GPU NUCLEAR

CALCULATION COVER SHEET
(Ref. EP-006T)

Subject:	Calculation No.	Rev. No.	System Nos.	Sheet
TMI-1 AC Voltage Regulation Study	C-1101-700-E510-010	2	700	1 of 77

1. Is this calculation within the scope of the GPUN Operational Quality Assurance Plan? (If **YES**, a verification is required.) ☒ Yes ☐ No

2. Does this calculation contain assumptions / design inputs that require confirmation? (If **YES**, provide CAP or appropriate configuration control number(s)) (e.g., ECD, PFU, MD, PCR, etc.) TSCR #283 ☒ Yes ☐ No

3. Does this calculation require revision to any existing documents? (If yes, provide CAP or appropriate configuration control number(s)) CAPs T1998-1143 ☒ Yes ☐ No

4. Is this calculation performed as a design basis calculation? (If **YES**, identify design basis parameters.) (See Section 3.3) ☒ Yes ☐ No

Parameter: Degraded Voltage Relay Dropout and Pickup Settings

Referenced Calculations and Safety Evaluations (See Section 4.3.2.7)	**Rev. No.**
Calculation C-1101-700-E510-008, TMI-1 Electrical Impedance Model	1
Calculation C-1101-741-E510-005, TMI-1 Loading Summary of Emergency Diesel Generator and Engineered Safeguards Buses	1
TDR-1064, TMI-1 Voltage and Frequency Study	0
TDR-900, Reconciliation of Loss of Ventilation Systems' Analyses and Tests	1
Calculation No. C-1101-734-5350-003, TMI-1 Battery Capacity Sizing and Voltage Drop for DC System	3
Calculation C-1101-730-5350-001, GL 89-10 MOVs Degraded Grid Voltage Drop Calc.	6
Calculation C-1101-901-5360-007, H2 Generation Inside the Containment	8
Calculation C-1101-733-E420-022, TOL Analysis for TDR-995 Conversion	1
Calculation C-1101-700-E420-011, GL 89-10 MOV FW-V-5 Transient Voltage Calculation	0
Calculation C-1101-732-E510-008, TMI-1 4160V Bus 1D & 1E Degraded Grid UVR Setpoint Drift Analysis	1
Calculation C-1101-826-5360-014, Degraded Voltage Accident Room Air Temp's	0

Comments:

APPROVALS

Originator G. B. Skinner / ~~I. Akos~~	**Date** 12-22-99
Verification Engineer/Herbert A Robinson	**Date** 12-22-99
Section Manager P. R. Panicker Ram Panick	**Date** 12-23-99
Other Verification Engineer/Reviewer	**Date**
Other Verification Engineer/Reviewer	**Date**

GPU NUCLEAR	**DOCUMENT NO.** C-1101-700-E510-010
TITLE	**TMI-1 AC Voltage Regulation Study**

REV	SUMMARY OF CHANGE	APPROVAL	DATE
1	Incorporated loading changes resulting from revision of Calculation C-1101-741-E510-005.	G.B. Skinner	
	Revised Degraded Voltage Relay uncertainty calculations to reflect replacement of relays with units equipped with harmonic filters. Revised voltage calculations to reflect new uncertainties.	T. Akos	
	Revised Cases 4A and 4B to evaluate short term post LOCA scenario.	Y.R. Tamayo	
	Redefined Cases 8A and 8B to evaluate long term post LOCA scenario.	P.R. Panicker	
	Revised acceptance criteria for the Battery Chargers.		
	Provided new Cases 4AC13 and 4BC13 to evaluate proposed modifications for Cycle 13.		
	Provided new Case 4BEQ to evaluate effect of accident ambient temperatures on cable voltage drop.		
	Provided new Case 4BNS to evaluate effect of running one NS pump with no other pumps running.		
	Provided additional justifications in Section 7.3 for motors which experience low voltage.		
	Provided confirmation of assumption that MOVs FW-V-5A/B with not stall during block load sequencing.		
	Miscellaneous editorial changes and corrections.		
2	Cover; updated list of referenced Calculations and revision level	G.B. Skinner	12-22-99
	Section 1.0; added determination of short circuit voltages to purpose.		
	Section 1.3; revised Acceptance Criteria to conform with SDD-T1-000, Revision 11.	~~T. Akos~~	
	Section 1.4, Cover; added DVR relay pickup as design basis parameter.	~~H.R. Robinson~~	
	Section 2; deleted completed action items. Revised numerical results consistent with new DAPPER runs.	P.R. Panicker	12-23-99
	Section 3; updated the revision level of several references. Added and deleted references to conform with text.		

GPU NUCLEAR	DOCUMENT NO. C-1101-700-E510-010
TITLE TMI-1 AC Voltage Regulation Study	

REV	SUMMARY OF CHANGE	APPROVAL	DATE
2 (cont.)	Assumptions 4.5 and 4.28, revised to delete Cases 4AC13 AND 4BC13. Assumption 4.28; revised to reflect new HP for DR Pumps Assumption 4.29 (new); increased HP for SR-P-1A Assumption 4.30 (new); ES trip of SR-P-1C Assumption 4.31 (new); bounding value for single contingency voltage Assumption 4.32 (new); derating of 1P and 1S USS transformers Assumption 4.33 (new); ES trip of non ES selected NR Pump Section 5.1; added information for new DAPPER bus for SR-P-1C Section 5.6.3; revised acceptance criteria for Battery Chargers Section 5.10; added Degraded Voltage Relay setpoints as design inputs Section 6.2; revised Cases 2 and 5 for bounding switchyard voltage input. Revised Case 3 for determining loading limits. Section 7.2; revised results values per new DAPPER runs Section 7.2.3; added results for loading limits calculations Table 7.2.4-1; Deleted entries for NR-S-1A, DR-S-1A, Battery Chargers Table 7.2.4-2; deleted entries for NR-S-1C, DR-S-1B, Battery Chargers, added DR-P-1B Section 7.2.4; deleted discussion of deleted Cases 4AC13 and 4BC13. Section 7.26; deleted discussion of TCN –199-0052. Appendix 8.1, Tables 1P, 1S; deleted notes for Cases 4AC13 and 4BC13 Appendix 8.1, Tables 1R; revised loads for DR-P-1A, NR-P-1A, SR-P-1A Appendix 8.1, Table 1T; revised loads for DR-P-1B, NR-P-1C		

REV	SUMMARY OF CHANGE	APPROVAL	DATE
2 (cont.)	Appendix 8.1 Table 1T; added bus number and load for SR-P-1C Appendix 8.1, Table 1A-V; changed load for comp 6BR to correct error (6.7 vs. 6.5 KW) Appendix 8.3; deleted entries for Cases 4AC13, 4BC13, 3BSUP, added entries for Cases 3B1, 3B2, 3B3, 11A, 11B Appendix 8.3, Tables 5A and 6A; added columns for SR-P-1A Appendix 8.9; replaced all DAPPER runs except Case 10 Appendix 8.10; updated all tables with new voltage results, changes marked in BOLD Appendix 8.10, Table 4A; removed Alternate Current Criteria calculation for NR-P-1A, NR-S-1A, DR-S-1A, DR-P-1A and RR-S-1A. Appendix 8.10, Table 4B; removed Alternate Current Criteria calculation for NR-P-1C General; miscellaneous editorial changes and corrections		

1.0 Purpose

1.1 Statement of Purpose

The purpose of this calculation is to demonstrate the adequacy of voltage regulation of the plant auxiliary power system when supplied by the offsite power sources, and to determine voltage levels to be used as inputs for other calculations. The scope of these demonstrations and determinations is defined by the following tasks:

1.1.1 Demonstrate acceptability of unit auxiliary transformer and unit substation transformer normal tap settings for the most limiting combinations of the following conditions:
  a. One or two transformer alignments
  b. Minimum expected grid voltage
  c. Normal and accident loading
  d. Steady state and LOCA Block Sequencing

1.1.2 Determine tolerances for, and demonstrate acceptability of the degraded voltage relay settings.

1.1.3 Determine maximum BOP and ES bus loading for minimum expected grid voltage (232KV), single transformer, normal operation.

1.1.4 Determine motor starting terminal voltages during Block Load Sequencing.

1.1.5 Demonstrate adequate current carrying capacity of 5 kV bus duct, 4 kV ES switchgear, 480 V ES switchgear, and 480 V MCCs under worst case degraded grid conditions.

1.1.6 Determine bus voltages for maximum grid voltage for use in short circuit calculations.

Case descriptions for the above tasks are provided in Section 6, Approach and Methodology.

1.2 Intended Use

This calculation is intended to provide guidance and criteria to the station in developing standards and procedures for the operation of the plant auxiliary power system. In addition, it is intended to provide input to other calculations such as GL 89-10 MOV calculations, control circuit voltage regulation, and short circuit and coordination studies.

1.3 Acceptance Criteria

The results of this study shall demonstrate that, for transformer normal tap settings (existing) and degraded voltage relay settings (determined herein), the following criteria are met for the limiting combinations of system alignment, grid voltage and bus loading:

1.3.1 Adequate voltage is available at the terminals of all NSR equipment.

1.3.2 Separation from offsite power does not occur due to 230KV system degraded grid voltage (single contingency), two transformer operation and accident loading.

1.3.3 Separation from offsite power does not occur due to minimum expected substation voltage, single transformer operation (automatic) and normal plant loading.

1.3.4 Separation from offsite power does not occur due to minimum expected substation voltage, single transformer operation (automatic) and accident loading.

1.3.5 Loading under worst case degraded voltage and load conditions does not exceed bus ratings.

1.3.6 Separation from offsite power does not occur due to minimum expected substation voltage, single transformer operation (tap change operation), and the entire station startup auxiliary load supplied by a single transformer.

Specific acceptance criteria values for system equipment are provided in Section 5 of this calculation.

1.4 Design Basis Calculation for Degraded Voltage Relay

This calculation establishes the design basis for the degraded voltage relay dropout and pickup settings.

2.0 Summary of Results

Degraded Voltage Relay Setpoints and Tolerances

The results of this calculation are based on the following degraded voltage relay setpoints and tolerances which were determined or validated in this calculation:

Nominal dropout setpoint	3760 V	(Assumption 4.8.1).
Minimum dropout setpoint	3727V	(Section 7.1.1)
Nominal pickup setpoint	3779V	(Assumption 4.8.2)
Maximum pickup setpoint	3806V	(Section 7.1.2)
Minimum pickup setpoint	3756V	(Section 7.1.3)

Technical Specification 3.5.3 Note 4 provides for a minimum allowed setting of 3740V, and a maximum allowed setting of 3773V. The Technical Specification bases state that the minimum and maximum allowed settings for the degraded voltage setpoint are based on a relay tolerance of –0.53%, +0.35% and is to be considered an "as-left" setting. The Technical Specification bases should be changed to define the minimum and maximum allowed settings as "acceptable-as-found" values. (CAP T1998-1143, Reference 3.7.20)

Technical Specification Table 4.1-1 item 43 a. should be revised to show a calibration interval of one year for the Degraded Voltage Relays vs. the existing interval of one refueling cycle, to be consistent with the interval used in the determination of Degraded Voltage Relay tolerances in Appendix 8.4 of this calculation. (CAP T1998-1143, Reference 3.7.20)

Results of DAPPER Voltage Studies

Cases 1A and 1B demonstrated that the existing transformer tap settings are adequate to provide all NSR equipment with voltage near to their rated values for two transformer alignment normal power operation, and normal grid voltage. This case satisfies the acceptance criteria in Sections 1.3, 5.6, and 6.3 of this calculation. (See Section 7.2.1)

Cases 2A and 2B determined that separation from offsite power does not occur due to a bounding value for 230KV system degraded grid voltage (single contingency), two transformer operation and maximum plant loading for 100% power operation. The results for Case 2A showed that the minimum voltage that would occur on Bus 1D for a switchyard voltage of 223.3 kV would be 3924 V vs. 3806 V minimum. The results for Case 2B showed that the minimum voltage that would occur on Bus 1E would be 3834 V vs. 3806 V minimum. All NSR motors have voltage above their minimum required values or satisfy the alternate current criteria of Section 5.6.1.

Cases 3A and 3B determined the maximum Turbine Plant and ES bus loading achievable on a single transformer for minimum expected grid voltage of 232KV and normal power operation as follows:

Case 3A (Transformer 1B)	25,722 KVA
Case 3B (Transformer 1A)	23,972 KVA

The results for Case 3B showed that, for minimum expected grid voltage of 232 KVA, TP loading would have to be limited to 23,972 KVA to assure ES Bus 1E would not be separated from the grid on fast transfer of BOP loads to Aux Transformer 1A. This limit is less than the assumed turbine plant loading of 24.3 MVA (Assumption 4.3.5). Case 3B1 showed that a switchyard voltage of 232.4 KV with Turbine Plant loading of 24,422 KVA was adequate to assure a minimum voltage of 3806 V on ES Bus 1E, and preclude separation of the ES Bus on fast transfer of BOP loads to Aux Transformer 1A. This is based on Procedure 1105-10A (Reference 3.1.9) which provides a control room alarm if the switchyard voltage reaches this value, and procedure 1203-41 (Reference 3.1.4) which directs the operators to reduce load if this alarm comes in. Cases 3B2 and 3B3 provided additional data points from which a graph of permissible loading vs. switchyard voltage was constructed and provided in Appendix 11. Case 3A determined that the 5000V bus duct sections immediately downstream of Auxiliary Transformer 1B (DAPPER Bus 40 to 41) could be subjected to current in excess of their 40° C rating of 4072 amperes, during single transformer operation and a TP load of 25,722 KVA. However, this loading is greater that the assumed TP loading limit of 24.3 MVA, and so is not expected. Case 3A-SUP determined that the proposed TP loading limit of 24.3 MVA and Switchyard voltage of 232.4 KV were adequate to limit 5000V bus duct current to 4075 A which is slightly above the 40° C rating. Since higher currents are permitted at different temperature ratings, this result is considered acceptable by engineering judgement.

Cases 4A and 4B determined equipment terminal voltages for the worst case minimum voltage on the 4KV ES buses afforded by the degraded voltage relays. These cases identified several loads, listed in Tables 7.2.4-1 and 7.2.4-2, that did not pass either the primary terminal voltage criteria or the alternate current criteria given in Section 5.6.1. It was determined, however, that switchyard voltage would have to decline well below the voltage criteria in System Design Description SDD T1-000 (Reference 3.3.1) in order to experience 4KV bus voltages postulated in these cases. It was therefore concluded that these low voltages would not persist for an extended period of time, due either to operator action defined in existing procedures, or actuation of the automatic degraded voltage protection scheme. Each of the affected loads was thereby determined to be acceptable (See Section 7.3). However, these results demonstrate a lack of robustness in the electrical distribution system design that, while not presenting safety concerns, could impose undesirable burdens on operators or impose constraints on power production. Consequently, the results of this calculation should be evaluated through the corrective action process to determine whether procedural or design enhancements should be made to improve the operating flexibility of the electrical distribution system. See CAP T1998-1143, Reference 3.7.20.

Case 4BEQ demonstrated that increased cable resistance due to elevated temperatures in accident environments will have negligible effect on voltage available to large motors. (See Section 7.2.4.)

Case 4BNS showed that the minimum voltage on one NS pump in run out with no other NS pumps running would be 398 V. This voltage was determined to be acceptable in Section 7.3.

The two transformer Block Load Sequencing cases 5A1S through 5B5R demonstrated that a bounding switchyard voltage of 223.3 KV was adequate to start and run all required motors during Block Load Sequencing, and that final recovery voltage after sequencing was adequate to prevent separation of the 4KV ES buses (3903 V vs. 3806 V required for ES Bus 1D and 3810 V vs. 3806 V required for ES Bus 1E). The starting voltages for all block loads are summarized in Tables 7.2.5-1 and 7.2.5-2 and final recovery voltages determined by cases 5A5R and 5B5R are tabulated in Appendix 8.10 Tables A and B.

The single transformer Block Load Sequencing cases 6A1S through 6B5R demonstrated that a switchyard voltage of 232 KV was adequate to start and run all required motors during Block Load Sequencing, and that final recovery voltage after sequencing was adequate to prevent separation of the 4KV ES buses (3856 V vs. 3806 V required for ES Bus 1D and 3824 V vs. 3806 V required for ES Bus 1E). The starting voltages for all block loads are summarized in Tables 7.2.6-1 and 7.2.6-2 and final recovery voltages determined by cases 6A5R and 6B5R are tabulated in Appendix 8.10 Tables A and B. The steady state running voltages for certain motors after the completion of block loading were below the 90% terminal voltage criteria established in Section 5.6.1 (See Appendix 8.10 Tables A and B). However, these cases are bounded by the more limiting results of Case 4, which are discussed in Sections 7.2.4 and 7.3.

Cases 7A and 7B determined LOCA Block Load Sequencing Minimum Recovery Voltage applicable to starting MOVs. Voltages at the MOV MCCs and their feeder buses are tabulated in Table 7.2.7. The results show that voltages at MCCs for GL 89-10 MOVs required to operated during block load sequencing were as good or better than those used in Calculation C-1101-730-5350-001, GL 89-10 MOVs Degraded Grid Voltage Drop Calculation (Reference 3.2.6).

Cases 8A and 8B determined voltages for the long term post LOCA situation. These cases determined that a voltage of 423 V on 480V ES Buses 1P or 1S results in less than 90% of rated voltage at some motor loads. However, each of the motor loads passed the alternate current criteria as shown in Appendix 8.10, Tables 8A and 8B. Non-motor loads such as the Inverters and Battery Chargers passed the voltage criteria given in Sections 5.6.3 and 5.6.4. It was concluded that the 480V bus low voltage alarms and appropriate operator response are adequate to assure acceptable voltage to NSR loads downstream of the 4160V ES buses in the long term post LOCA situation.

Cases 9A and 9B show that grid separation could occur during tap change operations when all five 4 KV buses are placed on a single auxiliary transformer, in the event of the simultaneous occurrence of maximum positive degraded voltage relay error, low system

voltage (232 KV) and plant loading above 41,876 KW. These results also demonstrate that the ES buses are more vulnerable to grid separation when fed from Auxiliary Transformer 1A. (Section 7.2.9)
Case 10 demonstrated that the voltages predicted by the DAPPER model used in this study were very close to the values determine by field measurements for the Green Train. It was therefore concluded that the methods and assumptions used in this study were conservative and appropriate. (Section 7.2.10).

3.0 References (Additional references are provided separately in Appendices 8.4 and 8.8)

3.1 Procedures

3.1.1 TMI-1 Operating Procedure 1107-1, Revision 47, Normal Electrical System.

3.1.2 TMI-1 Operating Procedure 1107-2, Revision 96, Emergency Electrical System

3.1.3 TMI-1 Preventive Maintenance Procedure E-26, Revision 22, Vital Power Inverter Maintenance

3.1.4 TMI-1 Abnormal Procedure 1203-41, Revision 20, Low System (Grid) Voltage

3.1.5 Special Test Procedure STP 1-98-0034, dated 9/16/98, Voltage Measurements to Confirm Degraded Grid Voltage Calculation

3.1.6 TMI-1 Emergency Procedure 1202-31, Revision 56, Fire

3.1.7 TMI-1 Operating Procedure 1102-1, Revision 151, Plant Heatup to 525°F

3.1.8 TMI-1 Operating Procedure 1102-11, Revision 120, Plant Cooldown

3.1.9 Procedure 1105-10A, Revision 40, Plant Computer Alarm Attributes

3.1.10 TCN 1-99-0090 to Procedure 1203-41, Revision 20, Low System (Grid) Voltage

3.1.11 TMI-1 Abnormal Transient Procedure 1210-6, Revision 27, Small Break LOCA Cooldown

3.1.12 TMI-1 Abnormal Transient Procedure 1210-7, Revision 27, Large Break LOCA Cooldown

3.1.13 TMI-1 Operating Procedure 1107-3, Revision 90, Diesel Generator

3.1.14 TMI Alarm Response Procedure MAP H-1-2, Revision 19, OTSG A BTU Limit

3.1.15 TMI Alarm Response Procedure MAP H-1-3, Revision 8, OTSG B BTU Limit

3.1.16 TMI-1 Alarm Response Procedure MAP B-2-4, Revision 10, 480V ES Bus UV/OV

3.1.17 TMI-1 Corrective Maintenance Procedure 1450-026, Revision 5, 480V Under/Overvoltage (Alarm) Relay Maintenance

3.1.18 TMI Abnormal Transient Procedure 1210-1, Revision 39, Reactor Trip

3.1.19 TMI Operating Procedure 1104-24M, Revision 13, Diesel Generator Building H & V System

3.1.20 TMI-1 Operating Procedure 1104-25, Revision 113, Instrument and Control Air System

3.1.21 TMI Engineering Procedure EP-007T, Revision 0, Numerical Analysis Computer Program Control.

3.1.22 GPU Corporate Procedure 1000-ADM-1230.10, Revision 2, Computer System Control Process

3.2 Calculations and TDRs

3.2.1 Calculation C-1101-700-E510-008, Revision 1, TMI-1 Electrical Impedance Model

3.2.2 Calculation C-1101-741-E510-005, Revision 1, TMI-1 Loading Summary of Emergency Diesel Generator and Engineered Safeguards Buses

3.2.3 TDR-1064, Revision 0, TMI-1 Voltage and Frequency Study

3.2.4 TDR-900, Revision 1, Reconciliation of Loss of Ventilation Systems' Analyses and Tests

3.2.5 Calculation No. C-1101-734-5350-003, Revision 3, "TMI-1 Battery Capacity Sizing and Voltage Drop for DC System"

3.2.6 Calculation C-1101-730-5350-001, Revision 6, GL 89-10 MOVs Degraded Grid Voltage Drop Calc.

3.2.7 Calculation C-1101-901-5360-007, Revision 8, H2 Generation Inside the Containment

3.2.8 Calculation C-1101-733-E420-022, Revision 1, TOL Analysis for TDR-995 Conversion

3.2.9 Calculation C-1101-700-E420-011, Revision 1, GL 89-10 MOV FW-V-5 Transient Voltage Calculation

3.2.10 Calculation C-1101-826-5360-014, Revision 0, Degraded Voltage Accident Room Air Temp's

3.3 Design Basis Documents and Specifications

3.3.1 SDD-T1-000, Revision 11, System Design Description For Three Mile Island Nuclear Station Unit No. 1, Division I Plant Level Criteria

3.3.2 SDBD-T1-211, Revision 2, System Design Basis Document, (SDBD) for Makeup and Purification System

3.3.3 SDBD-T1-212, Revision 1, System Design Basis Document, (SDBD) for Decay Heat System

3.3.4 SDBD-T1-214, Revision 1, System Design Basis Document, (SDBD) for Reactor Building Spray System

3.3.5 SDBD-T1-700 Reference B063, GAI Bill of Materials for Motors

3.3.6 SDBD-T1-823, Revision 0, System Design Basis Document, (SDBD) for Reactor Building Cooling System

3.3.7 Specification SP-9000-31-213, Revision 8, Technical Specification for Class 1E Electric Cable for Power, Control, and Instrumentation

3.3.8 Bill of Materials TMI-ED, Item No. ED-4, Issue 2, for 5kV Metal Enclosed Bus Duct

3.3.9 Bill of Materials TMI-ED, Item No. ED-2, Issue 3, for 4 KV Station Service and Engineered Safeguards Switchgear

3.3.10 Bill of Materials TMI-EE, Item No. EE-1, Issue 2, for 480 Volt Unit Substations

3.3.11 Bill of Materials TMI-EG, Item No. EG-5, Issue 3, for 480 Volt Motor Control Centers

3.4 Vendor Information

3.4.1 CD Technologies Memorandum from David Wilson to John Tesmer, dated 4/23/99, Re battery charger operation at less than 432 Vac.*

3.4.2 TMI-1 Vendor Manual VM-TM-0172, Revision 10, Solid State Controls Inc. (03471), 120 VAC Vital Power Inverters

3.4.3 Document 990-2121, Westinghouse (00919) Report on Motor Study, dated September 6, 1991

3.4.4 TMI-1 Vendor Manual VM-TM-0191,Revision 30, Fairbanks Morse (Colt Industries) (06796), Emergency Diesel Generators.

3.4.5 TMI-1 Vendor Manual VM-TM-0029, Revision 30, Limitorque (02733) Valve Operators

3.4.6 Limitorque Corporation Letter dated March 6, 1987, to R. C. Ezzo, Limitorque Motor Currents

3.4.7 Calvert Memorandum dated 10/28/98, Joe turner to Tom Akos (GPUN), Calvert Bus Ampacity Data *

3.4.8 TMI-1 Vendor Manual VM-TM-0019, Revision 15, Bingham-Willamette Co. (09190), Nine Stage Centrifugal Makeup Pumps

3.4.9 Fax from Gary Sarpolis (Rockwell Automation) to Dick Bensel (GPU Nuclear) dated 5/19/99, regarding motor SZY00272

3.4.10 TMI-1 Vendor Manual VM-TM-0155, Revision 11, Comsip Inc. (01336), Model K-III Post LOCA Hydrogen Analyzer

3.4.11 TMI-1 Vendor Manual VM-TM-0073, Revision 8, York (Borg Warner) (09720), Control and Service Bldg. Chillers

3.4.12 Westinghouse Nuclear Services Division Letter RRS/DSE(99)-298 to Mr. Dick Bensel, GPU, dated June 8, 1999 , Performance Characteristics for Selected Westinghouse Motors

3.4.13 Westinghouse Nuclear Services Division Letter RRS/DSE(99)-228 to Mr. Al Alberano, GPU, dated April 30, 1999, DR-P-1A/B Motor Study

3.4.14 TMI-1 Vendor Manual VM-TM-0718, Revision 9, Westinghouse (00919), Westinghouse AC Motors

3.4.15 Nuclear Logistics Inc. Test Report TR-069009-1, Revision 0, Test Report for TMI Battery Charger Test

3.4.16 TMI-1 Vendor Manual VM-TM-0283, Revision 13, Westinghouse (00919), 480 Volt Switchgear, Transformer and DB 25 & 50 Circuit Breakers

3.5 Correspondence

3.5.1 Memorandum D.E. Barber to R. Bensel, dated September 21, 1999, TMI Degraded Grid Voltage *

3.5.2 Memorandum R.W.Bensel (TMI-1) to D.A. Palaferro (Gilbert), dated July 20, 1989, Measurement to Support the TMI-1 Voltage Drop Study *

3.5.3 Not Used

3.5.4 FAX Dick Bensel to George Skinner, dated December 14, 1998, Vital Inverter Test Data *

3.5.5 Lotus Notes Dick Bensel to George Skinner, dated May 27, 1998, BOP Bus Loading *

3.5.6 Lotus Notes Earl D. Showalter to George Skinner, dated August 25, 1998, BOP Loads and CWP Loads for Single Transformer Ops *

3.5.7 Lotus Notes Floyd Reeser to George Skinner, dated October 8, 1998, Time and Voltage *

3.5.8 Lotus Notes Earl D. Showalter to George Skinner, dated September 11, 1998, Assumed Loads on Aux. Transformers for Tap Change *

3.5.9 Lotus Notes Dick Bensel to George Skinner, dated September 8, 1998, Motor Nameplate Info *

3.5.10 Lotus Notes Dick Bensel to George Skinner, dated October 8, 1998, EG-P-3A and EG-P-8A Current and Voltage Readings *

3.5.11 Lotus Notes Dick Bensel to George Skinner, dated September 25, 1998, Motor Nameplate Info/Current & Voltage Readings *

3.5.12 Lotus Notes Dick Bensel to George Skinner, dated September 17, 1998, Re: NR Water Pump Discharge Strainers, Nameplate Data Discrepancies and Voltage Study Results *

3.5.13 Lotus Notes Earl D. Showalter to George Skinner, dated December 9, 1998, 6900V Bus Readings & Fuel Oil Pumps *

3.5.14 Lotus Notes William McSorely to George Skinner, dated December 9, 1998, Function of MU-P-4A/B/C *

3.5.15 Lotus Notes Dick Bensel to George Skinner, dated December 17, 1998, DF-P-1A/C Nameplate Data *

3.5.16 Lotus Notes Dick Bensel to George Skinner, dated August 11, 1998, Voltage Criteria (With attached spreadsheet Bus4 Volts 2 Year Running Profile.xls) *

3.5.17 Memorandum C. E. Hartman to H. Robinson, dated 1/9/90, Re: Memo G/C/TMI-1CS/17052, dated 01/03/89, Brendlen to Langenbach, Voltage Drop Study on Degraded Grid *

3.5.18 Memorandum R. W. Bensel to D. A. Palaferro, dated 1/15/90, TMI-1 Voltage Study *

3.5.19 Lotus Notes Earl Showalter to George Skinner, dated 12/16/98, AH-E-18A & B Nameplate Data*

3.5.20 Lotus Notes Charles C. Seitz to George Skinner, dated 5/5/99, LO-P-7 Auto Start, TMI-1 Main Turbine Coastdown Time *

3.5.21 ~~Lotus Notes Dick Bensel to George Skinner, dated May 12, 1999, Scope of Calculation # C1101-700-E510-010 Rev. 1*~~ Deleted.

3.5.22 Deleted

3.6 Drawings

3.6.1 GAI Drawing SS 224-402, Revision 3, Electrical Station Auxiliaries 4000 Volt Motors & Controls Engineered Safeguards

3.6.2 GAI Drawing SS 224-403, Revision 3, Electrical Station Auxiliaries 4000 Volt Motors & Controls Engineered Safeguards Switchgear

3.6.3 GAI Drawing SS 224-404, Revision 3, Electrical Station Auxiliaries 460 Volt Motors & Controls

3.6.4 GAI Drawing SS 224-411, Revision 4, Electrical Station Auxiliaries 460 Volt Motors & Controls Engineered Safeguards Control Centers

3.6.5 GAI Drawing SS 224-412, Revision 3, Electrical Station Auxiliaries 460 Volt Motors & Controls Engineered Safeguards Control Centers

3.6.6 GAI Drawing SS 224-413, Revision 3, Electrical Station Auxiliaries 460 Volt Motors & Controls Engineered Safeguards Control Centers

3.6.7 GAI Drawing SS 224-426, Revision 4, Electrical Station Auxiliaries 460 Volt Motors & Controls E.S. Screen House Control Centers

3.6.8 GAI Drawing SS 224-427, Revision 3, Electrical Station Auxiliaries 460 Volt Motors & Controls E.S. Screen House Control Centers

3.6.9 Colt Industries Drawing 11865841, Sheet. 3B, Revision 7, Metropolitan Edison Diesel Generator 1B Three Mile Island Nuclear Station Unit 1 Electrical Schematic AC Auxiliary and Generator

3.6.10 York Drawing 70-755153-1A, Revision A, Hermetic Turbopak Liquid Chilling Systems with "Marine Type Water Boxes Model HT 90 through HT 350

3.6.11 York Drawing 70-755153-2A, Revision A, Hermetic Turbopak Liquid Chilling Systems with "Marine Type Water Boxes Model HT 90 through HT 350

3.6.12 Drawing E-206-021, Revision 10, Electrical One Line and Relay Diagram - 6900V and 4160V Switchgear

3.6.13 Drawing E-206-022, Revision 19, Electrical One Line and Relay Diagram - 4160V Engd. Safeguards Switchgear

3.6.14 Colt Industries Drawing 11865841, Sheet. 3A, Revision 20, Metropolitan Edison Diesel Generator 1A Three Mile Island Nuclear Station Unit 1 Electrical Schematic AC Auxiliary and Generator

3.6.15 Colt Industries Drawing 11865841, Sheet. 1A, Revision 28, Metropolitan Edison Diesel Generator 1A Three Mile Island Nuclear Station Unit 1 Electrical Schematic Diesel Engine Control

3.6.16 Colt Industries Drawing 11865841, Sheet. 1A, Revision 6, Metropolitan Edison Diesel Generator 1B Three Mile Island Nuclear Station Unit 1 Electrical Schematic Diesel Engine Control

3.6.17 GAI Drawing 201-043 Sh. 1, Revision 31, 480V Control Center 1A Engineered Safeguards

3.6.18 GAI Drawing 201-044 Sh. 1, Revision 28, 480V Control Center 1B Engineered Safeguards

3.6.19 GAI Drawing 201-052 Sh. 1, Revision 40, 480V Control Center 1A Engineered Safeguard Valves

3.6.20 GAI Drawing 201-053 Sh. 1, Revision 39, 480V Control Center 1B Engineered Safeguard Valves

3.6.21 GAI Drawing 201-062 Sh. 1, Revision 20, 480V Control Center 1A Engineered Safeguards Screen House

3.6.22 GAI Drawing 201-063 Sh. 1, Revision 24, 480V Control Center 1B Engineered Safeguards Screen House

3.6.23 GAI Drawing 201-069 Sh. 1, Revision 31, 480V Control Center 1C Engineered Safeguard Valves

3.6.24 GAI Drawing 201-076, Revision 3, 480V Control Center 1A Engd Sfgds Vent Bldg

3.6.25 GAI Drawing 201-077, Revision 4, 480V Control Center 1B Engd Sfgds ESF Vent Bldg

3.6.26 GAI Drawing SS 209-482, Revision 12, Electrical Elementary Diagrams, Engineered Safeguards

3.6.27 GAI Drawing SS 209-490, Revision 6, Electrical Elementary Diagram, Engineered Safeguard

3.6.28 GAI Drawing SS 209-492, Revision 9, Electrical Elementary Diagram, Engineered Safeguard

3.6.29 GAI Drawing SS 209-526, Revision 3, Electrical Elementary Diagrams, Engineered Safeguards

3.6.30 GAI Drawing SS 209-582, Revision 12, Electrical Elem. Diagram, Engineered Safeguard

3.6.31 GAI Drawing SS 209-590, Revision 5, Electrical Elem. Diagram, Engineered Safeguard

3.6.32 GAI Drawing SS 209-592, Revision 13, Electrical Elem. Diagram, Engineered Safeguard

3.6.33 GAI Drawing SS 209-626, Revision 1, Electrical Elementary Diagrams, Engineered Safeguards

3.6.34 GAI Drawing SS 209-755, Revision 11, Electrical Elementary Diagram, DC and Miscellaneous

3.6.35 GAI Drawing SS 209-756, Revision 12, Electrical Elementary Diagram, DC and Miscellaneous

3.6.36 GPUN/GAI Drawing No. 302-351, Revision 16, Emergency Diesel Generator Services Flow Diagram

3.6.37 GAI Drawing E-206-011, Revision 37, Electrical Main One Line and Relay Diagram

3.6.38 GAI Drawing 208-017, Revision 4, Electrical Elem. Diagram, Turbine, Generator Exciter & Transformers

3.7 Miscellaneous

3.7.1 IEEE Standard 399-1990, IEEE Recommended Practice for Industrial and Commercial Power Systems Analysis

3.7.2 NEMA Standard MG-1,Revision No. 8, November 1984, Motors and Generators

3.7.3 Engineering Standard ES-023, Revision 2, Selection and Sizing of Power, Lighting and Control Cables

3.7.4 Deleted

3.7.5 Modification MD-H355-001, Modification Documentation, Revision 0, DR-P-0001A/B Replacement

3.7.6 TMI-1 GMS2 Data Base

3.7.7 Deleted

3.7.8 TMI Maintenance Log dated 12/10/98, Time 05:23:04AM, NR-S-1B Motor Data

3.7.9 TMI Job Order 86168, 12/14/98

3.7.10 Electrical Load Sheet # T1-700-99-015

3.7.11 Pull Slip for Circuit LT5, dated 5/6/71

3.7.12 Modification MD-H520-001,Modification Documentation, Revision 0, ES Trip of SR-P-1C

3.7.13 Modification MD-H440-001,Modification Documentation, Revision 0, ES Trip of the Non-ES Selected NR Pump

3.7.14 Deleted

3.7.15 Engineering Standard ES-010, Revision 3, TMI-1 Environmental Parameters

3.7.16 TAR-TM-022, Figs. 23 &24 dated 5/13/93

3.7.17 TAP Number TMI-86-06, dated June 2, 1986, Transient Assessment Program Report for Three Mile Island Unit-1 Reactor Trip

3.7.18 TAP Number TMI-93-01, dated September 18, 1992, Transient Assessment Program Report for Three Mile Island Unit 1 Anticipatory Reactor Trip due to Turbine Trip

3.7.19 GPU Technical Document 990-1429, Revision 15, Three Mile Island Electrical Equipment Environmental Qualification Master List

3.7.20 CAP T1998-1143, dated 12/30/98, Calculation C-1101-700-E510-010, Revision 0

3.7.21 Request for Project Authorization H385, BA Number 11H385, Degraded Voltage- O&M Items

3.7.22 TMI Job Order 00164121, dated 3/24/99

3.7.23 Engineering Evaluation Request JO 00172010, Revision 0, DR-P-1A New Johnston Pump Operability

3.7.24 Engineering Evaluation Request JO 00172011, Revision 0, DR-P-1B New Johnston Pump Operability

3.8 Computer Programs

3.8.1 Distribution Analysis for Power Planning, Evaluation and Reporting (DAPPER), Mini/Micro Version 3.5 Level 2.1, Copyright SKM Systems Analysis, Inc., 1991.

3.8.2 Microsoft Excel 97, Copyright 1985-1996 Microsoft Corporation

* References marked with asterisk are retrievable through Lotus Notes Database "Calc C-1101-700-E510-010 Ref.nsf".

4.0 Assumptions

4.1 Running induction motors are modeled as constant KVA loads. Starting induction motors are modeled as constant impedance loads, except as noted in Sections 4.1.1 and 4.1.2. (Reference 3.7.1, Sections 4.9.2.1 and 4.9.2.3)

4.1.1 Control Building Water Chillers AH-C-4A and AH-C-4B are modeled as constant current devices for running (Reference 3.4.11).

4.1.2 For convenience, MOV starting loads will be conservatively assumed to be constant KVA loads.

4.2 Electrical system lineup during normal two transformer operation is assumed to be as described in Operating Procedures 1107-1 and 1107-2 (References 3.1.1 and 3.1.2). These procedures specify the following power source allocations, unless otherwise determined by the Plant Operations Director in conjunction with the Operations and Maintenance Director. It is assumed that alternate lineups will not be entered that are more limiting than the lineups specified here:

Aux. Transformer 1A supplies:	6900 V Reactor Plant Bus 1A 4160 V Buses 1A, 1B, 1E
Aux. Transformer 1B supplies:	6900 V Reactor Plant Bus 1B 4160 V Buses 1C, 1D, and 1F (through T1-C2)

4.3 BOP Bus Alignment and Loading

4.3.1 Reactor Plant Buses 1A and 1B

For the two transformer cases Reactor Plant Buses 1A and 1B are assumed to aligned to Auxiliary Transformers 1A and 1B, respectively, in accordance with system one line drawing E-206-011, (Reference 3.6.37). For single transformer cases the entire Reactor Plant load is aligned to the operable transformer.

Reactor Plant Bus loads and power factor are assumed to be as follows (Reference 3.5.2):

RP Bus 1A (DAPPER Bus 100)	14,000 KVA, -.88 PF Lag
RP Bus 1B (DAPPER Bus 200)	14,000 KVA, -.89 PF Lag

A review of recent plant electrical loading from 10/18/95 to 12/6/96 (Reference 3.5.13), summarized in Appendix 8.6, shows averages of the weekly load readings of approximately 13,748 KVA for RP Bus 1A and 13,875 KVA for RP Bus 1B. In addition, the total Reactor Plant loading of 28,000 KVA bounds over 95% of the measurements taken during this period. Therefore the loading assumed above is reasonable.

Reactor Plant Buses 1A and 1B are assumed to be at zero load for long term post LOCA Cases 8A and 8B because operators will trip the RCPs due loss of 25°F subcooled margin following a large break LOCA (Reference 3.1.18).

4.3.2 Turbine Plant Alignment for Two Transformer Normal Operation

For the two transformer models Turbine Plant Buses 1A and 1B are assumed to be aligned to Auxiliary Transformer 1A and, Turbine Plant Bus 1C is assumed to be aligned to Auxiliary Transformer 1B, as indicated on system one line drawing E-206-011, (Reference 3.6.37).

4.3.3 Turbine Plant Loading for Two Transformer Normal Operation

Maximum pre-trip Turbine Plant Bus loading for two transformer operation is assumed to be as follows:

Turbine Plant Bus 1A (DAPPER Bus 1000)	9600 KVA
Turbine Plant Bus 1B (DAPPER Bus 2000)	6000 KVA
Turbine Plant Bus 1C (DAPPER Bus 3000)	10100 KVA

STA data (Reference 3.5.5) from 1/94 through 5/98 was reviewed to establish the reasonableness of the above assumption. The assumed combined loading on Turbine Plant Buses 1A and 1B (15600 KVA) was exceeded only three times since the beginning of 1994, 16070 KVA on 6/4/95, 15910 KVA on 4/8/96 and 15680 on 6/2/97. (See Appendix 8.6).

The assumed loading (10100 KVA) on Turbine Plant Bus 1C was exceeded only once since the beginning of 1994, 10150 KVA on 1/21/94.

The effect of these infrequent excursions above the assumed loading values would be to slightly increase the grid separation voltage. The results of the two transformer, normal operation grid separation voltage calculations will be reviewed to assure that adequate margin exists to accommodate brief excursions above the assumed loading (See Section 7.2.2).

4.3.4 Turbine Plant Loading for Two Transformer LOCA Operation

A turbine trip will occur prior to or simultaneously with the receipt of a LOCA signal. This will result in automatic BOP load reduction due to reduced feedwater demand. This load reduction is assumed to be proportional to the reduction in feedwater flow observed during the plant trip of 3/12/93, and it will be applied in incremented steps for the Block Load Sequencing Cases 5A, 5B, 7A and 7B as follows (See Appendix 8.7):

Turbine Plant Loading for Two Transformer
Block Load Sequencing Cases 5A and 5B

BLOCK	1	2	3	4	5
Load Reduction	0	146	562	766	855
TP-1A	9600	9454	9038	8834	8745
TP-1C	10100	9954	9538	9334	9245

4.3.5 Turbine Plant Alignment for Single Transformer Operation

During single transformer operation Turbine Plant Buses 1A, 1B, and 1C are aligned to the operable transformer.

<u>Turbine Plant Loading for Single Transformer Case Following Fast Transfer</u>

SDD-T1-000, Section 700 (Reference 3.3.1), paragraph 3.10 establishes an administrative limit of 24.3MVA for Turbine Plant Bus loading. The loading is assumed to be distributed as follows:

Turbine Plant Bus 1A	9378 KVA
Turbine Plant Bus 1B	5692 KVA
Turbine Plant Bus 1C	9230 KVA

<u>Turbine Plant Loading for Single Transformer LOCA Operation</u>

For extended single transformer operation, it is assumed that one Circulating Water Pump will be tripped in order to reduce loading on the 4160V distribution system (Assumption 4.16 and Reference 3.1.1). It is further assumed for purposes of this analysis that the tripped pump will be CW-P-1A, since this will have the least beneficial effect on ES bus voltage due to the 4 kV bus duct arrangement (References 3.6.12 and 3.6.13). This will result in a load reduction of 1809 KVA on Turbine Plant Bus 1A prior to the onset of a LOCA (Reference 3.5.6). The Turbine Plant loading during single transformer pre-LOCA operation is therefore assumed to be distributed as follows based on loading of 24.3 MVA prior to the CWP trip:

Turbine Plant Bus 1A	9378 – 1809 = 7569 KVA
Turbine Plant Bus 1B	5692 KVA
Turbine Plant Bus 1C	9230 KVA

A turbine trip will occur prior to, or simultaneously with, the receipt of a LOCA signal. This will result in automatic BOP load reduction due to reduced feedwater demand. This load reduction is assumed to be proportional to the reduction in feedwater flow observed during the plant trip of 3/12/93, and will be applied in incremented steps for the Block Load Sequencing Cases 6A and 6B and in full for LOCA steady state Cases 4A, 4B, 8A, and 8B, as follows (See Appendix 8.7):

Turbine Plant Loading for Single Transformer Block Load Sequencing Cases 6A, 6B, and Steady State Cases 4A, 4B, 8A, and 8B

BLOCK	1	2	3	4	5	LONG TERM
Load Reduction	0	146	562	766	855	1148
TP-1A	7569	7423	7007	6803	6714	6421
TP-1C	9230	9084	8668	8464	8375	8082

4.3.6 Turbine Plant Bus Power Factor

Turbine Plant bus load power factor for all cases is assumed to be as follows (Reference 3.5.2):

Turbine Plant Bus 1A	0.88 lagging
Turbine Plant Bus 1B	0.87 lagging
Turbine Plant Bus 1C	0.85 lagging

4.4 Motor starting power factor is assumed to be 0.20 lagging for motors less than 1000 HP and 0.15 lagging for motors 1000 hp and over. (Reference 3.7.1, Section 9.5.2). An examination of typical loads and feeders used for this study indicates that variations in power factor of .05 from the assumed values will have a negligible effect on the final voltage drop results for motor starting.

4.5 Swing components are assumed to be on the train being analyzed for minimum voltage cases unless administrative control established a different lineup. (Reference 3.3.1, Section 700, paragraph 3.4). In order to minimize voltage on 480V Buses 1R and 1T NS-P-1B is assumed to be off for long term LOCA Cases 8A and 8B (Reference 3.1.12, section 2.21).

When only one of the three NS pumps is running, its run out HP will be greater than if two or three pumps are running (Reference 3.2.2, Appendix B, Calculation 9). This condition could occur in cases such as the loss of a redundant 480V ES bus supplying the other running pump(s). This would represent the most limiting condition for the NS pump. A review of preliminary DAPPER runs shows that the worst case voltage for an NS pump occurs for NS-P-1C. Therefore, an additional case (Case 4BNS) similar to Case 4B will be performed with NS-P-1C running alone in full run out to evaluate the worst case condition for an NS pump. Loading for NS-P-1A/C for Cases 8A and 8B will also be adjusted to reflect run out HP for a single NS pump since these cases assume that one NS pump is deliberately shut down, while the redundant pump might fail.

4.6 Bus Alignment and Loading During Transformer Tap Change Operation

During plant heatup, the taps on the auxiliary transformers are changed from the 3 position to the 4 position, and vice versa during plant cooldown (References 3.1.7 and 3.1.8). During these operations the entire plant auxiliary load is placed on a single transformer to permit the tap change on the unloaded transformer (Reference 3.1.2). Total plant auxiliary loading during auxiliary transformer tap change operations conducted during plant heatup and cooldown is assumed to be a maximum of 45 MW (Reference 3.5.8).

For purposes of modeling these cases, the total load is assumed to be distributed as follows:

Reactor Plant Buses (Section 4.3.1, Reference 3.5.2)

Reactor Plant Bus 1A	14000 KVA, -.88 Power Factor
Reactor Plant Bus 1B	14000 KVA, -.89 Power Factor

Turbine Plant Buses

Turbine Plant Bus 1A	Adjust to achieve total loading of 45 MW or 3806V on ES Bus
Turbine Plant Bus 1B	5692 KVA
Turbine Plant Bus 1C	9230 KVA

Turbine Plant bus load power factor for all cases is assumed to be as follows (Reference 3.5.2):

Turbine Plant Bus 1A	0.88 lagging
Turbine Plant Bus 1B	0.87 lagging
Turbine Plant Bus 1C	0.85 lagging

If the total loading criteria of 45 MW and the minimum voltage criteria of 3806V on the ES buses cannot be simultaneously satisfied, load will be reduced on TP Bus 1A until the voltage criteria is satisfied, in order to determine the maximum permissible loading.

ES Buses

The Impedance Model (Reference 3.2.1) provides the capability to fully model one safety train at a time, with the alternate train represented only by the redundant 4KV ES bus. The loading for the fully modeled train is assumed to be represented by the Appendix 8.1, 100% power loading. The loading for the alternate safety train is assumed to be represented by a lumped load that is approximately equal to the

Appendix 8.1, 100% power loading, less major swing loads, with a voltage of 3806 V on the 4 kV ES bus. This will be determined by DAPPER test runs with the final loading documented in the DAPPER runs for Cases 9A and 9B.

4.7 It is assumed that bus voltage recovers to its steady state value between Block Load Sequence intervals. This assumption is supported by TDR-1064 (Reference 3.2.3) which shows acceleration of large loads in less than 5 seconds when powered from an Emergency Diesel Generator, which is a less robust source than the auxiliary transformers.

4.8 The following assumptions apply to the Degraded voltage Relay setpoints and tolerances: (See Appendix 8.4 for input data and additional assumptions pertaining to the degraded voltage relay accuracy determination).

4.8.1 The nominal degraded voltage relay dropout setting is assumed to be 3760V. This corresponds to a voltage of 62.02V at the input terminals of the degraded voltage relays. (Appendix 8.4 Reference 3.2)

4.8.2 The nominal degraded voltage relay pickup (reset) setting is assumed to be 3779V, or approximately 100.5% of the dropout setting. This corresponds to a voltage of 62.33 V at the input terminals of the degraded voltage relays. (Appendix 8.4 Reference 3.2)

4.9 Vendor literature for the AC Vital Inverters does not provide tolerances for AC input voltage. The Inverters switch over to the DC input supply on low rectified DC voltage caused by low input voltage. A review of inverter test data (Reference 3.5.4) indicates that an AC input voltage of 480.5 V will produce a rectified DC voltage of: approximately 137.33 VDC. A review of inverter design (Reference 3.4.2) indicates that rectified DC voltage output of the transformer rectifier circuit will vary proportionally with input AC voltage. The low input voltage switchover setpoint is 108 to 110 VDC (Reference 3.1.3). Applying the voltage ratio described above, this would correspond to an AC input voltage of:

$$\frac{110V}{137.33V} \times 480.5V = 385.4V$$

This is approximately 80% of 480V. However, for conservatism, the minimum AC input voltage for the AC Vital Inverters will be assumed to be 400V or approximately 83.3% of rated voltage.

4.10 Minimum motor starting voltage for the Reactor Building Ventilation Fans (AH-E-1A/B/C) could not be retrieved from contract documents or vendor literature.

Reference 3.7.1, Table 16, states that a minimum terminal voltage of 80% is typical for NEMA Design B motors. Motor data in SDBD-T1-823 (Reference 3.3.6), Reference 36 shows that these motors are NEMA Design B. Therefore, a minimum terminal voltage of 80% will be assumed for these motors.

4.11 DG Skid components have the same terminal voltage as the local distribution panel. This is reasonable because the loads are located in the same room as the distribution panel and the cable runs between them are short.

4.12 Resistive circuits used for heating are assumed to be operable down to 80% voltage. This will result in an effective heating value of approximately 64%. Since these circuits are typically thermostatically controlled, this will usually mean only that they are energized for longer time periods than normal. In addition, periods of severely degraded voltage that would result in these conditions will be short due to operator action to improve voltage (See Assumption 4.13).

