Kovach

ATTACHMENT 1
Design Analysis Major Revision Cover Sheet
Page 1 of 1

Design Analysis (Major Revision)			**Last Page No.** 14.0-8 and R81
Analysis No.:	9389-46-19-1	**Revision:** 003	
Title:	Diesel Generator 3 Loading Under Design Bases Accident Condition		
EC/ECR No.:	EC 364066	**Revision:** 000	

		Components(s)	
Station(s):	Dresden	Various	
Unit No.:	3		
Discipline:	E		
Description Code/Keyword:	E15		
Safety/QA Class:	SR		
System Code:	66		
Structure:	N/A		

CONTROLLED DOCUMENT REFERENCES

Document No.	From/To	Document No.	From/To
See Section XIV			

Is this Design Analysis Safeguards Information? Yes ☐ No ☒ If yes, see SY-AA-101-106

Does this Design Analysis Contain Unverified Assumptions? Yes ☐ No ☒ If yes, ATI/AR#

This Design Analysis SUPERSEDES: N/A in its entirety

Description of Revision (list affected pages for partials):
See Page 1.0-3 for a description of this revision and a list of affected pages.

	Print Name	Sign Name	Date
Preparer	Scott Shephard	[signature]	4/4/07

Method of Review **Detailed Review** ☒ **Alternate Calculations (attached)** ☐ **Testing** ☐

	Print Name	Sign Name	Date
Reviewer	Glenn McCarthy	[signature]	4-4-2007

Review Notes: Independent Review ☒ Peer Review ☐

(For External Analyses Only)

	Print Name	Sign Name	Date
External Approver	Richard H. Low	[signature]	4-4-2007
Exelon Reviewer	J.G. Kovach	[signature]	04/04/07

Independent 3rd Party Review Required? Yes ☐ No ☒

	Print Name	Sign Name	Date
Exelon Reviewer	Louis Mallavarapu	[signature]	4/5/07

DIVISION: EPED FILE: 15B SYSTEM CODE: 6600

NOTE : FOR THE PURPOSE OF MICROFILMING THE PROJ. NO. FOR THE ENTIRE CALC. IS "9389-46"

I. REVISION SUMMARY AND REVIEW METHOD

A. Revision 0

Revision 0, Initial issue, all pages.

This calculation supersedes the Calculation for Diesel-Generator Loading Under Design Basis Accident Condition , Calculation Number 7317-33-19-1 . The major differences between Calculation 7317-33-19-1 and this calculation are as follows:

1) Dresden Diesel Generator (DG) surveillance test strip charts (Reference 23) show that the first LPCI pump starts almost 3.5 seconds after the closure of the DG output breaker. This is due to the under voltage (UV) relay disk resetting time. This revision shows that the 480V auxiliaries start as soon as the DG output breaker closes to the bus and the first LPCI pump starts approximately 3.5 seconds after the closure of the DG output breaker during Loss Of Offsite Power (LOOP) concurrent with Loss Of Coolant Accident (LOCA).

2) Created new ELMS-AC PLUS files for the DG for Unit 3 based on the latest base ELMS modified file D3A4.M21, including all modifications included in Revisions 0 through 14 of Calculation 7317-43-19-2 for Unit 3. Utilization of the ELMS-AC PLUS program in this calculation is to maintain the loading data base and totaling the running KVA for each step.

3) Additional loading changes were made due to DITs DR-EPED-0863-00, which revised lighting loads, and DR-EAD-0001-00, which revised the model for UPS and Battery Chargers. For non-operating loads in base ELMS-AC file, running horsepower was taken as rated horsepower for valves and 90% of rated horsepower for pumps, unless specific running horsepower data for the load existed.

4) Created Table 4 for totaling 480V loads starting KW/KVAR for determining starting voltage dip from the DG Dead Load Pickup Curve.

I. Revision Summary and Review Method (Cont)

Revision 1

In this revision, the following pages were revised:

1.0-1, 1.0-3, 2.0-1, 2.0-2, 2.0-3, 4.0-6, 7.0-1, 10.0-1 through 10.0-8, 11.0-1, 13.0-1, 14.0-1, 14.0-5, 14.0-7, C2, C3, C4, C6, D2, E1, E2, J4, J5, J6, J9, J10, J11

The following pages were added:

1.0-2, 2.0-4, Section 10.1 (pages 10.1-0 through 10.1-26), Section 15.0 (Pages 15.0-0 through 15.0-32), ELMS AC Reports pages F101 through F224, I3.

The following pages were deleted:

10.0-9 through 10.0-24, B15

For completeness, all text pages are being issued to correct various typographical errors throughout the text, however, revision bars were not used for these types of changes.

This revision incorporates load parameter changes determined in Revision 18 of Calculation 7317-43-19-2 (Ref. 26) into the ELMS-AC data file models used in this calculation to model generator operation. The most critical of these changes is the CCSW Pump BHP change from 450 hp to 575 hp. These load parameter changes normalize the DG data files so that file update can be made easily and accurately with the comparison program ELMSCOMP. In addition to the load/file changes, the calculation portion of the text dealing with determining starting KVA and motor start time for the 4.16 KV motors has been encoded into the MATHCAD program. This will simplify any future changes, and decrease the possibility of calculation error. ELMSCOMP reports showing data transfers and so forth will be added in a new attachment.

Please note: The BHP of CCSW Pump Motors is based on the nameplate rating of 500 hp with a 575 hp @ 90°C Rise. This assumption of CCSW Pump Motor BHP loading requires further verification.

CALCULATION REVISION SUMMARY

Revision Summary and Review Method (cont'd)

Revision 2

EC 364066 was created for Operability Evaluation # 05-005. This operability evaluation concluded that the diesel generator load calculation trips one Low Pressure Coolant Injection (LPCI) pump before the first CCSW pump is loaded onto the diesel, at which point the diesel is supplying one Core Spray pump, one LPCI and one CCSW pump. In contrast, station procedure DGA-12, which implements the manual load additions for LOCA/LOOP scenarios, instruct operators to load the first CCSW pump without tripping a LPCI pump. The procedure directs removal of a LPCI pump from the EDG only before loading of the second CCSW pump. In accordance with Corrective Action #2 of the Operability Evaluation, Calculations 9389-46-19-1,2,3 "Diesel Generator 3,2,2/3 Loading Under Design Basis Accident Condition" require revision to document the capability of the EDGs to support the start of the first CCSW pump without first tripping a LPCI pump.

This revision incorporates the changes resulting from EC 364066, Rev. 000. In addition, this revision replaces the ELMS-AC portions of the calculation with ETAP PowersStation (ETAP). All outstanding minor revisions have been incorporated. The parameters for valve 3-1501-22A/B were also revised in the ETAP model to reflect the latest installed motor. Section 10 calculations previously performed using MathCad were replaced with MS Excel spreadsheets.

In this revision the following pages were revised:

2.0-4, H2, H3, R18-R21, R61

In this revision the following pages were replaced:

1.0-3, 2.0-1, 2.0-2, 3.0-1, 4.0-1, 4.0-6, 5.0-1, 7.0-1, 8.0-2, 8.0-5, 9.0-1 – 9.0-5, 10.0-1, 10.0-3 – 10.0-8, 10.1-0 – 10.1-26, 11.0-1, 14.0-1, 14.0-6, 14.0-7, C1-C5, F1-F224 replaced by F1-F118, G1 replace by G1-G63

In this revision the following pages were added:

Design Analysis Cover Sheet (1.0-0), 2.0-5, R62-R76

In this revision the following pages were deleted:

15.0-0 – 15.0-32, Attachment I

Revision 3

This revision incorporates various changes to the EDG loading. Major changes include CS, LPCI and CCSW BHP values. Other changes include decreasing the LOCA bhp value for the RPS MG set and incorporating the DG cooling water pump replacement. New study cases and loading categories were generated in ETAP to model loading of the 4kV pumps after 10 minutes into the event. The scope was expanded to include a comparison of the DG loading at 102% of rated frequency to the 2000hr rating of the diesel. This revision incorporates changes associated with References XIV.64 through 72.

In this revision the following pages were revised: R3

A5, B7, E2, R76

In this revision the following pages were replaced:

1.0-0, 1.0-3, 2.0-1, 2.0-2, 2.0-5, 3.0-1, 3.0-2, 4.0-6, 5.0-1, 7.0-1, 9.0-1 – 9.0-3, 9.0-5, 10.0-1, 10.0-8, 10.1-1, 10.1-3 – 10.1-6, 10.1-8, 10.1-10 – 10.1-13, 10.1-15, 10.1-17 – 10.1-18, 10.1-24 – 10.1-26, 11.0-1, 12.1-0, 14.0-1, 14.0-7, C1, Attachments F and G.

In this revision the following pages were added:

4.0-7, 14.0-8, R77-R81

CALCULATION TABLE OF CONTENTS

CALC NO.: 9389-46-19-1 REV NO: 003 PAGE NO. 2.0-1

II TABLE OF CONTENTS / FILE DESCRIPTION

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VI. ENGINEERING JUDGEMENTS	6.0-1	
VII. ACCEPTANCE CRITERIA	7.0-1	
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IX. METHODOLOGY	9.0-1 - 9.0-7	
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XI. COMPARISON OF RESULTS WITH ACCEPTANCE CRITERIA	11.0-1 - 11.0-2	
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SECTION		PAGE NO.:	SUB PAGE NO.:
Attachments	**Description**		
A	Table 1 – Automatically Turn ON and OFF Devices Under the Design Basis Accident Condition when DG3 is powering the Unit 3 Division II loads.	A1-A11	
B	Table 2 – The Affects of AC Voltage Dip on control circuits of Dresden Unit 3, Division II when large motor starts.	B1-B13	
C	Table 4 – Starting KW and KVAR for all 480V Loads at each Step when DG 3 is powering Unit 3, Division II.	C1-C5	
D	Figure 1 – Single Line Diagram when DG 3 Powers SWGR 34-1	D1-D2	
E	Figure 2 – Time vs. Load Graph when DG 3 Powers SWGR 34-1	E1-E2	
F	DG Unit 3 Division II ETAP Output Reports – Nominal Voltage	F1-F115	
G	DG Unit 3 Division II ETAP Output Reports – Reduced Voltage	G1-G58	R3
H	Flow Chart 1 – Method of Determining Shed and Automatically Started Loads	H1-H3	
J	Unit 3 ELMS-AC Plus Data Forms	J1-J12	
R	Reference Pages	R1-R81	R3

Note: Table 3 has been omitted.

File Descriptions

Revision 0

File Name	Date	Time	File Description
D3A4DGD.G00	12/29/94	1413	General File - Original Issue
D3A4DGDR.G00	12/29/94	1418	General File - Original Issue - Reduced Voltage
D3A4DGD.I00	12/30/94	1209	Initial File - Original Issue
D3A4DGDR.I00	12/30/94	1238	Initial File - Original Issue - Reduced Voltage
D3TB1DGD.XLS	1/6/95	1505	Table 1 - Excel File
D3TB2DGDXLS	1/6/95	1512	Table 2 - Excel File
D3TB4DGDXLS	1/6/95	1020	Table 4 - Excel File
D3GRFDGD.XLS	1/6/95	1015	Time vs. Load Graph
DRESDGD3.00	1/5/95	1038	Flow Chart 1
D3SINGLE.PPT	12/28/94	1138	Sketch of Unit 3 safety system - Powerpoint
DRESDGD.WP	1/6/95		Calculation Text - Wordperfect

File Description (cont'd)

Revision 1

File Name	Date	Time	File Description
D3A4DGD.G01	10/17/96	03:22:20pm	General File - Data upgrade, see Revision Summary for Details
D3A4DGDR.G01	10/17/96	04:06:04pm	General File - Reduced Voltage, see Revision Summary for Details
D3A4DGD.I01	09/10/96	10:36:52pm	Initial File - Data upgrade, see Revision Summary for Details
D3A4DGDR.I01	10/13/96	03:35:48pm	Initial File - Reduced Voltage, see Revision Summary for Details
DG3GRAF1.XLS	10/17/96	2:45:06pm	Time Vs Load Graph in Excel
D3TBL4R1.XLS	10/18/96	2:03:00pm	Table - Excel File
DG3SLINE.PPT	09/19/96	6:58:50pm	Sketch of Unit 3 safety system - Powerpoint
DG3MCAD.MCD	10/18/96	10:33:48pm	Mathcad File for Section 10.1
DREDG3R1.WP	10/18/96		Calculation Text - Wordperfect

CALCULATION PAGE

File Descriptions (cont'd)

Revision 2

File Name	Size	Date	Time	File Description
9389-46-19-1 Rev. 2.doc	496640 bytes	8/9/06	8:58:04am	Text document
9389-46-19-1 Rev. 2 (section 10).xls	532992 bytes	8/03/06	10:16:22am	Section 10.1
9389-46-19-1 Rev. 2 (table 4).xls	48128 bytes	4/24/06	1:10:29pm	Table 4
DRE_Unit3_0004.mdb	18,509,824 bytes	8/03/06	1:41:09am	ETAP database
DRE_Unit3_0004.macros.xml	10568 bytes	8/03/06	11:12:31am	ETAP macros
DRE_Unit3_0004.scenarios.xml	12388 bytes	2/28/06	11:18:23am	ETAP Scenarios
DRE_Unit3_0004.oti	16384 bytes	8/03/06	1:41:08am	ETAP "OTI" file

Revision 3

File Name	Size	Date	Time	File Description
9389-46-19-1 Rev. 3.doc	502,748 bytes	4/4/07	7:42:35am	Text document
9389-46-19-1 Rev. 3 (section 10).xls	526848 bytes	3/2/07	8:50:48am	Section 10.1
9389-46-19-1 Rev. 3 (table 4).xls	48128 bytes	3/1/07	7:52:12pm	Table 4
DRE_Unit3_0005.mdb	19,559,360 bytes	3/29/07	8:17:29am	ETAP database
DRE_Unit3_0005.macros.xml	11293 bytes	3/21/07	2:47:02pm	ETAP macros
DRE_Unit3_0005.scenarios.xml	15500 bytes	2/26/07	7:50:53pm	ETAP Scenarios
DRE_Unit3_0005.oti	16384 bytes	3/29/07	8:32:57pm	ETAP "OTI" file

R3

III PURPOSE/SCOPE

A. Purpose

The purpose of this calculation is to ensure that the Dresden Diesel Generator has sufficient capacity to support the required loading during the maximum loading profile as determined in the Calculation Results section.

The purpose of this calculation includes the following:

1) Determine automatically actuated devices and their starting KVA at each step for the ac electrical load when the DG is powering the safety related buses.

2) Develop a Time versus Load profile for the DG when the DG is powering the safety related buses.

3) Compare the maximum loading in ETAP for the DG load profile against the capacity of the DG at each step.

4) Determine the starting voltage dip and one second recovery voltage at the DG terminals for initial loading and each 4000V motor starting step.

5) Evaluate the control circuits during the starting transient voltage dip.

6) Evaluate the protective device responses to ensure they do not inadvertently actuate or dropout during the starting transient voltage dip.

7) Evaluate the travel time of MOVs to ensure they are not unacceptably lengthened by the starting transient voltage dips.

8) Determine the starting duration of the automatically starting 4kV pump motors.

9) Ensure the loading on the EDG is within the 2000hr rating should the frequency on the machine increase to its maximum allowable value. R3

10) Determine the minimum power factor for the long term loading on the EDG.

B. Scope

The scope of this calculation is limited to determining the capability of the DG to start the sequential load (with or without the presence of the previous running load as applicable), without degrading the safe operating limits of the DG or the powered equipment & services. The minimum voltage recovery after 1 second following each sequential start will be taken from the DG dead load pickup characteristics and compared to the minimum recovery required to successfully start the motors and continue operation of all services.

PURPOSE/SCOPE (cont'd)

The total running load of the DG will also be compared against the rating of the DG at the selected loading step to confirm the loading is within the DG capacity. The scope will also include an evaluation based on review of identified drawings to determine the effects on control functionality during the transient voltage dips.

The EDG has a minimum and maximum allowable frequency range. Operating the EDG at a frequency above its nominal value results in additional loading on the EDG. The percent increase in load due to the increase in frequency will be quantified and compared to the EDG 2000 hr rating to ensure the limits of the EDG are not exceeded. The minimum power factor for EDG long term loading will be quantified. R3

The scope will also include an evaluation of protective devices which are subject to transient voltage dips.

The scope does not include loads fed through the cross-tie breakers between Unit 2 and 3 Buses of the same Division. Although DGA-12, Rev. 16 allows its use, loading is performed manually at Operations' discretion and is verified to be within allowable limits during manual loading. Therefore, this operation is not included in the scope of this calculation.

IV INPUT DATA

The input data extracted from the references is summarized below:

A. Abbreviations

ADS	Automatic Depressurization System
AO	Air Operated
CC	Containment Cooling
CCSW	Containment Cooling Service Water
Clg	Cooling
Clnup	Clean up
Cnmt	Containment
Comp	Compressor
Compt	Compartment
Diff	Differential
DIT	Design Information Transmittal
DG	Diesel Generator
DW	Drywell
EFF	Efficiency
EHC	Electro Hydraulic Control
ELMS	Electrical Load Monitoring System
ETAP	Electrical Transient Analyzer Program R2
Emerg	Emergency

Input Data (cont'd):

ECCS	-	Emergency Core Cooling System
FSAR	-	Final Safety Analysis System
gpm	-	Gallons Per Minute
GE	-	General Electric
Gen	-	Generator
Hndlg	-	Handling
HPCI	-	High Pressure Coolant Injection
HVAC	-	Heating Ventilation & Air Conditioning
Inbd	-	Inboard
Inst	-	Instrument
Isoln	-	Isolation
LOCA	-	Loss Of Coolant Accident
LOOP	-	Loss Of Offsite Power
LPCI	-	Low Pressure Coolant Injection
LRC	-	Locked Rotor Current
Mon	-	Monitoring
MCC	-	Motor Control Center
M-G	-	Motor Generator
MOV	-	Motor Operated Valve

Input Data (cont'd):

Outbd	-	Outboard
PF	-	Power Factor
Press	-	Pressure
Prot	-	Protection
Recirc	-	Recirculation
Rm	-	Room
Rx Bldg	-	Reactor Building
SBGT	-	Standby Gas Treatment System
Ser	-	Service
SWGR	-	Switchgear
Stm	-	Steam
Suct	-	Suction
TB	-	Turbine Building
Turb	-	Turbine
UPS	-	Uninterruptible Power Supply
Vlv	-	Valve
Wtr	-	Water
Xfmr	-	Transformer

Input Data (cont'd):

B. Emergency Diesel Generator Nameplate data for the Dresden Unit 3 is as follows (Reference 24):

Manufacturer	Electro - Motive Division (GM)
Model	A - 20 -C1
Serial No.	68 - E1 - 1013
Volts	2400 / 4160 v
Currents	782 / 452 Amps
Phase	3
Power Factor	0.8
RPM	900
Frequency	60
KVA	3250
Temperature Rise	85°C Stator - Therm 60°C Rotor - Res
KVA Peak Rating	3575 KVA For 2000 HR / YR
Temperature Rise	105°C Stator - Therm 70°C Rotor - Res
Insulation Class	Stator - H Rotor - F
Excitation	Volts - 144 Amps - 100
Diesel Engine Manufacturer	Electro - Motive Division (GM)
Model No.	S20E4GW
Serial No.	1159

Input Data (cont'd)

C. Dead Load Pickup Capability (Locked Rotor Current) - Generator Reactive Load Vs % Voltage Graph #SC - 5056 by Electro - Motive Division (EMD) [Reference 13].

This reference describes the dead load pickup capability of the MP45 Generating Unit. The curve indicates that even under locked rotor conditions an MP45, 2750 kw generating unit will recover to 70% of nominal voltage in 1 second when a load with 12,500 KVA inrush at rated voltage is applied. This indicates that the full range of the curve is usable. Also, page 8 of the purchase specification K-2183 (Reference 12) requires that the Generator be capable of starting a 1250 hp motor (starting current equal to 6 times full load current). The vertical line labelled as "Inherent capability" on the Dead Load Pickup curve is not applicable for the Dresden Diesel Generators because they have a boost system associated with the exciter. Per Reference 40 of this calculation, Graph #SC-5056 is applicable for Dresden Diesel Generators.

D. Speed Torque Current Curve (297HA945-2) for Core Spray Pump by GE (Reference 14).

E. Speed Torque Current Curve (#257HA264) for LPCI Pump by GE (Reference 15).

F. Dresden Re-baselined Updated FSAR Table 8.3-3, DG loading due to loss of offsite ac power (Reference 30)

G. Table 1: Automatically ON and OFF devices during LOOP Concurrent with LOCA when the DG 3 is powering the Unit 3 Division II loads (Attachment A)

H. Table 2: Affects of Voltage Dip on the Control Circuits during the Start of Each Large Motor when DG 3 is powering Unit 3, Division II loads (Attachment B).

I. Table 4: KW/KVAR/ KVA loading tables for total and individual starting load at each step when DG 3 is powering Unit 3, Division II loads (Attachment C).

J. CECO letter dated March 11, 1988 from Bruce B. Palagi to W. Fancher / M. Reed regarding the post LOCA ECCS Equipment requirements for the Dresden and Quad Cities Station (Reference 4, Page R1).

K. Dresden Re-baselined Updated FSAR Figure 8.3-6, DG loading under accident and during loss of offsite ac power (Reference 31).

L. Dresden Appendix R Table 3.1-1, DG loading for safe shutdown (Reference 32).

Input Data (cont'd)

N. Flow Chart No. 1, showing the source of data and establishing which load is ON when the DG is powering the safety buses during LOOP concurrent with LOCA (Attachment H)

O. ETAP Loadflow summary for comparing loading and calculated KVA input of running loads at each step to DG capacity for Unit 3 (Attachments F & G).

P. S&L Standard ESA-102, Revision 04-14-93 - Electrical and Physical Characteristics of Class B Electrical Cables (Reference 11)

Q. S&L Standard ESC-165, Revision 11-03-92 - Power Plant Auxiliary Power System Design (Reference 41)

R. S&L Standard ESI-167, Revision 4-16-84, Instruction for Computer Programs (Reference 1)

S. S&L Standard ESC-193, Revision 9-2-86, Page 5 for Determining Motor Starting Power Factor (Reference 39)

T. S&L Standard ESA-104a, Revision 1-5-87, Current carrying Capabilities of copper Cables (Reference 10)

U. S&L Standard ESC-307, Revision 1-2-64, for checking voltage drop in starting AC motors (Reference 21)

V. S&L Standard ESI-253, Revision 12-6-91 Electrical Department instruction for preparation, review, and approval of electrical design calculations (Reference 20)

W. Unit 3 ETAP file from Calculation DRE04-0019, Rev. 000 and 000B (Reference 55). See Section 2.0 for latest ETAP file. R3

X. 125Vdc and 250Vdc Battery Charger, and 250Vdc UPS Models from Calculation 9189-18-19-4 used in ETAP (Reference 25 & 34)

Y. Single Line diagram showing the breaker position when the DG output breaker closes to 4-kV Bus 34-1 during LOOP concurrent with LOCA (Attachment D)

Z. Walkdown data for CCSW Pumps (Ref 26)

AA. S&L Calculation 9198-18-19-4, Rev. 0 provides Reactor Protection M-G set brake horsepower. (Ref 34)

AB. The maximum allowable time to start each LPCI Pump and Core Spray Pump is 5 seconds (Ref. 56)

AC. The BHP values for the CS, LPCI and CCSW pumps after 10 minutes into a LOCA event are provided below (Ref. 64, 65, 66).

Core Spray Pump 3B	881.9 hp
LPCI Pump 3C	640.7 hp
LPCI Pump 3D	609.0 hp
CCSW Pump 3C	575.0 hp with 1 pump running, 465 hp with both pumps running
CCSW Pump 3D	575.0 hp with 1 pump running, 465 hp with both pumps running

AD. The 3 EDG Cooling Water Pump has a BHP of 69.28kW with a power factor of 83.5. The efficiency, LRC and starting power factor are 100%, 400% and 31.5% respectively (Ref. 67 & 68) R3

AE. The RPS MG Sets have a BHP of 3.9kW when unloaded with a power factor of 12.2%. This is based on a 5% tolerance in the data acquisition equipment (Ref. 69)

AF. The HPCI Aux Coolant Pump is manually controlled and not operated during a LOCA (Ref. 70)

AG. Dresden Technical Specification Section 3.8.1.16 allows a +2% tolerance on the nominal 60HZ EDG frequency (Ref. 73)

AH. The continuous rating of the EDG is 2600kW at a 0.8 pf (Ref. 74)

AI. For centrifugal pumps, the break horsepower varies as the cube of the speed (Ref. 75)

V ASSUMPTIONS

1) MCC control transformers (approximately 150VA – 200VA each) generally have only a small portion of their rating as actual load and can be neglected.

2) The Diesel Fuel Oil Transfer Pump is shown in this calculation as operating as soon as voltage is available on the MCC bus, but this is not the actual case as the pump responds to low day tank level which is normally full prior to DG starting. This is conservative and compensates for Assumption 1.

3) Individual load on buses downstream of 480/120V transformer have not been discretely analyzed to determine transformer loading. This transformer load on the 480V bus is assumed to be the rating of the distribution transformer or an equivalent three-phase loading for single phase transformers, which is conservative.

4) When Locked Rotor Currents are not available, it is considered 6.25 times the full load current. This is from S&L Standard ESC-165 and is reasonable and conservative.

5) For large motors (>250HP), the starting power factor is considered to be 20%. This is typical for large HP motors and does not require verification.

6) The line break will occur on Reactor Recirc Line B. This will result in the highest load and subsequently lower voltage at MCC 38-7. Although MCC voltages are not evaluated by this calculation, it will allow potential use of this calculation s input to future evaluation. This is conservative and does not require further evaluation.

