Boston Edison

Pilgrim Nuclear Power Station
Rocky Hill Road
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E. T. Boulette, PhD
Senior Vice President – Nuclear

September 25, 1995
BECo Ltr. #95-101

U.S. Nuclear Regulatory Commission
Region I
475 Allendale Road
King of Prussia, PA 19406
Attn: William Ruland

Docket No. 50-293
License No. DPR-35

Station Blackout Follow-up Inspection dated August 5-11, 1995
NRC Inspection No. 95-16.
23Kv Load Flow Calculations

Dear Sir:

This letter is in response to the commitment made by Boston Edison Company (BECo) at the Station Blackout Follow-up Inspection exit meeting on August 11, 1995. The commitment was to complete load flow calculations for the 23Kv offsite source by September 11, 1995, and provide the results to the NRC thereafter by a letter.

We have completed the subject calculation, and a copy of the calculation is attached as requested by the NRC Inspector, Mr. George Morris. The results of the calculation are as follows:

- For safe shutdown conditions, both safety buses were energized with Turbine Trip loads. The source voltage during peak load condition was used for worst case. The calculated available voltages at the safety related loads are above the minimum required voltages for starting and running conditions.
- The load flow study was performed for the LOCA scenario, with one bus energized and with the source voltage peak load condition. The calculated available voltages at safety related loads exceed their minimum required voltages.
- Although the 23Kv source is not credited to satisfy LOCA mitigation with loads from both safety buses, the calculations performed concluded all required safety loads will start and run properly with both emergency LOCA loads. Shutdown transformer loading, however, will be above its continuous rating but below the overload rating. The momentary overload will result in a minimal loss of transformer life.

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This letter completes our commitment made at the exit meeting on August 11, 1995.

Please contact Mr. Walter Lobo of our Regulatory Relations Department, at (508) 830-7940, if you have any further questions.

for E. T. Boulette, PhD

ETB/WGL/Rap95/SBO9517

Attachment

cc: Mr. R. Eaton, Project Manager
Division of Reactor Projects - I/II
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U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555

Senior Resident Inspector
Pilgrim Nuclear Power Station

CALCULATION COVER SHEET
PILGRIM NUCLEAR POWER STATION

SHEET 1 OF ~~46~~ 58

CALC. NO.161	REV. 0	FILE NO. N/A	SR ☒ NSR ☐	RTYPE
Subject: 23kv Offsite Source Load Flow Study			Preliminary Calc. ☐ Finalization Due Date:	
Discipline Division Manager: Bruce Chenard				
Approval/s/: Bruce Chenard		Date: 9/8/95	Final Calc. ☒	

Independent Reviewer: Lisa Hansen /s/ L.A. Hansen Statement Attached ☒

Page(s)	By: Swapan Das	Date	Ch'k'd Lisa Hansen	Date	Agreed
All	/s/ Swapan Das	9/8/95	/s/ L.A. Hansen	9/8/95	Yes

This design analysis ☐ DOES, ☒ DOES NOT require revision to affected design documents.

Affected Design Documents:

A PDC ☐ IS, ☒ IS NOT Required.

A Safety Evaluation ☐ IS. ☒ IS NOT Required. See attached preliminary evaluation checklist.

This design analysis ☐ DOES, ☒ DOES NOT affect the piping analysis index (PAI). If the PAI is affected, initiate a revision to Calculation M561.

Minor revisions made on pages N/A of this calculation. See next revision.

Replaces Calc. No. N/A	Voided By Calc. No. N/A ☐ Or Attached Memo

1. **Purpose**

The purpose of this calculation is to perform a load flow study for the 23kV offsite source. This calculation will utilize the "DAPPER" program. The study will ensure that the proper voltage exists at each safety related load to operate as required under the following different scenarios:

- CASE A: Turbine Trip with the Manomet transformer in service and the series capacitor out of service
- CASE B: Turbine Trip with the series capacitor in service and the Manomet transformer out of service
- CASE C: LOCA w/load shed with only one bus energized (swing bus not connected) with the Manomet transformer in service and the series capacitor out of service
- CASE D: LOCA w/load shed with only one bus energized (swing bus not connected) with the series capacitor in service and the Manomet transformer out of service
- CASE E: LOCA w/load shed with both buses energized with the Manomet transformer in service and the series capacitor in service
- CASE F: LOCA w/load shed with only one bus energized with the swing bus connected with the Manomet transformer in service and the series capacitor out of service

2. **Summary of Results and Recommendation**

The results of the calculation for Turbine Trip and LOCA are given in Table 1, Table 2, Table 3, and Table 4. Only safety related MCC's and only safety related loads are evaluated.

Turbine Trip
From Table 1, it can be concluded that during CASE A) all required safety related loads will start and run at the lowest expected source voltage (i.e. during peak load conditions). The available voltages are well above the minimum required voltages. For CASE B) all required safety related loads will operate properly at the lowest expected source voltage. However, the available voltage is marginal. Also A5 and A6 bus voltages will be below the degraded voltage alarm setpoint.
This calculation assumes that the operator will reset the alarm prior to initiating any manual starts. At this time, the bus voltages will be above the alarm reset value. The reset value at 4.16kv level corresponds to a voltage of greater than 22.2kv at the source. Calculations were also performed at this source voltage. The results indicate that the available voltages will be well above the minimum required for motor starting and running conditions.

LOCA w/load shed with only one bus energized

A review of Table 2 indicates that for CASE C), the available voltages for all safety loads are well above the minimum required voltage. For CASE D) all safety loads will start and run properly, the available voltages are above the minimum required. Also as mentioned in page 15, during steady state loading the bus voltage will be below the low voltage alarm set point.

LOCA w/load shed with both buses energized

The 23kv source is not required to satisfy LOCA mitigation with loads connected to both emergency buses. However this calculation was performed to show that this offsite source is capable of accomodating LOCA loads on both emergency buses. The calculation was performed using the source voltage available with both the Manomet transformer and PNPS series capacitor in service.
From Table 3, it can be concluded that all required loads will start and run with adequate voltage margin.

However, during the starting of load block-1, the voltage available at MOV's MO202-5A/5B, MO1001-28B and MO1001-29B is below that which is required. Subsequently calculations were performed which indicate that after a slight time delay, the bus voltage will have improved (i.e. after 4kv motors have started and are at steady state) the MOV's will have sufficient voltage to start.

Although the total calculated loading of 5.3MVA on the Shutdown transformer during steady state condition(without manual loading) exceeds it's continuous rating of 5MVA, this loading is below the overload rating of 5.6MVA. The momentary overloading will result in a minimal loss of the transformer life.

LOCA w/load shed with only one bus energized w/Swing bus B6 connected.

Although the swing bus B6 will not be connected to the affected bus by design, this study was performed with the assumption that bus B6 is connected to the affected bus.
A review of Table 4 indicates that the available voltages for all safety related loads are above the minimum required voltages for starting and running conditions. The available bus voltage during steady state condition will be above the degraded voltage setpoint.

Prepared by: Swapan Das
Checked by: Lisa Hansen
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3. **Method of Solution**

a. Identify all loads (i.e. both safety and non safety) that will be operating during the Turbine Trip and LOCA w/load shed scenarios.

b. Identify the source voltages to be used in the calculation.

c. Input the data into the DAPPER program.

d. Perform the load flow studies at the different source voltages for the different scenarios (see Section 1 of this calculation for the different scenarios which will be performed in this calculation) using the "DAPPER" program.

e. Review the results to ensure proper voltage is available at each safety related load. Summarize the results in Section 2 and provide recommendations, if any.

4. **Input Data and Assumption**

a. All loads that will be operating were obtained from calculation PS65A.

b. Power factor values for each load were assumed to be the same as those used in calculation PS65A.

c. Source voltages (i.e. voltage at Shutdown transformer terminal) were obtained from Attachment "A". Light and Peak load voltages were used.

d. 23kV is the delayed offsite source as required per GDC17 to maintain reactor coolant pressure boundary limit. The 23kv offsite source is required to supply both trains of Shutdown and 1 train of LOCA loads.

e. For LOCA scenarios with only one bus energized, bus "A5" was chosen as "A5" loading is normally higher than "A6" bus.

At PNPS 23kV is also considered as a reliable backup for one Emergency diesel generator (i.e. LCO situation when one EDG is out of service and hence one CSCS bus will be energized)

f. Only loads which will operate for the Turbine Trip scenarios and/or LOCA w/load shed scenarios will be evaluated. Loads which are off for these scenarios (as shown in PS65A) will not be evaluated.

g. Due to the nature of the "DAPPER" program, many loads which do not operate appear in the "Bus Special Study Data" section of the printouts. These loads have not been verified as they are removed from the calculation by taking the appropriate feeder out of service.

h. This calculation only considers loads fed from safety related load centers/busses as the shutdown transformer is only connected to safety busses.

- All Turbine Trip scenarios include load centers B1, B2, and B6 and all the loads fed from them. It is assumed B1 feeds B6.

- For LOCA w/load shed scenario, three separate studies were performed. One study with only "A5" connected, one w/o swing bus connected, one study with both buses "A5" and "A6" connected, one w/A5 connected w/swing bus connected.

j. For any 480v load requiring revision or addition, a demand factor of 90% (0.9 multiplier) was assumed. This is consistent with calculation PS65A.

k. The plant is assumed to have been operating normally at 100% power prior to the event.

l. It is assumed that no system testing is on going prior to the event and all systems are in their normal line-up (i.e. no system failure assumed).

m. All manual action taken by the operators will be assumed to occur 10-15 minutes into the event.

n. When "A5" and "A6" are energized after a dead bus transfer, only one TBCCW pump (P110A) will start after a 20 second time delay. This pump is capable of maintaining system pressure. The redundant pump (P110B) will not be started as long as P110A is running.

o. Per FSAR section 10.7.5, the maximum number of Salt Service Water pumps that are required during a LOCA is 2 pumps (i.e. 1 pump per loop) and 4 pumps during shutdown. The fifth pump P208C is not required to mitigate any design basis accident or any transient.

p. During normal power operation, only one CRD pump is running. During the dead bus transfer the pump will be tripped and will remain in the trip position. In Turbine Trip though it is not required, the operator may start one CRD pump manually. However during LOCA it will receive load shed signal.

q. While preparing this calculation, the cable impedance input for the feed from B2 to B18 was found to be incorrect. Subsequently an interim revision to calculation PS64 was issued. The cable impedance was recalculated and documented in PS-64-3. The revised value was entered into the DAPPER program.

r. The minimum required voltages as mentioned in Table 1, Table 2, Table 3, and Table 4 are obtained from PS65 and PS65A unless otherwise noted.

s. The SBGT system is not required during loss of offsite power nor during Turbine Trip, however by design the system will start and hence was included in the calculation.

t. In Turbine Trip motor starting cases, PS65A assumed the start of P208C at MCC B10 even though it clearly states that P208C is not required. This calculation will start the largest operating load (i.e. X101) at MCC B10 and not P208C.

u. At MCC B17, loads for B1735 and B17101 are 15hp and 30hp respectively according to dwg.SE155 Sh2,Rev.E44. Similarly at MCC B18 load for B18101 is 30hp These revised loads will be used in lieu of the loads used in PS65 and PS65A.

v. In Turbine Trip, PS65 and PS65A assumes both Control Room Air conditioning and CREAF system are operating. The CREAF system is the only manually operated load which will be started in the event of the loss of air conditioning system.

5. Calculation

The calculation will be performed for the following scenarios with different source voltages (as defined below):

- Turbine Trip transients

- LOCA w/load shed - shutdown transformer only connected to 4.16 KV safety bus "A5" (swing bus not connected)

- LOCA w/load shed- shutdown transformer connected to 4.16KV safety buses "A5" and "A6"

- LOCA w/load shed - shutdown transformer only connected to 4.16 KV safety bus "A5" (swing bus connected)

a) TURBINE TRIP CASE A
(Source voltage 22.4 kv-23.8 kv)

From Attachment "A" with the Manomet transformer in service and the PNPS series capacitor out of service, the expected voltage at the primary side of the shutdown transformer is between 22.4 kv (during peak load) and 23.8 kv (during light load).