4.13 It is assumed that extreme low ES bus voltage conditions which would require switchyard voltages to decline below the limits described SDD-T1-000 (Reference 3.3.1) will be of short duration and voltage will not hover at or near the limits used for analysis of various cases described below, for the following reasons:

- During short term post accident conditions loading on transformers is dynamic with a declining trend after Block Sequencing due to reduction of BOP loads. This will tend to increase ES bus voltage. If other factors such as grid conditions are acting in an opposing direction, these dynamic factors will cause actuation of the undervoltage protection scheme.
- During non-accident and long term post accident conditions, operators will move promptly to improve voltage by reducing loading on affected transformer, increasing generator output voltage or transfer to alternate sources (Reference 3.1.4)

4.14 Minimum sustained voltage on the 4160V ES buses during normal operation is assumed to be a voltage equal to the degraded voltage relay maximum reset setting, as determined in section 7.1.2. This is based on the acceptance criteria for normal operation Cases 2A, 2B, 3A, and 3B which include the requirement that a minimum 4160V ES bus voltage at least as great as the degraded voltage relay maximum reset setting be maintained for grid separation prevention, during the limiting minimum grid voltage and maximum loading conditions being evaluated in each case.

4.15 Cable Temperature Including Accident Effects

The effect of accident environments on cable temperature could increase voltage drop, although the effect on power cables is generally small. Even when a circuit is affected, only a portion of total circuit length is located in a high temperature area. Therefore, the resistance "saving" for the portion of the circuit operating below the assumed conductor temperature may exceed the resistance "penalty" for the portion in the high temperature area. This study will use conductor impedance data based on a conductor temperature of 75 ° C, as tabulated in the Impedance Model (Reference 3.2.1). This temperature is assumed to be adequate to account for variations in ambient temperature affecting portions of cable runs during accidents. In order to validate this assumption an additional case similar to Case 4 will be performed to assess the effect of elevated cable temperature on the voltage drop for motors located in a harsh environment. The conductor temperature for this case will be assumed to be 130°C. This temperature is based on the maximum emergency overload conductor temperature for the 90°C cable (Reference 3.3.7). This temperature is reasonable for the AH-E-1A,B,C cables since the temperature in the Reactor Building reaches a maximum of 274°F (134.4°C) for a period of less than 1000 seconds and then steadily declines, passing quickly below 130°C (266° F). It is reasonable for EF-P-2A,B cables since the peak temperature in the intermediate building is 322°F (161.1°C) for a period of less than 100 seconds, drops to 273°F (134°C) until 600 seconds, and then drops to 212°F (100°C) thereafter (Reference 3.7.15).

The EQML (Reference 3.7.19) shows the following three groups of motors as being in areas affected by accident temperatures:

AH-E-1A, AH-E-1B, AH-E-1C
EF-P-2A, EFP-2B
MOVs

The effect of accident temperatures on cables for MOVs required to operate during an accident are covered by Calculation C-1101-730-5350-001 (Reference 3.2.6). Of the remaining two groups of motors, AH-E-1C and EF-P-2B have the longest cable runs of their respective groups (Reference 3.2.1), and so represent the bounding cases for effects of accident temperature on cables. Therefore, the supplemental case will consider only these two motors.

4.16 The simultaneous occurrence of low probability events including a LOCA, minimum expected voltage at the switchyard, and the sudden loss of an auxiliary transformer will not occur. Consequently, in the case of the loss of one auxiliary transformer, and low switchyard voltage, operators will have time to reduce BOP loading prior to the onset of an accident (Reference 3.3.1, Section 700, paragraph 3.9).

4.17 Where standby devices (such as standby battery chargers and inverters) are not normally in service but represent a limiting component due to cable length, the DAPPER model will show the standby device in service in lieu of one of the normal devices to obtain the limiting voltage drop. In these cases the load for the normal device will be applied to the standby device.

4.18 It is assumed that the limiting case for transient current on any particular bus due to MOV starting is represented by all MOVs on the bus which will change position during Block Load Sequencing running, with the largest of such MOVs on the bus starting. This is reasonable because small MOVs start very quickly and the starting current drawn by small MOVs will not reduce MCC voltage to the point where they will simultaneously stall, even in the unlikely event they receive an exactly simultaneous start signal. For simplicity, all MOV starting loads are applied in all sequence blocks except as described in Assumption 4.19.

4.19 MOVs are assumed to start during the steady state voltage recovery period following the large motor starting transient occurring during their respective load blocks. The inrush KVA for large MOVs FW-V-5A/B is experienced in Block 1 only with all other MOVs on Buses 1AESV and 1BESV running. It is assumed that MOVs FW-V-5A/B will not stall during the voltage dips experienced during the starting of ensuing load blocks. This will be confirmed by comparing the results of Case 7 block load starting voltages with the criteria given in Reference 3.2.9. The running current for these MOVs is assumed to be 130% of full load current for load blocks 2 through 5 (Reference 3.4.6).

4.20 Cable losses for MOV loads are assumed to be small with respect to other loads and are considered negligible.

4.21 Limitorque MOV Power Factor is assumed to be 90% lagging, for both starting and running (Reference 3.4.5).

4.22 During single transformer operation one ES bus will be supplied from its diesel generator while the remaining 4160V ES bus, will be supplied by the operable transformer (Reference 3.1.1).

4.23 Normal switchyard voltage is assumed to be 235 KV based on a review of historical data (Reference 3.5.16).

4.24 The following loads are assumed to be off or reduced during block load sequencing and the period immediately following the onset of a LOCA (Cases 4, 5, 6, 7):

Emergency Diesel Generator Skid Components – Diesel generator auxiliary circuits except loads supplied by the single phase transformer are tripped off following EDG start on the LOCA signal (References 3.6.9 and 3.6.14). Loads supplied by the single phase transformer (0.25KW) are not required to support the operation of the diesels but are assumed to be 0.5KW/0.88 P.F. (0.6KVA) in order to force DAPPER to report a voltage result.

Turbine Lift Pumps (LO-P-7A-J) – The Turbine Lift Pumps do not start until the turbine shaft is essentially at zero speed. This will not occur until approximately 90 minute following a turbine trip, concurrent with LOCA initiation (References 3.6.38 and 3.5.20).

4.25 Voltage for Long Term Post LOCA Cases 8A and 8B is assumed to be a minimum of 423 V on ES Buses 1P and 1S based on the nominal 480 V bus undervoltage alarm setpoint and procedures that direct operators to take compensatory measures to restore and maintain voltage. (References 3.1.16, 3.1.4, and 3.1.12)

4.26 IA-P-1A,B Instrument air compressors are fed from ES MCCs 1A and1B and back up primary compressor IA-P-4. Degraded voltage or random failure could cause loss of the primary compressor. Incipient failures due to low voltage during normal operation would be mitigated by existing procedures (i.e. Reference 3.1.4). Degraded voltage concurrent with a LOCA would not cause immediate operation of the compressors due to the time required for the system to bleed down from normal system pressure of 100-115 PSIG to the IA-P-1A/B start setpoint of 85 PSIG (Reference 3.1.20). Therefore, the backup compressors are unlikely to be operating during block load sequencing and are assumed to be off for Cases 5, 6 and 7. As a further check of the reasonableness of this assumption, 480V bus loading used in Cases 5, 6 and 7 (which does not include the air compressors) was compared with Steady State Monitoring (SSM) data for Cycles 11 and 12 (Reference 3.5.13). The calculation loading was exceeded by the SSM data for only one reading from 10/95 to 12/98. SSM loading was typically considerably below that used in Cases 5, 6, and 7.

4.27 RCP Oil Lift Pumps are off when The Reactor Coolant Pumps are operating (Reference 3.2.2, Appendix C, Calculations 128-131). RCPs may be on or off during the period covered by Case 4. However, for conservatism both the RCPs and the RCP Oil Lift Pumps are considered on for Case 4. This is conservative for both the grid voltage, which will be lower, and for 480 V MCC voltage which will also be lower.

4.28 Modification H355 (Reference 3.7.5) provides for increasing the required run out horsepower output for DR-P-1A and DR-P-1B. The maximum horsepower was increased from 190 HP to 210 HP (References 3.7.23, 3.7.24). Therefore, the following KW loading will be used in lieu of the value provided in Reference 3.2.2. Assuming motor efficiency does not decrease appreciably for the 5% increase in horsepower output, the increase in KW input is proportional to the increase in horesepower as follows:

KW (NEW) = KW (OLD) X HP (NEW) / HP (OLD)

Where:

KW (OLD) = 153.4 KW	(Reference 3.2.2, Appendix B, Calculations 11, 12)
HP (OLD) = 190	(Reference 3.2.2, Appendix B, Calculations 11, 12)
HP (NEW) = 210	(Reference 3.7.5)

KW (NEW) = (210 X 153.4) / 190 = 169.55 KW

4.29 Electrical Load Sheet # T1-700-99-015 (Reference 3.7.10) documents a required run out power output of 210 HP for SR-P-1A, in lieu of the 200 HP documented in Reference 3.2.2. Therefore, the following KW loading will be used in lieu of the value provided in Reference 3.2.2, using the same technique used in Assumptiom 4.28:

KW (OLD) = 161.5 KW	(Reference 3.2.2, Appendix B, Calculation 15)
HP (OLD) = 200	(Reference 3.2.2, Appendix B, Calculations 15)
HP (NEW) = 210	(Reference 3.7.24)

KW (NEW) = (210 X 161.5) / 200 = 169.6 KW

4.30 Modification H520 (Reference 3.7.12) provides for tripping SR-P-1C on an ES signal if both SR-P-1B and SR-P-1C are running. This could cause SR-P-1A to start automatically if it is not already running. Consequently, a starting load for SR-P-1A will be included with Block 1 loads in Cases 5A, 6A, and 7A. Although this motor is non safety and is not required to start in an emergency, it is important that it does not stall and degrade voltage on the 480V ES Bus 1R. Vendor literature does not provide a starting voltage for the motor but Reference 3.4.14 shows that it is NEMA Design B. Reference 3.7.1, Table 16, states that a minimum starting terminal voltage of 80% of rated voltage is typical for NEMA Design B motors. Therefore a starting voltage criterion of 80% will be assumed for SR-P-1A. Because this motor has a pump load typically characterized by rapid acceleration, it is further assumed that the motor will accelerate prior to the start signal for Block 2 loads.

For conservatism, the two SR pumps supplied by 480V ES Bus 1T will be assumed to be in operation for normal operation cases 1B and 2B.

4.31 In order to accommodate future changes in the single contingency minimum grid voltage, a bounding value of 223.3 kV will be assumed for switchyard voltage in Cases 2 and 5. This bounds the existing value provided in Section 5.5.

4.32 Calculation C-1101-826-5360-014 (Reference 3.2.10) determined that the ambient temperature in the 1P and 1S Switchgear Rooms could exceed the temperature for continuous operation specified by the vendor of 30° C, during maximum transformer loading and high outside air temperatures. This calculation was based on the assumption that the 1P and 1S transformer were separately loaded to their maximum rating (1333 KVA). The calculation concluded that the temperature could reach 100° F (37.78° C) in the 1P Switchgear Room and 104° F (40° C) in the 1S Switchgear Room. The vendor manual (Reference 3.4.16) states that the transformers may be loaded at a de-rated loading level for temperatures that exceed a 24 hour average of 30° C without loss of life expectancy. This de-rating is specified as 0.6% of rated KVA for each degree Celsius that the average temperature exceeds 30° C. Therefore, the following de-ratings may be determined (conservatively assuming that the maximum temperatures determined in Reference are 24 hr. averages):

1P Switchgear Room	7.78 X 0.6% = 4.67%	95.33% x 1333 = 1271 KVA
1S Switchgear Room:	10 X 0.6% = 6%	94% X 1333 = 1253 KVA

These de-ratings are applicable to equipment aging only and are not related to transformer operability. Consequently, they will be used only as evaluation criteria with respect to whether any of the postulated long term loading profiles would pose concerns relating to accelerated aging of the transformers.

4.33 Modification H440 (Reference 3.7.13) provided for tripping the non ES selected NR pump on 480V ES Buses 1R and 1T upon receipt of an ES signal so that only one NR pump would be running on these buses during a LOCA. It will be assumed that the tripped pump on bus 1R will be NR-P-1A and on bus 1T it will be NR-P-1C.

5.0 Design Input

The DAPPER Load Flow and Voltage Drop program (Reference 3.8.1) used for studies in this calculation utilizes input data from various DAPPER Project Files and Project Libraries which define the configuration of the auxiliary electrical system and the conditions under which it is analyzed. In addition, specific data not contained in the project files and libraries is entered for individual cases run under DAPPER. The various types and sources of this input data are described below.

5.1 Impedance Model Inputs

The buses used for this study and their interconnecting impedance elements have been defined in Calculation C-1101-700-E510-008, "TMI-1 Electrical Impedance Model" (Reference 3.2.1). Specifically, the Impedance Model includes:

Identification of bus numbers and locations
Transformer data and supporting information
Interconnecting cable data and supporting documentation

The Impedance Model includes two design verified DAPPER project files, LOCAA and LOCAB which form the basis for all studies performed in this calculation. LOCAA defines the electrical distribution network supplied by the 1B Auxiliary transformer during one or two transformer operation, while LOCAB similarly defines the electrical distribution network supplied by the 1A Auxiliary transformer. These DAPPER project files include all circuits that could be fed by the respective transformer including the redundant 4KV ES bus used in Cases 9A and 9B. The project files were adapted for use in this calculation by selectively disconnecting circuits not applicable to the case being considered. These adaptations are tabulated in Appendix 8.3. In addition, for convenience, the redundant 4KV ES buses used in Cases 9A and 9B were deleted from the DAPPER project files for all cases except Cases 9A and 9B.

In order to provide for a lineup where both SR-P1B and SR-P-1C are run simultaneously, an additional DAPPER bus (5480) was added to the LOCAB model. This new bus is fed from 480 V ES Bus 1T (Bus 5400), and its feeder is 142.5 ft. of 500 MCM cable with an impedance of (0.0299 + j0.0298) ohm/M ft. (References 3.2.1 and 3.7.11).

5.2 Calculation C-1101-741-E510-005 Inputs

Safety bus loading, including non-safety loads supplied by safety buses, is based on Calculation C-1101-741-E510-005 (Reference 3.2.2). Data imported from Reference 3.2.2 is tabulated in Appendix 8.1. which contains tables corresponding to similarly named tables in Reference 3.2.2, Appendix A. The tables from Reference 3.2.2 were adapted for this calculation to show load data for the 100% Power and LOCA cases only (information for the LOOP cases was not relevant). The tables in Reference 3.2.2 list equipment loads in kilowatts (KW) and full load amps (FLA) whereas DAPPER input uses KVA and power factor (PF). In order to accommodate DAPPER input requirements, the Reference 3.2.2 tables were modified to provide columns for Power Factor (PF), Reactive Power (Q), and KVA. Power Factor values were taken from individual load calculations in Reference 3.2.2, Appendices B and C. Values of Q and KVA were calculated from KW and PF using standard power formulas. All non-unity values of Power Factor in Appendix 8.1 are lagging.

Itemized and Lumped Loads

A separate DAPPER bus was defined in the Impedance Model (Reference 3.2.1), and listed in Appendix 8.1 for "itemized" loads where a load terminal voltage is required to be reported . Other loads are lumped for DAPPER entry, usually on a per MCC basis. Where loads are lumped, individual loads from Reference 3.2.2 are combined by complex addition, and a power factor for the combined load is determined. This data is calculated in Appendix 8.1 and identified with the appropriate DAPPER Bus defined in the Impedance Model for the lumped load.

Loads are also added together in Appendix 8.1 to show the total loading on the various busses, for information only. These totals were not entered into DAPPER or otherwise used in the calculation. The "information only" totals are not representative of all cases. "Information only" totals may be identified by a DAPPER bus number enclosed in parentheses or the absence of a DAPPER bus number.

Power Factors and Load Types

Load power factors are entered into DAPPER by selecting one of a maximum of 20 "Load Types" for each load. The Load Type also defines the load property as constant KVA, constant current, or constant impedance. The Load Types used for this study are listed in Appendix 8.2 for each load entered into DAPPER. In some cases Reference 3.2.2 provided a power factor given to three significant digits, whereas DAPPER only accepts only a two digit value (other than 100). In these cases the three digit value was used to calculate KVA in Appendix 8.1 but a Load Type with a power factor corresponding to the a rounded two digit value was used DAPPER data entry. This adjustment to load power factor has a negligible effect on the results of the DAPPER voltage drop calculation.

Lumped loads are grouped and summed in Appendix 8.1 according to load type, either constant impedance or constant KVA. The sums were assigned the appropriate load type when entered into DAPPER. Itemized loads in Appendix 8.1are predominantly constant KVA type and were entered into DAPPER as such unless otherwise noted in Appendix 8.1.

Cable and Transformer Losses

Lumped cable losses were included in the Reference 3.2.2 tabulations. However, feeder losses are automatically calculated by DAPPER, and therefore were not separately imported from Reference 3.2.2 for those feeders already itemized in the Impedance Model Reference 3.2.1. For cables not itemized in the Impedance Model, i.e., feeders for MCC lumped loads, the cable loss values from Reference 3.2.2 were included in the lumped load tabulations. Similarly, transformer losses are calculated by DAPPER based on data provided in the Impedance Model. Therefore they were not separately imported from the Reference 3.2.2 data tables.

Other Data Adjustments

The loads for DR-P-1A, DR-P-1B, and SR-P-1A were revised in accordance with Assumptions 4.28 and 4.29. Other minor adjustments were made to data imported from Reference 3.2.2, such as for the treatment of loads subject to "Use Factors". Appropriate notes have been added to the Appendix 8.1 tables wherever these adjustments have been made.

5.3 Motor Starting Loads

Motor Starting Loads are entered into DAPPER as "Special Bus Loads". Input data consists of load KW, KVAR, and type (Constant Impedance, per Assumption 4.1). Load KW and KVAR were calculated in Appendix 8.5 based on motor starting currents and power factor. References for motor starting current are identified in Appendix 8.5 along with the starting power factor from Assumption 4.4.

5.4 Block Sequencing

Large loads are sequenced onto the ES buses in load blocks shown in Appendix 8.5 (Reference 3.6.26 through 3.6.35).

5.5 Grid Voltage

The critical contingency minimum expected voltage for the TMI 230kV substation is 224.3 kV. (Reference 3.5.1). The minimum expected voltage at the 230kV substation for single transformer operation is 232 kV. (References 3.3.1, 3.5.16) The maximum expected voltage at the 230kV substation is 242 kV. (References 3.3.1, 3.5.16)

5.6 Specific Voltage Criteria for Equipment

5.6.1 Motors shall have a minimum steady state voltage at their terminals of 90% of nameplate voltage rating (Reference 3.7.2, Sections 12.43 and 20.45). For 4000V rated motors this is 3600V, and for 460V rated motors this is 414V. Alternatively, if the steady state voltage is below 90%, the current at the reduced voltage shall not exceed the nameplate full load current multiplied by the service factor. (Reference 3.3.1, Section 700, paragraph 3.7)

5.6.2 Motors subject to Block Load Sequencing shall have a minimum of 80% or 75% of nameplate voltage rating as listed in Appendix 8.5.

5.6.3 Reference 3.4.1 specifies a minimum input voltage for the Battery Chargers of 411VAC. However, testing performed by the Battery Charger vendor (Reference 3.4.15) established adequate performance with input voltage as low as 385 VAC. For conservatism, and to provide margin for manufacturing variation in the tested and installed equipment, the minimum input voltage criteria will be set at 400 VAC.

5.6.4 Vital Inverter rated voltage is 480V. Vendor literature (Reference 3.4.2) does not provide tolerances for AC input voltage. In accordance with Assumption 4.9, the Vital Inverter minimum AC input voltage is 400V. The Vital Inverters feature automatic AC input overvoltage protection so no criteria is required for maximum input voltage. (Reference 3.4.2)

5.6.5 Hydrogen Analyzer

The Hydrogen Analyzers receive power from 120 V Vital AC which is outside the scope of this calculation, and from 480V ES MCCs 1A and 1B. The MCCs supply the analyzer pump motors which are subject to the criteria in Section 5.6.1 (Reference 3.4.10).

5.7 Bus Current Rating Criteria

5000V Bus Duct – BOM TMI-ED, Item No. ED-4 (Reference 3.3.8) specifies bus with 1200, 2000, 3000, and 4000 amperes capacity, maximum temperature rise 40° C over 40° C ambient. Reference 3.4.7 lists the following actual ampacities for the 5000V bus duct:

Calvert Figure	Rated Amps	65°C Rise	50°C Rise	40°C Rise
B	1200	1200	1037	917
C	2000	3021	2611	2308
D	2000	3035	2623	2319
E	3000	5073	4385	3876
F	3000	4687	4051	3581
G	4000	5330	4607	4072

4160 V Switchgear - BOM TMI-ED, Item No. ED-2 (Reference 3.3.9) specifies the bus rating for ES Buses 1D and 1E as 1200 amperes.

480 V Unit Substations 1P, 1R, 1S and 1T - BOM TMI-EE, Item No. EE-1 (Reference 3.3.10) does not specify a bus rating for the 480V Unit Substations. As an alternative the rating of the main breakers will be used, 1600A.

480 V MCCs – BOM TMI-EG, Item No. EG-5 (Reference 3.3.11) states that main incoming vertical and horizontal bus shall be rated 600 amperes minimum, or 1200 amperes minimum, in accordance with the drawings. Ratings specified on drawings are as follows:

	Horizontal	Vertical	Reference
ES MCC 1A	1200	600	See Note 1
ES MCC 1A-V	600	300	3.6.19
ES MCC 1A-ESF	600	300	See Note 2
ES MCC 1A-SH	1200	600	3.6.21
ES MCC 1B	1200	600	3.6.18
ES MCC 1B-V	600	300	3.6.20
ES MCC 1B-ESF	600	300	See Note 3
ES MCC 1B-SH	600	600	3.6.22
ES MCC 1C	1200	600	3.6.23

Note 1.	The bus rating is not shown on the applicable drawing (Reference 3.6.17), assumed to be similar to ES MCC 1B.
Note 2.	The bus rating is not shown on the applicable drawing (Reference 3.6.24), assumed to be minimum rating in Reference 3.3.11.
Note 3.	The bus rating is not shown on the applicable drawing (Reference 3.6.25, assumed to be minimum rating in Reference 3.3.11.

5.8 Model Validation Field Measurements

Field measurements used as inputs for the Model Validation Case were taken from Special Test Procedure STP 1-98-034 (Reference 3.1.5). Feeder load and voltage measurements are summarized in Table 7.2.10-1.

5.9 MOV Loads

MOV loads are taken from Calculation C-1101-730-5350-001 (Reference 3.2.6), and are tabulated in Appendix 8.8.

5.10 Degraded Voltage Relay Calibration Procedure

The setpoints for the Degraded Voltage Relay are given in Surveillance Procedure 1302-5.31A (Appendix 8.4, Reference 3.2) as follows:

Dropout Setting:	62.02 V	(61.96 V to 62.08 V)
Pickup Setting:	62.33 V	(62.27 V to 62.39 V)

5.11 Additional Design Inputs are defined in Appendix 8.4, Determination of Degraded Voltage Relay Tolerances

6.0 Overall Approach and Methodology

6.1 Computer Program Descriptions

The DAPPER computer code version 3.5 (Reference 3.8.1) was utilized to perform voltage drop analyses in this calculation. DAPPER stands for "Distribution and Analysis for Power Planning, Evaluation and Reporting." The program is the product of SKM Systems Analysis, Incorporated located in Manhattan Beach, California. The executable file is entitled LGODAP1. It is 103968bytes in length and dated 8/27/91, 1:12 PM. The program is controlled by Engineering Division Procedure EP-007, (Reference 3.1.21) which meets the requirements of Corporate Procedure 1000-ADM-1230.10 (Reference 3.1.22) and is on the software master list (CCP-PAR-61). DAPPER contains several integrated engineering tasks, of which two are used for this study; the DAPPER Demand Load Analysis (DLA) Program, and the Load Flow and Voltage Drop (VDSTUDY) program. Data inputs to the DAPPER program are described in Section 5 above.

Input data and output data was processed and analyzed using Microsoft Excel (Reference 3.8.2) spreadsheets. Spreadsheets are used to document results of simple or straightforward mathematical functions and all formulas and equations are described in the text of the calculation and all entries and results will be verified line by line during the design verification process. As such there is no need to include this in the computer configuration control. Formulas used to calculate numerical results displayed in the appendix spreadsheets are identified as follows:

Appendix 8.1

$$KVAR = \left[\left(\frac{KW}{PF}\right)^2 - KW^2\right]^{1/2}$$

For Individual loads: $KVA = [(KW)^2 + (KVAR)^2]^{1/2}$

For column totals, KW, KVAR, and KVA were calculated by summation of the column. Power Factor was calculated as follows:

$$PF = KW / KVA$$

Appendix 8.5

$$KVA = \frac{\sqrt{3} \times VOLTS \times LRA}{1000}$$

$$KW = KVA \text{ x } PF$$

$$KVAR = (KVA^2 - KW^2)^{1/2}$$

Appendix 8.8

$KVA = \frac{\sqrt{3} \times 460 \times FLA}{1000}$ or, $KVA = \frac{\sqrt{3} \times 460 \times LRA}{1000}$

Total KVA was calculated by summation of the KVA column.

Appendix 8.10

Tables 3A, 3B, 4A, 4B, 8A, 8B

The DAPPER Voltdrop program reports load current results to the nearest ampere. In order to calculate a more exact value of load current for the alternate current criteria test (Section 5.6.1), actual load current was calculated from the DAPPER voltage results as follows:

$$AMPS = \frac{1000 \times KVA}{\sqrt{3} \times VOLTS}$$

6.2 Case Descriptions

The following cases were determine to be necessary to establish a basis for the safe and orderly operation of the plant electrical distribution system, or to provide information for various proposed changes. Detailed Case Descriptions which define inputs for the various computer model cases are provided in Appendix 8.3.

Cases 1A, 1B – Normal Grid, Two Transformer, 100% Power Operation

Purpose:	Establish acceptability of transformer normal tap settings for two transformer alignment, normal operation, and normal grid voltage
Loading:	Normal loads for 100% power operation
Alignment:	Two cases, Red Train and Green Train, normal alignment
Voltage:	Normal Grid, 235KV
Criteria :	Adequate voltage is available at the terminals of all NSR equipment

Case 2A, 2B - Minimum Grid, Two Transformer, 100% Power Operation

Purpose:	Establish acceptability of transformer normal tap settings for two transformer alignment and critical contingency minimum expected substation voltage
Loading:	Normal loads for 100% power operation
Alignment:	Two cases, Red Train and Green Train, normal alignment
Voltage:	Bounding Value for Critical contingency minimum expected substation voltage (223.3 KV, Assumption 4.31)
Criteria :	Separation from offsite power does not occur due to 230KV system degraded grid voltage (critical contingency), two transformer operation and maximum plant loading. Adequate voltage is available at the terminals of all NSR equipment Buses are loaded within their design ratings

Case 3A, 3B - Minimum Grid, One Transformer, Fast Transfer of BOP Loads

Purpose:	Establish maximum BOP and ES bus loading for minimum expected grid voltage (232KV), normal power operation, fast transfer of BOP loads. Establish loading limits for grid voltages below minimum expected grid voltage
Loading:	Maximum loading consistent with preventing grid separation following fast transfer
Alignment:	Two cases, 1A and 1B Aux Transformers each supply the entire Turbine Plant and Reactor Plant load and one ES bus

Voltage:	Minimum expected single transformer substation voltage (232KV), and selected values of grid voltage below the minimum expected grid voltage, maximum degraded Voltage Relay pickup voltage on ES bus
Criteria:	Separation of both ES buses from offsite power does not occur due to minimum expected substation voltage, normal plant loading, fast transfer of BOP loads to single transformer Separation of both ES buses from offsite power does not occur due to less than minimum expected substation voltage, reduced plant loading, fast transfer of BOP loads to single transformer Adequate voltage is available at the terminals of all NSR equipment Buses are loaded within their design ratings

These cases determine the maximum Turbine Plant and ES bus loading achievable on a single transformer for minimum expected grid voltage of 232KV and normal power operation and determine acceptable loading levels for grid voltages below the minimum expected grid voltage. These cases also determine the minimum voltage available to NSR equipment during normal operation since the loading and grid voltage constraints used for this case will assure a voltage on the ES buses at least equal to the maximum degraded Voltage relay pickup voltage during normal operation (Assumption 4.14).

Case 4A, 4B - Short Term Post LOCA

Purpose:	Establish acceptability of DVR dropout (trip) setting to protect equipment for the period following a LOCA and prior to operator actions to improve voltage
Loading:	Maximum LOCA loading
Alignment:	Two cases, 1A and 1B Aux Transformers, four 4KV buses on each transformer (single transformer alignment)
Voltage:	Degraded Voltage Relay Minimum Dropout setting on 4kV ES bus
Criteria :	Adequate voltage is available at the terminals of all NSR equipment Busses are loaded within their design ratings

Case 4BEQ - Short Term Post LOCA With Accident Cable Temperature

Purpose:	Determine the effect of elevated conductor temperatures due to high ambient temperatures caused by accidents
Loading:	Same as Case 4B
Alignment:	Same as Case 4B
Voltage:	Same as Case 4B
Criteria :	Same as Case 4B

Case 4BNS - Short Term Post LOCA, One NS Pump Running

Purpose: Establish capability of a single NS pump in run out operation
Loading: Maximum LOCA loading except only one NS pump running, run out HP based on one pump operating
Alignment: Same as Case 4B
Voltage: Same as Case 4B
Criteria : Adequate voltage is available at the terminals of the running NS pump

Cases 5A-1S through 5B-5R, Minimum Grid, Two Transformer, LOCA Motor Starting

Purpose: Establish acceptability of transformer normal tap settings for two transformer alignment, minimum expected grid voltage, and LOCA Block Loading
Loading: Normal BOP loads for 100% power operation with incremented post trip load reduction, LOCA loading with sequenced LOCA block loads including MOV loads, two cases for each LOCA block load, transient and recovery
Alignment: Two cases, Red Train and Green Train, normal two transformer
Voltage: Bounding value for Critical contingency minimum expected substation voltage (223.3 KV, Assumption 4.31)
Criteria : Adequate voltage is available at the terminals of all NSR equipment
Separation from offsite power does not occur due to 230KV system degraded grid voltage (critical contingency), two transformer operation and LOCA block loading
Busses are loaded within their design ratings

Cases 6A-1S through 6B-5R - Minimum Grid, One Transformer, LOCA Motor Starting

Purpose: Establish acceptability of transformer normal tap settings for one transformer alignment, minimum expected grid voltage, and LOCA Block Loading
Loading: Normal BOP loads for 100% power operation with incremented post trip load reduction, only one ES bus aligned to transformer, LOCA loading with sequenced LOCA block loads including MOV loads, two cases for each LOCA block load, transient and recovery
Alignment: Two cases, 1A and 1B Aux Transformers each supply the entire Turbine Plant and Reactor Plant load and one ES bus
Voltage: Minimum expected single transformer substation voltage (232KV)
Criteria : Adequate voltage is available at the terminals of all NSR equipment
Separation from offsite power does not occur due to minimum expected substation voltage, single transformer operation (automatic) and maximum plant loading

Busses are loaded within their design ratings

Cases 7A, 7B - LOCA Block Load Sequencing Minimum Recovery Voltage

Purpose: Establish minimum bus voltages for GL 89-10 degraded grid analysis
Loading: Normal BOP loads for 100% power operation with incremented post trip load reduction, LOCA loading with sequenced LOCA block loads including MOV loads, one case for each LOCA block load, recovery after block start
Alignment: Two cases, Red Train and Green Train, normal two transformer
Voltage: Degraded Voltage Relay Minimum Pickup setting on the 4kV ES bus
Criteria: N/A

For Block 1, MOV loading is assumed to consist of all MOVs on each MCC running along with the largest MOV on each MCC starting (Assumption 4.18 and 4.19). The same loading is assumed for Blocks 2 through 5 for all MCCs except 1AESV and 1BESV which supply MOVs FW-V-5A and FW-V-5B respectively. Since these large MOVs are assumed to start in Block 1 and to continue run, only running loads are assumed for MCCs 1AESV and 1BESV. This methodology bounds restarting the largest MOV on all buses, except 1AESV and 1BESV, for each load block.

Cases 8A, 8B – Long Term Post LOCA

Purpose: Establish acceptability of 480V ES Bus Low Voltage Alarms
Loading: Post LOCA loading including automatic and manually applied loads and manual load shedding
Alignment: Two cases, 1A and 1B Aux Transformers, four 4KV buses on each transformer (single transformer alignment)
Voltage: 480V ES Bus Alarm Setpoint of 423 V on Buses 1P and 1S .
Criteria : Adequate voltage is available at the terminals of all NSR equipment. Busses are loaded within their design ratings

Cases 9A-9B – Minimum Grid, Tap Change

Purpose: Establish maximum BOP and ES bus loading for minimum expected grid voltage (232KV) during tap change operations
Loading: Maximum loading consistent with preventing grid separation during tap change operations
Alignment: Two cases, 1A and 1B Aux Transformers each supply the entire Turbine Plant and Reactor Plant load and both ES buses
Voltage: Minimum expected single transformer substation voltage (232KV)

Criteria : Separation of either ES bus from offsite power does not occur due to minimum expected substation voltage, single transformer operation with startup tap setting, and maximum plant loading during tap changes
Adequate voltage is available at the terminals of all NSR equipment
Busses are loaded within their design ratings

As noted in Assumption 4.6, only one ES train is fully modeled, with the alternate train represented by a lumped load on the 4 KV bus approximated by its normal load less the following swing loads:

Bus 4480 for 1C-ESVCC
Bus 5040 for MU-P-1B

Case 10 - Model Validation

Purpose: Verify analytical techniques and assumptions used in the voltage analyses
Loading: Actual loading from field measurements, minimum of 30% of normal bus loading
Alignment: Green train only, buses for which measured load data was taken and their upstream feeders modeled, other loads and buses are represented by lumped loads applied to the modeled buses to achieve the total loading observed in the field
Voltage: Actual substation voltage present during field measurements
Criteria: Analytical results no more than 3% lower than field measurements, with negative result applied as margin to other analytical cases as appropriate

6.3 Voltage Constraints

Each of the models described above includes a voltage constraint as part of the case description. In some cases a grid voltage is selected based on an assumed operating condition and the downstream voltages are examined to determine whether a equipment ratings or a relay setpoint has been exceeded. In other cases, grid voltage or bus loading is varied by trial and error to achieve a specific voltage on the ES bus which represents an extreme limit of relay setting tolerance. In these cases either the resultant upstream grid voltage and/or the downstream equipment terminal voltages are compared to the specific acceptance criteria for that case.

Voltage constraints for Long Term Post LOCA Cases 8A, and 8B are based on the nominal 480 V bus undervoltage alarm setpoint of 423 V which prompt manual operator actions (Assumption 4.25).

Criteria that utilize degraded voltage relay setpoints are subject to tolerances which were determined in Appendix 8.4. Tolerances were calculated for both the dropout and the pickup setpoints and are applied as follows:

6.3.1 Minimum Dropout Setting – This parameter establishes the minimum 4160V ES bus voltage that could occur without grid separation and determines the minimum voltage available to components during steady state bus operation. It is calculated by adding the channel error associated with the dropout setting to the nominal dropout setpoint. (See Section 7.1.1).

6.3.2 Maximum Pickup Setting – This parameter determines the highest voltage at which grid separation could occur following relay dropout, such as during LOCA Block Sequencing. It is calculated by adding the channel error associated with the maximum pickup setting to the nominal pickup setpoint. (See Section 7.1.2).

6.3.3 Minimum Pickup Setpoint - This parameter is the minimum ES bus recovery voltage that could occur during LOCA Block Sequencing without resulting in grid separation. It is used to determine minimum voltages available to start and run MOVs. It is calculated by adding the channel error associated with the minimum pickup setting to the nominal pickup setpoint. (See Section 7.1.3).

7.0 Calculations

7.1 Determination of Degraded Voltage Relay Setpoints

7.1.1 Calculation of Minimum Dropout Setting

Nominal Dropout Setpoint	62.02V	Section 5.10
Channel Error Associated with Dropout Setting	-0.54V	Appendix 8.4
Minimum Dropout	61.48V	Sum

Converting line to neutral voltage and multiplying by the PT ratio results in the 4160V ES bus voltage to be used for DAPPER input:

61.48 X 1.7321 X 35 = 3727V = Minimum Dropout Voltage

7.1.2 Calculation of Maximum Pickup Setting

Nominal Pickup Setpoint	62.33V	Section 5.10
Positive Channel Error Associated with Pickup Setting	+0.45V	Appendix 8.4
Maximum Pickup	62.78V	Sum

Converting line to neutral voltage and multiplying by the PT ratio results in the 4160V ES bus voltage to be used for DAPPER input:

62.78 X 1.7321 X 35 = 3806V = Maximum Pickup Voltage

7.1.3 Calculation of Minimum Pickup Setting

Nominal Pickup Setpoint	62.33V	Section 5.10
Negative Channel Error Associated with Pickup Setting	-0.38V	Appendix 8.4
Minimum Pickup	61.95V	Sum

Converting line to neutral voltage and multiplying by the PT ratio results in the 4160V ES bus voltage to be used for DAPPER input:

61.95 X 1.7321 X 35 = 3756V = Minimum Pickup Voltage

7.2 DAPPER Computer Studies

The raw results of the DAPPER computer studies for the cases defined in Section 6.2 are provided in Appendix 8.9. A partial tabulation of those results is provided in Appendix 8.10 as discussed below.

<u>Equipment Terminal Voltages</u>

Acceptance criteria for most of the cases in this study included the requirement that adequate voltage be present at the terminals of NSR equipment. A review of the case definitions in section 6 and the DAPPER results showed that the limiting cases for minimum equipment terminal voltage were Cases 3A and 3B for the normal operation scenarios and Cases 4A and 4B for the Short Term Post LOCA scenarios. This is because these cases employed the lowest voltages on the 4160V ES bus voltages, 3806 V and 3727 V respectively. In general, if the voltage criteria was met for one of these cases, it was satisfied for all of the other cases as well. Further, if the voltage criteria was met for LOCA Cases 4A and 4B, it was also met for normal operation Cases 3A and 3B.

In evaluating motor terminal voltage results, if the primary acceptance criteria of 90% of rated voltage was not met, then the alternate current criteria described in section 5.6.1 was applied. If the alternate acceptance criteria was not met, then the loads were individually evaluated with respect to their actual operating requirements to determine if the voltage deficits were detrimental to system operation. In certain cases temporary low voltage during the Short Term Post LOCA period, modeled by Cases 4A and 4B, was considered acceptable. In these cases voltage within the primary or alternate acceptance criteria was demonstrated for the longer term modeled in Cases 8A and 8B.

The results for Cases 3A, 3B, 4A, 4B, 8A, and 8B, are tabulated in Appendix 8.10, Tables 3A, 3B, 4A, 4B, 8A, and 8B. These tables also include calculation of the alternate acceptance criteria based on service factor current described in Section 5.6.1. In addition to the NSR loads listed in the Appendix 8.10 tables, there are several other bus voltages reported in the Appendix 8.9 DAPPER printouts. This is because the Impedance Model (Reference 3.2.1) provided separate DAPPER buses for several non-safety buses and loads, and created DAPPER buses for certain interconnection points. The voltages reported for these buses are generally not of interest to this study but were included in the summary tables in Appendix 8.10 for convenience. The acceptance criteria for these loads was listed as "N/A".

The interpretation of specific case results is as follows:

7.2.1 Cases 1A, 1B – Normal Grid, Two Transformer, 100% Power Operation

The DAPPER reports for these cases are provided in Appendix 8.9. All NSR equipment have voltage near to their rated values, and satisfy the acceptance criteria in Sections 1.3, 5.6, and 6.3 of this calculation.

7.2.2 Case 2A, 2B - Minimum Grid, Two Transformer, 100% Power Operation

The DAPPER reports for these cases are provided in Appendix 8.9, and partial results are tabulated in Appendix 8.10 Tables A and B. Separation from offsite power does not occur due to 230KV system degraded grid voltage (single contingency), two transformer operation and maximum plant loading for 100% power operation. The results for Case 2A showed that the minimum voltage that would occur on Bus 1D would be 3924 V vs. 3806 V minimum, with a bounding value for single contingency minimum expected grid voltage of 223.3 kV. The results for Case 2B showed that the minimum voltage that would occur on Bus 1E would be 3834 V vs. 3806 V minimum. These results demonstrate ample margin to accommodate small, infrequent excursions above the Turbine Plant Bus loading values adopted in Assumption 4.3.3.

All NSR equipment have voltage above their minimum required values listed in Section 5.6 except as follows:

Case 2B	5226	AH-E-19B	411V vs. 414V required
Case 2B	5232	AH-E-29B	406V vs. 414V required
Case 2B	5233	AH-E-24B	407V vs. 414V required
Case 2B	5229	1B-DG-SKID	402V vs. 414V required
Case 2B	5240	NS-P-1C	412V vs. 414V required

All of the motor loads passed the alternate current criteria for the worst case voltages postulated by Case 4B as shown in Appendix 8.10, Table 4B, and so are acceptable. EDG skid component results are bounded by the results of Case 3B and are discussed in Section 7.3, where they were determined to be acceptable.

7.2.3 Case 3A, 3B - Minimum Grid, One Transformer, Fast Transfer of BOP Loads

The DAPPER reports for these cases are provided in Appendix 8.9, and partial results are tabulated in Appendix 8.10 Tables A and B. These cases determine the maximum Turbine Plant and ES bus loading achievable on a single transformer for minimum expected grid voltage of 232KV and normal power operation. They also determine the minimum voltage available to NSR equipment during normal operation (Assumption 4.14).

<u>Loading Limits</u>

Determination of maximum loading was accomplished by performing DAPPER runs with normal single transformer loads on Turbine Plant Buses 1B and 1C while the load on Turbine Plant Bus 1A was adjusted to achieve 3806V on the ES bus. These cases evaluate the condition where the maximum Turbine Plant and Reactor Plant Loads in addition to one ES Bus are supplied by a single transformer, during normal operation, such as could occur following the sudden loss of one transformer and the fast transfer of BOP loads to the remaining transformer. Two cases were run, Case 3A where ES Bus 1D loads were connected to the transformer, and Case 3B where ES Bus 1E loads were connected to the transformer. In each case, the total TP Bus 1A load was varied until a voltage of 3806 V occurred on the ES bus. The results of Case 3A showed the following allowable Turbine Plant loading:

Case 3A Turbine Plant Loading

(1000)TP Bus 1A	10800 KVA
(2000)TP Bus 1B	5692 KVA
(3000)TP Bus 1C	9230 KVA

This represents a total allowable TP load of approximately 25,722 KVA, which is greater than the assumed limit of 24,300 KVA for single transformer operation (Assumption 4.3.5). Therefore, for a maximum TP loading of 24.3 MVA, a switchyard voltage of 232 KV is adequate to assure a minimum voltage of 3806 V on ES Bus 1D, and preclude separation of the ES bus on fast transfer of BOP loads to Aux Transformer 1B.

Case 3B Turbine Plant Loading

(1000)TP Bus 1A	9050 KVA
(2000)TP Bus 1B	5692 KVA
(3000)TP Bus 1C	9230 KVA

This represents a total TP load of approximately 23,972 KVA, which is less than the assumed limit of 24,300 KVA for single transformer operation (Assumption 4.3.5). It is also less than the value determined for the ES Bus 1D model in Case 3A (25,722 KVA) and so it represents the limiting case. Therefore, for minimum expected grid voltage of 232 KVA, TP loading would have to be limited to 23,972 KVA to assure ES Bus 1E would not be separated from the grid in case of the sudden loss of Auxiliary Transformer 1B.

Additional cases were run to determine the amount of load reduction required for various levels turbine plant loading, and to validate the switchyard voltage alarm setpoint of 232.4 kV (Reference 3.1.9). Since the limiting case for turbine plant loading occurs when fast transfers are made from Auxiliary Transformer 1B to Auxiliary Transformer 1A, these additional cases were based on the Case 3B lineup. Cases were run at three different loading levels to supplement the data obtained in Case 3B, and to provide four points for plotting a graph. The raw results of the DAPPER computer studies for these cases Appendix 8.9. The results are interpreted as follows:

- Case 3B1 showed that a TP Bus 1A load of 9500 KVA would result in a Voltage of 3806V on 4160V ES Bus 1E, for a switchyard voltage of 232.4 kV. This results in a total TP Bus load of 9500 + 5692 + 9230 = 24,422

KVA. The permissible loading for preventing grid separation is greater than the limit of 24,300 KVA thus validating the 232.4 kV alarm setpoint.

- Case 3B2 showed that a TP Bus 1A load of 6850 KVA would result in a Voltage of 3806V on 4160V ES Bus 1E, for a switchyard voltage of 230.0 kV. This results in a total TP Bus load of 6850 + 5692 + 9230 = 21,772 KVA.
- Case 3B3 showed that a TP Bus 1A load of 4600 KVA would result in a Voltage of 3806V on 4160V ES Bus 1E, for a switchyard voltage of 228.0 kV. This results in a total TP Bus load of 4600 + 5692 + 9230 = 19,522 KVA.

The results of these DAPPER runs are summarized in Table 7.2.3, in addition to the data point derived from Case 3B.

TABLE 7.2.3

CASE	230kV SWITCHYARD VOLTAGE (KV)	MAXIMUM TP LOAD (MVA)
3B3	228.0	19.522
3B2	230.0	21.772
3B	232.0	23.972
3B1	232.4	24.422

The data points in Table 7.2.3 have been plotted in Chart 7.2.3, which is contained in Appendix 8.11. As can be seen from the chart, the relationship between 230 kV switchyard voltage and maximum TP load is approximately linear. Therefore, the points on the straight lines between the calculated data points may be taken as limits of acceptable operation. It follows that the region above the plotted line represents combinations of loading and voltage that present a risk of grid separation in case of the sudden loss of an auxiliary transformer, while the region below the plotted line represents combinations where grid separation due to action of the degraded voltage relay scheme is effectively precluded.

<u>5000V Bus Duct Current</u>

The results of Case 3A showed that the 5000V bus duct sections immediately downstream of Auxiliary Transformer 1B (DAPPER Bus 40 to 41) could be subjected to current in excess of their 40° C rating of 4072 amperes, during single transformer operation and a TP load of approximately 25,722 KVA. However, this loading is greater that the assumed TP loading limit of 24.3 MVA, and so is not expected. An additional case (3A-SUP) was run with the proposed TP loading limit of 24.3 MVA and Switchyard voltage of 232.4 KV. This case showed that 5000V bus duct current was limited to 4075 A which is only slightly above the 40° C rating. Since higher currents are permitted at different temperature ratings, this result is considered acceptable by engineering judgement.

Equipment Terminal Voltages

Motor loads were evaluated with respect to the 90% voltage criteria and the alternate acceptance criteria based on full load current described in section 5.6.1. A voltage of 3806 V on the 4160V ES buses results in less than 90% of rated voltage at several motor loads. Each of the motor loads passed the alternate current criteria as shown in Appendix 8.10, Tables 3A and 3B. Non-motor loads including the Inverters and Battery Chargers passed the voltage criteria given in sections 5.6.3 and 5.6.4.

7.2.4 Case 4A, 4B - Short Term Post LOCA

The DAPPER reports for these cases are provided in Appendix 8.9, and partial results are tabulated in Appendix 8.10 Tables A and B. Two cases, 4A and 4B, were run to determine voltages at the terminals of NSR equipment during LOCA steady state conditions following the completion of block load sequencing, and prior to manual operator actions to apply or remove loads. During this period, 4160V ES bus voltage is modeled to be at the minimum degraded voltage relay dropout setting of 3727 V. Motor loads were evaluated with respect to the 90% voltage criteria and the alternate acceptance criteria based on full load current described in section 5.6.1. Non-motor loads were evaluated with respect to criteria provided in sections 5.6.3 and 5.6.4. Loads tabulated in Tables 7.2.4-1 and 7.2.4-2 did not pass the primary or alternate criteria (Appendix 8.10, Tables 4A and 4B) and are evaluated in Section 7.3.

TABLE 7.2.4-1
CASE 4A LOADS THAT DO NOT PASS CRITERIA

TAG NO	DAPPER BUS	ACCEPTANCE CRITERIA	DAPPER VOLTAGE	% VOLTAGE DEFICIT
MU-P-4A	4424	414	405	-2.2%
AH-E-29A	4443	414	391	-5.6%
DF-P-1A	4446	414	406	-1.9%
AH-E-95A	4447	414	406	-1.9%
AH-E-18A	4449	414	403	-2.7%
NR-S-1B	4487	414	401	-3.1%
MU-P-4B	4488	414	405	-2.2%

TABLE 7.2.4-2
CASE 4B LOADS THAT DO NOT PASS CRITERIA

TAG NO	DAPPER BUS	ACCEPTANCE CRITERIA	DAPPER VOLTAGE	% VOLTAGE DEFICIT
NR-S-1B	4487	414	400	-3.4%
MU-P-4B	4488	414	404	-2.4%
AH-E-95B	5224	414	405	-2.2%
DF-P-1C	5225	414	404	-2.4%
AH-E-18B	5228	414	398	-3.9%
MU-P-4C	5284	414	403	-2.7%
DR-P-1B	**5440**	**414**	**413**	**-0.2%**

Supplemental Case 4BEQ

Supplemental Case 4BEQ was run to determine the effect of elevated conductor temperatures due to high ambient temperatures caused by accidents. All inputs and conditions for this case were identical to Case 4B except the resistance value for Motors AH-E-1C and EF-P-2B, which were changed to reflect a 130°C conductor temperature in lieu of the 75°C temperature (Assumption 4.15). The cables subject to accident temperatures for both AH-E-1C (DAPPER Bus 4490) and EF-P-2B (DAPPER Bus 5010) are a size 4/0 power cable with a 75°C resistance of 0.0658 ohms/1000 ft. (Appendix 8.7.1 of Reference 3.2.1). Only the portion of the feeder cable inside the containment for AH-E-1C is considered as being subject to the accident temperature. Resistance at 130°C is determined as follows using the resistance conversion formula given in Reference 3.7.3.

$$R_2 = R_1 \times \left[\frac{234.5 + T_2}{234.5 + T_1} \right]$$

Where:
R_1=0.0658
T_1=75°C
T_2=130°C

Substituting and calculating:

$$R_2 = 0.0658 \times \left[\frac{234.5 + 130}{234.5 + 75} \right] = 0.0775$$

The results of Case 4BEQ are compared with case 4B as follows:

Load	Bus	Case 4BEQ	Case 4B
AH-E-1C	4490	402V	403V
EF-P-2B	5010	3723V	3723V

The effect of accident temperature effects was about the same or less than the resolution of the DAPPER program, which rounds voltage results to the nearest volt. It was therefore concluded that the accident temperature effects on cable resistance for the motors considered here are negligible.

Supplemental Cases 4BNS

This case evaluates the condition where one NS pump is operating in run out with no other NS pumps running. This represents the most severe loading on a NS pump. Since the total loading on the 480V ES bus is less than for Case 4B, the Case 4BNS voltages at loads other than the NS pump are bounded by that case. Therefore only the voltage at the running NS pump is of interest.