7) The load on the diesel generator is assumed to increase by 6% when the frequency of the machine is 2% above its nominal value. A majority of the load consists of large centrifugal pumps. The break horsepower of these pumps varies as the cube of the speed. Thus, a 2% increase in speed corresponds to a 6% increase in load (1.02^3) (Ref. 75). Note that these pumps will operate on a different point on the performance curve and the BHP may actually increase less than 6%. R3

8) For determining starting time for the large motors, the starting current is assumed to be constant throughout the evaluation. Although the speed torque curve shows a decrease in current with speed as is expected, using a constant current will simplify the starting time evaluation. Motor starting time would be somewhat less if the speed-current characteristics were included. This assumption of pump motor starting current is conservative and requires no further verification.

The above assumptions 1, 2, 3, 4, 5, 6, 7 and 8 do not require verification.

VI. ENGINEERING JUDGEMENT

1.) Based on engineering judgement an efficiency of 90% is to be used to convert the cumulative HP to an equivalent KW for Table 8.3-3 of the Dresden Re-baselined Updated FSAR, Revision 0. This is considered conservative because the majority of this load consists of 2-4kV motors. Also, this result is only to be used for a comparison.

2.) For the purposes of this calculation, a LOCA is defined as a large line break event. This is a bounding case, as in this event, the large AC powered ECCS-related loads will be required to operate in the first minutes of the event. In small and intermediate line break scenarios, there will be more time between the LOCA event initiation and the low pressure (i.e. AC) ECCS system initiation.

3) It is acknowledged that system parameters (i.e. low level, high pressure, etc.) for different ECCS and PCIS functions have distinctly different setpoints. For the purposes of this calculation, it will be assumed that these setpoints will have been reached prior to the EDG output breaker closure except as otherwise noted. This is conservative as it will result in the greatest amount of coincidental loading at time t=0- and time t=0+.

4) Based on the fact that large motors will cause larger voltage dips when started on the Diesel Generator, the manually initiated loads starting at t=10+ minutes will be assumed started as follows:

a) CCSW Pump D
b) CCSW Pump C

VII ACCEPTANCE CRITERIA

The following are used for the acceptance criteria:

1) Continuous loading of the Diesel Generator.

- The total running load of the DG must not exceed its peak rating of 3575kVA @ 0.8 pf (Ref. 24) or 2860 KW for 2000 hr/yr operation.

  Note: The load refinements performed under Revision 003 of this calculation showed that the running load is within the 2600 KW continuous rating of the DG. Should a future calculation revision show that the loading is greater than the 2600KW continuous rating; a 50.59 safety evaluation should be performed to assess the impact on the current Dresden design/licensing basis.

- The total running load of the DG must not exceed its nameplate rating of 3575 KVA @ 0.8 pf (Ref. 24) or 2860 kW for 2000 hr/yr operation when considering the maximum frequency tolerance. If the EDG is at 102% of its nominal frequency, the EDG load is expected to be 1.02^3 or 1.06 times larger since a centrifugal pump input BHP varies as the cube of the speed (Ref. 75) R3

- EDG Power Factor during Time Sequence Steps DG3_T=10+m, DG3_T=10++m, and DG3_T=CRHVAC must be ≥88% (Ref. 76 and 77)

  Note: Should a future calculation revision show that the criterion for reactive power during the above noted DG time sequence steps can no longer be met; a review should be performed to assess the impact on the current Dresden design/licensing basis.

2) Transient loading of the Diesel Generator.

Voltage recovery after 1 second following each start must be greater than or equal to 80% of the DG bus rated voltage (Ref. 12). This 80% voltage assures motor acceleration.

The transient voltage dip will not cause any significant adverse affects on control circuits.

The transient voltage dip will not cause any protective device to inadvertently actuate or dropout as appropriate.

The transient voltage dip will not cause the travel time of any MOV to be longer than allowable.

The starting durations of the automatically starting 4kV pump motors are less than or equal to the following times (see Section IV.AB):

Service	Allowable-Starting Time (sec.)
LPCI Pump 3C	5
LPCI Pump 3D	5
Core Spray Pump 3B	5

VIII. LOAD SEQUENCING OPERATION

A. Load Sequencing During LOOP/LOCA

By reviewing the Table 1 schematic drawings, it was determined that there are three automatic load starting steps, which start the two LPCI Pumps sequentially, followed by the Core Spray Pump. Also, there is another inherent step which delays the large pumps from starting by 3 seconds. This delay is due to the undervoltage relay recovery time, which is interlocked with the start time for the large pumps.

This calculation considers that all the devices auto start from an initiating signal (pressure, level, etc.) or from a common relay start at the same time (unless a timer is in the circuit). It considers all devices are in normal position as shown on the P&ID. It was found from discussion with ComEd Tech. Staff and the Control Room Operators that valves always remain in the position as shown on the design document.

For long term cooling, manual operation is required to start 2 Containment Cooling Service Water pumps and associated auxiliaries.

1) Automatic Initiation of DG during LOOP concurrent with LOCA

The DG will automatically start with any one of the signals below:

- 2 psig drywell pressure, or
- -59" Reactor water level, or
- Primary Under voltage on Bus 34-1, or
- Breaker from Bus 34 to Bus 34-1 opens, or
- Backup undervoltage on Bus 34-1 with a 7 second time delay under LOCA
- Backup undervoltage on Bus 34-1 with a 5 minutes time delay without a LOCA

Upon loss of all normal power sources, DG starts automatically and is ready for loading within 10 seconds (Reference 7, page 8.3-14). When the safety-related 4160V bus is de-energized, the DG automatically starts and the DG output breaker closes to energize the bus when the DG voltage and frequency are above the minimum required. Closure of the output breaker, interlocks ECCS loads from automatically reclosing to the emergency bus, and then the loads are started sequentially with their timers. This prevents overloading of the DG during the auto-starting sequence.

LOAD SEQUENCING OPERATION (cont'd)

2) Automatic Load Sequence Operation for LOOP with LOCA

- When the DG automatically starts and its output breaker closes to Switchgear 34-1, the diesel auxiliaries and certain MOVs start operating, and the UV relay (IAV 69B) starts its reset recovery timing.

- As soon as UV relay (IAV 69B) completes its reset, the first LPCI pump starts.

- 5 seconds after UV relay (IAV 69B) reset, the second LPCI pump starts. At the same time, associated valves and equipment with the LPCI pump start operating.

- 10 seconds after the UV relay (IAV 69B) reset, the Core Spray pump starts. At the same time, associated valves and equipment with the Core Spray pump start operating.

Automatically activated loads on the DG during LOOP concurrent with LOCA are identified in Table 1.

3) Manual actuation required for long term cooling

After 10 minutes of continued automatic operation of the LPCI Pumps and Core Spray system, the operator has to do the following actions to initiate long term cooling (see References 33 and 63):

- Appropriate loads on Bus 34 will be shed and locked out. R2

- At this point the operator can manually close the breaker to the switchgear bus and start one of the CC Service Water pumps, and also opens the CC Heat Exchanger Service Water Discharge Valve.

- Turn off one of the LPCI pumps R2

- After the first CCSW Pump is started and one of the LPCI pumps is shut off, the operator will start the second CCSW Pump and associated equipment (e.g. cooler fans).

B. Description of sequencing for various major systems with large loads

1) LPCI/CC - LPCI Mode

LPCI/CC

To prevent a failure of fuel cladding as a result of various postulated LOCAs for line break sizes ranging from those for which the core is adequately cooled by HPCI system alone, up to and including a DBA (Reference 6).

LPCI Mode

The LPCI mode of the LPCI/CC is to restore and maintain the water level in the reactor vessel to at least two-thirds of core height after a LOCA (Ref. 6).

i) Initiation of LPCI occurs at low-low water level (-59"), and low reactor pressure (<350 psig), or high drywell pressure (+2 psig). For the purposes of this calculation, it is assumed that LPCI loop selection and the <350 psig interlocks have occurred prior to DG Output breaker closure.

- CC Service Water pumps are tripped and interlocked off.
- The Heat Exchanger Bypass Valve 1501-11B receives an open signal and is interlocked open for 30 seconds and then remains open. Note: these valves will be required to close to obtain flow throughout LPCI Heat Exchanger; See Section VIII.B.3.iii.
- LPCI pump suction valves (1501-5C and 5D) - To prevent main system pump damage caused by overheating with no flow, these valves are normally open and remain open upon system initiation.
- Containment Cooling valves 1501-18B, 19B, 20B, 27B, 28B, and 38B are interlocked closed.
- With time delay, the Low Level/High Drywell Pressure signal closes the Recirculation Pump Discharge Valve 202-5A and 1501-22B, opens 1501-21A.
- LPCI Pump 3C will start immediately after UV relay resets.
- LPCI Pump 3D will start 5 seconds after UV relay resets.

- LPCI pumps minimum bypass valve (1501-13B) - To prevent the LPCI pumps from overheating at low flow rates, a minimum flow bypass line, which routes water from pump discharge to the suppression chamber is provided for each pump. A single valve for both LPCI pumps controls the minimum flow bypass line. The valve opens automatically upon sensing low flow in the discharge lines from the pump. The valve also auto-closes when flow is above the low flow setting.

2) Core Spray

The function of the Core Spray system is to provide the core with cooling water spray to maintain sufficient core cooling on a LOCA or other condition which causes low reactor water, enough to potentially uncover the core.

i) The core spray pump starts automatically on any of the following signal:

- High Drywell Pressure (2 psig) or,
- Low -Low reactor water level (-59") and low reactor pressure (<350 psig), or
- Low-Low reactor water level (-59") for 8.5 minutes.

ii) The following valves respond to initiation of core spray:

- Minimum Flow Bypass Valve 1402-38B - This valve is a N.O. valve which remains open to allow enough flow to be recirculated to the torus to prevent overheating of core spray pump when pumping against a closed discharge valve. When sufficient flow is sensed, it will close automatically
- Outboard Injection Valve 1402-24B - This valve is normally open and interlocks open automatically when reactor pressure is less than 350 psig.
- Inboard Injection Valve 1402-25B - This valve is normally closed, but will open automatically when reactor pressure is less than 350 psig.
- Test Bypass Valve 1402-4B - This is a normally closed valve and interlocks closed with Core Spray initiation.
- Core Spray Pump Suction Valve 1402-3B - This is a normally open valve and interlocks open with the initiation of Core Spray.

3) CC Service Water (CCSW) Pump

The CC Service Water pumps provide river water at a pressure of 20 psig over the LPCI water pressure for removing the heat from the LPCI heat exchanger. One CC Service Water pump is sized to assure sufficient cooling in the secondary cooling loop of the CC heat exchanger for LPCI operation, even though there are two CC Service Water pumps per heat exchanger. The pump flow required is 3500 gpm. Each CCSW pump has the flow rate of 3500gpm, so at this rate, one pump is enough for adequate cooling. However, the Dresden Station was licensed on the basis both CC Service Water pumps would be operating.

i) The CCSW pump trips when it senses UV, overcurrent, or a LPCI initiation signal on Bus 34 and will not auto start when the proper voltage is back on Bus 34.

ii) According to Dresden FSAR Section 8, Table 8.2.5 two CC Service Water pumps are required during LOOP concurrent with LOCA. After 10 minutes of running both LPCI pumps and the Core Spray pump, the operator manually turns on the CCSW pumps, but is required R2 for DG loading capacity to turn off one of the LPCI pumps [e.g. pump 3D for this calculation] before the second CCSW pump is turned on (see References 33 and 63). Dresden Updated R2 FSAR section 5.2.3.3 analyzed the recovery portion of LOCA for the equipment availability and concluded that one LPCI, one Core Spray, and two CCSW pump is adequate for recovery beyond 10 minutes after LOCA.

iii) After the CC Service Water Pumps are turned on, the CC Heat Exchanger Service Water Discharge Control Valve 1501-3A opens to provide CCSW flow through the CC heat exchanger. The operator at some time during the event will close the CC 3B Heat Exchanger Bypass Valve 1501-11B to establish LPCI flow through the heat exchanger. As this is a manual initiation of an intermittent load, this valve operation is not considered in this calculation.

4) Standby Gas Treatment (SBGT)

The purpose of the SBGT system is to maintain a small negative pressure in the reactor building to prevent ground level release of airborne radioactivity. The system also treats the affluent from the reactor building and discharges the treated affluent through a 310 foot chimney in order to minimize the release of radioactive material to the environment.

The SBGT system will auto initiate on the following conditions:

1) B train in Primary, A train in Standby

   a. High radiation in Reactor Building Vent System (4mr/hr)

   b. High radiation on refuel floor (100mr/hr)

   c. High drywell pressure (+2 psig)

   d. Low Reactor water level (+8 inches)

   e. High radiation inside the drywell (10^2 x R/hr)

2) A train in Primary, B train in Standby

   If the B train of SBGT system is in standby, a timer is enabled which will initiate the B train of SBGT if a low flow is present on A train SBGT for longer than the allowed time. Per DIS7500-01, this time is set to operate within 18 to 22 seconds

   Since the Case 2 scenario is after the Core Spray Pump start and before t=10-minutes, B train SBGT will be shown to operate as described in Case 1 above.

Upon initiation, the SBGT trips the normal Reactor Building vent supply and exhaust fans, and closes A0 valves. It also trips the drywell and torus purge fans. Motor Operated Inlet Butterfly Valve 7503 (N.O.) remains open. The electric heater raises the air temperature sufficiently to lower the relative humidity. Motor operated Butterfly Valve 7505B is normally closed and interlocked open upon system initiation. Motor Operated Butterfly Valve 7507B is normally closed and interlocked open. Motor operated valve 7504B is normally open and is interlocked closed on system initiation. SBGT Fan 2/3-7506 will drive the filtered air out through the ventilating chimney.

IX METHODOLOGY

A. Loading Scenarios:

There are three different abnormal conditions on which the Emergency Diesel Generator can be operating:

1) Loss of AC Offsite Power (LOOP)
2) Safe Shutdown Due to Fire
3) LOOP concurrent with LOCA

The above scenarios will be compared for total loading and heaviest sequential loading to determine worst case scenario and why the scenario was chosen.

B. Continuous Loading Evaluation

The following Attachments are used to determine and develop the continuous loading of the DG:

- Table 1
- ETAP for the load summary of the loading of the DG at selected steps of automatically and manually started loads (Attachments F & G).

The loading based on the maximum loading scenario, including cumulative proposed modifications to the loading, will be tracked in the ETAP data file. In all of the cases that will be analyzed, the proposed loading will be greater than that of the existing loading, since all modified load reductions will remain at previous loads until installed and changed to existing. Thus the capability of the DG to pickup the modified loading and operate within the safe operating limit of the DG will envelope the existing loading.

For all of the various steps in the DG load profile, the ETAP total load will be the summation of the steady state load of all running and starting services for the starting step being analyzed.

The ETAP model was revised to mimic the ELMS-AC data files that were part of the calculation prior to Revision 002. Scenarios were created in ETAP to model the various loading steps in the DG load profile as loads are energized and de-energized.

The scenarios used to model the DG loading in ETAP are listed in the table that follows. The scenarios use one of three loading categories named "DG Ld 0 CCSW", DG Ld 1 CCSW" and "DG Ld 2 CCSW". These loading categories were created by duplicating loading category "Condition 3". In cases where a load was identified in loading category "Condition 3" as zero and the load is energized during the diesel loading scenario, the loads were modeled as 100% in these loading categories. If the bhp for a given load in the previous DG data files was different than that in load condition 3, it was revised to match the bhp value in the previous ELMS-AC data files for this calculation. Breakers were added for various loads that change state as part of the DG load profile. No specific breaker data was entered as these breakers are only used as switches. The breakers were opened and closed as required creating configurations which duplicate the loading on the DG for each load step previously captured in the ELMS-AC program. The three loading categories are identical except the BHP values associated with the CS, LPCI and CCSW pumps are varied. "DG Ld 0 CCSW" represents the first 10 minutes of the accident where no CCSW pumps are operating. "DG Ld 1 CCSW" reflects reduced CS and LPCI loading values after 10 minutes and a 115% bhp loading value for a single CCSW pump in operation. "DG Ld 2 CCSW" is the same as "DG Ld 1 CCSW" except CCSW bhp values are reduced to reflect operation of both pumps.

R3

R3

R3

Four study cases were created for use with this calculation: DG_0_CCSW, DG_1_CCSW, DG_2_CCSW and DG_Vreduced. The first three study cases use the corresponding similarly named loading category and the DG_Vreduced case uses the DG_0_CCSW loading category as all runs correspond to less than 10 minutes into the event. The generating category was set to "Nominal" and "Gen Min" for the first three study cases and DG_Vreduced study case respectively. The Unit 3 diesel voltage was set to 100% and 60% for the "Nominal" and "Gen Min" generation categories respectively. 60% was chosen as it envelopes the lowest expected DG terminal voltage. This value is supported by the calculations performed in Section 10. In each of these study cases, the Newton Raphson method of load flow was selected with the maximum number of iterations set at 99 and the precision set to 0.000001. Only the initial bus voltages were chosen to be updated as a result of execution of the load flow. No diversity factors or global tolerances were used. R3

The scenario wizard in ETAP was used to set up the configuration, study case, and output report for each time step in the DG load profile. The study wizard was used to group and run all of the scenarios. Each scenario was run three times in a row as part of each study macro. The results can vary depending upon the order that the study cases are run as certain calculations within ETAP are run using the initial bus voltages in the bus editor. The multiple runs assure a unique solution is reached regardless of the bus voltages in the bus editors prior to each load flow run. The precision for each study case is not accurate enough to guarantee a unique solution. The scenarios used to calculate the loading on the DG during each time step are listed below along with the relevant ETAP settings, configurations, etc.

CALCULATION PAGE

METHODOLOGY (cont'd)

Scenario	Configuration	Study Case	DG Voltage	Output Report	Study Macro	Description
DG3_Bkr_Cl	DG3_Bkr_Cl	DG_0_CCSW	4160V	DG3_Bkr_Close	DG3_Vnormal	Initial loading on DG due to 480V loads when DG breaker closes
DG3_UV_Reset	DG3_UV_Reset	DG_0_CCSW	4160V	DG3_UV_Reset	DG3_Vnormal	Scenario DG3_Bkr_Cl plus 1st LPCI pump and auxiliaries
DG3_T=5sec	DG3_T=5sec	DG_0_CCSW	4160V	DG3_T=5sec	DG3_Vnormal	Scenario DG3_UV_Reset plus 2nd LPCI pump
DG3_T=10sec	DG3_T=10sec	DG_0_CCSW	4160V	DG3_T=10sec	DG3_Vnormal	Scenario DG3_T=5sec plus Core Spray Pump and Auxiliaries
DG3_T=10-min	DG3_T=10-m	DG_0_CCSW	4160V	DG3_T=10-min	DG3_Vnormal	Scenario DG3_T=10sec minus MOV that have completed stroke
DG3_T=10+min	DG3_T=10+m	DG_1_CCSW	4160V	DG3_T=10+min	DG3_Vnormal	Scenario DG3_T=10-min plus 1st CCSW pump and Auxiliaries
DG3_T=10++min	DG3_T=10++m	DG_2_CCSW	4160V	DG3_T=10++min	DG3_Vnormal	Scenario DG3_T=10+min plus 2nd CCSW pump and Auxiliaries minus 1 LPCI pump.
DG3_CRHVAC	DG3_CRHVAC	DG_2_CCSW	4160V	DG3_CR_HVAC	DG3_Vnormal	Scenario DG3_T=10++min plus Control Room HVAC and all other long term loads.
DG3_Bkr_Vlow	DG3_Bkr_Cl	DG_Vreduced	2496V	DG3_Bkr_Vred	DG3_Vreduced	Scenario DG3_Bkr_Cl run at lowest expected voltage
DG3_UV_Vlow	DG3_UV_Reset	DG_Vreduced	2496V	DG3_UV_Vred	DG3_Vreduced	Scenario DG3_UV_Reset run at lowest expected voltage
DG3_T=5sVlow	DG3_T=5sec	DG_Vreduced	2496V	DG3_T=5sVred	DG3_Vreduced	Scenario DG3_T=5sec run at lowest expected voltage
DG3_T=10-mVl	DG3_T=10-m	DG_Vreduced	2496V	DG3_T=10-mVred	DG3_Vreduced	Scenario DG3_T=10-min run at lowest expected voltage

R3

METHODOLOGY (cont'd)

No other manual loads outside the Dresden Re-baselined Updated FSAR (Revision 0) scope were considered for this analysis.

C. Transient Loading Evaluation.

The following attachments are used to determine and develop the transient loading of the DG:

- Table 1
- Table 4
- Flow Chart 1
- Use of Dead Load Pickup Curve.

The following formulas will be used to determine the starting KVA on the DG at each step from the motor data provided and the ETAP reduced voltage scenarios. R2

Calculating starting KVA ($SKVA_R$) at the machine's rated voltage (V_R)

$$SKVAR = \sqrt{3}\, V_R\, I_{LRC}$$

where, I_{LRC} is the machine's Locked Rotor Current

Calculating starting KVA (SKVA) at the machine's rated voltage (V_2)

$$SKVA\ @\ V_2 = (V_2)^2 / (V_R)^2 \times SKVA_R$$

The starting kW/kVAR for the starting loads in each step will be calculated and tabulated separately in Table 4.

The reduced voltage ETAP files are run for each timeframe immediately preceeding a large motor start with the exception of the last CCSW pump which is bounded by a start of the 1st CCSW pump. The 1st CCSW pump was modeled as starting concurrent with the aux loads energized concurrently with the 2nd CCSW pump in order to create a bounding case for a CCSW pump start. The reduced DG terminal voltage is equal to or lower than the voltage dip during the most severe starting step. The reduced terminal voltage will be used to determine an incremental increase in current caused by the running loads operating at lower than rated voltage. R2

METHODOLOGY (cont'd)

The difference in current will be reflected as the equivalent kw/kvar at full voltage (at the power factor of the running loads) and added to the total starting kw/kvar of the starting loads to determine the net starting KVA.

The power factor of the running loads is taken from ETAP.

Calculating the incremental KVA for previously running loads is done as follows:

$I_{Curr@100\%}$ = Taken from ETAP output report from study cases run at nominal voltage R3

$I_{Curr@reduced\ voltage}$ = Taken from ETAP output report from DG_Vreduced study cases

$\Delta I = I_{Curr@reduced\ voltage} - I_{Curr@100\%}$

$\Delta KVA = \Delta I \times \sqrt{3} \times 4.16KV$

Conservatively, the worst voltage drop case due to the presence of running load will be applied to all large motor starting cases. The previous calculation revisions show that the largest voltage dip occurs when the Core Spray Pump starts. Revision 10 of Calculation 7317-33-19-1 shows that the voltage dip is 62.2% of bus rated voltage for Unit 3 when the first LPCI Pump is starting. For conservatism, 60.0% (i.e. 2496V) of bus rated voltage will be used for all running load conditions.

The voltage dip and one second recovery at the DG for the initial start at breaker closing is determined from the EMD's Dead Load Pickup Curve #SSC-5056 (Ref. 13) by using the total starting KVA value from Table 4. Following the initial start, the total KVA is determined by vectorially adding the step starting load KW/KVAR from Table 4, the ΔKVA changed to KW/KVAR of the running load of the previous scenario in the ETAP file, and the starting KW/KVAR of the 4000V motor that is starting to determine the total starting KVA, which is then used to determine the voltage dip and one second recovery at the DG terminals.

The Dead Load Pickup Curve provides initial voltage dip and recovery after 1 second following a start based on the DG transient starting load. The curve includes the combined effect of the exciter and the governor in order to provide recovery voltages. The voltage dip and recovery analysis utilizes the results of dynamic DG characteristics reflected in the manufacturer's curve. Though the

METHODOLOGY (Cont'd)

curve shows voltage recovery up to 1 second, the voltage will continue to improve after 1 second due to exciter and governor operation. The DG Strip Chart for the surveillance test (Ref. 23) shows the voltage improvement past 1 second.

To determine motor starting terminal voltage, the cable voltage drop is calculated using the locked rotor current at rated voltage. This is conservative since the locked rotor current is directly proportional to applied voltage.

D. Analysis of control circuits during motor starting transient voltage dip.

When the DG starts a large motor, the momentary voltage dip can be below 70% of generator rated voltage. There is a concern whether momentary low voltage could cause certain control circuits to drop-out. Table 2 of this calculation analyzes the effect of an ac momentary voltage dip on the operation of the mechanical equipment. This table analyzes the momentary voltage dip at 5 seconds & 10 seconds after UV reset; and 10 minutes and after for its effect on the operation of mechanical equipment.

E. Protective device evaluation and MOV operating time effects during motor starting transient voltage dip

The voltage recovery after one second will be evaluated for net effect on the protective devices The duration of starting current is expected to be shorter than operation from offsite power source because of better DG voltage recovery. Because protective devices are set to allow adequate starting time at motor rated voltage and during operation from offsite power, protective device operation due to overcurrent or longer operating time is not expected to be a concern when operating from the DG power during LOOP concurrent with LOCA. The voltage and frequency protection of MCCs 39-7/38-7 has been studied in S&L calculation 8231-03-19-1 (Ref. 44).

F. Methodology for Determining Starting Time of Large Motors. (Ref. 42)

To determine large motor starting times, the time needed for the motor to accelerate through an increment of motor speed will be found. This will be accomplished by determining from motor and load speed-torque curves net accelerating torque (i.e. the difference between the torque produced by the motor and the torque required by the load) for each increment of speed. Using the combined motor and load inertia, the time needed to accelerate through the increment of speed can be calculated. All the time intervals will be summed to obtain a total motor starting time. Since motor torque is directly proportional to the square of applied terminal voltage, values obtained from the 100% rated voltage speed-torque curve will be adjusted downward for lower than rated applied terminal voltage. And, since this calculation determines for each motor start an initial voltage and a recovery voltage after 1 second, these two values will be used when adjusting motor torque for applied terminal voltage (i.e. For the initial speed increment and all subsequent increments occurring 1 second or less from the beginning of the motor start period, the initial voltage value will be used to determine motor torque. All later increments will use the 1 second recovery voltage value.) The time for each speed increment will be found using the following process:

1) At each speed increment, the motor torque will be found at the initial or 1 second recovery motor terminal voltage, as appropriate this will be done using the equation:

   $T = [(Vterm)^2 / (Vrated)^2]$ x Motor Base Torque x 100% Voltage Motor Torque from speed-torque curve

2) At each speed increment, load torque will be obtained from the load speed-torque curve.