The following is the tabulation of the individual MCC's and loads that are connected to "A5" and "A6". These values were obtained from PS65A, page 29 and 30.

MCC B15:	276 + j149 KVA
MCC B17:	138 + j75 KVA
MCC B29:	1 + j0 KVA
MCC B17A:	8 + j4 KVA
MCC B14:	320 + j173 KVA
MCC B18:	119 + j64 KVA
MCC B18A:	8 + j4 KVA
MCC B28:	118+ j67 KVA
MCC B10:	233 + j126 KVA
MCC B20:	19 + j10 KVA
P209A :	162+ j87 KVA
P110A :	80 + j46 KVA
G23 :	66 + j35 KVA
SWYD. AUX.	66 + j36 KVA

The above loads will be revised to reflect any addition or deletion of loads that have taken place since calculation PS65A was done. Calculation PS65A was calculated for the scenario where PNPS is powered via the Startup Transformer. Hence loss of voltage was not assumed while making fast transfer.

In this calculation loads will be connected to the Shutdown Transformer (i.e. via 23KV). Only safety buses A5 and A6 will be connected. The transfer from the Unit Aux. Transformer to the Shutdown Transformer is a dead bus transfer. Both buses will suffer a loss of voltage momentarily. Hence some of the loads will be revised accordingly.

The revised loading is as follows:

MCC B15: **276 + j149 KVA** no change from PS65A

MCC B17: MCC cubicle B1735 and B17101 loads decreased by 5hp and 10hp respectively (see Section 4, item u). Also B17A load was included in B17 loading in PS65A.

The revised loading:

138 + j75 = 157 KVA (PS65A)
- 9 KVA (B17A load of 10 * 0.9)
- 9 KVA (B17101 load of 10hp * 0.9)

- 4.5 KVA (B1735 load of 5hp *0.9)

134.5 KVA = 118 + j64

MCC B29: **1+ j0** no change from PS65A
MCC B17A: **8 + j4** no change from PS65A

MCC B14: The Standby Gas Treatment loads were not included in PS65A. These loads are automatically started coincident with train "A" SBGT and shut off after 65 seconds if train "A" establishes the required flow.

The revised loading:

320 + j173 = 363.75 KVA (PS65A)
\+ 13.5 KVA (B1426 load of 15hp * 0.9)
\+ 19.3 KVA (B1416A load of 21.4kw * 0.9)

396.55 KVA = 349 +j 188

MCC B18: MCC cubicle B18101 is decreased by 10hp (see Section 4, item u). Also B18A load was included in PS65A.

The revised loading:

119+ j64 = 135 KVA (PS65A)
- 9 KVA (B18101 load of 10hp * 0.9)
- 9 KVA (B18A load of 10 KVA * 0.9)

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117 KVA= 103 + j56

MCC B28: **118 + j67** no change from PS65A
MCC B18A: **8 + j 4** no change from PS65A

MCC B10:	**233 + j126**	no change from PS65A
MCC B20:	**19 + j10**	no change from PS65A
P209A:	**162 + j87**	no change from PS65A
P110A	**80 + j46**	no change from PS65A
G23:	**66 + j35**	no change from PS65A
SWYD AUX.	**66 + j36**	no change from PS65A

The "DAPPER" runs are then performed with the inputs as calculated above. The following is the list of "DAPPER" runs for different conditions. Only the lowest minimum source voltage of 22.4 kv was used. If all loads can operate satisfactorily at source voltage of 22.4 kv, calculation with higher voltage (i.e. 23.8kv) is not required/performed.

1. Steady-state loading with voltage of 22.4kv. This loading includes all automatic as well as manually operated loads that will be running. Loading for each MCC was taken from above. Results of the run are shown in Attachment "B".

2. Motor starting for each MCC: Verification that the largest motor on each MCC will start will prove that all other motors will have sufficient MCC voltage to start.

MCC B15. The largest motor on this MCC is a 100 hp Salt Service Water Pump (P208A, P208B). One pump (P208A) will automatically start after the voltage recovery. Pump P208B is then manually started by the operator if necessary. The loading on MCC B15 prior to start of this P208B pump is:

204 + j110 KVA from PS65A, Page 70

The starting KVA for this motor is:

192 + j599 KVA from PS65A Page 70

Results of the run are shown in Attachment "C"

MCC B14:

Similar to B15. Salt Service Water pump P208E will be started for this MCC.

The loading on MCC B14 prior to start of this pump is

396.55 KVA from Page 8
- 81.72 KVA (P208E load of 90.8 x 0.9)
314.83 KVA = 277 + j149 KVA

The starting KVA for this motor is

192 + j599 KVA (PS65A, Page 65)

Results of the run are shown in Attachment "D"

MCC B17: the largest load in this MCC is P207A, a 50 hp motor. This motor is not required to operate for this scenario. However for conservatism this motor will be started.
The starting KVA of this motor is:

123 + j304 KVA (PS65A, Page 74)

Results of the run are shown in Attachment "E"

MCC B18: Similar to MCC B17 . P207B will be started. The starting KVA of this motor is:

123 + j304 KVA (PS65A, page 76)

Results of the run as shown on Attachment "F"

MCC B20: The largest motor in this MCC is M01001-28B which is an isolation valve. This loading was not included in the steady state loading since it is a short term load (30 sec. typical).

The starting KVA of this motor is:

213 + j284.6 KVA (PS65A page 78)

Results of this run as shown on Attachment "G"

MCC B10: The largest load on this MCC that will be operating is Turning Gear X101, a 60 hp motor. This load is manually started and was included in the steady state loading.

The loading on MCC B10 prior to start of X101 is

186 + j100 KVA (PS65A, Page 81)

The starting KVA of this motor is:

140 + j365 KVA (PS65A, Page 81)

Results of this run are shown in Attachment "H"

The results of each run are shown in Table 1 for comparison with the minimum required voltage for each load. This is to ensure that each load will start and run as required.

b) TURBINE TRIP CASE B
(Source voltage 21.3-24.0 kv)

From Attachment "A", with the Manomet transformer out of service and PNPS series capacitor in service, the expected voltage at shutdown transformer is between 21.3 kv (during peak load) and 24.0 kv (during light load).

"DAPPER" runs will be performed utilizing both source voltages.

Steady state loading as calculated in A) will be used. The steady state loads are:

MCC B15: 276 + j149 KVA
MCC B17: 118 + j65 KVA
MCC B17A: 8 + j4 KVA
MCC B29: 1 + j0 KVA
MCC B14: 349 + j188 KVA
MCC B18: 102 + j55 KVA
MCC B18A: 8 + j4 KVA
MCC B28: 118 + j67 KVA
MCC B10: 233 + j126 KVA
MCC B20: 19 + J10 KVA
P209A: 162 +j87 KVA
G-23: 66 + j35 KVA
SWYD. Aux: 66 + j36 KVA

The results of the DAPPER runs with source voltages of 21.3kv and 24.0 kv are shown in Attachments "AA" and "AB" respectively. Figure 1 summarizes the results of DAPPER computer runs Attachments "AA" and "AB". From figure 1, it can be seen that with source voltage of 21.3 kv, the 4160 kv buses will set a low voltage alarm. Currently PNPS procedure 2.4.144 (degraded voltage) is being revised to instruct the operator to shed non-essential loads to improve bus voltages. The steady state calculation includes both essential and non-essential loads.

It is assumed that the bus voltages will be improved to be above the reset value of the undervoltage relays. The reset value of these undervoltage relays is approximately 3986 volts. The corresponding 23kv voltage is approximately 22.3 kv, for conservatism and margin this calculation uses 22.2 kv as the source voltage. This source voltage of 22.2 kv will be used to start large motors at each MCC.

For the steady state operation, from Figure 1, at 22.2 kv, the minimum available MCC bus voltage is greater than 440 volts which is well above the minimum required MCC bus voltage.

For motor starting in each MCC, the same loading as used in "A" was used with a source voltage of 22.2 kv. The results of each run are shown in Attachment AC for B15, Attachment AD for B14, Attachment AE for B17, Attachment AF for B18, AG for B20 and Attachment AH for B10.

The results of the steady state and motor starting runs are shown in Table 1 to compare against the minimum required voltage for each load. This is to ensure that all required safety related loads will start and run as required.

c) <u>LOCA w/load Shed Study, Only "A5" Energized (swing bus not connected)-CASES C AND D</u>
(Source voltage: 23.8 - 22.4 kv, Manomet transformer in, series capacitor out source voltage: 24.0 - 21.3 kv series capacitor in and Manomet transformer out)

This calculation will use the lowest source voltage values of 22.4 and 21.3 kv (peak load conditions). The following is the tabulation of the individual MCC's and loads that are connected to the "A5" Bus. The values were obtained from PS-65A, Page 35 and 36. This loading includes all automatic loads and manually operated loads that may be operating.

MCC B10:	135 + j73 KVA
MCC B20:	19 + j10 KVA
MCC B15:	307 + j166 KVA
MCC B17:	52 + j28 KVA
P110A:	80 + j46 KVA
P203A:	639 + J309
P203C:	639 + j309 KVA
P215A:	604 + j318 KVA
G23:	66 + j35 KVA

The above loading will be revised to reflect the scenario assumed in this calculation.

In this scenario, a DBA LOCA was assumed with Emergency Diesel Generator "A" out of service. Hence swing bus B6 will be lined up with the B Loop. Bus "A5" will be energized in approximately 12.5 sec. upon LOCA w/loop by the Shutdown Transformer. All large ECCS pumps will be sequentially loaded in 5 second intervals (approximately). All non-essential loads will be tripped via the load shed logic. Pump P110A will not be energized until 20 seconds after voltage recovery. Swing bus B6 will still be connected to the "B" loop. All 480V large motors (Salt Service Water and RBCCW) will be loaded after time delays. Also various motor operated valves (short time loading, typically 30 sec) will be operating at different times during this scenario. MOV loads will be included as starting loads but will not be included in Steady State loading.

- Starting of loads at various time intervals

  When power is available,(i.e. at approximately 12.5 seconds) the following loads (load block-1) will be at steady state or will be starting (from PS-65A, Pg. 88,89) via A5 bus:

  MCC B15: 47 + j25 Steady state
  MCC B17: 52 + j28 Steady state
  MCC B17: 42 + j55 Starting
  MCC B15: 84 + j107 Starting

  P215A will also start at approximately 12.5 seconds. The starting load for this motor is 840 + j3910 KVA(PS65A).

  The DAPPER program was run with the above loading. The results are in Attachment SAB for 21.3 KV and Attachment SAA for 22.4kv. From the results, all loads will start and accelerate with the exception of VEX210A. However, cables associated with this load were replaced via PDC 93-05. A voltage drop calculation was performed for the replacement cables using a Lotus Spreadsheet. Using the Lotus spreadsheet set up in calculation PS113, it was verified that VEX210A will be able to start with 410v available voltage at MCC B15. See Attachment AAC.

- Next loads (load block-2) that will be starting are:

P203A:	840 + j3910 (PS65A)
MCC B17: M01400-25A	74 + j99 (PS65A)

Steady state loading including loads that previously started is (valve loading neglected):

MCC B17: 52+j28 (from previous run)

MCC B15: 47+j25 (from previous run)

=53.23 kva

+1.35 kva (B1546 steady state load of 1.5hp*0.9, previously started)

+14.35 kva (B1516A steady state load of 16kw*0.9, previously started)

+13.50 kva (B1526 steady state load of 15hp*0.9, previously started)

82.50 kva = 73+j39 kv

P215A: 604+j318 kva

The program was run with the above input. The results are in Attachment SAC for 22.4 kv and Attachment SAD for 21.3 kv.