Case 4BNS (Appendix 8.9) shows that the voltage at NS-P-1C (Bus 5240) is 398V with a current of 169A. At 398V terminal voltage, NS-P-1C fails the 90% terminal voltage criteria (414 V) and also fails the ACC (169A actual vs. 161A maximum per Appendix 8.10 Table 4B). This condition is evaluated in Section 7.3.

7.2.5 Cases 5A-1S through 5B-5R, Minimum Grid, Two Transformer, LOCA Motor Starting

The DAPPER reports for these cases are provided in Appendix 8.9. The starting voltages for all block loads are summarized in Tables 7.2.5-1 and 7.2.5-2 and final recovery voltages determined by cases 5A5R and 5B5R are tabulated in Appendix 8.10 Tables A and B. The terminal voltage for all block loads satisfied the acceptance criteria listed in Appendix 8.5 for the two transformer Block Load Sequencing Cases. The steady state running voltages for certain motors after the completion of block loading was below the 90% terminal voltage criteria established in Section 5.6.1 (See Appendix 8.10 Tables A and B). However, these cases are bounded by the more limiting results of Case 4, which are discussed in Sections 7.2.4 and 7.3. Non-motor loads including the Inverters and Battery Chargers passed the voltage criteria given in sections 5.6.3 and 5.6.4. In all cases the 4kV ES Bus voltage recovered above the Degraded Voltage Relay maximum reset setpoint of 3806V after all starting transients (3903V for Case 5A5R and 3810V for Case 5B5R).

Table 7.2.5-1
Red Train Two Transformer Block Loading

TAG NO.	DAPPER BUS	BLOCK	VOLTS (RUN)	STARTING VOLTAGE CRITERIA		DAPPER RESULTS	CASE
MU-P-1A	4030	1	4000	80%	3200	**3754**	5A-1S
DH-P-1A	4020	1	4000	80%	3200	**3761**	5A-1S
SR-P-1A	**4650**	**1**	**460**	**80%**	**368**	**413**	**5A-1S**
RR-P-1A	4050	2	4000	75%	3000	**3835**	5A-2S
AH-E-1A	4445	2	460	80%	368	**404**	5A-2S
AH-E-1C	4490	2	460	80%	368	**403**	5A-2S
DR-P-1A	4640	3	460	75%	345	396	5A-3S
DC-P-1A	4460	3	460	75%	345	**379**	5A-3S
NS-P-1B	5270	3	460	75%	345	**372**	5A-3S
NR-P-1B	5470	3	460	75%	345	389	5A-3S
BS-P-1A	4040	4	4000	80%	3200	**3866**	5A-4S
EF-P-2A	4010	5	4000	75%	3000	**3847**	5A-5S

Table 7.2.5-2
Green Train Two Transformer Block Loading

TAG NO.	DAPPER BUS	BLOCK	VOLTS (RUN)	STARTING VOLTAGE CRITERIA		DAPPER RESULTS	CASE
MU-P-1C	5030	1	4000	80%	3200	**3670**	5B-1S
DH-P-1B	5020	1	4000	80%	3200	**3676**	5B-1S
RR-P-1B	5060	2	4000	75%	3000	**3744**	5B-2S
AH-E-1B	5223	2	460	80%	368	**391**	5B-2S
AH-E-1C	4490	2	460	80%	368	**392**	5B-2S
DR-P-1B	5440	3	460	75%	345	**385**	5B-3S
DC-P-1B	5260	3	460	75%	345	**366**	5B-3S
NS-P-1B	5270	3	460	75%	345	**364**	5B-3S
NR-P-1B	5470	3	460	75%	345	**383**	5B-3S
BS-P-1B	5050	4	4000	80%	3200	**3773**	5B-4S
EF-P-2B	5010	5	4000	75%	3000	**3753**	5B-5S

7.2.6 Cases 6A-1S through 6B-5R - Minimum Grid, One Transformer, LOCA Motor Starting

The DAPPER reports for these cases are provided in Appendix 8.9. The starting voltages for all block loads are summarized in Tables 7.2.6-1 and 7.2.6-2 and final recovery voltages determined by cases 6A5R and 6B5R are tabulated in Appendix 8.10 Tables A and B.

The starting terminal voltage for all block loads satisfied the acceptance criteria listed in Appendix 8.5 for the single transformer Block Load Sequencing Cases. The steady state running voltages for certain motors after the completion of block loading was below the 90% terminal voltage criteria established in Section 5.6.1 (See Appendix 8.10 Tables A and B). However, these cases are bounded by the more limiting results of Case 4, which are discussed in Sections 7.2.4 and 7.3. Non-motor loads including the Inverters and Battery Chargers passed the voltage criteria given in Sections 5.6.3 and 5.6.4. In all cases the 4kV ES Bus voltage recovered above the Degraded Voltage Relay maximum reset setpoint of 3806V after starting transients. Final recovery voltage after sequencing was 3856 V vs. 3806 V required for ES Bus 1D (Case 6A5R) and 3824 V vs. 3806 V required for ES Bus 1E (Case 6B5R).

Table 7.2.6-1
Red Train Single Transformer Block Loading

TAG NO.	DAPPER BUS	BLOCK	VOLTS (RUN)	STARTING VOLTAGE CRITERIA		DAPPER RESULTS	CASE
MU-P-1A	4030	1	4000	80%	3200	**3689**	6A-1S
DH-P-1A	4020	1	4000	80%	3200	**3695**	6A-1S
SR-P-1A	**4650**	**1**	**460**	**80%**	**368**	**405**	**6A-1S**
RR-P-1A	4050	2	4000	75%	3000	**3775**	6A-2S
AH-E-1A	4445	2	460	80%	368	**398**	6A-2S
AH-E-1C	4490	2	460	80%	368	396	6A-2S
DR-P-1A	4640	3	460	75%	345	**391**	6A-3S
DC-P-1A	4460	3	460	75%	345	**374**	6A-3S
NS-P-1B	5270	3	460	75%	345	**367**	6A-3S
NR-P-1B	5470	3	460	75%	345	**384**	6A-3S
BS-P-1A	4040	4	4000	80%	3200	**3817**	6A-4S
EF-P-2A	4010	5	4000	75%	3000	**3798**	6A-5S

Table 7.2.6-2
Green Train Single Transformer Block Loading

TAG NO.	DAPPER BUS	BLOCK	VOLTS (RUN)	STARTING VOLTAGE CRITERIA		DAPPER RESULTS	CASE
MU-P-1C	5030	1	4000	80%	3200	**3660**	6B-1S
DH-P-1B	5020	1	4000	80%	3200	**3666**	6B-1S
RR-P-1B	5060	2	4000	75%	3000	**3740**	6B-2S
AH-E-1B	5223	2	460	80%	368	391	6B-2S
AH-E-1C	4490	2	460	80%	368	391	6B-2S
DR-P-1B	5440	3	460	75%	345	**385**	6B-3S
DC-P-1B	5260	3	460	75%	345	367	6B-3S
NS-P-1B	5270	3	460	75%	345	364	6B-3S
NR-P-1B	5470	3	460	75%	345	**383**	6B-3S
BS-P-1B	5050	4	4000	80%	3200	**3783**	6B-4S
EF-P-2B	5010	5	4000	75%	3000	**3764**	6B-5S

7.2.7 Cases 7A, 7B - LOCA Block Load Sequencing Minimum Recovery Voltage

The DAPPER reports for these cases are provided in Appendix 8.9. The final voltages determined by cases 7A5R and 7B5R are tabulated in Appendix 8.10 Tables A and B. Both the minimum recovery voltages and the minimum transient voltages at the MOV MCCs and their feeder buses are tabulated in Table 7.2.7.

The results show that the minimum recovery voltages at MCCs for GL 89-10 MOVs required to operated during block load sequencing were as good or better than those used in Calculation C-1101-730-5350-001, Revision 6, GL 89-10 MOVs Degraded Grid Voltage Drop Calculation (Reference 3.2.6).

Reference 3.2.9 provided minimum MCC voltages required to prevent stalling of the FW-V-5 MOVs as follows:

FW-V-5A (1A-ES CC)	312V
FW-V-5B (1B-ES CC)	325V

Minimum transient voltages represented by the block load sequencing starting cases shown in Table 7.2.7 exceed the required values for all cases, thereby confirming that the FW-V-5 MOVs will not stall in accordance with Assumption 4.19.

Table 7.2.7
MOV Bus Voltage

DAPPER BUS		CASE 7A-									
		1S	1R	2S	2R	3S	3R	4S	4R	5S	5R
4000	1D-ES SWGR	**3629**	**3771**	**3714**	**3767**	3713	3763	3728	**3764**	3712	3756
4400	1P BUS	**401**	418	396	416	383	412	408	412	406	411
4420	1A-ESV CC	**393**	410	392	412	379	408	**404**	408	402	407
4440	1A-ES CC	**401**	418	395	416	382	411	407	**412**	405	411
4480	1C-ESV CC	**401**	**418**	391	414	381	410	406	410	404	409
4600	1R BUS	**402**	**428**	**421**	**427**	**385**	**420**	**415**	**420**	**413**	**419**
4620	1A-SHES CC	**401**	**428**	**421**	**427**	**385**	**419**	**415**	**419**	**413**	**419**
		CASE 7B-									
		1S	1R	2S	2R	3S	3R	4S	4R	5S	5R
5000	1E-ES SWGR	3632	3773	3712	3769	**3711**	3764	3726	3764	**3708**	3756
5200	1S BUS	401	418	395	416	381	411	407	411	404	410
5220	1B-ES	400	417	394	415	381	**410**	406	410	404	409
5280	1B-ESV CC	389	406	388	409	375	405	400	405	398	404
4480	1C-ESV CC	400	417	390	414	379	409	405	409	402	408
5400	1T BUS	**412**	**428**	**421**	**428**	**384**	**420**	**415**	**420**	**413**	**418**
5420	1B-SHES CC	**411**	**428**	**421**	**427**	**384**	**419**	**415**	**419**	**413**	**418**

7.2.8 Cases 8A, 8B – Long Term Post LOCA

The DAPPER reports for these cases are provided in Appendix 8.9, and partial results are tabulated in Appendix 8.10. Motor loads were evaluated with respect to the 90% voltage criteria and the alternate acceptance criteria based on full load current described in Section 5.6.1. A voltage of 423 V on 480V ES Buses 1P and 1S results in less than 90% of rated voltage at some motor loads. Each of these motor loads passed the alternate current criteria as shown in Appendix 8.10, Tables 8A and 8B, except NS-P-1C, which is justified in Section 7.3. Non-motor loads such as the Inverters and Battery Chargers passed the voltage criteria given in Sections 5.6.3 and 5.6.4. It is therefore concluded that the 480V bus low voltage alarms and appropriate operator response are adequate to assure acceptable voltage to NSR loads downstream of the 4160V ES buses in the long term post LOCA situation.

7.2.9 Cases 9A-9B – Minimum Grid, Tap Change

DAPPER runs for Cases 9A and 9B (Appendix 8.9) show that total plant auxiliary loading of (45 MW) described in Reference 3.5.8 could result in voltage lower than the degraded voltage relay maximum reset setting (3806 V) during tap change operations at low system voltage. The degraded voltage relay reset setting is normally used as the criteria for grid separation prevention. DAPPER cases were run with all five 4KV buses and the entire Turbine Plant and Reactor Plant load connected to each transformer, with the transformer in the 230 KV tap, and switchyard voltage at 232 KV. ES bus loading was based on normal operating loads on one bus and estimated normal loading less swing loads on the other bus, as follows:

Case 9A	Bus 1E Estimated Load –1502 KVA @ .88 PF lagging
Case 9B	Bus 1D Estimated Load - 2095 KVA @ .88 PF lagging

Loading on TP bus 1A was varied until a minimum voltage of 3806V was achieved on either ES bus. Case 9B showed a maximum permissible Aux Transformer 1A loading of 41,876 KW (DAPPER Bus 3), and Case 9A showed a maximum permissible Aux Transformer 1B (DAPPER Bus 3) loading of 43,601 KW. These results demonstrate that the ES buses are more vulnerable to grid separation when fed from Aux Transformer 1A. They also demonstrate that grid separation of the ES buses could occur during tap change operations with the simultaneous occurrence of maximum positive degraded voltage relay error, low system voltage and plant loading above 41,876 KW.

Voltages at the terminals of NSR equipment are similar to Case 3 since both Cases 3 and 9 used a 4160 V ES bus voltage of 3806 and the same downstream loading.

7.2.10 Case 10 - Model Validation

In order to validate the methods and assumptions used in this study, a comparison of voltage readings predicted by DAPPER was compared with actual field measurements. Load measurements were taken at various plant buses in order to obtain input data for a DAPPER test case that would duplicate as nearly as practicable the observed field conditions (Reference 3.1.5). Voltage and current measurements were made at ES Buses 1E, 1S, 1T, 1B ES and 1B ES SH, TP Buses 1A and 1B and RP Bus 1A. Feeder loads and average L-L voltage were calculated from the field voltage and current readings using standard power formulas, and were tabulated in Table 7.2.10-1.

GPU NUCLEAR

CALCULATION SHEET
(Ref. EP-006T)

Subject:	Calculation No.	Rev. No.	System Nos.	Sheet
TMI-1 AC Voltage Regulation Study	C-1101-700-E510-010	2	700	61 of 77

Table 7.2.10-1

(1) BUS 1E				
POWER ANALYZER DATA		KVA / PHASE	SUMMARY	
VOLTS (L-N)	AMPS		VOLTS (L-L, POWER ANALYZER)	4116.5
2380	229	545.0	KVA (TOTAL)	1630.4
2380	230	547.4	P.F.	0.89
2370	227	538.0	SWITCHYARD VOLTS	235.31

(2) 5000 BUS 1E to 5100 BUS 1S PRI				
POWER ANALYZER DATA		KVA / PHASE	SUMMARY	
VOLTS (L-N)	AMPS		VOLTS (L-L, POWER ANALYZER)	4128.1
2380	80.7	192.1	KVA (TOTAL)	571.8
2390	80.5	192.4	P.F.	0.87
2380	78.7	187.3	SWITCHYARD VOLTS	235.39

(3) 5000 BUS 1E to 5300 BUS 1T PRI				
POWER ANALYZER DATA		KVA / PHASE	SUMMARY	
VOLTS (L-N)	AMPS		VOLTS (L-L, POWER ANALYZER)	4128.1
2380	75.8	180.4	KVA (TOTAL)	541.0
2400	75.7	181.7	P.F.	0.86
2370	75.5	178.9	SWITCHYARD VOLTS	235.35

(4) 5200 BUS 1S to 5220 BUS 1B				
POWER ANALYZER DATA		KVA / PHASE	SUMMARY	
VOLTS (L-N)	AMPS		VOLTS (L-L, POWER ANALYZER)	467.1
270	402	108.5	KVA (TOTAL)	328.7
271	417	113.0	P.F.	0.89
268	400	107.2	SWITCHYARD VOLTS	235.57

(4A) 5220 BUS 1B				
DVM DATA			SUMMARY	
VOLTS (L-L)			VOLTS (L-L,DVM)	465.6
465.5				
466.0				
465.2			SWITCHYARD VOLTS	235.46

Table 7.2.10-1 (Continued)

(5) 5400 BUS 1T to 5420 BUS 1B SHES

POWER ANALYZER DATA		KVA / PHASE	SUMMARY	
VOLTS (L-N)	AMPS		VOLTS (L-L, POWER ANALYZER)	470.0
271	50.5	13.7	KVA (TOTAL)	40.9
272	46.6	12.7	P.F.	0.8
271	53.7	14.6	SWITCHYARD VOLTS	236.85

(5A) 5420 BUS 1B SHES

DVM DATA			SUMMARY	
VOLTS (L-L)			VOLTS (L-L,DVM)	468.7
469.0				
469.1				
468.1			SWITCHYARD VOLTS	236.74

(6) 100 RP BUS 1A

POWER ANALYZER DATA		KVA / PHASE	SUMMARY	
VOLTS (L-N)	AMPS		VOLTS (L-L, POWER ANALYZER)	7107.2
4100	1120	4592.0	KVA (TOTAL)	13787.3
4110	1130	4644.3	P.F.	0.9
4100	1110	4551.0	SWITCHYARD VOLTS	236.81

(7) 1000 TP BUS 1A

POWER ANALYZER DATA		KVA / PHASE	SUMMARY	
VOLTS (L-L)	AMPS		VOLTS (L-L, POWER ANALYZER)	4133.3
4150	1160	2779.4	KVA (TOTAL)	8257.1
4140	1160	2772.7	P.F.	0.86
4110	1140	2705.1	SWITCHYARD VOLTS	235.8

(8) 2000 TP BUS 1B

POWER ANALYZER DATA		KVA / PHASE	SUMMARY	
VOLTS (L-L)	AMPS		VOLTS (L-L, POWER ANALYZER)	4133.3
4150	667	1598.1	KVA (TOTAL)	4741.8
4140	662	1582.3	P.F.	0.85
4110	658	1561.4	SWITCHYARD VOLTS	235.95

Voltage readings for the 230 kV switchyard, as recorded by the Plant Process Computer, were obtained for times concurrent with bus voltage readings (Reference 3.1.5). Voltage variation at the 230 kV switchyard observed during field measurements was 234.863 kV to 236.85 kV. This represents a variation of approximately 0.839%. Since variations in bus voltage could affect the load KVA actually measured, the observed variations in switchyard voltage were evaluated to determine whether they could have an adverse effect on the results. Loads tabulated in Appendix 8.1 consist of both constant KVA loads and constant impedance loads, although they consists predominantly of constant KVA loads. Field measurements, however, did not discern the relative proportions of constant KVA and constant impedance loads. Since the loads are predominantly constant KVA, small variations in voltage will have relatively little effect on field KVA measurements. However, in order to compensate for whatever small effect may be present due to the presence of constant impedance loads, the grid voltage used for the DAPPER case was set at the maximum value observed during field measurements (236.85 kV), and all loads were entered as the constant KVA type. This minimized feeder currents and voltage drops and predicted higher voltages relative to the normalized field measurements. This is a conservative approach because prediction by DAPPER of higher voltages than field measurements is considered undesirable for purposes of this comparison.

Field load measurements included feeder loads to the Green Train ES Buses and large BOP buses, but did not include separate measurements of all loads that contribute to the feeder loads. DAPPER calculates upstream feeder loads based on a vector summation of downstream loads. Consequently, the upstream feeder loads could not be entered directly into DAPPER. In order to reproduce in DAPPER the observed field loading values (including power factor), additional loads were applied to appropriate DAPPER buses as lumped loads. For simplicity, these loads were assumed to be constant KVA loads. This was reasonable since this DAPPER case considered a single input voltage, and the type of loading does not affect results as long as the feeder loads and power factor are correct. For the BOP buses there were no measurements downstream of the bus feeder so the observed loading was entered directly into DAPPER.

The field measured upstream loads which acted as constraints in the determination of the additional end use loads were as follows:

Table 7.2.10-2

FROM (DAPPER BUS)	TO	KVA	PF
34 DISTA3-LOW	5000 1E-ES	1630	0.89
5000 1E-ES SWGR	5100 1SPRI	572	0.87
5000 1E-ES SWGR	5300 1TPRI	541	0.86

The additional end use loads (determined by trial and error) and field measured loads (Section 5.8) used as direct input to DAPPER were as follows:

Table 7.2.10-3

FROM (DAPPER BUS)	TO	KVA	PF
5000 1E-ES SWGR	1E-ES END USE LOAD	520.5	0.93
5200 1S BUS	5220 1B-ES CC (Measured)	328.7	0.89
5200 1S BUS	1S BUS END USE LOAD	243.5	0.85
5400 1T BUS	5420 1BSHES CC (Measured)	40.9	0.8
5400 1T BUS	1T BUS END USE LOAD	500.3	0.87
14 DIST-HIGH	100 1A-RP SWGR (Measured)	13787.3	0.9
31 DIST-LOW	1000 1A-TP SWGR (Measured)	8257.1	0.86
33 DISTA2-LOW	2000 1B-TP SWGR (Measured)	4741.8	0.85

The results of the DAPPER calculations are provided in Appendix 8.9 and are summarized in Table 7.2.10-4. As was noted above, switchyard voltage fluctuated during the period that field measurements were taken but the DAPPER study was performed at a single voltage. Consequently, measured voltages were normalized to the highest measured switchyard voltage and the DAPPER study was also performed with this voltage at the switchyard bus. The measured voltage (normalized) was compared with the calculated voltage. As can be seen from Table 7.2.10-4, DAPPER predicted a lower voltage than expected for all cases except items 1, 7, and 8. Items 7 and 8 pertain to non-safety related buses and the voltage discrepancies in the DAPPER predicted voltages are extremely small. Consequently, a slightly non-conservative voltage calculation for these buses will have no adverse effect on the safety-related portions of this calculation. The results for item 1 (ES Bus 1E) are acceptable because items 2 and 3 are also for ES Bus 1E and show conservative results. It was concluded that the reading for item 1 was taken during a period of fluctuating switchyard voltage so a representative value was not obtained (Reference 3.5.7).

Table 7.2.10-4

ITEM	DAPPER BUS	MEASURED VOLTAGE	GRID VOLTAGE	CORR. FACTOR (236.85/GRID)	EXPECTED VOLTAGE	CALC. VOLTAGE (DAPPER CASE 10)	DIFFERENCE	% DIFFERENCE
1	5000 1E-ES SWGR	4116.5	235.31	1.0065	4143.4	4153	9.6	0.23
2	5000 1E-ES SWGR	4128.1	235.39	1.0062	4153.7	4153	-0.7	-0.02
3	5000 1E-ES SWGR	4128.1	235.35	1.0064	4154.4	4153	-1.4	-0.03
4	5200 1S BUS	467.1	235.57	1.0054	469.6	469	-0.6	-0.13
4A	5220 1B-ES CC	465.6	235.46	1.0059	468.3	468	-0.3	-0.07
5	5400 1T BUS	470.0	236.85	1.0000	470.0	468	-2.0	-0.42
5A	5420 1BSHES CC	468.7	236.74	1.0005	469.0	468	-1.0	-0.20
6	100 1A-RP SWGR	7107.2	236.81	1.0002	7108.4	7064	-44.4	-0.63
7	1000 1A-TP SWGR	4133.3	235.80	1.0045	4151.7	4155	3.3	0.08
8	2000 1B-TP SWGR	4133.3	235.95	1.0038	4149.1	4154	4.9	0.120

7.2.11 Cases 11A and 11B Maximum Voltage Short Circuit Study Case

The DAPPER reports for these cases are provided in Appendix 8.9. Tables 7.2.11A and 7.2.11B contain a summary of bus voltages for maximum switchyard voltage (242 kV) and maximum motor loading.

Table 7.2.11A

CASE 11A				
DAPPER BUS	BUS NAME	RATED VOLTAGE	CALCULATED VOLTAGE	P.U. VOLTAGE
3	GRID	230000	242004	1.05
100	1A-RP SWGR	6900	7006	1.02
200	1B-RP SWGR	6900	7007	1.02
1000	1A-TP SWGR	4160	4088	0.98
2000	1B-TP SWGR	4160	4085	0.98
3000	1C-TP SWGR	4160	4082	0.98
4000	1D-ES SWGR	4160	4079	0.98
4100	1NPRI	4160	4078	0.98
4200	1N BUS	480	461	0.96
4300	1PPRI	4160	4077	0.98
4400	1P BUS	480	450	0.94
4420	1A-ESV CC	480	448	0.93
4430	1A-ESF CC	480	448	0.93
4440	1A-ES CC	480	449	0.94
4480	1C-ESV CC	480	449	0.94
4500	1RPRI	4160	4068	0.98
4600	1R BUS	480	457	0.95
4620	1A-SHES CC	480	457	0.95
6010	PENTRATN-C	480	448	0.93
6020	PENTRATN-A	480	448	0.93

TABLE 7.2.11B

CASE 11B				
DAPPER BUS	BUS NAME	RATED VOLTAGE	CALCULATED VOLTAGE	P.U. VOLTAGE
3	GRID	230000	242004	1.05
100	1A-RP SWGR	6900	6975	1.01
200	1B-RP SWGR	6900	6974	1.01
1000	1A-TP SWGR	4160	4059	0.98
2000	1B-TP SWGR	4160	4055	0.97
3000	1C-TP SWGR	4160	4052	0.97
4480	1C-ESV CC	480	444	0.93
5000	1E-ES SWGR	4160	4050	0.97
5100	1SPRI	4160	4049	0.97
5200	1S BUS	480	446	0.93
5220	1B-ES CC	480	445	0.93
5280	1B-ESV CC	480	443	0.92
5290	1B-ESF CC	480	442	0.92
5300	1TPRI	4160	4040	0.97
5400	1T BUS	480	454	0.95
5420	1B-SHES CC	480	454	0.95
6000	PENTRATN-B	480	443	0.92
6010	PENTRATN-C	480	444	0.93

7.3 Evaluation of Low Terminal Voltage

The DAPPER cases discussed in Section 7.2 demonstrated that several loads may experience terminal voltage below the criteria established in Section 5.6. Most of these cases relate to Cases 4A and 4B for short term LOCA operation. Cases 4A and 4B results show that the grid conditions necessary to achieve a voltage on the 4160V buses equal to the minimum dropout setting of the degraded voltage relay (3727V), are outside the design criteria of the plant. Case 4A requires a switchyard voltage of 225.49 kV with single transformer operation to achieve 3727V on ES Bus 1D while Case 4B requires a switchyard voltage of 227.01 kV to achieve 3727V on ES Bus 1E. Both of these values are below the minimum expected voltage of 232kV cited in SDD-T1-000 (Reference 3.3.1). Two transformer cases with 3727 on the ES buses were not performed, but these would be bounded by Cases 7A and 7B which consider higher voltage on the 4160V ES buses (3756V). Even with this higher voltage on the 4160V ES buses, Switchyard voltage must still fall below the single contingency voltage of 224.7kV cited in SDD-T1-000 (215.97 kV for case 7A-5R and 220.66 kV for case 7B-5R). Therefore, in accordance with Assumption 4.13, voltages calculated in Cases 4A and 4B are not expected to occur for extended periods for either the one or two transformer operation.

Evaluations of specific loads with voltage deficits identified in Section 7.2 are as follows.

Diesel Generator Skid Components

Case 2B	5229	1B-DG-SKID	402V vs. 414V required
Case 3A	4450	1A-DG SKID	405V vs. 414 V required
Case 3B	5229	1B-DG SKID	398V vs. 414 V required

The most limiting voltage results are represented by Case 3B. This is also the most limiting cases from an operational standpoint because during the Short Term Post LOCA case represented by Cases 4A and 4B, the diesels are assumed to be running and do not require support provided by the skid auxiliaries (Assumption 4.24).

During normal operation, the minimum expected voltage available to the diesel generator auxiliaries is determined in Cases 3A and 3B. These cases consider a minimum voltage on the 4160V ES buses of 3806V. Although this is a ceiling for degraded voltage relay reset setting, it may be considered a floor (minimum) for ES bus voltage during normal operation since BOP load and system voltage will be managed by controlling load and switchyard voltage to assure that this minimum value is not violated (Reference 3.1.4). Any excursions below this value will be brief and will have no adverse effect on system operation (Assumption 4.13).

Diesel generator skid loads consist of the following circuits (References 3.6.9 and 3.6.14):

Circuit 1:	Generator Space Heater (3KW)
Circuit 2:	500 VA, 480/120V/ 1 ph Transformer
Circuit 3:	Lube Oil Pump (EG-P-3A/B)
Circuit 4:	Pre-Lube Pump (EG-P-5A/B)
Circuit 5:	Jacket Coolant Heater (EG-H-1A/B) (24KW)
Circuit 6:	Jacket Coolant Pump (EG-P-8A/B)

Based on Case 3B voltages, heater circuits 1 and 5 will receive approximately 83% of rated voltage, which will only result in reduced heating output and longer energization time (Assumption 4.12). Circuit 2 serves the engine hour meter which is not essential, and the Gear Box Heater. Circuit 4, Pre-Lube Pumps (EG-P-5A/B), are manually started and are not used in standby or emergency operation. The Lube Oil Pumps (EG-P-3A/B) (S.F. 1.15) and the Jacket Coolant Pumps EG-P-8A/B (Service Factor = 1) pass on the alternate current criteria for Cases 3A and 3B, based on field current readings (References 3.5.10 and 3.5.11). In addition, loss of either of these components will result in an alarm due to low lube oil pressure or temperature (References 3.6.15 and 3.6.16). For these reasons, temporary low voltage on these circuits will not degrade the diesels and is considered acceptable.

Control Building Emergency Vent Supply Fans

Case 4A	4449	AH-E-18A	403 V vs. 414 V required
Case 4B	5228	AH-E-18B	398 V vs. 414 V required

AH-E-18A fails Case 4A on voltage criteria, and fails ACC by a small margin (68.05 vs. 67.85A maximum). AH-E-18B fails Case 4B on voltage criteria and also fails ACC (74.13A vs. 71.88A maximum). The fans are off for non-LOCA cases and are manually applied loads which may be required for Control Room Habitability following an accident with a radiological release.

Westinghouse Report RRS/DSE(99)-298 (Reference 3.4.12) determined that the AH-E-18A motor (S.O. 71C14434) could start and operate at a voltage of 398V and a current of 74.37 A without exceeding the motor thermal limits. The report determined that the AH-E-18B motor (S.O. 81C35875) could operate at a voltage of 398V and a current of 74.74A without exceeding the motor thermal limits. These conditions meet or exceed the conditions determined in Cases 4A and 4B. Also, in accordance with Assumption 4.13, the extreme low voltage conditions postulated in Cases 4A and 4B are not expected to persist for extended periods of time. Therefore, by engineering judgement, these motors are considered to be acceptable.

AH-E-29A Diesel Generator Room Supply Fan (North)

Case 4A 4443 AH-E-29A 391 V vs. 414V required

This fan fails Case 4A on voltage criteria (391V vs. 414V required). Also fails Case 4A on alternate current criteria (38.26 amps calculated vs. 37.375 amps maximum). It passes Case 3A alternate current criteria.

This fan is required to maintain the North Diesel Generator Room within its required temperature specifications during diesel generator operation. Since Case 4A involves supplying the ES bus from the 1B Auxiliary Transformer, the diesel will not be loaded and the fan will not be required to dissipate heat from a loaded diesel generator. Even though the diesel will start at the initiation of a LOCA, it will not be automatically loaded as long as offsite power is available. Since the motor passes the Case 3A criteria, it will operate satisfactorily up to the time of the accident.

Reference 3.4.12 determined that the AH-E-29A motor (S.O. 70D66866) could start and operate at a voltage of 390V, and could draw a current of 39.44 without exceeding the motor thermal limits. These conditions meet or exceed the conditions determined in Case 4A. Also, in accordance with Assumption 4.13, the extreme low voltage conditions postulated in Case 4 are not expected to persist for extended periods of time. Therefore, by engineering judgement, these motors are considered to be acceptable.

In addition, TDR 900 (Reference 3.2.4) determined that the maximum allowable Diesel Generator Room temperature of 120° F would not be reached for 72 hours following a loss of DG building HVAC, provided that certain doors were opened to increase airflow to the DG rooms within approximately one hour of the loss of HVAC. Procedure 1104-24M (Reference 3.1.19) provides for this alternate ventilation. Therefore, temporary loss of Diesel Generator Room ventilation due to inadequate voltage to AH-E-29A would also be acceptable.

Control Building Booster Fans AH-E-95A/B

Case 4A	4447	AH-E-95A	406V vs. 414 V required
Case 4B	5224	AH-E-95B	405V vs. 414 V required

AH-E-95A and AH-E-95B fail Case 4A and 4B, respectively, on voltage criteria. Since the motors are Totally Enclosed Air Over, they do not have a service factor with which to apply ACC.

Reference 3.4.12 determined that the AH-E-95A/B motors (S.O. 71D12380) could start and operate at a voltage of 405V without exceeding motor thermal limits. These conditions meet or exceed the conditions determined in Cases 4A and 4B. Therefore, by engineering judgement, these motors are considered to be acceptable.

Diesel Generator Fuel Pumps

Case 4A	4446	DF-P-1A	406 V vs. 414 V required
Case 4B	5225	DF-P-1C	404 V vs. 414 V required

These pumps are under automatic control and run based on Day Tank level, thus they will not be running continuously (Reference 3.6.9 and 3.6.14).

The motors for DF-P-1A/C are rated for a service factor of 1.00 at an ambient temperature of 65°C and for a service factor of 1.15 at an ambient temperature of 40°C (Reference 3.5.15). Per ES-010 (Reference 3.7.15) the aging temperature for the Diesel Generator Building is 95°F (35°C) and the accident temperature is 122°F (50°C). The accident temperature is based on TDR No. 900 (Reference 3.2.4), which addresses loss of ventilation conditions with the diesel running at full load.

The Cases 4A and 4B operating conditions assume that the diesel is running under a full speed, no load condition, with the offsite power source supplying the ES Buses. Operating Procedures 1107-3 (Reference 3.1.13) and 1107-2 (Reference 3.1.2) caution against running the diesel for extended periods of time at no load; therefore the diesel will either be shut down, or if voltage can not be improved, the affected bus will be transferred to the diesel per Abnormal Procedure 1203-41 (Reference 3.1.4). If the diesel is shut down the demand for the fuel oil pump would be intermittent based on tank level and the pump would not be running continuously under reduced voltage conditions. Since the ambient temperature would be less than 50°C, there is margin built into the motor. If the AC motor would fail, the DC pump would be available.

Therefore, based on engineering judgement the temporary low voltage condition for these motors is considered to be acceptable.

Make-up Pump Gear Oil Pumps

Case 4A	4424	MU-P-4A	405 V vs. 414 V required
Case 4A	4488	MU-P-4B	405 V vs. 414 V required
Case 4B	4488	MU-P-4B	404 V vs. 414 V required
Case 4B	5284	MU-P-4C	403 V vs. 414 V required

The MU/HPI Pumps (MU-P-1A/B/C) are driven by a 1800 RPM motor through a gear drive unit at 6800 RPM. The gear drive unit is lubricated and cooled through an oil recirculation system. The gear drive oil system has redundant oil pump MU-P-4 & MU-P-5. These pumps are identical positive displacement pumps with capacity of 7.7 GPM at 1800 RPM. MU-P-4A/B/C is driven by an AC motor. MU-P-5 is driven from the gear drive low speed shaft (@ 1800 RPM). MU-P-4 provides redundant capability which protects the gear drive unit in the case of the shaft driven pump failure.

The shaft driven pumps MU-P-5A/B/C are not susceptible to any known common mode failures. The MU pump oil systems for MU-P-1A, B & C are functionally and physically independent. MU-P-5 A,B,C alone can provide all of the required gear unit cooling and lubrication. The operation of MU-P-4A,B,C is not required for the MU pumps and the HPI system to perform its ECCS function. Therefore, the temporary low voltage at and/or tripping of these motors is acceptable. (References 3.4.8, 3.5.14)

<u>Nuclear Service River Water Pump Discharge Strainers</u>

Case 4A	4487	NR-S-1B	401 V vs. 414 V required
Case 4B	4487	NR-S-1B	400 V vs. 414 V required

The NR-S-1B motor has a service factor of 1.0 and was analyzed to be operating a nameplate current. Therefore the ACC could not be satisfied for this motor. Current and voltage readings taken on 12/10/98 recorded in the TMI Maintenance Log (Reference 3.7.8) shows that the NR-S-1B strainer motor current was 1.89 amps with normal river conditions. Voltage was 460 V. The corresponding motor current at 400 V would be 2.17 amps. The motor full load current is 2.3 amps. Under normal river conditions the motor current will typically be less than nameplate current.

The Thermal Overload heater (TOL) for this motor is a Westinghouse H26 with a minimum trip current of 2.95 amps (Reference 3.2.8). With the motor running at rated horse power the worst case motor current per Table 4A is 2.45 amps which is less than the TOL minimum trip current. Therefore the motor will not trip on TOL if operating under Case 4A/B conditions. Based on reference 3.4.9, operation at 2.45 amps for a period of 8 hours will not damage the motor. Also, in accordance with Assumption 4.13 the voltage is not expected to hover near the minimum dropout setpoint of the degraded voltage relays for an extended period of time, as was modeled in Case 4. Therefore, by engineering judgement, this load is considered to be acceptable.

Nuclear Service Closed Cooling Water Pumps

Case 4BNS	5240	NS-P-1C	398 V vs. 414 V required
Case 8B	5240	NS-P-1C	413 V vs. 414 V required

NS-P-1C fails the primary voltage criteria and the ACC for the cases shown above. The worst case current for case 4BNS is approximately 169A vs. a maximum service factor current of 161A (1.15 X 140A). Data from the motor vendor indicates that the motor is actually capable of operating at a voltage of 395V and 130HP without exceeding its rated temperature rise (Reference 3.4.12). These conditions bound the conditions modeled in Case 4BNS and are considerably worse than the conditions modeled in Case 8B. Also, in accordance with Assumption 4.13 the voltage is not expected to hover near the minimum dropout setpoint of the degraded voltage relays for an extended period of time, as was modeled in Case 4. Therefore, by engineering judgement, these loads are considered to be acceptable.

Decay Heat River Water Pumps

Case 4B	5440	DR-P-1B	413 vs. 414 required

DR-P-1B fails the primary voltage criteria and the ACC for the case shown above. The worst case current for Case 4B is approximately 273.72A vs. a maximum service factor current of 264.5A (1.15 X 230A). Data from the motor vendor (Reference 3.4.13) indicates that the motor is actually capable of operating at a voltage of 410V and 210HP for 8 hours with minimal reduction in motor life. These conditions bound the conditions calculated in Case 4B. In accordance with Assumption 4.13 the voltage is not expected to hover near the minimum dropout setpoint of the degraded voltage relays for an extended period of time, as was modeled in Case 4. Therefore, by engineering judgement, this load is considered to be acceptable.

7.4 Evaluation of Bus Current Results

Tables 7.4-1 and 7.4-2 summarize the bus current for the 5KV bus duct from the auxiliary transformers to the 4KV ES busses as well as the current for all NSR switchgear and MCCs. Bus current values listed in the tables were taken from selected DAPPER cases judged to capture the worst case steady state current for each of the buses listed. All buses passed the acceptance criteria listed in Section 5.7 except 5000v Bus Duct 41 which had a worst case current of 4075 A vs. a 40°C rating of 4072. The postulated current is only slightly above the 40°C rating used for determination of bus duct resistance, and will cause negligible additional heating or increase in resistance. Therefore, by engineering judgement, this condition is considered to be acceptable.

TABLE 7.4-1 TRAIN A BUS CURRENT (AMPERES)

BUS NO	BUS NAME	CASE 2A	CASE 3A	CASE 3ASUP	CASE 4A	CASE 6A5R	CASE 8A	CASE 9A	ACCEPTANCE CRITERIA (SECTION 5.7)	REMARKS
41	1B-LOW	**1905**	**4328**	***4075***	**3904**	**3862**	**3773**	**3250**	4072	Calvert G
42	1B1-LOW	**1905**	**2694**	**2669**	**2912**	**2860**	**2816**	**2925**	4072	Calvert G
43	1B2-LOW	**1905**	**1831**	**1815**	**2032**	**2009**	**1967**	**2063**	3876	Calvert E
44	1B3-LOW	**420**	**433**	**429**	**782**	**757**	**762**	**664**	2308	Calvert C
4000	1D-ES SWGR	**420**	**433**	**429**	**782**	**757**	**762**	**437**	917	Calvert B
4000	1D-ES SWGR	**420**	**433**	**429**	**782**	**757**	**762**	**437**	1200	
4400	1P BUS	**1472**	**1514**	1501	1532	**1484**	**1551**	1547	1600	
4440	1A-ES CC	**842**	871	862	699	549	**886**	876	1600	
4420	1A-ESV CC	124	124	124	**125**	223	73	124	1200	
4430	1A-ESF CC	**47**	46	47	45	46	6	46	600	
4480	1C-ESV CC	**177**	183	181	139	156	134	183	1200	
4600	1R BUS	**653**	**675**	**668**	**977**	**949**	**939**	**675**	1600	
4620	1A-SHES CC	**91**	94	93	**102**	106	**98**	94	600	

TABLE 7.4-2 TRAIN B BUS CURRENT (AMPERES)

BUS NO	BUS NAME	CASE 2B	CASE 3B	CASE 3B1	CASE 4B	CASE 6B5R	CASE 8B	CASE 9B	ACCEPTANCE CRITERIA (SECTION 5.7)	REMARKS
31	DIST-LOW	**2716**	3975	**4043**	**3824**	**3816**	**3690**	**2952**	4072	Calvert G
32	DISTA1-LOW	**1272**	2605	**2605**	**2832**	**2805**	**2732**	**2925**	4072	Calvert G
33	DISTA2-LOW	**369**	1742	**1743**	**1952**	**1947**	**1882**	**2063**	3876	Calvert E
34	DISTA3-LOW	**369**	343	**344**	**702**	**684**	**675**	**664**	2308	Calvert C
5000	1E-ES SWGR	**369**	343	**344**	**702**	**684**	**675**	347	917	Calvert B
5000	1E-ES SWGR	**369**	343	**344**	**702**	**684**	**675**	347	1200	
5200	1S BUS	**1459**	1468	**1469**	**1580**	**1536**	**1501**	1497	1600	
5220	1B-ES CC	**811**	817	**817**	**696**	569	802	817	1200	
5280	1B-ESV CC	132	132	**132**	**132**	241	80	132	600	
5290	1B-ESF CC	51	50	**50**	**49**	50	11	50	600	
4480	1C-ESV CC	**181**	182	**182**	139	158	134	183	1200	
5400	1T BUS	**910**	672	**672**	**974**	**954**	**937**	672	1600	
5420	1B-SHES CC	**103**	103	**103**	**112**	116	**107**	**102**	600	

7.5 Evaluation of 480 Volt Unit Substation Transformer Loading Results

Neither the 1P nor the 1S 480 V USS Transformer exceeded their forced air cooled load rating of 1333 KVA or their high ambient temperature de-rated loading levels of 1271 KVA and 1253 KVA, respectively (Assumption 4.32), for any loading scenario (See Appendix 8.9 DAPPER runs).

8.0 Appendices

8.1 Load Tables for Steady State Operation (25 Pages)
8.2 DAPPER Load Types (2 Pages)
8.3 Detailed Case Descriptions (6 Pages)
8.4 Determination of Degraded Voltage Relay Tolerances (17 Pages)
8.5 Motor Starting Loads and Voltage Criteria (1 Page)
8.6 Reactor Plant and Turbine Plant Bus Historical Loading Data (6 Pages)
8.7 Turbine Plant Load Reduction on Plant Trip (3 Pages)
8.8 MOV Loads (9 Pages)
8.9 DAPPER Printouts (4157 Pages)
8.10 Tabulation of Results (8 Pages)
8.11 Permissible Turbine Plant Loading With Low Grid Voltage (1 Page)

GPU NUCLEAR

CALCULATION
VERIFICATION PLAN/SUMMARY SHEET

(Ref. EP-006T)

Subject:	Calculation No.	Rev. No.	System Nos.	Sheet:
TMI-1 AC Voltage Regulation Study	C-1101-700-E510-010	2	700	76 of 77

PLAN

Scope of Verification:

Item No.	Method/Depth of Verification Required	Req'd. Comp. Date
1	(Check Applicable Boxes) Design Review ☒ Alternate Calculation ☐ Qualification Test ☐ Other ☐ (Specify below)	12-30-99

Assigned Verification Engineer H. A. Robinson

Other Verification Engineer

Section Manager (*Sign*) P. R. Panicker/ Ravi Panicker — Date 12-10-99

SUMMARY

Summary of verification scope, methods, results and conclusions:

The changes made by Revision 2 of this calculation were verified using design review methodology and included a review of the purpose, summary of results, references, assumptions, design input, overall approach and methodology, calculations, and the appendices. Verification of Revisions 0 and 1 are addressed by previous design reviews.

<u>Results:</u> The following concerns were noted in the design review:

1. Assumption 4.26 indicates that instrument air compressors will not be operating during normal plant conditions just prior to an accident. This assumption is inconsistent with the design basis loading calculation of Reference 3.2.2, and does not agree with plant procedures or normal operation when IA-P-4 is out of service. The comparison to SSM data indicates that the loading used in the calculation is reasonable, and provides margin for the additional loading of a compressor. Therefore the calculation and assumption are acceptable. This inconsistency presents a documentation problem as the design basis loading for safety related buses, and the methodology for determining steady state load, is different between the two calculations.

---Continued on attached sheet---

Based on this evaluation, the calculation is verified to be acceptable.

APPROVALS (Sign)

Assigned Verification Engineer H. A. Robinson/	Date 12/22/99
Other Verification Engineer	Date

Use Additional Sheets if Necessary

CALCULATION
VERIFICATION PLAN/SUMMARY SHEET

2. Assumption 4.30 indicates that two secondary river water pumps could be operating from 480V Bus 1T per the modification of Reference 3.7.12, and considers two pumps running for normal plant operation in Cases 1B and 2B. The assumption is inconsistently applied since normal plant operation is also addressed in Cases 3B and 9B, and these cases do not consider two SR pumps running. The reliance on SSM data to justify reasonable plant loading for these two cases is an acceptable method of determining bus loading, therefore the calculation is acceptable. But this inconsistency presents a documentation problem since design basis loading is different for normal operation cases within the same calculation. The lack of two SR pumps running for Cases 3B and 9B is also not consistent with the basis for the modification of Reference 3.7.12.

Based on this design verification and the resolution of comments, the calculation is considered to be technically acceptable.

HAR
H. A. Robinson - 12/22/99

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CALCULATION VERIFICATION CHECKLIST
(Ref. EP-006T)

Subject:	Calculation No.	Rev. No.	System Nos.	Sheet:
TMI-1 AC Voltage Regulation Study	C-1101-700-E510-010	2	700	77 of 77

Place an "X" in the applicable box (Yes, No, N/A) for each item.

A "NO" response may indicate that the design or verification is incomplete and may require a CAP to be assigned by the responsible Section Manager. The Section Manager shall review each "NO" response to determine if the "NO" response requires further investigation.

A "N/A" (Not Applicable) response does **not** require any further action by the Verification Engineer.

The Verification Summary (Exhibit 7A) may be used to outline the Verification Engineer's work or to document comments that are deemed appropriate by the Verification Engineer.

ITEMS	Review Check Design Compliance		
	Yes	No	N/A
1. **Design Input and Data** – Were the inputs correctly selected, referenced (latest revision) and incorporated into the calculation?	☒	☐	☐
2. **Assumptions** – Are assumptions necessary to perform the calculation adequately described and reasonable?	☒	☐	☐
3. **Regulatory Requirements** – Are the applicable codes and standards and regulatory requirements, including issue and addenda, properly identified and their requirements met?	☒	☐	☐
4. **Construction and Operating Experience** – Has applicable construction and operating experience been considered?	☒	☐	☐
5. **Interfaces** – Have the design interface requirements been satisfied?	☐	☐	☒
6. **Methods** –Is the appropriate calculation method used?	☒	☐	☐
7. **Output** – Is the output reasonable compared to the inputs?	☒	☐	☐
8. **Acceptance Criteria** – Are the acceptance criteria incorporated in the calculation sufficient to allow verification that the design requirements have been satisfactorily accomplished?	☒	☐	☐
9. **Radiation Exposure** – Has the calculation properly considered radiation exposure to the public and plant personnel?	☐	☐	☒

Comments:

See Calculation Verification Summary Sheet.