3) The torque of the load is subtracted from the determined motor torque to obtain the net accelerating torque.

4) Finally the time fo accelerate through an RPM increment is found using the following equation:

   $t = [WK^2$(pump + motor) x RPM increment] / (307.5 x Net Accelerating Torque)

5) All the time increments are summed to obtain the total motor starting time.

X CALCULATIONS AND RESULTS

The following set of Calculations and Results are for the condition when DG 3 is powering the Unit 3 buses.

A. Loading Scenarios:

Dresden Re-baselined Updated FSAR, Rev. 0, loading table 8.3-3 shows that the maximum DG 3 loading during LOOP is only **1552 kW**.

Dresden Station Fire Protection Reports - Safe Shutdown Report dated July 1993, Table 3.1-1, shows that the maximum loading on DG 3 is **1541 kW**, which is adequate for Dresden Station

Also, the Dresden Re-baselined Updated FSAR, Rev. 0, Figure 8.3-7 shows that the maximum loading on DG 3 during LOOP concurrent with LOCA is **2260 kW**

By comparing all three conditions, it is concluded that the combination of LOOP concurrent with LOCA is the worst case of DG loading. Therefore, LOOP concurrent with LOCA scenario was analyzed in detail in this calculation.

The load values for the three conditions stated above are historical values and are used only for comparison of load magnitudes to determine the worst-case loading scenario for the Diesel Generator. For currently predicted loading values on the diesel generator, see Section XI, Subsection A, "Continuous Loading of the Diesel Generator".

B. Continuous Loading

Table 1 was developed to show loads powered by the DG and the loads that will be automatically activated when the DG output breaker closes to 4-kV Bus 34-1 following LOOP concurrent with LOCA. The ETAP model was then set up using the "DG Ld 0 CCSW", DG Ld 1 CCSW" and DG Ld 2 CCSW" loading categories and the various configurations to model the loads as described in the methodology section. The CCSW Pumps are manually started and a LPCI Pump is turned off to stay within the DG capacity. R3

Also, for conservatism the Diesel Fuel Oil Transfer Pumps are shown as operating from 0 seconds, even though these pumps will not operate for the first few hours because the Day Tank has fuel supply for approximately four hours.

C. DG Terminal Voltages under Different Loading Steps

Figure 2 Load vs Time profile of starting loads for the DG was developed from Table 1 showing loads operating at each different time sequence. The values for the running loads in kW/kVAR/kVA were taken from the appropriate ETAP output report, and the starting values for 480V loads are calculated in Table 4. The following is a sample calculation for LPCI Pump 3C showing the determination of motor starting kVA and starting time. It is shown for demonstrative purposes only (based on Rev. 2). For actual starting and recovery voltages, see Section 10.1.. This sample calculation is based on use of the ETAP program. R3

CALCULATION AND RESULTS (Cont'd) For Demonstration Only

2) Starting of First LPCI Pump 3C (700HP)

i) Starting KVA of LPCI Pump 3C

Base voltage(motor rated voltage)	4000v (4.0KV)
Operating voltage	4160v (4.16KV)
Base current(FLC)	90A
LRC	7 Times FLC
Starting Power Factor (SPF%)	20%

Calculating the starting KVA at base voltage

$SKVA_1 = \sqrt{3} \times 4.0KV \times (90A \times 7.00) = 4365\ KVA$

Starting KVA @ Operating voltage = $(4160V)^2/(4000V)^2 \times 4365KVA$
= 4721KVA @20%PF

The starting KVA is converted at starting power factor to the following KW and KVAR values:

R1

Starting KW = 4721KVA x .20PF = 944.2KW

Starting KVAR = 4721KVA x ($\sin[\cos^{-1} 0.20PF]$) = 4625.6KVAR

The initial voltage dip (Based on 4721 KVA) due to starting the LPCI pump is found from the Dead Load Pickup Curve #SC-5056 and multiplying by 0.97 to account for -3% curve tolerance is

= (69.8% x 0.97) = 67.7% of 4160v

ii) When the first LPCI Pump starts, LPCI/CS Pump Cooling Unit and LPCI Pump Flow Bypass Valve 3B operates. The starting load is summarized in Table 4. The results are as follows:

Starting auxiliary load	= 23.1 + j30.1
Starting LPCI Pump 3C	= 944.2 + j4625.6
Total Starting Load	967.3 + j 4655.7

Vector starting KVA = $\sqrt{[(967.3)^2 + (4655.7)^2]}$ = 4755.1 KVA

CALCULATIONS AND RESULTS (cont'd)

The initial voltage dip (Based on 4755 KVA) due to starting the LPCI pump and auxiliaries from the Dead Load Pickup Curve #SC-5056 and multiplying by 0.97 to account for –3% curve tolerance is

= (69.8% x 0.97) = 67.7% of 4160v

iii) When first LPCI Pump starts, at that time there are running loads on DG powered buses. Therefore, the actual voltage drop on the bus is assumed to be more than the starting of the first LPCI Pump alone. The running KVA from ETAP supplied by the Unit 3 EDG is 507 KVA.

The current at 100% voltage (i.e. at 4160 volts) from ETAP scenario DG3_Bkr_CI is

$I_{run@100\%}$ = 70.4 amps

The kVAR & kW from ETAP scenario DG3_Bkr_Vlow at reduced voltage are 231 kVAR & 414 kW.

The power factor from the same ETAP scenario at the reduced voltage running load is

PF = 0.874 PF

The current at the reduced voltage dip for this KVA load from ETAP is

$I_{run@reduced\ voltage}$ = 109.7 amps

R2

The incremental difference of current is

ΔI = 109.7 amps – 70.4 amps = 39.3 amps R2

The incremental KVA (ΔKVA) used to determine additional starting KVA is

ΔKVA = √3 x 4.160 kV x 39.3 amps = 283.2 KVA R2

The incremental running load equivalent is converted to an equivalent kW/kVAR from the incremental KVA previously determined.

Incremental running load KW = 283.2 kVA x 0.874 PF = 247.49 kW

Incremental running load KVAR= 283.2 kVA x ($\sin[\cos^{-1} 0.874$ PF]) = 137.60 kVAR

R2

CALCULATIONS AND RESULTS (cont'd)

iv) The starting KVA equivalent as seen by the DG is calculated as follows:

Incremental running load equivalent	247.49 + j137.60	
LPCI Pump 3C Starting load	944.2 + j4625.6	
Concurrent Starting Auxiliary Load (from Table 4)	23.1+j30.1	R2
Total Starting KVA equivalent	1214.78 + j4793.25	

Vector starting KVA = $\sqrt{[(1214.78)^2 + (4793.25)^2]}$ = 4944.79 kVA

From Dead Load Pickup Curve (SC-5056) the initial starting voltage and 1 second recovery voltage (Based on 4944.79 kVA) and multiplying by 0.97 to account for - 3% curve tolerance

Initial Voltage drop = (68.8% x 0.97) = 66.74% of 4160V R2

Voltage recovery after 1 second = (95.2% x 0.97) = 92.34% of 4160V

v) The feed cable of LPCI Pump 3C is 3/C - #1/0 - 5 kV, and the cable number is 30980. The length of the cable is 227 feet and this length is taken from ETAP. R2

The impedance of the cable (Ref. S&L Standard ESA-102) is:

Z_{cable} = 227 ft. x [(0.0128 + j0.00384 ohms)/100ft p.u. imp.]

Z_{cable} = 0.02906 + j0.00872 ohms R2

$|Z_{cable}| = \sqrt{[(0.02906)^2 + (0.00872)^2]}$ = 0.0303 ohms

The maximum motor terminal line-to-line voltage drop which may occur on this cable where 630 amps is the LRC is:

ΔVcable = $\sqrt{3}$ x 630 amps x 0.0303 ohm = 33.11 volts (0.80% of 4160V) R2

Deducting the voltage drop due to motor feed cable to determine the actual voltage at the motor terminal, the initial starting voltage at the motor terminals is

66.74% - 0.80% = 65.94% of 4160V R2

The voltage after 1 second at the motor terminals is

92.34% - 0.80% = 91.55% of 4160V R2

CALCULATIONS AND RESULTS (cont'd)

D. Starting Time Calculations (FOR DEMONSTRATION ONLY)

1) LPCI Pump 3C

Initial (Starting) Voltage (@ motor) 65.94% of 4160v = 2743.1 volts
Voltage at 1 second (@ motor) 91.55% of 4160v = 3808.5 volts R2

Motor Base Torque 1030 ft-lb

WK2 Pump (wet)	18.1 $lb\text{-}ft^2$
WK2 Motor	190.0 $lb\text{-}ft^2$
Total WK2	208.1 $lb\text{-}ft^2$

Motor Torque at 2743.1 volts R2

T $= [(2743.1V)^2 / (4000V)^2] \times 1030$ ft-lb x 100% voltage x Motor Torque from speed-torque curve

= 484.4 x 100% voltage x Motor Torque from speed-torque curve

Motor Torque at 3808.5 volts R2

T $= [(3808.5)^2 / (4000)^2] \times 1030$ ft-lb x 100% voltage x Motor Torque from speed-torque curve

= 933.7 x 100% voltage x Motor Torque from speed-torque curve R2

CALCULATION PAGE

CALCULATIONS AND RESULTS (cont'd) (FOR DEMONSTRATION ONLY)

% RPM	RPM	Voltage %	Motor Torque From Curve	Motor Torque lb - ft	Pump Torque From Curve	Pump Torque lb - ft	Net Torque lb - ft	Time in Seconds
0 - 10	360	65.94	0.80	387.52	0.0	0.00	387.52	0.63
10 - 20	360	65.94	0.80	387.52	0.02	20.60	366.92	0.66
20 - 30	360	91.55	0.81	756.29	0.05	51.50	704.79	0.35
30 - 40	360	91.55	0.82	765.63	0.06	61.80	703.83	0.35
40 - 50	360	91.55	0.83	774.96	0.10	103.00	671.96	0.36
50 - 60	360	91.55	0.85	793.64	0.15	154.50	639.14	0.38
60 - 70	360	91.55	0.92	859.00	0.19	195.70	663.30	0.37
70 - 80	360	91.55	1.07	999.05	0.25	257.50	741.55	0.33
80 - 90	360	91.55	1.50	1400.54	0.32	329.60	1070.94	0.23
90 - 95	180	91.55	2.20	2054.12	0.38	391.40	1662.72	0.07
95 - 99	144	91.55	2.35	2194.17	0.43	442.90	1751.27	0.06
							TOTAL	3.78

R2

Notes for the table above:

1. Motor Torque in above table is from GE drawing 257HA264.
2. Motor Torque in above table is read from mid-point of applicable speed range.
3. Motor Torque in lb-ft is obtained by multiplying the torque from the curve by motor at applicable voltage.
4. Pump torques are from GE Curve 257HA264 and then multiplied by motor base torque.
5. Net Torque is motor torque minus pump torque, both in lb-ft.
6. Time in Seconds to accelerate through an RPM Increment =

$$\frac{[WK^2(\text{Pump + Motor}) \times \text{RPM Increment}]}{(307.5 \times \text{Net Torque})}$$

<u>CALCULATIONS AND RESULTS</u> (cont'd)

E. Control Circuit Evaluation for Voltage Dips

The voltage recovery (@ DG terminal bus) is at least 88.4% after one second following the Core Spray motor start. The voltage will continue to improve after one second due to the exciter and the governor characteristics. These voltages during motor starting period (after the initial dip) are much better than the voltages expected during the operation from the offsite source. Table 2 has evaluated the effects on the control circuits of all services on the DG and has determined any transient effect during the short initial voltage dip and no lasting effects have been identified. R2

F. Protective Device Operation during Voltage Dips

The voltage recovery (@ DG terminal bus) is at least 88.4% after one second following the Core Spray motor start. The voltage will continue to improve after one second due to the exciter and the governor characteristics. These voltages during motor starting period (after the initial dip) are much better than the voltages expected during the operation from the offsite source. Therefore, the duration of starting current is shorter than operation from offsite power source. Because protective devices are set to allow adequate starting time at motor rated voltage and during operation from offsite power, protective device operation due to overcurrent is not a concern when operating from the DG power during LOOP concurrent with LOCA. For Example, R2

- TID-E&IC-02 provides that the recommended settings for thermal overloads (TOL) be able to withstand 1 duty cycle (two valve strokes) before tripping. It is not expected that any of the operating valves will be required to complete a full duty cycle. Rather, operating valves are expected to complete 1 stroke (1/2 duty cycle) when called upon during DG operation. Therefore, TOL settings will not be operated by the voltage dips. (Reference 35)

- Typical settings for the 480V MCC feed breakers allow for approximately 1800 amperes of current to flow for 20 seconds. Large motor starting will not take longer than 5 seconds, and the actual voltage recovery of the DG after 1 second is more than 88%. With a 20 second delay in feed breaker tripping, the short time of the voltage dips will not cause feed breakers to be tripped. (Reference 45)

G. **Results of calculations**

Summary of Motor Starting Times

Device	Total Starting Time (Seconds)	Starting Time Allowed (Seconds) (See IV.AB)
LPCI Pump 3C	3.77	5
LPCI Pump 3D	3.67	5
Core Spray Pump	3.90	5

R3

The results of the calculation show that the minimum voltage drop to the DG powered buses occur when the Core Spray Pump starts. The table below shows the starting (at 0.1 sec.) voltages and recovery voltages after 1 second following the start.

Equipment Description	Starting KVA	Voltage Drop @ 0.1 Second	Voltage Recovery after 1 second
LPCI Pump 3C	4933.8	66.83% of 4160V	92.44% of 4160V
LPCI Pump 3D	4040.5	71.00% of 4160V	95.16% of 4160V
Core Spray Pump 3B	6125.4	62.18% of 4160V	88.46% of 4160V
CCSW Pump 3D	4150.0	70.52% of 4160V	94.96% of 4160V

R3

During LOOP concurrent with LOCA there is a 5 second time delay from the start of the first LPCI Pump to the start of the second LPCI Pump. Starting time calculations for the LPCI Pumps show that both the pumps accelerate to full speed in under 4 seconds. Therefore by the time the second LPCI Pump starts, the first LPCI Pump is at full speed (i.e. running load). There is also a 5 second time delay from the start of the second LPCI Pump to the start of the Core Spray Pump. Therefore, by the time the Core Spray pump starts, the second LPCI Pump is at full speed.

CALCULATIONS AND RESULTS (cont'd)

Section 10.1

Section 10.1 contains the MS Excel calculations of starting kVA and starting times for the 4.16 kV motors. R2

1) <u>Starting kVA of the DG auxiliaries after the closure of the DG output breaker (Page C1 & C2 Calculation)</u>

Aggregate	SKW =	807.30	(Ref. Table 4)	R3
Aggregate	SKVAR =	1391.60	(Ref. Table 4)	R3
Aggregate	SKVA =	SKW + j SKVAR		
	SKVA =	807.3 + j1391.6		R3
	|SKVA| =	1608.81		R3

Angle = $\tan^{-1}$(SKVAR/SKW)

Angle = 59.88 Degrees

To determine the initial starting voltage (V_{curve_i}) and 1 second recovery voltage (V_{curve_1}), use the Dead Load Pickup Curve (SC-5056) and SKVA (calculated above) as "Generator Reactive Load MVA". Multiply the initial and 1 second curve values by 0.97 to account for a -3% curve tolerance.

Initial Voltage Dip:

V_{curve_i} = 87.9% of 4160V | R3

$V_{dip} = V_{curve\_i} \times 0.97$

V_{dip} = 85.3% of 4160V | R3

Voltage recovery after 1 second:

V_{curve_1} = 100.0% of 4160V

$V_{recovery} = V_{curve\_1} \times 0.97$

$V_{recovery}$ = 97.0% of 4160V

2) Starting of First LPCI Pump 3C (700HP)

Motor parameters

Base Voltage (motor rated voltage)	V_{base} = 4000	Volts	(Ref. 18)
Operating Voltage	V_{OP} = 4160	Volts	
Base Current (full load)	I_{FL} = 90	Amps	(Ref. 18)
Locked Rotor Current	$I_{LRC} = I_{FL}$ x 7.00		(Ref. 18)
	I_{LRC} = 630.0		
Starting Power factor	PF_{start} = 0.20		(Ref. 18)

Motor Cable data

Conductor Size	3/C - #1/0 -5kV	
Cable Number	30980	
Cable Length (feet)	L = 227	(ETAP)
Cable Impedance (ohms)	Z_{cable} = 0.02906 + j0.00872	(ETAP)

R2

Motor parameters to be used to determine starting time of the pump.

Motor Base Torque	$Torque_{rated}$ = 1030	ft-lb	(Ref. 15)
WK^2 Pump (wet)	WK_{pump} = 18.1	lb-ft^2	(Ref. 15)
WK^2 Motor	WK_{motor} = 190.0	lb-ft^2	(Ref. 15)
Motor rated RPM	RPM = 3600		(Ref. 15)

2) Starting kVA of LPCI Pump 3C

Calculating the starting kVA at base voltage

$SKVA_1 = \sqrt{3} \times V_{base} \times I_{LRC})/1000$ $SKVA_1 = 4364.8$

Calculating starting kVA at operating voltage

$KVA_{start1} = (V_{op}^2/V_{base}^2) \times SKVA_1$ $KVA_{start1} = 4720.9$ at $Pf_{start} = 0.20$

The starting kVA is converted at starting power factor to the following KW and KVAR values:

Motor parameters

$LPCI_{start} = (KVA_{start1} \times PF_{start}) + j \times [KVA_{start1} \times (\sin(a\cos(PF_{start})))]$

$LPCI_{start} = 944.19 + j4625.55$ kVA

ii) When the LPCI Pump starts, the LPCI Core Spray Pump Area Cooling Unit 3B, and MOV 3-1501-13B will also start operating. The starting load is summarized in Table 4, with the results as follows:

Additional Starting auxiliary load: $Load_{start} = 23.1 + j30.1$ kVA

iii) When the first LPCI Pump starts, at that time, there are running loads on DG powered Buses. Therefore, the actual voltage drop on the bus will be more than that of the starting of the first LPCI Pump alone. The running kW & kVA from the ETAP DG3_Bkr_CI scenario is:

$kW_{ETAP100\%} = 392$

$kVAR_{ETAP100\%} = 293$

$KVA_{ETAP\_100\%} = 489$ R3

The current at 100% voltage (i.e. at 4.16kV) from ETAP is:

$I_{run\_100\%} = 67.9$ Amps R3

The KVA & KW from the special ETAP scenario DG3_Bkr_Vlow for the reduced voltage condition is:

$V_{reduced} = 2496$ Volts

$KW_{reduced} = 386$

$KVAR_{reduced} = 229$

$KVA_{reduced} = 449$ R3

The power factor from the same ETAP scenario at reduced voltage running load is:

$PF_{reduced} = 0.860$ R3

The calculated current at the reduced voltage for this kVA load from ETAP is:

$I_{reduced} = 103.9$ Amps R3

Therefore, the incremental difference of current is:

$$I_{delta} = I_{reduced} - I_{run\_100\%}$$
$$I_{delta} = 36.00 \quad \text{Amps}$$ R3

The incremental KVA (KVA_{delta}) used to determine additional starting kVA is

$$KVA_{delta} = (\sqrt{3} \times V_{op} \times I_{delta}) / 1000 \qquad KVA_{delta} = 259.4$$ R3

The incremental running load equivalent is converted to an equivalent KW and KVA from the incremental kVA previously determined

$$KVA_{increment} = (KVA_{delta} \times PF_{reduced}) + j \times [KVA_{delta} \times (\sin(\operatorname{acos}(PF_{reduced})))]$$
$$KVA_{increment} = 223.08 + j132.37 \quad \text{kVA}$$ R3

iv) The starting KVA equivalent as seen by the DG is calculated as follows:

LPCI Pump 3C starting load:	$LPCI_{start} = 944.19 + j4625.55$	kVA	
Additional starting load:	$Load_{start} = 23.1 + j30.1$	kVA	
Incremental running load equiv.:	$KVA_{increment} = 223.08 + j132.37$	kVA	R3

Total Starting kVA equivalent:

$$Total_{start} = Load_{start} + KVA_{increment} + LPCI_{start}$$
$$Total_{start} = 1190.36 + j4788.02 \quad \text{kVA}$$ R3

$$Vector_{start} = \sqrt{Re(Total_{start})^2 + Im(Total_{start})^2}$$

$$Vector_{start} = 4933.77 \quad \text{kVA}$$ R3

To determine the initial starting voltage ($V_{curve\_initial}$) and 1 second recovery voltage (V_{curve_1sec}), use the Dead Load Pickup Curve (SC-5056) and $Vector_{start}$ (calculated above) as "Generator Reactive Load MVA". Multiply the initial and 1 second curve values by 0.97 to account for a -3% curve tolerance.

Initial Voltage Dip:

$V_{curve\_initial}$ = 68.9% of 4160V R3

V_{drop} = $V_{curve\_initial}$ x 0.97

V_{drop} = 66.83% of 4160V R3

Voltage recovery after 1 second:

V_{curve_1sec} = 95.3% of 4160V R3

V_{drop_1sec} = V_{curve_1sec} x 0.97

V_{drop_1sec} = 92.44% of 4160V R3

v) The impedance of the pump feed cable, as defined earlier:

Z_{cable} = 0.02906 + j0.00872 ohms

$|Z_{cable}|$ = 0.0303 ohms

The maximum motor terminal line-to-line voltage drop which may occur on this cable given the LRC is:

I_{LRC} = 630.0 Amps

$V_{delta\_max} = (\sqrt{3} \times I_{LRC} \times |Z_{cable}|)$ V_{delta_max} = 33.11 Volts

$V_{delta\_\%} = V_{delta\_max} / V_{op} \times 100$ $V_{delta\_\%}$ = 0.80% of 4160V

Deducting the voltage drop due to motor feed cable to determine the actual voltage at the motor terminals, the initial starting voltage at the motor terminals is:

$$V_{initial.LPCI3C} = V_{drop} - V_{delta\_\%}$$

$$V_{initial.LPCI3C} = 66.04\% \quad \text{of } 4160V$$ R3

The voltage after 1 second at the motor terminals is:

$$V_{1second.LPCI3C} = V_{drop\_1sec} - V_{delta\_\%}$$

$$V_{1second.LPCI3C} = 91.65\% \quad \text{of } 4160V$$ R3

<u>Calculation of Motor Starting Time:</u>

Initial Starting Voltage (converted to decimal) $Vi = V_{initial.LPCI3C} / 100$

Voltage at 1 second (converted to decimal) $V1 = V_{1second.LPCI3C} / 100$

Total inertia of the motor and pump together from above (WK^2):

$WK_{pump} = 18.1$ lb-ft^2 $WK_{motor} = 190.0$ lb-ft^2

$$WK2 = WK_{pump} + WK_{motor}$$

$$WK2 = 208.10 \quad \text{lb-ft}^2$$

The folowing variables define the speed intervals and corresponding motor and pump torque increments necessary to compute the starting time of the pump.

$\%RPM_o$ - initial RPM of increment as a percentage of rated RPM

$\%RPM_f$ - final RPM of increment as a percentage of rated RPM

$\%Torque_{Motor}$ - motor torque value from pump torque-speed curve read from the midpoint of the applicable speed range.

$\%Torque_{Pump}$ - pump torque value from pump torque-speed curve read from the midpoint of the applicable speed range.

%Volt - either the initial voltage (Vi) or the voltage at 1 second (V1).

Note that the determination of which voltage (%Volt) to use is made when the motor acceleration time exceeds 1 second, and that can only be determined by looking at the calculated cumulative time below (i.e. Vi until 1 second, V1 after that).

R2

%rpm_o	%rpm_f	%$Torque_{Motor}$	%$Torque_{Pump}$	%Volt
0	10	0.80	0.00	Vi
10	20	0.80	0.02	Vi
20	30	0.81	0.05	V1
30	40	0.82	0.06	V1
40	50	0.83	0.10	V1
50	60	0.85	0.15	V1
60	70	0.92	0.19	V1
70	80	1.07	0.25	V1
80	90	1.50	0.32	V1
90	95	2.20	0.38	V1
95	99	2.35	0.43	V1

Compute the motor torque at the initial voltage (Vi) and at 1 second (V1) using the motor torque at motor rated voltage (Ref 15).

$V_{OP} = 4160$ Volts

$V_{base} = 4000$ Volts

$$Torque_{Motor.at.voltage} = \overrightarrow{[Torque_{rated} \times (\%Volt \times V_{op})^2 / V_{base}^2]} \quad \text{ft-lb}$$

Convert the percentage of motor torque from the curve to motor torque by using the applicable motor torque computed at Vi and V1 above.

$$Torque_{Motor} = \overrightarrow{(Torque_{motor} \times Torque_{Motor.at.voltage})} \quad \text{ft-lb}$$

Torque of the pump is determined by multiplying the pump torque from Ref. 15 by the base torque of the motor.

$$Torque_{Pump} = Torque_{rated} \times \%Torque_{pump} \quad \text{ft-lb}$$

Net torque is the motor torque minus the pump torque:

$$Torque_{Net} = Torque_{Motor} - Torque_{Pump} \quad \text{ft-lb}$$

Speed increment (% of rated RPM):

$$\%\Delta_{rpm} = \%rpm_f - \%rpm_o$$

Time in seconds to accelerate through an RPM increment is calculated by the following:

$$\text{Time} = \overrightarrow{(\text{WK2} \times \text{RPM} \times \%\Delta\text{rpm} / 100) / (307.5 \times \text{Torque}_{Net})} \quad \text{seconds}$$

Cumulative time from 0% to full speed at $\%\Delta_{rpm}$ increments.