Results indicate that at 22.4 kv both the motor operated valve and P203A will start. At 21.3 kv M01400-25A will start, however the available voltage is marginal (402.3 required vs. 411 available)

- Next load that will start is P203C.

P203C: Starting load: 840 + j3910 KVA

Steady State Loading:

MCC B15: 73 + j39

MCC B17 52 + j28

P203A: 639+j309

Results of both runs indicate (Attachments SAE and SAF) that P203C will start.

- The next pump is P208A, salt service water pump which will start at 25 seconds.

P208A starting at B15: 192 + j599 KVA

The steady state loading:

MCC B15: 73 + j39
MCC B17: 52 + j28
P110A: 80 + j46 (this pump was started at 20 seconds and is now at steady state)
P203A: 639+j309
P203C 639+j309

The results of both runs indicate that P208A will start (Attachment SAG, SAH)

- The last pump that will be sequenced on is P202A, RBCCW pump.

P202A: 135 + j353 on B15 (PS65A, pg. 66)

MCC B17: 52 + j28
MCC B15: 73 + j39 = 82.5 KVA
+81.72 KVA(P208A steady state load 90.8 x 0.9)
164.22 KVA = 144.5 + j78
= 145 + j78
P110A: 80+j46
P203A: 639+j309
P203C: 639+j309

The results of both runs indicate that P202A will start (Attachment SAI, SAJ)

This completes the start sequence.

- Then the steady state loading was calculated for all loads automatically connected to this bus. Steady state loading is as follows from the previous run:

MCC B17: 52 + j28
MCC B15: 145 + j78 = 164.22 KVA
50.94 KVA (P202A load)
215.16 KVA = 189 +j102

The DAPPER runs were performed and results are in Attachments AAA and AAB. A review of results indicate that at 22.4 kv, all loads will run with adequate margin. The voltage at A5 will be slightly above the bus undervoltage alarm set point.

The run at 21.3 kv indicates that all 480v loads will operate marginally. All 4160v loads will operate, however the available voltage will be only slightly above 90% (90.65%). The results also indicate that the bus voltage will be below the set point of the undervoltage alarm (approx.3950v). This will set an alarm in the control room. Currently PNPS procedure 2.4.144 is being revised to instruct the operator to take proper action in the event that this alarm is received when the plant is in this configuration. According to Attachment A, during peak loading with the Manomet transformer out, the voltage will be between 24 kv and 21.3 kv. The source voltage of 21.3 kv used is the worst case voltage during the peak loading. In reality, the voltage will be somewhat higher than 21.3 kv.

The above steady state loading only includes the automatic loads which are required to mitigate a LOCA. However other manually operated loads could be started by the control room operator. These loads are brought on later on in the scenario after an ECCS pump has been manually tripped. In this calculation we will start an additional SSW (P208B) pump without tripping an ECCS load. Also during the start of this pump we will load an additional RBCCW pump (P202B) as a steady state load

The steady state loading as follows are from the beginning of section C:

MCC B17: 52+ j28 KVA
P110A: 80+ j46 KVA
P203A 639+j309 KVA
P203C 639+j309 KVA
P215A 604+j318 KVA
MCC B15: 307+ j166 KVA (includes P208B and P202B)
= 349.0 KVA
- 81.72 KVA (P208B loading of 90.8 * 0.9)

236+ j127 KVA

Also the starting load of P208B is 192+ j599 KVA

The DAPPER run was performed and the results are in Attachment AAE. The results show that P208B will start properly at 22.4 KV. Also the steady state loading including P208B at steady state was run. The results in attachment AAD show that the available voltage is higher than the minimum required.
The manual loading with source voltage of 21.3 kv was not performed. As previously mentioned for the automatically connected loads, the 4.16 KV bus voltage is well below the alarm set point. It is assumed that the operator will clear the alarm prior to initiating any manual starts. The alarm reset point is approximately 3986 volts. The 3986 volts corresponds to approximately 22.4KV. Attachment AAE shows that P208B will start at 22.4KV.

d)LOCA w/load Shed Study "A5" and"A6" Energized - CASE E
(Source voltage: 24.6 - 23.8 kv, Manomet transformer in, and series capacitor in)

This calculation will use the lowest source voltage value of 23.8kv (peak load conditions). The following is the tabulation of the individual MCC's and loads that are connected to "A5" and "A6" Bus. The values were obtained from PS-65A, Page 35 and 36. This loading includes all automatic loads and manually operated loads that may be operating.

MCC B10:	135 + j73 KVA	MCC B14:	350+j189 KVA
MCC B20:	19 + j10 KVA	MCC B18:	50+j27 KVA
MCCB15:	307 + j166 KVA	P203B:	639+j309 KVA
MCC B17:	52 + j28 KVA	P203D:	639+j309 KVA
P110A:	80 + j46 KVA	P215B:	604+j318 KVA
P203A:	639 + j309 KVA		
P203C:	639 + j309 KVA		
P215A:	604 + j318 KVA		
G23:	66 + j35 KVA		

The above loading will be revised to reflect the scenario assumed in this calculation.

In this scenario, a DBA LOCA was assumed with both Emergency Diesel Generators out of service. The swing bus B6 is lined up with the A Loop. Both buses will be energized in approximately 12.5 sec. upon LOCA w/loop by the Shutdown Transformer. All large ECCS pumps will be sequentially loaded in 5 second intervals (approximately). All non-essential loads will be tripped via the load shed logic. Pump P110A will not be energized until 20 seconds after voltage recovery. Swing bus B6 will still be connected to the A loop. The vital M-G set from the swing bus will not be connected until 120 second. All 480V large motors (Salt Service Water and RBCCW) will be loaded after time delays. Also various motor operated valves (short time loading, typically 30 sec) will be operating at different times during this scenario. MOV loads will be included as starting loads but will not be included in Steady State loading.

• Starting of loads at various time intervals

When power is available,(i.e. at approximately 12.5 seconds) the following loads (load block-1) will be at steady state or will be starting (from PS-65A. Pg. 88,89) via A5 bus:

MCC B15: 47 + j25 Steady state, 84+j107 Starting
MCC B17: 52 + j28 Steady state, 42+j55 Starting
MCC B14: 99 + j54 Steady state, 37+j17 Starting
MCC B18: 50 + j27 Steady state, 39+j51 Starting
MCC B20: 19 +j10 Steady state, 16+j21 Starting
MCC B10: 68 +j37 Steady state

Prior to the energization of both buses, the LPCI loop selection will be completed in approximately 4 seconds after the break. The isolation valves MO1001-28A/28B and MO202-5A/5B will receive closure signal. These valves are powered via MCC B20 and should be included as Starting loads at 12.5 seconds. The revised loading for MCC B20 is:

16 +j21 (from above)
+213+j285 (MO1001-28A/28B,PS65A page 98)
+ 74+j99 (MO202-5A/5B,PS65A page 98)

303+j405

P215A and P215B will also start at approximately 12.5 seconds. The starting load for each of these motors is 840 + j3910 KV(PS65A).
The DAPPER program was run with the above loading. The results are in Attachment SAK. From the results, all loads will start and accelerate with the exception of VEX210A, M01001-28B and M0202-5A/5B. However, cables associated with VEX210A were replaced via PDC 93-05. A voltage drop calculation was performed for the replacement cables using a Lotus Spreadsheet. Using the Lotus spreadsheet set up in calculation PS113, it was verified that VEX210A will be able to start with 400v available voltage at MCC B15. See Attachment SAK-1A. Also M01001-28B and M0202-5A/5B will not start within their manufacturer's limits. However after all other loads are successfully started, there will be an improvement in bus voltages. To verify that these valves will start after slight time delays, we will model the two core spray pumps as running loads. For conservatism we will keep remaining starting loads unchanged.
The results of the run (Attachment SAK-1B) indicate that these valves will start and accelerate properly.

- Next loads (load block-2) that will be starting are:

P203A:	840 + j3910(PS-65A)
P203B:	840 +j3910(PS-65A)
MCC B17: M01400-25A	74 + j99 (PS-65A)
MCC B18: M01400-25B	74 +j99 (PS-65A)
MCC B20: M01001-29A/29B	74 +j99 PS-65A)

Steady state loading including loads that previously started is (valves loading neglected):

MCC B17: 52+j28 (from previous run)

MCC B15: 47+j25 (from previous run)

=53.23 kva

\+ 1.35 kva (B1546 steady state load of 1.5hp*0.9, previously started)

+14.35 kva (B1516A steady state load of 16kw*0.9, previously started)

+13.50 kva (B1526 steady state load of 15hp*0.9, previously started)

82.50 kva = 73+j39 kva

MCC B14: 99+j54 (from previous run)

=112.77 kva

\+ 1.35 kva (B1446 steady state load of 1.5hp*0.9, previously started)

+18.00kva (B1416B steady state load of 20kw*0.9, previously started)

132.12 kva= 117+j63 kva

P215A:	604+j318 kva
P215B:	604+j318 kva
MCC B18:	50 +j27 kva
MCC B10:	68 +j37 kva
MCC B20	19 +j10 kva

The program was run with the above input. The results are in Attachment SAL. results indicate that the motor operated valves, P203A and P203C will start with the exception of M01001-29B. To verify that this valve will start,we will utilize the same method as used in the previous run. P203A and P203B will be used as steady state loads.

The results of the run (Attachment SAL-1A) indicate that M01001-29B will start.

- Next loads that will start are P203C and P203D.

P203C and P203D: Starting loads 840 + j3910 KVA

Steady State Loading:
MCC B15: 73 + j39
MCC B!7 52 + j28
P203A: 639+j309
P203B: 639+j309
P215A: 604+j318
P215B: 604+j318
MCC B14: 117+j63
MCC B18: 50+j27
MCC B10: 68+j37
MCC B20: 19+j10

Results of both runs indicate (Attachment SAM) that both pumps P203C and P203D will start.

• The next pumps are P208A and P208D (Salt Service Water pumps) which will start at 25 and 30 seconds respectively. Although these pumps will start at separate time intervals, for conservatism we will start them at the same time.

P208A starting at B15: 192 + j599 KVA
P208D starting at B14: 192 + j599 KVA

The steady state loading:

MCC B15: 73 + j39
MCC B17: 52 + j28
MCC B14: 117+ j63
MCC B18: 50+j27
MCC B10: 68+j37
MCC B20: 19+j10
P110A: 80 + j46 (this pump was started at 20 seconds and is now at steady state)
P203A: 639+j309
P203C: 639+j309
P203B: 639+j309
P203D: 639+j309
P215A: 604+j318
P215B: 604+j318

The results indicate that both pumps P208A and P208D will start (Attachment SAN).

• The last two pumps that will be sequenced on are P202A and P202D (RBCCW pumps) at B15 and B14.

P202A and P202D: 135 + j353 each (PS65A, pg. 66)
MCC B17: 52 + j28
MCC B18: 50 + j27
MCC B10: 68 +j37
MCC B20: 19 +j10
MCC B15: 73 + j39 = 82.5 KVA
+81.72 KVA(P208A steady state load 90.8 x 0.9)
164.22 KVA = 144.5 + j78
= 145 + j78
MCC B14: 117+j63 =132.88 KVA
+ 81.72 KVA(P208D steady state load 90.8 x 0.9)

214.60 KVA = 189 + j102
P110A: 80+j46
P203A: 639+j309
P203C: 639+j309
P203B: 639+j309
P203D: 639+j309
P215A: 604+j318
P215B: 604+j318

The results indicate that P202A and P202D will start (Attachment SAO)

This completes the start sequence.