Use Additional Sheets if Necessary

APPENDIX 8.1
TABLE 1D
Loading of 4.16 KV (ES) Switchgear 1D

EQUIPMENT				OPERATING LOAD								REMARKS
Comp't No.	Description	Tag No.	DAPPER BUS	100% Power at Nominal Bus Voltage				LOCA at Nominal Bus Voltage				
				KW	PF	KVAR	KVA	KW	PF	KVAR	KVA	
1D1	Incoming Breaker Aux Transf 1B	1B Aux.Xfmr										
1D2	Diesel Generator 1A	EG-Y-1A										
1D3	Emergency Feedwater Pump A	EF-P-2A	4010					406.0	0.850	251.6	477.6	
1D4	Spare											
1D5	480V (ES) Unit Substation 1P	1P-480V-ES	(4400)	1013.3	0.912	457.2	1111.7	981.2	0.898	481.8	1093.1	App. 8.1, Table 1P
1D6	DH Removal Pump A	DH-P-1A	4020					299.0	0.920	127.4	325.0	
1D7	Make-up Pump A	MU-P-1A	4030					588.3	0.922	247.1	638.1	Note 1
1D8	Make-up Pump B	MU-P-1B	5040	588.3	0.922	247.1	638.1	588.3	0.922	247.1	638.1	Note 1
1D9	RB Spray Pump A	BS-P-1A	4040					204.0	0.920	86.9	221.7	
1D10	RB Emergency Cooling RW Pump A	RR-P-1A	4050					302.9	0.901	145.8	336.2	Note 1
1D11	480V (ES) Unit Substation 1R	1R-480V-ES	(4600)	451.8	0.905	213.0	499.5	624.8	0.894	312.7	698.7	App. 8.1, Table 1R
1D12	480V (ES) Unit Substation 1N	1N-480V-ES	(4100)	475.9	0.882	254.0	539.4	475.9	0.882	254.0	539.4	App. 8.1, Table 1N
1D13	Spare											
1D14	SBO Diesel Generator	EG-Y-4										
1D15	Incoming Breaker Aux Trans. 1A	1A Aux.Xfmr										
		Total	(4000)	2529.3	0.907	1171.2	2788.7	4470.4	0.900	2154.4	4967.9	

NOTES

1. Power factor rounded to two decimal places for DAPPER entry.

APPENDIX 8.1
TABLE 1P
Loading of 480V (ES) Unit Substation 1P

EQUIPMENT				OPERATING LOAD								REMARKS
Comp't No.	Description	Tag No.	DAPPER BUS	100% Power at Nominal Bus Voltage				LOCA at Nominal Bus Voltage				
				KW	PF	Q	KVA	KW	PF	Q	KVA	
1A	Instrument Compt.											
1B	Main Breaker	1P-02										
1C	480V (ES) MCC 1A	1A-480V-ES	(4440)	558.1	0.889	287.7	627.9	422.1	0.878	229.7	480.6	App. 8.1, Table 1A
2A	DH Closed Cooling Water Pump	DC-P-1A	4460					70.4	0.870	39.9	80.9	
2B	Control Building Water Chiller	AH-C-4A	4465	130.0	0.900	63.0	144.4	130.0	0.900	63.0	144.4	
2C	Spare											
2D	Future											
3A	Pressurizer Heater Group 8	RC-GRP-8										
3B	Future											
3C	NS Closed Cooling Water Pump	NS-P-1A	4470	101.0	0.905	47.5	111.6	89.1	0.905	41.9	98.5	Notes 1,2
3D	NS Closed Cooling Water Pump	NS-P-1B	5270					89.1	0.905	41.9	98.5	Notes 2,3
4A	Tie to 480V (ES) USS 1S	1P-12										
4B	480V (ES) Valve MCC 1C	1C-480V-ESV	(4480)	118.4	0.905	55.5	130.8	74.7	0.770	61.9	97.0	App. 8.1, Table 1C-V
4C	480V (ES) Valve MCC 1A	1A-480V-ESV	(4420)	105.8	0.999	3.5	105.9	105.8	0.999	3.5	105.9	App. 8.1, Table 1A-V
	Additional Cable Losses			0.0				0.0				
		Total	(4400)	1013.3	0.912	457.2	1111.7	981.2	0.898	481.8	1093.1	

NOTES

1. **Loading for Case 8A is 105.3KW (116.4KVA) per Assumption 4.5.**
2. Power factor rounded to two decimal places for DAPPER entry.
3. **Off for Case 8A.**

APPENDIX 8.1
TABLE 1A
Loading of 480V (ES) Motor Control Center 1A

EQUIPMENT				OPERATING LOAD								REMARKS
Comp't No.	Description	Tag No.	DAPPER BUS	100% Power at Nominal Bus Voltage				LOCA at Nominal Bus Voltage				
				KW	PF	Q	KVA	KW	PF	Q	KVA	
1AL	Inverter A	Inverter 1A	Itemized									
1AR	Inverter C	Inverter 1C	Itemized									
1BL	Battery Charger A	Batt. Ch. 1A	Itemized									
1BR	Battery Charger C	Batt. Ch. 1C	Itemized									
1CL	Battery Charger E	Batt. Ch. 1E	Itemized									
1CR	Inverter E	Inverter 1E	Itemized									
1DL	DG Start-up Air Compressor	EG-P-1A	Itemized									
1DR	Regulating Transformer A		4456	5.1	0.88	2.8	5.8	5.1	0.88	2.75	5.8	
1EL	Subst. Diesel Equipt. Dist. Pnl (Norm	D-26	4456	4.0	0.88	2.2	4.5	4.0	0.88	2.16	4.5	
1ER	TB Instrument Air Compressor	IA-P-2A										
1F	Air Cooling Fan for DH & NS Pumps	AH-E-15A	Itemized									
2A	DG Room Supply Fan (North)	AH-E-29A	Itemized									
2B	Motor Operated Valve (MOV)	EF-V-1A										
2C	MOV	RR-V-4C										
2D	MOV	EF-V-2A										
3A	RB Vent Unit Fan A	AH-E-1A	Itemized									
4A	Aux Building Sump Pump	WDL-P-5A	4456	7.4	0.88	4.0	8.4	7.4	0.88	3.99	8.4	
4B	Instrument Air Compressor A	IA-P-1A	4456	47.5	0.88	25.64	54.0	47.5	0.88	25.64	54.0	Notes 2, 4
4C	EFW Pump Room A Sump Pump A	SD-P-3A	4456	1.2	0.88	0.6	1.4	1.2	0.88	0.65	1.4	
4D	EFW Pump Room B Sump Pump A	SD-P-4A	4456	1.2	0.88	0.6	1.4	1.2	0.88	0.65	1.4	
5AL	TB Lighting Panel (EM)	TB-1, 2, 3	4456	6.1	0.88	3.3	6.9	6.1	0.88	3.29	6.9	
5AR	CB Lighting Panel (EM)	CT-2	4456	14.7	0.88	7.9	16.7	14.7	0.88	7.93	16.7	
5B	Spent Fuel Cooling Pump Air Unit A	AH-E-8A	Itemized									
5CL	Hydrogen Analyzer - Ch. A	HM-AE-42A	Itemized									
5CR	H2 Recombiner	HR-R1	Itemized									
5DL	Heating Coil for AH-E-29A	AH-C-184A	Constant Z									
5DR	Cont. Twr Inst. Air Compressor #1	AH-P-8A/B	Itemized									
5EL	DG A Fuel Pump	DF-P-1A	Itemized									
5ER	480V Receptacles D1.2	D1, 2										
5F	Control Building Booster Fan A	AH-E-95A	Itemized									
6A	Main Turbine Oil Lift Pump	LO-P-7A/B	4456					10.4	0.88	5.61	11.8	Note 3
6B	Main Turbine Oil Lift Pump	LO-P-7C/D	4456					10.4	0.88	5.61	11.8	Note 3
6C	Main Turbine Oil Lift Pump	LO-P-7E/F	4456					10.4	0.88	5.61	11.8	Note 3
6D	Main Turbine Turning Gear	G-N-Y1						49.8	0.88	26.88	56.6	Notes 3,4
7A	Control Building Return Fan A	AH-E-19A	Itemized									
7B	Control Bldg Chilled Water Pump A	AH-P-3A	4456	17.4	0.88	9.4	19.8	17.4	0.88	9.39	19.8	
7C	CB Emergency Vent Supply Fan A	AH-E-18A	Itemized									
7D	MOV	MU-V-14A										
7EL	DG Auxiliaries	EG-Y-1A	Itemized									
7ER	Feeder for Panel CT-5 Transf.		4456	3.6	0.88	1.9	4.1	3.6	0.88	1.94	4.1	
8A	120-208V Pnl	CT-5										
8B	Transformer for Pnl CT-5											
9A	MOV	CO-V-14A										
9B	MOV	RC-V-1										
9C	Spare											
9D	Space (Not Available)											
10A	Space											
10B	Space											
10C	Normal Vent Supply Fan	AH-E-17A	4456	40.3	0.88	21.8	45.8	40.3	0.88	21.8	45.8	Note 1
10D	Spare											
11A	Intermed. Closed Cooling Pump A	IC-P-1A	4456	58.3	0.88	31.5	66.3	41.4	0.88	22.35	47.0	
11B	Penetration Cooling Fan A	AH-E-9A	4456	62.2	0.88	33.6	70.7					
12AL	Rad Monitor	RMA-4	4456	1.2	0.88	0.6	1.4	1.2	0.88	0.65	1.4	
12AR	Rad Monitor	RMA-9	4456	1.3	0.88	0.7	1.5	1.3	0.88	0.70	1.5	
12BL	Rad Monitor	RMA-6	4456	1.2	0.88	0.6	1.4	1.2	0.88	0.65	1.4	
12BR	Control Twr Lighting Panel (Normal)	CT-1	4456	19.7	0.88	10.6	22.4	19.7	0.88	10.63	22.4	
12C	Air Cooling Fan A for EFW Pump	AH-E-24A	Itemized									

EQUIPMENT				OPERATING LOAD								
Comp't No.	Description	Tag No.	DAPPER BUS	100% Power at Nominal Bus Voltage				LOCA at Nominal Bus Voltage				REMARKS
				KW	PF	Q	KVA	KW	PF	Q	KVA	
12D	MOV	CO-V-111A										
12E	Main Turbine Turn. Gear Oil Pump	LO-P-5	4456					43.5	0.88	23.48	49.4	Note 2
13A	Aux. Relay Compt	R1A/R2A										
13B	RC Pump 1A Oil Lift Pump	RC-P-2A-1	4456					9.8	0.88	5.29	11.1	Note 2
13C	RC Pump 1C Oil Lift Pump	RC-P-2C-1	4456					9.8	0.88	5.29	11.1	Note 2
13D	Space											
13E	Spent Fuel Cooling Pump A	SF-P-1A	Itemized									
14A	Boric Acid Tank Mixer	CA-M-1										
14B	Boric Acid Pump A	CA-P-1A	4455	2.3	0.88	1.2	2.6	2.3	0.88	1.2	2.6	
14C	Make-up Pump A Main Oil Pump	MU-P-3A	Itemized									
14D	MOV	RR-V-3A										
14E	MOV	RR-V-4A										
15A	Incoming Feed EG-Y-6 Flood Diesel Temp Power	EG-Y-6										
15B	Spare											
15C	Space											
15D	Boric Acid Mix Tank Heater 1A	CA-H-1	Constant Z									
	Additional Cable Losses		Constant Z									See Table Below
Sub-Total (Constant KVA EXCEPT CASES 4, 8)			4456	294.7	0.88	159.1	334.9	168.1	0.88	90.7	191.0	
Sub-Total (Constant KVA CASE 4 Only)			4456					238.4	0.88	128.7	270.9	
Sub-Total (Constant KVA CASE 8 Only)			4456					319.4	0.88	172.4	363.0	

NOTES:

Note 1. ON for all LOCA cases except Cases 4 and 8 where AH-E-18A is ON.

Note 2. OFF for LOCA Block Sequencing Cases 5,6,7.

Note 3. OFF for LOCA Block Sequencing Cases 5;6,7 and Case 4.

Note 4. Power factor assumed to be 0.88 for conveience.

ITEMIZED LOADS

1AL	Inverter A	Inverter 1A	4471	9.2	0.88	5.0	10.5	9.2	0.88	4.97	10.5	
1AR	Inverter C	Inverter 1C	4472	4.3	0.88	2.3	4.9	4.3	0.88	2.32	4.9	
1BL	Battery Charger A	Batt. Ch. 1A	4473	0.5	0.88	0.3	0.6	0.5	0.88	0.27	0.6	Note 8
1BR	Battery Charger C	Batt. Ch. 1C	4474	4.5	0.88	2.4	5.1	4.5	0.88	2.43	5.1	
1CL	Battery Charger E	Batt. Ch. 1E	4477	4.5	0.88	2.4	5.1	4.5	0.88	2.43	5.1	Note 8
1CR	Inverter E	Inverter 1E	4478	8.9	0.88	4.8	10.1	8.9	0.88	4.80	10.1	
1DL	DG Start-up Air Compressor	EG-P-1A	4441	5.0	0.88	2.7	5.7	5.0	0.88	2.70	5.7	
1F	Air Cooling Fan for DH & NS Pumps	AH-E-15A	4442	2.9	0.88	1.6	3.3	2.9	0.88	1.57	3.3	
2A	DG Room Supply Fan (North)	AH-E-29A	4443	22.8	0.88	12.3	25.9	22.8	0.88	12.31	25.9	
3A	RB Vent Unit Fan A	AH-E-1A	4445	96.5	0.90	46.7	107.2	51.3	0.70	52.34	73.3	
5B	Spent Fuel Cooling Pump Air Unit A	AH-E-8A	4444	2.0	0.88	1.1	2.3					
5CL	Hydrogen Analyzer - Ch. A	HM-AE-42A	4475					1.2	0.88	0.6	1.4	Note 1
5CR	H2 Recombiner	HR-R1	4476					42.0	1.00	0.00	42.00	Notes 1, 9
5DR	Cont. Twr Inst. Air Compressor #1	AH-P-8A/B	4454/4455	1.3	0.88	0.7	1.5	1.3	0.88	0.70	1.5	Note 2
5EL	DG A Fuel Pump	DF-P-1A	4446	0.7	0.88	0.4	0.8	0.7	0.88	0.38	0.8	Note 3
5F	Control Building Booster Fan A	AH-E-95A	4447	2.1	0.88	1.1	2.4	2.1	0.88	1.13	2.4	
7A	Control Building Return Fan A	AH-E-19A	4448	10.2	0.88	5.5	11.6	10.2	0.88	5.51	11.6	
7C	CB Emergency Vent Supply Fan A	AH-E-18A	4449					41.8	0.88	22.56	47.5	Note 4
7EL	DG Auxiliaries (1A-DG SKID)	EG-Y-1A	4450	29.4	.0.88	15.9	33.4	29.4	0.88	15.87	33.4	Note 5, 7
12C	Air Cooling Fan A for EFW Pump	AH-E-24A	4451	10.8	0.88	5.8	12.3	10.8	0.88	5.83	12.3	
13E	Spent Fuel Cooling Pump A	SF-P-1A	4457	32.2	0.88	17.4	36.6					
14C	Make-up Pump A Main Oil Pump	MU-P-3A	4453	0.5	0.88	0.3	0.6	0.5	0.88	0.3	0.6	Notes 6,10
Sub-Total (Itemized Loads)				248.3	0.89	128.7	279.7	253.9	0.88	139.02	289.5	

NOTES:

1. Manually applied load - OFF for Block Load Sequencing Cases 5, 6 and 7, ON for Cases 4, 8.
2. This load is entered for Bus 4454 only. Bus 4455 load = 0.
3. Eliminated use factor from Reference 3.2.2 to obtain proper voltage drop.
4. Manually applied load included in LOCA Case 4 and 8 only in lieu of AH-E-17A.
5. Load when Diesel is running is 0.6KVA (Assumption 4.24) - Applicable for Cases 4, 5, 6 and 7.
6. Load off when MU Pump running but shown on in all DAPPER runs to get voltage drop, negligible effect on MCC bus voltage.
7. Load revised from 19. 8 KW in Ref. 3.2.2 to 29.4 KW to eliminate EG-H-1A use factor, 0.88 PF assumed.
8. Standby Battery Charger 1E is shown in service in lieu of 1A due to more limiting cable length. Standby load shown for 1A. Largest Battery Charge load shown for Battery Charger 1E (4.5 KW).
9. Load is predominantly resistive, use 1.0 PF, constant Z load type.
10. Load increased from 0.4 kW to 0.5 kW to force DAPPER to report voltage result.

EQUIPMENT				OPERATING LOAD								REMARKS
Comp't No.	Description	Tag No.	DAPPER BUS	100% Power at Nominal Bus Voltage				LOCA at Nominal Bus Voltage				
				KW	PF	Q	KVA	KW	PF	Q	KVA	

CONSTANT Z LOADS

5DL	Heating Coil for AH-E-29A	AH-C-184A		0.0	1.00	0.0	0.0	0.0	1.00	0.0	0.0	
15D	Boric Acid Mix Tank Heater 1A	CA-H-1		15.0	1.00	0.0	15.0					
	Additional Cable Losses			0.1	1.00	0.0	0.1	0.1	1.00	0.0	0.1	
			Subtotal (Constant Z) 4456	15.1	1.00	0.0	15.1	0.1	1.00	0.0	0.1	

TABLE 1A TOTAL (EXCEPT CASES 4,8)

			Total (4440)	558.1	0.89	287.7	627.93	422.1	0.88	229.7	480.6	

REDUCTION OF CALCULATED TOTAL CABLE LOSSES FOR ITEMIZED LOADS

1AL	Inverter A	Inverter 1A	4471									
1AR	Inverter C	Inverter 1C	4472									
1BL	Battery Charger A	Batt. Ch. 1A	4473	0.1108				0.1108				
1BR	Battery Charger C	Batt. Ch. 1C	4474	0.0725				0.0725				
1DL	DG Start-up Air Compressor	EG-P-1A	4441	0.0950				0.0950				
1F	Air Cooling Fan for DH & NS Pumps	AH-E-15A	4442	0.0245				0.0245				
2A	DG Room Supply Fan (North)	AH-E-29A	4443									
3A	RB Vent Unit Fan A	AH-E-1A	4445	0.3136				0.3136				
5B	Spent Fuel Cooling Pump Air Unit A	AH-E-8A	4444									
5CL	Hydrogen Analyzer - Ch. A	HM-AE-42A	4475									
5CR	H2 Recombiner	HR-R1	4476									
5DR	Cont. Twr Inst. Air Compressor #1	AH-P-8A/B	4454/4455	0.0026				0.0026				
5EL	DG A Fuel Pump	DF-P-1A	4446	0.0003				0.0003				
5F	Control Building Booster Fan A	AH-E-95A	4447									
7A	Control Building Return Fan A	AH-E-19A	4448									
7C	CB Emergency Vent Supply Fan A	AH-E-18A	4449									
7EL	DG Auxiliaries CALLED 1A-DG	EG-Y-1A	4450	0.0002				0.0002				
12C	Air Cooling Fan A for EFW Pump	AH-E-24A	4451									
13E	Spent Fuel Cooling Pump A	SF-P-1A	4457									
14C	Make-up Pump A Main Oil Pump	MU-P-3A	4453									
11A	Intermed. Closed Cooling Pump A	IC-P-1A	N/A	0.0431				0.0431				
		Sub-Total		0.6626				0.6626				
		Calculated Total		0.7933				0.7933				
		Balance		0.1307	1.00			0.1307	1.00			

APPENDIX 8.1
TABLE 1A-V
Loading of 480V (ES) Motor Control Center 1A (Valves)

EQUIPMENT				OPERATING LOAD								REMARKS
Comp't No.	Description	Tag No.	DAPPER BUS	100% Power at Nominal Bus Voltage				LOCA at Nominal Bus Voltage				
				KW	PF	Q	KVA	KW	PF	Q	KVA	
1A	MOV	BS-V-2A										
1B	MOV	AH-V-1B										
1C	MOV	DH-V-4A										
1DL	Fltr Unit 1A Htr Cntl Pnl	AH-C-57A										
1DR	Tank Heat Trace	BS-T-2A	4421	8.6	1.00	0.0	8.6	8.6	1.00	0.0	8.6	
2A	MOV	BS-V-3A										
2B	MOV	FW-V-5A										
2C	MOV	FW-V-92A										
2D	MOV	MU-V-36										
3A	MOV	DH-V-5A										
3B	MOV	DH-V-6A										
3C	MOV	DH-V-7A										
3D	MOV	IC-V-79A										
4A	Make-up PP Aux. Oil PP	MU-P-2B	Itemized									
4B	MOV	MU-V-16A										
4C	MOV	MU-V-16B										
4D	MOV	MU-V-25										
5A	MOV	CF-V-2A										
5B	MOV	CF-V-2B										
5C	MOV	BS-V-1A										
5D	MOV	MU-V-39										
6AL	Lighting Panel (EM)	AB-1	4421	2.0	1.00	0.0	2.0	2.0	1.00	0.0	2.0	Note 1
6AR	480V Recept.	A1, A7										
6BL	Heat Trace Panel	3A-1	4421	5.9	1.00	0.0	5.9	5.9	1.00	0.0	5.9	
6BR	Heat Trace Panel	3A-2	4421	6.7	1.00	0.0	6.7	6.7	1.00	0.0	6.7	
6C	Make-up Pump A Aux. Oil Pump	MU-P-2A	Itemized									
6D	MOV	WDG-V-3										
6E	MOV	CA-V-4A										
7A	480V (ES) ESF Vent MCC 1A	1A-480V-ESF	(4430)									Load Listed Below
7B	MOV	IC-V-79C										
7C	MOV	NR-V-4A										
7D	MOV	NS-V-4										
8A	MOV	NR-V-16A										
8B	MOV	NR-V-16B										
8C	MOV	WDL-V-303										
8D	MOV	NR-V-5										
9A	MOV	NR-V-8A										
9B	MOV	NR-V-8B										
9C	MOV	NR-V-10A										
9D	MOV	NR-V-10B										
10AL	Heat Trace Panel	4A, 7A	4421	14.0	1.00	0.0	14.0	14.0	1.00	0.0	14.0	
10AR	480V Recept.	A4,A5,A6										
10B	Make-up Pump A Gear Oil Pump	MU-P-4A	Itemized									
10CL	Heat Trace Panel	2A	4421	10.4	1.00	0.0	10.4	10.4	1.00	0.0	10.4	
10CR	Heat Trace Panel	3A	4421	8.2	1.00	0.0	8.2	8.2	1.00	0.0	8.2	
10D	MOV	CO-V-12										
10EL	480V Recept.; Crane Hoist	A2, A3;MHS-A-28										
10ER	Heat Trace Panel	2A-1	4421	4.5	1.00	0.0	4.5	4.5	1.00	0.0	4.5	
		Subtotal (Constant Z)	4421	60.3	1.00	0.0	60.3	60.3	1.00	0.0	60.3	

Notes:
1. Changed PF from 0.88 to 1.00 for convenience, negligible effect on results.

EQUIPMENT				OPERATING LOAD								REMARKS
				100% Power at Nominal Bus Voltage				LOCA at Nominal Bus Voltage				
Compt No.	Description	Tag No.	DAPPER BUS	KW	PF	Q	KVA	KW	PF	Q	KVA	

ITEMIZED LOADS

4A	Make-up PP Aux. Oil PP	MU-P-2B	4423	0.7	.88	0.4	0.8	0.7	.88	0.4	0.8	Notes 1, 2
6C	Make-up Pump A Aux. Oil Pump	MU-P-2A	4422	0.7	.88	0.4	0.8	0.7	.88	0.4	0.8	Notes 1, 2
10B	Make-up Pump A Gear Oil Pump	MU-P-4A	4424	1.1	.88	0.6	1.3	1.1	.88	0.6	1.3	Notes 1, 3
		Subtotal (Itemized)	-	2.5	0.88	1.3	2.8	2.5	0.88	1.3	2.8	

Notes

1. Load off when MU Pump running but shown on in all DAPPER runs to get voltage drop, negligible effect on MCC bus voltage.
2. KVA based on FLA of 0.95A from Reference 3.7.6, 0.88 PF assumed.
3. KVA based on FLA of 1.55A from Reference 3.7.6, 0.88 PF assumed.

TABLE 1A-ESF TOTAL

7A	480V (ES) ESF Vent MCC 1A	1A-480V-ESF	(4430)	43.00	0.99	2.2	43.5	43.00	0.99	2.2	43.5	App. 8.1, Table 1A-ESF

TABLE 1A-V TOTAL

		Total	(4421)	105.8	1.00	3.5	105.9	105.8	1.00	3.5	105.9	

APPENDIX 8.1
TABLE 1A-ESF
Loading of 480V (ES) Motor Control Center 1A (ESF Vent System)

EQUIPMENT				OPERATING LOAD								REMARKS
Compt No.	Description	Tag No.	DAPPER BUS	100% Power at Nominal Bus Voltage				LOCA at Nominal Bus Voltage				
				KW	PF	Q	KVA	KW	PF	Q	KVA	
1B	Space											
1DL	Spare											
1DR	Spare											
1F	Spare											
1K	Borated Water Storage Tank Htr 1A	DH-T1-H1	Constant Z									
1M	Transf for Panel CC/ESF V-1											
2BL	Bleed Heater Control Panel	AH-C-56A										
2BR	Spare											
2F	Exhaust Fan A	AH-E-137A										
2K	Bleed Damper	AH-D-216A										
2M	Transf for Panel ESFV-1											
3C	MCC 1AES Valves											
3GL	Feeder for 3-5 KVA Transf											
3GR	Feeder for Panel ESFV-1		4432	4.0	0.88	2.2	4.5	4.0	0.88	2.2	4.5	
3K	120/208V Dist. Panel	ESFV-1										
3M	Transf for Panel ESFV-1											
		Subtotal (Constant KVA)	4432	4.0	0.88	2.2	4.5	4.0	0.88	2.2	4.5	

CONSTANT Z LOADS

1K	Borated Water Storage Tank Htr 1A	DH-T1-H1	4432	39.0	1.00	0.0	39.0	39.0	1.00	0.0	39.0	
		Subtotal (Constant Z)	4432	39.0	1.00	0.0	39.0	39.0	1.00	0.0	39.0	

TABLE 1A-ESF TOTAL

		Total	(4430)	43.0	0.99	2.2	43.5	43.0	0.99	2.2	43.5	

APPENDIX 8.1
TABLE 1C-V
Loading of 480V (ES) Motor Control Center 1C (Valves)

EQUIPMENT				OPERATING LOAD								REMARKS
Compt No.	Description	Tag No.	Dapper Bus	100% Power at Nominal Bus Voltage				LOCA at Nominal Bus Voltage				
				KW	PF	Q	KVA	KW	PF	Q	KVA	
1A	Incoming Service											
1B	Space											
1C	Space											
1D	Spare											
1E	Make-up Pump B Gear Oil Pump	MU-P-4B	Itemized									
2A	MOV	NR-V-1B										
2B	MOV	NS-V-15										
2C	MOV	NS-V-32										
2D	MOV	RB-V-2A										
3A	MOV	DH-V-1										
3B	MOV	DH-V-2										
3C	MOV	CF-V-1A										
4A	Spare											
4B	MOV	DH-V-3										
4C	MOV	CF-V-1B										
5A	MOV	VA-V-8										
5B	MOV	RC-V-4										
5C	MOV	RC-V-2										
5D	MOV	NR-V-19										
6A	120/208V Pnl	AB-E										
6B	Transformer for Pnl AB-E											
7A	MOV	EF-V-4										
7B	MOV	EF-V-5										
7C	MOV	WDG-V-2										
7D	MOV	NR-V-18										
8A	MOV	MS-V-8A										
8B	MOV	MS-V-8B										
8C	Spare											
8D	MOV	MS-V-2A										
9AL	RB Lighting Pnl	CV-E	4491	3.0	0.88	1.6	3.4	3.0	0.88	1.6	3.4	
9AR	Jockey Pump Control	FS-P-4	4491	1.6	0.88	0.9	1.8	1.6	0.88	0.9	1.8	
9BL	Fdr for Pnl AB-E Transf.		4491	2.0	0.88	1.1	2.3	2.0	0.88	1.1	2.3	
9BR	Instrument Air Dryer	IA-Q-1	Constant Z									
9CL	Rad Monitor	RMA-1	4491	1.2	0.88	0.6	1.4	1.2	0.88	0.6	1.4	
9CR	Rad Monitor	RML-7	4491	2.7	0.88	1.5	3.1	2.7	0.88	1.5	3.1	
9D	Space											
9E	Space Not Available											
10AL	CO2 Vaporizer/Temp Cntl Htrs	PG-Z-1										
10AR	Generator CO2 Chiller	PG-P-1	4491	1.6	0.88	0.9	1.8	1.6	0.88	0.9	1.8	
10B	Caustic Pump	CA-P-4										
10C	MOV	MS-V-2B										
10D	Space											
10E	Space											
11A	MOV	RR-V-5										
11B	Spare											
11C	MOV	MS-V-1C										
12AL	Rad Monitor Pwr Cabinet	RM-A-14	4491	2.6	0.88	1.4	3.0	2.6	0.88	1.4	3.0	
12AR	Space											
12B	MOV	MS-V-1D										
12C	MOV	MS-V-1B										
13AL	NR Pump B Disch Strainer	NR-S-1B	Itemized									
13AR	Fdr Bell Tel. Power Trans (EM)	D-20	4491	1.6	0.88	0.9	1.8	1.6	0.88	0.9	1.8	
13B	Spare											
13C	MOV	RR-V-3C										
13D	MOV	MS-V-1A										
14A	RB Vent Unit Fan C	AH-E-1C	Itemized									
	Additional Cable Losses		Constant Z									See Table Below
		Subtotal (Constant KVA)	4491	16.3	0.88	8.8	18.5	16.3	0.88	8.8	18.5	

EQUIPMENT				OPERATING LOAD								
Comp't No.	Description	Tag No.	Dapper Bus	100% Power at Nominal Bus Voltage				LOCA at Nominal Bus Voltage				REMARKS
				KW	PF	Q	KVA	KW	PF	Q	KVA	
ITEMIZED LOADS												
1E	Make-up Pump B Gear Oil Pump	MU-P-4B	4488	1.1	.88	0.6	1.3	1.1	.88	0.6	1.3	Notes 1, 2
13AL	NR Pump B Disch Strainer	NR-S-1B	4487					1.5	0.88	0.8	1.7	
14A	RB Vent Unit Fan C	AH-E-1C	4490	96.5	0.90	46.7	107.2	51.3	0.70	52.3	73.3	
Subtotal (Itemized Loads)				96.5	0.90	46.7	107.2	52.8	0.70	53.1	74.9	

Notes
1. Load off when MU Pump running but shown on in DAPPER runs to get voltage drop, negligible effect on MCC bus volt
2. KVA based on FLA of 1.55A from Reference 3.7.6, 0.88 PF assumed.

CONSTANT Z LOADS

9BR	Instrument Air Dryer	IA-Q-1		5.4	1.00	0.0	5.4	5.4	1.00	0.0	5.4	
	Additional Cable Losses			0.2	1.00	0.0	0.2	0.2	1.00	0.0	0.2	See Table Below
Subtotal (Constant Z)			4491	5.6	1.00	0.0	5.6	5.6	1.00	0.0	5.6	

TABLE 1C-V TOTAL

Total			(4480)	118.4	0.91	55.5	130.8	74.7	0.77	61.9	97.0	

REDUCTION OF CALCULATED TOTAL CABLE LOSSES FOR ITEMIZED LOADS

1E	Make-up Pump B Gear Oil Pump	MU-P-4B	4488									
13AL	NR Pump B Disch Strainer	NR-S-1B	4487	0.0156				0.0156				
14A	RB Vent Unit Fan C	AH-E-1C	4490	0.2406				0.2406				
Subtotal				0.2562				0.2562				
Calculated Total				0.4316				0.4316				
Balance				0.1754				0.1754				

APPENDIX 8.1
TABLE 1R
Loading of 480V (ES) Unit Substation 1R

EQUIPMENT				OPERATING LOAD								LOAD DATA REFERENCE
Comp't No.	Description	Tag No.	DAPPER BUS	100% Power at Nominal Bus Voltage				LOCA at Nominal Bus Voltage				
				KW	PF	Q	KVA	KW	PF	Q	KVA	
1A	Instrument Comp't											
1B	Main Brk	1R-02										
1C	Fire Pump	FS-P-2										
2A	Spare											
2B	NS River Water Pump A	NR-P-1A	4630	119.0	0.889	61.3	133.9	0.0			0.0	Note 1
2C	DH River Water Pump A	DR-P-1A	4640					169.6	0.866	97.9	195.8	Note 1
2D	Screen Wash Pump A	SW-P-1A	4660	102.1	0.915	45.0	111.6	102.1	0.915	45.0	111.6	Notes 1, 2
3A	NS River Water Pump B	NR-P-1B	5470					119.0	0.889	61.3	133.9	Note 1
3B	Second. Serv. River Wtr Pump A	SR-P-1A	4650	169.6	0.917	73.8	185.0	169.6	0.917	73.8	185.0	Note 1
3C	Spare											
3D	Future											
4A	Tie to 480V (ES) USS 1T	1R-12										
4B	Future											
4C	480V (ES) SH MCC 1A	1A-480V-ESSH	(4620)	61.1	0.880	32.9	69.4	64.5	0.880	34.8	73.3	App. 8.1, Table 1A-SH
	Additional Cable Losses			0.0				0.0				
		Total	(4600)	451.8	0.905	213.0	499.5	624.8	0.894	312.7	698.7	

Notes
1. Power factor rounded to two decimal places for DAPPER entry.
2. Eliminated use factor from Reference 3.2.2 to obtain proper voltage drop.

APPENDIX 8.1
TABLE 1A-SH
Loading of 480V (ES) Motor Control Center 1A (Screen House (SH))

EQUIPMENT				OPERATING LOAD								REMARKS
				100% Power at Nominal Bus Voltage				LOCA at Nominal Bus Voltage				
Comp't No.	Description	Tag No.	Dapper Bus	KW	PF	Q	KVA	KW	PF	Q	KVA	
1A	Incoming Service											
1BL	NR Water Pump Disch Strainer	NR-S-1A	Itemized									
1BR	DR Water Pump Disch Strainer	DR-S-1A	Itemized									
1CL	RR Water Pump Disch Strainer	RR-S-1A	Itemized									
1CR	Spare											
1D	Spare											
1E	Spare											
1F	Spare											
2A	MOV	NR-V-2										
2B	MOV	NR-V-3										
2C	MOV	SR-V-2A										
2D	Spare											
3A	Space											
3B	Space											
3C	Space											
3D	Space											
3E	Space											
3F	Space											
4A	Space											
4B	Space											
4C	SH Vent Equipment Pump	SW-P-2A	4628	13.7	0.88	7.4	15.6	13.7	0.88	7.4	15.6	
4D	Spare											
5A	Space											
5B	Space											
5C	Space											
5D	Space											
6A	Traveling Screen A	SR-S-3A	4628	1.9	0.88	1.0	2.2	1.9	0.88	1.0	2.2	
6B	Traveling Screen C	SR-S-3C										
6C	Spare											
6D	Space											
7A	120/208V Dist. Panel	SH-1										
7B	Transformer for Panel SH-1											
8A	Spare											
8BL	Space											
8BR	Feeder for Panel SH-1 Transformer		4628	8.9	0.88	4.8	10.1	8.9	0.88	4.8	10.1	
8CL	Spare											
8CR	SR Water Pump Disch Strainer	SR-S-1A	4628	1.4	0.88	0.8	1.6	1.4	0.88	0.8	1.6	
8D	Spare											
8EL	Screen & Rake Control Power											
8ER	Spare											
8F	Space											
9AL	Bar Rake A	SR-S-2A	4628	3.5	0.88	1.9	4.0	3.5	0.88	1.9	4.0	
9AR	SH Vent Pump Disch Strainer A	SW-S-2A	4628	1.0	0.88	0.5	1.1	1.0	0.88	0.5	1.1	
9BL	Screen Wash PP 1A Disch Strainer	SW-S-1A	4628	1.5	0.88	0.8	1.7	1.5	0.88	0.8	1.7	
9BR	Bar Rake C	SR-S-2C										
9C	Spare											
9D	Spare											
9E	Space											
9F	Space											
10A	Space											
10BL	Spare											
10BR	Spare											
10C	SH Roof Fan	AH-E-76	4628	0.5	0.88	0.3	0.6	0.5	0.88	0.3	0.6	
10D	Space											
10E	Lube Pump	WT-P-33A	4628	13.0	0.88	7.0	14.8	13.0	0.88	7.0	14.8	
10FL	SH Trash Pit Unloading Hoist A	MIS-A-18A										

EQUIPMENT				OPERATING LOAD								REMARKS
Comp't No.	Description	Tag No.	Dapper Bus	100% Power at Nominal Bus Voltage				LOCA at Nominal Bus Voltage				
				KW	PF	Q	KVA	KW	PF	Q	KVA	
10FR	SH Trash Pit Unloading Hoist B	MIS-A-18B										
11A	SH Unit Heater A	AH-C-20A	Constant Z									
11B	SH Unit Heater B	AH-C-20B	Constant Z									
11C	Air Handling Unit Fan A	AH-E-27A	Itemized									
11D	Aux Relay Compt											
12A	MOV	DR-V-1A										
12B	MOV	NR-V-1A										
12C	MOV	RR-V-1A										
12D	Space											
	Additional Cable Losses		Constant Z									
		Subtotal (Constant KVA)	4628	45.4	0.88	24.5	51.6	45.4	0.88	24.5	51.6	

CONSTANT Z LOADS

11A	SH Unit Heater A	AH-C-20A	4628	0.0	1.00	0.0	0.0	0.0	1.00	0.0	0.0	
11B	SH Unit Heater B	AH-C-20B	4628	0.0	1.00	0.0	0.0	0.0	1.00	0.0	0.0	
	Additional Cable Losses			0.1	1.00	0.0	0.1	0.1	1.00	0.0	0.1	See Table Below
		Subtotal (Constant Z)	4628	0.1	1.00	0.0	0.1	0.1	1.00	0.0	0.1	

ITEMIZED LOADS

1BL	NR Water Pump Disch Strainer	NR-S-1A	4621	1.6	0.88	0.9	1.8	1.6	0.88	0.9	1.8	
1BR	DR Water Pump Disch Strainer	DR-S-1A	4622					2.0	0.88	1.1	2.3	
1CL	RR Water Pump Disch Strainer	RR-S-1A	4623					1.4	0.88	0.8	1.6	
11C	Air Handling Unit Fan A	AH-E-27A	4624	14.0	0.88	7.6	15.9	14.0	0.88	7.6	15.9	
		Subtotal (Itemized Loads)		15.6	0.88	8.4	17.7	19.0	0.88	10.3	21.6	

TABLE 1A-SH TOTAL

		Total	(4620)	61.1	0.88	32.9	69.4	64.5	0.88	34.8	73.3	

REDUCTION OF CALCULATED TOTAL CABLE LOSSES FOR ITEMIZED LOADS

1BL	NR Water Pump Disch Strainer	NR-S-1A	4621									
1BR	DR Water Pump Disch Strainer	DR-S-1A	4622	0.0049				0.0049				
1CL	RR Water Pump Disch Strainer	RR-S-1A	4623	0.0024				0.0024				
11C	Air Handling Unit Fan A	AH-E-27A	4624	0.2958				0.2958				
		Subtotal		0.3031				0.3031				
		Calculated Total		0.4233				0.4233				
		Balance		0.1202				0.1202				

APPENDIX 8.1
TABLE 1N
Loading of 480V Unit Substation 1N

EQUIPMENT				OPERATING LOAD								REMARKS
Comp't No.	Description	Tag No.	DAPPER Bus	100% Power at Nominal Bus Voltage				LOCA at Nominal Bus Voltage				
				KW	PF	Q	KVA	KW	PF	Q	KVA	
1A	Instrument Comp.											
1B	Main Breaker	1N-02										
1C	Control Building H&V CC	480V-CBHV	4200	342.8	0.88	185.0	389.5	342.8	0.88	185.0	389.5	
2A	Tie to 480V USS 1L & 1J	1N-12										
2B	Turbine Room Crane Rails	MIS-A-3&4										
2C	S.S. Closed Cooling Water Pp. C	SC-P-1C	4200	117.5	0.89	60.5	132.2	117.5	0.89	60.5	132.2	
2D	Swyd Panels via Xfr. Sw. ATS-A/B	PM1, PM2	4200	15.6	0.88	8.4	17.7	15.6	0.88	8.4	17.7	
		Total (Constant KVA)	4200	475.9	0.88	254.0	539.4	475.9	0.88	254.0	539.4	

APPENDIX 8.1
TABLE 1E
Loading of 4.16 KV (ES) Switchgear 1E

EQUIPMENT				OPERATING LOAD								
Comp't No.	Description	Tag No.	DAPPER BUS	100% Power at Nominal Bus Voltage				LOCA at Nominal Bus Voltage				REMARKS
				KW	PF	Q	KVA	KW	PF	Q	KVA	
1E1	Incoming Breaker Aux. Transf. 1B	1B Aux Xfmr										
1E2	SBO Diesel Generator	EG-Y-4										
1E3	Diesel Generator 1B	EG-Y-1B										
1E4	Spare											
1E5	Emergency Feed Water Pump B	EF-P-2B	5010					406.0	0.850	251.6	477.6	
1E6	480V (ES) Unit Substation 1S	1S-480V-ES	(5100)	984.0	0.913	439.3	1077.6	1033.6	0.900	499.9	1148.1	App. 8.1, Table 1S
1E7	DH Removal Pump B	DH-P-1B	5020					299.0	0.920	127.4	325.0	
1E8	Make-up Pump C	MU-P-1C	5030					588.3	0.922	247.1	638.1	Note 1
1E9	Make-up Pump B	MU-P-1B	5040	588.3	0.922	247.1	638.1	588.3	0.922	247.1	638.1	Note 1
1E10	RB Spray Pump B	BS-P-1B	5050					204.0	0.920	86.9	221.7	
1E11	RB Emergency Cooling RW Pump B	RR-P-1B	5060					302.9	0.901	145.8	336.2	Note 1
1E12	480V (ES) Unit Substation 1T	1T-480V-ES	(5300)	611.1	0.907	282.9	673.3	622.5	0.894	312.4	696.5	App. 8.1, Table 1T
1E13	Spare											
1E14	Incoming Breaker Aux Transf 1A	1A Aux Xfmr										
		Total	(5000)	2183.4	0.914	969.2	2388.8	4044.6	0.904	1918.1	4476.4	

NOTES
1. Power factor rounded to two decimal places for DAPPER entry.

APPENDIX 8.1
TABLE 1S
Loading of 480V (ES) Unit Substation 1S

EQUIPMENT				OPERATING LOAD								LOAD DATA REFERENCE
Comp't No.	Description	Tag No.	DAPPER BUS	100% Power at Nominal Bus Voltage				LOCA at Nominal Bus Voltage				
				KW	PF	Q	KVA	KW	PF	Q	KVA	
1A	Instrument Compt											
1B	Main Breaker	1S-02										
1C	480V (ES) MCC 1B	1B-480V-ES	(5020)	523.8	0.890	269.0	588.8	469.5	0.885	247.0	530.5	App. 8.1, Table 1B
2A	DH Closed Cooling Water Pump B	DC-P-1B	5260					70.4	0.870	39.9	80.9	
2B	CB Water Chiller B	AH-C-4B	5250	130.0	0.900	63.0	144.4	130.0	0.900	63.0	144.4	
2C	Spare											
2D	Future											
3A	Pressurizer Heater Group 9	RC-GRP-9										
3B	Future											
3C	NS Closed Cooling Water Pump C	NS-P-1C	5240	101.0	0.905	47.5	111.6	89.1	0.905	41.9	98.5	Notes 1,2
3D	NS Closed Cooling Water Pump B	NS-P-1B	5270					89.1	0.905	41.9	98.5	Notes 2,3
4A	Tie to 480V (ES) USS 1P	1S-12										
4B	480V (ES) Valve MCC 1C	1C-480V-ESV	(4480)	118.4	0.905	55.5	130.8	74.7	0.770	61.9	97.0	App. 8.1, Table 1C-V
4C	480V (ES) Valve MCC 1B	1B-480V-ESV	(5280)	110.8	0.999	4.3	110.9	110.8	1.00	4.3	110.9	App. 8.1, Table 1B-V
	Additional Cable Losses			0.0				0.0				
		Total	(5200)	984.0	0.913	439.3	1077.6	1033.6	0.900	499.9	1148.1	

NOTES
1. **Loading for Case 4BNS and 8B is 105.3KW (116.4KVA) per Assumption 4.5.**
2. Power factor rounded to two decimal places for DAPPER entry.
3. **Off for Cases 4BNS and 8B.**

APPENDIX 8.1
TABLE 1B
Loading of 480V (ES) Motor Control Center 1B

EQUIPMENT				OPERATING LOAD								REMARKS
Comp't No.	Description	Tag No.	DAPPER BUS	100% Power at Nominal Bus Voltage				LOCA at Nominal Bus Voltage				
				KW	PF	Q	KVA	KW	PF	Q	KVA	
1AL	Inverter B	Inverter 1B	Itemized									
1AR	Inverter D	Inverter 1D	Itemized									
1BL	Battery Charger B	Battery Ch. 1B	Itemized									
1BR	Battery Charger D	Battery Ch. 1D	Itemized									
1CL	Battery Charger F	Battery Ch. 1F	Itemized									
1CR	Regulating Transformer B		5236	4.0	0.88	2.2	4.5	4.0	0.88	2.2	4.5	
1D	Air Cooling Fan B for DH&NS Pumps	AH-E-15B	Itemized									
1EL	Hydrogen Analyzer Ch. B	HM-AE-42B	Itemized									
1ER	Spare											
1F	Boric Acid Mix Tank Heater 1B	CA-H-2	Constant Z									
2A	Make-up Pump C Main Oil Pump	MU-P-3C	Itemized									
2B	Space											
2C	Boric Acid Pump B	CA-P-1B	5236	2.5	0.88	1.3	2.8	2.5	0.88	1.3	2.8	
2D	Backup to Panels PM1 & PM2	PM1 & PM2										
3A	RB Vent Unit Fan B	AH-E-1B	Itemized									
4A	EFW Pump Room A Sump Pump B	SD-P-3B	5236	1.2	0.88	0.6	1.4	1.2	0.88	0.6	1.4	
4B	EFW Pump Room B Sump Pump B	SD-P-4B	5236	1.2	0.88	0.6	1.4	1.2	0.88	0.6	1.4	
4C	RC Pump 1B Oil Lift Pump	RC-P-2B-1	5236					9.8	0.88	5.3	11.1	Note 2
4D	RC Pump 1D Oil Lift Pump	RC-P-2D-1	5236					8.7	0.88	4.7	9.9	Note 2
4E	Spare											
4FL	Control Twr Lighting Panel (EM)	CT-1	5236	19.7	0.88	10.6	22.4	19.7	0.88	10.6	22.4	
4FR	Intmed Bldg Inst Air Comp	IA-P-2B										
5A	Aux Bldg Sump Pump B	WDL-P-5B	5236	7.4	0.88	4.0	8.4	7.4	0.88	4.0	8.4	
5B	Instrument Air Compressor B	IA-P-1B		47.5	0.88	25.64	54.0	47.5	0.88	25.64	54.0	Notes 2, 4
5C	Control Bldg Booster Fan B	AH-E-95B	Itemized									
5D	Space											
6A	Spent Fuel Cooling Pump B	SF-P-1B	Itemized									
6BL	DG Fuel Pump	DF-P-1C	Itemized									
6BR	Space											
6C	Control Bldg Return Fan B	AH-E-19B	Itemized									
6D	Control Bldg Chilled Wtr Pump B	AH-P-3B	Itemized									
6E	Cntrl Bldg Emerg Vent Supply Fan B	AH-E-18B	Itemized									
7AL	Subst Diesel Eqpt Dist Pnl (Emer)	D-26	5236									
7AR	H2 Recombiner (Back-up)	HR-R1	Itemized									
7BL	Cont Twr Inst Air Compressor #2	AH-P-9A/B	Itemized									
7BR	DG Auxiliaries	EG-Y-1B	Itemized									
7C	Penetration Cooling Fan B	AH-E-9B	5236	64.2	0.88	34.7	73.0	64.2	0.88	34.7	73.0	
7D	Space											
8AL	Serv Bldg Lighting Panels (EM)	SB-1,2	5236	4.2	0.88	2.3	4.8	4.2	0.88	2.3	4.8	
8AR	Mod Comp Computer Power (Constant	ATC										
8B	Spent Fuel Cool Pump Air Unit B	AH-E-8B	Itemized									
8CL	Feeder for Panel CT-E Transf	(Lighting)	5236	4.1	0.88	2.2	4.7	4.1	0.88	2.2	4.7	
8CR	DG Startup Air Compressor	EG-P-1B	Itemized									
8D	Aux Relay Compt	R1B										
9A	120/208V Dist. Panel	CT-E										
9B	Transformer for Panel CT-E											
10A	Intermed CC Pump 1B	IC-P-1B	5236	56.5	0.88	30.5	64.2	43.1	0.88	23.3	49.0	
10B	MOV	RC-V-3										
10C	MOV	RC-V-2B										
11A	MOV	CO-V-14B										
11B	Normal Vent Supply Fan	AH-E-17B	5236	35.9	0.88	19.4	40.8	35.9	0.88	19.4	40.8	Note 1
11C	Spare											
11D	MOV	RB-V-7										
12A	Space											
12B	Space											
12CL	Rad Monitor	RMA-8	5236	1.0	0.88	0.5	1.1	1.0	0.88	0.5	1.1	
12CR	Spare											

EQUIPMENT				OPERATING LOAD								
				100% Power at Nominal Bus Voltage				LOCA at Nominal Bus Voltage				REMARKS
Compt No.	Description	Tag No.	DAPPER BUS	KW	PF	Q	KVA	KW	PF	Q	KVA	
12DL	Rad Monitor	RMA-2	5236	1.1	0.88	0.6	1.3	1.1	0.88	0.6	1.3	
12DR	Spare											
12E	Space											
13A	Main Turbine Oil Lift Pump	LO-P-7G/H	5236					10.4	0.88	5.6	11.8	Note 3
13B	Main Turbine Oil Lift Pump	LO-P-7I/J	5236					10.4	0.88	5.6	11.8	Note 3
13C	Air Cooling Fan B for EFW Pump	AH-E-24B	Itemized									
13D	Spare											
13E	DG Room Supply Fan (South)	AH-E-29B	Itemized									
13FL	CB Lighting Panel (Norm)	CT-2	5236	14.7	0.88	7.9	16.7	14.7	0.88	7.9	16.7	
13FR	DG Room Heating Coil for AH-E-29B	AH-C-176	Constant Z									
14A	MOV	RR-V-4B										
14B	MOV	RR-V-4D										
14C	MOV	RR-V-3B										
14D	MOV	CO-V-11B										
15A	Spare											
15B	Remote Shutdown Pnl B											
15C	Space		15C									
15D	MOV	EF-V-1B										
15E	MOV	EF-V-2B										
	Additional Cable Losses											See Table Below
Sub-Total (Constant KVA EXCEPT CASES 4,8)			5236	265.2	0.88	143.1	301.4	204.3	0.88	110.3	232.2	
Sub-Total (Constant KVA CASE 4 ONLY)			5236					234.4	0.90	116.5	261.8	
Sub-Total (Constant KVA CASE 8 ONLY)			5236					255.2	0.88	137.7	290.0	

NOTES:

Note 1. ON for all LOCA cases except Cases 4 and 8 where AH-E-18B

Note 2. OFF for LOCA Block Sequencing Cases 5,6,7.

Note 3. OFF for LOCA Block Sequencing Cases 5,6,7 and Case 4.

Note 4. Power factor assumed to be 0.88 for conveience.

ITEMIZED LOADS

1AL	Inverter B	Inverter 1B	5241	5.8	0.88	3.1	6.6	5.8	0.88	3.1	6.6	
1AR	Inverter D	Inverter 1D	5242	4.7	0.88	2.5	5.3	4.7	0.88	2.5	5.3	
1BL	Battery Charger B	Battery Ch. 1B	5243	4.5	0.88	2.4	5.1	4.5	0.88	2.4	5.1	
1BR	Battery Charger D	Battery Ch. 1D	5244	4.4	0.88	2.4	5.0	4.4	0.88	2.4	5.0	
1CL	Battery Charger F	Battery Ch. 1F	5245	0.5	0.88	0.3	0.6	0.5	0.88	0.3	0.6	
1D	Air Cooling Fan B for DH&NS Pumps	AH-E-15B	5221	2.8	0.88	1.5	3.2	2.8	0.88	1.5	3.2	
1EL	Hydrogen Analyzer Ch. B	HM-AE-42B	5246					1.2	0.88	0.6	1.4	Note 1
2A	Make-up Pump C Main Oil Pump	MU-P-3C	5222	0.5	0.88	0.3	0.6	0.5	0.88	0.3	0.6	Notes 6,9
3A	RB Vent Unit Fan B	AH-E-1B	5223	96.5	0.90	46.7	107.2	51.3	0.70	52.3	73.3	
5C	Control Bldg Booster Fan B	AH-E-95B	5224	2.0	0.88	1.1	2.3	2.0	0.88	1.1	2.3	
6A	Spent Fuel Cooling Pump B	SF-P-1B	5237	34.4	0.88	18.6	39.1					
6BL	DG Fuel Pump	DF-P-1C	5225	0.7	0.88	0.4	0.8	0.7	0.88	0.4	0.8	Note 3
6C	Control Bldg Return Fan B	AH-E-19B	5226	9.8	0.88	5.3	11.1	9.8	0.88	5.3	11.1	
6D	Control Bldg Chilled Wtr Pump B	AH-P-3B	5227	15.1	0.88	8.2	17.2	15.1	0.88	8.2	17.2	
6E	Cntrl Bldg Emerg Vent Supply Fan B	AH-E-18B	5228					45.0	0.88	24.3	51.1	Note 4
7AR	H2 Recombiner (Back-up)	HR-R1	5247					42.0	1.00	0.00	42.0	Note 1, 8
7BL	Cont Twr Inst Air Compressor #2	AH-P-9A/B	5234/5235	1.3	0.88	0.7	1.5	1.3	0.88	0.7	1.5	Note 2
7BR	DG Auxiliaries	EG-Y-1B	5229	29.4	0.88	15.9	33.4	29.4	0.88	15.9	33.4	Note 5, 7
8B	Spent Fuel Cool Pump Air Unit B	AH-E-8B	5231	2.0	0.88	1.1	2.3					
8CR	DG Startup Air Compressor	EG-P-1B	5230	5.0	0.88	2.7	5.7	5.0	0.88	2.7	5.7	
13C	Air Cooling Fan B for EFW Pump	AH-E-24B	5233	11.8	0.88	6.4	13.4	11.8	0.88	6.4	13.4	
13E	DG Room Supply Fan (South)	AH-E-29B	5232	11.9	0.88	6.4	13.5	11.9	0.88	6.4	13.5	
Sub-Total (Itemized Loads)			(5220)	243.1	0.89	125.86	273.8	249.7	0.88	136.8	284.7	

NOTES:

1. Manually applied load - OFF for Block Load Sequencing Cases 5, 6 and 7, and Case 4 ON for Case 8.
2. This load is entered for Bus 5234 only. Bus 5235 load = 0.
3. Eliminated use factor from Reference 3.2.2 to obtain proper voltage drop.
4. Manually applied load included in LOCA Case 4 and 8 only in lieu of AH-E-17A. Load based on Reference 3.7.22 data.
5. Load when Diesel is running is 0.6KVA (Assumption 4.24) - Applicable for Cases 4, 5, 6 and 7.
6. Load off when MU Pump running but shown on in all DAPPER runs to get voltage drop, negligible effect on MCC bus voltage.
7. Load revised from 19. 8 KW in Ref. 3.2.2 to 29.4 KW to eliminate EG-H-1B use factor, 0.88 PF assumed.
8. Load is predominantly resistive, use 1.0 PF, constant Z load type.
9. Load increased from 0.4 kW to 0.5 kW to force DAPPER to report voltage result.