Time_{cumul} = Total Cumulative Start Time

Calculations:

%rpm	$\%\text{Torque}_{Motor}$	$\%\text{Torque}_{Pump}$	$\%\text{Torque}_{Net}$	Time	Time_{cumul}
10	388.66	0.00	388.66	0.63	0.63
20	388.66	20.60	368.06	0.66	1.29
30	757.89	51.50	706.39	0.34	1.63
40	767.25	61.80	705.45	0.35	1.98
50	776.61	103.00	673.61	0.36	2.34
60	795.32	154.50	640.82	0.38	2.72
70	860.82	195.70	665.12	0.37	3.09
80	1001.17	257.50	743.67	0.33	3.41
90	1403.51	329.60	1073.91	0.23	3.64
95	2058.48	391.40	1667.08	0.07	3.71
99	2198.83	442.90	1755.93	0.06	3.77

R3

Therefore, the total time for this pump to accelerate is: Time_{cumul} = 3.77 seconds

3) Starting LPCI Pump 3D (700HP)

Motor parameters

Base Voltage (motor rated voltage)	V_{base} = 4000	Volts	(Ref. 59)	R2
Operating Voltage	V_{OP} = 4160	Volts		
Base Current (full load)	I_{FL} = 90	Amps	(Ref. 59)	R2
Locked Rotor Current	$I_{LRC} = I_{FL} \times 5.3$		(Ref. 59)	
	I_{LRC} = 477.0			
Starting Power factor	PF_{start} = 0.229		(Ref. 60)	

Motor Cable data

Conductor Size	3/C - #1/0 -5kV		
Cable Number	30986		
Cable Length (feet)	L = 191	(ETAP)	R2
Cable Impedance (ohms)	Z_{cable} = 0.02445 + j0.00733	(ETAP)	

Motor parameters to be used to determine starting time of the pump.

Motor Base Torque	$Torque_{rated}$ = 1033	ft-lb	(Ref. 59)	R2
WK^2 Pump (wet)	WK_{pump} = 18.1	$lb\text{-}ft^2$	(Ref. 15)	
WK^2 Motor	WK_{motor} = 183.0	$lb\text{-}ft^2$	(Ref. 59)	R2
Motor rated RPM	RPM = 3600		(Ref. 59)	

2) Starting kVA of LPCI Pump 3D

Calculating the starting kVA at base voltage

$SKVA_1 = (\sqrt{3} \times V_{base} \times I_{LRC})/1000$ $SKVA_1 = 3304.8$ R2

Calculating starting kVA at operating voltage

$KVA_{start1} = (V_{op}^2/V_{base}^2) \times SKVA_1$ $KVA_{start1} = 3574.4$ at $Pf_{start} = 0.229$ R2

The starting kVA is converted at starting power factor to the following KW and KVAR values:

Motor parameters

$LPCI_{start} = (KVA_{start1} \times PF_{start}) + j \times [KVA_{start1} \times (\sin(\operatorname{acos}(PF_{start})))]$

$LPCI_{start} = 818.54 + j3479.44$ kVA

ii) There are no additional loads starting with this pump:

Additional Starting auxiliary load: $Load_{start} = 0 + j0$ kVA

iii) When the second LPCI Pump starts, at that time, there are running loads on DG powered Buses. Therefore, the actual voltage drop on the bus will be more than that of the starting of the second LPCI Pump alone. The running kW & kVA from the ETAP DG3_UV_Reset scenario is:

$KW_{ETAP\_100\%} = 919$

$KVAR_{ETAP\_100\%} = 550$

$KVA_{ETAP\_100\%} = 1071$ R3

The current at 100% voltage (i.e. at 4.16kV) from ETAP is:

$I_{run\_100\%} = 148.6$ Amps R3

The KVA & KW from the special ETAP scenario DG3_UV_Vlow for the reduced voltage condition is:

$V_{reduced} = 2496$ Volts

$KW_{reduced} = 916$

$KVAR_{reduced} = 489$

$KVA_{reduced} = 1038$ R3

The power factor from the same ETAP scenario at reduced voltage running load is:

$PF_{reduced} = 0.882$ R3

The calculated current at the reduced voltage for this kVA load from ETAP is:

$I_{reduced} = 240.1$ Amps R3

Therefore, the incremental difference of current is:

$I_{delta} = I_{reduced} - I_{run\_100\%}$

$I_{delta} = 91.50$ Amps | R3

The incremental KVA (KVA_{delta}) used to determine additional starting kVA is

$KVA_{delta} = (\sqrt{3} \times V_{op} \times I_{delta}) / 1000$ $KVA_{delta} = 659.3$ | R3

The incremental running load equivalent is converted to an equivalent KW and KVA from the incremental kVA previously determined

$KVA_{increment} = (KVA_{delta} \times PF_{reduced}) + j \times [KVA_{delta} \times (\sin(\mathrm{acos}(PF_{reduced})))]$

$KVA_{increment} = 581.49 + j310.69$ kVA | R3

iv) The starting KVA equivalent as seen by the DG is calculated as follows:

LPCI Pump 3D starting load:	$LPCI_{start} = 818.54 + j3479.44$	kVA	R3
Additional starting load:	$Load_{start} = 0 + j0$	kVA	
Incremental running load equiv.:	$KVA_{increment} = 581.49 + j310.69$	kVA	R3

Total Starting kVA equivalent:

$Total_{start} = Load_{start} + KVA_{increment} + LPCI_{start}$

$Total_{start} = 1400.03 + j3790.12$ kVA | R3

$$Vector_{start} = \sqrt{Re(Total_{start})^2 + Im(Total_{start})^2}$$

$Vector_{start} = 4040.44$ kVA | R3

To determine the initial starting voltage ($V_{curve\_initial}$) and 1 second recovery voltage (V_{curve_1sec}), use the Dead Load Pickup Curve (SC-5056) and $Vector_{start}$ (calculated above) as "Generator Reactive Load MVA". Multiply the initial and 1 second curve values by 0.97 to account for a -3% curve tolerance.

Initial Voltage Dip:

$V_{curve\_initial}$ = 73.2% of 4160V | R3

$V_{drop} = V_{curve\_initial} \times 0.97$

V_{drop} = 71.00% of 4160V | R3

Voltage recovery after 1 second:

V_{curve_1sec} = 98.1% of 4160V | R3

$V_{drop\_1sec} = V_{curve\_1sec} \times 0.97$

V_{drop_1sec} = 95.16% of 4160V | R3

v) The impedance of the pump feed cable, as defined earlier:

$Z_{cable} = 0.02445 + j0.00733$ ohms

$|Z_{cable}| = 0.0255$ ohms

The maximum motor terminal line-to-line voltage drop which may occur on this cable given the LRC is:

I_{LRC} = 477.0 Amps

$V_{delta\_max} = \sqrt{3} \times I_{LRC} \times |Z_{cable}|$ V_{delta_max} = 21.09 Volts

$V_{delta\_\%} = V_{delta\_max} / V_{op} \times 100$ $V_{delta\_\%}$ = 0.51% of 4160V

Deducting the voltage drop due to motor feed cable to determine the actual voltage at the motor terminals, the initial starting voltage at the motor terminals is:

$V_{initial.LPCI3D} = V_{drop} - V_{delta\_\%}$

$V_{initial.LPCI3D} = 70.50\%$ of 4160V | R3

The voltage after 1 second at the motor terminals is:

$V_{1second.LPCI3D} = V_{drop\_1sec} - V_{delta\_\%}$

$V_{1second.LPCI3D} = 94.65\%$ of 4160V | R3

Calculation of Motor Starting Time:

Initial Starting Voltage (converted to decimal) $Vi = V_{initial.LPCI3D} / 100$

Voltage at 1 second (converted to decimal) $V1 = V_{1second.LPCI3D} /100$

Total inertia of the motor and pump together from above (WK^2):

$WK_{pump} = 18.1$ lb-ft^2 $WK_{motor} = 183.0$ lb-ft^2

$WK2 = WK_{pump} + WK_{motor}$

$WK2 = 201.10$ lb-ft^2

The folowing variables define the speed intervals and corresponding motor and pump torque increments necessary to compute the starting time of the pump.

$\%RPM_o$ - initial RPM of increment as a percentage of rated RPM

$\%RPM_f$ - final RPM of increment as a percentage of rated RPM

$\%Torque_{Motor}$ - motor torque value from pump torque-speed curve read from the midpoint of the applicable speed range.

$\%Torque_{Pump}$ - pump torque value from pump torque-speed curve read from the midpoint of the applicable speed range.

%Volt - either the initial voltage (Vi) or the voltage at 1 second (V1).

Note that the determination of which voltage (%Volt) to use is made when the motor acceleration time exceeds 1 second, and that can only be determined by looking at the calculated cumulative time below (i.e. Vi until 1 second, V1 after that).

%rpm$_o$	%rpm$_f$	%Torque$_{Motor}$	%Torque$_{Pump}$	%Volt
0	10	0.70	0.00	Vi
10	20	0.75	0.02	Vi
20	30	0.75	0.05	V1
30	40	0.75	0.06	V1
40	50	0.75	0.10	V1
50	60	0.80	0.15	V1
60	70	0.85	0.19	V1
70	80	1.00	0.25	V1
80	90	1.40	0.32	V1
90	95	1.85	0.38	V1
95	99	1.50	0.43	V1

R2

Compute the motor torque at the initial voltage (Vi) and at 1 second (V1) using the motor torque at motor rated voltage (Ref 15).

V_{OP} = 4160 Volts

V_{base} = 4000 Volts

$$Torque_{Motor.at\,voltage} = \overrightarrow{[Torque_{rated} \times (\%Volt \times V_{op})^2 / V_{base}^2]} \quad \text{ft-lb}$$

Convert the percentage of motor torque from the curve to motor torque by using the applicable motor torque computed at Vi and V1 above.

$$Torque_{Motor} = \overrightarrow{(Torque_{motor} \times Torque_{Motor.at\,voltage})} \quad \text{ft-lb}$$

Torque of the pump is determined by multiplying the pump torque from Ref. 15 by the base torque of the motor.

$$Torque_{Pump} = Torque_{rated} \times \%Torque_{Pump} \quad \text{ft-lb}$$

Net torque is the motor torque minus the pump torque:

$$Torque_{Net} = Torque_{Motor} - Torque_{Pump} \quad \text{ft-lb}$$

Speed increment (% of rated RPM):

$$\%\Delta_{rpm} = \%rpm_f - \%rpm_o$$

Time in seconds to accelerate through an RPM increment is calculated by the following:

$$\text{Time} = \overrightarrow{(\text{WK2} \times \text{RPM} \times \%\Delta\text{rpm} / 100) / (307.5 \times \text{Torque}_{Net})} \quad \text{seconds}$$

Cumulative time from 0% to full speed at $\%\Delta_{rpm}$ increments.

Time_{cumul} = Total Cumulative Start Time

Calculations:

%rpm	$\%\text{Torque}_{Motor}$	$\%\text{Torque}_{Pump}$	$\%\text{Torque}_{Net}$	Time	Time_{cumul}
10	388.69	0.00	388.69	0.61	0.61
20	416.46	20.66	395.80	0.59	1.20
30	750.71	51.65	699.06	0.34	1.54
40	750.71	61.98	688.73	0.34	1.88
50	750.71	103.30	647.41	0.36	2.24
60	800.75	154.95	645.80	0.36	2.61
70	850.80	196.27	654.53	0.36	2.97
80	1000.94	258.25	742.69	0.32	3.28
90	1401.32	330.56	1070.76	0.22	3.50
95	1851.74	392.54	1459.20	0.08	3.58
99	1501.41	444.19	1057.22	0.09	3.67

R3

Therefore, the total time for this pump to accelerate is: $\text{Time}_{cumul10}$ = 3.67 seconds

4) <u>Starting Core Spray Pump 3B (800HP)</u>

Motor parameters

Base Voltage (motor rated voltage)	V_{base} = 4000	Volts	(Ref. 17)	
Operating Voltage	V_{OP} = 4160	Volts		
Base Current (full load)	I_{FL} = 102	Amps	(Ref. 17)	
Locked Rotor Current	$I_{LRC} = I_{FL} \times 7.00$		(Ref. 17)	
	I_{LRC} = 714.0			
Starting Power factor	PF_{start} = 0.20		(Ref. 17)	

Motor Cable data

Conductor Size	3/C - #4/0 -5kV		
Cable Number	30962		
Cable Length (feet)	L = 148	(ETAP)	R2
Cable Impedance (ohms)	Z_{cable} = 0.00946 + j0.0053	(ETAP)	R2

Motor parameters to be used to determine starting time of the pump.

Motor Base Torque	$Torque_{rated}$ = 1180	ft-lb	(Ref. 15)
WK^2 Pump (wet)	WK_{pump} = 18.1	$lb\text{-}ft^2$	(Ref. 15)
WK^2 Motor	WK_{motor} = 220.0	$lb\text{-}ft^2$	(Ref. 15)
Motor rated RPM	RPM = 3600		(Ref. 15)

2) Starting kVA of Core Spray Pump 3B

Calculating the starting kVA at base voltage

$SKVA_1 = (\sqrt{3} \times V_{base} \times I_{LRC})/1000$ $\quad$ $SKVA_1 = 4946.7$

Calculating starting kVA at operating voltage

$KVA_{start1} = (V_{op}^2/V_{base}^2) \times SKVA_1$ $\quad$ $KVA_{start1} = 5350.4$ $\quad$ at $Pf_{start} = 0.20$

The starting kVA is converted at starting power factor to the following KW and KVAR values:

Motor parameters

$CoreSpray_{start} = (KVA_{start1} \times PF_{start}) + j \times [KVA_{start1} \times (\sin(\mathrm{acos}(PF_{start})))]$

$CoreSpray_{start} = 1070.08 + j5242.29$ kVA

ii) When the Core Spray Pump starts, MOVs 1402-38B, 1402-25B, Turbine Room 3 Emergency Lighting; and RX Building Emergency Lighting will also start operating. The starting load is summarized in Table 4, with the results as follows:

Additional Starting auxiliary load: $Load_{start} = 54.1 + j45.7$ kVA

iii) When the Core Spray Pump starts, at that time, there are running loads on DG powered Buses. Therefore, the actual voltage drop on the bus will be more than that of the starting of the Core Spray Pump alone. The running kW & kVA from the ETAP DG3_T=5sec scenario is:

$KW_{ETAP\_100\%} = 1413$

$KVAR_{ETAP\ 100\%} = 810$

$KVA_{ETAP\_100\%} = 1629$

R3

The current at 100% voltage (i.e. at 4.16kV) from ETAP is:

$I_{run\_100\%} = 226.0$ Amps

The KVA & KW from the special ETAP scenario DG3_T=5sVlow output at reduced voltage are:

R3

$V_{reduced} = 2496$ Volts

$KW_{reduced} = 1412$

$KVAR_{reduced} = 752$

$KVA_{reduced} = 1600$

R3

The power factor from the same ETAP scenario at reduced voltage running load is:

$PF_{reduced} = 0.883$ R3

The calculated current at the reduced voltage for this kVA load from ETAP is:

$I_{reduced} = 370.1$ Amps R3

Therefore, the incremental difference of current is:

$I_{delta} = I_{reduced} - I_{run\_100\%}$

$I_{delta} = 144.10$ Amps | R3

The incremental KVA (KVA_{delta}) used to determine additional starting kVA is

$KVA_{delta} = (\sqrt{3} \times V_{op} \times I_{delta}) / 1000$ $KVA_{delta} = 1038.3$ | R3

The incremental running load equivalent is converted to an equivalent KW and KVA from the incremental kVA previously determined

$KVA_{increment} = (KVA_{delta} \times PF_{reduced}) + j \times [KVA_{delta} \times (\sin(\operatorname{acos}(PF_{reduced})))]$

$KVA_{increment} = 916.81 + j487.34$ kVA | R3

iv) The starting KVA equivalent as seen by the DG is calculated as follows:

Core Spray Pump starting load:	$CoreSpray_{start} = 1070.08 + j5242.29$	kVA	
Additional starting load:	$Load_{start} = 54.1 + j45.7$	kVA	
Incremental running load equiv.:	$KVA_{increment} = 916.81 + j487.34$	kVA	R3

Total Starting kVA equivalent:

$Total_{start} = Load_{start} + KVA_{increment} + CoreSpray_{start}$

$Total_{start} = 2040.99 + j5775.34$ kVA | R3

$$Vector_{start} = \sqrt{Re(Total_{start})^2 + Im(Total_{start})^2}$$

$Vector_{start} = 6125.37$ kVA | R3

To determine the initial starting voltage ($V_{curve\_initial}$) and 1 second recovery voltage (V_{curve_1sec}), use the Dead Load Pickup Curve (SC-5056) and $Vector_{start}$ (calculated above) as "Generator Reactive Load MVA". Multiply the initial and 1 second curve values by 0.97 to account for a -3% curve tolerance.

Initial Voltage Dip:

$V_{curve\_initial} = 64.1\%$ of 4160V | R2

$V_{drop} = V_{curve\_initial} \times 0.97$

$V_{drop} = 62.18\%$ of 4160V | R2

Voltage recovery after 1 second:

$V_{curve\_1sec} = 91.2\%$ of 4160V | R2

$V_{drop\_1sec} = V_{curve\_1sec} \times 0.97$

$V_{drop\_1sec} = 88.46\%$ of 4160V

v) The impedance of the pump feed cable, as defined earlier: R2

$Z_{cable} = 0.00946 + j0.0053$ ohms

$|Z_{cable}| = 0.0108$ ohms

The maximum motor terminal line-to-line voltage drop which may occur on this cable given the LRC is:

$I_{LRC} = 714.0$ Amps

$V_{delta\_max} = \sqrt{3} \times I_{LRC} \times |Z_{cable}|$ $V_{delta\_max} = 13.41$ Volts

$V_{delta\_\%} = V_{delta\_max} / V_{op} \times 100$ $V_{delta\_\%} = 0.32\%$ of 4160V | R2

Deducting the voltage drop due to motor feed cable to determine the actual voltage at the motor terminals, the initial starting voltage at the motor terminals is:

$$V_{initial.CSP3B} = V_{drop} - V_{delta\_\%}$$
$$V_{initial.CSP3B} = 61.85\% \quad \text{of } 4160V$$ R2

The voltage after 1 second at the motor terminals is:

$$V_{1second.CSP3B} = V_{drop\_1sec} - V_{delta\_\%}$$
$$V_{1second.CSP3B} = 88.14\% \quad \text{of } 4160V$$ R2

Calculation of Motor Starting Time:

Initial Starting Voltage (converted to decimal) $Vi = V_{initial.CSP3B} / 100$

Voltage at 1 second (converted to decimal) $V1 = V_{1second.CSP3B} / 100$

Total inertia of the motor and pump together from above (WK^2):

$WK_{pump} = 18.1$ $lb\text{-}ft^2$ $WK_{motor} = 220.0$ $lb\text{-}ft^2$

$$WK2 = WK_{pump} + WK_{motor}$$

$$WK2 = 238.10 \quad lb\text{-}ft^2$$

The folowing variables define the speed intervals and corresponding motor and pump torque increments necessary to compute the starting time of the pump.

$\%RPM_o$ - initial RPM of increment as a percentage of rated RPM

$\%RPM_f$ - final RPM of increment as a percentage of rated RPM

$\%Torque_{Motor}$ - motor torque value from pump torque-speed curve read from the midpoint of the applicable speed range.

$\%Torque_{Pump}$ - pump torque value from pump torque-speed curve read from the midpoint of the applicable speed range.

%Volt - either the initial voltage (Vi) or the voltage at 1 second (V1).

Note that the determination of which voltage (%Volt) to use is made when the motor acceleration time exceeds 1 second, and that can only be determined by looking at the calculated cumulative time below (i.e. Vi until 1 second, V1 after that).

R2

%rpm$_o$	%rpm$_f$	%Torque$_{Motor}$	%Torque$_{Pump}$	%Volt
0	10	0.89	0.00	Vi
10	20	0.90	0.00	Vi
20	30	0.90	0.02	V1
30	40	0.90	0.06	V1
40	50	0.90	0.13	V1
50	60	0.94	0.20	V1
60	70	1.02	0.26	V1
70	80	1.18	0.35	V1
80	90	1.61	0.46	V1
90	95	2.25	0.58	V1
95	99	2.35	0.65	V1

Compute the motor torque at the initial voltage (Vi) and at 1 second (V1) using the motor torque at motor rated voltage (Ref 15).

V_{OP} = 4160 Volts

V_{base} = 4000 Volts

$$Torque_{Motor.at.voltage} = \overrightarrow{[Torque_{rated} \times (\%Volt \times V_{op})^2 / V_{base}^2]} \quad \text{ft-lb}$$

Convert the percentage of motor torque from the curve to motor torque by using the applicable motor torque computed at Vi and V1 above.

$$Torque_{Motor} = \overrightarrow{(Torque_{motor} \times Torque_{Motor.at.voltage})} \quad \text{ft-lb}$$

Torque of the pump is determined by multiplying the pump torque from Ref. 15 by the base torque of the motor.

$$Torque_{Pump} = Torque_{rated} \times \%Torque_{Pump} \quad \text{ft-lb}$$

Net torque is the motor torque minus the pump torque:

$$Torque_{Net} = Torque_{Motor} - Torque_{Pump} \quad \text{ft-lb}$$

Speed increment (% of rated RPM):

$$\%\Delta_{rpm} = \%rpm_f - \%rpm_o$$

Time in seconds to accelerate through an RPM increment is calculated by the following:

$$\text{Time} = (\text{WK2} \times \text{RPM} \times \%\Delta\text{rpm} / 100) / (307.5 \times \text{Torque}_{Net}) \quad \text{seconds}$$

Cumulative time from 0% to full speed at $\%\Delta_{rpm}$ increments.

Time_{cumul} = Total Cumulative Start Time R2

Calculations:

$\%rpm_f$	$\%Torque_{Motor}$	$\%Torque_{Pump}$	$\%Torque_{Net}$	Time	$Time_{cumul}$
10	434.59	0.00	434.59	0.64	0.64
20	439.48	0.00	439.48	0.63	1.28
30	892.39	23.60	868.79	0.32	1.60
40	892.39	70.80	821.59	0.34	1.94
50	892.39	153.40	738.99	0.38	2.31
60	932.05	236.00	696.05	0.40	2.71
70	1011.37	306.80	704.57	0.40	3.11
80	1170.02	413.00	757.02	0.37	3.48
90	1596.38	542.80	1053.58	0.26	3.74
95	2230.97	684.40	1546.57	0.09	3.83
99	2330.12	767.00	1563.12	0.07	3.90

R2

Therefore, the total time for this pump to accelerate is: $\text{Time}_{cumul10}$ = 3.90 seconds

5) Starting of Containment Cooling Service Water Pump 3D (500HP) R2

Motor parameters

Base Voltage (motor rated voltage)	V_{base} = 4000	Volts	(Ref. 26)
Operating Voltage	V_{OP} = 4160	Volts	
Base Current (full load)	I_{FL} = 67	Amps	(Ref. 26)
Locked Rotor Current	$I_{LRC} = I_{FL} \times 5.91$		(Ref. 52 & 43)
	I_{LRC} = 395.97		
Starting Power factor	PF_{start} = 0.20		(Ref. 41)

i) Starting kVA of CCSW Pump

Calculating the starting kVA at base voltage

$SKVA_1 = (\sqrt{3} \times V_{base} \times I_{LRC})/1000$ $SKVA_1 = 2743.4$

Calculating starting kVA at operating voltage

$KVA_{start1} = (V_{op}^2/V_{base}^2) \times SKVA_1$ $KVA_{start1} = 2967.2$ at $Pf_{start} = 0.20$

The starting kVA is converted at starting power factor to the following KW and KVAR values:

$CCSW_{start} = (KVA_{start1} \times PF_{start}) + j \times [KVA_{start1} \times (\sin(\text{acos}(PF_{start})))]$

$CCSW_{start} = 593.44 + j2907.27$ kVA

ii) The CCSW Pumps are turned on manually between 10 minutes and 2 hours depending on the situation. For the purpose of this calculation the CCSW Pump 3D is turned on by the operator after 10 minutes into the event and CCSW Pump 3C is turned on shortly after CCSW Pump 3D.

The CC Heat exchanger Discharge Valve is required to operate to exchange CC residual heat with the CCSW system. When CCSW Pump 3D starts, the Containment Cooling Heat Exchanger Discharge Valve (3-1501-3B) also starts. When CCSW Pump 3C starts, the CC Heat Exchanger Discharge Valve is considered to be in operation (i.e. running load), however, at this time the CCSW Pump Cubical Cooler Fans (total 4) are also starting. R2

This calculation will only calculate the voltage dip due to the starting of CCSW Pump 3D (the first CCSW pump) instead of CCSW Pump 3C because the starting kVA (due to the votlage dip) for the load already on the diesel when the 3D pump starts is the largest. However, the 3D pump is evaluated with the starting kVA of the loads that start concurrently with the 3C CCSW pump as this load is greater than the load starting concurrently with the 3D CCSW pump. The starting load is summarized in Table 4, with the results as follows: R2

Additional Starting auxiliary load: $Load_{start} = 62.7 + j67.6$ kVA

iii) When the CCSW Pump 3D starts, there are running loads on DG powered Buses. Therefore, the actual voltage drop on the bus will be more than that of the starting of the CCSW Pump 3D alone.

All of the valves which are initiated by LOOP/LOCA have completed their operations and have stopped operating before CCSW Pump 3D was started. Therefore, these valve loads are taken off from the initial running load.