• Then the steady state loading was calculated for all loads automatically connected to both buses. Steady state loading is as follows from previous run:

MCC B17: 52 + j28
MCC B15: 145 + j78 = 164.22 KVA
+50.94 KVA (P202A steady state load of 56.6hp x0.9)
215.16 KVA = 189 +j102
MCC B14: 214.6 KVA
+50.94 KVA (P202D steady state load of 56.6hp x 0.9)

265.54 KVA= 234+j126
MCC B18: 50+j27
MCC B10: 68+j37
MCC B20: 19+j10
P203A : 639+j309

P203B : 639+j309
P203C : 639+j309
P203D : 639+j309
P215A : 604+j318
P215B : 604+j318
P110A : 80+j46
G23 : 66+j35 (load started at 120 seconds and is now at steady state)

The DAPPER run was performed and results are on Attachments SAP. A review of results indicate that all loads will run with adequate margin. The voltage at both buses will be above the bus undervoltage alarm set point.

The above steady state loading only includes the automatic loads which are required to mitigate a LOCA. However other manually operated loads could be started by the control room operator. These loads are brought on later on in the scenario after an ECCS pump has been manually tripped. In this calculation we will start two additional SSW (P208B,P208E) pumps at the same time without tripping an ECCS load. Also during the start of these pumps we will load additional RBCCW pumps (P202B, P202E) as a steady state loads.
The steady state loading which will be used are the same as beginning of this section except for B15 and B14

MCC B15: 307+ j166 KVA (includes P208B and P202B)
= 349.0 KVA
- 81.72 KVA (P208B loading of 90.8 * 0.9)
----
267 = 236+ j127 KVA

MCC B14: 350+j189= 397.77 KVA (includes P208E and P202E)
- 81.72 KVA (P208E loading of 90.8 * 0.9)

316.05 = 278+j150

Also the starting load of P208B and P208E is 192+ j599 KVA each.

The DAPPER run was performed and the results are in Attachment SAQ. The results show that P208B and P208E will start properly. Also the steady state loading including P208B and P208E at steady state was run. The results in attachment SAR show that the available voltage is higher than the minimum required.

e) LOCA w/load Shed Study, "A5" Energized Swing bus connected- CASE F
(Source voltage: 23.8 - 22.4 kv, Manomet transformer in, series capacitor out)

The calculation in section c) was performed with bus "A5" energized without the swing bus B6 connected. Although the swing bus B6 will not be connected to "A5" in this scenario by design a sensitivity study will be performed assuming swing bus B6 is connected to "A5". Since it is a sensitivity study, only the Manomet transformer in with the series capacitor out condition will be evaluated. This calculation will use the lowest source voltage values of 22.4kv (peak load conditions). The following is the tabulation of the individual MCC's and loads that are connected to the "A5" bus. The values were obtained from PS-65A, Page 35 and 36. This loading includes all automatic loads and manually operated loads that may be operating.

MCC B10: 135 + j73 KVA
MCC B20: 19 + j10 KVA
MCC B15: 307 + j166 KVA
MCC B17: 52 + j28 KVA
P110A: 80 + j46 KVA
P203A: 639 + j309
P203C: 639 + j309 KVA
P215A: 604 + j318 KVA
G23: 66 + j35 KVA

The above loading will be revised to reflect the scenario assumed in this calculation.

In this scenario, a DBA LOCA was assumed with Emergency Diesel Generator "A" out of service. Swing bus B6 will be assumed to be lined up with the A Loop. Bus "A5" will be energized in approximately 12.5 sec. upon LOCA w/loop by the Shutdown Transformer. All large ECCS pumps will be sequentially loaded in 5 second intervals (approximately). All non-essential loads will be tripped via the load shed logic. Pump P110A will not be energized until 20 seconds after voltage recovery. All 480V large motors (Salt Service Water and RBCCW) will be loaded after time delays. Also various motor operated valves (short time loading, typically 30 sec) will be operating at different times during this scenario. MOV loads will be included as starting loads but will not be included in Steady State loading.

- Starting of loads at various time intervals

When power is available,(i.e. at approximately 12.5 seconds) the following loads (load block-1) will be at steady state or will be starting (from PS-65A, Pg. 88,89) via A5 bus:

MCC B15: 47 + j25 Steady state
MCC B17: 52 + j28 Steady state

MCC B10: 68 + j37 Steady state
MCC B20: 19 +j10 Steady state
MCC B17: 42 + j55 Starting
MCC B15: 84 + j107 Starting
MCC B20: 16 + j21 Starting

P215A will also start at approximately 12.5 seconds. The starting load for this motor is 840 + j3910 KVA(PS65A). Also M0202-5A/5B and M01001-28A/28B will be starting at the same time. These valves are powered via MCC B20 and the starting loads will be added to the above MCC B20 starting load. The revised MCC B20 starting load:

16 + j21
+74+j99 (M0202-5A/5B from PS65A page 98)
+213+285 (M01001-28A/28B from PS65A page 98)

303+j405 KVA

The DAPPER program was run with the above loading. The results are in Attachment SAAA. A review of the results indicate that all loads will start and accelerate properly.

- Next loads (load block-2) that will be starting are:

P203A:	840 + j3910 (PS65A)
MCC B17: M01400-25A	74 + j99 (PS65A)
MCC B20: M01001-29A/29B	74 + j99 (PS65A)

Steady state loading including loads that previously started is (valve loading neglected):

MCC B17: 52+j28 (from previous run)
MCC B15: 47+j25 (from previous run)
=53.23 kva
+1.35 kva (B1546 steady state load of 1.5hp*0.9, previously started)
+14.35 kva (B1516A steady state load of 16kw*0.9, previously started)
+13.50 kva (B1526 steady state load of 15hp*0.9, previously started)

82.50 kva = 73+j39 kva

P215A: 604+j318 kva
MCC B10: 68+j37 kva
MCC B20 19+j10 kva

The program was run with the above input. The results are in Attachment SAAB. Results indicate that both motor operated valves and P203A will start.

- Next load that will start is P203C.

  P203C: Starting load: 840 + j3910 KVA
  Steady State Loading:
  MCC B15: 73 + j39
  MCC B17 52 + j28
  P203A: 639+j309
  P215A 604+j318

Results of the run indicate (Attachment SAAC) that P203C will start.

- The next pump is P208A, salt service water pump which will start at 25 seconds.

  P208A starting at B15: 192 + j599 KVA

  The steady state loading:

  MCC B15: 73 + j39
  MCC B17: 52 + j28
  P110A: 80 + j46 (this pump was started at 20 seconds and is now at steady state)
  P203A: 639+j309
  P203C 639+j309
  P215A 604+j318

The results of the run indicate that P208A will start (Attachment SAAD)

- The last pump that will be sequenced on is P202A, RBCCW pump.

  P202A: 135 + j353 on B15 (PS65A, pg. 66)

  MCC B17: 52 + j28
  MCC B15: 73 + j39 = 82.5 KVA
  +81.72 KVA(P208A steady state load 90.8 x 0.9)
  164.22 KVA = 144.5 + j78
  = 145 + j78
  P110A: 80+j46
  P203A: 639+j309
  P203C: 639+j309
  P215A: 604+j318

The result of the run indicate that P202A will start (Attachment SAAE)

This completes the start sequence.

•Then the steady state loading was calculated for all loads automatically connected to this bus. Steady state loading is as follows from the previous run:

MCC B17:	52 + j28
MCC B15:	145 + j78 = 164.22 KVA
	<u>50.94 KVA</u> (P202A load)
	215.16 KVA = 189 +j102
MCC B10:	68 + j37
MCC B20:	19 + j10
P110A:	80 + j46
P203A:	639 + j309
P203B:	639 + j309
P215A:	604 + j318
G23:	66 + j35 (load was started at 120 seconds and is now at steady state)

The DAPPER runs were performed and results are in Attachments AAAA. A review of the results indicate that all loads will run with adequate margin. The voltage at A5 will be slightly above the bus undervoltage alarm set point.

The above steady state loading only includes the automatic loads which are required to mitigate a LOCA. However other manually operated loads could be started by the control room operator. These loads are brought on later on in the scenario after an ECCS pump has been manually tripped. In this calculation we will start an additional SSW (P208B) pump without tripping an ECCS load. Also during the start of this pump we will load an additional RBCCW pump (P202B) as a steady state load.

The steady state loading as follows are from the beginning of section e:

MCC B17:	52+ j28 KVA
MCC B10:	135+j73 KVA
MCC B20:	19+j10 KVA
P110A:	80+ j46 KVA
P203A	639+j309 KVA
P203C	639+j309 KVA
P215A	604+j318 KVA

MCC B15: 307+ j166 KVA (includes P208B and P202B)
= 349.0 KVA
\- 81.72 KVA (P208B loading of 90.8 * 0.9)
\------------------
236+ j127 KVA
G23 66+ j35 KVA
Also the starting load of P208B is 192+ j599 KVA

The DAPPER run was performed and the results are in Attachment AAAB. The results show that P208B will start properly. Also the steady state loading including P208B at steady state was run. The results in attachment AAAC show that the available voltage is higher than the minimum required.

CALCULATION SHEET

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SUBJECT: 23 KV OFFSITE SOURCE LOAD FLOW STUDY

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TABLE 1, PAGE 1

TURBINE TRIP

MCC: B10

LOAD BKR#	EQUIPMENT I.D	REQUIRED MCC VOLTAGE (V) START	REQUIRED MCC VOLTAGE (V) RUN	Q/NQ	COMMENTS
B1013	X59	–	414.9	NQ	
B1014	U47	378.7	416.9	NQ	
B1015	X-19	–	414.5	NQ	
B1023A	16L	–	414.4	NQ	
B1023B	P146	422.2	433.8	NQ	
B1024B	X105	–	420.5	NQ	
B1025	P132	382.25	418.52	NQ	
B1026	K101	397.18	422.74	NQ	
B1031	VAC104A	403.1	428.1	NQ	
B1033A	VRC101A	–	421.3	NQ	
B1034	VRF101A	412.9	429.1	NQ	
B1041	P131	383.3	419.5	NQ	
B1042	P129	394.9	423	NQ	
B1044	X101	381.9	419.1	NQ	
B1064	K104C	397.3	425.1	NQ	

CASE A) MANOMET TRANSFORMER IN, SERIES CAPACITOR OUT

MINIMUM AVAILABLE MCC BUS VOLTAGE

STEADY STATE: 460V (ATTACHMENT 'B' PG.19)

MOTOR STARTING: 434V (ATTACHMENT 'H', PG.19)

CASE B) MANOMET TRANSFORMER OUT, SERIES CAPACITOR IN

MINIMUM AVAILABLE MCC BUS VOLTAGE

STEADY STATE: 433 (Attachment AA, Pg.19), > 452 (FIG. 1)

MOTOR STARTING: 430V (Attachment AH, Pg. 21)

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SUBJECT: 23KV OFFSITE SOURCE LOAD FLOW STUDY

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TABLE 1, PAGE 2
TURBINE TRIP

MCC: B15

LOAD BKR#	EQUIPMENT I.D	REQUIRED MCC VOLTAGE (V) START	RUN	Q/NQ	COMMENTS
B1513	D11	-	417.4	Q	
B1516A	VGTF201A	-	426.7	Q	Loads not required per FSAR, "G"
B1516B	VCRF101A	-	-	Q	Not reqd. Air conditioning working
B1521	VEX104A	381.4	418.1	NQ	
B1525	K104A	406.2	428.3	NQ	
B1526	VEX210A	411.8	430.2	Q	Loads not required per FSAR, "G"
B1531	P202A	372.4	415.5	Q	
B1541	P208A	389.2	419.8	Q	
B1544	P208B	389.2	419.8	Q	
B1563	VEX103A	385.1	418.7	NQ	

CASE A) MANOMET TRANSFORMER IN, SERIES CAPACITOR OUT

MINIMUM AVAILABLE MCC BUS VOLTAGE

STEADY STATE: 450V (ATTACHMENT B, PAGE 14)
MOTOR STARTING: 401V (ATTACHMENT B, Pg 21)

CASE B) MANOMET TRANSFORMER OUT, SERIES CAPACITOR IN
MINIMUM AVAILABLE MCC BUS VOLTAGE

STEADY STATE: 422V (Attachment AA, Pg. 14), >442V (Fig. 1
MOTOR STARTING: 396V (Attachment AC, Pg 21)

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SUBJECT: 23 KV OFFSITE SOURCE LOAD FLOW STUDY

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TABLE 1, PAGE 3

TURBINE TRIP

MCC: B14

LOAD BKR#	EQUIPMENT I.D	REQUIRED MCC VOLTAGE (V) START	REQUIRED MCC VOLTAGE (V) RUN	Q/NQ	COMMENTS
B1413	D12	–	417.4	Q	
B1414A	D13	–	421	Q	
B1416A	VGTF201B	–	421.8	Q	Loads not required per FSAR, 'G'
B1416B	VCRF101B	–	–	Q	Not reqd. Air conditioning Working
B1425	K104B	408.1	428.9	NQ	
B1426	VEX210B	410.6	429.8	Q	Loads not required per FSAR, "G"
B1431	P202D	375.1	416.3	Q	
B1441	P208D	385.5	418.6	Q	
B1444	P208E	384.9	418.5	Q	
B1461	P152B	383.4	418.2	NQ	
B1463	VEX103B	385.3	418.7	NQ	

CASE A) MANOMET TRANSFORMER IN, SERIES CAPACITOR OUT

MINIMUM AVAILABLE MCC BUS VOLTAGE

STEADY STATE: 457 V (ATTACHMENT B, Page 16)
MOTOR STARTING: 410 V (Attachment D, Page 21)

CASE B) MANOMET TRANSFORMER OUT, SERIES CAPACITOR IN

MINIMUM AVAILABLE MCC BUS VOLTAGE

STEADY STATE: 430V (Attachment AA, Pg. 16), >452V (Fig. 1)
MOTOR STARTING: 405V (Attachment AD, Pg 21)

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SUBJECT: 23KV OFFSITE SOURCE LOAD FLOW STUDY

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TABLE 1, PAGE 4.