EQUIPMENT				OPERATING LOAD								REMARKS
Comp't No.	Description	Tag No.	DAPPER BUS	100% Power at Nominal Bus Voltage				LOCA at Nominal Bus Voltage				
				KW	PF	Q	KVA	KW	PF	Q	KVA	
CONSTANT Z LOADS												
1F	Boric Acid Mix Tank Heater 1B	CA-H-2	5236	15.0	1.00	0.0	15.0	15.0	1.00	0.0	15.0	
13FR	DG Room Heating Coil for AH-E-29B	AH-C-176	5236	0.0	1.00	0.0	0.0	0.0	1.00	0.0	0.0	
	Additional Cable Losses		5236	0.5	1.00	0.0	0.5	0.5	1.00	0.0	0.5	
		Subtotal (Constant Z)	5236	15.5	1.00	0.0	15.5	15.5	1.00	0.0	15.5	
TABLE 1B TOTAL (EXCEPT CASES 4,8)												
		Total	(5220)	523.8	0.89	269.0	588.84	469.5	0.88	247.0	530.5	
REDUCTION OF CALCULATED TOTAL CABLE LOSSES FOR ITEMIZED LOADS												
1AL	Inverter B	Inverter 1B	5241									
1AR	Inverter D	Inverter 1D	52422									
1BL	Battery Charger B	Battery Ch. 1B	5243	0.1134				0.1134				
1BR	Battery Charger D	Battery Ch. 1D	5244	0.0972				0.0972				
1CL	Battery Charger F	Battery Ch. 1F	5245									
1D	Air Cooling Fan B for DH&NS Pumps	AH-E-15B	5221									
1E	Hydrogen Analyzer Ch. B	HM-AE-42B	5246									
2A	Make-up Pump C Main Oil Pump	MU-P-3C	5222									
3A	RB Vent Unit Fan B	AH-E-1B	5223	0.3664				0.3664				
5C	Control Bldg Booster Fan B	AH-E-95B	5224									
6A	Spent Fuel Cooling Pump B	SF-P-1B	5237									
6BL	DG Fuel Pump	DF-P-1C	5225	0.0005				0.0005				
6C	Control Bldg Return Fan B	AH-E-19B	5226									
6D	Control Bldg Chilled Wtr Pump B	AH-P-3B	5227									
6E	Cntrl Bldg Emerg Vent Supply Fan B	AH-E-18B	5228									
7AR	H2 Recombiner (Back-up)	HR-R1	5247									
7BL	Cont Twr Inst Air Compressor #2	AH-P-9A/B	5234/5235	0.0042				0.0042				
7BR	DG Auxiliaries	EG-Y-1B	5229	0.0003				0.0003				
8B	Spent Fuel Cool Pump Air Unit B	AH-E-8B	5231									
8CR	DG Startup Air Compressor	EG-P-1B	5230	0.1429				0.1429				
13C	Air Cooling Fan B for EFW Pump	AH-E-24B	5233									
13E	DG Room Supply Fan (South)	AH-E-29B	5232									
4FR	Intmed Bldg Inst Air Comp	IA-P-2B	N/A	0.1081				0.1081				
		Sub-Total		0.8330				0.8330				
		Calculated Total		1.3372				1.3372				
		Balance		0.5042	1.00	0.0	0.5	0.5042	1.00	0.0	0.5	

APPENDIX 8.1
TABLE 1B-V
Loading of 480V (ES) Motor Control Center 1B (Valves)

EQUIPMENT				OPERATING LOAD								LOAD DATA REFERENCE
Comp't No.	Description	Tag No.	DAPPER BUS	100% Power at Nominal Bus Voltage				LOCA at Nominal Bus Voltage				
				KW	PF	Q	KVA	KW	PF	Q	KVA	
1A	MOV	BS-V-2B										
1B	MOV	AH-V-1C										
1C	MOV	DH-V-4B										
1D	Make-up Pump C Gear Oil Pump	MU-P-4C	Itemized									
2A	MOV	BS-V-3B										
2B	MOV	FW-V-5B										
2C	MOV	FW-V-92B										
2D	MOV	MU-V-37										
3A	MOV	DH-V-5B										
3B	MOV	DH-V-6B										
3C	MOV	DH-V-7B										
3D	MOV	IC-V-79B										
4A	MOV	MU-V-14B										
4B	MOV	MU-V-16C										
4C	MOV	MU-V-16D										
4D	MOV	MU-V-2A										
5A	MOV	IC-V-79D										
5B	MOV	IC-V-2										
5C	MOV	CA-V-13										
5D	MOV	MU-V-2B										
6A	Make-up Pump B Main Oil Pump	MU-P-3B	Itemized									
6BL	Ht Trace Pnl	3B-1	5281	5.9	1.00	0.0	5.9	5.9	1.00	0.0	5.9	
6BR	Ht Trace Pnl	3B-2	5281	6.7	1.00	0.0	6.7	6.7	1.00	0.0	6.7	
6C	Make-up Pump C Aux Oil Pump	MU-P-2C	Itemized									
6D	MOV	CA-V-4B										
6E	MOV	CA-V-3										
7A	480V (ES) ESF Vent MCC 1B	1B-480V-ESF	(5290)									Note 1
7B	MOV	BS-V-1B										
7C	MOV	NR-V-4B										
7D	MOV	CA-V-1										
8A	MOV	NR-V-16C										
8B	MOV	NR-V-16D										
8C	MOV	NS-V-35										
8DR	Fdr - Bell Tel Pwr Tranf (Norm)	D-20	5281	1.6	1.00	0.0	1.6	1.6	1.00	0.0	1.6	Note 2
8DL	Lighting Pnl (EM)	AB-2	5281	3.9	1.00	0.0	3.9	3.9	1.00	0.0	3.9	Note 2
9A	MOV	NR-V-8C										
9B	MOV	NR-V-8D										
9C	MOV	NR-V-15A										
9D	MOV	NR-V-15B										
10AL	Ht Trace Pnl	4B/7B	5281	14.0	1.00	0.0	14.0	14.0	1.00	0.0	14.0	
10AR	Ht Trace Pnl	2B-1	5281	4.5	1.00	0.0	4.5	4.5	1.00	0.0	4.5	
10BL	Fltr Unit B Htr Control Pnl	AH-C-57B										
10BR	Tank Heat Trace	BS-T-2B	5281	8.6	1.00	0.0	8.6	8.6	1.00	0.0	8.6	
10CL	Ht Trace Pnl	2B	5281	10.4	1.00	0.0	10.4	10.4	1.00	0.0	10.4	
10CR	Ht Trace Pnl	3B	5281	8.2	1.00	0.0	8.2	8.2	1.00	0.0	8.2	
10D	MOV	NR-V-6										
10E	MOV	SR-V-2										
		Subtotal (Constant Z)	5281	63.8	1.00	0.0	63.8	63.8	1.00	0.0	63.8	

Notes:
1. See Table 1B-ESF for this load, omitted here for convenience.
2. Changed PF from 0.88 to 1.00 for convenience, negligible effect on results.

EQUIPMENT				OPERATING LOAD								
Comp't No.	Description	Tag No.	DAPPER BUS	100% Power at Nominal Bus Voltage				LOCA at Nominal Bus Voltage				LOAD DATA REFERENCE
				KW	PF	Q	KVA	KW	PF	Q	KVA	
ITEMIZED LOADS												
1D	Make-up Pump C Gear Oil Pump	MU-P-4C	5284	1.1	.88	0.6	1.3	1.1	.88	0.6	1.3	Notes 1, 4
6A	Make-up Pump B Main Oil Pump	MU-P-3B	5283	0.5	0.88	0.27	0.6	0.5	0.88	0.27	0.6	Notes 1,2
6C	Make-up Pump C Aux Oil Pump	MU-P-2C	5282	0.7	.88	0.4	0.8	0.7	.88	0.4	0.8	Notes 1, 3
		Subtotal (Itemized)		1.1	0.88	0.6	1.3	1.1	0.88	0.6	1.3	

Notes

1. Load off when MU Pump running but shown on in all DAPPER runs to get voltage drop, negligible effect on MCC bus voltage.
2. Load increased from 0.4 kW to 0.5 kW to force DAPPER to report voltage result.
3. KVA based on FLA of 0.95A from Reference 3.7.6, 0.88 PF assumed.
4. KVA based on FLA of 1.55A from Reference 3.7.6, 0.88 PF assumed.

TABLE 1B-ESF TOTAL

7A	480V (ES) ESF Vent MCC 1B	1B-480V-ESF	(5290)	45.9	0.98	3.7	46.8	45.9	0.98	3.7	46.8	App. 8.1, Table 1B-ESF

TABLE 1B-V TOTAL

		Total	(5280)	110.8	1.00	4.3	110.9	110.8	1.00	4.3	110.9	

APPENDIX 8.1
TABLE 1B-ESF
Loading of 480V (ES) Motor Control Center 1B (ESF Vent System)

EQUIPMENT				OPERATING LOAD								REMARKS
Comp't No.	Description	Tag No.	DAPPER BUS	100% Power at Nominal Bus Voltage				LOCA at Nominal Bus Voltage				
				KW	PF	Q	KVA	KW	PF	Q	KVA	
1B	Space											
1DL	Lighting Panel (EM)	FH-1		2.9	0.88	1.6	3.3	2.9	0.88	1.6	3.3	
1DR	Spare											
1F	Spare											
1K	Borated Water Storage Tank Htr 1B	DH-TI-H2	Constant Z									
1M	Transformer for Panel ESFV-2											
2BL	Bleed Heater Control Pnl	AH-C-56B										
2BR	Spare											
2F	Exhaust Fan B	AH-E-137B										
2K	Bleed Damper	AH-D-216B										
2M	Transformer for Panel ESFV-2											
3C	Incoming Line											
3GL	Feeder for 3-5 KVA Transformer											
3GR	Feeder for Panel ESFV-2		5292	4.0	0.88	2.2	4.5	4.0	0.88	2.2	4.5	
3K	120/208V Dist. Panel	ESF V-2										
3M	Transformer for Panel ESFV-2											
	Subtotal (Constant KVA)		5292	6.9	0.88	3.7	7.8	6.9	0.88	3.7	7.8	

CONSTANT Z LOADS

1K	Borated Water Storage Tank Htr 1B	DH-TI-H2	5292	39.0	1.00	0.0	39.0	39.0	1.00	0.0	39.0	
	Subtotal (Constant Z)		5292	39.0	1.00	0.0	39.0	39.0	1.00	0.0	39.0	

TABLE 1B-ESF TOTAL

Total	(5290)	45.9	0.98	3.7	46.8	45.9	0.98	3.7	46.8	

APPENDIX 8.1
TABLE 1T
Loading of 480V (ES) Unit Substation 1T

EQUIPMENT				OPERATING LOAD								REMARKS
Comp't No.	Description	Tag No.	DAPPER BUS	100% Power at Nominal Bus Voltage				LOCA at Nominal Bus Voltage				
				KW	PF	Q	KVA	KW	PF	Q	KVA	
1A	Instrument Compt											
1B	Main Breaker	IT-02										
1C	Fire Pump	FS-P-2										
2A	Spare											
2B	NS River Water Pump C	NR-P-1C	5430	119.0	0.889	61.3	133.9	0.0			0.0	Note 1
2C	DH River Water Pump B	DR-P-1B	5440					169.6	0.866	97.9	195.8	Note 1
2D	Future											
3A	NS River Water Pump B	NR-P-1B	5470					119.0	0.889	61.3	133.9	Note 1
3B	Second Serv River Water Pump	SR-P-1B	5450	161.5	0.917	70.3	176.1	161.5	0.917	70.3	176.1	Note 1
3C	Second Serv River Water Pump	SR-P-1C	5480	161.5	0.917	70.3	176.1					Note 3
3D	Screen Wash Pump B	SW-P-1B	5460	102.1	0.915	45.0	111.6	102.1	0.915	45.0	111.6	Notes 1, 2
4A	Tie To 480V (ES) USS 1R	1T-12										
4B	Future											
4C	480V (ES) SH MCC 1B	1B-480V-ESSH	(5420)	67.0	0.880	36.1	76.0	70.4	0.880	37.9	79.9	App. 8.1. Table 1B-SH
	Additional Cable Losses			0.0	1.000	0.0	0.0	0.0	1.000	0.0	0.0	
			Total (5400)	611.1	0.907	282.9	673.3	622.5	0.894	312.4	696.5	

NOTES
1. Power factor rounded to two decimal places for DAPPER entry.
2. Eliminated use factor from Reference 3.2.2 to obtain proper voltage drop.
3. ON for Cases 1B, 2B

APPENDIX 8.1
TABLE 1B-SH
Loading of 480V (ES) Motor Control Center 1B (Screen House (SH))

EQUIPMENT				OPERATING LOAD								REMARKS
Comp't No.	Description	Tag No.	DAPPER BUS	100% Power at Nominal Bus Voltage				LOCA at Nominal Bus Voltage				
				KW	PF	Q	KVA	KW	PF	Q	KVA	
1A	Incoming Line											
1B	MOV	NR-V-1C										
1C	MOV	RR-V-1B										
1DL	NR Water Pump Disch Strainer	NR-S-1C	Itemized									
1DR	Screen & Rake Control Power											
1EL	DR Water Pump Disch Strainer	DR-S-1B	Itemized									
1ER	RR Water Pump Disch Strainer	RR-S-1B	Itemized									
2A	MOV	NR-V-7										
2B	MOV	SR-V-1B										
2C	MOV	SR-V-1C										
2D	Traveling Screen B	SR-S-3B	5428	1.9	0.88	1.0	2.2	1.9	0.88	1.0	2.2	
3AL	Space											
3AR	SH Overhead Doors											
3BL	Bar Rake B	SR-S-2B	5428	3.5	0.88	1.9	4.0	3.5	0.88	1.9	4.0	
3BR	Spare											
3C	SH Vent Equip Pump	SW-P-2B	5428	13.7	0.88	7.4	15.6	13.7	0.88	7.4	15.6	
3D	Air Handling Unit Fan B	AH-E-27B	Itemized									
3E	Space											
4A	Unusable											
4B	Space											
4C	Lube Pump	WT-P-33B	5428	13.0	0.88	7.0	14.8	13.0	0.88	7.0	14.8	
4D	Space											
4E	Space											
5A	Space											
5B	Unit Heater	AH-C-20C	Constant Z									
5C	Chlorine House Unit Heater	A-C-18A	Constant Z									
5D	Unit Heater	AH-C-20D	Constant Z									
5E	Diesel Fire PP RN Unit Heater	AH-C-20E	Constant Z									
6A	Spare											
6B	Spare											
6C	SH Supply Fan	AH-E-58	Itemized									
6D	Spare											
6E	Chlorine House Unit Heater	AH-C-18B	Constant Z									
6F	Spare											
7AL	480V Recept	S1, S2										
7AR	SR Water Pump Disch Strainer	SR-S-1B	5428	1.4	0.88	0.8	1.6	1.4	0.88	0.8	1.6	
7BL	SR Water Pump Disch Strainer	SR-S-1C										
7BR	Spare											
7CL	Spare											
7CR	SH Vent Pump Disch Strainer	SW-S-2B	5428	1.0	0.88	0.5	1.1	1.0	0.88	0.5	1.1	
7DL	SH Wash Pump Disch Strainer	SW-S-1B	5428	1.5	0.88	0.8	1.7	1.5	0.88	0.8	1.7	
7DR	Space											
7EL	Space											
7ER	Spare	CL-Z-2										
7FL	Feeder for Panel SH-2 Transf		5428	13.7	0.88	7.4	15.6	13.7	0.88	7.4	15.6	
7FR	Spare											
8A	120/208V Panel	SH-2										
8B	Transformer for Panel SH-2											
9A	Aux Relay Compt											
9B	Chlorine Eject Booster Pump	CL-P-2										
9C	Chlorine House Exhaust Fan	AH-E-72	5428	0.9	0.88	0.5	1.0	0.9	0.88	0.5	1.0	

EQUIPMENT				OPERATING LOAD								REMARKS
Comp't No.	Description	Tag No.	DAPPER BUS	100% Power at Nominal Bus Voltage				LOCA at Nominal Bus Voltage				
				KW	PF	Q	KVA	KW	PF	Q	KVA	
9DL	480V Recept	S3										
9DR	Spare											
10A	MOV	DR-V-1B										
10B	Spare											
10C	Spare											
10D	Spare											
10E	Spare											
	Additional Cable Losses		Constant Z									
Subtotal (Constant KVA)			5428	50.6	0.88	27.3	57.5	50.6	0.88	27.3	57.5	

CONSTANT Z LOADS

5B	Unit Heater	AH-C-20C	Constant Z	0.0	1.00	0.0	0.0	0.0	1.00	0.0	0.0	
5C	Chlorine House Unit Heater	A-C-18A	Constant Z	0.0	1.00	0.0	0.0	0.0	1.00	0.0	0.0	
5D	Unit Heater	AH-C-20D	Constant Z	0.0	1.00	0.0	0.0	0.0	1.00	0.0	0.0	
5E	Diesel Fire PP RN Unit Heater	AH-C-20E	Constant Z	0.0	1.00	0.0	0.0	0.0	1.00	0.0	0.0	
6E	Chlorine House Unit Heater	AH-C-18B	Constant Z	0.0	1.00	0.0	0.0	0.0	1.00	0.0	0.0	
	Additional Cable Losses		Constant Z	0.2	1.00	0.0	0.2	0.2	1.00	0.0	0.2	See Table Below
Subtotal (Constant Z)			5428	0.2	1.00	0.0	0.2	0.2	1.00	0.0	0.2	

ITEMIZED LOADS

1DL	NR Water Pump Disch Strainer	NR-S-1C	5429	1.6	0.88	0.9	1.8	1.6	0.88	0.9	1.8	
1EL	DR Water Pump Disch Strainer	DR-S-1B	5424					2.0	0.88	1.1	2.3	
1ER	RR Water Pump Disch Strainer	RR-S-1B	5425					1.4	0.88	0.8	1.6	
3D	Air Handling Unit Fan B	AH-E-27B	5426	14.0	0.88	7.6	15.9	14.0	0.88	7.6	15.9	
6C	SH Supply Fan	AH-E-58	5427	0.6	0.88	0.3	0.7	0.6	0.88	0.3	0.7	
Subtotal (Itemized Loads)				16.2	0.88	8.7	18.4	19.6	0.88	10.6	22.3	

TABLE 1B-SH TOTAL

Total			(5420)	67.0	0.88	36.1	76.0	70.4	0.88	37.9	79.9	

REDUCTION OF CALCULATED TOTAL CABLE LOSSES FOR ITEMIZED LOADS

1DL	NR Water Pump Disch Strainer	NR-S-1C	5429	0.0000				0.0000				
1EL	DR Water Pump Disch Strainer	DR-S-1B	5424	0.0036				0.0036				
1ER	RR Water Pump Disch Strainer	RR-S-1B	5425	0.0026				0.0026				
3D	Air Handling Unit Fan B	AH-E-27B	5426	0.2821				0.2821				
6C	SH Supply Fan	AH-E-58	5427	0.0003				0.0003				
Subtotal				0.2886				0.2886				
Calculated Total				0.4388				0.4388				
Balance				0.1502				0.1502				

DAPPER Load Types

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LOAD DEMAND TABLE FOR CASES 1-9
============================================================================
LOAD DESCRIPTION  LOAD   1ST LEVEL      2ND LEVEL      3RD LEVEL    %   LEAD LCL
                  TYPE    KVA   %        KVA   %        KVA   %     PF  LAG  FACT
============================================================================

 1 CONSTANT KVA(70) K     ALL 100.      ALL 100.      ALL 100.  70.0 LAG  1.00
 2 CONSTANT KVA(85) K     ALL 100.      ALL 100.      ALL 100.  85.0 LAG  1.00
 3 CONSTANT KVA(86) K     ALL 100.      ALL 100.      ALL 100.  86.0 LAG  1.00
 4 CONSTANT KVA(87) K     ALL 100.      ALL 100.      ALL 100.  87.0 LAG  1.00
 5 CONSTANT KVA(88) K     ALL 100.      ALL 100.      ALL 100.  88.0 LAG  1.00
 6 CONSTANT KVA(89) K     ALL 100.      ALL 100.      ALL 100.  89.0 LAG  1.00
 7 CONSTANT KVA(90) K     ALL 100.      ALL 100.      ALL 100.  90.0 LAG  1.00
 8 CONSTANT KVA(91) K     ALL 100.      ALL 100.      ALL 100.  91.0 LAG  1.00
 9 CONSTANT KVA(92) K     ALL 100.      ALL 100.      ALL 100.  92.0 LAG  1.00
10 CONSTANT Z (100) Z     ALL 100.      ALL 100.      ALL 100. 100.0 LAG  1.00
11 MOV CON KVA(90)  K     ALL 100.      ALL 100.      ALL 100.  90.0 LAG  1.00
12 CONSTANT I (90)  I     ALL 100.      ALL 100.      ALL 100.  90.0 LAG  1.00
13 SPARE            K     ALL 100.      ALL 100.      ALL 100.  88.0 LAG  1.00
14 SPARE            K     ALL 100.      ALL 100.      ALL 100.  88.0 LAG  1.00
15 SPARE            K     ALL 100.      ALL 100.      ALL 100.  88.0 LAG  1.00
16 SPARE            K     ALL 100.      ALL 100.      ALL 100.  88.0 LAG  1.00
17 SPARE            K     ALL 100.      ALL 100.      ALL 100.  88.0 LAG  1.00
18 SPARE            K     ALL 100.      ALL 100.      ALL 100.  88.0 LAG  1.00
19 SPARE            K     ALL 100.      ALL 100.      ALL 100.  88.0 LAG  1.00
20 SPARE            K     ALL 100.      ALL 100.      ALL 100.  88.0 LAG  1.00


NOTES:  LOAD TYPE 10 PROVIDES TRANSFER FUNCTION TO LOAD TYPE 9
        DEMAND AND DESIGN FACTORS APPLIED AT EACH LOAD BUS
        AND ALL LOAD TOTALS ARE POWER FACTOR CORRECTED
```

DAPPER Load Types

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POWER TOOLS LIBRARY      DATE 17 DEC 98           TIME 11   1 AM          PAGE     1


LOAD DEMAND TABLE FOR CASE 10
===============================================================================
LOAD DESCRIPTION    LOAD   1ST LEVEL       2ND LEVEL       3RD LEVEL      %   LEAD LCL
                    TYPE    KVA    %        KVA    %        KVA    %      PF  LAG  FACT
===============================================================================

 1 CONSTANT KVA(70)  K     ALL 100.        ALL 100.        ALL 100.   70.0 LAG   1.00
 2 CONSTANT KVA(85)  K     ALL 100.        ALL 100.        ALL 100.   85.0 LAG   1.00
 3 CONSTANT KVA(86)  K     ALL 100.        ALL 100.        ALL 100.   86.0 LAG   1.00
 4 CONSTANT KVA(87)  K     ALL 100.        ALL 100.        ALL 100.   87.0 LAG   1.00
 5 CONSTANT KVA(88)  K     ALL 100.        ALL 100.        ALL 100.   88.0 LAG   1.00
 6 CONSTANT KVA(89)  K     ALL 100.        ALL 100.        ALL 100.   89.0 LAG   1.00
 7 CONSTANT KVA(90)  K     ALL 100.        ALL 100.        ALL 100.   90.0 LAG   1.00
 8 CONSTANT KVA(91)  K     ALL 100.        ALL 100.        ALL 100.   91.0 LAG   1.00
 9 CONSTANT KVA(92)  K     ALL 100.        ALL 100.        ALL 100.   92.0 LAG   1.00
10 CONSTANT Z (100)  Z     ALL 100.        ALL 100.        ALL 100.  100.0 LAG   1.00
11 CONSTANT KVA(80)  K     ALL 100.        ALL 100.        ALL 100.   80.0 LAG   1.00
12 CONSTANT KVA(93)  K     ALL 100.        ALL 100.        ALL 100.   93.0 LAG   1.00
13 SPARE             K     ALL 100.        ALL 100.        ALL 100.   88.0 LAG   1.00
14 SPARE             K     ALL 100.        ALL 100.        ALL 100.   88.0 LAG   1.00
15 SPARE             K     ALL 100.        ALL 100.        ALL 100.   88.0 LAG   1.00
16 SPARE             K     ALL 100.        ALL 100.        ALL 100.   88.0 LAG   1.00
17 SPARE             K     ALL 100.        ALL 100.        ALL 100.   88.0 LAG   1.00
18 SPARE             K     ALL 100.        ALL 100.        ALL 100.   88.0 LAG   1.00
19 SPARE             K     ALL 100.        ALL 100.        ALL 100.   88.0 LAG   1.00
20 SPARE             K     ALL 100.        ALL 100.        ALL 100.   88.0 LAG   1.00


NOTES:   LOAD TYPE 10 PROVIDES TRANSFER FUNCTION TO LOAD TYPE 9
         DEMAND AND DESIGN FACTORS APPLIED AT EACH LOAD BUS
         AND ALL LOAD TOTALS ARE POWER FACTOR CORRECTED
```

DETAILED CASE DESCRIPTIONS

CASE	DESCRIPTION	IMPED. MODEL	IMPEDANCE MODEL CIRCUIT ADAPTATIONS	BOP BUS LOADING	ES BUS LOADING (Note 1)	VOLTAGE REQUIREMENT
1A	Two Transformer, 100% Power Operation	LOCAA	RP BUS 1A OFF TP BUSES 1A, 1B OFF CO-P-2C OFF	TP BUS IC 10100 KVA	APPENDIX 8.1, RED TRAIN, 100% POWER	NORMAL GRID 235 KV
1B	Two Transformer, 100% Power Operation	LOCAB	RP BUS 1B OFF TP 1C OFF CO-P-2A OFF	TP BUS 1A 9600 KVA TP BUS 1B 6000 KVA	APPENDIX 8.1, GREEN TRAIN 100% POWER	NORMAL GRID 235 KV
2A	Two Transformer, 100% Power Operation	LOCAA	RP BUS 1A OFF TP BUSES 1A, 1B OFF CO-P-2C OFF	TP BUS IC 10100 KVA	APPENDIX 8.1, RED TRAIN, 100% POWER	BOUNDING VALUE FOR SINGLE CONTINGENCY MINIMUM GRID 223.3 KV
2B	Two Transformer, 100% Power Operation	LOCAB	RP BUS 1B OFF TP 1C OFF CO-P-2A OFF	TP BUS 1A 9600 KVA TP BUS 1B 6000 KVA	APPENDIX 8.1, GREEN TRAIN 100% POWER	BOUNDING VALUE FOR SINGLE CONTINGENCY MINIMUM GRID 223.3 KV
3A	Fast Transfer to One Transformer, 100% Power Operation	LOCAA	CO-P-2C OFF	TP BUS 1A DETERMINED BY MODEL TP BUS 1B 5692 KVA TP BUS 1C 9230 KVA	APPENDIX 8.1, RED TRAIN, 100% POWER	MINIMUM GRID 232 KV, ADJUST BUS TP 1A LOAD TO RESULT IN AT LEAST 3806V ON BUS 1D
3B	Fast Transfer to One Transformer, 100% Power Operation	LOCAB	CO-P-2A OFF	TP BUS 1A DETERMINED BY MODEL TP BUS 1B 5692 KVA TP BUS 1C 9230 KVA	APPENDIX 8.1, GREEN TRAIN 100% POWER	MINIMUM GRID 232 KV, ADJUST TP BUS 1A LOAD TO RESULT IN AT LEAST 3806V ON BUS 1E
4A	Short Term Post LOCA (Based on One Transformer)	LOCAA	CO-P-2C OFF	TP BUS 1A 6421 KVA TP BUS 1B 5692 KVA TP BUS IC 8082 KVA (FULL POST TRIP REDUCTION)	APPENDIX 8.1, RED TRAIN, LOCA	ES BUS 1D MINIMUM DVR DROPOUT 3727V
4B	Short Term Post LOCA (Based on One Transformer)	LOCAB	CO-P-2A OFF	TP BUS 1A 6421KVA TP BUS 1B 5692 KVA TP BUS IC 8082 KVA (FULL POST TRIP REDUCTION)	APPENDIX 8.1, GREEN TRAIN, LOCA	ES BUS 1E MINIMUM DVR DROPOUT 3727V
5A	Two Transformer, LOCA Motor Starting	LOCAA	RP BUS 1A OFF TP BUSES 1A, 1B OFF CO-P-2C OFF	INCREMENTED REDUCTION ON TP BUS 1C PER TABLE 5A	APPENDIX 8.1, RED TRAIN, LOCA, MODIFIED PER TABLE 5A PLUS MOV LOADS FROM APPENDIX 8.8	BOUNDING VALUE FOR SINGLE CONTINGENCY MINIMUM GRID 223.3 KV
5B	Two Transformer, LOCA Motor Starting	LOCAB	RP BUS 1B OFF TP 1C OFF CO-P-2A OFF	INCREMENTED POST TRIP REDUCTION ON TP BUS 1A PER TABLE 5B TP BUS 1B 6000 KVA	APPENDIX 8.1, GREEN TRAIN, LOCA, MODIFIED PER TABLE 5B PLUS MOV LOADS FROM APPENDIX 8.8	BOUNDING VALUE FOR SINGLE CONTINGENCY MINIMUM GRID 223.3 KV
6A	One Transformer, LOCA Motor Starting	LOCAA	CO-P-2C OFF	INCREMENTED REDUCTION ON TP BUSES 1A AND 1C PER TABLE 6A TP BUS 1B 5692 KVA	APPENDIX 8.1, RED TRAIN, LOCA, MODIFIED PER TABLE 6A PLUS MOV LOADS FROM APPENDIX 8.8	MINIMUM GRID 232 KV
6B	One Transformer, LOCA Motor Starting	LOCAB	CO-P-2A OFF	INCREMENTED REDUCTION ON TP BUSES 1A AND 1C PER TABLE 6A TP BUS 1B 5692 KVA	APPENDIX 8.1, GREEN TRAIN, LOCA, MODIFIED PER TABLE 6B PLUS MOV LOADS FROM APPENDIX 8.8	MINIMUM GRID 232 KV
7A	LOCA Block Load Sequencing Minimum Recovery Voltage	LOCAA	RP BUS 1A OFF TP BUSES 1A, 1B OFF CO-P-2C OFF	INCREMENTED REDUCTION ON TP BUS 1C PER TABLE 5A	APPENDIX 8.1, RED TRAIN, LOCA, MODIFIED PER TABLE 5A PLUS MOV LOADS FROM APPENDIX 8.8	ES BUS 1D MINIMUM DVR PICKUP 3756V
7B	LOCA Block Load Sequencing Minimum Recovery Voltage	LOCAB	RP BUS 1B OFF TP 1C OFF CO-P-2A OFF	INCREMENTED POST TRIP REDUCTION ON TP BUS 1A PER TABLE 5B TP BUS 1B 6000 KVA	APPENDIX 8.1, GREEN TRAIN, LOCA, MODIFIED PER TABLE 5B PLUS MOV LOADS FROM APPENDIX 8.8	ES BUS 1E MINIMUM DVR PICKUP 3756V
8A	Long Term Post LOCA (Based on One Transformer)	LOCAA	RP BUSES 1A AND 1B OFF CO-P-2C OFF	TP BUS 1A 6421 KVA TP BUS 1B 5692 KVA TP BUS IC 8082 KVA (FULL POST TRIP REDUCTION)	APPENDIX 8.1, RED TRAIN, LOCA	480V BUS 1P AT LOW VOLTAGE ALARM SETPOINT OF 423V
8B	Long Term Post LOCA (Based on One Transformer)	LOCAB	RP BUSES 1A AND 1B OFF CO-P-2A OFF	TP BUS 1A 6421 KVA TP BUS 1B 5692 KVA TP BUS 1C 8082 KVA (FULL POST TRIP REDUCTION)	APPENDIX 8.1, GREEN TRAIN, LOCA	480V BUS 1S AT LOW VOLTAGE ALARM SETPOINT OF 423V

DETAILED CASE DESCRIPTIONS

CASE	DESCRIPTION	IMPED. MODEL	IMPEDANCE MODEL CIRCUIT ADAPTATIONS	BOP BUS LOADING	ES BUS LOADING (Note 1)	VOLTAGE REQUIREMENT
9A	Minimum Grid, Start Up	LOCAA	CO-P-2C OFF IMPEDANCE VALUES AND TAP SETTING FOR SHUTDOWN (230 KV TAP)	TP BUS 1A DETERMINED BY MODEL TP BUS 1B 5692 KVA TP BUS 1C 9230 KVA	BUS 1D; APPENDIX 8.1, RED TRAIN, 100% POWER BUS 1E; ESTIMATED NORMAL LOAD LESS MAJOR SWING LOADS	MINIMUM GRID 232 KV. ADJUST BUS 1A LOAD TO RESULT IN AT LEAST 3806V ON BUS 1D AND 1E
9B	Minimum Grid, Start Up	LOCAB	CO-P-2A OFF IMPEDANCE VALUES AND TAP SETTING FOR SHUTDOWN (230 KV TAP)	TP BUS 1A DETERMINED BY MODEL TP BUS 1B 5692 KVA TP BUS 1C 9230 KVA	BUS 1E; APPENDIX 8.1, GREEN TRAIN 100% POWER BUS 1D; ESTIMATED NORMAL LOAD LESS MAJOR SWING LOADS	MINIMUM GRID 232 KV. ADJUST BUS 1A LOAD TO RESULT IN AT LEAST 3806V ON BUS 1D AND 1E
10	Model Validation	LOCAB	ES BUSES 1E, 1S, 1T, 1B ES AND 1B ES SH MODELED, TP BUSES 1A AND 1B AND RP BUSES 1A, MODELED. BUSES DOWNSTREAM OF THESE BUSES DELETED	MEASURED LOAD FROM FIELD TESTS	MEASURED LOAD FROM FIELD TESTS. PLUS ESTIMATED LOAD FOR DELETED BUSES TO RECONCILE FEEDER LOADS FROM TEST DATA	ACTUAL GRID VOLTAGE FROM TEST DATA
11A	Maximum Voltage, Short Circuit Study Bus Voltages	LOCAA	SAME AS CASE 4A	SAME AS CASE 4A	SAME AS CASE 4A	MAXIMUM GRID VOLTAGE 242 KV
11B	Maximum Voltage, Short Circuit Study Bus Voltages	LOCAB	SAME AS CASE 4B	SAME AS CASE 4B	SAME AS CASE 4B	MAXIMUM GRID VOLTAGE 242 KV
				SUPPLEMENTAL CASES		
3A-SUP	Fast Transfer to One Transformer, 100% Power Operation	LOCAA	Same as Case 3A	TP BUS 1A 9378 KVA TP BUS 1B 5692 KVA TP BUS 1C 9230 KVA (24,300 KVA TOTAL)	Same as Case 3A	GRID 232.4 KV
3B1	Fast Transfer to One Transformer, 100% Power Operation	LOCAB	Same as Case 3B	TP BUS 1A DETERMINED BY MODEL TP BUS 1B 5692 KVA TP BUS 1C 9230 KVA	Same as Case 3B	GRID 232.4 KV
3B2	Fast Transfer to One Transformer, 100% Power Operation	LOCAB	Same as Case 3B	TP BUS 1A DETERMINED BY MODEL TP BUS 1B 5692 KVA TP BUS 1C 9230 KVA	Same as Case 3B	GRID 230.0 KV
3B3	Fast Transfer to One Transformer, 100% Power Operation	LOCAB	Same as Case 3B	TP BUS 1A DETERMINED BY MODEL TP BUS 1B 5692 KVA TP BUS 1C 9230 KVA	Same as Case 3B	GRID 228.0 KV
4BEQ	Short Term Post LOCA with Accident Cable Temperature	LOCAB	Same As Case 4B Except Feeder Cable Resistance for AH-E-1C and EF-P-2B Based on 130 deg C Conductor Temperature	Same as Case 4B	Same as Case 4B	Same as Case 4B
4BNS	Short Term Post LOCA One NS Pump Running	LOCAB	Same as Case 4B	Same as Case 4B	Same As Case 4B Except NS-P-1B OFF. NS-P-1C load 116.4 KVA	Same as Case 4B

Notes
1. For purposes of this appendix, the Red Train is defined as ES Bus 1D and connected downstream loads defined in the Appendix 8.1 tables.
For purposes of this appendix, the Green Train is defined as ES Bus 1E and connected downstream loads defined in the Appendix 8.1 tables.

DETAILED CASE DESCRIPTIONS

TABLE 5A
CASE 5A LOADING - MINIMUM GRID, TWO TRANSFORMER, LOCA BLOCK SEQUENCING, RED TRAIN

			BLOCK 1			BLOCK 2			BLOCK 3				LOCK 4	LOCK 5	BOP
			MU-P-1A	DH-P-1A	**SR-P-1A**	RR-P-1A	AH-E-1A	AH-E-1C	DR-P-1A	DC-P-1A	NS-P-1B	NR-P-1B	BS-P-1A	EF-P-2A	TP-1C
CASE 5A	BUS LOADING		4030	4020	**4650**	4050	4445	4490	4640	4460	5270	5470	4040	4010	3000
1S	BRANCH LOAD		0	0	**0**	0	0	0	0	0	0	0	0	0	10100
	SPECIAL	KW	880	364	**111**										
		KVA	4311	1785	**544**										
1R	BRANCH LOAD		N/C	N/C	**N/C**	0	0	0	0	0	0	0	0	0	10100
2S	BRANCH LOAD		N/C	N/C	**N/C**	0	0	0	0	0	0	0	0	0	9954
	SPECIAL	KW				366	80	80							
		KVAR				1792	390	390							
2R	BRANCH LOAD		N/C	N/C	**N/C**	N/C	N/C	N/C	0	0	0	0	0	0	9954
3S	BRANCH LOAD		N/C	N/C	**N/C**	N/C	N/C	N/C	0	0	0	0	0	0	9538
	SPECIAL	KW							158	108	141	156			
		KVAR							775	529	691	763			
3R	BRANCH LOAD		N/C	N/C	**N/C**	N/C	N/C	N/C	N/C	N/C	N/C	N/C	0	0	9538
4S	BRANCH LOAD		N/C	N/C	**N/C**	N/C	N/C	N/C	N/C	N/C	N/C	N/C	0	0	9334
	SPECIAL	KW											320		
		KVAR											1568		
4R	BRANCH LOAD		N/C	N/C	**N/C**	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	0	9334
5S	BRANCH LOAD		N/C	N/C	**N/C**	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	0	9245
	SPECIAL	KW												439	
		KVAR												2152	
5R	BRANCH LOAD		N/C	N/C	**N/C**	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	9245

Bus loading for Block Load Sequencing Cases is based on Appendix 8.1 LOCA loading, adjusted as shown in the table. The "N/C" entries indicate that there is no change to the Appendix 8.1 value normally entered into DAPPER as a Branch Load. A zero indicates that the Branch Load for that bus is set to zero, in lieu of the Appendix 8.1 value. The Special Bus Loads listed in the table are entered to reflect the motor starting loads applicable to the load block being considered. For example, for Case 5A-1S, Block 1 Starting, the Branch Loads loads for the indicated buses are set to zero, and Special Bus Loads are entered for buses 4030 (MU-P 1A), and 4020 (DH-P-1A) to simulate the starting of these motors. For Case 5A-1R, Block 1 Running, the Branch Loads for buses 4030 (MU-P-1A), and 4020 (DH-P-1A) are unchanged from the Appendix A values, but other buses subject to Block Load Sequencing are still zero because they have not yet started.

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DETAILED CASE DESCRIPTIONS

TABLE 5B
CASE 5B LOADING - MINIMUM GRID, TWO TRANSFORMER, LOCA BLOCK SEQUENCING, GREEN TRAIN

			BLOCK 1		BLOCK 2			BLOCK 3				LOCK 4	LOCK 5	BOP
			MU-P-1C	DH-P-1B	RR-P-1B	AH-E-1B	AH-E-1C	DR-P-1B	DC-P-1B	NS-P-1B	NR-P-1B	BS-P-1B	EF-P-2B	TP-1A
CASE 5B	BUS LOADING		5030	5020	5060	5223	4490	5440	5260	5270	5470	5050	5010	1000
1S	BRANCH LOAD		0	0	0	0	0	0	0	0	0	0	0	9600
	SPECIAL	KW	880	364										
		KVAR	4311	1785										
1R	BRANCH LOAD		N/C	N/C	0	0	0	0	0	0	0	0	0	9600
2S	BRANCH LOAD		N/C	N/C	0	0	0	0	0	0	0	0	0	9454
	SPECIAL	KW			366	80	80							
		KVAR			1792	390	390							
2R	BRANCH LOAD		N/C	N/C	N/C	N/C	N/C	0	0	0	0	0	0	9454
3S	BRANCH LOAD		N/C	N/C	N/C	N/C	N/C	0	0	0	0	0	0	9038
	SPECIAL	KW						158	108	141	156			
		KVAR						775	529	691	763			
3R	BRANCH LOAD		N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	0	0	9038
4S	BRANCH LOAD		N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	0	0	8834
	SPECIAL	KW										320		
		KVAR										1568		
4R	BRANCH LOAD		N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	0	8834
5S	BRANCH LOAD		N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	0	8745
	SPECIAL	KW											439	
		KVAR											2152	
5R	BRANCH LOAD		N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	8745

See explanatory note below table 5A.

DETAILED CASE DESCRIPTIONS

TABLE 6A
CASE 6A LOADING - MINIMUM GRID, ONE TRANSFORMER, LOCA BLOCK SEQUENCING, RED TRAIN

			BLOCK 1			BLOCK 2			BLOCK 3				LOCK 4	LOCK 5	BOP LOADING	
			MU-P-1A	DH-P-1A	SR-P-1A	RR-P-1A	AH-E-1A	AH-E-1C	DR-P-1A	DC-P-1A	NS-P-1B	NR-P-1B	BS-P-1A	EF-P-2A	TP-1A	TP-1C
CASE 6A	BUS LOADING		4030	4020	4650	4050	4445	4490	4640	4460	5270	5470	4040	4010	1000	3000
1S	BRANCH LOAD		0	0	0	0	0	0	0	0	0	0	0	0	7569	9230
	SPECIA	KW	880	364	111											
		KVAR	4311	1785	544											
1R	BRANCH LOAD		N/C	N/C	N/C	0	0	0	0	0	0	0	0	0	7569	9230
2S	BRANCH LOAD		N/C	N/C	N/C	0	0	0	0	0	0	0	0	0	7423	9084
	SPECIA	KW				366	80	80								
		KVAR				1792	390	390								
2R	BRANCH LOAD		N/C	N/C	N/C	N/C	N/C	N/C	0	0	0	0	0	0	7423	9084
3S	BRANCH LOAD		N/C	N/C	N/C	N/C	N/C	N/C	0	0	0	0	0	0	7007	8668
	SPECIA	KW							158	108	141	156				
		KVAR							775	529	691	763				
3R	BRANCH LOAD		N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	0	0	7007	8668
4S	BRANCH LOAD		N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	0	0	6803	8464
	SPECIA	KW											320			
		KVAR											1568			
4R	BRANCH LOAD		N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	0	6803	8464
5S	BRANCH LOAD		N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	0	6714	8375
	SPECIA	KW												439		
		KVAR												2152		
5R	BRANCH LOAD		N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	6714	8375

See explanatory note below table 5A.

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DETAILED CASE DESCRIPTIONS

TABLE 6B
CASE 6B LOADING - MINIMUM GRID, ONE TRANSFORMER, LOCA BLOCK SEQUENCING, GREEN TRAIN

			BLOCK 1		BLOCK 2			BLOCK 3				LOCK 4	LOCK 5	BOP LOADING	
			MU-P-1C	DH-P-1B	RR-P-1B	AH-E-1B	AH-E-1C	DR-P-1B	DC-P-1B	NS-P-1B	NR-P-1B	BS-P-1B	EF-P-2B	TP-1A	TP-1C
CASE 6B	BUS LOADING		5030	5020	5060	5223	4490	5440	5260	5270	5470	5050	5010	1000	3000
1S	BRANCH LOAD		0	0	0	0	0	0	0	0	0	0	0	7569	9230
	SPECIAL	KW	880	364											
		KVAR	4311	1785											
1R	BRANCH LOAD		N/C	N/C	0	0	0	0	0	0	0	0	0	7569	9230
2S	BRANCH LOAD		N/C	N/C	0	0	0	0	0	0	0	0	0	7423	9084
	SPECIAL	KW			366	80	80								
		KVAR			1792	390	390								
2R	BRANCH LOAD		N/C	N/C	N/C	N/C	N/C	0	0	0	0	0	0	7423	9084
3S	BRANCH LOAD		N/C	N/C	N/C	N/C	N/C	0	0	0	0	0	0	7007	8668
	SPECIAL	KW						158	108	141	156				
		KVAR						775	529	691	763				
3R	BRANCH LOAD		N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	0	0	7007	8668
4S	BRANCH LOAD		N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	0	0	6803	8464
	SPECIAL	KW										320			
		KVAR										1568			
4R	BRANCH LOAD		N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	0	6803	8464
5S	BRANCH LOAD		N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	0	6714	8375
	SPECIAL	KW											439		
		KVAR											2152		
5R	BRANCH LOAD		N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	N/C	6714	8375

See explanatory note below table 5A.

1.0 Purpose:

The purpose of this attachment is to determine the total channel errors for the degraded voltage relays, identified as follows:

1D-4160V-ES-27-1	Model No. 211T6175-HF
1D-4160V-ES-27-2	Model No. 211T6175-HF
1D-4160V-ES-27-3	Model No. 211T6175-HF
1E-4160V-ES-27-1	Model No. 211T6175-HF
1E-4160V-ES-27-2	Model No. 211T6175-HF
1E-4160V-ES-27-3	Model No. 211T6175-HF

Relay Function and Connections

The relay function is to provide a second level of undervoltage protection for the ES buses in the event of degraded voltage event that does not develop into a complete voltage collapse. The relays feature two settings, pickup and dropout, which are adjustable by fixed taps as well as internal adjustment potentiometers. The dropout setting determines the value that the output contacts will transfer on decreasing voltage. The pickup setting, also referred to as the reset setting, determines the value that the output contacts will transfer on increasing voltage. (Reference 3.1)

ES buses 1D and 1E are each provided with 3 relays, one per phase, which are Y connected to the potential transformer secondary. The normally open output contacts of the relays, which close on low bus voltage, are connected to a two out of three logic scheme, such that voltage below the relay setpoint on two out of three relays will initiate a 10 second timer (27XCTD, 27XETD). If the voltage on at least two of the relays does not recover to the pickup setpoint before the time delay relay times out, the affected bus will be disconnected from its offsite source of power. (References 3.4-3.7)

The relay setpoints are subject to tolerances which determine the limits of the operating voltages the for significant operating features of the relays. The minimum dropout setting is significant relative to assuring critical voltage to Nuclear Safety Related (NSR) loads connected to the ES buses. The maximum pickup setting is significant relative to preventing premature separation of the grid following voltage dips, such as occur during Block Load Sequencing, while the minimum pickup setting is significant relative to establishing the minimum voltage available for starting and running MOVs during Block Load Sequencing. This appendix will determine channel uncertainties for both the dropout and pickup settings. In addition, this appendix will determine Acceptable-as-Found Limits for the dropout and pickup settings. This appendix will not determine actual setpoints since these will be determined in the body of the calculation, taking into account the errors determine here.

2.0 Summary of Results

Tolerances for the dropout and pickup settings were determined as follows:

Tolerance	*% of setting*	*Volts*
Channel Error Associated with Dropout Setting (CE_{DO})	− 0.852%	− 0.54 V
Positive Channel Error Associated with Pickup Setting (CE_{PU+})	+ 0.721%	+ 0.45 V
Negative Channel Error Associated with Pickup Setting (CE_{PU-})	− 0.609%	− 0.38 V
Dropout Acceptable-as-Found Limit ($AAFL_{DO}$)	± 0.552%	± 0.35 V
Pickup Upper Acceptable-as-Found Limit ($AAFL_{PU+}$)	+ 0.421%	+ 0.27 V
Pickup Lower Acceptable-as-Found Limit ($AAFL_{PU-}$)	− 0.309%	− 0.19 V

3.0 References:

3.1 TMI-1 Vendor Manual VM-TM-0124, Asea Brown Boveri IB 7.4.1.7-7, Issue D, Instructions for Single Phase Relays Types 27N and 59N.
3.2 TMI-1 Surveillance Procedure 1302-5.31A, Revision 16, 4160V D and E Bus Degraded Grid Undervoltage Relay
3.3 Calculation C-1101-732-E510-008 Revision 1, TMI-1 4160v Bus 1D &1E Degraded Grid UVR Setpoint Drift Analysis
3.4 Electrical Elementary Diagram 208-168, Sheet 1, Revision 22, E.S. Bus 1D Undervoltage & Potential Circuits
3.5 Electrical Elementary Diagram 208-168, Sheet 2, Revision 5, E.S. Bus 1D Undervoltage & Potential Circuits
3.6 Electrical Elementary Diagram 208-169, Sheet 1, Revision 23, E.S. Bus 1E Undervoltage & Potential Circuits
3.7 Electrical Elementary Diagram 208-169, Sheet 2, Revision 5, E.S. Bus 1E Undervoltage & Potential Circuits
3.8 TMI-1 GMS2 Data Base
3.9 Engineering Standard ES-010, Revision 3, TMI-1 Environmental Parameters
3.10 TMI-1 Vendor Manual VM-TM-0104, Asea Brown Boveri IB 18.4.7-2, Issue E, Instructions for Single Phase Relays Types ITE-27D, ITE-27H, and ITE-59D.
3.11 TMI-1 Vendor Manual VM-TM-0378, Revision 1, Agastsat Timing Relay, Series E7000 and series 7000.
3.12 TMI-1 Vendor Manual VM-TM-0266, Revision 5, Westinghouse 4160V and 6900V Switchgear.
3.13 Memorandum dated 6/16/98, Joe Valent to George Skinner, PT Indicating Bulbs
3.14 ISA-RP67.04, Part II, Dated May,1995, "Methodologies for the Determination of Setpoints for Nuclear Safety-Related Instrumentation"

3.15 Engineering Standard ES-002, Revision 4, "Instrument Error Calculation and Setpoint Determination"
3.16 Calculation No. C-1101-734-5350-003, Revision 3, "TMI-1 Battery Sizing and Voltage Drop for DC System"
3.17 Deleted
3.18 TMI-1 Operating Procedure 1107-2, Revision 93, "Emergency Electrical System"
3.19 USAS C57.13-1968, "Requirements for Instrument Transformers" (TMI SDBD-T1-700, Reference D013)
3.20 Modification H375, BA Number 41H375, Replace Degraded Grid UV Relays

4.0 Assumptions

4.1 Tolerances provided in vendor literature (Reference 3.1) are expressed as percentages without specifying the base. These percentages may be assumed to be based on the actual setting. However, in order to simplify the calculation, the setting base will conservatively be assumed to be a single value of 63V.