The running kW & kVA from the ETAP scenario DG3_T=10-min is:

$$KW_{ETAP\_100\%} = 2106$$
$$KVAR_{ETAP\ 100\%} = 1095$$
$$KVA_{ETAP\_100\%} = 2374$$

R3

The current at 100% voltage (i.e. at 4.16kV) from ETAP is:

$I_{run\_100\%} = 329.4$ Amps

The KVA & KW from the special ETAP scenario DG3_T=10-mVL for the reduced voltage condition is:

R3

$V_{reduced} = 2496$ Volts

$$KW_{reduced} = 2084$$
$$KVAR_{reduced} = 1024$$
$$KVA_{reduced} = 2322$$

R3

The power factor from the same ETAP scenario at reduced voltage running load is:

$PF_{reduced} = 0.897$ R3

The calculated current at the reduced voltage for this kVA load from ETAP is:

$I_{reduced} = 537.2$ Amps R3

Therefore, the incremental difference of current is:

$I_{delta} = I_{reduced} - I_{run\_100\%}$

$I_{delta} = 207.80$ Amps | R3

The incremental KVA (KVA_{delta}) used to determine additional starting kVA is

$KVA_{delta} = (\sqrt{3} \times V_{op} \times I_{delta}) / 1000$ $KVA_{delta} = 1497.3$ | R3

The incremental running load equivalent is converted to an equivalent KW and KVA from the incremental kVA previously determined

$KVA_{increment} = (KVA_{delta} \times PF_{reduced}) + j \times [KVA_{delta} \times (\sin(\mathrm{acos}(PF_{reduced})))]$

$KVA_{increment} = 1343.05 + j661.84$ kVA | R3

iv) The starting KVA equivalent as seen by the DG is calculated as follows:

CCSW Pump 3D starting load:	$CCSW_{start} = 593.44 + j2907.27$	kVA	
Additional starting load:	$Load_{start} = 62.7 + j67.6$	kVA	
Incremental running load equiv.:	$KVA_{increment} = 1343.05 + j661.84$	kVA	R3

Total Starting kVA equivalent:

$Total_{start} = Load_{start} + KVA_{increment} + CCSW_{start}$

$Total_{start} = 1999.19 + j3636.71$ kVA | R3

$$Vector_{start} = \sqrt{Re(Total_{start})^2 + Im(Total_{start})^2}$$

$Vector_{start} = 4149.99$ kVA | R3

To determine the initial starting voltage ($V_{curve\_initial}$) and 1 second recovery voltage (V_{curve_1sec}), use the Dead Load Pickup Curve (SC-5056) and $Vector_{start}$ (calculated above) as "Generator Reactive Load MVA". Multiply the initial and 1 second curve values by 0.97 to account for a -3% curve tolerance.

Initial Voltage Dip:

$V_{curve\_initial}$ = 72.7% of 4160V | R3

$V_{drop} = V_{curve\_initial} \times 0.97$

V_{drop} = 70.52% of 4160V | R3

Voltage recovery after 1 second:

V_{curve_1sec} = 97.9% of 4160V | R3

$V_{drop\_1sec} = V_{curve\_1sec} \times 0.97$

V_{drop_1sec} = 94.96% of 4160V | R3

XI COMPARISON OF RESULTS WITH ACCEPTANCE CRITERIA

A. Continuous loading of the Diesel Generator

The results of the calculation show that the maximum continuous load on the Diesel Generator is 2562 kW (ETAP Scenario DG3_T=10+min), which is below the 2600kW continuous rating of the Diesel Generator. This loading value occurs only while the 1st CCSW pump is energized and prior to de-energizing one of the LPCI pumps. The maximum long term DG loading is 2385kW when both CCSW pumps are in operation (DG3_T=10++m and DG3_CRHVAC). Therefore, from a continuous loading point of view the DG 3 has adequate capacity to accept the emergency load under LOOP concurrent with LOCA in accordance with the acceptance criteria. R3

If the EDG is at 102% of its nominal frequency, the EDG load is expected to be 1.02^3 or 1.06 times larger since input power is proportional to the speed cubed (Section V.5). This results in a maximum loading of $2562kW \times 1.02^3 = 2719kW$ which is within the 2000 hr 2860kW rating of the diesel. R3

The lowest power factor for the EDG load during the DG3_T=10+m, DG3_T=10++m and DG3_CRHVAC is 88.8%. This value is above the 88% acceptance criteria.

B. Transient loading of the Diesel Generator

Results of this calculation show that the minimum recovery voltage after 1 second following the start of any large 4-kv motors is 88.4% of 4160v which is above the 80% recovery requirement in the acceptance criteria.

This calculation shows that when the Core Spray Pump starts, the initial voltage dips below 63% of operating voltage (i.e. 4160v). However, within 1 second after the start, voltage recovers to above 88% of 4160v. This voltage dip and recovery analysis utilizes the results of dynamic DG characteristics reflected in the manufacturer's curve. The curve includes the combined effect of exciter and governor in order to provide recovery voltages.

In this calculation, the voltage dip was conservatively calculated from the Dead Load Pick up curve utilizing the total KVA loading on the DG bus. The Dead Load Pickup curve indicates that reactive load (KVAR) should be used to determine the voltage dip when using this curve. Even with that conservatism, the minimum voltage recovery after 1 second following the start is greater than 88% of 4160v. After one second, the voltage will continue to improve due to exciter and governor operation. These recovery voltages during the motor starting period (after the first second) are much better than the voltage expected during operation from the offsite power source under degraded voltage condition.

Due to momentary sharp voltage drops to approximately 62% during large motor starting, certain contactors or relays may drop out, and that could use some control circuits to de-energize. The required loads all have start signals which will be present through the voltage dip, and therefore, will be capable of restarting after the voltage dip. The calculation shows that the voltage will recover to more than 88% within 1 second following the start and will continue recover to 100% voltage due to exciter and governor operation. Strip chart (Ref. 23) of the DG surveillance tests show that the DG recover to 100% of rated voltage within 3 to 4 seconds. The 480v loads which may drop out will experience recovery voltages sufficient to pick up at different times due to variations in the network impedances (such as cable size and length) and variations in loading in each bus. This diverse restarting of 480v loads will have minimum impact on the DG performance.

Due to this momentary sharp drop, operating valves may stop momentarily. However, Table 2 of this calculation shows that these valves would start operating again as soon as the sufficient operating voltage is recovered. The analysis in Table 2 shows that the momentary voltage drop will not cause any unacceptable effect on the valve operation. The momentary drop may cause the operating time of those valves to increase by 2 seconds. Even with that pause, the increased operating time is below the time limit set by various Dresden Operating Procedures (see References 47 through 51 and Ref. 53).

For LOOP concurrent with LOCA the minimum voltage recovery is more than 88% after one second following the Core Spray motor start. The voltage will continue to improve after one second due to the excitor and governor characteristics. Due to the momentary nature of this dips the duration of starting current at reduced voltage is shorter. Because protective devices are set to allow adequate starting time at motor rated voltage and during operation from offsite power (voltages from offsite power will be much worse than the voltages when powered by the DG), the protective device operation due to over current is not a concern when operating from the DG power during LOOP concurrent with LOCA. Section X.F discussed whether protective devices will operate during system voltage dips. It was concluded that protective device (e.g. TOL s and MCC feed breakers) operation is not a concern during the short voltage dips.

Starting times for large motors during LOOP concurrent with LOCA were calculated to ensure the starting times of LPCI Pumps do not exceed 5 seconds (when the second pump starts the first pump is in full speed, likewise when the Core Spray starts the second LPCI pump is in running condition).

XII CONCLUSIONS

The results of the calculation show that the maximum continuous running load under the maximum loading scenario is less than the continuous 2600kW rating. The loading of the DG at maximum frequency of 102% is within the 2000hr nameplate rating. Also, the worst voltage recovery after one second following the start of large 4kv motor (Core Spray Pump Motor) is above 88% of DG terminal rated voltage. This 88% voltage recovery is above the minimum voltage recovery of 80% per the DG specification K-2183 requirement. The worst case power factor from the DG3_T=10+m time period and after is 88.8% which is above the 88% criteria. R3

The starting times for LPCI Pumps 3C, and 3D are less than 4 seconds, and the starting time for Core Spray Pump 3B is less than 5 seconds. All of these pump starting times are below the maximum allowable starting time of 5 seconds, and therefore, are acceptable. R3

Also, the analysis in Table 2, and the detailed explanation under the Calculation and Results section show that while some of the control circuits may dropout during the lowest portion of the voltage dip, no adverse effects are identified and no protective devices are expected to operate. This calculation also shows that momentary voltage dip will not cause the travel time of any MOV to increase any longer than allowable.

XIII. RECOMMENDATIONS

None

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CALCULATION PAGE

XIV REFERENCES

1) S & L Standard ESI-167, Revision 4-16-84, Instruction for Computer Programs.

2) Operation Technology Software, ETAP PowerStation & Users Manual, Version 5.5.0N R3

3) Not used

4) Dresden DG 3 Calculation 7317-33-19-1, Revision 11. (superseded).

5) Quad Cities DG 1 Calculation 7318-33-19-1, Revision 0.

6) Dresden Units 2 & 3, Equipment Manual from GE, Number GEK-786.

7) Dresden Re-baselined Updated FSAR, Revision 0.

8) Guidelines for Estimating Data (Used by Electrical Analytical Division in Various Projects like Clinton, Byron & Braidwood), which is used for determining % PF and efficiency (Attached).

9) ANSI / IEEE C37.010-1979 for Determining X/R Range for Power Transformers, and 3-phase Inductor Motor,

10) S & L Standard ESA-104a, Revision 1-5-87, Current Carrying Capacities of Copper Cables.

11) S & L Standard ESA-102, Revision 4-14-93, Electrical & Physical Characteristics of Electrical Cables.

12) Specification for Diesel Engine Generator Sets K-2183, Pages 3 and 8 (Attached).

13) Dead Load Pickup Capability (Locked Rotor Condition) - Generator Reactive Load vs. % Voltage Graph (#SC-5056) by Electro-Motive Division (EMD) (Attached).

14) Speed - Torque - Current Curve (#297HA945-2) for Core Spray Pump by GE (Attached).

15) Speed - Torque - Current Curve (#857HA264) for RHR/LPCI Pump by GE (Attached).

16.

Drawing No	Rev.	Drawing No	Rev.
12E-2306	W	12E-3420B	R
12E-23351B, Sh. 3	Z	12E-3420C	D
12E-2344, Sh. 2	P	12E-3425	L
12E-2344, Sh. 1	P	12E-3429, Sh. 1	P
12E-2344, Sh. 3	P	12E-3429, Sh. 2	P
12E-2344, Sh. 4	P	12E-3430, Sh. 1	AH
12E-2346, Sh. 2	AF	12E-3430. Sh. 2	AH
12E-2346, Sh. 1	AC	12E-3431, Sh. 1	R
12E-2346, Sh. 3	AB	12E-3431, Sh. 2	S
12E-2348	F	12E-3432	P
12E-2349, Sh. 1	W	12E-3433	K
12E-2349, Sh. 2	W	12E-3435, Sh. 1	P
12E-2349, Sh. 3	W	12E-3435, Sh. 2	P
12E-2350A, Sh. 1	AB	12E-3435, Sh. 3	P
12E-2350A, Sh. 2	AB	12E-3436, Sh, 1	K
12E-2350B, Sh. 2	X	12E-3436, Sh, 2	L
12E-2350B, Sh. 1	V	12E-3436, Sh, 3	K
12E-2350B, Sh. 2	V	12E-3436, Sh, 4	K
12E-2351B, Sh. 2	AC	12E-3438, Sh. 1	AA
12E-2351B, Sh. 1	AA	12E-3438, Sh. 2	Z
12E-2374	T	12E-3439	H
12E-2375	M	12E-3440, Sh. 1	T
12E-2389	B	12E-3440, Sh. 2	U
12E-2389	C	12E-3440, Sh. 3	T
12E-2393	N	12E-3441, Sh. 1	N
12E-2400A	S	12E-3441, Sh. 2	N

12E-2400B	M	12E-3441, Sh. 3	N
12E-2400B	M	12E-3441, Sh. 4	N
12E-2400C, Sh. 2	AA	12E-3509, Sh. 2	W
12E-2400C, Sh. 1	AA	12E-3522	K
12E-2429, Sh. 2	X	12E-3529	W
12E-2431, Sh. 2	X	12E-3531	R
12E-2431, Sh. 1	X	12E-3532	N
12E-2432	Y	12E-3546A, Sh. 1	F
12E-2433	M	12E-3546A, Sh. 2	F
12E-2435, Sh. 1	X	12E-3547A	A
12E-2436, Sh. 1	W	12E-3547B	D
12E-2436, Sh. 3	W	12E-3548	H
12E-2440, Sh. 2	Z	12E-3592	J
12E-2440, Sh. 1	Z	12E-3577E	S
12E-2440, Sh. 3	Z	12E-3654B	P
12E-2441, Sh. 3	W	12E-3662B	D
12E-2441, Sh.		12E-3674A	AB
12E-2441, Sh. 1	W	12E-3674B	R
12E-2441, Sh. 4	W	12E-3674C	AC
12E-2441A	W	12E-3674D	W
12E-2531	AB	12E-3677C	L
12E-2532	V	12E-3677G	K
12E-2592	J	12E-3678A	P
12E-2661B	T	12E-3678B	T
12E-2668A	M	12E-3679A	AD
12E-2678B	U	12E-3679B	E
12E-2678C	E	12E-3679C	D

12E-2811B	E	12E-3811B	G
12E-3301	X	12E-6555A	E
12E-3302A	J	12E-6556	E
12E-3302B	R	12E-6606A	B
12E-3303	G	12E-6811A	4
12E-3304	Q	12E-6811B	5
12E-3305	Y	12E-6811D	5
12E-3306	Q	12E-7552, Sh.2	R
12E-3311	AD	12E-7555A	E
12E-3312	AD	12E-7556	E
12E-3314	H	12E-7820	L
12E-3319, Sh. 1	Q	12E-7820A	F
12E-3319, Sh. 2	Q	12E-7820B	E
12E-3319, Sh. 3	S	M-1297	C
12E-3320	U	M-173	M
12E-3344, Sh. 1	Q	M-22	AZ
12E-3344, Sh. 2	Q	M-269	L
12E-3344, Sh. 3	Q	M-27	WX
12E-3344, Sh. 4	Q	M-274	A
12E-3346, Sh. 1	AE	M-274	D
12E-3346, Sh. 2	AE	M-29, Sh. 2	P
12E-3347	F	M-29, Sh. 1	AT
12E-3348	F	M-355	MZ
12E-3349	M	M-358	AR
12E-3350B	Z	M-360, Sh. 2	L
12E-3372	L	M-360, Sh. 1	UC
12E-3374	P	M-374	AL

12E-3389	R	M-41, Sh, 1	KK
12E-3393	F	M-41, Sh. 2	E
12E-3397	H	M-49	PP
12E-3398	C	M-51	AE
12E-3420A	P	M-529	K

In addition to the above listed drawings, any drawings listed in Table 1 or Table 2 are also considered as references for this calculation.

17.) GE Drawing 992C510AB, Dresden Core Spray Pump Motor (Attached).

18.) GE Drawing 992C510, Dresden LPCI Pump Motor (Attached).

19.) IEEE Standard 399-1980, Chapter 8, for determining motor starting voltage drop at the source when some running load is already present

20.) S & L Standard, ESI-253, Revision 12-6-91, Electrical Department instruction for preparation, review, and approval of electrical design calculations

21.) S & L Standard ESC-307, Revision 1-2-64, for checking voltage drop in starting ac motors

22.) Western Engine letter dated 1/19/87 to Mr. Wayne Hoan identifying the voltage dip curve applicable to Dresden and Quad Cities (Attached).

23.) Strip Charts (2) for Diesel Generator Surveillance Test: Dated December 10, 1992 and May 22, 1993 (Attached)

24.) Walkdown Data for Diesel Generator 3 dated April 15, 1994 (Attached).

25.) DIT DR-EAD-0001-00 regarding the Battery Charger and UPS Models (Attached).

26.) CCSW Pump Motor Walkdown information. (Attached)

27.) Dresden Unit 3 Electrical Load Monitoring System (ELMS) - AC, Calculation Number 7317-43-19-2, Revision 16, ELMS File: D3A4CONF.M30

28.) DIT DR-EPED-0863-00 (Attached).

29.) CIS-2: Tabulation for cables lengths (Applicable pages attached)

CALCULATION PAGE

30) Dresden Re-baselined Updated FSAR, Revision 0, Table 8.3-3; DG loading due to Loss of Offsite AC Power. (Attached)

31) Dresden Re-baselined Updated FSAR, Revision 0, Figure 8.3-5, DG loading under Accident and during Loss of Offsite AC Power. (Attached)

32) Dresden Station Fire Protection Reports -- Safe Shutdown Report dated July 1993, Table 3.1-1, DG Loading for Safe Shutdown. (Attached)

33) Dresden Station Procedure DGA-12, Rev. 55, "Partial or Complete Loss of Offsite Power"

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34) S&L Calculation 9198-18-19-4, Rev. 003, 003A & 003B, entitled "Calculation for Dresden 3/II Safety-Related Continuous Load Running/Starting Voltages"

35) ComEd Technical Information Manual Section TID-E/I&C-02, Rev. 0

36) Calculation for Evaluation of 3HP, 460V CCSW Motor Minimum Voltage Starting Requirements; Calculation Number 9215-99-19-1, Revision 1.

37) 4160 Volt Switchgear Sepcification K-3141 (page 3-5 attached)

38) Calculation for Single Line Impedance Diagrams for ELMS-AC; Calculation 7317-38-19-1, Revision 1.

39) S & L Standard ESC-193, Revision 9-2-86, Page 5 for Determining Motor Starting Power Factor.

40) Not Used

41) S & L Standard ESC-165, Revision 11-3-92, Electrical Engineering Standard for Power Plant Auxiliary Power System Design.

42) Letter addressed to E. Guse from G.C. Mulick dated March 8, 1967 regarding EMD Inquiry No. 66-708 (attached).

43) Dresden Station Procedure DOS-6600-04, Rev 5, (Pages 1 and 43 attached)

44) S&L Calculation 8231-03-19-1, Rev 1, dated 2/20/90, entitled "LPCI/RHR Swing Bus (MCC 39-7/38-7) Relay Settings"

45) S&L Report SL-4500, Volumes 1-3, entitled "Overcurrent Protective Device coordination study, Dresden Station – Unit and 3", dated 3/24/89

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46) Dresden Original FSAR, 3/22/68

47) Memorandum from R.M. Dahlgren to C.A. Tobias dated December 30, 1994 entitled "Stroke Times for Motor Operated Valves" (Attached).

48) CHRON Letter 0302643 from E.J. Rowley to T. Reid dated 6/21/94 entitled "Dresden Units 2 and 3 Generic Letter 89-10 MOV Design Review ECCS MOV Stroke Time Changes." (Attached).

49) Dresden Station Procedure DOS 1600-18, Revision 15; (pages 1, 18, 21 & 23 attached)

50) Dresden Station Procedure DOS 1600-5, Revision 4; (pages 1, 39, 44 attached)

51) Dresden Station Procedure DOS 7500-2, Revision 11; (pages 1, 15 attached)

52) Hand Calculation of CCSW Pump Locked Rotor Current (attached)

53) Comparison table of MOV measured stroke times vs. their acceptable limits (Attached).

54) Dresden Station Procedure DIS 7500-1, Revision 12

55) Calculation DRE04-0019, Rev. 000B, "Auxiliary Power Analysis for Dresden Unit 3"

56) OPL-4, Rev. 003, GE LOCA Analysis Inputs for Dresden 2 & 3 and Quad Cities 1 & 2.

57) MOV 2-1501-22A & B Field Data Sheet dated 3/13/03, (Attachment R)

58) GE correspondence, Containment Cooling Service Water Pumps – Motor Ratings, dated 2/25/71 (Attachment R)

59) LPCI Pump 3D Replacement Motor Data Sheet, DS2831204, Rev. 01 (Attachment R)

60) LPCI Pump 3D Replacement Motor Test Report, SN 283003667, dated 06/03/03 (Attachment R)

61) LPCI Pump 3D Replacement Motor Starting Characteristics, SC2831024, Rev. 00 (Attachment R)

62) EC 342134, Replace LPCI Pump Motor 3-1502-D with an Equivalent Motor Supplied by the OEM.

63) EC 358579, Rev 000, Controlled Document Changes Required to Support Closure of Operability Evaluation 05-005.

64) Calculation DRE07-0003, Rev. 000, "EDG Loading for CCSW Pump – LOCA Long Term Cooling"

65) Calculation DRE07-0002, Rev. 000, "EDG Loading for LPCI Pump – LOCA Long Term Cooling"

66) Calculation DRE07-0001, Rev. 000, "EDG Loading for CS Pump – LOCA Long Term Cooling" R3

67) Calculation 8982-13-19-4, Rev. 001A, "Evaluation of 460V Diesel Generator Cooling Water Pump Minimum Starting Voltage:

68) EC 347744, Rev. 000, "Replace Diesel Generator Cooling Water Pump and Motor with New Pump and Motor – U3"

69) TODI-07-003, Dated 2/1/07, "EDG Design Input Loading – RPS MG Set Unloaded" (Attachment R)

70) Operability Evaluation 06-002, Rev. 002, Dwg. 12E-3531, Rev. AE

71) A/R No. 00583950, "UFSAR Figures 8.3-4, -5, -6, -7 EDG Load Profile Discrepancies"

72) A/R No. 00578451, "DG Frequency Tolerance Band not Reflected in Calculations"

73) Technical Specification Section SR 3.8.1.12, SR 3.8.1.16 & SR 3.8.1.19, Amendment 185/180 R3

74) UFSAR Table 8.3.1, Rev. 5

75) Cameron Hydraulic Data, Copyright 1995 by Ingersoll-Dresser Pump Co (Attachment R).

76) Technical Specification Section SR 3.8.1.15, Amendment 185/180

77) EC 364072, Rev. 000, "Evaluate and Determine Power Factor and KVAR Range for Emergency Diesel Generator 24-Hour Endurance Test."

SARGENT & LUNDY ENGINEERS	Calculation For Diesel Generator 3 Loading Under Design Bases Accident Condition	Calc. No. 9389-46-19-1
	X Safety-Related / Non-Safety-Related	Rev. 0 Date
		Page A1 of

Client ComEd	Prepared by	Date
Project Dresden Station Unit 3	Reviewed by	Date
Proj. No. 9389-46 Equip. No.	Approved by	Date

Attachment A

Table 1
Automatically Turn On and Off Devices Under the
Design Basis Accident Condition
Dresden Station - Unit 3

Bus No.	Equipment Description/No.	Load Shed	Known Fact	Assumption / Engineering Judgement	Dwg. Ref.	Rev	Other Ref. (P & ID)
34-1	RX Bldg Cooling Water Pump 3B (3-3701-B)	Yes	Trip due to core spray initiation. Will not auto start.		12E-3397	H	M-353
34-1	RX Shutdown Cooling Water Pump 3C (3-1002-C)	Yes	Trip due to UV relay and will not auto start.		12E-3516 12E-3517	C D	M-353
34-1	RX Cleanup Recirc. Pump 3B (3-1205-B)	Yes	Trip due to UV relay and will not auto start.		12E-3520	J	M-353
34-1	RX Shutdown Cooling Pump 3B (3-1002-B)	Yes	Trip due to UV relay and will not auto start.		12E-3516	C	M-353
34-1	Core Spray Pump 3B (3-1401-B)	No	Starts 10 Sec. after UV relay resets.		12E-3429	L	M-358
34-1	LPCI Pump 3C (3-1502-C)	No	Starts 0 Sec. after UV relay resets.		12E-3436 Sh.3	K	M-360 Sh.1
34-1	LPCI Pump 3D (3-1502-D)	No	Starts 5 Sec. after UV relay resets.		12E-3436 Sh.4	K	M-360 Sh.1
34-1	RX Bldg. Cooling Water Pump 2/3 (2/3-3701)	Yes	Trip due to UV relay and will not auto start.		12E-3397	H	M-20
34-1	Bus Tie between 24-1 and 34-1	Yes	N.O. and will not autoclose	Operation of the crosstie is manually activated at Operation's discretion, and assumed off for this calculation.	12E-3346 Sh. 1	AH	

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Dresden Station - Unit 3

Bus No.	Equipment Description/No.	Load Shed	Known Fact	Assumption / Engineering Judgement	Dwg. Ref.	Rev	Other Ref. (P & ID)
34-1	480V Gatehouse MCC	Yes	Trip due to UV relay and will not auto load.		12E-3656D 12E-3346 Sh. 2	H AL	
39	Fuel Pool Cooling Water Pump 3B (3-1902-B)	Yes	Trip due to UV relay and will not auto start.		12E-3548	H	M-362
39	Recirc. M-G Sets Vent Fan 3B (3-5701-B)	No	Trip due to UV relay and will not restart due to the presence of LOCA and UV signals		12E-3420C	D	
39	480 V Turb Bldg MCC 26-4 Reserve Feed (2-7326-40)	Yes	Operates only by manual action.		12E-3661H	D	
39	South Turbine Bldg. Vent Fan 3B (3-5702-B)	Yes	Trip due to UV relay and will not restart due to the presence of LOCA and UV signals		12E-3387B	E	
39	RX Bldg. Vent Fan 3B (3-5703-B)	Yes	Trip due to UV relay and will not auto start.		12E-3399A	E	
39	RX Bldg. Exhaust Fan 3B (3-5704-B)	Yes	Trip due to UV relay and will not auto start.		12E-3399A	E	
39	RX Bldg. Exhaust Fan 3C (3-5704-C)	Yes	Trip due to UV relay and will not auto start.		12E-3399A	E	
39	120/240 VAC Uninterruptable Power Supply Panel 903-63	No	Starts operating at 0 Sec.		12E-3811B	G	

Table 1
Automatically Turn On and Off Devices Under the
Design Basis Accident Condition
Dresden Station - Unit 3