TURBINE TRIP

MCC: B17 AND B17A

LOAD BKR#	EQUIPMENT I.D	REQUIRED MCC VOLTAGE (V)		Q/NQ	COMMENTS
		START	RUN		
B1716	VAC205F1	379.7	418.2	NQ	
B1722	VAC202A	386.6	419.7	Q	
B1723	VAC203A	378.2	417.1	NQ	
B1725	VAC204A	405.7	426.9	Q	
B1726	VAC205 A1	398.9	424.7	NQ	
B1731	VAC205B1	388.6	421.3	NQ	
B1732	VAC205C1	398.4	424.5	NQ	
B1733	VAC205D1	384.6	419.9	NQ	
B1734	VAC205E1	401.8	425.6	NQ	
B1735	VAC206A1	383.0	420.0	NQ	
B1736	VAC206B1	386.5	421.3	NQ	
B1746	MO1400-25A	402.7	—	Q	
B1751	MO1001-7A	372.6	—	Q	
B1753	MO1001-7C	372.6	—	Q	
B1754	MO1001-18A	370.5	—	Q	
B1763	MO1001-16A	393.0	—	Q	
B1783	MO4060A	370.8	—	Q	
B1784	MO4060B	370.8	—	Q	
B1794	X-74	—	414.3	Q	
B17101	P224A	393.6	423.8	NQ	
B17115	X55	—	396.0	Q	From PDC 91-59A, PS-70
B17A13B	X57	—	396.0	Q	From PDC 91-59B, PS-73

CASE A) MANOMET TRANSFORMER IN, SERIES CAPACITOR OUT

MINIMUM AVAILABLE MCC BUS VOLTAGE

STEADY STATE: 461V (ATTACHMENT B, PAGE 14)
MOTOR STARTING: 433V (Attachment E, Pg. 21)

CASE B) MANOMET TRANSFORMER OUT, SERIES CAPACITOR IN
MINIMUM AVAILABLE MCC BUS VOLTAGE
STEADY STATE: 434V (Attachment AA, Pg 14), >454V (Fig 1)
MOTOR STARTING: 429V (Attachment AE, Pg 21)

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TABLE 1, PAGE 5

TURBINE TRIP

MCC: B18 AND B18A

LOAD BKR#	EQUIPMENT I.D	REQUIRED MCC VOLTAGE (V)		Q/NQ	COMMENTS
		START	RUN		
B1816	VAC205F2	396.4	423.8	NQ	
B1822	VAC201A	378.6	417.4	Q	
B1825	VAC204D	385.7	420.2	Q	
B1826	VAC205A2	380.3	418.4	NQ	
B1 31	VAC205B2	389.2	421.5	NQ	
B1 32	VAC205C2	381.8	418.9	NQ	
B1833	VAC205D2	391.3	422.1	NQ	
B1834	VAC205E2	388.7	421.3	NQ	
B1835	VAC206A2	387.6	421.8	NQ	
B1836	VAC206B2	386.5	421.3	NQ	
B1846	MO1001-25B	398.9	–	Q	
B1851	MO1001-7B	372.2	–	Q	
B1853	MO1001-7D	371.8	–	Q	
B1854	MO1001-18B	369.8	–	Q	
B1863	MO1001-16B	387.4	–	Q	
B1883	MO4010A	370.3	–	Q	
B1884	MO4010B	370.4	–	Q	
B1885	X75	–	414.6	Q	
B18101	P225A	377.4	417.8	NQ	
B18115	X56	–	396.0	Q	PDC 91-59A, PS-70
B18A13B	X58	–	396.0	Q	PDC 91-59B, PS-73

CASE A) MANOMET TRANSFORMER IN, SERIES CAPACITOR OUT

MINIMUM AVAILABLE MCC BUS VOLTAGE

STEADY STATE: 466 V (ATTACHMENT B, Pg. 16)
MOTOR STARTING: 433V (Attachment F, Pg. 21)

CASE B) MANOMET TRANSFORMER OUT, SERIES CAPACITOR IN

MINIMUM AVAILABLE MCC BUS VOLTAGE

STEADY STATE: 440V (Attachment AA, Pg. 16), >462V (FIG. 1)
MOTOR STARTING: 428 V (Attachment AF, Pg. 21)

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TABLE 1, PAGE 6
TURBINE TRIP

MCC: B20

LOAD BKR#	EQUIPMENT I.D	REQUIRED MCC VOLTAGE (V) START	REQUIRED MCC VOLTAGE (V) RUN	Q/NQ	COMMENTS
B2013A	X-40	–	415.4	NQ	
B2014	X-50	–	415.6	NQ	
B2024	MO1001-29A	382.1	–	Q	
B2026	MO1001-29B	414.5	–	Q	
B2031	MO1001-28A	379.3	–	Q	
B2034	MO1001-28B	404.3	–	Q	
B2041	MO1001-19	379.9	–	Q	
B2043	MO1001-32	370.9	–	Q	
B2046	MO1001-50	382.8	–	Q	
B2053	MO1001-63	–	–	Q	VALVE NO LONGER IN SERVICE
B2054	MO1201-2	370.7	–	Q	
B2056	MO1201-80	373.5	–	Q	
B 2084	X-76	–	419.3	Q	

CASE A) MANOMET TRANSFORMER IN, SERIES CAPACITOR OUT
MINIMUM AVAILABLE MCC BUS VOLTAGE
STEADY STATE: 461V (Attachment B, Pg. 19)
MOTOR STARTING: 429V (Attachment G, Pg. 21)

CASE B) MANOMET TRANSFORMER OUT, SERIES CAPACITOR IN
MINIMUM AVAILABLE MCC BUS VOLTAGE
STEADY STATE: 434V (Attachment AA, Pg 19), >452V (FIG. 1)
MOTOR STARTING: 425V (Attachment AG, Pg. 21)

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TABLE 2 PAGE 1

LOCA WITH 'A5' BUS

MCC: B15

LOAD BKR#	EQUIPMENT I.D	REQUIRED MCC VOLTAGE (V) START	REQUIRED MCC VOLTAGE (V) RUN	Q/NQ	AVAILABLE VOLT. START CASE C	AVAILABLE VOLT. START CASE D
B1513	D11	–	417.4	Q	N/A	N/A
B1516A	VGTF201A	–	426.7	Q	N/A	N/A
B1516B	VCRF101A	–	430.0	Q	N/A	N/A
B1526	VEX210A	411.8	430.2	Q	432 (Att. SAA)	See Pg. 13
B1531	P202A	372.4	415.5	Q	432 (Att. SAJ)	408 (Att. SAI)
*B1533	P202B	375.1	416.3	Q	N/A	N/A
B1541	P208A	389.2	419.8	Q	420 (Att. SAH)	(Att. SAH)
*B1544	P208B	389.2	419.8	Q	N/A	N/A
B1546	P141A	382.4	417.9	NQ	432 (Att. SAA)	(Att. SAB)
B1563	VEX103A	385.1	418.7	NQ	–	–
B1564	MO3800	369.2	–	Q	432 (Att. SAA)	410 (Att. SAB)
B1566	MO3801	368.1	–	Q	432 (Att. SAA)	410 (Att. SAB)

CASE C) MANOMET TRANSFORMER IN, SERIES CAPACITOR OUT
CASE D) MANOMET TRANSFORMER OUT, SERIES CAPACITOR IN
STEADY STATE LOADING FOR CASE A. 467V (Attachment AAA)
STEADY STATE LOADING FOR CASE B. 441V (Attachment AAB)

* THESE LOADS ARE NOT REQUIRED FOR LOCA. ONLY ONE PUMP PER LOOP IS REQUIRED. LOADINGS WERE NOT INCLUDED IN THIS CALCULATION. LOADINGS ARE MANUAL OPERATION. SEE FSAR 10.5.5.3 AND 10.7.5

SUBJECT: 23 KV OFFSITE SOURCE LOAD FLOW STUDY

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TABLE 2 PAGE 2

LOCA WITH 'A5' BUS

MCC: B17

LOAD BKR#	EQUIPMENT I.D	REQUIRED MCC VOLTAGE (V) START	REQUIRED MCC VOLTAGE (V) RUN	Q/NQ	AVAILABLE VOLT. START CASE C	AVAILABLE VOLT START CASE D
B1713	C103A	-	418.8	NQ	N/A	N/A
B1714	VSF208A	372.8	415.1	Q	>437 *	>415 V *
B1722	VAC202A	386.6	419.65	Q	>437 *	>415 V *
B1725	VAC204B	389.7	421.6	Q	>437 *	>415 V *
B1741	MO1400-3A	373.1	—	Q	437 (Attch. SAA)	415 (Attach. SAB)
B1763	MO1001-16A	392.9	—	Q	437 (Attach. SAA)	415 (Attach. SAB)
B1796	MO4084	372.3	—	Q	437 (Att. SAA)	415 (Attach. SAB)
B1786	MO4065	371.3	—	Q	437 (Att. SAA)	415 (Attach. SAB)
B1794	X74	—	414.3	Q	N/A	N/A
B17115	X55	—	396.0**	Q	N/A	N/A
B1746	MO1400-25A	402.7	—	Q	433 (Att. SAC)	415 (Att. SAD)

CASE C) MANOMET TRANSFORMER IN, SERIES CAPACITOR OUT
CASE D) MANOMET TRANSFORMER OUT, SERIES CAPACITOR IN

STEADY STATE LOADING FOR CASE A. 475V (Attachment AAA)
STEADY STATE LOADING FOR CASE B. 449V (Attachment AAB)

* BASED ON THESE LOADS ARE STARTED PRIOR TO LOAD BLOCK-1 (Attachments. SAA, SAB)

** From PDC 91-59A, calculation PS-70

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TABLE 2 PAGE 3
LOCA WITH 'A5' BUS

LOAD BKR#	EQUIPMENT I.D	REQUIRED MCC VOLTAGE (V) START	REQUIRED MCC VOLTAGE (V) RUN	Q/NQ	AVAILABLE VOLT. START CASE C	AVAILABLE VOLT. START CASE D
A503	P203A	3328*	3744*	Q	3638 (AH. SAC)	3438 (AH. SAD)
A506	P203C	3328*	3744*	Q	3589 (AH. SAF)	3402 (AH. SAE)
A507	P215A	3328*	3744*	Q	3657 (AH. SAA)	3476 (AH. SAB)
B106	P110A	368*	414*	NQ	–	–