4.2 Deleted

4.3 Drift for up to a 24 month calibration interval plus 25% interval margin was determined in Calculation C-1101-732-E510-008 (Reference 3.3) by performing a statistical analysis of calibration as-found as-left data. Since this calculation was based on actual field calibration data, the calculated drift values also include the verification of relay reference accuracy and M&TE errors. Consequently, these terms will be assumed to be included in the drift term. It is further assumed that M&TE at least as good as is presently being used, will continued to be used for the calibration of these relays.

In order to reduce total uncertainties this analysis will assume that the calibration interval will not exceed 500 days. Consequently, drift values from Reference 3.3 for the 500 day interval will be used. Also, the drift results in Reference 3.3 are based on as-found as-left data for Model 211T0175 relays without a harmonic filter. Since this data is being applied to the similar Model 211T6175-HF relay, the calibration interval should be initially set at 90 days until sufficient new data is available to justify a longer interval.

4.4 Minimum control power voltage for the degraded voltage relays was calculated during worst case accident battery loading. However, a review of calculation C-1101-734-5350-003, (Reference 3.16) revealed that this voltage was based on a Loop/LOCA scenario for during which the battery chargers were not available. The station is provided with spare battery chargers that can be promptly placed in service in case of failure or planned outage of a primary charger (Reference 3.18). Therefore, loss of battery charging capability with AC power available is not expected. It follows that the low DC system voltages will not occur while AC power is available. Further, since the degraded voltage relays are only required to operate when AC power is available, it may be assumed that they will only experience normal DC power system voltage fluctuations. Voltage is normally controlled within the 130 Vdc ± 1 Vdc float voltage criteria listed in Reference 3.18, Section 3.2.6.b.6. Reference 3.16 shows a maximum voltage drop of approximately 4 volts between the distribution panel and the switchgear where the relays are located, resulting in a minimum normal voltage at the relays of 130 –1 – 4 = 125Vdc. The degraded voltage relays are calibrated with either station 125 Vdc power or power from a 125 Vdc power supply (Reference 3.2). Thus, 125 Vdc would represent the minimum relay supply voltage. The maximum supply voltage would occur during the brief periods of battery equalization during which 125 Vdc system voltage is maintained at or below 137 Vdc (Reference 3.18 , Section 3.2.6.d.2). Assuming no voltage drop between the battery charges and the relays, the maximum DC system voltage may therefore be assumed to be the maximum equalization voltage of 137 Vdc.

4.5 It is assumed that vendor tolerance specifications are random, and independent of other error terms. In addition, when tolerances are specified for a definite range of a variable (such as power supply variation) it is assumed that the error may be adjusted proportionally for a smaller range of the variable.

4.6 Manufacturer's accuracy specifications are assumed to have been determined to at least a 2 sigma (95%) confidence level, unless otherwise indicated.

4.7 Bias error components with unknown signs will be combined algebraically with other error components in the most conservative direction.

4.8 Relay Model No. is assumed to be 211T6175-HF in lieu of the presently installed 211T0175 (Reference 3.8) pursuant to Modification H375 (Reference 3.20). The new relays are equipped with harmonic filters and have more limiting accuracy values than the installed relays (Reference 3.1), and so this calculation will bound both the installed and proposed relays.

5.0 Design Inputs

5.1 Equipment

5.1.1 Degraded Voltage Relays

Degraded Voltage Relay Tag Nos.	1D-4160V-ES-27-1 1D-4160V-ES-27-2 1D-4160V-ES-27-3 1E-4160V-ES-27-1 1E-4160V-ES-27-2 1E-4160V-ES-27-3	Reference 3.8
Model Nos.	211T6175-HF	Assumption 4.8
Pickup Range	60 –110 V	Reference 3.1
Dropout Range	70% - 99.5%	Reference 3.1
Control Power Allowable Variation	100 – 140 VDC	Reference 3.1
Pickup and Dropout Settings, Repeatability at Constant Temperature and Constant Control Voltage	± 0.1%	Reference 3.1
Pickup and Dropout Settings, Repeatability Over Allowable DC Control Power Range	± 0.1%	Reference 3.1
Pickup and Dropout Settings, Repeatability Over Temperature Range	0 to 55° C; ± 0.75% +10 to 40° C; ± 0.4% -20 to +70° C; 1.5%	Reference 3.1
Equipment Location	CB338-6	Reference 3.8
Normal Temperature	70 – 85° F	Reference 3.9
Accident Temperature	70 – 85° F	Reference 3.9
Power Supply Variation:	137 Vdc Maximum 125 Vdc Minimum	Assumption 4.4

5.1.2 Potential Transformers

Potential Transformer Tag Nos.	P-1D P-1E	Reference 3.4 Reference 3.6
Style No.	261A448A02	Reference 3.8
Metering Accuracy Line No.	10	Reference 3.8
Primary Voltage	4200 V	Reference 3.4 Reference 3.6
Secondary Voltage	120 V	Reference 3.4 Reference 3.6
Ratio	35:1	Calculated
Accuracy Class	W .3, X .3, Y 1.2	Reference 3.12

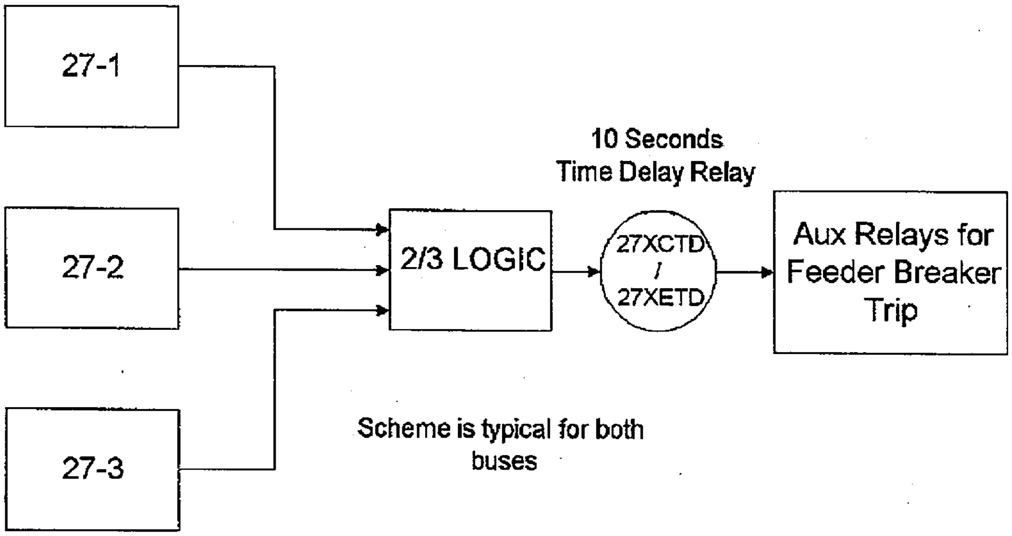
5.2 Calibration Procedures

TMI-1 Surveillance Procedure 1302-5.31A, Revision 15, 4160V D and E Bus Degraded Grid Undervoltage Relay (Reference 3.2) provides the following calibration acceptance criteria:

Dropout Setting	62.02V +/- 0.1%
Pickup Setting	62.33V +/- 0.1%

5.3 Functional Block Diagram

(References 3.4 – 3.7)



Scheme is typical for both buses

5.4 Technical Specification Requirements

Technical Specification 3.5.3, Engineered Safeguards Protection System Actuation Setpoints, lists the following limits for the degraded voltage relays:

Initiating Signal	Function	Setpoint
Degraded Voltage	Switch to Onsite Power Source and load shedding	3760 V
Degraded Voltage Timer		10 sec.

The Technical Specification 3.5.3 Note 4 provides for a minimum allowed setting of 3740V, and a maximum allowed setting of 3773V. The Technical Specification bases state that the minimum and maximum allowed settings for the degraded voltage setpoint are based on a relay tolerance of –0.53%, +0.35% and is to be considered an "as-left" setting.

5.5 Relay Drift

The relay manufacturer does not provide a drift specification for the subject relays. Drift for a 500 day calibration interval was determined in Calculation C-1101-732-E510-008 (Reference 3.3) by analyzing as-found as left data. This calculation determined drift for the pickup and dropout functions of the relay separately as follows.

Dropout
The calculation determined a 95% Confidence Interval Limit at 500 days, around a mean setpoint of 62.05 Volts, of 61.65 Volts to 62.46 Volts. This represents a variation of +0.661%, -0.645% around the mean. A value of ±0.661% will be used for conservatism. This value may be considered a two sigma, random variable. The regression line showed a slight upward setpoint trend from 62.02 Volts to 62.05 Volts over the 500 day interval. This represents a positive bias of +0.048%

Pickup
The calculation determined a 95% Confidence Interval Limit at 500 days, around a mean setpoint of 62.69 Volts, of 62.52 Volts to 62.87 Volts. This represents a variation of +0.271%, -0.287% around the mean. A value of ±0.287% will be used for conservatism. This value may be considered a two sigma, random variable. The regression line showed a upward setpoint trend from 62.62 Volts to 62.69 Volts over the 500 day interval. This represents a positive bias of +0.112%.

5.6 PT Accuracy

A review of 4160V ES bus undervoltage and potential circuits (References 3.4 and 3.6) indicates, that the Y connected secondaries of potential transformers P-1D and P-1E have the following devices connected to them:

- Three ITE Type 27N degraded voltage relays
- Three ITE Type 27H loss of voltage relays
- Three local indicator lights

In addition, one phase has an ITE Type 59N overvoltage relay, another phase has an Agastat 7012 timing relay (MU Pump/Interlock), and the last phase is connected to synchronizing circuits and a remote indicating light. Also, all three phases may be connected individually by selector switches to a local or remote voltmeter.

The voltmeters are high impedance devices that impose negligible burden, and so may be disregarded. Of the remaining devices, the ITE Type 59N relay imposes a burden of 0.5 VA (Reference 3.1), the Agastat timing relay imposes a burden of approximately 8 watts (round to 10VA) (Reference 3.11), while the indicating light is approximately 4.2 VA (Reference 3.13), and the synchronizing circuits are expected to impose negligible burden. Consequently, the phase with the timing relay will be considered as having the maximum burden. The undervoltage relays, ITE Type 27N and ITE Type 27H are Y connected so that the maximum voltage they see is approximately 70 volts, vs. the 120 volts on which their burden rating is based. However, for conservatism, the 120V burden will be assumed. The maximum burden on any phase may be summarized as follows:

Device	Model	VA	Reference
Degraded Voltage Relay	ITE Type 27N	0.5	Reference 3.1
Loss of Voltage Relay	ITE Type 27H	1.2	Reference 3.10
MU Pump/Interlock	Agastat 7012	10.0	Reference 3.11
Indicator Light	1124156	4.2	Reference 3.13
Total		15.9	

As can be seen, the resulting burden is considerably less than the 25 VA standard burden for the X accuracy class (Reference 3.19). The accuracy class at burden X for metering accuracy Line No. 10 is 0.3 (Reference 3.12, Tab 11, page 13). Therefore, the Ratio Correction Factor of the PTs would be no worse than 1.0 ±0.3%, i.e., the error would be no greater than 0.3%.

For any particular instrument transformer, the ratio error may be considered fixed (systematic). Also, although multiple transformers affect the trip and reset functions of the degraded voltage relays, because of the Y connection of the relays , and the two out of three scheme, the PT with the greatest error will govern the overall protection scheme setpoint. For these reasons, the ratio correction error should be treated as a bias of unknown sign and be applied in the most conservative direction.

6.0 Overall Approach and Methodology

This calculation will employ the methodology described in Engineering Standard ES-002 (Reference 3.15). Specifically, individual error components of the instrument loops in question will be quantified and then combined using the square root of the sum of the squares (SRSS), or algebraically, as appropriate. Errors associated with the following parameters will be computed using the formulas shown:

6.1 Minimum Dropout Setpoint

This parameter establishes the minimum voltage available to components during steady state bus operation. Channel errors will be determined by combining all random components SRSS and bias components algebraically. Bias error components associated with the dropout function include a time dependent drift error and the PT ratio correction factor error. The bias error associated with dropout drift has a known positive sign and it will tend to increase the Minimum Dropout Voltage (Section 5.5). Also, since it is time dependent, it may not be present at all times. Accordingly, it will be conservatively disregarded for this parameter. The bias error associated with the PT ratio correction factor will be added to the SRSS combination of random errors to determine the total error. Only the negative components of random error and PT ratio correction factor bias are considered so that the resultant error, when added to the nominal dropout setpoint, will determine the minimum voltage on the ES bus prior to grid separation. Since the dropout setpoint represents a single value of a parameter that is approached in the decreasing direction only, a single side of interest distribution can be utilized. Accordingly, the 2 sigma random uncertainties for a two sided distribution may be reduced by a factor of 1.645/2 (Reference 3.14, Section 8.1):

$$CE_{DO} = -1.645/2\left[\left|\,(DVR_{DO\text{-}REPEAT}^{\,2} + DVR_{DO\text{-}PS}^{\,2} + DVR_{DO\text{-}TE}^{\,2} + DVR_{DO\text{-}DRIFT}^{\,2} + DVR_{DO\text{-}M\&TE}^{\,2} + DVR_{ALCT\text{-}DO}^{\,2})^{0.5}\right|\right] - \left|PT_{RCF\text{-}DO}\right|$$

Where:

CE_{DO} = Total Channel Error Associated with Dropout Setting

$DVR_{DO\text{-}REPEAT}$ = Dropout Setting Repeatability at Constant Temperature and Constant Control Voltage

$DVR_{DO\text{-}PS}$ = Dropout Setting Repeatability Over Allowable DC Control Power Range

$DVR_{DO\text{-}TE}$ = Dropout Setting Repeatability Over Temperature Range

$DVR_{DO\text{-}DRIFT}$ = Drift Associated with Dropout Setting

$DVR_{M\&TE\text{-}DO}$ = M&TE Errors Associated with Dropout Setting

$DVR_{ALCT\text{-}DO}$ = Dropout As Left Calibration Tolerance

$PT_{RCF\text{-}DO}$ = PT Ratio Correction Error Associated with Dropout Setting

6.2 Maximum Pickup

This parameter determines the highest voltage at which grid separation could occur following relay dropout, such as during LOCA Block Sequencing. Channel errors will be determined by combining all random components SRSS, and bias components algebraically. Bias error components associated with the pickup function include a time dependent drift error and the PT ratio correction factor error. Both of these will be added to the SRSS combination of random errors to determine the total error, as shown below. Only the positive components of random error and PT ratio correction factor bias are considered. The pickup drift bias is always positive. The resultant error, will be added to the nominal pickup setpoint to determine minimum voltage that must be maintained on the 4160 V ES bus to prevent grid separation.

$$CE_{PU+} = \left|\left(DVR_{PU\text{-}REPEAT}^{\,2} + DVR_{PU\text{-}PS}^{\,2} + DVR_{PU\text{-}TE}^{\,2} + DVR_{PU\text{-}DRIFT\text{-}RAN}^{\,2} + DVR_{PU\text{-}M\&TE}^{\,2} + DVR_{ALCT\text{-}PU}^{\,2}\right)^{0.5}\right| + DVR_{PU\text{-}DRIFT\text{-}BIAS} + \left|PT_{RCF\text{-}PU}\right|$$

Where:

$CE_{PU}+$ = Total Positive Channel Error Associated with Pickup Setting

$DVR_{PU\text{-}REPEAT}$ = Pickup Setting Repeatability at Constant Temperature and Constant Control Voltage

DVR_{PU-PS} = Pickup Setting Repeatability Over Allowable DC Control Power Range

DVR_{PU-TE} = Pickup Setting Repeatability Over Temperature Range

$DVR_{PU-DRIFT-RAN}$ = Random Drift Associated with Pickup Setting

$DVR_{M\&TE-PU}$ = M&TE Errors Associated with Pickup Setting

$DVR_{ALCT-PU}$ = Pickup As Left Calibration Tolerance

$DVR_{PU-DRIFT-BIAS}$ = Drift Bias Associated with Pickup Setting

PT_{RCF-PU} = PT Ratio Correction Error Associated with Pickup Setting

6.3 Minimum Pickup

This parameter is the minimum ES bus recovery voltage that could occur during LOCA Block Sequencing without resulting in grid separation. It is used to determine minimum voltages available to start and run MOVs. Channel error associated with this parameter will be computed by combining all random components SRSS, and bias components algebraically. As noted above, bias error components associated with the pickup function include a time dependent drift error, and a PT ratio correction factor error. Only the negative components of random and bias errors are considered. Since the bias error associated with pickup drift has a known positive sign, it will tend to increase the Minimum Pickup Voltage. Also, since it is time dependent, it may not be present at all times. Accordingly, it will be conservatively disregarded for this parameter. The resultant total error, when added to the nominal pickup setpoint, will determine the minimum recovery voltage that could occur on the 4160V ES buses during Block Load Sequencing without resulting in grid separation.

$$CE_{PU-} = -\left| (DVR_{PU-REPEAT}{}^2 + DVR_{PU-PS}{}^2 + DVR_{PU-TE}{}^2 + DVR_{PU-DRIFT-RAN}{}^2 + DVR_{PU-M\&TE}{}^2 + DVR_{ALCT-PU}{}^2)^{0.5} \right| - \left| PT_{RCF-PU} \right|$$

Where:

CE_{PU-} = Total Negative Channel Error Associated with Pickup Setting

$DVR_{PU-REPEAT}$ = Pickup Setting Repeatability at Constant Temperature and Constant Control Voltage

DVR_{PU-PS} = Pickup Setting Repeatability Over Allowable DC Control Power Range

DVR_{PU-TE} = Pickup Setting Repeatability Over Temperature Range

$DVR_{PU-DRIFT-RAN}$ = Random Drift Associated with Pickup Setting

$DVR_{M\&TE-PU}$ = M&TE Errors Associated with Pickup Setting

$DVR_{ALCT-PU}$ = Pickup As Left Calibration Tolerance

PT_{RCF-PU} = PT Ratio Correction Error Associated with Pickup Setting

7.0 Calculations

7.1 Relay Errors

The vendor has identified the following tolerances, as noted in Section 5.1.1 above:

7.1.1 Pickup and Dropout Setting Repeatability at Constant Temperature and Constant Control Voltage

This parameter was specified as ±0.1% and is equivalent to the instrument's reference accuracy. However, in accordance with assumption 4.3, reference accuracy is included in the drift terms determined in Reference 3.3. Therefore:

$DVR_{PU-REPEAT}=0$

Similarly;

$DVR_{DO-REPEAT}=0$

7.1.2 Pickup and Dropout Settings, Repeatability Over Allowable DC Control Power Range

The control power for the degraded voltage relays can vary from a maximum of 137 Vdc during battery equalization, to a minimum of 125 Vdc during calibration (Assumption 4.4). The vendor specification for this parameter was given as ±0.1% over the allowable supply voltage range of 100 to 140 Vdc. The maximum error may be adjusted for the actual DC voltage variation as follows (Assumption 4.5):

$$DVR_{PU-PS} = DVR_{DO-PS} = \frac{(137-125)}{(140-100)} \times (\pm 0.1\%) = \pm 0.03\%$$

7.1.3 Pickup and Dropout Settings, Repeatability Over Temperature Range

The ambient temperature in the essential switchgear rooms can vary between 70° F and 85° F. The vendor specification for this parameter was given as ± 0.4% for a temperature variation of +10° C to 40° C (50° F to 104° F). The maximum error may be adjusted for the actual temperature variation as follows (Assumption 4.5):

$$\mathrm{DVR}_{PU-TE} = \mathrm{DVR}_{DO-TE} = \frac{(85-70)}{(104-50)} \times (\pm 0.4\%) = \pm 0.111\%$$

7.1.4 Drift

As noted in Section 5.5, relay drift was determined separately for the pickup and dropout functions of the relay in Reference 3.3. These values include both random and non-random components as follows:

Pickup Setting Drift	$\mathrm{DVR}_{PU-DRIFT-RAN} = \pm 0.287\%$
	$\mathrm{DVR}_{PU-DRIFT-BIAS} = +0.112\%$ bias
Dropout Setting Drift	$\mathrm{DVR}_{DO-DRIFT} = \pm 0.661\%$ random

7.1.5 Measurement and Test Equipment (M&TE)

In accordance with assumption 4.3, M&TE errors are included in the empirically determined drift value discussed in Section 5.5 of this appendix. Therefore, M&TE errors will not be separately quantified:

$$\mathrm{DVR}_{M\&TE-DO} = \mathrm{DVR}_{M\&TE-PU} = 0$$

7.1.6 As Left Calibration Tolerance

The as left calibration tolerance is equal to the relay repeatability of +/- 0.1% (Sections 5.1.1 and 5.2). In accordance with assumption 4.3 verification of reference accuracy, which includes repeatability, is assumed to be included in the results of the drift statistical analysis. Consequently, a separate term for as left calibration tolerance need not be included (Reference 3.14, Section 6.2.6.2). Therefore:

$$\mathrm{DVR}_{ALCT-DO} = \mathrm{DVR}_{ALCT-PU} = 0$$

7.2 Potential Transformer Errors

7.2.1 Ratio Correction Factor

As noted in Section 5.6, the maximum PT ratio correction factor error is a bias of unknown sign, with a value of ±0.3% Therefore:

$PT_{RCF\text{-}PU} = PT_{RCF\text{-}DO} = \pm 0.3\%$ (bias)

7.3 Channel Error

From Section 6 above, the total channel errors for the degraded voltage relay instrument loop may be computed as follows:

7.3.1 Minimum Dropout Setpoint Channel Error

$$CE_{DO} = -1.645/2 \left[\left| (DVR_{DO\text{-}REPEAT}{}^2 + DVR_{DO\text{-}PS}{}^2 + DVR_{DO\text{-}TE}{}^2 + DVR_{DO\text{-}DRIFT}{}^2 + DVR_{DO\text{-}M\&TE}{}^2 + DVR_{ALCT\text{-}DO}{}^2)^{0.5} \right| \right] - \left| PT_{RCF\text{-}DO} \right|$$

Where:

$DVR_{DO\text{-}REPEAT} = 0\%$ (Section 7.1.1)

$DVR_{DO\text{-}PS} = \pm 0.03\%$ (Section 7.1.2)

$DVR_{DO\text{-}TE} = \pm 0.111\%$ (Section 7.1.3)

$DVR_{DO\text{-}DRIFT} = \pm 0.661\%$ (Section 7.1.4)

$DVR_{DO\text{-}M\&TE} = 0\%$ (Section 7.1.5)

$DVR_{ALCT\text{-}DO} = 0\%$ (Section 7.1.6)

$PT_{RCF\text{-}DO} = \pm 0.3\%$ (Section 7.2.1)

Substituting and computing:

$$CE_{DO} = -0.852\%$$

Converting to process terms;

$$CE_{DO} = -0.00852 \times 63\text{ V} = -0.54\text{V}$$

7.3.2 Maximum Pickup Setpoint Channel Error

$$CE_{PU+} = \left|(DVR_{PU\text{-}REPEAT}{}^{2} + DVR_{PU\text{-}PS}{}^{2} + DVR_{PU\text{-}TE}{}^{2} + DVR_{PU\text{-}DRIFT\text{-}RAN}{}^{2} + DVR_{PU\text{-}M\&TE}{}^{2} + DVR_{ALCT\text{-}PU}{}^{2})^{0.5}\right| + DVR_{PU\text{-}DRIFT\text{-}BIAS} + \left|PT_{RCF\text{-}PU}\right|$$

Where:

$DVR_{PU\text{-}REPEAT}$	= 0%	(Section 7.1.1)
$DVR_{PU\text{-}PS}$	= ± 0.03%	(Section 7.1.2)
$DVR_{PU\text{-}TE}$	= ± 0.111%	(Section 7.1.3)
$DVR_{PU\text{-}DRIFT\text{-}RAN}$	= ± 0.287%	(Section 7.1.4)
$DVR_{PU\text{-}M\&TE}$	= 0%	(Section 7.1.5)
$DVR_{ALCT\text{-}PU}$	= 0%	(Section 7.1.6)
$DVR_{PU\text{-}DRIFT\text{-}BIAS}$	= +0.112%	(Section 7.1.4)
$PT_{RCF\text{-}PU}$	= ±0.3%	(Section 7.2.1)

Substituting and computing:

$$CE_{PU+} = 0.721\%$$

Converting to process terms;

$$CE_{PU+} = 0.00721 \text{ X } 63 \text{ V} = 0.45 \text{ V}$$

7.3.3 Minimum Pickup Setpoint Channel Error

$$CE_{PU-} = -\left|(DVR_{PU\text{-}REPEAT}{}^{2} + DVR_{PU\text{-}PS}{}^{2} + DVR_{PU\text{-}TE}{}^{2} + DVR_{PU\text{-}DRIFT\text{-}RAN}{}^{2} + DVR_{PU\text{-}M\&TE}{}^{2} + DVR_{ALCT\text{-}PU}{}^{2})^{0.5}\right| - \left|PT_{RCF\text{-}PU}\right|$$

Where:

$DVR_{PU-REPEAT}$	= 0%	(Section 7.1.1)
DVR_{PU-PS}	= ± 0.03%	(Section 7.1.2)
DVR_{PU-TE}	= ± 0.111%	(Section 7.1.3)
$DVR_{PU-DRIFT-RAN}$	= ± 0.287%	(Section 7.1.4)
$DVR_{PU-M\&TE}$	= 0%	(Section 7.1.5)
$DVR_{ALCT-PU}$	= 0%	(Section 7.1.6)
PT_{RCF-PU}	= ± 0.3%	(Section 7.2.1)

Substituting and computing:

$$CE_{PU-} = -0.609\%$$

Converting to process terms;

$$CE_{PU-} = -0.00609 \times 63\text{ V} = -0.38\text{ V}$$

7.4 Acceptable-as-Found Limit

7.4.1 Dropout Acceptable-as-Found Limit

The Acceptable-as-Found Limit for the dropout setting will include error terms which may be present at the time of calibration. Although a two sided tolerance band is calculated, the correction factor for the single sided distribution will be used for consistency with the method used to determine channel error. The upper tolerance limit is not significant relative to the maintenance of safety limits, but should be used as an indication of possible equipment malfunction.

$$AAFL_{DO} = \pm 1.645/2\left[\left| (DVR_{DO-REPEAT}{}^2 + DVR_{DO-PS}{}^2 + DVR_{DO-TE}{}^2 + DVR_{DO-DRIFT}{}^2 + DVR_{DO-M\&TE}{}^2 + DVR_{ALCT-DO}{}^2)^{0.5} \right| \right]$$

Substituting values from Section 7.3.1 and computing:

$$AAFL_{DO} = \pm 0.552\%$$

Converting to process terms;

$$AAFL_{DO} = \pm 0.00552 \text{ X } 63 = \pm 0.35 \text{ V}$$

7.4.2 Pickup Upper Acceptable-as-Found Limit

$$AAFL_{PU+} = \left|(DVR_{PU\text{-}REPEAT}{}^2 + DVR_{PU\text{-}PS}{}^2 + DVR_{PU\text{-}TE}{}^2 + DVR_{PU\text{-}DRIFT\text{-}RAN}{}^2 + DVR_{PU\text{-}M\&TE}{}^2 + DVR_{ALCT\text{-}PU}{}^2)^{0.5}\right| + DVR_{PU\text{-}DRIFT\text{-}BIAS}$$

Substituting values from Section 7.3.2 and computing:

$$AAFL_{PU+} = +0.421\%$$

Converting to process terms;

$$AAFL_{PU+} = +0.00421 \text{ X } 63 = +0.27 \text{ V}$$

7.4.3 Pickup Lower Acceptable-as-Found Limit

$$AAFL_{PU-} = -\left|DVR_{PU\text{-}REPEAT}{}^2 + DVR_{PU\text{-}PS}{}^2 + DVR_{PU\text{-}TE}{}^2 + DVR_{PU\text{-}DRIFT\text{-}RAN}{}^2 + DVR_{PU\text{-}M\&TE}{}^2 + DVR_{ALCT\text{-}PU}{}^2)^{0.5}\right|$$

Substituting values from Section 7.3.3 and computing:

$$AAFL_{PU-} = -0.309\%$$

Converting to process terms;

$$AAFL_{PU-} = -0.00309 \text{ X } 63 = -0.19 \text{ V}$$

CALCULATION C-1100-700-E510-010, REV. 2

APPENDIX 8.5
Motor Starting Loads and Voltage Criteria

Red Train Loads

TAG NO.	DAPPER BUS	BLOCK	MOTOR DATA					REFERENCES FOR MOTOR DATA	CALCULATED DATA		
			HP	NAME-PLATE VOLTS	STARTING VOLTAGE CRITERIA	LRA	PF		KVA	KW	KVAR
MU-P-1A	4030	1	700	4000	80%	635	0.2	1, 10, 12	4399	880	4311
DH-P-1A	4020	1	350	4000	80%	263	0.2	2, 6, 12	1822	364	1785
SR-P-1A	4650	1	210	460	80%	697	0.2	12, 13, 14	555	111	544
RR-P-1A	4050	2	400	4000	75%	264	0.2	4, 9, 12	1829	366	1792
AH-E-1A	4445	2	75	460	80%	500	0.2	5, 8, 11, 12	398	80	390
AH-E-1C	4490	2	75	460	80%	500	0.2	5, 8, 11, 12	398	80	390
DR-P-1A	4460	3	200	460	75%	993	0.2	4, 9, 12	791	158	775
DC-P-1A	4630	3	100	460	75%	678	0.2	4, 9, 12	540	108	529
NS-P-1B	4470	3	125	460	75%	885	0.2	4, 9, 12	705	141	691
NR-P-1B	5470	3	150	460	75%	978	0.2	4, 9, 12	779	156	763
BS-P-1A	4040	4	250	4000	80%	231	0.2	3, 6, 12	1600	320	1568
EF-P-2A	4010	5	450	4000	75%	317	0.2	4, 9, 12	2196	439	2152

Green Train Loads

TAG NO.	DAPPER BUS	BLOCK	MOTOR DATA					REFERENCES FOR MOTOR DATA	CALCULATED DATA		
			HP	NAME-PLATE VOLTS	STARTING VOLTAGE CRITERIA	LRA	PF		KVA	KW	KVAR
MU-P-1C	5030	1	700	4000	80%	635	0.2	1, 10, 12	4399	880	4311
DH-P-1B	5020	1	350	4000	80%	263	0.2	2, 6, 12	1822	364	1785
RR-P-1B	5060	2	400	4000	75%	264	0.2	4, 9, 12	1829	366	1792
AH-E-1B	5223	2	75	460	80%	500	0.2	5, 8, 11, 12	398	80	390
AH-E-1C	4490	2	75	460	80%	500	0.2	5, 8, 11, 12	398	80	390
DR-P-1B	5440	3	200	460	75%	993	0.2	4, 9, 12	791	158	775
DC-P-1B	5260	3	100	460	75%	678	0.2	4, 9, 12	540	108	529
NS-P-1B	5270	3	125	460	75%	885	0.2	4, 9, 12	705	141	691
NR-P-1B	5470	3	150	460	75%	978	0.2	4, 9, 12	779	156	763
BS-P-1B	5050	4	250	4000	80%	231	0.2	3, 6, 12	1600	320	1568
EF-P-2B	5010	5	450	4000	75%	317	0.2	4, 9, 12	2196	439	2152

References for Motor Data

1. SDBD-T1-211 (Reference 3.3.2)
2. SDBD-T1-212 (Reference 3.3.3)
3. SDBD-T1-214 (Reference 3.3.4)
4. SDBD-T1-700 (Reference 3.3.5)
5. SDBD-T1-823 (Reference 3.3.6)
6. GAI Drawing SS 224-402 (Reference 3.6.1)
7. GAI Drawing SS 224-403 (Reference 3.6.2)
8. GAI Drawing SS 224-411 (Reference 3.6.4)
9. Westinghouse Motor Study (Reference 3.4.3)
10. TDR 1064 (Reference 3.2.3)
11. Assumption 4.10
12. Assumption 4.4
13. GAI Drawing SS 224-404 (Reference 3.6.3)
14. Assumption 4.30

REACTOR PLANT LOADING

	REACTOR PLANT BUS 1A							REACTOR PLANT BUS 1B						
DATE	A AMPS	B AMPS	C AMPS	A VOLTS	B VOLTS	C VOLTS	KVA	A AMPS	B AMPS	C AMPS	A VOLTS	B VOLTS	C VOLTS	KVA
10/18/95	1160	1125	1125	7000	7000	7000	13781	1110	1140	1110	7200	7200	7200	13967
10/29/95	1165	1140	1145	7000	7000	7000	13943	1110	1150	1110	7150	7150	7150	13912
11/6/95	1150	1150	1150	7000	7000	7000	13943	1100	1150	1125	7150	7150	7150	13932
11/19/95	1170	1140	1140	6970	6970	6970	13883	1120	1150	1120	7100	7100	7100	13896
11/26/95	1160	1125	1135	7000	7000	7000	13822	1110	1140	1120	7200	7200	7200	14009
12/2/95	1170	1140	1130	7000	7000	7000	13903	1120	1150	1100	7150	7150	7150	13912
12/9/95	1155	1145	1145	7000	7000	7000	13923	1100	1150	1100	7150	7150	7150	13829
12/14/95	1150	1125	1140	7000	7000	7000	13802	1100	1150	1100	7200	7200	7200	13926
12/21/95	1150	1140	1140	6950	7000	7000	13829	1100	1150	1125	7100	7150	7100	13868
1/3/96	1160	1140	1140	7000	7000	7000	13903	1120	1150	1120	7150	7150	7150	13994
1/14/96	1150	1150	1125	7000	7000	7000	13842	1100	1150	1100	7200	7200	7200	13926
1/27/96	1150	1150	1150	6950	6950	6950	13843	1120	1120	1120	7100	7100	7100	13773
2/7/96	1160	1140	1140	7000	7000	7000	13903	1120	1150	1120	7150	7150	7150	13994
2/11/96	1160	1140	1135	7000	7000	7000	13882	1110	1155	1110	7150	7150	7150	13932
2/18/96	1150	1150	1125	7000	7000	7000	13842	1100	1150	1100	7200	7200	7200	13926
2/21/96	1160	1140	1125	7000	7000	7000	13842	1110	1145	1110	7200	7200	7200	13988
2/25/96	1160	1140	1125	7000	7000	7000	13842	1110	1150	1100	7200	7200	7200	13967
3/11/96	1175	1150	1140	6950	6950	6950	13904	1120	1150	1120	7100	7100	7100	13896
3/17/96	1160	1140	1130	7000	7000	7000	13862	1110	1150	1110	7200	7200	7200	14009
3/27/96	1160	1130	1125	7000	7000	7000	13802	1110	1145	1110	7200	7200	7200	13988
4/14/96	1150	1125	1100	7050	7050	7050	13737	1100	1140	1100	7250	7250	7250	13981
4/20/96	1150	1125	1100	7000	7000	7000	13640	1100	1150	1100	7200	7200	7200	13926
5/10/96	1150	1125	1110	7000	7000	7000	13680	1100	1150	1100	7200	7200	7200	13926
6/10/96	1160	1130	1130	7000	7000	7000	13822	1100	1140	1100	7200	7200	7200	13884
6/16/96	1175	1140	1140	6950	6950	6950	13863	1120	1145	1100	7100	7100	7050	13762
6/22/96	1150	1115	1110	7000	7000	7000	13640	1100	1110	1100	7200	7200	7150	13728
7/7/96	1170	1130	1170	6950	6950	6950	13924	1120	1140	1100	7100	7100	7100	13773
7/20/96	1150	1120	1120	7000	7000	7000	13701	1100	1125	1100	7200	7200	7200	13822
7/30/96	1150	1130	1120	7000	7000	7000	13741	1100	1130	1100	7200	7200	7200	13843
8/4/96	1165	1125	1125	6975	6950	6950	13720	1120	1140	1110	7100	7100	7100	13814
8/13/96	1150	1120	1130	7000	7000	7000	13741	1100	1130	1100	7200	7200	7200	13843
8/16/96	1120	1120	1120	7050	7050	7050	13676	1100	1100	1100	7200	7200	7200	13718
8/23/96	1160	1200	1175	6950	6950	6950	14184	1120	1140	1120	7050	7050	7050	13758
8/30/96	1160	1200	1175	6950	6950	6950	14184	1120	1140	1120	7050	7050	7050	13758
9/1/96	1160	1140	1125	7000	7000	6975	13826	1110	1140	1100	7100	7100	7100	13732
9/7/96	1150	1125	1125	7000	7000	7000	13741	1110	1125	1100	7000	7000	7000	13478
9/11/96	1150	1120	1130	7000	7000	7000	13741	1100	1130	1110	7200	7200	7200	13884
9/21/96	1150	1120	1130	7000	7000	7000	13741	1100	1130	1110	7100	7100	7100	13691
10/6/96	1160	1140	1140	6900	6900	6900	13704	1110	1150	1110	7200	7200	7200	14009
10/13/96	1160	1125	1125	7000	7000	7000	13781	1110	1140	1110	7190	7190	7190	13948
11/9/96	1160	1145	1140	6950	6950	6950	13823	1110	1150	1110	7100	7100	7100	13814
11/17/96	1160	1130	1130	7000	7000	7000	13822	1100	1150	1100	7200	7200	7200	13926
11/30/96	1150	1125	1120	7050	7050	7050	13819	1100	1140	1100	7200	7200	7200	13884
12/7/96	1175	1140	1130	7000	7000	7000	13923	1120	1150	1110	7150	7150	7150	13953
12/15/96	1160	1130	1125	7000	7000	7000	13802	1100	1150	1100	7150	7150	7150	13829
12/22/96	1175	1145	1140	7000	7000	7000	13983	1120	1150	1120	7100	7100	7100	13896
12/29/96	1160	1140	1140	7000	7000	7000	13903	1110	1150	1110	7300	7300	7300	14203
1/5/97	1160	1140	1125	7000	7000	7000	13842	1100	1150	1100	7150	7150	7150	13829
1/12/97	1160	1140	1125	7000	7000	7000	13842	1110	1145	1110	7170	7170	7170	13930
1/19/97	1160	1140	1140	7000	7000	7000	13903	1110	1150	1110	7150	7150	7150	13912
2/1/97	1150	1125	1120	7050	7050	7050	13819	1100	1140	1100	7200	7200	7200	13884
2/16/97	1155	1130	1130	7000	7000	7000	13802	1100	1140	1110	7200	7200	7200	13926
2/23/97	1150	1140	1140	7000	7000	7000	13862	1100	1150	1100	7150	7150	7150	13829
3/2/97	1150	1130	1110	7000	7000	7000	13701	1100	1150	1100	7200	7200	7200	13926
3/8/97	1160	1145	1145	6900	6900	6900	13744	1100	1150	1100	7150	7150	7150	13829
3/16/97	1160	1140	1120	7000	7000	7000	13822	1110	1150	1110	7200	7200	7200	14009
3/23/97	1160	1140	1125	7000	7000	7000	13842	1105	1150	1105	7175	7175	7175	13919
3/30/97	1150	1125	1100	7000	7000	7000	13640	1100	1140	1100	7200	7200	7200	13884
4/6/97	1160	1130	1120	7000	7000	7000	13781	1110	1150	1100	7150	7150	7150	13870
4/13/97	1155	1140	1120	7000	7000	7000	13802	1100	1145	1100	7200	7200	7200	13905
4/20/97	1170	1170	1170	7000	7000	7000	14185	1110	1150	1100	7200	7200	7200	13967
4/27/97	1160	1140	1120	7000	7000	7000	13822	1110	1150	1100	7200	7200	7200	13967
5/4/97	1175	1140	1130	6950	6950	6950	13823	1115	1150	1110	7100	7100	7100	13835
5/11/97	1120	1120	1120	7000	7000	7000	13579	1110	1110	1110	7150	7150	7150	13746
5/17/97	1150	1125	1120	7000	7000	7000	13721	1110	1150	1110	7200	7200	7200	14009
5/25/97	1160	1130	1120	7000	7000	7000	13781	1100	1140	1100	7200	7200	7200	13884
6/1/97	1160	1130	1120	6950	6950	6950	13683	1100	1140	1100	7100	7100	7100	13691
7/6/97	1160	1125	1120	6950	6950	6950	13663	1100	1130	1100	7100	7100	7100	13650
7/12/97	1150	1150	1100	7000	7000	7000	13741	1100	1125	1100	7200	7200	7200	13822
7/19/97	1150	1110	1110	6950	6950	6950	13522	1100	1125	1100	7100	7100	7100	13630

REACTOR PLANT LOADING

	REACTOR PLANT BUS 1A							REACTOR PLANT BUS 1B						
DATE	A AMPS	B AMPS	C AMPS	A VOLTS	B VOLTS	C VOLTS	KVA	A AMPS	B AMPS	C AMPS	A VOLTS	B VOLTS	C VOLTS	KVA
7/27/97	1150	1125	1125	6900	6900	6900	13545	1100	1125	1100	7100	7100	7100	13630
8/3/97	1160	1120	1120	6950	6950	6950	13643	1110	1130	1100	7100	7100	7100	13691
8/10/97	1150	1125	1125	7000	7000	6950	13708	1100	1150	1100	7100	7100	7100	13732
8/16/97	1160	1120	1120	6950	6950	6950	13643	1100	1120	1100	7100	7100	7100	13609
8/23/97	1150	1110	1110	7000	7000	7000	13620	1100	1125	1100	7200	7200	7150	13790
8/31/97	1170	1130	1130	7000	7000	7000	13862	1120	1140	1110	7100	7100	7100	13814
10/25/97	1110	1120	1110	7100	7100	7100	13691	1100	1140	1100	7200	7200	7200	13884
11/2/97	1120	1125	1120	7100	7100	7100	13794	1100	1150	1100	7200	7200	7200	13926
11/16/97	1120	1130	1120	7100	7100	7100	13814	1100	1150	1100	7200	7200	7200	13926
11/22/97	1110	1120	1110	7100	7100	7100	13691	1100	1150	1100	7200	7200	7200	13926
11/30/97	1120	1130	1120	7000	7000	7000	13620	1120	1150	1120	7300	7300	7300	14288
12/6/97	1110	1125	1110	7100	7100	7100	13712	1100	1145	1100	7200	7200	7200	13905
12/13/97	1110	1125	1110	7100	7100	7100	13712	1100	1150	1100	7200	7200	7200	13926
12/21/97	1125	1140	1125	7100	7100	7100	13896	1120	1150	1120	7350	7350	7350	14386
1/4/98	1120	1130	1120	7100	7100	7100	13814	1100	1140	1100	7200	7200	7200	13884
1/11/98	1110	1120	1110	7100	7100	7100	13691	1100	1140	1100	7200	7200	7200	13884
1/17/98	1110	1120	1120	7300	7300	7300	14119	1100	1150	1100	7200	7200	7200	13926
1/25/98	1110	1130	1110	7100	7100	7100	13732	1100	1150	1100	7200	7200	7200	13926
1/31/98	1100	1150	1120	7100	7100	7100	13814	1110	1140	1110	7200	7200	7200	13967
2/7/98	1120	1130	1100	7100	7100	7100	13732	1100	1150	1100	7200	7200	7200	13926
2/14/98	1110	1120	1105	7100	7100	7100	13671	1100	1120	1100	7250	7250	7250	13897
2/21/98	1105	1125	1120	7100	7100	7100	13732	1110	1150	1110	7150	7150	7150	13912
3/1/98	1120	1140	1110	7100	7100	7100	13814	1110	1150	1100	7200	7200	7200	13967
3/7/98	1120	1120	1120	7000	7000	7000	13579	1110	1150	1110	7150	7150	7150	13912
3/15/98	1120	1130	1110	7050	7000	7000	13612	1120	1150	1100	7100	7100	7100	13814
3/22/98	1125	1150	1115	7050	7050	7000	13766	1100	1150	1100	7200	7175	7150	13877
3/29/98	1120	1125	1120	7200	7200	7200	13988	1100	1140	1110	7400	7400	7400	14313
4/5/98	1120	1120	1100	7100	7100	7100	13691	1100	1150	1100	7200	7200	7200	13926
4/11/98	1120	1140	1100	7000	7000	7000	13579	1100	1140	1100	7200	7200	7200	13884
4/19/98	1110	1120	1110	7050	7050	7100	13627	1125	1150	1100	7150	7150	7100	13900
4/26/98	1125	1140	1100	7100	7100	7100	13794	1100	1140	1100	7225	7225	7200	13916
5/3/98	1100	1125	1120	7100	7100	7100	13712	1100	1140	1100	7200	7200	7200	13884
5/10/98	1100	1125	1120	7000	7000	7000	13519	1100	1150	1100	7150	7150	7100	13797
5/16/98	1100	1140	1110	7000	7000	7000	13539	1100	1140	1100	7150	7150	7150	13788
5/24/98	1110	1120	1100	7000	7000	7000	13458	1100	1150	1100	7200	7200	7200	13926
5/30/98	1100	1125	1110	7000	7000	7000	13478	1120	1140	1100	7150	7150	7150	13870
6/7/98	1120	1130	1120	7200	7200	7200	14009	1100	1140	1110	7400	7400	7400	14313
6/14/98	1110	1130	1130	6950	6950	6950	13522	1120	1150	1100	7100	7100	7100	13814
6/20/98	1130	1140	1120	7000	7000	7000	13701	1110	1140	1110	7100	7100	7100	13773
6/28/98	1120	1130	1110	7000	7000	7000	13579	1110	1140	1100	7100	7100	7100	13732
7/5/98	1110	1120	1125	7000	7000	7000	13559	1110	1140	1100	7100	7100	7100	13732
7/19/98	1125	1125	1110	7000	7000	7000	13579	1100	1140	1100	7150	7150	7150	13788
7/25/98	1110	1115	1120	7000	7000	7000	13519	1125	1140	1110	7100	7100	7100	13835
8/2/98	1130	1130	1120	7000	7000	7000	13660	1100	1140	1100	7100	7100	7100	13691
8/9/98	1120	1125	1110	7000	7000	7000	13559	1110	1140	1100	7100	7100	7100	13732
8/15/98	1120	1130	1125	7000	7000	7000	13640	1125	1130	1125	7000	7000	7000	13660
8/23/98	1125	1125	1100	7000	7000	7000	13539	1100	1150	1100	7150	7150	7150	13829
8/29/98	1100	1100	1120	7000	7000	7000	13418	1110	1140	1110	7150	7150	7150	13870
9/5/98	1120	1130	1125	7000	7000	7000	13640	1120	1150	1100	7100	7100	7050	13763
9/13/98	1125	1130	1110	7000	7000	7000	13599	1110	1140	1100	7150	7100	7100	13764
9/20/98	1125	1125	1110	7100	7100	7100	13773	1100	1140	1100	7200	7200	7200	13884
9/26/98	1110	1110	1100	7100	7100	7100	13609	1100	1140	1100	7200	7200	7200	13884
10/3/98	1100	1120	1100	7000	7000	7000	13418	1100	1140	1100	7200	7200	7200	13884
10/11/98	1100	1130	1100	7100	7100	7100	13650	1100	1140	1100	7200	7200	7200	13884
10/17/98	1100	1110	1110	7100	7100	7100	13609	1100	1145	1100	7200	7200	7200	13905
10/24/98	1115	1120	1110	7100	7100	7100	13712	1110	1130	1110	7200	7200	7200	13926
10/31/98	1110	1120	1110	7100	7100	7100	13691	1100	1150	1100	7200	7200	7200	13926
11/7/98	1110	1140	1110	7100	7100	7100	13773	1110	1140	1110	7200	7200	7200	13967
11/14/98	1110	1130	1110	7100	7100	7100	13732	1100	1140	1100	7200	7200	7200	13884
11/21/98	1110	1125	1110	7100	7100	7100	13712	1100	1125	1100	7210	7220	7200	13841
11/28/98	1110	1125	1110	7000	7000	7000	13519	1100	1140	1100	7100	7100	7100	13691
12/6/98	1125	1125	1110	7000	7000	7000	13579	1100	1140	1100	7100	7100	7100	13691
						AVERAGE	13748						AVERAGE	13875

Turbine Plant Load Reduction on Plant Trip

Turbine plant load will be automatically reduced following a plant trip due to the reduction in feedwater flow. Electrical loads that will be reduced include two condensate pumps per each of two trains and one heater drain pump per each of two trains. These loads are normally aligned to the A and C turbine plant buses so the load reduction will be experienced on both of these buses. Per references 3.5.17 and 3.5.18, loads are reduced during a turbine trip as follows:

Load	100% Power	Post Trip Shutdown
CO-P-1	120A	96A (Reference 3.5.18)
CO-P-2	240A	165A
HD-P-1	124A	65A
Total	484A	326A

This represents a load reduction of 158A per train.

Using a voltage of 4200V per Reference 3.5.17 to calculate load reduction in KVA:

158 x 1.73 x 4.2 = 1148 KVA

Per Assumptions 4.3.4 and 4.3.5, this load reduction is assumed to be proportional to the reduction in feedwater flow observed during the plant trip of 3/12/93, and which was documented in TAR-TM-022 (Reference 3.7.16) Figures 23 and 24. This assumption is based on engineering judgement of the plant response to a reactor/turbine trip. For a large break LOCA the reactor and turbine trip will precede or occur simultaneously with the ESAS actuation signal. On turbine trip the turbine stop valves slam shut in about 1 sec. and therefore the steam generator pressure rises rapidly from 905 psig to about 1060 psig which is one of the main steam safety valve setpoints. This rise in pressure chokes off feedwater flow, which in turn chokes off heater drain flow to the feedwater pumps (FW-P-1A&B). This sharp reduction in feedwater flow unloads the motors for the condensate (CO-P-1 A, B, C), condensate booster (CO-P-2A, B, C) and heater drain pumps (HD-P-1A, B, C). These pumps go from near 100% design flow to the minimum flow provide by the minimum flow recirculation lines. This happens rapidly and automatically as a result of plant design.