Bus No.	Equipment Description/No.	Load Shed	Known Fact	Assumption / Engineering Judgement	Dwg. Ref.	Rev	Other Ref. (P & ID)
39	Drywell Cooler Blower 3C, 3D, & 3E (3-5734-C, D, E)	Yes	Trip due to core spray initiation and will not auto start.		12E-3393	F	M-273
39	480V MCC 39-3	Yes	This MCC is load shed, no loads are energized for LOCA mitagation.		12E-3374	U	
39	480V MCC 39-5	Yes	This MCC is load shed, no loads are energized for LOCA mitagation.		12E-3374	U	
39	480V MCC 39-6	Yes	This MCC is load shed, no loads are energized for LOCA mitagation.		12E-3374	U	
MCC 39-1	Distribution Transformer Feed (9 KVA)	No	Will start operating at 0 Sec.		12E-3593	D	
MCC 39-1	Standby Liquid Control Pump 3B (3-1102B)	Yes	Manually operated load. Not used in LOCA event.		12E-3460 Sh.2	W	M-364
MCC 39-1	Drywell & Torus Purge Exhaust Fan 3B (3-5708B)	Yes	Will not operate due to high drywell pressure and low water level.		12E-3393	F	M-529
MCC 39-1	Core Spray Outbd. Isol. Valve 3B (3-1402-24B)	No	N.O. and interlock open with high drywell and low water level.		12E-3431 Sh.2	A	M-358
MCC 39-1	Core Spray Inbd. Isol. Valve 3B (3-1402-25B)	No	N.C. but interlock open with high drywell press or low water level after UV relay resets.	Assume to open concurrent with Core Spray Pump, resulting in highest concurrent load. (Conservative)	12-3431 Sh.2	A	M-358

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Automatically Turn On and Off Devices Under the
Design Basis Accident Condition
Dresden Station - Unit 3

Bus No.	Equipment Description/No.	Load Shed	Known Fact	Assumption / Engineering Judgement	Dwg. Ref.	Rev	Other Ref. (P & ID)
MCC 39-1	Core Spray Pump Suction Valve 3B (3-1402-3B)	No	N.O. and interlock open with Core Spray initiation.		12E3432	P	M-358
MCC 39-1	RX Bldg. Emerg. Lighting	No	Starts at 1 min.	Assume starting at 10 seconds for conservatism	12E-3677C	T	
MCC 39-1	CRD Hydraulic System Pressure Cont. Valve 3A (3-0302- 8)	Yes	Manually operated valve.		12E-3416	L	M-365
MCC 39-1	Core Spray Test Bypass Valve 3B (3B-1402-4B)	No	N.C. and interlock close on high drywell pressure		12E-3433	K	M-358
MCC 39-1	HPCI Aux. Coolant Pump (3-2301-57)	No	Manually operated	Not operated during a LOCA	12E-3531	P	M-374 Ref. 70
MCC 39-1	LPCI Pump 3C Suction Valve (3-1501-5C)	No	N.O. and interlock open with LPCI iniation.		12E-3440	P	M-360 Sh.1
MCC 39-1	Post LOCA H_2 & O_2 Monitoring Sample Pump 3B (3-2400-B)	Yes	Operator has to turn switch HS5 to standby or analyze position considering this equip. Will show starting at 10 min.		12E-7555A	E	
MCC 39-1	Drywell/Torus Differential Pressure Air Compressor 3B (3-8551-B)	Yes	Will not operate in auto mode.		12E-3372	L	
MCC 39-1	LPCI Drywell Spray Valve 3C (3-1501-27B)	No	N.C. and interlock close with high Drywell pressure and low RX level.		12E-3440	P	M-360 Sh.1

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Table 1
Automatically Turn On and Off Devices Under the
Design Basis Accident Condition
Dresden Station - Unit 3

Bus No.	Equipment Description/No.	Load Shed	Known Fact	Assumption / Engineering Judgement	Dwg. Ref.	Rev	Other Ref. (P & ID)
MCC 39-1	LPCI Torus Ring Spray Valve 3D (3-1501-19B)	No	N.C. and interlock close with high Drywell pressure and low RX level.		12E-3441 Sh.2	N	M-360 Sh.1
MCC 39-1	LPCI Torus Ring Spray Valve 3C (3-1501-18B)	No	N.C. and interlock close with high Drywell pressure and low RX level.		12E-3441 Sh.2	N	M-360 Sh.1
MCC 39-1	LPCI Torus Ring Spray Valve 3D (3-1501-20B)	No	N.C. and interlock close with high Drywell pressure and low RX level.		12E-3441 Sh.1	N	M-360 Sh.1
MCC 39-1	LPCI Torus Ring Spray Valve 3C (3-1501-38B)	No	N.C. and interlock close with high Drywell pressure and low RX level.		12E-3441 Sh.1	N	M-360 Sh.1
MCC 39-1	Closed Cool Water Drywell Return Valve 3B (3-3706)	Yes	Will not operate in auto mode. N.O. will remain open.		12E-3398	B	M-353
MCC 39-1	LPCI Header Crosstie Isol. Valve 3B (3-1501-32B)	No	N.O. and interlock open with switch on open position (with key removable).		12E-3440	N	M-360 Sh.1
MCC 39-1	LPCI Heat Exchanger Bypass Valve 3B (3-1501-11B)	No	N.O. and interlock open for 30 sec	See description in Section VIII.B.3	12E-3440	N	M-360 Sh.1
MCC 39-1	LPCI Pump Flow Bypass Valve 3B (3-1501-13B)	No	N.O. and remain open until flow is above set point and then it will close.	Consider valve to operate concurrent with 1st LPCI pump start.	12E-3440	P	M-360 Sh.1
MCC 39-1	East LPCI/CS Room Sump Pump 3B (3-2001-510B)	No	Pump operates on level switch high	Water level on core spray pump will not go up and pump will not operate.	12E-3677E	K	M-358

Table 1
Automatically Turn On and Off Devices Under the
Design Basis Accident Condition
Dresden Station - Unit 3

Bus No.	Equipment Description/No.	Load Shed	Known Fact	Assumption / Engineering Judgement	Dwg. Ref.	Rev	Other Ref. (P & ID)
MCC 39-1	West LPCI/CS Room Sump Pump 3A (3-2001-511A)	No	Pump operates on level switch high	Water level on core spray pump will not go up and pump will not operate.	12E-3677E	K	M-358
MCC 39-1	Safety System Jockey Pump (3-1401-4)	Yes	Manually operated, will not start automatically		12E-3667E	Y	
MCC 39-1	LPCI Pump 3D Suction Valve (3-1501-5D)	No	N.O. and interlock with LPCI initiation.		12E-3440	P	M-360 Sh.1
MCC 39-1	Closed Cooling Water Drywell Supply Valve (3-3702)	Yes	Manually operated		12E-3398	B	M-353
MCC 39-1	Closed Cooling Water Header Isol. Valve (3-3701)	Yes	Manually operated		12E-3398	B	M-353
MCC 39-1	Contain Cooling Heat Exchanger Discharge Valve 3B (3-1501-3B)	No	N.C. but interlock open when CCSW pump is not operating. After 10 min., the operator will open when the CCSW begins operating.		12E-3440	N	M-360 Sh.1
MCC 39-1	LPCI/Core Spray Pump Area Cooling Unit 3B (3-5746-B)	No	Thermostatically controlled. Assume start at t=0 sec		12E-3393	F	
MCC 39-1	HPCI Turbine Inlet Isol. Vlv (3-2301-4)	No	N.O. but interlock close by reactor low pressure concurrent with LPCI initiation.		12E-3529	W	M-374
MCC 39-1	Core Spray Pump Recirc. Isol. Valve 3B (3-1402-38B)	No	N.O. remain open for low flow but will close when enough flow is established.	Closes with Core Spray pump	12E-3433	K	M-358

Table 1
Automatically Turn On and Off Devices Under the
Design Basis Accident Condition
Dresden Station - Unit 3

Bus No.	Equipment Description/No.	Load Shed	Known Fact	Assumption / Engineering Judgement	Dwg. Ref.	Rev	Other Ref. (P & ID)
MCC 39-1	HPCI Pump 3 Area Cooling Unit (3-5747)	No	Starts operating when MCC 39-1 has voltage.		12E-3393	F	
MCC 39-1	ACAD Air Compressor Unit No. 3-2501	Yes	Manually Operated	Application is as a post-LOCA device, assume on in last time period	12E-7556	E	
MCC 39-1	LPCI Drywell Spray Valve 3D (3-1501-28B)	No	N.C. and interlock closed with LPCI initiation.		12-3441 Sh.3	N	M-360 Sh.1
MCC 39-1	HPCI Oil Tank Heater	No		Consider that temp switch will close and heater will operate at 0 Sec.	12E-3532	M	
MCC 39-2	SBGT Air Heater (2/3-B-7503)	No	Starts operating at 0 Sec.	B Train in Primary, A Train in Standby	12E-2400B	M	M-49
MCC 39-2	250V Battery Charger 2/3 (2/3-8350-2/3)	No	Starts operating at 0 Sec.		12E-2389B	C	
MCC 39-2	SBGT Fan Disch Damper 2/3B (2/3-7507B)	No	N.C. but will open with PCIS initiation (operates at 0 Sec.)	B Train in Primary, A Train in Standby	12E-2400A	S	M-49
MCC 39-2	SBGT Fan 2/3B (2/3-B-7506)	No	Starts operating with iniation on PCIS (starts at 0 Sec.)	B Train in Primary, A Train in Standby	12E-2400B	M	M-49
MCC 39-2	Turbine Room 3 Emerg. Lighting (3-7902)	No	Starts operating at 1 min	Assume 10 second start for conservatism	12E-3678B	Z	

Table 1
Automatically Turn On and Off Devices Under the
Design Basis Accident Condition
Dresden Station - Unit 3

Bus No.	Equipment Description/No.	Load Shed	Known Fact	Assumption / Engineering Judgement	Dwg. Ref.	Rev	Other Ref. (P & ID)
MCC 39-2	SBGT Sys. Inlet Damper 2/3B (2/3-7505B)	No	N.C. but interlock open with high drywell and low RX pressure.	B Train in Primary, A Train in Standby	12E-2400A	S	M-49
MCC 39-2	Contain Cooling SWP Cub. Cooler Fan 2 (3-5700-30C)	No	This fan will be operating only when Containment Cooling SWP C is operating (start at 10 min.)		12E-3678A	N	M-275
MCC 39-2	Contain Cooling SWP Cub. Cooler Fan 1 (3-5700-30C)	No	This fan will be operating only when Containment Cooling SWP C is operating (start at 10 min.)		12E-3678A	N	M-275
MCC 39-2	Contain Cooling SWP Cub. Cooler Fan 1 (3-5700-30D)	No	This fan will be operating only when Containment Cooling SWP C is operating (start at 10 min.)		12E-3678B	N	M-275
MCC 39-2	125V Battery Charger 3 (3-8300-3)	No	Starts operating at 0 Sec.		12E-3389	N	
MCC 39-2	Condensate Transfer Pump 3B (3-3319-B)	Yes	Will not operate in auto mode.	Assume in auto	12E-3370	J	
MCC 39-2	DG Starting Air Compressor 3B (3-4611-B)	No	Starts operating at 0 Sec.		12E-3350B	W	M-173
MCC 39-2	Contain Cooling SWP Cub. Cooler Fan 2 (3-5700-30D)	No	This fan will be operating only when Containment Cooling SWP C is operating (start at 10 min.)		12E-3678B	T	M-275
MCC 39-2	SBGT Outside Air Damper 2/3B (2/3-7504B)	No	N.O. Damper closes on high drywell press or RX low level.		12E-2400A	S	M-49

Table 1
Automatically Turn On and Off Devices Under the
Design Basis Accident Condition
Dresden Station - Unit 3

Bus No.	Equipment Description/No.	Load Shed	Known Fact	Assumption / Engineering Judgement	Dwg. Ref.	Rev	Other Ref. (P & ID)
MCC 39-2	RX Bldg. Vent SBGT Damper 2/3B (3-7503)	Yes	Power cables disconnected.		12E-2400A	S	M-49
MCC 39-2	DG Cooling Water Pump 3 (3-3903)	No	Starts operating at 0 Sec.		12E-3350B	W	M-355
MCC 39-2	DG Fuel Oil Transfer Pump 3 (3-5203)	No	Starts operating at 0 Sec.		12E-3350B	W	M-41 Sh.2
MCC 39-2	RX Protection M-G Set 3B (3-8001-B)	No	Will restart on restoration of bus voltage.		12E-3592	J	
MCC 39-2	DG Ventilation Fan 3 (3-5790)	No	Starts operating at 0 Sec.		12E-3350B	W	M-1297
MCC 39-7	Recirc. Pump 3B Suction Valve (3-0202-4B)	Yes	N.O. and remain open.		12E-3420B	R	M-357 Sh.2
MCC 39-7	Recirc. Pump 3B Disch Valve (3-0202-5B)	No	N.O. but interlock closed with LPCI initiation if selected by the LOOP selection logic.		12E-3420B	R	M-357 Sh.2
MCC 39-7	LPCI Inboard Isol. Valve 3B (3-1501-22B)	No	N.C. but interlock open or closed with LPCI initiation if selected by the LOOP selection logic.		12E-3441A	M	M-360 Sh.1
MCC 39-7	LPCI Outboard Isol Valve 3B (3-1501-21B)	No	N.O. but interlock open or closed with LPCI initiation if selected by the LOOP selection logic.	Assume closes based on scenario	12E-3441	N	M-360 Sh. 1
MCC 38-7	LPCI Inboard Isol. Valve 3A (3-1501-22A)	No	N.C. but interlock open or closed with LPCI initiation if selected by the LOOP selection logic.	Assume opens based on scenario	12E-3441A Sh.4	N	M-360 Sh.1

Table 1
Automatically Turn On and Off Devices Under the
Design Basis Accident Condition
Dresden Station - Unit 3

Bus No.	Equipment Description/No.	Load Shed	Known Fact	Assumption / Engineering Judgement	Dwg. Ref.	Rev	Other Ref. (P & ID)
MCC 38-7	Recirc. Pump 3A Suction Valve 3A (3-202-4A)	Yes	N.O. and will remain open.		12E-3420A	P	M-347 Sh.2
MCC 38-7	Recirc. Pump 3A Disch. Valve 3A (3-202-5A)	No	N.O. but interlock open or closed with LPCI initiation if selected by the LOOP selection logic.	Assume closes based on scenario	12E-3420A	P	M-357 Sh.2
MCC 38-7	LPCI Outboard Isol. Valve 3A (3-1501-21A)	No	N.O. but interlock open or closed with LPCI initiation if selected by the LOOP selection logic.		12E-3441	N	M-360 Sh.1

N.O. - Normally Open
N.C. - Normally Closed
N/A - Not Available

Attachment B

TABLE 2

AFFECTS OF VOLTAGE DIP

PURPOSE

The purpose of Table 2 is to determine the affects of an AC voltage dip, that is low enough to de-energize control circuits ie., contactors, relays, etc., has on the operation of the mechanical equipment.

METHOD

Table 2 shows the results of the review. The conclusion of Table 2 is shown in the analysis of data section. Below is the explanation for each column in Table 2.

Table 2 Column Description	Explanation of What is Shown in the Column
Equipment Description/No.	This column lists all of the loads connected to the DG buses. It is the same list as shown in Table 1.
Load Shed	All loads that are tripped off and interlocked off or require manual action to restart are considered load shed. Operating loads and loads with auto start capabilities that have power available that do not operate (i.e. an MOV that is N.O. and remains open) is considered not load shed.
Will the voltage dip at 5 seconds, 10 seconds, and 10 minutes affect the equipments' operation (Question 1)	The "affect" looked for is that the control circuit per the referenced schematics is de-energized or energized by a voltage dip. If the circuit was not energized before the dip and/or the energized state of the circuit did not change due to a dip, the answer is no. If the energized state of the circuit changed, the answer is yes.

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AFFECTS OF A VOLTAGE DIP

Table 2 Column Description	Explanation of What is Shown in the Column
Will the equipment restart after the voltage recovery (Question 2)	This question is to verify that equipment required is restarted automatically after a voltage dip. Only AC control circuits need to be considered. DC control circuits will be unaffected by an AC voltage dip. Circuits that have seal-in contacts are types that would not restart.
Will the equipment operate in an adverse mode due to a voltage dip (Question 3)	If the answer to Question 1 is yes, and to Question 2 is yes, then Question 3 has to be answered. The "adverse modes" looked for are items like, valves moving in the wrong direction, time delay relays being reset by the dip causing equipment to operate for shorter or longer periods than required, etc.
Will the time delay in operation cause any adverse affect (Question 4)	If the answer to Question 1 is yes, and 2 is yes, Question 4 has to be answered. The time delay referred to is the one second it takes the DG to recover ~~to~~ above 80% after the start of a large motor. The adverse affects looked for are items like, could within one second the room temperature rise excessively if a cooler is de-energized, if a valve travel requires one more second to operate will its total travel time exceed design limits, etc. The "no" answers to this question are based on the following engineering judgements: a. Reference 53 provides a comparaison between allowable and measured and/or calculated valve stroke times for the valves in question. This shows that the addition of 2 seconds to the stroke time of any valve will not result in the total stroke time exceeding the maximum allowable stroke time. b. Based on Engineering Judgement, 2 second time delays in room coolers, pumps, etc. would not cause rooms, equipment, etc. to overheat, etc.

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TABLE 2

AFFECTS OF A VOLTAGE DIP

Table 2 Column Description	Explanation of What is Shown in the Column
	c. Instrument bus loads may give erroneous readings for a fraction of a second due to momentary sharp voltage drop. But the instrument bus is designed with transfer switch, which takes about one second to transfer the loads. Therefore, the operators are familiar with the behavior of these loads during abnormal condition. This will not require any special attention of the operators.
Drawing Reference	This drawing shows the main schematic or wiring diagram for the control circuit reviewed.
Revision	This is the revision number of the drawing referenced above.
Other Reference	Other references used to understand the operation of control circuit may be listed here or see the main reference section of this calculation.

TABLE 2
AFFECTS OF VOLTAGE DIP
Dresden Station - Unit 3

Bus No.	Equipment Description/No.	Load Shed	Will the voltage dips @ 5 sec, 10 sec, & 10 min. affect the equipment's operation?	Will the equipment start after voltage recovery?	Will the equipt. operate in adverse mode due to the voltage dips?	Will the time delay in operation cause any adverse affect?	Dwg. Ref.	Rev	Other Ref.
34-1	RX Bldg. Cooling Water Pump 3B (3-3701-B)	Yes	No	N/A	N/A	N/A	12E-3397	H	M-353
34-1	RX Shutdown Cooling Water Pump 3C (3-1002-C)	Yes	No	N/A	N/A	N/A	12E-3516 12E-3517	C D	M-353
34-1	RX Cleanup Recirc. Pump 3B (3-1205-B)	Yes	No	N/A	N/A	N/A	12E-3520	J	M-353
34-1	RX Shutdown Cooling Pump 3B (3-1002-B)	Yes	No	N/A	N/A	N/A	12E-3516	C	M-353
34-1	Core Spray Pump 3B (3-1401-B)	No	Yes, the pump might stop momentarily	Yes, interlock relay controlled by 125V DC	No	No	12E-3429	L	M-358
34-1	LPCI Pump 3C (3-1502-C)	No	Yes, the pump might stop momentarily	Yes, interlock relay controlled by 125V DC	No	No	12E-3436 Sh.3	K	M-360 Sh.1
34-1	LPCI Pump 3D (3-1502-D)	No	Yes, the pump might stop momentarily	Yes, interlock relay controlled by 125V DC	No	No	12E-3436 Sh.4	K	M-360 Sh.1
34-1	RX Bldg. Cooling Water Pump 2/3 (2/3-3701)	Yes	No	N/A	N/A	N/A	12E-3397	H	M-20
39	Fuel Pool Cooling Water Pump 3B (3-1902-B)	Yes	No	N/A	N/A	N/A	12E-3548	H	M-362
39	Recirc. M-G Sets Vent Fan 3B (3-5701-B)	Yes	No. Interlocked off after trip	No	N/A	N/A	12E3420 C	D	

TABLE 2
AFFECTS OF VOLTAGE DIP
Dresden Station - Unit 3

Bus No.	Equipment Description/No.	Load Shed	Will the voltage dips @ 5 sec, 10 sec, & 10 min. affect the equipment's operation?	Will the equipment start after voltage recovery?	Will the equipt. operate in adverse mode due to the voltage dips?	Will the time delay in operation cause any adverse affect?	Dwg. Ref.	Rev	Other Ref.
39	480 V Turb Bldg MCC 26-4 Reserve Feed (2-7326-40)	Yes	No	N/A	N/A	N/A	12E3661 H	D	
39	South Turbine Bldg. Vent Fan 3B (3-5702-B)	Yes	No	N/A	N/A	N/A	12E-3387B	E	
39	RX Bldg. Vent Fan 3B (3-5703-B)	Yes	No	N/A	N/A	N/A	12E-3399A	E	
39	RX Bldg. Exhaust Fan 3B (3-5704-B)	Yes	No	N/A	N/A	N/A	12E-3399A	E	
39	RX Bldg. Exhaust Fan 3C (3-5704-C)	Yes	No	N/A	N/A	N/A	12E-3399A	E	
39	120/240 VAC Uninterruptable Power Supply Panel 903-63	No	No, UPS will be supplied by alternate (DC) source until adequate AC voltage is available	Yes, UPS will return to AC source with restoration of adequate voltage	No	No	12E-3811B	G	
39	Drywell Cooler Blower 3C, 3D, & 3E (3-5734-C, D, E)	Yes	No	N/A	N/A	N/A	12E-3393	F	M-273
39	480V MCC 39-3	Yes	No	N/A	N/A	N/A			
39	480V MCC 39-5	Yes	No	N/A	N/A	N/A			
39	480V MCC 39-6	Yes	No	N/A	N/A	N/A			

TABLE 2
AFFECTS OF VOLTAGE DIP
Dresden Station - Unit 3

Bus No.	Equipment Description/No.	Load Shed	Will the voltage dips @ 5 sec, 10 sec, & 10 min. affect the equipment's operation?	Will the equipment start after voltage recovery?	Will the equipt. operate in adverse mode due to the voltage dips?	Will the time delay in operation cause any adverse affect?	Dwg. Ref.	Rev	Other Ref.
MCC 39-1	Distribution Transformer Feed (9 KVA)	No	Yes might de-energize momentarily	Yes, no aux. relay interlock	No	No	12E-3677A	AC	
MCC 39-1	Standby Liquid Control Pump 3B (3-1102B)	Yes	No	N/A	N/A	N/A	12E3460 Sh.2	W	M-364
MCC 39-1	Drywell & Torus Purge Exhaust Fan 3B (3-5708B)	Yes	No	N/A	N/A	N/A	12E-3393	F	M-529
MCC 39-1	Core Spray Outbd. Isol Valve 3B (3-1402-24B)	No	No, N.O. interlock open Vlv. is not operating	No not required			12E-3431 sh.2	A	M-358
MCC 39-1	Core Spray Inbd. Isol Valve 3B (3-1402-25B)	No	Yes might Stop Momentarily	Yes interlock relay controlled by 125V DC.	No	No, increased operating time within acceptable limit.	12E-3431 Sh.2	A	M-358
MCC 39-1	Core Spray Pump Suction Valve 3B (3B-1402-3)	No	No, N.O. interlock open Vlv. is not operating	No not required	N/A	N/A	12E-3432	P	M-358
MCC 39-1	RX Bldg. Emerg. Lighting.	No	Yes might de-energize momentarily	Yes interlock relay energizes when voltage is back.	No	No	12E-3677C	K	
MCC 39-1	Core Spray Test Bypass Valve 3B (3B-1402-4B)	No	No, N.C. & interlock close, vlv is not operating.	No, not required	N/A	N/A	12E-3433	K	M-358
MCC 39-1	HPCI Aux. Coolant Pump (3-2301-57)	No	No, Equipment is not operating	N/A	No	No	12E-3531	P	M-374 Ref 70
MCC 39-1	LPCI Pump 3C Suction Valve (3-1501-5C)	No	No, N.O. & interlock open, vlv is not operating	No, not required	N/A	N/A	12E-3440	P	M-360 Sh.1

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TABLE 2
AFFECTS OF VOLTAGE DIP
Dresden Station - Unit 3

Bus No.	Equipment Description/No.	Load Shed	Will the voltage dips @ 5 sec, 10 sec, & 10 min. affect the equipment's operation?	Will the equipment start after voltage recovery?	Will the equipt. operate in adverse mode due to the voltage dips?	Will the time delay in operation cause any adverse affect?	Dwg. Ref.	Rev	Other Ref.
MCC 39-1	Post LOCA H_2 & O_2 Monitoring Sample Pump 3B	Yes	No, pump will be operating only after 10 min.	Voltage does not dip below 70% after 10min.	N/A	N/A	12E-7555A	E	
MCC 39-1	Drywell/Torus Differential Pressure Air Compressor 3B (3-8551-B)	Yes	N/A	N/A	N/A	N/A	12E-3372	L	
MCC 39-1	LPCI Drywell Spray Valve 3C (3-1501-27B)	No	No, N.C. & interlock close, vlv. is not operating.	No, not required	No	No	12E-3440	P	M-360 Sh.1
MCC 39-1	LPCI Torus Ring Spray Valve 3D (3-1501-19B)	No	No, N.C. & interlock close, vlv. is not operating.	No, not required	No	No	12E3441	N	M-360 Sh.1
MCC 39-1	LPCI Torus Ring Spray Valve 3C (3-1501-18B)	No	No, N.C. & interlock close, vlv. is not operating.	No, not required	No	No	12E3441 Sh.1	N	M-360 Sh.1
MCC 39-1	LPCI Torus Ring Spray Valve 3D (3-1501-20B)	No	No, N.C. & interlock close, vlv. is not operating.	No, not required	No	No	12E3441 Sh.2	N	M-360 Sh.1
MCC 39-1	LPCI Torus Ring Spray Valve 3C (3-1501-38B)	No	No, N.C. & interlock close, vlv. is not operating.	No, not required	No	No	12E3441 Sh.1	N	M-360 Sh.1
MCC 39-1	Closed Cool Water Drywell Return Valve 3B (3-3706)	Yes	N/A	No, not required	N/A	N/A	12E-3398	B	M-353
MCC 39-1	LPCI Header Crosstie Isol. Valve 3B (3-1501-32B)	No	No, N.O. & interlock open vlv is not operating.	No, not required	N/A	N/A	12E-3440	N	M-360 Sh.1
MCC 39-1	LPCI Heat Exchanger Bypass Valve 3B (3-1501-11B)	No	No, N.O. & interlock open. Valve is not operating when large motors are	N/A	N/A	N/A	12E-3440	N	M-360 Sh.1