CASE C) MANOMET TRANSFORMER IN, SERIES CAPACITOR OUT
CASE D) MANOMET TRANSFORMER OUT, SERIES CAPACITOR IN

* ASSUMED 80% start and 90% run, NQ LOAD STARTING NOT PERFORMED

STEADY STATE LOADING FOR CASE A. 4KV - 3984 V, 480V - 467 V (Attachment AAA)
STEADY STATE LOADING FOR CASE B - 4KV - 3779 V, 480V - 442 (Attachment AAB)

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TABLE 3 PAGE 1

LOCA WITH A5 AND A6

MCC: B15

LOAD BKR#	EQUIPMENT I.D	REQUIRED MCC VOLTAGE (V) START	REQUIRED MCC VOLTAGE (V) RUN	Q/NQ	AVAILABLE VOLT. START	AVAILABLE VOLT. RUN (ATTACH. SAR)
B1513	D11	—	N/A	Q	N/A	472
B1516A	VGTF201A	—	N/A	Q	N/A	472
B1516B	VCRF101A	—	N/A	Q	N/A	472
B1526	VEX210A	411.8	430.2	Q	See Page 1B	472
B1531	P202A	372.4	415.5	Q	437 (Attch. SAQ)	472
*B1533	P202B	375.1	416.3	Q	>401 (Attch. SAQ)	472
B1541	P208A	389.2	419.8	Q	423 (Attch. SAN)	472
*B1544	P208B	389.2	419.8	Q	401 (Attch. SAQ)	472
B1546	P141A	382.4	417.9	NQ	400 (Attch. SAK)	472
B1563	VEX103A	385.1	418.7	NQ	—	472
B1564	MO3800	369.2	—	Q	400 (Attch. SAK)	472
B1566	MO3801	368.1	—	Q	400 (Attch. SAK)	472

* THESE LOADS ARE NOT REQUIRED FOR LOCA. ONLY ONE PUMP PER LOOP IS REQUIRED. LOADINGS WERE NOT INCLUDED IN THIS CALCULATION. LOADINGS ARE MANUAL OPERATION. SEE FSAR 10.5.5.3 AND 10.7.5. Available Starting voltage for B1533 based on starting of higher hp (i.e 100hp for B1544 Start) load.

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TABLE 3 PAGE 2

LOCA WITH A5 AND A6

MCC: B17

LOAD BKR#	EQUIPMENT I.D	REQUIRED MCC VOLTAGE (V) START	REQUIRED MCC VOLTAGE (V) RUN	Q/NQ	AVAILABLE VOLT. START	AVAILABLE VOLT. RUN (ATTACHMENT SAR)
B1713	C103A	–	418.8	NQ	N/A	486
B1714	VSF208A	372.8	415.1	Q	>405 *	486.
B1722	VAC202A	386.6	419.65	Q	>405 *	486
B1725	VAC204B	389.7	421.6	Q	>405 *	486
B1741	MO1400-3A	373.1	–	Q	405 (Attch. SAK)	486
B1763	MO1001-16A	392.9	–	Q	405 (Attch. SAK)	486
B1796	MO4084	372.3	–	Q	405 (Attch. SAK)	486
B1786	MO4065	371.3	–	Q	405 (Attch. SAK)	486
B1794	X74	–	414.3	Q	N/A	486
B17115	X55	–	396**	Q	N/A	486
B1746	MO1400-25A	402.7	–	Q	408 (Attch. SAL)	486

* Based on these loads are started prior to Load Block-1 (Attachment SAK)

** Required Run voltage based on PDC 91-59A

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TABLE 3 PAGE 3

LOCA WITH A5 AND A6

MCC: B14

LOAD BKR#	EQUIPMENT I.D	REQUIRED MCC VOLTAGE (V) START	REQUIRED MCC VOLTAGE (V) RUN	Q/NQ	AVAILABLE VOLT. START	AVAILABLE VOLT. RUN (ATTACHMENT SAR)
B1413	P12	—	417.4	Q	N/A	480
B1414A	P13	—	421.0	Q	N/A	480.
B1416B	VCRF101B	—	419.0	Q	N/A	480
B1431	P202D	375.0	416.3	Q	442(Attch.SAO)	480
*B1433	P202E	375.9	416.3	Q	>412(Attch.SAQ)	480
B1441	P208D	385.4	418.5	Q	428(Attch.SAN)	480
*B1444	P208E	384.9	418.4	Q	412(Attch SAQ)	480
B1446	P141B	383.3	418.1	NQ	418(Attch.SAK)	480
B1461	P152B	383.3**	418.2	NQ	>418**	480
B1463	VEX103B	385.3**	418.7	NQ	>418**	480
B1464	MO3806	369.5	—	Q	418(Attch.SAK)	480
B1466	MO3806	369.2	—	Q	418(Attch.SAK)	480

* THESE LOADS ARE NOT REQUIRED FOR LOCA. ONLY ONE PUMP PER LOOP IS REQUIRED LOADINGS WERE NOT INCLUDED IN THIS CALCULATION. LOADINGS ARE MANUAL OPERATION. SEE FSAR 10.5.5.3 AND 10.7.5. Available starting voltage for B1433 based on starting of higher hp (i.e. 100hp for B1444) load.

** Based on prior start of Load block-1 (Attachment SAK)

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TABLE 3 PAGE 4

LOCA WITH A5 AND A6

MCC: B18

LOAD BKR#	EQUIPMENT I.D	REQUIRED MCC VOLTAGE (V) START	REQUIRED MCC VOLTAGE (V) RUN	Q/NQ	AVAILABLE VOLT. START	AVAILABLE VOLT RUN (ATTACHMENT SAR)
B1813A	C104A	-	42.5	NQ	N/A	491
B1822	VAC201A	378.5	417.3	Q	>419*	491
B1825	VAC204D	385.7	420.2	Q	>419*	491
B1841	MO1400-3B	372.0	—	Q	419 (Attch SAK)	491
B1846	MO1400-25B	398.9	—	Q	409 (Attch SAL)	491
B1863	MO1001-16B	387.3	—	Q	419 (Attch. SAK)	491
B1885	X-75	—	414.5	Q	N/A	491
B1896	MO4083	369.9	—	Q	419 (Attch. SAK)	491
B18115	X-56	—	419.0	Q	N/A	491
B18116	VEX214B	375.5	415.8	Q	>419*	491

* Based on these loads started prior to Load block-1 (Attachment SAK)

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TABLE 3 PAGE 5

LOCA WITH A5 AND A6

MCC: B10

LOAD BKR#	EQUIPMENT I.D	REQUIRED MCC VOLTAGE (V)		Q/NQ	AVAILABLE VOLT. START	AVAILABLE VOLT RUN (ATTACHMENT SAR)
		START	RUN			
B1013	X-59	–	414.9	NQ	N/A	485
B1015	X-19	–	414.5	NQ	N/A	485
B1023A	16L	–	414.3	NQ	N/A	485
B1023B	P-146	422.1	433.8	NQ	–	485
B1024B	X-105	–	420.4	NQ	N/A	485
B1026	K-101	397.1	422.7	NQ	–	485
B1041	P-131	383.3	419.4	NQ	–	485

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TABLE 3 PAGE 6

LOCA WITH A5 AND A6

MCC: B20

LOAD BKR#	EQUIPMENT I.D	REQUIRED MCC VOLTAGE (V)		Q/NQ	AVAILABLE VOLT. START	AVAILABLE VOLT RUN (Attachment SAR)
		START	RUN			
B2013A	X-40	–	415.4	NQ	N/A	485
B2014	X-50	–	415.6	NQ	N/A	485
B2024	MO1001-29A	382.1	–	Q	407 (Attch SAL)	485
B2026	MO1001-29B	414.5	–	Q	481 (Attch. SAL-1A)	485
B2031	MO1001-28A	379.3	–	Q	394 (Attch. SAK)	485
B2034	MO1001-28B	404.3	–	Q	464 (Attch. SAK-1B)	485
B2054	MO1201-2	370.6	–	Q	394 (Attch. SAK)	485
B2056	MO1201-80	373.4	–	Q	394 (Attch SAK)	485
B2083	MO202-5A	403.7	–	Q	464 (Att. SAK-1B)	485
B2096	MO202-5B	403.7	–	Q	464 (Att. SAK-1B)	485

SUBJECT: 23KV OFFSITE SOURCE LOAD FLOW STUDY

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TABLE 3 PAGE 7

LOCA WITH A5 AND A6

LOAD BKR#	EQUIPMENT I.D	REQUIRED MCC VOLTAGE (V)		Q/NQ	AVAILABLE VOLT. START	AVAILABLE VOLT RUN
		START	RUN			
A503	P203A	3328	3744	Q	3459 (Attch. SAL)	4131 (Attch. SAR)
A506	P203C	3328	3744	Q	3419 (Attch SAM)	4130 (Attch. SAR)
A507	P215A	3328	3744	Q	3514 (Attch. SAK)	4130 (Attch. SAR)
A603	P203B	3328	3744	Q	3439 (Attch SAL)	4125 (Attch. SAR)
A606	P203D	3328	3744	Q	3406 (Attch. SAM)	4130 (Attch. SAR)
A607	P215B	3328	3744	Q	3495 (Attch. SAK)	4125 (Attch. SAR)
B106	P110A	368	414	NQ	-	478 (Attch. SAR)
B606	G23	368	414	NQ	-	481 (Attch. SAR)

The required starting and running voltages are assumed to be 80% and 90% respectively

SUBJECT: 23 KV OFFSITE SOURCE LOAD FLOW STUDY.

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TABLE 4 PAGE 1

LOCA WITH A5 BUS AND SWING BUS B6

MCC: B10

LOAD BKR#	EQUIPMENT I.D	REQUIRED MCC VOLTAGE (V) START	REQUIRED MCC VOLTAGE (V) RUN	Q/NQ	AVAILABLE VOLT. START	AVAILABLE VOLT. RUN (ATTACHMENT AAAA)
B1013	X-59	–	414.9	NQ	N/A	463
B1015	X-19	–	414.5	NQ	N/A	463
B1023A	16L	–	414.3	NQ	N/A	463
B1023B	P-146	422.1	433.8	NQ	–	463
B1024B	X-105	–	420.4	NQ	N/A	463
B1026	K-101	397.1	422.7	NQ	–	463
B1041	P-131	383.3	419.4	NQ	–	463

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TABLE 4 PAGE 2

LOCA WITH A5 BUS AND SWING BUS B6

MCC: B20

LOAD BKR#	EQUIPMENT I.D	REQUIRED MCC VOLTAGE (V) START	REQUIRED MCC VOLTAGE (V) RUN	Q/NQ	AVAILABLE VOLT. START	AVAILABLE VOLT RUN (Attachment AAAC)
B2013A	X-40	–	415.4	NQ	N/A	463
B2014	X-50	–	415.6	NQ	N/A	463
B2024	MO1001-29A	382.1	–	Q	425 (Atch. SAAB)	463
B2026	MO1001-29B	414.5	–	Q	425 (Atch. SAAB)	463
B2031	MO1001-28A	379.3	–	Q	406 (Atch. SAAA)	463
B2034	MO1001-28B	404.3	–	Q	406 (Atch. SAAA)	463
B2054	MO1201-2	370.6	–	Q	406 (Atch. SAAA)	463
B2056	MO1201-80	373.4	–	Q	406 (Atch. SAAA)	463
B2083	MO202-5A	403.7	–	Q	406 (Atch. SAAA)	463
B2096	MO202-5B	403.7	–	Q	406 (Atch. SAAA)	463

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TABLE 4 PAGE 3.