Several other plant design details also act to insure a reduction of feedwater flow. The ICS, Integrated Control System, reduces FW flow demand post trip due to the following:

- Reduction in generated megawatts

Turbine Plant Load Reduction on Plant Trip

- BTU limits – With higher steam generator pressure, lower feedwater temperature, lower reactor outlet temperature and lower RCS flow, the feedwater flow will be reduced. (References 3.1.14 and 3.1.15)

When the turbine is tripped the steam flow to the feedwater heaters essentially stops. The level control valves for the high pressure heaters will start to close because the heaters are no longer condensing steam that needs to be removed to keep from flooding the heater cooling coils. The water flowing to the 6th stage drain collection tank decreases. The HD pump discharge valves would start to close to control tank level because the amount of inflow has decreased. HD pump flow decreases accordingly. Note that there are minimum flow recirculation lines on each pump back to the tank with a valve that opens to assure that the minimum HD pump flow is maintained >= 640 gpm by OPM, 800 gpm by system engineer.

The curves from Reference 3.7.16 have been combined and plotted on an expanded scale on Figure 8.7-1. Feedwater flow is given in Mlb/hr and is plotted against time in seconds. Investigation of the plant computer data from the 3/12/93 trip verifies that this curve is an accurate depiction of feedwater flow verses time. Also the steam generator pressure can be seen to have an inverse effect on the feedwater flow. The TMI-1 response to a reactor/turbine trip on 9/18/92 and 6/2/86 was also reviewed. TAP TMI-93-01 (Reference 3.7.17) and TAP TMI-86-06 (Reference 3.7.18) respectively show a similar response as would be expected.

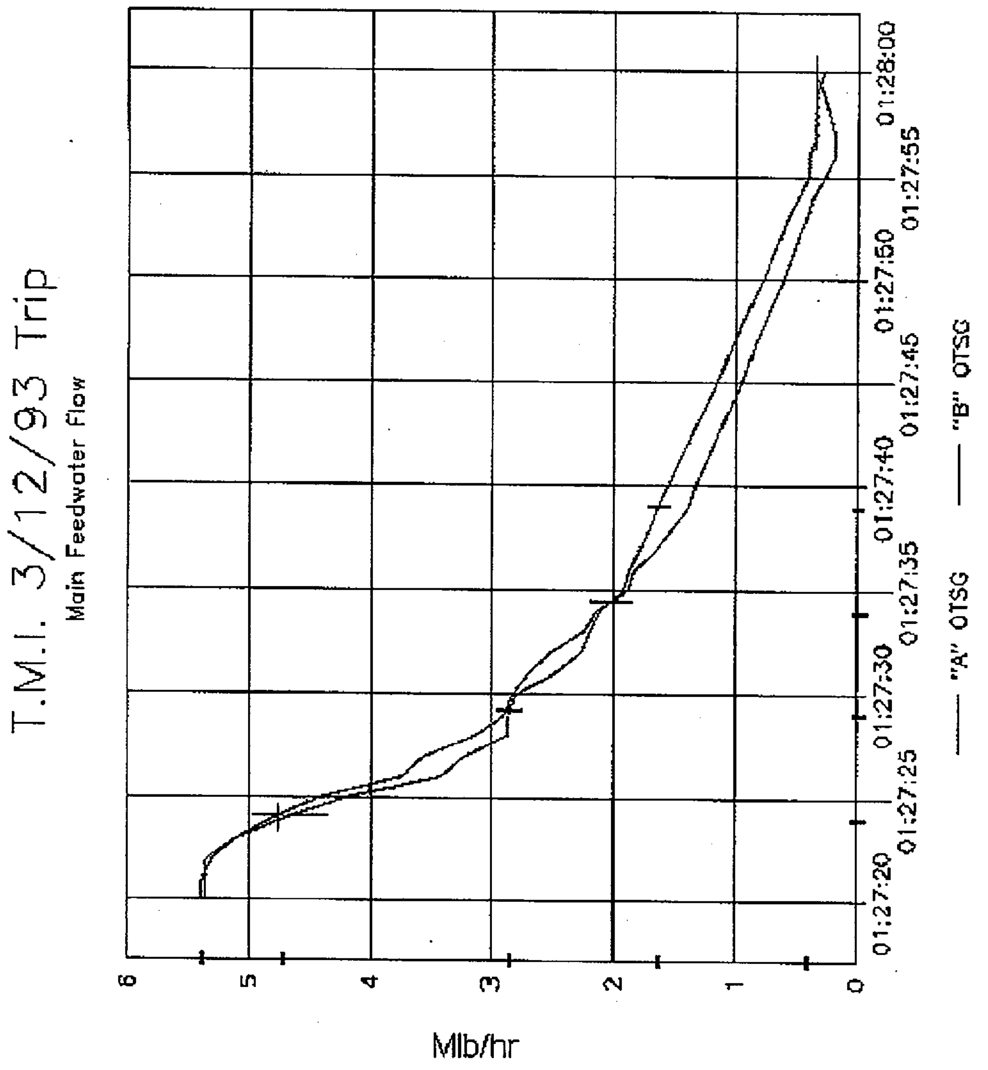
Feedwater flow varied from a maximum of 5.4 Mlb/hr maximum at 0 seconds to 0.3 Mlb/hr at 40 seconds. This represents a range of 5.1 Mlb/hr which was used to calculate the proportional decrease in electrical load. The time increments of interest correspond to the Block Load Sequence intervals which occur at 0, 5, 10, 15, and 20 seconds. For conservatism, and to account for timer tolerances, time intervals after the event initiation were adjusted by -1 second. Feedwater flow at the various time intervals, along with the proportional decrease in electrical load are tabulated in Table 8.7-1.

Table 8.7-1

Time	Feedwater Flow	Adjusted Flow	% of 5.1	100%-% of 5.1	Electrical Load Reduction
1:27:20	5.4	5.1	100.0	0.0	0.0
1:27:24	4.75	4.45	87.3	12.7	145.8
1:27:29	2.9	2.6	51.0	49.0	562.5
1:27:34	2	1.7	33.3	66.7	765.7
1:27:39	1.6	1.3	25.5	74.5	855.3
1:28:00	0.3	0	0.0	100.0	1148.0

Turbine Plant Load Reduction on Plant Trip

Figure 8.7-1



APPENDIX 8.8
TABLE 1A
MOV Loading of 480V (ES) Motor Control Center 1A

EQUIPMENT			OPERATING LOAD			NOTES	DRAWING REFERENCE (SEE PAGES 8 & 9)
Comp't No.	Description	Tag No.	FLA	LRA	KVA		
2B	MOV	EF-V-1A				2	208422 sh 1
2C	MOV	RR-V-4C	2.8		2.2	1	209518
2D	MOV	EF-V-2A				2	208422 sh 2
7D	MOV	MU-V-14A		38.0	30.3	1	209491
9A	MOV	CO-V-14A				2	208475
9B	MOV	RC-V-1				2	208426 sh 1
12D	MOV	CO-V-111A				2	208505
14D	MOV	RR-V-3A	2.8		2.2	1	209518
14E	MOV	RR-V-4A	2.8		2.2	1	209518
Total Bus 4456 (MOV CON KVA (90))					37.0		

Notes

1. MOVs with safety signal (HSPS or ESAS)
2. NSR MOVs with active safety function but not automatic, OR MOVs which are NSR and do not have an active safety function. Reference TR 113, Revision 0, "Generic Letter 89-10 Motor Operated Valve Program Description"
3. Manual pushbutton operation.

APPENDIX 8.8
TABLE 1A-V
MOV Loading of 480V (ES) Motor Control Center 1A (Valves)

EQUIPMENT			OPERATING LOAD					
Comp't No.	Description	Tag No.	FLA	LRA	Block 1 KVA	Blocks 2 through 5 KVA	NOTES	DRAWING REFERENCE (SEE PAGES 8 & 9)
1B	MOV	AH-V-1B	7.50		6.0	6.0	1	209522
5C	MOV	BS-V-1A	4.80		3.8	3.8	1	209521
IA	MOV	BS-V-2A	0.95		0.8	0.8	1	209520
2A	MOV	BS-V-3A	4.00		3.2	3.2	1	209519
6E	MOV	CA-V-4A	0.45		0.4	0.4	1	209518
5A	MOV	CF-V-2A	0.95		0.8	0.8	1	209518
5B	MOV	CF-V-2B	0.45		0.4	0.4	1	209518
10D	MOV	CO-V-12					3	208423
1C	MOV	DH-V-4A	10.00		8.0	8.0	1	209492
3A	MOV	DH-V-5A	5.50		4.4	4.4	1	209492
3B	MOV	DH-V-6A					2	208434 sh 1
3C	MOV	DH-V-7A					2	208431 sh 1
2B	MOV	FW-V-5A	33.41	196.00	156.2	26.6	1	208425
2C	MOV	FW-V-92A	3.80		3.0	3.0	1	208524 sh 1
3D	MOV	IC-V-79A					3	208512
7B	MOV	IC-V-79C					3	208512
4B	MOV	MU-V-16A	5.20		4.1	4.1	1	209491
4C	MOV	MU-V-16B	5.20		4.1	4.1	1	209491
4D	MOV	MU-V-25	2.80		2.2	2.2	1	209521
2D	MOV	MU-V-36	0.95		0.8	0.8	1	209491
5D	MOV	MU-V-39					2	208691
9C	MOV	NR-V-10A					2	208448
9D	MOV	NR-V-10B					2	208448
8A	MOV	NR-V-16A					2	208451
8B	MOV	NR-V-16B					2	208451
7C	MOV	NR-V-4A	1.40		1.1	1.1	1	209491
8D	MOV	NR-V-5					2	208447
9A	MOV	NR-V-8A					2	208450
9B	MOV	NR-V-8B					2	208450
7D	MOV	NS-V-4	2.30		1.8	1.8	1	209520
6D	MOV	WDG-V-3	0.96		0.8	0.8	1	209522
8C	MOV	WDL-V-303	0.95		0.8	0.8	1	209518
Total Bus 4481 (MOV CON KVA (90))					202.5	73.0		

Notes

1. MOVs with safety signal (HSPS or ESAS)
2. NSR MOVs with active safety function but not automatic, OR MOVs which are NSR and do not have an active safety function. Reference TR 113, Revision 0, "Generic Letter 89-10 Motor Operated Valve Program Description"
3. Manual pushbutton operation.

APPENDIX 8.8
TABLE 1A-SH
MOV Loading of 480V (ES) Motor Control Center 1A (Screen House (SH))

EQUIPMENT			OPERATING LOAD			NOTES	DRAWING REFERENCE (SEE PAGES 8 & 9)
Comp't No.	Description	Tag No.	FLA	LRA	KVA		
2A	MOV	NR-V-2				2	208446
2B	MOV	NR-V-3				2	208447
2C	MOV	SR-V-1A				3	208472
12A	MOV	DR-V-1A		4.70	3.7	1	209490, 208342, 208487 sh 1,
12B	MOV	NR-V-1A	0.45		0.4	1	209490, 208355, 208486 sh 1, 209104, 209103
12C	MOV	RR-V-1A	1.50		1.2	1	209518
Total Bus 4628 (MOV CON KVA (90))					5.3		

Notes
1. MOVs with safety signal (HSPS or ESAS)
2. NSR MOVs with active safety function but not automatic, OR MOVs which are NSR and do not have an active safety function. Reference TR 113, Revision 0, "Generic Letter 89-10 Motor Operated Valve Program Description"
3. Manual pushbutton operation.

APPENDIX 8.8
TABLE 1B
MOV Loading of 480V (ES) Motor Control Center 1B

EQUIPMENT			OPERATING LOAD			NOTES	DRAWING REFERENCE (SEE PAGES 8 & 9)
Comp't No.	Description	Tag No.	FLA	LRA	KVA		
10B	MOV	RC-V-3				2	208426 sh2
10C	MOV	RC-V-28				2	208430
11A	MOV	CO-V-14B				2	208475
11D	MOV	RB-V-7	0.7		0.6	1	209620
14A	MOV	RR-V-4B	2.8		2.2	1	209618
14B	MOV	RR-V-4D	2.8		2.2	1	209618
14C	MOV	RR-V-3B		16.00	12.7	1	209618
14D	MOV	CO-V-111B				2	208505
15D	MOV	EF-V-1B				2	208422 sh 1
15E	MOV	EF-V-2B				2	208422 sh2
Total Bus 5236 (MOV CON KVA (90))					17.8		

Notes

1. MOVs with safety signal (HSPS or ESAS)
2. NSR MOVs with active safety function but not automatic, OR MOVs which are NSR and do not have an active safety function. Reference TR 113, Revision 0, "Generic Letter 89-10 Motor Operated Valve Program Description"
3. Manual pushbutton operation.

APPENDIX 8.8
TABLE 1B-V
MOV Loading of 480V (ES) Motor Control Center 1B (Valves)

EQUIPMENT			OPERATING LOAD				NOTES	DRAWING REFERENCE (SEE PAGES 8 & 9)
Comp't No.	Description	Tag No.	FLA	LRA	Block 1 KVA	Blocks 2 through 5 KVA		
1B	MOV	AH-V-1C	7.50		6.0	6.0	1	209622
7B	MOV	BS-V-1B	5.75		4.6	4.6	1	209621
1A	MOV	BS-V-2B	0.95		0.8	0.8	1	209620
2A	MOV	BS-V-3B	4.00		3.2	3.2	1	209619
7D	MOV	CA-V-1					2	209353
5C	MOV	CA-V-13	0.45		0.4	0.4	1	209619
6E	MOV	CA-V-3					2	209355
6D	MOV.	CA-V-4B	0.45		0.4	0.4	1	209618
1C	MOV	DH-V-4B	10.00		8.0	8.0	1	209592
3A	MOV	DH-V-5B	5.50		4.4	4.4	1	209592
3B	MOV	DH-V-6B					2	208434 sh 2
3C	MOV	DH-V-7B					2	208431 sh 2
2B	MOV	FW-V-5B	33.41	196.00	156.2	26.6	1	208425
2C	MOV	FW-V-92B	3.80		3.0	3.0	1	208524 sh 2
5B	MOV	IC-V-2	0.95		0.8	0.8	1	209620
3D	MOV	IC-V-79B					3	208512
5A	MOV	IC-V-79D					3	208512
4A	MOV	MU-V-14B	5.75		4.6	4.6	1	209591
4B	MOV	MU-V-16C	5.20		4.1	4.1	1	209591
4C	MOV	MU-V-16D	5.20		4.1	4.1	1	209591
4D	MOV	MU-V-2A	2.80		2.2	2.2	1	209620
5D	MOV	MU-V-2B	2.80		2.2	2.2	1	209621
2D	MOV	MU-V-37	0.95		0.8	0.8	1	209591
9C	MOV	NR-V-15A					2	208449 sh 1
9D	MOV	NR-V-15B					2	208449 sh 2
8A	MOV	NR-V-16C					2	208451
8B	MOV	NR-V-16D					2	208451
7C	MOV	NR-V-4B	1.40		1.1	1.1	1	209591
10D	MOV	NR-V-6					2	208446
9A	MOV	NR-V-8C					2	208450
9B	MOV	NR-V-8D					2	208450
8C	MOV	NS-V-35	2.30		1.8	1.8	1	209620
10E	MOV	SR-V-2					3	208469
Total Bus 5281(MOV CON KVA (90))					208.5	79.0		

Notes
1. MOVs with safety signal (HSPS or ESAS)
2. NSR MOVs with active safety function but not automatic, OR MOVs which are NSR and do not have an active safety function. Reference TR 113, Revision 0, "Generic Letter 89-10 Motor Operated Valve Program Description"
3. Manual pushbutton operation.

APPENDIX 8.8
TABLE 1B-SH
MOV Loading of 480V (ES) Motor Control Center 1B (Screen House (SH))

EQUIPMENT			OPERATING LOAD			NOTES	DRAWING REFERENCE (SEE PAGES 8 & 9)
Comp't No.	Description	Tag No.	FLA	LRA	KVA		
1B	MOV	NR-V-1C	0.45		0.4	1	209590, 208358, 208486 sh 2, 209104, 209103
1C	MOV	RR-V-1B	1.50		1.2	1	209618
2A	MOV	NR-V-7				2	208446
2B	MOV	SR-V-1B				3	208472
2C	MOV	SR-V-1C				3	208472
10A	MOV	DR-V-1B		4.70	3.7	1	209590, 208343, 208487 sh 2
Total Bus 5428 (MOV CON KVA (90))					5.3		

Notes
1. MOVs with safety signal (HSPS or ESAS)
2. NSR MOVs with active safety function but not automatic, OR MOVs which are NSR and do not have an active safety function. Reference TR 113, Revision 0, "Generic Letter 89-10 Motor Operated Valve Program Description"
3. Manual pushbutton operation.

APPENDIX 8.8
TABLE 1C-V
MOV Loading of 480V (ES) Motor Control Center 1C (Valves)

EQUIPMENT			OPERATING LOAD			NOTES	DRAWING REFERENCE (SEE PAGES 8 & 9)
Comp't No.	Description	Tag No.	FLA	LRA	KVA		
3C	MOV	CF-V-1A				2	208443
4C	MOV	CF-V-1B				2	208443
3A	MOV	DH-V-1				4	209503
3B	MOV	DH-V-2				4	209603
4B	MOV	DH-V-3				2	208454
7A	MOV	EF-V-4				2	208424
7B	MOV	EF-V-5				2	208424
13D	MOV	MS-V-1A				2	208421
12C	MOV	MS-V-1B				2	208421
11C	MOV	MS-V-1C				2	208421
12B	MOV	MS-V-1D				2	208421
10C	MOV	MS-V-2B				2	208427
8D	MOV	MS-V-2A				2	208427
8A	MOV	MS-V-8A				2	208429 sh 1
8B	MOV	MS-V-8B				2	208429 sh 2
7D	MOV	NR-V-18				2	208481 sh 1
5D	MOV	NR-V-19				2	208481 sh 2
2A	MOV	NR-V-1B	0.45		0.4	1	208490, 209490, 209590, 208356, 209104, 209103, 209520, 209620
2B	MOV	NS-V-15	2.30		1.8	1	209520, 209620
2C	MOV	NS-V-32				2	208484
2D	MOV	RB-V-2A	2.50		2.0	1	209521, 209621
5C	MOV	RC-V-2				2	208426 sh 1
5B	MOV	RC-V-4				2	208500
13C	MOV	RR-V-3C		16.00	12.7	1	209518
11A	MOV	RR-V-5				2	208509
5A	MOV	VA-V-8				3	208476
7C	MOV	WDG-V-2				3	209315
Total Bus 4491(MOV CON KVA (90))					16.9		

Notes

1. MOVs with safety signal (HSPS or ESAS)
2. NSR MOVs with active safety function but not automatic, OR MOVs which are NSR and do not have an active safety function. Reference TR 113, Revision 0, "Generic Letter 89-10 Motor Operated Valve Program Description"
3. Manual pushbutton operation.
4. Receive ES close signal but normally closed and remain closed during initial stages of event. Reference TR 113, Revision 0, "Generic Letter 89-10 Motor Operated Valve Program Description"

APPENDIX 8.8
REFERENCES

Reference No.	Drawing No	Full Description
1	208342	GAI Drawing SS-208-342, Revision 5, Electrical Elementary Wiring Diagrams 480V Switchgear (E.S.)
2	208343	GAI Drawing SS-208-343, Revision 7, Electrical Elementary Wiring Diagrams 480V Switchgear (E.S.) (1T-2C) A Decay Heat River Water Pump (DR-P-1B)
3	208355	GAI Drawing SS-208-355, Revision 8, Electrical Elementary Wiring Diagrams 480V Switchgear (E.S.)
4	208356	GAI Drawing SS-208-356, Revision 7, Electrical Elementary Diagram 480V Switchgear (E.S.) (1R-
5	208358	GAI Drawing SS-208-358, Revision 10, Electrical Elementary Diagram 480V Switchgear (E.S.) (1T-2B) C Nuclear Service River Water Pump (NR-P-1C)
6	208421	GAI Drawing SS-208-421, Revision 7, Electrical Elementary Diagram 480V Control Center
7	208422 sh1	GAI Drawing SS-208-422, Sh. 1, Revision 8, Elec Elementary Diagram 480V Control Ctr
8	208422 sh2	GAI Drawing 208-422, Sh. 2, Revision 1, Elec Elementary Diagram 480V Control Ctr
9	208423	GAI Drawing SS-208-423, Revision 5, Elect. Elementary Diagram 480V Control Ctr..
10	208425	GAI Drawing SS-208-425, Revision 12, Elect. Elementary Diagram 480V Control Ctr.
11	208426 sh 1	GAI Drawing SS-208-426, Revision 6, Electrical Elementary Diag 480V Cont. Ctr.1C-ESV – Unit 5C Pressurizer Relief Block Valve RC-V-2
12	208426 sh2	GAI Drawing SS-208-43026, Revision 0, Electrical Elementary Diagram 480V Cont. Ctr.1B-ES -- Unit 10B Pressurizer SprayBlock Valve RC-V-3
13	208427	GAI Drawing SS-208-427, Revision 4, Elect. Elementary Diagram 480V Control Center
14	208429 sh 1	GAI Drawing SS-208-429, Sh. 1, Revision 2, Electrical Elementary Diagram 480V Cont. Center 1C-ESV – Unit 8A Steam Dump to Cond Isol Valve MS-V-8A
15	208429 sh 2	GAI Drawing SS-208-429, Sh. 2,Revision 0, Electrical Elementary Diagram 480V Cont. Center 1C-ESV – Unit 8B Steam Dump to Cond Isol Valve MS-V-8B
16	208430	GAI Drawing SS-208-430, Revision 4, Electrical Elementary Diag 480V Cont. Ctr.1B-ES – Unit 10C Pressurizer Vent Valve RC-V-28
17	208431 sh 1	GAI Drawing SS-208-431, Sh. 1, Revision 4, Electrical Elementary Diag. 480V Cont. Ctr. 1A-ESV - Unit 3C DH Pump to MU Pump Valve DH-V-7A
18	208431 sh 2	GAI Drawing SS-208-431, Sh. 2, Revision 0, Electrical Elementary Diag. 480V Cont. Ctr. 1B-ESV - Unit 3C DH Pump B to MU Pumps Valve DH-V-7B
19	208434 sh 1	GAI Drawing SS-208-434, Sh. 1, Revision 4, Electrical Elementary Diag. 480V Cont Ctr 1A-ESV - Unit 3B RB Sump to DH Pump "A" Valve DH-V-6A
20	208434 sh 2	GAI Drawing SS-208-434, Sh. 2, Revision 2, Electrical Elementary Diag. 480V Cont Ctr 1B-ESV - Unit 3B RB Sump to DH Pump "B" Valve DH-V-6B
21	208446	GAI Drawing SS-208-446, Revision 3, Electrical Elementary Diagram 480V Control Center
22	208449 sh 1	GAI Drawing SS-208-449, Sh. 1, Revision 2, Electrical Elementary Diagram 480V Control Center
23	208449 sh 2	GAI Drawing SS-208-449, Sh. 2, Revision 0, Electrical Elementary Diagram 480V Control Center 1B-ESV - Unit 9D Inter Cooler "B" Outlet Valve NR-V-15B
24	208450	GAI Drawing SS-208-450, Revision 2, Electrical Elementary Diagram 480V Control Center
25	208451	GAI Drawing SS-208-451, Revision 2, Electrical Elementary Diagram 480V Control Center
26	208454	GAI Drawing SS-208-454, Revision 4, Electrical Elementary Diag. 480V Cont. Ctr. 1C-ESV – Unit 4B R.C. Outlet to D.H.SystemDH-V-3
27	208469	GAI Drawing SS-208-469, Revision 2, Electrical Elementary Diagram 480V Control Center
28	208472	GAI Drawing SS-208-472, Revision 2, Electrical Elementary Diagram 480V Control Center
29	208475	GAI Drawing SS-208-475, Revision 2, Electrical. Elementary Diagram 480V Control Ctr.
30	208476	GAI Drawing SS-208-476, Revision 4, Electrical. Elementary Diagram 480V Control Ctr.
31	208481 sh 1	GAI Drawing SS-208-481, Sh. 1,Revision 1, Electrical Elementary Diagram 480V Control Center 1C-ESV Unit 7D, NR-V-18
32	208481 sh 2	GAI Drawing SS-208-481, Sh. 2,Revision 4, Electrical Elementary Diagram 480V Control Center
33	208484	GAI Drawing SS-208-484, Revision 9, Elect. Elementary Diagram 480V Control Ctr.
34	208486 sh 1	GAI Drawing SS-208-486, Sh. 1, Revision 8, Electrical Elementary Diag 480V Cont. Ctr.1A-ESSH – Unit 12B NR Pump 1A Discharge Valve NR-V-1A
35	208486 sh 2	GAI Drawing SS-208-486, Sh. 2, Revision 3, Electrical Elementary Diag 480V Cont. Ctr.1B-ESSH – Unit 1B NR Pump "C" Discharge Valve NR-V-1C
36	208487 sh 1	GAI Drawing SS-208-487, Sh. 1, Revision 8, Electrical Elementary Diag 480V Cont. Ctr.1B-ESSH – Unit 12A DR Pump 1A Discharge Valve DR-V-1A
37	208487 sh 2	GAI Drawing SS-208-487, Sh. 2, Revision 4, Electrical Elementary Wiring Diag 480V Cont.Ctr.1B-ESSSH – Unit 10A DR Pump 1B Discharge Valve DR-V-1B
38	208500	GAI Drawing SS-208-500, Revision 4, Electrical Elementary Diag 480V Cont. Ctr.1C-ESV – Unit 5B Pressurizer Quench Valve RC-V-4
39	208505	GAI Drawing SS-208-505, Revision 5, Electrical Elementary Diagram 480V Control Center

APPENDIX 8.8
REFERENCES

Reference No.	Drawing No	Full Description
40	208509	GAI Drawing SS-208-509, Revision 5, Electrical Elementary Diag 480V Cont. Ctr.1C-ESV – Unit 11A R.B. Emer. Clr. Disch. Press. Reg. Bypass Valve RR-V-5
41	208512	GAI Drawing SS-208-512, Revision 3, Electrical Elementary Diagram 480V Control Center
42	208524 sh 1	GAI Drawing SS-208-524, Sh. 1, Revision 5, Electrical Elementary Wiring Diag 480V Cont.Ctr.1A-ESV– Unit 2C FW-V-16A Upstream Isolation Valve FW-V-92A
43	208524 sh 2	GAI Drawing SS-208-524, Sh. 2, Revision 0, Electrical Elementary Diag 480V Cont.Ctr.1B-ESV– Unit 2C FW-V-16B Upstream Isolation Valve FW-V-92B
44	209103	GAI Drawing SS-209-103, Revision 4, Electrical Elementary Diag DC & Miscellaneous
45	209104	GAI Drawing SS-209-104, Revision 5, Electrical Elementary Diag DC & Miscellaneous
46	209315	GAI Drawing SS-209-315, Revision 3, Elect. Elementary Diagram 480V Waste Handling System
47	209353	GAI Drawing SS-209-353, Revision 7, Elect. Elementary Diagram Waste Handling System
48	209355	GAI Drawing SS-209-355, Revision 8, Electrical Elementary Diag. 480V Cont. Ctr.1B-ESV – Unit 6E Preesurize Wtr. Space Sample Isol. Valve CA-V-3
49	208490	GAI Drawing SS-208-490, Revision 5, Electrical Elementary Diag 480V Cont. Ctr.1C-ESV – Unit 2A N.R. Pump B Discharge Valve NR-V-1B
50	209490	GAI Drawing SS-209-490, Revision 6, Electrical Elementary Wiring Diagram Engineered Safeguard
51	209491	GAI Drawing SS-209-491, Revision 8, Electrical Elementary Wiring Diagram Engineered Safeguard
52	209492	GAI Drawing SS-209-492, Revision 9, Electrical Elementary Wiring Diagram Engineered Safeguard
53	209503	GAI Drawing SS-209-503, Revision 4, Electrical Elementary Wiring Diagram Engineered Safeguard
54	209518	GAI Drawing SS-209-518, Revision 5, Electrical Elementary Wiring Diagram Engineered Safeguard
55	209519	GAI Drawing SS-209-519, Revision 6, Electrical Elementary Wiring Diagram Engineered Safeguard
56	209520	GAI Drawing SS-209-520, Revision 7, Electrical Elementary Wiring Diagram Engineered Safeguard
57	209521	GAI Drawing SS-209-521, Revision 9, Electrical Elementary Wiring Diagram Engineered Safeguard
58	209522	GAI Drawing SS-209-522, Revision 5, Electrical Elementary Wiring Diagram Engineered Safeguard
59	209590	GAI Drawing SS-209-590, Revision 5, Electrical Elem. Wiring Diagram Engineered Safeguard
60	209591	GAI Drawing SS-209-591, Revision 8, Electrical Elementary Wiring Diagram Engineered Safeguard
61	209592	GAI Drawing SS-209-592, Revision 13, Electrical Elementary Wiring Diagram Engineered Safeguard
62	209603	GAI Drawing SS-209-603, Revision 4, Electrical Elementary Wiring Diagram Engineered Safeguard
63	209618	GAI Drawing SS-209-618, Revision 10, Electrical Elementary Wiring Diagram Engineered Safeguard
64	209619	GAI Drawing SS-209-619, Revision 5, Electrical Elementary Wiring Diagram Engineered Safeguard
65	209620	GAI Drawing SS-209-620, Revision 6, Electrical Elementary Wiring Diagram Engineered Safeguard
66	209621	GAI Drawing SS-209-621, Revision 10, Electrical Elementary Wiring Diagram Engineered Safeguard
67	209622	GAI Drawing SS-209-622, Revision 5, Electrical Elementary Wiring Diagram Engineered Safeguard
68	208424	GAI Drawing SS-208-424, Revision 2, Electrical Elementary Diagram 480V Control Center
69	208443	GAI Drawing SS-208-443, Revision 6, Electrical Elementary Diagram 480V Control Center
70	208447	GAI Drawing SS-208-447, Revision 3, Electrical Elementary Diagram 480V Control Center
71	208448	GAI Drawing SS-208-448, Revision 2, Electrical Elementary Diagram 480V Control Center
72	208691	GAI Drawing SS-208-691, Revision 2, Electrical Elementary Diagram 480V Control Center
73	N/A	Technical Report TR 113, Revision 0, Generic Letter 89-10 Motor Operated Valve Program Description

APPENDIX 8.9 CONSISTS OF 4157 PAGES AND IS NOT SCANNED. HARD COPY IS STORED AT NUS

TABLE A

TRAIN "A" VOLTAGE SUMMARY

DAPPER BUS		ACCEPTANCE CRITERIA	CASE 2A Two Transformer, Normal Op, Min Grid			CASE 3A One Transformer, Fast Transfer			CASE 4A Short Term Post LOCA			CASE 5A5R Two Transformer Motor Start			CASE 6A5R One Transformer Motor Start			CASE 7A5R MOV Start			Case 8A Long Term Post LOCA		
			DAPPER Voltage	% Above (+) / Below (-) Criteria	Pass/Fail Voltage Criteria	DAPPER Voltage	% Above (+) / Below (-) Criteria	Pass/Fail Voltage Criteria	DAPPER Voltage	% Above (+) / Below (-) Criteria	Pass/Fail Voltage Criteria	DAPPER Voltage	% Above (+) / Below (-) Criteria	Pass/Fail Voltage Criteria	DAPPER Voltage	% Above (+) / Below (-) Criteria	Pass/Fail Voltage Criteria	DAPPER Voltage	% Above (+) / Below (-) Criteria	Pass/Fail Voltage Criteria	DAPPER Voltage	% Above (+) / Below (-) Criteria	Pass/Fail Voltage Criteria
1D-ES SWGR	4000	N/A	3924	N/A	N/A	3806	N/A	N/A	3727	N/A	N/A	3803	N/A	N/A	3856	N/A	N/A	3756	N/A	N/A	3865	N/A	N/A
EF-P-2A	4010	3600	OFF	N/A	N/A	OFF	N/A	N/A	3723	3.4%	PASS	3899	8.3%	PASS	3852	7.0%	PASS	3753	4.3%	PASS	3861	7.3%	PASS
DH-P-1A	4020	3600	OFF	N/A	N/A	OFF	N/A	N/A	3724	3.4%	PASS	3900	8.3%	PASS	3853	7.0%	PASS	3754	4.3%	PASS	3862	7.3%	PASS
MU-P-1A	4030	3600	OFF	N/A	N/A	OFF	N/A	N/A	3723	3.4%	PASS	3899	8.3%	PASS	3852	7.0%	PASS	3753	4.3%	PASS	3861	7.3%	PASS
BS-P-1A	4040	3600	OFF	N/A	N/A	OFF	N/A	N/A	3725	3.5%	PASS	3901	8.4%	PASS	3854	7.1%	PASS	3755	4.3%	PASS	3863	7.3%	PASS
RR-P-1A	4050	3600	OFF	N/A	N/A	OFF	N/A	N/A	3720	3.3%	PASS	3896	8.2%	PASS	3848	6.9%	PASS	3749	4.1%	PASS	3858	7.2%	PASS
1NPRI	4100	N/A	3923	N/A	N/A	3805	N/A	N/A	3725	N/A	N/A	3802	N/A	N/A	3855	N/A	N/A	3755	N/A	N/A	3864	N/A	N/A
1N BUS	4200	N/A	443	N/A	N/A	429	N/A	N/A	419	N/A	N/A	440	N/A	N/A	434	N/A	N/A	423	N/A	N/A	436	N/A	N/A
1PPRI	4300	N/A	3923	N/A	N/A	3805	N/A	N/A	3725	N/A	N/A	3901	N/A	N/A	3854	N/A	N/A	3755	N/A	N/A	3863	N/A	N/A
1P BUS	4400	N/A	432	N/A	N/A	418	N/A	N/A	408	N/A	N/A	429	N/A	N/A	423	N/A	N/A	411	N/A	N/A	423	N/A	N/A
1A-ESV CC	4420	N/A	430	N/A	N/A	416	N/A	N/A	405	N/A	N/A	425	N/A	N/A	419	N/A	N/A	407	N/A	N/A	422	N/A	N/A
1AESV LOAD	4421	N/A	430	N/A	N/A	416	N/A	N/A	405	N/A	N/A	425	N/A	N/A	419	N/A	N/A	407	N/A	N/A	422	N/A	N/A
MU-P-2A	4422	414	430	3.9%	PASS	416	0.5%	PASS	405	-2.2%	FAIL	425	2.7%	PASS	419	1.2%	PASS	407	-1.7%	FAIL	422	1.9%	PASS
MU-P-2B	4423	414	430	3.9%	PASS	416	0.5%	PASS	405	-2.2%	FAIL	425	2.7%	PASS	419	1.2%	PASS	407	-1.7%	FAIL	422	1.9%	PASS
MU-P-4A	4424	414	430	3.9%	PASS	416	0.5%	PASS	405	-2.2%	FAIL	424	2.4%	PASS	419	1.2%	PASS	407	-1.7%	FAIL	422	1.9%	PASS
1A-ESF CC	4430	N/A	430	N/A	N/A	416	N/A	N/A	405	N/A	N/A	425	N/A	N/A	419	N/A	N/A	407	N/A	N/A	422	N/A	N/A
1AESF LOAD	4432	N/A	430	N/A	N/A	416	N/A	N/A	405	N/A	N/A	425	N/A	N/A	419	N/A	N/A	407	N/A	N/A	422	N/A	N/A
1A-ES CC	4440	N/A	432	N/A	N/A	417	N/A	N/A	407	N/A	N/A	428	N/A	N/A	423	N/A	N/A	411	N/A	N/A	422	N/A	N/A
EG-P-1A	4441	N/A	424	N/A	N/A	410	N/A	N/A	399	N/A	N/A	421	N/A	N/A	415	N/A	N/A	403	N/A	N/A	415	N/A	N/A
AH-E-15A	4442	414	428	3.4%	PASS	414	0.0%	PASS	403	-2.7%	FAIL	425	2.7%	PASS	419	1.2%	PASS	407	-1.7%	FAIL	419	1.2%	PASS
AH-E-29A	4443	414	417	0.7%	PASS	402	-2.9%	FAIL	391	-5.6%	FAIL	413	-0.2%	FAIL	407	-1.7%	FAIL	395	-4.6%	FAIL	407	-1.7%	FAIL
AH-E-8A	4444	414	430	3.9%	PASS	416	0.5%	PASS	OFF	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A
AH-E-1A	4445	414	428	3.4%	PASS	413	-0.2%	FAIL	404	-2.4%	FAIL	426	2.9%	PASS	420	1.4%	PASS	408	-1.4%	FAIL	420	1.4%	PASS
DF-P-1A	4446	414	431	4.1%	PASS	416	0.5%	PASS	406	-1.9%	FAIL	427	3.1%	PASS	422	1.9%	PASS	410	-1.0%	FAIL	421	1.7%	PASS
AH-E-95A	4447	414	431	4.1%	PASS	417	0.7%	PASS	406	-1.9%	FAIL	428	3.4%	PASS	422	1.9%	PASS	410	-1.0%	FAIL	421	1.7%	PASS
AH-E-19A	4448	414	425	2.7%	PASS	411	-0.7%	FAIL	400	-3.4%	FAIL	422	1.9%	PASS	416	0.5%	PASS	404	-2.4%	FAIL	416	0.5%	PASS
AH-E-18A	4449	414	OFF	N/A	N/A	OFF	N/A	N/A	403	-2.7%	FAIL	OFF	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A	418	1.0%	PASS
1A-DG SKID	4450	414	420	1.4%	PASS	406	-2.2%	FAIL	407	-1.7%	FAIL	428	3.4%	PASS	423	2.2%	PASS	410	-1.0%	FAIL	410	-1.0%	FAIL
AH-E-24A	4451	414	419	1.2%	PASS	404	-2.4%	FAIL	393	-5.1%	FAIL	416	0.5%	PASS	410	-1.0%	FAIL	397	-4.1%	FAIL	409	-1.2%	FAIL
MU-P-3A	4453	414	431	4.1%	PASS	417	0.7%	PASS	406	-1.9%	FAIL	428	3.4%	PASS	422	1.9%	PASS	410	-1.0%	FAIL	422	1.9%	PASS
AH-P-8A	4454	N/A	431	N/A	N/A	416	N/A	N/A	406	N/A	N/A	428	N/A	N/A	422	N/A	N/A	410	N/A	N/A	421	N/A	N/A
AH-P-8B	4455	N/A	OFF	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A
1AES LOAD	4456	N/A	432	N/A	N/A	417	N/A	N/A	407	N/A	N/A	428	N/A	N/A	423	N/A	N/A	411	N/A	N/A	422	N/A	N/A
SF-P-1A	4457	414	424	2.4%	PASS	409	-1.2%	FAIL	OFF	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A
DC-P-1A	4460	414	OFF	N/A	N/A	OFF	N/A	N/A	399	-3.6%	FAIL	421	1.7%	PASS	415	0.2%	PASS	403	-2.7%	FAIL	415	0.2%	PASS
AH-P-8A/B	4461	N/A	431	N/A	N/A	416	N/A	N/A	406	N/A	N/A	428	N/A	N/A	422	N/A	N/A	410	N/A	N/A	421	N/A	N/A
AH-C-4A	4465	N/A	429	N/A	N/A	415	N/A	N/A	404	N/A	N/A	426	N/A	N/A	420	N/A	N/A	408	N/A	N/A	420	N/A	N/A
NS-P-1A	4470	414	425	2.7%	PASS	410	-1.0%	FAIL	400	-3.4%	FAIL	422	1.9%	PASS	416	0.5%	PASS	404	-2.4%	FAIL	415	0.2%	PASS
INVERTER A	4471	400	430	7.5%	PASS	416	4.0%	PASS	405	1.3%	PASS	427	6.8%	PASS	421	5.3%	PASS	409	2.3%	PASS	421	5.3%	PASS
INVERTER C	4472	400	431	7.8%	PASS	417	4.3%	PASS	406	1.5%	PASS	428	7.0%	PASS	422	5.5%	PASS	410	2.5%	PASS	422	5.5%	PASS
BAT CHGR A	4473	400	431	7.8%	PASS	417	4.3%	PASS	407	1.8%	PASS	428	7.0%	PASS	423	5.8%	PASS	411	2.8%	PASS	422	5.5%	PASS
BAT CHGR C	4474	400	431	7.8%	PASS	417	4.3%	PASS	406	1.5%	PASS	428	7.0%	PASS	422	5.5%	PASS	410	2.5%	PASS	422	5.5%	PASS
H2 AL CH A	4475	414	OFF	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A	420	1.4%	PASS
H2 RECOMBR	4476	414	OFF	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A	417	0.7%	PASS
BAT CHGR E	4477	400	431	7.8%	PASS	417	4.3%	PASS	406	1.5%	PASS	428	7.0%	PASS	422	5.5%	PASS	410	2.6%	PASS	422	5.5%	PASS
INVERTER E	4478	400	430	7.5%	PASS	416	4.0%	PASS	405	1.3%	PASS	427	6.8%	PASS	421	5.3%	PASS	409	2.3%	PASS	421	5.3%	PASS
1C-ESV CC	4480	N/A	430	N/A	N/A	416	N/A	N/A	406	N/A	N/A	427	N/A	N/A	421	N/A	N/A	409	N/A	N/A	421	N/A	N/A
NR-S-1B	4487	414	OFF	N/A	N/A	OFF	N/A	N/A	401	-3.1%	FAIL	423	2.2%	PASS	417	0.7%	PASS	405	-2.2%	FAIL	417	0.7%	PASS
MU-P-4B	4488	414	428	3.4%	PASS	415	0.2%	PASS	405	-2.2%	FAIL	426	2.9%	PASS	421	1.7%	PASS	408	-1.4%	FAIL	421	1.7%	PASS
AH-E-1C	4490	414	428	3.4%	PASS	413	-0.2%	FAIL	404	-2.4%	FAIL	425	2.7%	PASS	420	1.4%	PASS	407	-1.7%	FAIL	420	1.4%	PASS
1CESV LOAD	4491	N/A	430	N/A	N/A	416	N/A	N/A	406	N/A	N/A	427	N/A	N/A	421	N/A	N/A	409	N/A	N/A	421	N/A	N/A
1RPRI	4500	N/A	3816	N/A	N/A	3798	N/A	N/A	3714	N/A	N/A	3891	N/A	N/A	3844	N/A	N/A	3744	N/A	N/A	3853	N/A	N/A
1R BUS	4600	N/A	443	N/A	N/A	429	N/A	N/A	415	N/A	N/A	436	N/A	N/A	431	N/A	N/A	419	N/A	N/A	432	N/A	N/A
1A-SHES CC	4620	N/A	443	N/A	N/A	429	N/A	N/A	415	N/A	N/A	436	N/A	N/A	430	N/A	N/A	419	N/A	N/A	432	N/A	N/A
NR-S-1A	4621	414	442	6.8%	PASS	428	3.4%	PASS	414	0.0%	PASS	435	5.1%	PASS	430	3.8%	PASS	418	1.0%	PASS	431	4.1%	PASS
DR-S-1A	4622	414	OFF	N/A	N/A	OFF	N/A	N/A	414	0.0%	PASS	435	5.1%	PASS	429	3.6%	PASS	418	1.0%	PASS	431	4.1%	PASS
RR-S-1A	4623	414	OFF	N/A	N/A	OFF	N/A	N/A	414	0.0%	PASS	435	5.1%	PASS	430	3.8%	PASS	418	1.0%	PASS	431	4.1%	PASS
AH-E-27A	4624	414	435	5.1%	PASS	421	1.7%	PASS	406	-1.9%	FAIL	428	3.4%	PASS	422	1.9%	PASS	410	-1.0%	FAIL	423	2.2%	PASS
1ASHES LD	4628	N/A	443	N/A	N/A	429	N/A	N/A	415	N/A	N/A	436	N/A	N/A	430	N/A	N/A	419	N/A	N/A	432	N/A	N/A
NR-P-1A	4630	414	442	6.8%	PASS	428	3.4%	PASS	OFF	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A
DR-P-1A	4640	414	OFF	N/A	N/A	OFF	N/A	N/A	414	0.0%	PASS	435	5.1%	PASS	429	3.6%	PASS	417	0.7%	PASS	430	3.9%	PASS
SR-P-1A	4650	N/A	441	N/A	N/A	427	N/A	N/A	413	N/A	N/A	434	N/A	N/A	428	N/A	N/A	416	N/A	N/A	430	N/A	N/A
SW-P-1A	4660	414	441	6.5%	PASS	427	3.1%	PASS	413	-0.2%	FAIL	434	4.8%	PASS	428	3.4%	PASS	416	0.5%	PASS	429	3.6%	PASS
MU-P-1B	5040	3600	3921	8.9%	PASS	3803	5.6%	PASS	3723	3.4%	PASS	3900	8.3%	PASS	3853	7.0%	PASS	3753	4.3%	PASS	3862	7.3%	PASS
NS-P-1B	5270	414	OFF	N/A	N/A	OFF	N/A	N/A	398	-3.9%	FAIL	420	1.4%	PASS	415	0.2%	PASS	402	-2.9%	FAIL	OFF	N/A	N/A
NR-P-1B	5470	414	OFF	N/A	N/A	OFF	N/A	N/A	412	-0.5%	FAIL	433	4.6%	PASS	427	3.1%	PASS	415	0.2%	PASS	428	3.4%	PASS
PENTRATN-C	6010	N/A	428	N/A	N/A	415	N/A	N/A	405	N/A	N/A	427	N/A	N/A	421	N/A	N/A	409	N/A	N/A	421	N/A	N/A
PENTRATN-A	6020	N/A	430	N/A	N/A	415	N/A	N/A	405	N/A	N/A	427	N/A	N/A	421	N/A	N/A	409	N/A	N/A	421	N/A	N/A