TABLE 2
AFFECTS OF VOLTAGE DIP
Dresden Station - Unit 3

Bus No.	Equipment Description/No.	Load Shed	Will the voltage dips @ 5 sec, 10 sec, & 10 min. affect the equipment's operation?	Will the equipment start after voltage recovery?	Will the equipt. operate in adverse mode due to the voltage dips?	Will the time delay in operation cause any adverse affect?	Dwg. Ref.	Rev	Other Ref.
MCC 39-1	LPCI Pump Flow Bypass Valve 3B (3-1501-13B)	No	No, N.O. & interlock open vlv is not operating.	No, not required	N/A	N/A	12E-3440	N	M-360 Sh.1
MCC 39-1	East LPCI/CS Room Sump Pump 3B (3-2001-510B)	Yes	N/A	N/A	N/A	N/A	12E-3677E	K	M-358
MCC 39-1	West LPCI/CS Room Sump Pump 3A (3-2001-511A)	Yes	N/A	N/A	N/A	N/A	12E-3677E	K	M-358
MCC 39-1	Saftey System Jockey Pump (3-1401-4)	Yes	N/A	N/A	N/A	N/A	12E-3667E	Y	
MCC 39-1	LPCI Pump 3D Suction Valve (3-1501-5D)	No	No, N.O. & interlock open vlv is not operating.	No, not required	N/A	N/A	12E-3440	P	M-360 Sh.1
MCC 39-1	Closed Cooling Water Drywell Supply Valve (3-3702)	Yes	N/A	N/A	N/A	N/A	12E-3398	B	M-353
MCC 39-1	Closed Cooling Water Header Isol. Valve (3-3701)	Yes	N/A	N/A	N/A	N/A	12E-3398	B	M-353
MCC 39-1	Contain Cooling Heat Exchanger Discharge Valve 3B (3-1501-3B)	No	No, N.O. & interlock open vlv is not operating.	No, not required	N/A	N/A	12E-3440	N	M-360 Sh.1
MCC 39-1	LPCI/Core Spray Pump Area Cooling Unit 3B (3-5746-B)	No	Yes might stop momentarily.	Yes, interlock with temperature switch only.	No	No	12E-3393	F	
MCC 39-1	HPCI Turbine Inlet Isol Valve (3-2301-4)	No	Yes might stop momentarily.	Yes, interlock relay energize with low RX pressure, steam line break etc.	No	No,increased operating time is within acceptable limit.	12E-3529	W	M-374

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TABLE 2
AFFECTS OF VOLTAGE DIP
Dresden Station - Unit 3

Bus No.	Equipment Description/No.	Load Shed	Will the voltage dips @ 5 sec, 10 sec, & 10 min. affect the equipment's operation?	Will the equipment start after voltage recovery?	Will the equipt. operate in adverse mode due to the voltage dips?	Will the time delay in operation cause any adverse affect?	Dwg. Ref.	Rev	Other Ref.
MCC 39-1	Core Spray Pump Recirc. Isol. Valve 3B (3-1402-38B)	No	Yes might stop momentarily.	Yes interlock relay controlled by 24V DC.	No	No,increased operating time is within acceptable limit.	12E-3433	K	M-358
MCC 39-1	HPCI Pump 3 Area Cooling Unit (3-5747)	No	Yes might stop momentarily.	Yes, interlock with temperature switch only.	No	No	12E-3393	F	
MCC 39-1	ACAD Air Compressor Unit No. 3-2501	No	Yes might stop momentarily.	Yes, interlock with pressure switch only.	No	No	12E-7556	E	
MCC 39-1	HPCI Oil Tank Heater	No	Yes might stop momentarily.	Yes, interlock with temperature switch only.	No	No	12E-3532	M	
MCC 39-2	SBGT Air Heater (2/3-B-7503)	No	Yes, might stop momentarily	Yes, interlock relay energize by a flow switch	No	No	12E-2400B	M	M-49
MCC 39-2	250V Battery Charger 2/3 (2/3-8350-2/3)	No	Yes, might stop momentarily	Yes no aux. relay interlock	No	No	12E-2389B	C	
MCC 39-2	SBGT Fan Disch Damper 2/3B (2/3-7507B)	No	Yes, might stop momentarily	Yes, interlock relay energizes concurrently with LPCI initiation	No	Increased stroke time	12E-2400A	S	M-49
MCC 39-2	SBGT Fan 2/3B (2/3-B-7506)	No	Yes, might stop momentarily	Yes, interlock relay energizes concurrently with LPCI initiation	No	Increased stroke time	12E-2400B	M	M-49
MCC 39-2	Turbine Room 3 Emerg. Lighting	No	Yes, might stop momentarily	Yes, interlock relay energizes when voltage is back.	No	No	12E-2678B	T	
MCC 39-2	SBGT Sys. Inlet Damper 2/3B (2/3-7505B)	No	Yes, might stop momentarily	Yes, interlock relay energizes concurrently with LPCI initiation.	No	Increased stroke time	12E-2400A	S	M-49

TABLE 2
AFFECTS OF VOLTAGE DIP
Dresden Station - Unit 3

Bus No.	Equipment Description/No.	Load Shed	Will the voltage dips @ 5 sec, 10 sec, & 10 min. affect the equipment's operation?	Will the equipment start after voltage recovery?	Will the equipt. operate in adverse mode due to the voltage dips?	Will the time delay in operation cause any adverse affect?	Dwg. Ref.	Rev	Other Ref.
MCC 39-2	Contain Cooling SWP Cub. Cooler Fan 2 (3-5700-30C)	No	No, fan will be operating only after the CCSWP C is operating.	N/A	N/A	N/A	12E-3678A	N	M-275
MCC 39-2	Contain Cooling SWP Cub. Cooler Fan 1 (3-5700-30C)	No	No, fan will be operating only after the CCSWP C is operating.	N/A	N/A	N/A	12E-3678A	N	
MCC 39-2	Contain Cooling SWP Cub. Cooler Fan 1 (3-5700-30D)	No	No, fan will be operating only after the CCSWP C is operating.	N/A	N/A	N/A	12E-3678B	N	M-275
MCC 39-2	125V Battery Charger 3 (3-8300-3)	No	Yes, might stop momentarily	Yes, no aux. relay interlock	No	No	12E-3389	N	
MCC 39-2	Condensate Transfer Pump 3B (3-3319-B)	Yes	No	N/A	N/A	N/A	12E-3370	J	
MCC 39-2	DG Starting Air Compressor 3B (3-4611-B)	No	Yes, might stop momentarily	Yes interlock with pressure switch only.	No	No	12E-3350B	W	M-173
MCC 39-2	Contain Cooling SWP Cub. Cooler Fan 2 (3-5700-30D)	No	No, fan will be operating only after the CCSWP C is operating.	N/A	N/A	N/A	12E-3678B	T	M-275
MCC 39-2	SBGT Outside Air damper 2/3B (2/3-7504B)	No	Yes, might stop momentarily	Yes, interlock relay energizes on low flow	No	Increased stroke time within acceptable limits	12E-2400A	S	M-49
MCC 39-2	RX Bldg. Vent SBGT Damper 2/3B (3-7503B)	Yes	No	N/A	N/A	N/A	12E-2400A	S	M-49
MCC 39-2	DG Cooling Water Pump 3 (3-3903)	No	Yes, might stop momentarily	Yes, interlock relay energizes when voltage is back.	No	No	12E-3350B	W	M-355

TABLE 2
AFFECTS OF VOLTAGE DIP
Dresden Station - Unit 3

Bus No.	Equipment Description/No.	Load Shed	Will the voltage dips @ 5 sec, 10 sec, & 10 min. affect the equipment's operation?	Will the equipment start after voltage recovery?	Will the equipt. operate in adverse mode due to the voltage dips?	Will the time delay in operation cause any adverse affect?	Dwg. Ref.	Rev	Other Ref.
MCC 39-2	DG Fuel Oil Transfer Pump 3 (3-5203)	No	Yes, might stop momentarily	Yes, starts operating at 0 sec.	No	N/A	12E-3350B	W	M-41 Sh.2
MCC 39-2	RX Protection M-G Set 3B	No	Yes, M-G set is a high inertia machine, designed to ride through voltage dips	N/A	N/A	N/A	12E-3592	J	
MCC 39-2	DG Ventilation Fan 3 (3-5790)	No	Yes, might stop momentarily	Yes, interlock relay energizes when voltage is back.	No	No	12E-3350B	W	M-1297
MCC 39-7	Refueling Floor Jib Cranes (3-899)	No	No.This crane will not operate.	No, not required	N/A	N/A	12E-3622C	K	
MCC 39-7	LPCI Outbd. Isol Valve 3B (3-1501-21B)	No	No, valve will not operate.	N/A	N/A	N/A	12E-3441A	M	M-360 Sh.1
MCC 39-7	Recirc. Pump 3B Suction Valve (3-0202-4B)	Yes	No	N/A	N/A	N/A	12E-3420B	R	M-357 Sh.2
MCC 39-7	Recirc. Pump 3B Disch Valve (3-0202-5B)	No	No, valve will not operate.	N/A	N/A	N/A	12E-3420B	R	M-357 Sh.2
MCC 39-7	LPCI Inboard Isol. Valve 3B (3-1501-22B)	No	Yes might stop momentarily.	Yes, interlock relay controlled by 125V DC.	No	No,increased operating time within acceptable limit.	12E-3441A	M	M-360 Sh.1
MCC 39-7	LPCI Outboard Isol Valve 3B (3-1501-21B)	No	No	N/A	N/A	N/A	12E-3441A	M	M-360 Sh. 1
MCC 38-7	LPCI Inboard Isol. Valve 3A (3-1501-22A)	No	No, N.O. & interlock open. Vlv. is not operating.	No, not required	N/A	N/A	12E-3441A Sh.4	N	M-360 Sh.1

TABLE 2
AFFECTS OF VOLTAGE DIP
Dresden Station - Unit 3

Bus No.	Equipment Description/No.	Load Shed	Will the voltage dips @ 5 sec, 10 sec, & 10 min. affect the equipment's operation?	Will the equipment start after voltage recovery?	Will the equipt. operate in adverse mode due to the voltage dips?	Will the time delay in operation cause any adverse affect?	Dwg. Ref.	Rev	Other Ref.
MCC 38-7	Recirc. Pump 3A Suction Valve 3A (3-202-4A)	Yes	No	N/A	N/A	N/A	12E-3420A	P	M-357 Sh.2
MCC 38-7	Recirc. Pump 3A Disch. Valve 3A (3-202-5A)	No	Yes might stop momentarily.	Yes, interlock relay. controlled by 125V DC.	No	No, increased operating time within acceptable limit.	12E-3420A	P	M-357 Sh.2
MCC 38-7	LPCI Outboard Isol. Valve 3A (3-1501-21A)	No	Yes might stop momentarily.	Yes, interlock relay. controlled by 125V DC.	No	No, increased operating time within acceptable limit.	12E-3441 Sh.3	N	M-360 Sh.1

NC - Normally Closed
NO - Normally Open

For further explanation of this table see Flow Chart No. 2.

Table 4

DG Auxiliaries and Other 480V Loads Starting 0 Seconds after Closing of DG Breaker

Load No.	Load Description	Bus No.	Rating	Unit	Vrated	PF%	Eff. %	FLC	LRC%	SPF%	SKW	SKVAR	
	3-902-63 ESS UPS Panel	39	From ETAP								50.5	37.1	
	120/208V Distribution Transformer 39-1	39-1	9	KVA	480	75	100	10.8	100	75	6.8	6.0	R3
	Post LOCA H2 and O2 Sample Monitoring Pump 3B	39-1	1	HP	460	80	75	1.6	625	79	6.1	4.8	
3-2301-4	HPCI Turbine Inlet Isol. Valve	39-1	7.8	HP	460	78	70	13.4	827	54	47.6	74.2	
3-5747	HPCI Pump 3 Area Cooling Unit	39-1	3	HP	460	85	80	4.1	625	68	14.0	15.1	
	HPCI Oil Tank Heater	39-1	9	KW	480	100	100	10.8	100	100	9.0	0.0	
2/3-8350-2/3	250V DC Battery Charger 2/3	39-2	From ETAP								66.1	58.0	
2/3-B-7503	SBGT Air Heater 2/3B	39-2	30	KW	440	100	100	39.4	100	100	30.0	0.0	
2/3-7504B	SBGT Outside Air Damper 2/3B	39-2	0.6	HP	440	80	75	1.0	625	83	3.9	2.6	
2/3-7507B	SBGT Fan Disch. Damper 2/3B	39-2	4.3	HP	440	85	80	6.2	625	68	20.0	21.6	
2/3-B-7506	SBGT Fan 2/3B	39-2	20	HP	460	85	85	25.9	625	44	56.8	115.9	
2/3-7505B	SBGT Sys Inlet Damper 2/3B	39-2	1.8	HP	440	80	75	2.9	625	75	10.5	9.3	
3-8300-3	125V DC Battery Charger 3	39-2	From ETAP								34.1	30.6	
3-4611-B	DG Starting Air Compressor 3B	39-2	5	HP	460	85	80	6.9	625	58	19.9	27.9	
3-3903	DG Cooling Water Pump 3	39-2	87	KW	460	83.5	100	130.8	400	31.5	131.3	395.5	R3
3-5203	DG Fuel Oil Transfer Pump 3	39-2	1.5	HP	460	80	75	2.3	625	75	8.7	7.7	
3-5790	DG Ventilation Fan 3	39-2	30	HP	440	85	85	40.6	625	42	81.3	175.7	
3-8001-B	Reactor Protection M-G Set 3B	39-2	25	HP	440	85	85	33.9	625	43	69.4	145.7	
3-1501-22A	LPCI Inbd Isol. Valve 3A	38-7	10.5	HP	460	85	83.78	13.8	826	43	39.1	82.0	
3-202-5A	Recirc. Pump 3A Disch. Valve	38-7	13	HP	460	85	85	16.8	775	49	51.0	90.7	
3-1501-21B	LPCI Outbd Isol. Valve 3B	38-7	16.2	HP	460	85	90	19.8	663	49	51.3	91.3	
										TOTAL STARTING KW & KVAR	807.3	1391.6	R3

Full Load Current (FLC) form HP = (HP x 746) / (1.732 x kV x PF x eff.)
FLC from KW = KW / (1.732 x kV x PF x eff.)
FLC from KVA = KVA / (1.732 x kV x eff.)

Starting KW (SKW) = 1.732 x kV x LRC% x FLC x SPF
Starting KVAR (SKVAR) = 1.732 x kV x LRC% x FLC x sin(acos(SPF))

Table 4

DG Auxiliaries and Other 480V Loads Starting 0 Seconds after UV Relay Resets

Load No.	Load Description	Bus No.	Rating	Unit	Vrated	PF%	Eff. %	FLC	LRC%	SPF%	SKW	SKVAR
3-1501-13B	LPCI Pump Flow Bypass Valve 3B	39-1	0.6	HP	440	80	75	1.0	527	83	3.3	2.2
3-5746B	LPCI/Core Spray Pump Area Cooling Unit	39-1	5	HP	460	85	80	6.9	625	58	19.9	27.9
										TOTAL STARTING KW & KVAR	23.1	30.1

Full Load Current (FLC) form HP = (HP x 746) / (1.732 x kV x PF x eff.)
FLC from KW = KW / (1.732 x kV x PF x eff.)
FLC from KVA = KVA / (1.732 x kV x eff.)

Starting KW (SKW) = 1.732 x kV x LRC% x FLC x SPF
Starting KVAR (SKVAR) = 1.732 x kV x LRC% x FLC x sin(acos(SPF))

R2

Table 4

DG Auxiliaries and Other 480V Loads Starting 10 Seconds after UV Relay Resets

Load No.	Load Description	Bus No.	Rating	Unit	Vrated	PF%	Eff. %	FLC	LRC%	SPF%	SKW	SKVAR
	Turbine Room 3 Emerg. Lighting	39-2	13.68	KW	480	90	100	18.3	100	90	13.7	6.6
3-1401-25B	Core Spray Inbd Isol Valve 3B	39-1	3.9	HP	440	85	80	5.6	830	58	20.6	28.9
	RX Bldg. Emerg. Lighting	39-1	18.36	KVA	480	90	100	22.1	100	90	16.5	8.0
3-1402-38B	Core Spray Pump Recirc Isol. Valve 3B	39-1	0.6	HP	440	80	75	1.0	527	83	3.3	2.2
								TOTAL STARTING KW & KVAR			54.1	45.7

Full Load Current (FLC) form HP = (HP x 746) / (1.732 x kV x PF x eff.)
FLC from KW = KW / (1.732 x kV x PF x eff.)
FLC from KVA = KVA / (1.732 x kV x eff.)

Starting KW (SKW) = 1.732 x kV x LRC% x FLC x SPF
Starting KVAR (SKVAR) = 1.732 x kV x LRC% x FLC x sin(acos(SPF))

R2

Table 4

DG Auxiliaries and Other 480V Loads Starting at 10+ Minutes after UV Relay Resets (1st CCSW Pump)

Load No.	Load Description	Bus No.	Rating	Unit	Vrated	PF%	Eff. %	FLC	LRC%	SPF%	SKW	SKVAR
3-1501-3B	Containment Cooling Heat Exchanger Discharge Valve 3B	39-1	0.33	HP	460	80	75	0.5	245	85	0.9	0.5
										TOTAL STARTING KW & KVAR	0.9	0.5

Full Load Current (FLC) form HP = (HP x 746) / (1.732 x kV x PF x eff.)
FLC from KW = KW / (1.732 x kV x PF x eff.)
FLC from KVA = KVA / (1.732 x kV x eff.)

Starting KW (SKW) = 1.732 x kV x LRC% x FLC x SPF
Starting KVAR (SKVAR) = 1.732 x kV x LRC% x FLC x sin(acos(SPF)) | R2

Table 4

DG Auxiliaries and Other 480V Loads Starting at 10++ Minutes after UV Relay Resets (2nd CCSW Pump)

Load No.	Load Description	Bus No.	Rating	Unit	Vrated	PF%	Eff. %	FLC	LRC%	SPF%	SKW	SKVAR	
3-5700-30C	Contain Cooling SWP Cub. Cooler C Fan 2	39-2	3	HP	460	85	80	4.1	700	68	15.7	16.9	R2
3-5700-30C	Contain Cooling SWP Cub. Cooler C Fan 1	39-2	3	HP	460	85	80	4.1	700	68	15.7	16.9	
3-5700-30D	Contain Cooling SWP Cub. Cooler D Fan 1	39-2	3	HP	460	85	80	4.1	700	68	15.7	16.9	
3-5700-30D	Contain Cooling SWP Cub. Cooler D Fan 2	39-2	3	HP	460	85	80	4.1	700	68	15.7	16.9	
									TOTAL STARTING KW & KVAR		62.7	67.6	R2

Full Load Current (FLC) form HP = (HP x 746) / (1.732 x kV x PF x eff.)
FLC from KW = KW / (1.732 x kV x PF x eff.)
FLC from KVA = KVA / (1.732 x kV x eff.)

Starting KW (SKW) = 1.732 x kV x LRC% x FLC x SPF
Starting KVAR (SKVAR) = 1.732 x kV x LRC% x FLC x sin(acos(SPF)) | R2

SARGENT & LUNDY ENGINEERS

Calculation For Diesel Generator 3 Loading Under Design Bases Accident Condition			
X	Safety-Related		Non-Safety-Related

Calc. No. 9389-46-19-1	
Rev. 1	Date
Page D1 of	

Client ComEd	
Project Dresden Station Unit 3	
Proj. No. 9389-46	Equip. No.