LOCA WITH A5 BUS AND SWING BUS B6

MCC: B15

LOAD BKR#	EQUIPMENT I.D	REQUIRED MCC VOLTAGE (V) START	REQUIRED MCC VOLTAGE (V) RUN	Q/NQ	AVAILABLE VOLT. START	AVAILABLE VOLT. RUN (ATTACH. AAAC)
B1513	D11	—	N/A	Q	N/A	450
B1516A	VGTF201A	—	N/A	Q	N/A	450
B1516B	VCRF101A	—	N/A	Q	N/A	450
B1526	VEX210A	411.8	430.2	Q	412 (Attch. SAAA)	450
B1531	P202A	372.4	415.5	Q	429 (Attch. SAAE)	450
*B1533	P202B	375.1	416.3	Q	398 (Attch. AAAB)	450
B1541	P208A	389.2	419.8	Q	417 (Attch. SAAD)	450
*B1544	P208B	389.2	419.8	Q	398 (Attch. AAAB)	450
B1546	P141A	382.4	417.9	NQ	412 (Attch. SAAA)	450
B1563	VEX103A	385.1	418.7	NQ	—	450
B1564	MO3800	369.2	—	Q	412 (Attch. SAAA)	450
B1566	MO3801	368.1	—	Q	412 (Attch. SAAA)	450

* THESE LOADS ARE NOT REQUIRED FOR LOCA. ONLY ONE PUMP PER LOOP IS REQUIRED. LOADINGS WERE NOT INCLUDED IN THIS CALCULATION. LOADINGS ARE MANUAL OPERATION SEE FSAR 10.5.5.3 AND 10.7.5. Available Starting voltage for B1533 based on starting of higher hp (i.e 100hp for B1544 Start) load.

CALCULATION SHEET

☐ PRELIMINARY
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REV___DATE______

BOSTON EDISON

AUTHORIZATION NO.______
PREPARED BY______ DATE______
CHECKED BY______ DATE______
APPVD BY______ DATE______
SHEET 47 OF ~~46~~ 58

SUBJECT: 23 KV OFFSITE SOURCE LOAD FLOW STUDY

SR ☐
NSR ☐

TABLE 4 PAGE 4

LOCA WITH A5 BUS AND SWING BUS B6

MCC: B17

LOAD BKR#	EQUIPMENT I.D	REQUIRED MCC VOLTAGE (V) START	REQUIRED MCC VOLTAGE (V) RUN	Q/NQ	AVAILABLE VOLT. START	AVAILABLE VOLT. RUN (ATTACHMENT AAAC)
B1713	C103A	–	418.8	NQ	N/A	464
B1714	VSF208A	372.8	415.1	Q	>417 *	464
B1722	VAC202A	386.6	419.65	Q	>417 *	464
B1725	VAC204B	389.7	421.6	Q	>417 *	464
B1741	MO1400-3A	373.1	–	Q	417 (Attch. SAAA)	464
B1763	MO1001-16A	392.9	–	Q	417 (Attch. SAAA)	464
B1796	MO4084	372.3	–	Q	417 (Attch. SAAA)	464
B1786	MO4065	371.3	–	Q	417 (Attch. SAAA)	464
B1794	X74	–	414.3	Q	N/A	464
B17115	X55	–	396**	Q	N/A	464
B1746	MO1400-25A	402.7	–	Q	425 (Attch. SAAB)	

* Based on these loads are started prior to Load Block-1 (Attachment SAAA)

** Required Run voltage based on PDC 91-59A

CALCULATION SHEET

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SUBJECT: 23KV OFFSITE SOURCE LOAD FLOW STUDY

SR ☐
NSR ☐

TABLE 4 PAGE 5

LOCA WITH A5 BUS
AND SWING BUS B6

LOAD BKR#	EQUIPMENT I.D	REQUIRED MCC VOLTAGE (V)		Q/NQ	AVAILABLE VOLT. START	AVAILABLE VOLT. RUN
		START	RUN			
A503	P203A	3328*	3744*	Q	3605 (AHch. 5AAB)	3960 (AHch. AAAC)
A506	P203C	3328*	3744*	Q	3582 (AHch. 5AAC)	3960 (AHch. AAAC)
A507	P215A	3328*	3744*	Q	3614 (AHch. 5AAA)	3960 (AHch. AAAC)
B106	P110A	368*	414*	NQ	—	456 (AHch. AAAC)
B606	G23	368*	414*	NQ	—	459 (AHch. AAAC)

* ASSUMED 80% START AND 90% RUN

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REV___DATE_______

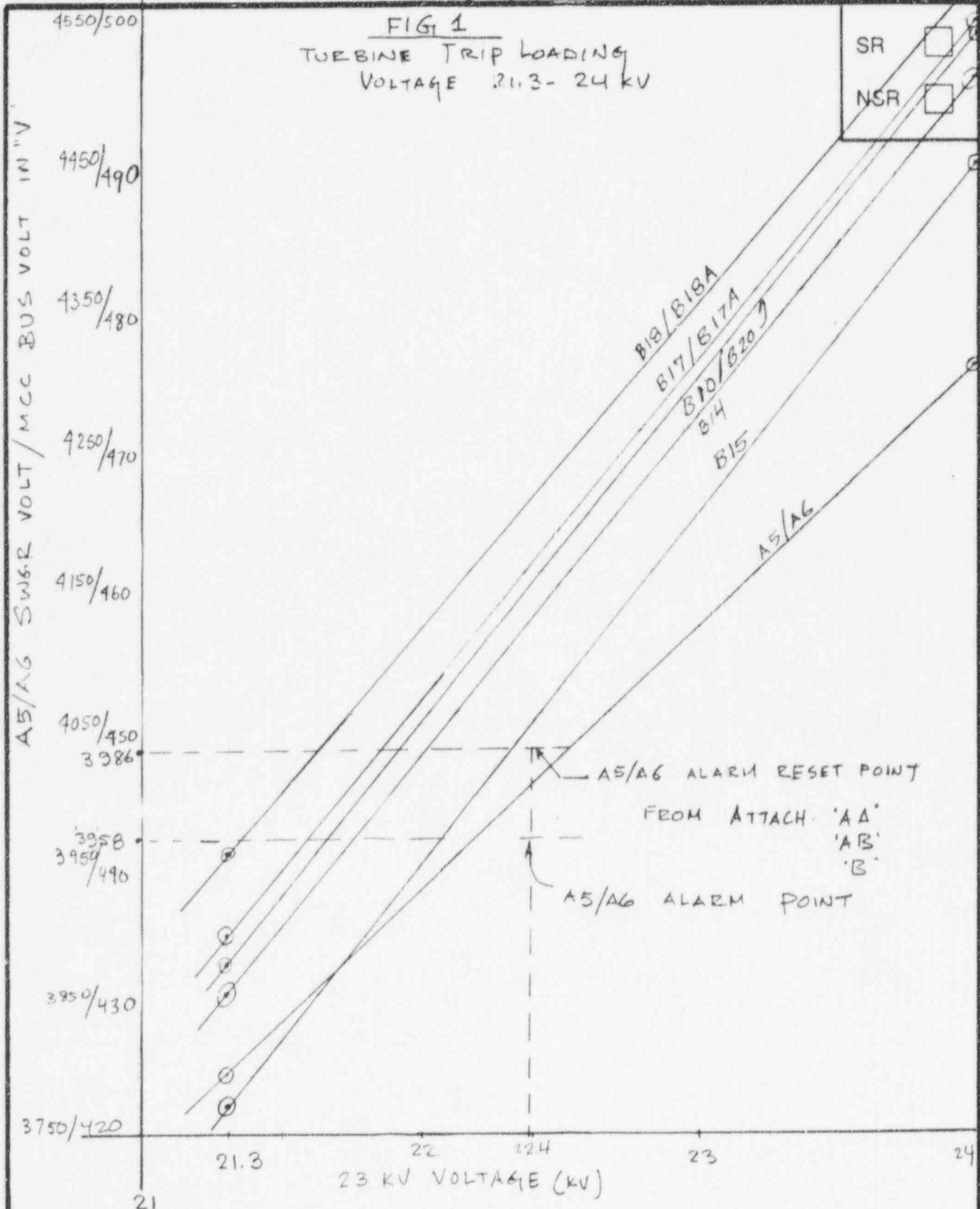
CALCULATION SHEET

BOSTON EDISON

CAPITAL AUTHORIZATION NO.__________
PREPARED BY [initials] DATE 8/23/95
CHECKED BY__________ DATE______
APPVD BY__________ DATE______
SHEET 49 OF 58

SUBJECT: 23KV OFFSITE SOURCE LOAD FLOW STUDY

FIG 1
TURBINE TRIP LOADING
VOLTAGE 21.3 - 24 KV



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☒ FINAL PS-161, REV. 0
REV___DATE_______

CALCULATION SHEET

BOSTON EDISON

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APPVD BY________ DATE________

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SUBJECT: 23 KV OFFSITE SOURCE VOLTAGE LOAD FLOW STUDY

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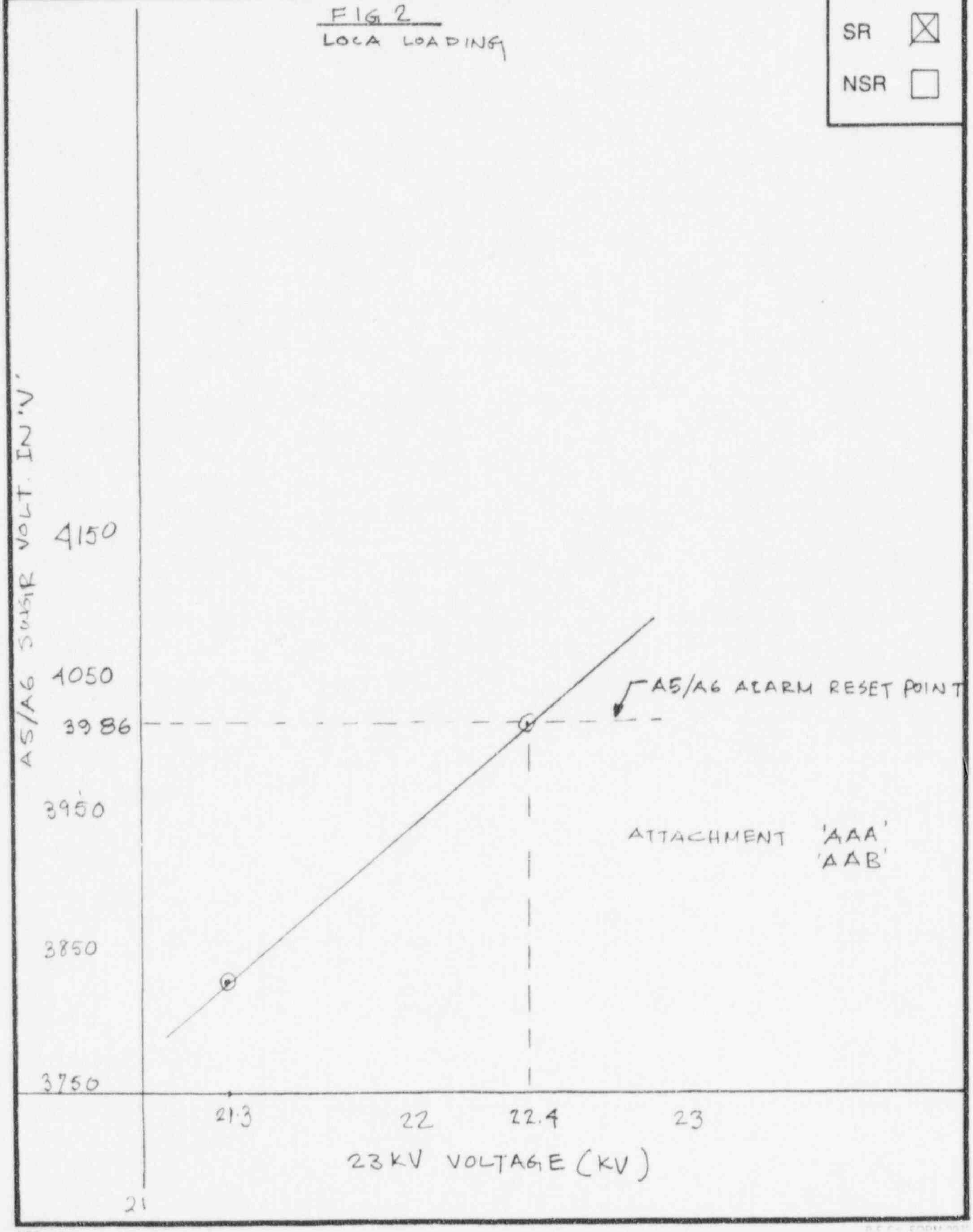
FIG 2

LOCA LOADING



6. **References**

a. Calculation PS64, Rev. 0
b. Calculation PS65, Rev. 0
c. Calculation PS65A, Rev. 0
d. Drawing E1 Sh. 1, Rev. E15
e. Drawing E8, Rev. E16
f. Drawing E9, Rev. E39
g. Drawing E10, Rev. E29
h. National Electric Code - 1987
i. PNPS procedure 2.4.144
j. Calculation PS113, Rev.0
k. Drawing SE155 Sh.2, Rev.E44
l. GE LOCA Analysis, NEDC-31852P
m. FSAR sections 10.5 and 10.7

7. **Attachments**

Attachment A - BECo. Memorandum from Mr. J. F. Gurkin to Mr. J. Pawlak, dated September 16, 1988.