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TABLE B

TRAIN "B" VOLTAGE SUMMARY

DAPPER BUS		ACCEPTANCE CRITERIA	CASE 2B Two Transformer, Normal Op, Min Grid			CASE 3B One Transformer, Fast Transfer			CASE 4B Short Term Post LOCA			CASE 5B5R Two Transformer Motor Start			CASE 6B5R One Transformer Motor Start			CASE 7B5R MOV Start			Case 8B Long Term Post LOCA		
			DAPPER Voltage	% Above (+) / Below (-) Criteria	Pass/Fail Voltage Criteria	DAPPER Voltage	% Above (+) / Below (-) Criteria	Pass/Fail Voltage Criteria	DAPPER Voltage	% Above (+) / Below (-) Criteria	Pass/Fail Voltage Criteria	DAPPER Voltage	% Above (+) / Below (-) Criteria	Pass/Fail Voltage Criteria	DAPPER Voltage	% Above (+) / Below (-) Criteria	Pass/Fail Voltage Criteria	DAPPER Voltage	% Above (+) / Below (-) Criteria	Pass/Fail Voltage Criteria	DAPPER Voltage	% Above (+) / Below (-) Criteria	Pass/Fail Voltage Criteria
1C-ESV CC	4480	N/A	420	N/A	N/A	416	N/A	N/A	405	N/A	N/A	415	N/A	N/A	417	N/A	N/A	408	N/A	N/A	421	N/A	N/A
NR-S-1B	4487	414	OFF	N/A	N/A	OFF	N/A	N/A	400	-3.4%	FAIL	411	-0.7%	FAIL	412	-0.5%	FAIL	404	-2.4%	FAIL	417	0.7%	PASS
MU-P-4B	4488	414	419	1.2%	PASS	416	0.5%	PASS	404	-2.4%	FAIL	414	0.0%	PASS	416	0.5%	PASS	407	-1.7%	FAIL	421	1.7%	PASS
AH-E-1C	4490	414	417	0.7%	PASS	414	0.0%	PASS	403	-2.7%	FAIL	413	-0.2%	FAIL	415	0.2%	PASS	406	-1.9%	FAIL	420	1.4%	PASS
1CESV LOAD	4491	N/A	420	N/A	N/A	416	N/A	N/A	405	N/A	N/A	416	N/A	N/A	417	N/A	N/A	408	N/A	N/A	421	N/A	N/A
1E-ES SWGR	5000	N/A	3834	N/A	N/A	3806	N/A	N/A	3727	N/A	N/A	3810	N/A	N/A	3824	N/A	N/A	3756	N/A	N/A	3860	N/A	N/A
EF-P-2B	5010	3600	OFF	N/A	N/A	OFF	N/A	N/A	3723	3.4%	PASS	3807	5.8%	PASS	3820	6.1%	PASS	3752	4.2%	PASS	3856	7.1%	PASS
DH-P-1B	5020	3600	OFF	N/A	N/A	OFF	N/A	N/A	3724	3.4%	PASS	3808	5.8%	PASS	3821	6.1%	PASS	3753	4.3%	PASS	3857	7.1%	PASS
MU-P-1C	5030	3600	OFF	N/A	N/A	OFF	N/A	N/A	3723	3.4%	PASS	3807	5.8%	PASS	3820	6.1%	PASS	3752	4.2%	PASS	3856	7.1%	PASS
MU-P-1B	5040	3600	3830	6.4%	PASS	3802	5.6%	PASS	3723	3.4%	PASS	3806	5.7%	PASS	3819	6.1%	PASS	3751	4.2%	PASS	3856	7.1%	PASS
BS-P-1B	5050	3600	OFF	N/A	N/A	OFF	N/A	N/A	3725	3.5%	PASS	3809	5.8%	PASS	3822	6.2%	PASS	3754	4.3%	PASS	3858	7.2%	PASS
RR-P-1B	5060	3600	OFF	N/A	N/A	OFF	N/A	N/A	3720	3.3%	PASS	3803	5.6%	PASS	3817	6.0%	PASS	3748	4.1%	PASS	3853	7.0%	PASS
1SPRI	5100	N/A	3833	N/A	N/A	3805	N/A	N/A	3725	N/A	N/A	3809	N/A	N/A	3822	N/A	N/A	3754	N/A	N/A	3858	N/A	N/A
1S BUS	5200	N/A	422	N/A	N/A	419	N/A	N/A	406	N/A	N/A	417	N/A	N/A	418	N/A	N/A	410	N/A	N/A	423	N/A	N/A
1B-ES CC	5220	N/A	421	N/A	N/A	418	N/A	N/A	406	N/A	N/A	416	N/A	N/A	418	N/A	N/A	409	N/A	N/A	422	N/A	N/A
AH-E-15B	5221	414	418	1.0%	PASS	414	0.0%	PASS	402	-2.9%	FAIL	413	-0.2%	FAIL	414	0.0%	PASS	406	-1.9%	FAIL	419	1.2%	PASS
MU-P-3C	5222	414	421	1.7%	PASS	417	0.7%	PASS	405	-2.2%	FAIL	416	0.5%	PASS	417	0.7%	PASS	409	-1.2%	FAIL	422	1.9%	PASS
AH-E-1B	5223	414	417	0.7%	PASS	413	-0.2%	FAIL	403	-2.7%	FAIL	413	-0.2%	FAIL	415	0.2%	PASS	406	-1.9%	FAIL	419	1.2%	PASS
AH-E-95B	5224	414	420	1.4%	PASS	417	0.7%	PASS	405	-2.2%	FAIL	415	0.2%	PASS	417	0.7%	PASS	409	-1.2%	FAIL	421	1.7%	PASS
DF-P-1C	5225	414	419	1.2%	PASS	416	0.5%	PASS	404	-2.4%	FAIL	414	0.0%	PASS	416	0.5%	PASS	408	-1.4%	FAIL	420	1.4%	PASS
AH-E-19B	5226	414	411	-0.7%	FAIL	407	-1.7%	FAIL	395	-4.6%	FAIL	406	-1.9%	FAIL	407	-1.7%	FAIL	399	-3.6%	FAIL	412	-0.5%	FAIL
AH-P-3B	5227	N/A	414	N/A	N/A	411	N/A	N/A	398	N/A	N/A	409	N/A	N/A	411	N/A	N/A	402	N/A	N/A	415	N/A	N/A
AH-E-18B	5228	414	OFF	N/A	N/A	OFF	N/A	N/A	398	-3.9%	FAIL	OFF	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A	414	0.0%	PASS
1B-DG SKID	5229	414	402	-2.9%	FAIL	398	-3.9%	FAIL	405	-2.2%	FAIL	416	0.5%	PASS	417	0.7%	PASS	409	-1.2%	FAIL	403	-2.7%	FAIL
EG-P-1B	5230	N/A	409	N/A	N/A	406	N/A	N/A	394	N/A	N/A	404	N/A	N/A	406	N/A	N/A	398	N/A	N/A	411	N/A	N/A
AH-E-8B	5231	414	419	1.2%	PASS	416	0.5%	PASS	OFF	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A
AH-E-29B	5232	414	406	-1.9%	FAIL	402	-2.9%	FAIL	390	-5.8%	FAIL	401	-3.1%	FAIL	402	-2.9%	FAIL	394	-4.8%	FAIL	407	-1.7%	FAIL
AH-E-24B	5233	414	407	-1.7%	FAIL	404	-2.4%	FAIL	392	-5.3%	FAIL	OFF	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A	409	-1.2%	FAIL
AH-P-9A	5234	N/A	420	N/A	N/A	417	N/A	N/A	405	N/A	N/A	415	N/A	N/A	417	N/A	N/A	408	N/A	N/A	421	N/A	N/A
AH-P-9B	5235	N/A	OFF	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A
1BES LOAD	5236	N/A	421	N/A	N/A	418	N/A	N/A	406	N/A	N/A	416	N/A	N/A	418	N/A	N/A	409	N/A	N/A	422	N/A	N/A
SF-P-1B	5237	N/A	411	N/A	N/A	408	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A
AH-P-9A/B	5238	N/A	420	N/A	N/A	417	N/A	N/A	405	N/A	N/A	415	N/A	N/A	417	N/A	N/A	408	N/A	N/A	421	N/A	N/A
NS-P-1C	5240	414	412	-0.5%	FAIL	409	-1.2%	FAIL	397	-4.1%	FAIL	408	-1.4%	FAIL	410	-1.0%	FAIL	401	-3.1%	FAIL	413	-0.2%	FAIL
INVERTER B	5241	400	420	5.0%	PASS	417	4.3%	PASS	405	1.3%	PASS	415	3.8%	PASS	417	4.3%	PASS	408	2.0%	PASS	421	5.3%	PASS
INVERTER D	5242	400	420	5.0%	PASS	417	4.3%	PASS	405	1.3%	PASS	416	4.0%	PASS	417	4.3%	PASS	409	2.3%	PASS	421	5.3%	PASS
BAT CHGR B	5243	400	421	5.3%	PASS	417	4.3%	PASS	405	1.3%	PASS	416	4.0%	PASS	417	4.3%	PASS	409	2.3%	PASS	422	5.5%	PASS
BAT CHGR D	5244	400	421	5.3%	PASS	417	4.3%	PASS	405	1.3%	PASS	416	4.0%	PASS	417	4.3%	PASS	409	2.3%	PASS	422	5.5%	PASS
BAT CHGR F	5245	400	421	5.3%	PASS	418	4.5%	PASS	406	1.5%	PASS	416	4.0%	PASS	418	4.5%	PASS	409	2.3%	PASS	422	5.5%	PASS
H2 AL CH B	5246	414	OFF	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A	420	1.4%	PASS
H2 RECOMBR	5247	414	OFF	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A	415	0.2%	PASS
AH-C-4B	5250	N/A	419	N/A	N/A	415	N/A	N/A	402	N/A	N/A	413	N/A	N/A	416	N/A	N/A	407	N/A	N/A	419	N/A	N/A
DC-P-1B	5260	414	OFF	N/A	N/A	OFF	N/A	N/A	397	-4.1%	FAIL	408	-1.4%	FAIL	409	-1.2%	FAIL	401	-3.1%	FAIL	414	0.0%	PASS
NS-P-1B	5270	414	OFF	N/A	N/A	OFF	N/A	N/A	398	-3.9%	FAIL	409	-1.2%	FAIL	410	-1.0%	FAIL	402	-2.9%	FAIL	OFF	N/A	N/A
1B-ESV CC	5280	N/A	419	N/A	N/A	415	N/A	N/A	403	N/A	N/A	410	N/A	N/A	412	N/A	N/A	404	N/A	N/A	421	N/A	N/A
1BESV LOAD	5281	N/A	419	N/A	N/A	415	N/A	N/A	403	N/A	N/A	410	N/A	N/A	412	N/A	N/A	404	N/A	N/A	421	N/A	N/A
MU-P-2C	5282	414	418	1.0%	PASS	415	0.2%	PASS	403	-2.7%	FAIL	410	-1.0%	FAIL	411	-0.7%	FAIL	403	-2.7%	FAIL	421	1.7%	PASS
MU-P-3B	5283	414	418	1.0%	PASS	415	0.2%	PASS	403	-2.7%	FAIL	410	-1.0%	FAIL	412	-0.5%	FAIL	403	-2.7%	FAIL	421	1.7%	PASS
MU-P-4C	5284	414	418	1.0%	PASS	415	0.2%	PASS	403	-2.7%	FAIL	410	-1.0%	FAIL	412	-0.5%	FAIL	403	-2.7%	FAIL	421	1.7%	PASS
1B-ESF CC	5290	N/A	418	N/A	N/A	415	N/A	N/A	403	N/A	N/A	410	N/A	N/A	412	N/A	N/A	403	N/A	N/A	421	N/A	N/A
1BESF LOAD	5292	N/A	418	N/A	N/A	415	N/A	N/A	403	N/A	N/A	410	N/A	N/A	412	N/A	N/A	403	N/A	N/A	421	N/A	N/A
1TPRI	5300	N/A	3824	N/A	N/A	3798	N/A	N/A	3715	N/A	N/A	3789	N/A	N/A	3813	N/A	N/A	3744	N/A	N/A	3849	N/A	N/A
1T BUS	5400	N/A	429	N/A	N/A	429	N/A	N/A	415	N/A	N/A	425	N/A	N/A	427	N/A	N/A	418	N/A	N/A	431	N/A	N/A
1B-SHES CC	5420	N/A	429	N/A	N/A	429	N/A	N/A	415	N/A	N/A	425	N/A	N/A	427	N/A	N/A	418	N/A	N/A	431	N/A	N/A
DR-S-1B	5424	414	OFF	N/A	N/A	OFF	N/A	N/A	414	0.0%	PASS	424	2.4%	PASS	426	2.9%	PASS	418	1.0%	PASS	430	3.9%	PASS
RR-S-1B	5425	414	OFF	N/A	N/A	OFF	N/A	N/A	414	0.0%	PASS	424	2.4%	PASS	426	2.9%	PASS	418	1.0%	PASS	430	3.9%	PASS
AH-E-27B	5426	414	421	1.7%	PASS	421	1.7%	PASS	407	-1.7%	FAIL	417	0.7%	PASS	419	1.2%	PASS	410	-1.0%	FAIL	423	2.2%	PASS
AH-E-5B	5427	N/A	429	N/A	N/A	429	N/A	N/A	415	N/A	N/A	425	N/A	N/A	426	N/A	N/A	418	N/A	N/A	431	N/A	N/A
1BSHES LD	5428	N/A	429	N/A	N/A	429	N/A	N/A	415	N/A	N/A	425	N/A	N/A	427	N/A	N/A	418	N/A	N/A	431	N/A	N/A
NR-S-1C	5429	414	428	3.4%	PASS	429	3.6%	PASS	414	0.0%	PASS	424	2.4%	PASS	426	2.9%	PASS	418	1.0%	PASS	430	3.9%	PASS
NR-P-1C	5430	414	428	3.4%	PASS	428	3.4%	PASS	OFF	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A
DR-P-1B	5440	414	OFF	N/A	N/A	OFF	N/A	N/A	413	-0.2%	FAIL	423	2.2%	PASS	425	2.7%	PASS	416	0.5%	PASS	429	3.6%	PASS
SR-P-1B	5450	N/A	427	N/A	N/A	427	N/A	N/A	413	N/A	N/A	423	N/A	N/A	425	N/A	N/A	416	N/A	N/A	429	N/A	N/A
SW-P-1B	5460	414	427	3.1%	PASS	427	3.1%	PASS	413	-0.2%	FAIL	423	2.2%	PASS	424	2.4%	PASS	416	0.5%	PASS	429	3.6%	PASS
NR-P-1B	5470	414	OFF	N/A	N/A	OFF	N/A	N/A	413	-0.2%	FAIL	423	2.2%	PASS	424	2.4%	PASS	416	0.5%	PASS	429	3.6%	PASS
SR-P-1C	5480	N/A	427	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A	OFF	N/A	N/A
PENTRATN-B	6000	N/A	418	N/A	N/A	415	N/A	N/A	404	N/A	N/A	414	N/A	N/A	416	N/A	N/A	407	N/A	N/A	420	N/A	N/A
PENTRATN-C	6010	N/A	419	N/A	N/A	416	N/A	N/A	404	N/A	N/A	414	N/A	N/A	416	N/A	N/A	408	N/A	N/A	421	N/A	N/A

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TABLE 3A

CASE 3A VOLTAGE SUMMARY

TAG NO	DAPPER BUS	ACCEPTANCE CRITERIA	DAPPER RESULTS						ALTERNATIVE CURRENT CRITERIA				
			VOLTAGE	%	VOLTAGE CRITERIA PASS/FAIL	KVA (Appendix 8.1)	% OF RATED	AMPS	FLA	SF	MAX (SF X FLA)	PASS/ FAIL	REFERENCES/ REMARKS
1D-ES SWGR	4000	N/A	3806	N/A	N/A								
EF-P-2A	4010	3600	OFF	N/A	N/A								
DH-P-1A	4020	3600	OFF	N/A	N/A								
MU-P-1A	4030	3600	OFF	N/A	N/A								
BS-P-1A	4040	3600	OFF	N/A	N/A								
RR-P-1A	4050	3600	OFF	N/A	N/A								
1NPRI	4100	N/A	3805	N/A	N/A								
1N BUS	4200	N/A	429	N/A	N/A								
1PPRI	4300	N/A	3805	N/A	N/A								
1P BUS	4400	N/A	418	N/A	N/A								
1A-ESV CC	4420	N/A	416	N/A	N/A								
1AESV LOAD	4421	N/A	416	N/A	N/A								
MU-P-2A	4422	414	416	0.5%	PASS								
MU-P-2B	4423	414	416	0.5%	PASS								
MU-P-4A	4424	414	416	0.5%	PASS								
1A-ESF CC	4430	N/A	416	N/A	N/A								
1AESF LOAD	4432	N/A	416	N/A	N/A								
1A-ES CC	4440	N/A	417	N/A	N/A								
EG-P-1A	4441	N/A	410	N/A	N/A								NON-SAFETY
AH-E-15A	4442	414	414	0.0%	PASS								
AH-E-29A	4443	414	402	-2.9%	FAIL	25.9	87	37.21	32.50	1.15	37.38	PASS	Ref 3.6.5
AH-E-8A	4444	414	416	0.5%	PASS								
AH-E-1A	4445	414	413	-0.2%	FAIL	**73.3**	**90**	**102.47**	**113.00**	**1.00**	**113.00**	**PASS**	**Ref 3.6.4**
DF-P-1A	4446	414	416	0.5%	PASS								
AH-E-95A	4447	414	417	0.7%	PASS								
AH-E-19A	4448	414	411	-0.7%	FAIL	11.6	89	16.28	21.50	1.00	21.50	PASS	Ref 3.6.5
AH-E-18A	4449	414	OFF	N/A	N/A								
1A-DG SKID	4450	414	405	-2.2%	FAIL								SKID,See Below
AH-E-24A	4451	414	404	-2.4%	FAIL	12.3	88	17.54	20.00	1.15	23.00	PASS	Ref 3.6.5
MU-P-3A	4453	414	417	0.7%	PASS								
AH-P-8A	4454	N/A	416	N/A	N/A								NON-SAFETY
AH-P-8B	4455	N/A	OFF	N/A	N/A								NON-SAFETY
1AES LOAD	4456	N/A	417	N/A	N/A								
SF-P-1A	4457	414	409	-1.2%	FAIL	36.6	89	51.67	49.00	1.15	56.35	PASS	Ref 3.6.4
DC-P-1A	4460	414	OFF	N/A	N/A								
AH-P-8A/B	4461	N/A	416	N/A	N/A								NON-SAFETY
AH-C-4A	4465	N/A	415	N/A	N/A								NON-SAFETY
NS-P-1A	4470	414	410	-1.0%	FAIL	111.6	89	157.15	140.00	1.15	161.00	PASS	Ref 3.3.5, 3.6.3
INVERTER A	4471	400	416	4.0%	PASS								
INVERTER C	4472	400	417	4.3%	PASS								
BAT CHGR A	4473	**400**	417	**4.3%**	PASS								BATT CHGR
BAT CHGR C	4474	**400**	417	**4.3%**	PASS								BATT CHGR
H2 AL CH A	4475	414	OFF	N/A	N/A								
H2 RECOMBR	4476	414	OFF	N/A	N/A								
BAT CHGR E	4477	**400**	417	**4.3%**	PASS								BATT CHGR
INVERTER E	4478	400	416	4.0%	PASS								
1C-ESV CC	4480	N/A	416	N/A	N/A								
NR-S-1B	4487	414	OFF	N/A	N/A								
MU-P-4B	4488	414	415	0.2%	PASS								
AH-E-1C	4490	414	413	-0.2%	FAIL	**73.3**	**90**	**102.47**	**113.00**	**1.00**	**113.00**	**PASS**	**Ref 3.6.4**
1CESV LOAD	4491	N/A	416	N/A	N/A								
1RPRI	4500	N/A	3798	N/A	N/A								
1R BUS	4600	N/A	**429**	N/A	N/A								
1A-SHES CC	4620	N/A	429	N/A	N/A								
NR-S-1A	4621	414	**428**	**3.4%**	PASS								
DR-S-1A	4622	414	OFF	N/A	N/A								
RR-S-1A	4623	414	OFF	N/A	N/A								
AH-E-27A	4624	414	421	1.7%	PASS								
1ASHES LD	4628	N/A	429	N/A	N/A								
NR-P-1A	4630	414	428	3.4%	PASS								
DR-P-1A	4640	414	OFF	N/A	N/A								
SR-P-1A	4650	N/A	427	N/A	N/A								
SW-P-1A	4660	414	427	3.1%	PASS								
MU-P-1B	5040	3600	3803	5.6%	PASS								
NS-P-1B	5270	414	OFF	N/A	N/A								
NR-P-1B	5470	414	OFF	N/A	N/A								
PENTRATN-C	6010	N/A	415	N/A	N/A								
PENTRATN-A	6020	N/A	415	N/A	N/A								
EG-P-3A	4450	414	405	-2.2%	FAIL	1.4	88	2.05	2.60	1.15	2.99	PASS	Ref 3.5.9, 3.5.10
EG-P-8A	4450	414	405	-2.2%	FAIL	0.6	88	0.86	0.90	1.00	0.90	PASS	Ref 3.5.9, 3.5.10

TABLE 3B

CASE 3B VOLTAGE SUMMARY

TAG NO	DAPPER BUS	ACCEPTANCE CRITERIA	DAPPER RESULTS						ALTERNATIVE CURRENT CRITERIA				
			VOLTAGE	%	VOLTAGE CRITERIA PASS/FAIL	KVA (Appendix 8.1)	% OF RATED	AMPS	FLA	SF	MAX (SF X FLA)	PASS/ FAIL	REFERENCES/ REMARKS
1C-ESV CC	4480	N/A	416	N/A	N/A								
NR-S-1B	4487	414	OFF	N/A	N/A								
MU-P-4B	4488	414	416	0.5%	PASS								
AH-E-1C	4490	414	414	0.0%	PASS								
1CESV LOAD	4491	N/A	416	N/A	N/A								
1E-ES SWGR	5000	N/A	3806	N/A	N/A								
EF-P-2B	5010	3600	OFF	N/A	N/A								
DH-P-1B	5020	3600	OFF	N/A	N/A								
MU-P-1C	5030	3600	OFF	N/A	N/A								
MU-P-1B	5040	3600	3802	5.6%	PASS								
BS-P-1B	5050	3600	OFF	N/A	N/A								
RR-P-1B	5060	3600	OFF	N/A	N/A								
1SPRI	5100	N/A	3805	N/A	N/A								
1S BUS	5200	N/A	419	N/A	N/A								
1B-ES CC	5220	N/A	418	N/A	N/A								
AH-E-15B	5221	414	414	0.0%	PASS								
MU-P-3C	5222	414	417	0.7%	PASS								
AH-E-1B	5223	414	413	-0.2%	FAIL	73.3	90	102.47	113.00	1.00	113.00	PASS	Ref 3.6.4
AH-E-95B	5224	414	417	0.7%	PASS								
DF-P-1C	5225	414	416	0.5%	PASS								
AH-E-19B	5226	414	407	-1.7%	FAIL	11.1	88	15.75	21.50	1.00	21.50	PASS	Ref 3.6.5
AH-P-3B	5227	N/A	411	N/A	N/A								NON-SAFETY
AH-E-18B	5228	414	OFF	N/A	N/A								
1B-DG SKID	5229	414	398	-3.9%	FAIL								SKID,See Below
EG-P-1B	5230	N/A	406	N/A	N/A								NON-SAFETY
AH-E-8B	5231	414	416	0.5%	PASS								
AH-E-29B	5232	414	402	-2.9%	FAIL	13.5	87	19.39	26.00	1.15	29.90	PASS	Ref 3.6.5
AH-E-24B	5233	414	404	-2.4%	FAIL	13.4	88	19.15	20.00	1.15	23.00	PASS	Ref 3.6.5
AH-P-9A	5234	N/A	417	N/A	N/A								NON-SAFETY
AH-P-9B	5235	N/A	OFF	N/A	N/A								NON-SAFETY
1BES LOAD	5236	N/A	418	N/A	N/A								
SF-P-1B	5237	N/A	408	N/A	N/A								
AH-P-9A/B	5238	N/A	417	N/A	N/A								NON-SAFETY
NS-P-1C	5240	414	409	-1.2%	FAIL	111.6	89	157.54	140.00	1.15	161.00	PASS	Ref 3.6.3, 3.3.5
INVERTER B	5241	400	417	4.3%	PASS								
INVERTER D	5242	400	417	4.3%	PASS								
BAT CHGR B	5243	400	417	4.3%	PASS								BATT CHGR
BAT CHGR D	5244	400	417	4.3%	PASS								BATT CHGR
BAT CHGR F	5245	400	418	4.5%	PASS								BATT CHGR
H2 AL CH B	5246	414	OFF	N/A	N/A								
H2 RECOMBR	5247	414	OFF	N/A	N/A								
AH-C-4B	5250	N/A	415	N/A	N/A								NON-SAFETY
DC-P-1B	5260	414	OFF	N/A	N/A								
NS-P-1B	5270	414	OFF	N/A	N/A								
1B-ESV CC	5280	N/A	415	N/A	N/A								
1BESV LOAD	5281	N/A	415	N/A	N/A								
MU-P-2C	5282	414	415	0.2%	PASS								
MU-P-3B	5283	414	415	0.2%	PASS								
MU-P-4C	5284	414	415	0.2%	PASS								
1B-ESF CC	5290	N/A	415	N/A	N/A								
1BESF LOAD	5292	N/A	415	N/A	N/A								
1TPRI	5300	N/A	3798	N/A	N/A								
1T BUS	5400	N/A	429	N/A	N/A								
1B-SHES CC	5420	N/A	429	N/A	N/A								
DR-S-1B	5424	414	OFF	N/A	N/A								
RR-S-1B	5425	414	OFF	N/A	N/A								
AH-E-27B	5426	414	421	1.7%	PASS								
AH-E-58	5427	N/A	429	N/A	N/A								
1BSHES LD	5428	N/A	429	N/A	N/A								
NR-S-1C	5429	414	429	3.6%	PASS								
NR-P-1C	5430	414	428	3.4%	PASS								
DR-P-1B	5440	414	OFF	N/A	N/A								
SR-P-1B	5450	N/A	427	N/A	N/A								
SW-P-1B	5460	414	427	3.1%	PASS								
NR-P-1B	5470	414	OFF	N/A	N/A								
SR-P-1C	5480	N/A	OFF	N/A	N/A								
PENTRATN-B	6000	N/A	415	N/A	N/A								
PENTRATN-C	6010	N/A	416	N/A	N/A								
EG-P-3B	5229	414	398	-3.9%	FAIL	1.3	87	1.85	2.60	1.15	2.99	PASS	Ref 3.5.9, 3.5.11
EG-P-8B	5229	414	398	-3.9%	FAIL	0.6	87	0.81	0.90	1.00	0.90	PASS	Ref 3.5.9, 3.5.11

TABLE 4A

CASE 4A VOLTAGE SUMMARY

TAG NO	DAPPER BUS	ACCEPTANCE CRITERIA	DAPPER RESULTS						ALTERNATIVE CURRENT CRITERIA				
			VOLTAGE	%	VOLTAGE CRITERIA PASS/FAIL	KVA (Appendix 8.1)	% OF RATED	AMPS	FLA	SF	MAX (SF X FLA)	PASS/ FAIL	REFERENCES/ REMARKS
1D-ES SWGR	4000	N/A	3727	N/A	N/A								
EF-P-2A	4010	3600	3723	3.4%	PASS								
DH-P-1A	4020	3600	3724	3.4%	PASS								
MU-P-1A	4030	3600	3723	3.4%	PASS								
BS-P-1A	4040	3600	3725	3.5%	PASS								
RR-P-1A	4050	3600	3720	3.3%	PASS								
1NPRI	4100	N/A	3725	N/A	N/A								
1N BUS	4200	N/A	419	N/A	N/A								
1PPRI	4300	N/A	3725	N/A	N/A								
1P BUS	4400	N/A	408	N/A	N/A								
1A-ESV CC	4420	N/A	405	N/A	N/A								
1AESV LOAD	4421	N/A	405	N/A	N/A								
MU-P-2A	4422	414	405	-2.2%	FAIL	0.8	88	1.14	0.95	1.42	1.35	PASS	Refs 3.6.6, 3.5.12
MU-P-2B	4423	414	405	-2.2%	FAIL	0.8	88	1.14	0.95	1.42	1.35	PASS	Refs 3.6.6, 3.5.12
MU-P-4A	4424	414	405	-2.2%	FAIL	1.2	88	1.71	1.55	1.00	1.55	FAIL	Ref 3.7.6
1A-ESF CC	4430	N/A	405	N/A	N/A								
1AESF LOAD	4432	N/A	405	N/A	N/A								
1A-ES CC	4440	N/A	407	N/A	N/A								
EG-P-1A	4441	N/A	399	N/A	N/A								NON-SAFETY
AH-E-15A	4442	414	403	-2.7%	FAIL	3.3	88	4.73	4.50	1.15	5.18	PASS	Ref 3.6.5
AH-E-29A	4443	414	391	-5.6%	FAIL	25.9	85	38.26	32.50	1.15	37.38	FAIL	Ref 3.6.5
AH-E-8A	4444	414	OFF	N/A	N/A								
AH-E-1A	4445	414	404	-2.4%	FAIL	73.3	88	104.75	113.00	1.00	113.00	PASS	Ref 3.6.4
DF-P-1A	4446	414	406	-1.9%	FAIL	0.7	88	1.00	0.95	1.00	0.95	FAIL	Ref 3.4.4
AH-E-95A	4447	414	406	-1.9%	FAIL	2.4	88	3.39	2.60	1.00	2.60	FAIL	Ref 3.6.6
AH-E-19A	4448	414	400	-3.4%	FAIL	11.6	87	16.73	21.50	1.00	21.50	PASS	Ref 3.6.5
AH-E-18A	4449	414	403	-2.7%	FAIL	47.5	88	68.05	59.00	1.15	67.85	FAIL	Ref 3.5.19
1A-DG SKID	4450	N/A	407	N/A	N/A								
AH-E-24A	4451	414	393	-5.1%	FAIL	12.3	85	18.03	20.00	1.15	23.00	PASS	Ref 3.6.5
MU-P-3A	4453	414	406	-1.9%	FAIL	0.8	88	1.08	0.93	1.42	1.31	PASS	Refs 3.6.6, 3.5.12
AH-P-8A	4454	N/A	406	N/A	N/A								NON-SAFETY
AH-P-8B	4455	N/A	OFF	N/A	N/A								NON-SAFETY
1AES LOAD	4456	N/A	407	N/A	N/A								
SF-P-1A	4457	414	OFF	N/A	N/A								
DC-P-1A	4460	414	399	-3.6%	FAIL	80.9	87	117.06	120.00	1.15	138.00	PASS	Ref 3.6.3
AH-P-8A/B	4461	N/A	406	N/A	N/A								NON-SAFETY
AH-C-4A	4465	N/A	404	N/A	N/A								NON-SAFETY
NS-P-1A	4470	414	400	-3.4%	FAIL	98.5	87	142.17	140.00	1.15	161.00	PASS	Ref 3.3.5, 3.6.3
INVERTER A	4471	400	405	1.3%	PASS								
INVERTER C	4472	400	406	1.5%	PASS								
BAT CHGR A	4473	400	407	1.8%	PASS								BATT CHGR
BAT CHGR C	4474	400	406	1.5%	PASS								BATT CHGR
H2 AL CH A	4475	414	OFF	N/A	N/A								MANUAL
H2 RECOMBR	4476	414	OFF	N/A	N/A								MANUAL
BAT CHGR E	4477	400	406	1.5%	PASS								BATT CHGR
INVERTER E	4478	400	405	1.3%	PASS								
1C-ESV CC	4480	N/A	406	N/A	N/A								
NR-S-1B	4487	414	401	-3.1%	FAIL	1.7	87	2.45	2.30	1.00	2.30	FAIL	Ref 3.5.12
MU-P-4B	4488	414	405	-2.2%	FAIL	1.2	88	1.71	1.55	1.00	1.55	FAIL	Ref 3.7.6
AH-E-1C	4490	414	404	-2.4%	FAIL	73.3	88	104.75	113.00	1.00	113.00	PASS	Ref 3.6.4
1CESV LOAD	4491	N/A	406	N/A	N/A								
1RPRI	4500	N/A	3714	N/A	N/A								
1R BUS	4600	N/A	415	N/A	N/A								
1A-SHES CC	4620	N/A	415	N/A	N/A								
NR-S-1A	4621	414	414	0.0%	PASS								
DR-S-1A	4622	414	414	0.0%	PASS								
RR-S-1A	4623	414	414	0.0%	PASS								
AH-E-27A	4624	414	406	-1.9%	FAIL	15.9	88	22.61	20.00	1.15	23.00	PASS	Ref 3.6.7
1ASHES LD	4628	N/A	415	N/A	N/A								
NR-P-1A	4630	414	OFF	N/A	N/A								
DR-P-1A	4640	414	414	0.0%	PASS								
SR-P-1A	4650	N/A	413	N/A	N/A								NON-SAFETY
SW-P-1A	4660	414	413	-0.2%	FAIL	111.6	90	156.01	140.00	1.15	161.00	PASS	Ref 3.6.3
MU-P-1B	5040	3600	3723	3.4%	PASS								
NS-P-1B	5270	414	398	-3.9%	FAIL	98.45	87	142.81	140.00	1.15	161.00	PASS	Ref 3.6.3
NR-P-1B	5470	414	412	-0.5%	FAIL	133.9	90	187.64	168.00	1.15	193.20	PASS	Ref 3.6.3
PENTRATN-C	6010	N/A	405	N/A	N/A								
PENTRATN-A	6020	N/A	405	N/A	N/A								
EG-P-3A	4450	N/A	OFF	N/A	N/A								
EG-P-8A	4450	N/A	OFF	N/A	N/A								

TABLE 4B

CASE 4B VOLTAGE SUMMARY

			DAPPER RESULTS						ALTERNATIVE CURRENT CRITERIA				
TAG NO	DAPPER BUS	ACCEPTANCE CRITERIA	VOLTAGE	%	VOLTAGE CRITERIA PASS/FAIL	KVA (Appendix 8.1)	% OF RATED	AMPS	FLA	SF	MAX (SF X FLA)	PASS/ FAIL	REFERENCES/ REMARKS
1C-ESV CC	4480	N/A	405	N/A	N/A								
NR-S-1B	4487	414	400	-3.4%	FAIL	1.7	87	2.45	2.30	1.00	2.30	FAIL	Ref 3.5.12
MU-P-4B	4488	414	404	-2.4%	FAIL	1.3	88	1.86	1.55	1.00	1.55	FAIL	Ref 3.7.6
AH-E-1C	4490	414	403	-2.7%	FAIL	73.3	88	105.01	113.00	1.00	113.00	PASS	Ref 3.6.4
1CESV LOAD	4491	N/A	405	N/A	N/A								
1E-ES SWGR	5000	N/A	3727	N/A	N/A								
EF-P-2B	5010	3600	3723	3.4%	PASS								
DH-P-1B	5020	3600	3724	3.4%	PASS								
MU-P-1C	5030	3600	3723	3.4%	PASS								
MU-P-1B	5040	3600	3723	3.4%	PASS								
BS-P-1B	5050	3600	3725	3.5%	PASS								
RR-P-1B	5060	3600	3720	3.3%	PASS								
1SPRI	5100	N/A	3725	N/A	N/A								
1S BUS	5200	N/A	406	N/A	N/A								
1B-ES CC	5220	N/A	406	N/A	N/A								
AH-E-15B	5221	414	402	-2.9%	FAIL	3.3	87	4.74	4.50	1.15	5.18	PASS	Ref 3.6.5
MU-P-3C	5222	414	405	-2.2%	FAIL	0.8	88	1.08	0.95	1.42	1.35	PASS	Refs 3.6.6, 3.5.12
AH-E-1B	5223	414	403	-2.7%	FAIL	73.3	88	105.01	113.00	1.00	113.00	PASS	Ref 3.6.4
AH-E-95B	5224	414	405	-2.2%	FAIL	2.3	88	3.28	2.60	1.00	2.60	FAIL	Ref 3.6.6
DF-P-1C	5225	414	404	-2.4%	FAIL	0.7	88	1.00	0.93	1.00	0.93	FAIL	Ref 3.4.4
AH-E-19B	5226	414	395	-4.6%	FAIL	11.1	86	16.22	21.50	1.00	21.50	PASS	Rcf 3.6.5
AH-P-3B	5227	N/A	398	N/A	N/A								NON-SAFETY
AH-E-18B	5228	414	398	-3.9%	FAIL	51.1	87	74.13	62.50	1.15	71.88	FAIL	**Ref 3.5.19**
1B-DG SKID	5229	N/A	405	N/A	N/A								SKID, See Below
EG-P-1B	5230	N/A	394	N/A	N/A								NON-SAFETY
AH-E-8B	5231	414	OFF	N/A	N/A								
AH-E-29B	5232	414	390	-5.8%	FAIL	13.5	85	19.99	26.00	1.15	29.90	PASS	Ref 3.6.5
AH-E-24B	5233	414	392	-5.3%	FAIL	13.4	85	19.74	20.00	1.15	23.00	PASS	Ref 3.6.5
AH-P-9A	5234	N/A	405	N/A	N/A								NON-SAFETY
AH-P-9B	5235	N/A	OFF	N/A	N/A								NON-SAFETY
1BES LOAD	5236	N/A	406	N/A	N/A								
SF-P-1B	5237	N/A	OFF	N/A	N/A								
AH-P-9A/B	5238	N/A	405	N/A	N/A								
NS-P-1C	5240	414	397	-4.1%	FAIL	98.5	86	143.25	140.00	1.15	161.00	PASS	Ref 3.6.3, 3.3.5
INVERTER B	5241	400	405	1.3%	PASS								
INVERTER D	5242	400	405	1.3%	PASS								
BAT CHGR B	5243	**400**	405	**1.3%**	**PASS**								BATT CHGR
BAT CHGR D	5244	**400**	405	**1.3%**	**PASS**								BATT CHGR
BAT CHGR F	5245	**400**	406	**1.5%**	**PASS**								BATT CHGR
H2 AL CH B	5246	414	OFF	N/A	N/A								MANUAL
H2 RECOMBR	5247	414	OFF	N/A	N/A								MANUAL
AH-C-4B	5250	N/A	402	N/A	N/A								NON-SAFETY
DC-P-1B	5260	414	397	-4.1%	FAIL	80.9	86	117.65	120.00	1.15	138.00	PASS	Ref 3.6.3
NS-P-1B	5270	414	398	-3.9%	FAIL	98.5	87	142.89	140.00	1.15	161.00	PASS	Ref 3.6.3
1B-ESV CC	5280	N/A	403	N/A	N/A								
1BESV LOAD	5281	N/A	403	N/A	N/A								
MU-P-2C	5282	414	403	-2.7%	FAIL	0.8	88	1.15	0.95	1.42	1.35	PASS	Refs 3.6.6, 3.5.12
MU-P-3B	5283	414	403	-2.7%	FAIL	0.8	88	1.08	0.95	1.42	1.35	PASS	Refs 3.6.6, 3.5.12
MU-P-4C	5284	414	403	-2.7%	FAIL	1.2	88	1.72	1.55	1.00	1.55	FAIL	Ref 3.7.6
1B-ESF CC	5290	N/A	403	N/A	N/A								
1BESF LOAD	5292	N/A	403	N/A	N/A								
1TPRI	5300	N/A	**3715**	N/A	N/A								
1T BUS	5400	N/A	**415**	N/A	N/A								
1B-SHES CC	5420	N/A	**415**	N/A	N/A								
DR-S-1B	5424	**414**	**414**	**0.0%**	**PASS**								
RR-S-1B	5425	**414**	**414**	**0.0%**	**PASS**								
AH-E-27B	5426	**414**	**407**	**-1.7%**	FAIL	15.9	88	22.55	20.00	1.15	23.00	PASS	Ref 3.6.7
AH-E-58	5427	N/A	**415**	N/A	N/A								
1BSHES LD	5428	N/A	**415**	N/A	N/A								
NR-S-1C	5429	**414**	**414**	**0.0%**	**PASS**								
NR-P-1C	5430	414	**OFF**	**N/A**	N/A								
DR-P-1B	5440	414	**413**	**-0.2%**	FAIL	**195.8**	90	**273.72**	230.00	1.15	**264.50**	FAIL	Ref 3.6.3
SR-P-1B	5450	N/A	**413**	N/A	N/A								**NON-SAFETY**
SW-P-1B	5460	414	**413**	**-0.2%**	FAIL	111.6	90	156.01	140.00	1.15	161.00	PASS	Ref 3.6.3
NR-P-1B	5470	414	**413**	**-0.2%**	FAIL	133.9	90	187.18	168.00	1.15	193.20	PASS	Ref 3.6.3
SR-P-1C	**5480**	**N/A**	**OFF**	**N/A**	**N/A**								
PENTRATN-B	6000	N/A	404	N/A	N/A								
PENTRATN-C	6010	N/A	404	N/A	N/A								
EG-P-3B	5229	N/A	405	N/A	N/A								
EG-P-8B	5229	N/A	405	N/A	N/A								

TABLE 8A

CASE 8A VOLTAGE SUMMARY

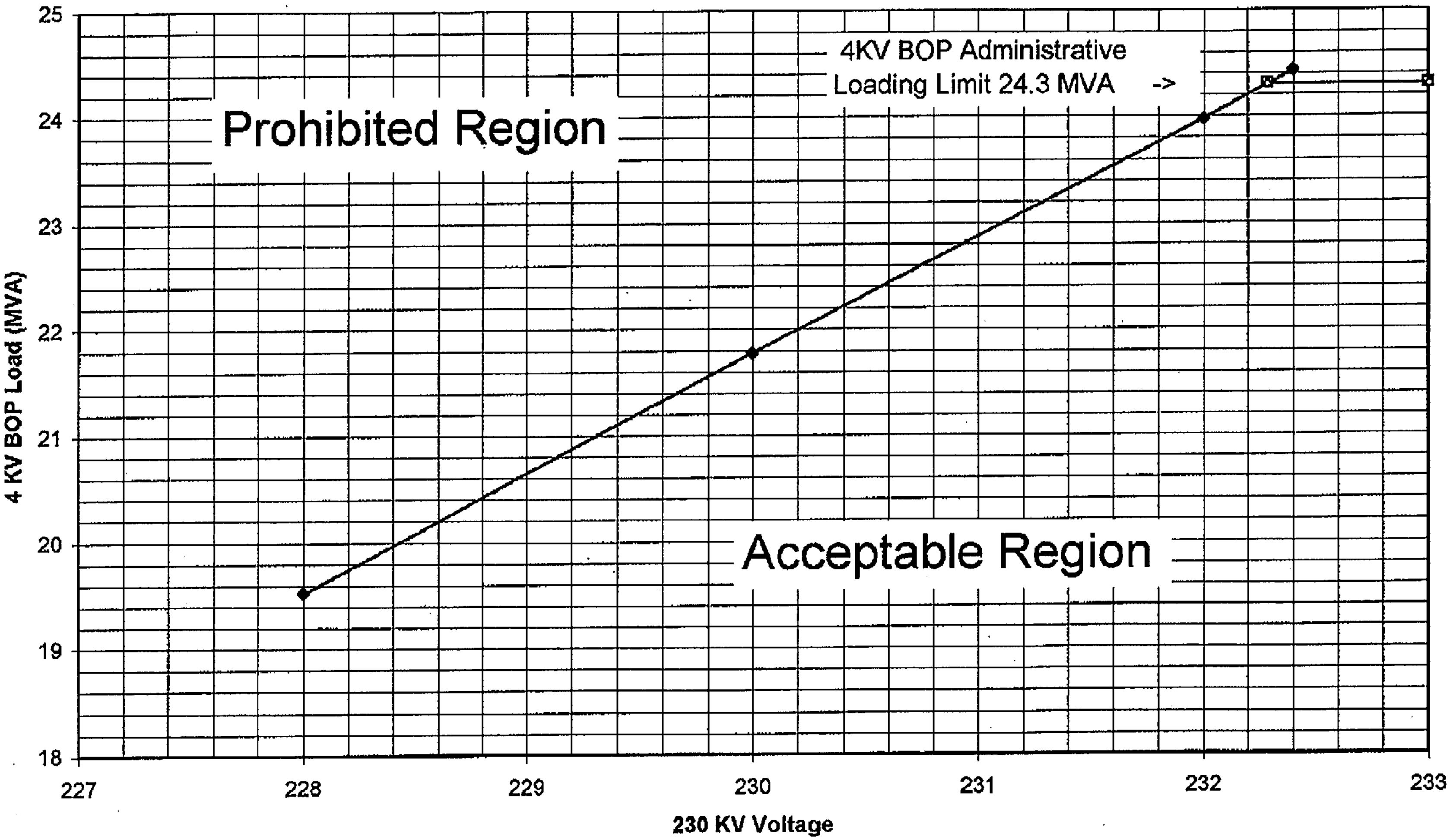
TAG NO	DAPPER BUS	ACCEPTANCE CRITERIA	DAPPER RESULTS						ALTERNATIVE CURRENT CRITERIA				
			VOLTAGE	%	VOLTAGE CRITERIA PASS/FAIL	KVA (Appendix 8.1)	% OF RATED	AMPS	FLA	SF	MAX (SF X FLA)	PASS/ FAIL	REFERENCES/ REMARKS
1D-ES SWGR	4000	N/A	3865	N/A	N/A								
EF-P-2A	4010	3600	3861	7.3%	PASS								
DH-P-1A	4020	3600	3862	7.3%	PASS								
MU-P-1A	4030	3600	3861	7.3%	PASS								
BS-P-1A	4040	3600	3863	7.3%	PASS								
RR-P-1A	4050	3600	3858	7.2%	PASS								
1NPRI	4100	N/A	3864	N/A	N/A								
1N BUS	4200	N/A	436	N/A	N/A								
1PPRI	4300	N/A	3863	N/A	N/A								
1P BUS	4400	N/A	423	N/A	N/A								
1A-ESV CC	4420	N/A	422	N/A	N/A								
1AESV LOAD	4421	N/A	422	N/A	N/A								
MU-P-2A	4422	414	422	1.9%	PASS								
MU-P-2B	4423	414	422	1.9%	PASS								
MU-P-4A	4424	414	422	1.9%	PASS								
1A-ESF CC	4430	N/A	422	N/A	N/A								
1AESF LOAD	4432	N/A	422	N/A	N/A								
1A-ES CC	4440	N/A	422	N/A	N/A								
EG-P-1A	4441	N/A	415	N/A	N/A								NON-SAFETY
AH-E-15A	4442	414	419	1.2%	PASS								
AH-E-29A	4443	414	407	-1.7%	FAIL	25.9	88	36.75	32.50	1.15	37.38	PASS	Ref 3.6.5
AH-E-8A	4444	414	OFF	N/A	N/A								
AH-E-1A	4445	414	420	1.4%	PASS								
DF-P-1A	4446	414	421	1.7%	PASS								
AH-E-95A	4447	414	421	1.7%	PASS								
AH-E-19A	4448	414	416	0.5%	PASS								
AH-E-18A	4449	414	418	1.0%	PASS								
1A-DG SKID	4450	414	410	-1.0%	FAIL								SKID,See Below
AH-E-24A	4451	414	409	-1.2%	FAIL	12.3	89	17.32	20.00	1.15	23.00	PASS	Ref 3.6.5
MU-P-3A	4453	414	422	1.9%	PASS								
AH-P-8A	4454	N/A	421	N/A	N/A								NON-SAFETY
AH-P-8B	4455	N/A	OFF	N/A	N/A								NON-SAFETY
1AES LOAD	4456	N/A	422	N/A	N/A								
SF-P-1A	4457	414	OFF	N/A	N/A								
DC-P-1A	4460	414	415	0.2%	PASS								
AH-P-8A/B	4461	N/A	421	N/A	N/A								NON-SAFETY
AH-C-4A	4465	N/A	420	N/A	N/A								NON-SAFETY
NS-P-1A	4470	414	415	0.2%	PASS								
INVERTER A	4471	400	421	5.3%	PASS								
INVERTER C	4472	400	422	5.5%	PASS								
BAT CHGR A	4473	400	422	5.5%	PASS								BATT CHGR
BAT CHGR C	4474	400	422	5.5%	PASS								BATT CHGR
H2 AL CH A	4475	414	420	1.4%	PASS								MANUAL
H2 RECOMBR	4476	414	417	0.7%	PASS								MANUAL
BAT CHGR E	4477	400	422	5.5%	PASS								BATT CHGR
INVERTER E	4478	400	421	5.3%	PASS								
1C-ESV CC	4480	N/A	421	N/A	N/A								
NR-S-1B	4487	414	417	0.7%	PASS								
MU-P-4B	4488	414	421	1.7%	PASS								
AH-E-1C	4490	414	420	1.4%	PASS								
1CESV LOAD	4491	N/A	421	N/A	N/A								
1RPRI	4500	N/A	3853	N/A	N/A								
1R BUS	4600	N/A	432	N/A	N/A								
1A-SHES CC	4620	N/A	432	N/A	N/A								
NR-S-1A	4621	414	431	4.1%	PASS								
DR-S-1A	4622	414	431	4.1%	PASS								
RR-S-1A	4623	414	431	4.1%	PASS								
AH-E-27A	4624	414	423	2.2%	PASS								
1ASHES LD	4628	N/A	432	N/A	N/A								
NR-P-1A	4630	414	OFF	N/A	N/A								
DR-P-1A	4640	414	430	3.9%	PASS								
SR-P-1A	4650	N/A	430	N/A	N/A								
SW-P-1A	4660	414	429	3.6%	PASS								
MU-P-1B	5040	3600	3862	7.3%	PASS								
NS-P-1B	5270	414	OFF	N/A	N/A								
NR-P-1B	5470	414	428	3.4%	PASS								
PENTRATN-C	6010	N/A	421	N/A	N/A								
PENTRATN-A	6020	N/A	421	N/A	N/A								
EG-P-3A	4450	414	410	-1.0%	FAIL	1.4	89	1.96	2.60	1.15	2.99	PASS	Ref 3.5.9, 3.5.10
EG-P-8A	4450	414	410	-1.0%	FAIL	0.6	89	0.86	0.90	1.00	0.90	PASS	Ref 3.5.9, 3.5.10

TABLE 8B

CASE 8B VOLTAGE SUMMARY

TAG NO	DAPPER BUS	ACCEPTANCE CRITERIA	DAPPER RESULTS						ALTERNATIVE CURRENT CRITERIA				
			VOLTAGE	%	VOLTAGE CRITERIA PASS/FAIL	KVA (Appendix 8.1)	% OF RATED	AMPS	FLA	SF	MAX (SF X FLA)	PASS/FAIL	REFERENCES/ REMARKS
1C-ESV CC	4480	N/A	421	N/A	N/A								
NR-S-1B	4487	414	417	0.7%	PASS								
MU-P-4B	4488	414	421	1.7%	PASS								
AH-E-1C	4490	414	420	1.4%	PASS								
1CESV LOAD	4491	N/A	421	N/A	N/A								
1E-ES SWGR	5000	N/A	3860	N/A	N/A								
EF-P-2B	5010	3600	3856	7.1%	PASS								
DH-P-1B	5020	3600	3857	7.1%	PASS								
MU-P-1C	5030	3600	3856	7.1%	PASS								
MU-P-1B	5040	3600	3856	7.1%	PASS								
BS-P-1B	5050	3600	3858	7.2%	PASS								
RR-P-1B	5060	3600	3853	7.0%	PASS								
1SPRI	5100	N/A	3858	N/A	N/A								
1S BUS	5200	N/A	423	N/A	N/A								
1B-ES CC	5220	N/A	422	N/A	N/A								
AH-E-15B	5221	414	419	1.2%	PASS								
MU-P-3C	5222	414	422	1.9%	PASS								
AH-E-1B	5223	414	419	1.2%	PASS								
AH-E-95B	5224	414	421	1.7%	PASS								
DF-P-1C	5225	414	420	1.4%	PASS								
AH-E-19B	5226	414	412	-0.5%	FAIL	11.1	90	15.55	21.50	1.00	21.50	PASS	Ref 3.6.5
AH-P-3B	5227	N/A	415	N/A	N/A								NON-SAFETY
AH-E-18B	5228	414	414	0.0%	PASS								
1B-DG SKID	5229	414	403	-2.7%	FAIL								SKID, See Below
EG-P-1B	5230	N/A	411	N/A	N/A								NON-SAFETY
AH-E-8B	5231	414	OFF	N/A	N/A								
AH-E-29B	5232	414	407	-1.7%	FAIL	13.5	88	19.15	26.00	1.15	29.90	PASS	Ref 3.6.5
AH-E-24B	5233	414	409	-1.2%	FAIL	13.4	89	18.92	20.00	1.15	23.00	PASS	Ref 3.6.5
AH-P-9A	5234	N/A	421	N/A	N/A								NON-SAFETY
AH-P-9B	5235	N/A	OFF	N/A	N/A								NON-SAFETY
1BES LOAD	5236	N/A	422	N/A	N/A								
SF-P-1B	5237	N/A	OFF	N/A	N/A								
AH-P-9A/B	5238	N/A	421	N/A	N/A								
NS-P-1C	5240	414	413	-0.2%	FAIL	116.4	90	162.72	140.00	1.15	161.00	FAIL	
INVERTER B	5241	400	421	5.3%	PASS								
INVERTER D	5242	400	421	5.3%	PASS								
BAT CHGR B	5243	400	422	5.5%	PASS								BATT CHGR
BAT CHGR D	5244	400	422	5.5%	PASS								BATT CHGR
BAT CHGR F	5245	400	422	5.5%	PASS								BATT CHGR
H2 AL CH B	5246	414	420	1.4%	PASS								MANUAL
H2 RECOMBR	5247	414	415	0.2%	PASS								MANUAL
AH-C-4B	5250	N/A	419	N/A	N/A								NON-SAFETY
DC-P-1B	5260	414	414	0.0%	PASS								
NS-P-1B	5270	414	OFF	N/A	N/A								
1B-ESV CC	5280	N/A	421	N/A	N/A								
1BESV LOAD	5281	N/A	421	N/A	N/A								
MU-P-2C	5282	414	421	1.7%	PASS								
MU-P-3B	5283	414	421	1.7%	PASS								
MU-P-4C	5284	414	421	1.7%	PASS								
1B-ESF CC	5290	N/A	421	N/A	N/A								
1BESF LOAD	5292	N/A	421	N/A	N/A								
1TPRI	5300	N/A	3849	N/A	N/A								
1T BUS	5400	N/A	431	N/A	N/A								
1B-SHES CC	5420	N/A	431	N/A	N/A								
DR-S-1B	5424	414	430	3.9%	PASS								
RR-S-1B	5425	414	430	3.9%	PASS								
AH-E-27B	5426	414	423	2.2%	PASS								
AH-E-58	5427	N/A	431	N/A	N/A								
1BSHES LD	5428	N/A	431	N/A	N/A								
NR-S-1C	5429	414	430	3.9%	PASS								
NR-P-1C	5430	414	OFF	N/A	N/A								
DR-P-1B	5440	414	429	3.6%	PASS								
SR-P-1B	5450	N/A	429	N/A	N/A								
SW-P-1B	5460	414	429	3.6%	PASS								
NR-P-1B	5470	414	429	3.6%	PASS								
SR-P-1C	**5480**	**N/A**	**OFF**	**N/A**	**N/A**								
PENTRATN-B	6000	N/A	420	N/A	N/A								
PENTRATN-C	6010	N/A	421	N/A	N/A								
EG-P-3B	5229	414	403	-2.7%	FAIL	1.3	88	1.83	2.60	1.15	2.99	PASS	Ref 3.5.9, 3.5.11
EG-P-8B	5229	414	403	-2.7%	FAIL	0.6	88	0.80	0.90	1.00	0.90	PASS	Ref 3.5.9, 3.5.11

CHART 7.2.3
230KV vs 4KV BOP Load



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