Attachment B - "Turbine Trip steady state load 23 kv source voltage 22.4"

Attachment C - DAPPER run "Turbine Trip Motor Start at B15 - 23 kv source voltage 22.4"

Attachment D - DAPPER run "Turbine Trip Motor Start at B14 - 23 kv source voltage 22.4"

Attachment E - DAPPER run "Turbine Trip Motor Start at B17- 23 kv source voltage 22.4"

Attachment F - DAPPER run "Turbine Trip Motor Start at B18 - 23 kv source voltage 22.4"

Attachment G - "Turbine Trip Motor Start at B20- 23 kv source voltage 22.4"

Attachment H - "Turbine Trip Motor Start at B10 - 23 kv source voltage 22.4"

Attachment AA - Turbine Trip Steady State Load - 23 kv source voltage 21.3"

Attachment AB - "Turbine Trip Steady State Load - 23 kv source voltage 24.0"

Attachment AC - "Turbine Trip Motor Start At B15 - 23 kv source voltage 22.2"

Attachment AD - "Turbine Trip Motor Start at B14 - 23 kv source voltage 22.2"

Attachment AE - "Turbine Trip Motor Start At B17-23 kv source voltage 22.2"

Attachment AF - "Turbine Trip Motor Start At B18 - 23 kv source voltage 22.2"

Attachment AG- "Turbine Trip Motor Start at B20-23 kv source voltage 22.2"

Attachment AH - "Turbine Trip Motor Start At B10- 23 kv source voltage 22.2"

Attachment AAA - "LOCA w/load shed with A5 Bus Steady State - 23 kv source voltage 22.4"

Attachment AAB - "LOCA w/load shed with A5 Bus Steady State - 23 kv source voltage 21.3"

Attachment AAC -"Lotus spread sheet showing VEX210A acceptable at 391V"

Attachment AAD "LOCA w/load shed with A5 Bus SS w/MAN Loading-23kv source voltage 22.4"

Attachment AAE "LOCA w/load shed with A5 Bus P208B starting -23kv source voltage 22.4"

Attachment SAA - "LOCA w/load shed with A5 Bus Load block-1 starting source voltage 22.4"

Attachment SAB - "LOCA w/load shed with A5 Bus Load block 1 starting source voltage 21.3"

Attachment SAC - "LOCA w/load shed with A5 Bus Load block-2 starting source voltage 22.4"

Attachment SAD - "LOCA w/load shed with A5 Bus Load block-2 starting source voltage 21.3"

Attachment SAE - "LOCA w/load shed with A5 Bus P203C starting source voltage 21.3"

Attachment SAF - "LOCA w/load shed with A5 bus P203C starting source voltage 22.4"

Attachment SAG - "LOCA w/load shed with A5 Bus P208A starting source voltage 22.4"

Attachment SAH - "LOCA w/load shed with A5 Bus P208A starting source voltage 21.3"

Attachment SAI - "LOCA w/load shed with A5 Bus P202A starting source voltage 21.3"

Attachment SAJ - "LOCA w/load shed with A5 Bus. P202A starting source voltage, 22.4"

Attachment SAK - "LOCA w/load shed with Load block-1 starting source voltage. 23.8."

Attachment SAK-1A - "Lotus spread sheet showing VEX210A acceptable at 400V"

Attachment SAK-1B - "LOCA w/load shed with M01001-28A/28B starting source voltage 23.8."

Attachment SAL - "LOCA w/load shed with Load block-2 starting source voltage 23.8."

Attachment SAL-1A - "LOCA w/load shed with M01001-29B starting source voltage 23.8

Attachment SAM - "LOCA w/load shed with load P203C,P203D starting source voltage 23.8"

Attachment SAN - "LOCA w/load shed with P208A,P208D starting source voltage 23.8"

Attachment SAO - "LOCA w/load shed wi.h load P202A,P202D starting source voltage 23.8"

Attachment SAP - "LOCA w/load shed with both bus steady state source voltage 23.8"

Attachment SAQ - "LOCA w/load shed with P208B,P208E starting source voltage 23.8"

Attachment SAR - "LOCA w/load shed with both bus steady state source voltage 23.8"

Attachment AAAA - "LOCA w/load shed with A5 bus steady state source voltage 22.4"

Attachment AAAB - "LOCA w/load shed with A5 bus P208B starting source voltage 22.4"

Attachment AAAC - "LOCA w/load shed with A5 bus ss w/man load source voltage 22.4"

Attachment SAAA - "LOCA w/load shed with A5 bus load block-1 starting source voltage 22.4"

Attachment SAAB - "LOCA w/load shed with A5 bus load block-2 starting source voltage 22.4"

Attachment SAAC - "LOCA w/load shed with A5 bus load P203C starting source voltage 22.4

Attachment SAAD - "LOCA w/load shed with A5 bus load P208A starting source voltage 22.4"

Attachment SAAE - "LOCA w/load shed with A5 bus load P202A starting source voltage 22.4"

RType A9.02

PRELIMINARY EVALUATION CHECKLIST

1. IDENTIFICATION: Document Number PS-161 Revision 0

Description 23KV OFFSITE SOURCE LOAD FLOW STUDY

2. CLASSIFICATION:

☒ Yes ☐ No a. Does the proposed change involve Q listed equipment?

☐ Yes ☒ No b. For a new procedure, Temporary Procedure, or major revision; does the Procedure contain procedural steps or requirements in the FSAR?

If yes, identify FSAR sections.

☐ Yes ☒ No c. Is this a new procedure or Temporary Procedure that is Fire Protection Program related or a major revision that makes an existing procedure Fire Protection Program related?

3. PRELIMINARY EVALUATION:

☐ Yes ☒ No a. Would this modify plant characteristics or procedural steps described in the FSAR? If yes, identify section:

☐ Yes ☒ No b. Does this affect the design of systems, structures, or components described in the FSAR?

☐ Yes ☒ No c. Does this affect the function of systems, structures, or components described in FSAR?

☐ Yes ☒ No d. Does this affect the method of performing the function of systems, structures, or components described in FSAR?

☐ Yes ☒ No e. Does this indirectly affect the capability of safety related systems, structures, or components described in the FSAR to perform their functions?

☐ Yes ☒ No f. Does this create a new test not described in the FSAR that could affect plant safety?

EXHIBIT 4
Sheet 2 of 2

PRELIMINARY EVALUATION CHECKLIST (Continued)

☐ Yes ☒ No g. Would this change assumptions used in the accident analyses described in FSAR Chapter 14? If yes, identify sections:

____

☐ Yes ☒ No h. Does this change affect the ability of a system required to achieve and maintain safe shutdown in the event of a fire?

☐ Yes ☒ No i. Does this change affect a requirement of, or major commitment to, 10CFR50 Appendix R?

☐ Yes ☒ No j. Does this change affect a requirement of IE Circular 80-18 (for Radioactive Waste Systems)?

☐ Yes ☒ No k. Could this affect the function of systems or components required for compliance with the Limiting Conditions for Operation in the Technical Specifications?

☐ Yes ☒ No l. In the judgment of the evaluator, is a Safety Evaluation required?

If the answer to any question in Part 3 is "Yes", then a Safety Evaluation is required prior to implementation. Check the appropriate block and provide any explanatory comments below:

____

____

____

4. SAFETY EVALUATION REQUIRED? ☐ Yes ☒ No

5. PREPARED BY: Swapan Das / Sr. Electrical Engg Date 8/7/95
Title

APPROVED BY: Bruce Chun / Division Manager Date 9/8/95
Title

Calculation - Independent Verification Statement Record

Calculation # PS161, Revision # 0 has been independently verified by the following method(s), as noted below:

Mark each item yes, no or not applicable (N/A) and initial each item checked by you.

Design Review ☒ including verification that:

- LAH • Yes Design inputs were correctly selected and included in the calculation.
- LAH • Yes Assumptions are adequately described and are reasonable.
- LAH • N/A Input or assumptions requiring confirmation are identified, and if any exist, the calculation has been identified as "Preliminary" and a "Finalization Due Date" has been specified.
- LAH • Yes Design requirements from applicable codes, standards and regulatory documents are identified and reflected in the design.
- LAH • Yes Applicable construction and operating experience was considered in the design.
- LAH • Yes The calculation number has been properly obtained and entered.
- LAH • Yes An appropriate design method or computer code was used.
- LAH • Yes* A mathematical check has been performed.
- LAH • Yes The output is reasonable compared to the input.

* Where applicable, computer program (DAPPER) has been previously qualified and therefore results of DAPPER runs are not checked

Alternate Calculation ☐ including verification of asterisked items noted above. The alternate calculation (pages) is attached. N/A

Qualification Testing ☐ for design feature   including verification of asterisked items noted above and the following: N/A

- The test was performed in accordance with written test procedures.
- Most adverse design conditions were used in the test.
- Scaling laws were established and verified and error analyses were performed, if applicable.
- Test acceptance criteria were clearly related to the design calculation.
- Test results (documented in   ) were reviewed by the calculation Preparer or other cognizant engineer.

Independent Reviewer Comments: see p. 2

/S/ L. A. Hansen   9/8/95
Independent Reviewer /Date

Preparer concurrence with findings and comment resolution   /S/ Swapan Das   9/8/95
Preparer or Other Cognizant Engineer

Note: Exhibit 3.06-B (Sheet 3 of 3) may to used for additional comments by IV as a part of the Independent Verification for calculations.

Calculation Independent Verification Statement Record (Cont'd) - Calc. PS161 Rev. 0

- All previous comments have been resolved and the calculation text has been revised accordingly.
- Errors found in the input data were corrected and new DAPPER runs were performed.
- In some instances the values shown in Tables 1,2 and 3 did not match the output of the DAPPER runs. These tables have been revised to accurately reflect the results of the DAPPER runs.
- Figure 1 is for the Turbine Trip case only, Figure 2 needed to be created to reflect the LOCA with load shed case.
- There are differences in the appearance of the DAPPER printouts between this calculation and PS65A. These differences do not impact the results of the calculation, they are only differences in appearance.
- The DAPPER outputs contain several "Isolated Busses". These isolated busses are created when the feeder cable to the bus/MCC is taken out of service (to model the scenarios in this calculation) but the feeder from the MCC to the load is left in service. In order to prevent these loads from showing up as "isolated busses", the feeder from the MCC to the load should also be taken out of service. However, this would be time-consuming and would not change the results of the calculation, only the appearance of the calculation.