Prepared by	Date
Reviewed by	Date
Approved by	Date

Attachment D

Diesel Generator 3

LOCA & LOOP Conditions

Dresden

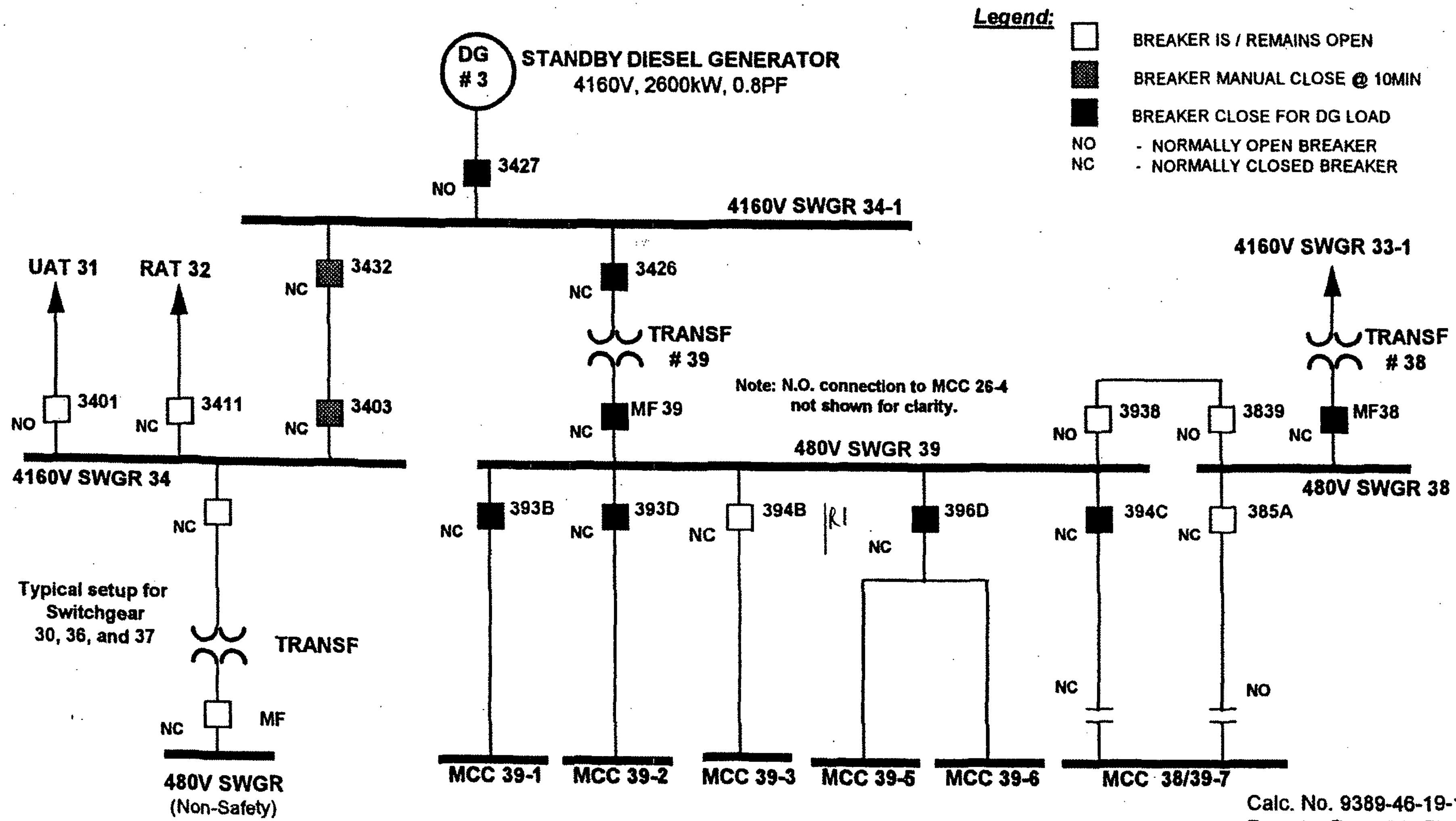


Figure 1

Calc. No. 9389-46-19-1
Rev. 1, Page D2 /Final
Proj. No. 9389-46

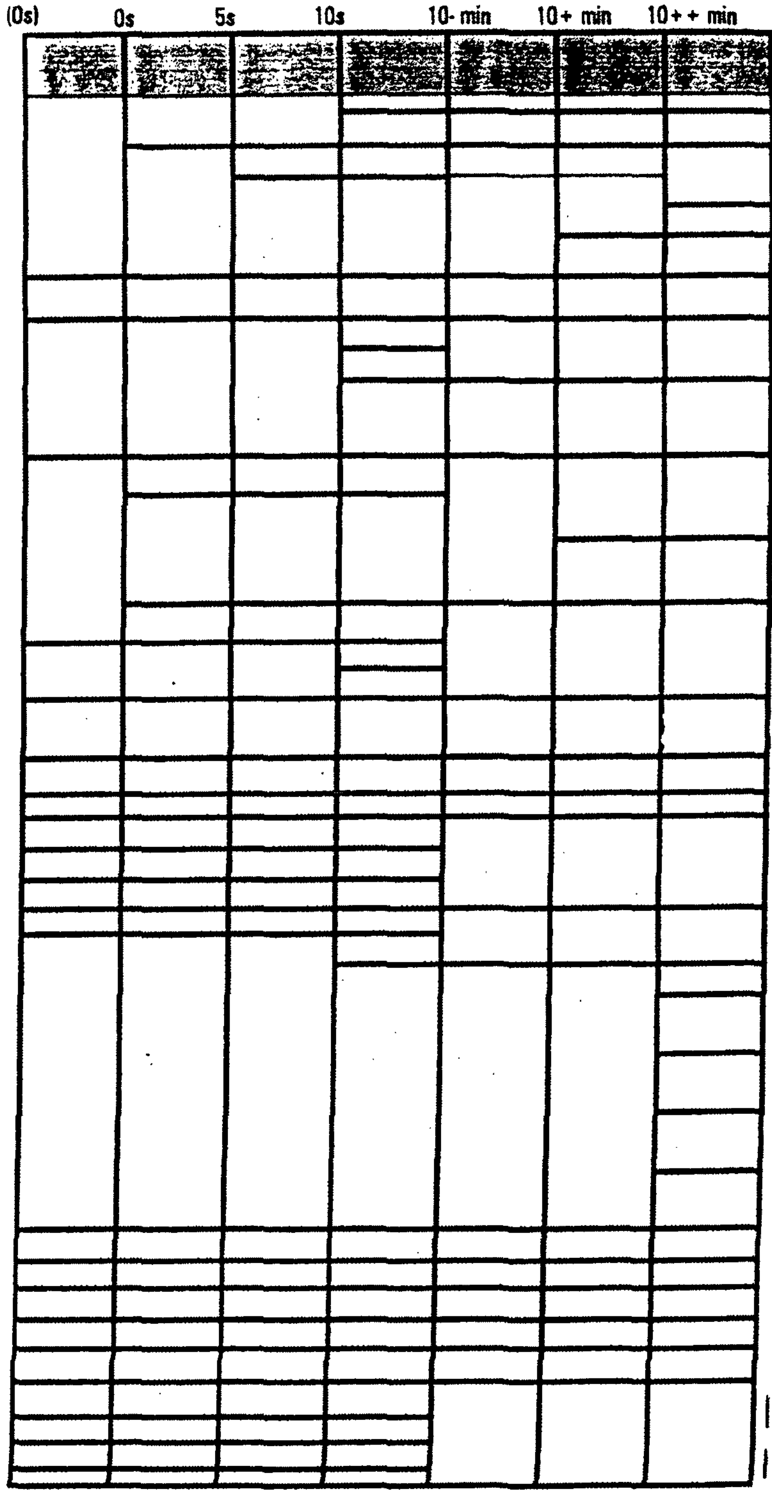
Attachment E

FIGURE 2 - DG AUXILIARIES AND OTHER 4kV AND 480V LOADS

Calc. No. 9389-46-19-1, Rev. 3 PageNo. E2/FINAL ,Proj. No. 9389-46

Emergency Diesel 3 Powers Unit 3 Loads

Load No.	Load Description	Bus No.
3-1401-B	Core Spray Pump 3B	34-1
3-1502-C	LPCI Pump 3C	34-1
3-1502-D	LPCI Pump 3D	34-1
	Containment Cooling SWP #3C	34
	Containment Cooling SWP #3D	34
	3-903-63 Essential Service Uniterruptable Power Supply Panel	39
	120/208V Distribution Transf. 39-1	39-1
3-1402-25B	Core Spray Inbd. Isol. Vlv. 3B	39-1
	RX Bldg. Emerg. Lighting	39-1
~~3-2301-57~~	~~HPCI Aux Coolant Pump~~	39-1
	Post LOCA H2 And O2 Monitoring Sample Pump 3B	39-1
3-1501-13B	LPCI Pump Flow Bypass Valve 3B	39-1
3-1501-3B	Contain Cooling Heat Exchanger Discharge Valve 3B	39-1
3-5746B	LPCI / Core Spray Pump Area Cooling Unit 3B	39-1
3-2301-4	HPCI Turbine Inlet Isol. Vlv	39-1
3-[illegible]2-38B	Core Spray Pump Recirc. Isol. Valve	39-1
3-[illegible]7	HPCI Pump 3 Area Cooling Unit	39-1
	~~ACAD Air Compressor Unit No. 3-2501~~	39-1
	HPCI Oil Tank Heater	39-1
2/3-8350-2/3	250 VDC Battery Charger 2/3	39-2
2/3-7503B	SBGT Air Heater 2/3B	39-2
2/3-7504B	SBGT Outside Air Damper 2/3B	39-2
2/3-7507B	SBGT Fan Disch. Damper 2/3B	39-2
2/3B-7506	SBGT Fan 2/3B	39-2
2/3-7505B	SBGT Sys. Inlet Damper 2/3B	39-2
3-7902	Turbine Room 3 Emerg. Lighting	39-2
3-5700-30C	Cnmt. Cooling SWP Cub. Cooler C Fan 2	39-2
3-5700-30C	Cnmt. Cooling SWP Cub. Cooler C Fan 1	39-2
3-5700-30D	Cnmt. Cooling SWP Cub. Cooler D Fan 1	39-2
3-5700-30D	Cnmt. Cooling SWP Cub. Cooler D Fan 2	39-2
3-8300-3	125 VDC Battery Charger 3	39-2
3-5319-B	DG Starting Air Compressor 3B	39-2
3-3903	DG Cooling Water Pump 3	39-2
3-5203	DG Fuel Oil Transfer Pump 3	39-2
3-5790	DG Ventilation Fan 3	39-2
3-8001-B	Reactor Protection M-G Set 3B	39-2
3-1501-22A	LPCI Inbd. Isol. Valve 3A	38-7
3-2[illegible]5A	Recirc. Pump 3A Disch Valve	38-7
3-[illegible]-21B	LPCI Outbd. Isol. Valve 3B	39-7



R3
R3
R3
R3

(0s) - 0 seconds after closing of DG Breaker
0s - 0 seconds after UV relay resets
5s - 5 seconds after UV relay resets
10s - 10 seconds after UV relay resets

10- min - all loads that automatically stop before 10 minutes are shown off
10+ min - CCSW Pump is started with it auxiliaries
10++ min - CCSW Pump is running and other loads starting after 10 minutes are shown here

Attachment F

DG Unit 3 Division II ETAP Output Reports – Nominal Voltage

Scenario	Page #'s
DG3_Bkr_Cl	F2-F15
DG3_UV_Reset	F16-F29
DG3_T=5sec	F30-F44
DG3_T=10sec	F45-F59
DG3_T=10-min	F60-F73
DG3_T=10+min	F74-F87
DG3_T=10++m	F88-F101
DG3_CR_HVAC	F102-F115

R3

Only Load Flow Report (Page 8) of these scenarios has been included [initials] 4/24/07

Converted from ELMS PLUS

Diesel Generator connected using nominal voltage, Time period is less than 10 minutes into the event.

LOAD FLOW REPORT

Bus		Voltage		Generation		Load		Load Flow					XFMR
ID	kV	kV	Ang.	MW	Mvar	MW	Mvar	ID	MW	Mvar	Amp	% PF	% Tap
3-903-63 ESS UPS PNL	0.480	0.480	-1.5	0	0	0.050	0.037	480V SWGR 39	-0.050	-0.037	75.4	80.5	
4KV SWGR 34-1	4.160	4.158	0.0	0	0	0	0	HIGH SIDE OF XFMR 39	0.392	0.293	67.9	80.1	
								DG 3 TERMINAL	-0.392	-0.293	67.9	80.1	
125V DC CHGR 3	0.480	0.454	-0.3	0	0	0.034	0.027	480V MCC 39-2	-0.034	-0.027	55.0	78.6	
250V DC CHGR 2/3	0.480	0.455	-0.7	0	0	0.066	0.052	480V MCC 39-2	-0.066	-0.052	106.6	78.7	
480V MCC 38-7	0.480	0.478	-1.5	0	0	0.021	0.013	480V MCC 39-7	-0.021	-0.013	29.8	85.4	
480V MCC 39-1	0.480	0.479	-1.5	0	0	0.027	0.014	480V SWGR 39	-0.027	-0.014	36.5	88.1	
480V MCC 39-2	0.480	0.471	-1.7	0	0	0.168	0.119	125V DC CHGR 3	0.036	0.027	55.0	80.1	
								250V DC CHGR 2/3	0.069	0.053	106.6	79.7	
								480V SWGR 39	-0.273	-0.198	413.7	80.9	
480V MCC 39-7	0.480	0.479	-1.5	0	0	0.013	0.008	480V MCC 38-7	0.021	0.013	29.8	85.4	
								480V SWGR 39	-0.035	-0.021	48.9	85.2	
480V SWGR 39	0.480	0.480	-1.5	0	0	0	0	480V MCC 39-7	0.035	0.021	48.9	85.3	
								480V MCC 39-2	0.278	0.203	413.7	80.7	
								3-903-63 ESS UPS PNL	0.050	0.037	75.4	80.5	
								480V MCC 39-1	0.027	0.014	36.5	88.1	
								HIGH SIDE OF XFMR 39	-0.390	-0.276	574.1	81.6	
* DG 3 TERMINAL	4.160	4.160	0.0	0.392	0.293	0	0	4KV SWGR 34-1	0.392	0.293	67.9	80.1	
HIGH SIDE OF XFMR 39	4.160	4.157	0.0	0	0	0	0	4KV SWGR 34-1	-0.392	-0.293	67.9	80.1	
								480V SWGR 39	0.392	0.293	67.9	80.1	-2.500

* Indicates a voltage regulated bus (voltage controlled or swing type machine connected to it)

# Indicates a bus with a load mismatch of more than 0.1 MVA

Converted from ELMS PLUS

Diesel Generator connected using nominal voltage. Time period is less than 10 minutes into the event.

LOAD FLOW REPORT

Bus		Voltage		Generation		Load		Load Flow					XFMR
ID	kV	kV	Ang.	MW	Mvar	MW	Mvar	ID	MW	Mvar	Amp	% PF	% Tap
3-903-63 ESS UPS PNL	0.480	0.480	-1.6	0	0	0.050	0.037	480V SWGR 39	-0.050	-0.037	75.4	80.6	
4KV SWGR 34-1	4.160	4.155	0.0	0	0	0.521	0.252	HIGH SIDE OF XFMR 39	0.397	0.296	68.8	80.1	
								DG 3 TERMINAL	-0.918	-0.549	148.6	85.8	
125V DC CHGR 3	0.480	0.454	-0.3	0	0	0.034	0.027	480V MCC 39-2	-0.034	-0.027	55.0	78.7	
250V DC CHGR 2/3	0.480	0.454	-0.8	0	0	0.066	0.052	480V MCC 39-2	-0.066	-0.052	106.6	78.8	
480V MCC 38-7	0.480	0.478	-1.5	0	0	0.021	0.013	480V MCC 39-7	-0.021	-0.013	29.9	85.4	
480V MCC 39-1	0.480	0.479	-1.5	0	0	0.032	0.017	480V SWGR 39	-0.032	-0.017	43.5	87.5	
480V MCC 39-2	0.480	0.470	-1.7	0	0	0.168	0.119	125V DC CHGR 3	0.036	0.027	55.0	80.2	
								250V DC CHGR 2/3	0.069	0.052	106.6	79.8	
								480V SWGR 39	-0.273	-0.198	413.9	80.9	
480V MCC 39-7	0.480	0.478	-1.5	0	0	0.013	0.008	480V MCC 38-7	0.021	0.013	29.9	85.4	
								480V SWGR 39	-0.035	-0.021	49.0	85.2	
480V SWGR 39	0.480	0.480	-1.6	0	0	0	0	480V MCC 39-7	0.035	0.021	49.0	85.3	
								480V MCC 39-2	0.278	0.203	413.9	80.7	
								3-903-63 ESS UPS PNL	0.050	0.037	75.4	80.6	
								480V MCC 39-1	0.032	0.017	43.5	87.5	
								HIGH SIDE OF XFMR 39	-0.395	-0.279	581.3	81.7	
* DG 3 TERMINAL	4.160	4.160	0.0	0.919	0.550	0	0	4KV SWGR 34-1	0.919	0.550	148.6	85.8	
HIGH SIDE OF XFMR 39	4.160	4.155	0.0	0	0	0	0	4KV SWGR 34-1	-0.397	-0.296	68.8	80.1	
								480V SWGR 39	0.397	0.296	68.8	80.1	-2.500

* Indicates a voltage regulated bus (voltage controlled or swing type machine connected to it)

\# Indicates a bus with a load mismatch of more than 0.1 MVA

Converted from ELMS PLUS

Diesel Generator connected using nominal voltage, Time period is less than 10 minutes into the event.

LOAD FLOW REPORT

Bus		Voltage		Generation		Load		Load Flow					XFMR
ID	kV	kV	Ang.	MW	Mvar	MW	Mvar	ID	MW	Mvar	Amp	% PF	% Tap
3-903-63 ESS UPS PNL	0.480	0.479	-1.6	0	0	0.050	0.037	480V SWGR 39	-0.050	-0.037	75.4	80.7	
4KV SWGR 34-1	4.160	4.153	-0.1	0	0	1.014	0.511	HIGH SIDE OF XFMR 39	0.397	0.296	68.8	80.1	
								DG 3 TERMINAL	-1.411	-0.807	226.0	86.8	
125V DC CHGR 3	0.480	0.453	-0.3	0	0	0.034	0.027	480V MCC 39-2	-0.034	-0.027	55.0	78.7	
250V DC CHGR 2/3	0.480	0.454	-0.8	0	0	0.066	0.052	480V MCC 39-2	-0.066	-0.052	106.6	78.8	
480V MCC 38-7	0.480	0.478	-1.6	0	0	0.021	0.013	480V MCC 39-7	-0.021	-0.013	29.9	85.4	
480V MCC 39-1	0.480	0.478	-1.6	0	0	0.032	0.017	480V SWGR 39	-0.032	-0.017	43.5	87.5	
480V MCC 39-2	0.480	0.470	-1.7	0	0	0.168	0.119	125V DC CHGR 3	0.036	0.027	55.0	80.2	
								250V DC CHGR 2/3	0.069	0.052	106.6	79.8	
								480V SWGR 39	-0.273	-0.198	414.1	80.9	
480V MCC 39-7	0.480	0.478	-1.6	0	0	0.013	0.008	480V MCC 38-7	0.021	0.013	29.9	85.4	
								480V SWGR 39	-0.035	-0.021	49.0	85.2	
480V SWGR 39	0.480	0.479	-1.6	0	0	0	0	480V MCC 39-7	0.035	0.021	49.0	85.3	
								480V MCC 39-2	0.278	0.203	414.1	80.8	
								3-903-63 ESS UPS PNL	0.050	0.037	75.4	80.6	
								480V MCC 39-1	0.032	0.017	43.5	87.5	
								HIGH SIDE OF XFMR 39	-0.395	-0.279	581.5	81.7	
* DG 3 TERMINAL	4.160	4.160	0.0	1.413	0.810	0	0	4KV SWGR 34-1	1.413	0.810	226.0	86.8	
HIGH SIDE OF XFMR 39	4.160	4.152	-0.1	0	0	0	0	4KV SWGR 34-1	-0.397	-0.296	68.8	80.1	
								480V SWGR 39	0.397	0.296	68.8	80.1	-2.500

* Indicates a voltage regulated bus (voltage controlled or swing type machine connected to it)

\# Indicates a bus with a load mismatch of more than 0.1 MVA

Converted from ELMS PLUS
Diesel Generator connected using nominal voltage, Time period is less than 10 minutes into the event.

LOAD FLOW REPORT

Bus		Voltage		Generation		Load		Load Flow					XFMR
ID	kV	kV	Ang.	MW	Mvar	MW	Mvar	ID	MW	Mvar	Amp	% PF	% Tap
3-903-63 ESS UPS PNL	0.480	0.478	-1.8	0	0	0.050	0.037	480V SWGR 39	-0.050	-0.037	75.4	80.8	
4KV SWGR 34-1	4.160	4.149	-0.1	0	0	1.724	0.811	HIGH SIDE OF XFMR 39	0.433	0.317	74.7	80.7	
								DG 3 TERMINAL	-2.157	-1.128	338.8	88.6	
125V DC CHGR 3	0.480	0.452	-0.5	0	0	0.034	0.026	480V MCC 39-2	-0.034	-0.026	55.0	79.0	
250V DC CHGR 2/3	0.480	0.452	-1.0	0	0	0.066	0.051	480V MCC 39-2	-0.066	-0.051	106.7	79.0	
480V MCC 38-7	0.480	0.476	-1.7	0	0	0.021	0.013	480V MCC 39-7	-0.021	-0.013	30.0	85.4	
480V MCC 39-1	0.480	0.476	-1.8	0	0	0.054	0.029	480V SWGR 39	-0.054	-0.029	74.6	88.1	
480V MCC 39-2	0.480	0.468	-1.9	0	0	0.180	0.125	125V DC CHGR 3	0.036	0.026	55.0	80.5	
								250V DC CHGR 2/3	0.069	0.052	106.7	80.0	
								480V SWGR 39	-0.286	-0.204	432.4	81.4	
480V MCC 39-7	0.480	0.477	-1.7	0	0	0.013	0.008	480V MCC 38-7	0.021	0.013	30.0	85.4	
								480V SWGR 39	-0.035	-0.021	49.2	85.3	
480V SWGR 39	0.480	0.478	-1.8	0	0	0	0	480V MCC 39-7	0.035	0.021	49.2	85.3	
								480V MCC 39-2	0.291	0.209	432.4	81.2	
								3-903-63 ESS UPS PNL	0.050	0.037	75.4	80.8	
								480V MCC 39-1	0.054	0.029	74.6	88.1	
								HIGH SIDE OF XFMR 39	-0.431	-0.296	630.9	82.4	
* DG 3 TERMINAL	4.160	4.160	0.0	2.161	1.134	0	0	4KV SWGR 34-1	2.161	1.134	338.8	88.5	
HIGH SIDE OF XFMR 39	4.160	4.149	-0.1	0	0	0	0	4KV SWGR 34-1	-0.433	-0.317	74.7	80.7	
								480V SWGR 39	0.433	0.317	74.7	80.7	-2.500

* Indicates a voltage regulated bus (voltage controlled or swing type machine connected to it)

\# Indicates a bus with a load mismatch of more than 0.1 MVA

Converted from ELMS PLUS

Diesel Generator connected using nominal voltage, Time period is less than 10 minutes into the event.

LOAD FLOW REPORT

Bus		Voltage		Generation		Load		Load Flow					XFMR
ID	kV	kV	Ang.	MW	Mvar	MW	Mvar	ID	MW	Mvar	Amp	% PF	% Tap
3-903-63 ESS UPS PNL	0.480	0.480	-1.5	0	0	0.050	0.037	480V SWGR 39	-0.050	-0.037	75.4	80.6	
4KV SWGR 34-1	4.160	4.149	-0.1	0	0	1.724	0.811	HIGH SIDE OF XFMR 39	0.378	0.277	65.3	80.6	
								DG 3 TERMINAL	-2.103	-1.089	329.4	88.8	
125V DC CHGR 3	0.480	0.453	-0.3	0	0	0.034	0.027	480V MCC 39-2	-0.034	-0.027	55.0	78.7	
250V DC CHGR 2/3	0.480	0.454	-0.8	0	0	0.066	0.052	480V MCC 39-2	-0.066	-0.052	106.6	78.8	
480V MCC 38-7	0.480	0.480	-1.5	0	0	0	0	480V MCC 39-7	0.000	0.000	0.0	0.0	
480V MCC 39-1	0.480	0.478	-1.5	0	0	0.041	0.019	480V SWGR 39	-0.041	-0.019	54.9	90.5	
480V MCC 39-2	0.480	0.470	-1.7	0	0	0.174	0.121	125V DC CHGR 3	0.036	0.027	55.0	80.2	
								250V DC CHGR 2/3	0.069	0.052	106.6	79.8	
								480V SWGR 39	-0.279	-0.200	422.1	81.3	
480V MCC 39-7	0.480	0.480	-1.5	0	0	0	0	480V MCC 38-7	0.000	0.000	0.0	0.0	
								480V SWGR 39	0.000	0.000	0.0	0.0	
480V SWGR 39	0.480	0.480	-1.5	0	0	0	0	480V MCC 39-7	0.000	0.000	0.0	0.0	
								480V MCC 39-2	0.285	0.205	422.1	81.1	
								3-903-63 ESS UPS PNL	0.050	0.037	75.4	80.6	
								480V MCC 39-1	0.041	0.019	54.9	90.5	
								HIGH SIDE OF XFMR 39	-0.376	-0.262	551.5	82.1	
* DG 3 TERMINAL	4.160	4.160	0.0	2.106	1.095	0	0	4KV SWGR 34-1	2.106	1.095	329.4	88.7	
HIGH SIDE OF XFMR 39	4.160	4.149	-0.1	0	0	0	0	4KV SWGR 34-1	-0.378	-0.277	65.3	80.6	
								480V SWGR 39	0.378	0.277	65.3	80.6	-2.500

* Indicates a voltage regulated bus (voltage controlled or swing type machine connected to it)

\# Indicates a bus with a load mismatch of more than 0.1 MVA

Converted from ELMS PLUS

Diesel Generator connected using nominal voltage, Time period is 10 min or greater into the event, 1 CCSW pump.

LOAD FLOW REPORT

Bus		Voltage		Generation		Load		Load Flow					XFMR
ID	kV	kV	Ang.	MW	Mvar	MW	Mvar	ID	MW	Mvar	Amp	% PF	% Tap
3-903-63 ESS UPS PNL	0.480	0.480	-1.6	0	0	0.050	0.037	480V SWGR 39	-0.050	-0.037	75.4	80.6	
4KV SWGR 34	4.160	4.146	-0.1	0	0	0.477	0.212	4KV SWGR 34-1	-0.477	-0.212	72.7	91.4	
4KV SWGR 34-1	4.160	4.147	-0.1	0	0	1.702	0.804	HIGH SIDE OF XFMR 39	0.379	0.278	65.3	80.6	
								4KV SWGR 34	0.477	0.213	72.7	91.3	
								DG 3 TERMINAL	-2.557	-1.294	399.0	89.2	
125V DC CHGR 3	0.480	0.453	-0.3	0	0	0.034	0.027	480V MCC 39-2	-0.034	-0.027	55.0	78.8	
250V DC CHGR 2/3	0.480	0.454	-0.8	0	0	0.066	0.052	480V MCC 39-2	-0.066	-0.052	106.6	78.8	
480V MCC 38-7	0.480	0.480	-1.6	0	0	0	0	480V MCC 39-7	0.000	0.000	0.0	0.0	
480V MCC 39-1	0.480	0.478	-1.6	0	0	0.041	0.020	480V SWGR 39	-0.041	-0.020	55.4	90.4	
480V MCC 39-2	0.480	0.470	-1.7	0	0	0.174	0.121	125V DC CHGR 3	0.036	0.027	55.0	80.2	
								250V DC CHGR 2/3	0.069	0.052	106.6	79.8	
								480V SWGR 39	-0.279	-0.200	422.2	81.3	
480V MCC 39-7	0.480	0.480	-1.6	0	0	0	0	480V MCC 38-7	0.000	0.000	0.0	0.0	
								480V SWGR 39	0.000	0.000	0.0	0.0	
480V SWGR 39	0.480	0.480	-1.6	0	0	0	0	480V MCC 39-7	0.000	0.000	0.0	0.0	
								480V MCC 39-2	0.285	0.205	422.2	81.1	
								3-903-63 ESS UPS PNL	0.050	0.037	75.4	80.6	
								480V MCC 39-1	0.042	0.020	55.4	90.4	
								HIGH SIDE OF XFMR 39	-0.377	-0.262	552.1	82.1	
* DG 3 TERMINAL	4.160	4.160	0.0	2.562	1.303	0	0	4KV SWGR 34-1	2.562	1.303	399.0	89.1	
HIGH SIDE OF XFMR 39	4.160	4.147	-0.1	0	0	0	0	4KV SWGR 34-1	-0.378	-0.278	65.3	80.6	
								480V SWGR 39	0.378	0.278	65.3	80.6	-2.500

* Indicates a voltage regulated bus (voltage controlled or swing type machine connected to it)

\# Indicates a bus with a load mismatch of more than 0.1 MVA

Converted from ELMS PLUS

Diesel Generator connected using nominal voltage, Time period is 10 min or greater into the event, 2 CCSW pumps.

LOAD FLOW REPORT

Bus		Voltage		Generation		Load		Load Flow					XFMR
ID	kV	kV	Ang.	MW	Mvar	MW	Mvar	ID	MW	Mvar	Amp	% PF	% Tap
3-903-63 ESS UPS PNL	0.480	0.479	-1.6	0	0	0.050	0.037	480V SWGR 39	-0.050	-0.037	75.4	80.7	
4KV SWGR 34	4.160	4.145	-0.1	0	0	0.771	0.395	4KV SWGR 34-1	-0.771	-0.395	120.7	89.0	
4KV SWGR 34-1	4.160	4.148	-0.1	0	0	1.219	0.549	HIGH SIDE OF XFMR 39	0.391	0.286	67.3	80.7	
								4KV SWGR 34	0.772	0.396	120.7	89.0	
								DG 3 TERMINAL	-2.381	-1.231	373.0	88.8	
125V DC CHGR 3	0.480	0.453	-0.4	0	0	0.034	0.027	480V MCC 39-2	-0.034	-0.027	55.0	78.9	
250V DC CHGR 2/3	0.480	0.453	-0.9	0	0	0.066	0.051	480V MCC 39-2	-0.066	-0.051	106.6	78.9	
480V MCC 38-7	0.480	0.479	-1.6	0	0	0	0	480V MCC 39-7	0.000	0.000	0.0	0.0	
480V MCC 39-1	0.480	0.478	-1.6	0	0	0.041	0.020	480V SWGR 39	-0.041	-0.020	55.4	90.4	
480V MCC 39-2	0.480	0.469	-1.8	0	0	0.186	0.128	125V DC CHGR 3	0.036	0.027	55.0	80.3	
								250V DC CHGR 2/3	0.069	0.052	106.6	79.9	
								480V SWGR 39	-0.291	-0.207	439.1	81.5	
480V MCC 39-7	0.480	0.479	-1.6	0	0	0	0	480V MCC 38-7	0.000	0.000	0.0	0.0	
								480V SWGR 39	0.000	0.000	0.0	0.0	
480V SWGR 39	0.480	0.479	-1.6	0	0	0	0	480V MCC 39-7	0.000	0.000	0.0	0.0	
								480V MCC 39-2	0.297	0.212	439.1	81.3	
								3-903-63 ESS UPS PNL	0.050	0.037	75.4	80.7	
								480V MCC 39-1	0.042	0.020	55.4	90.4	
								HIGH SIDE OF XFMR 39	-0.389	-0.269	569.1	82.2	
* DG 3 TERMINAL	4.160	4.160	0.0	2.385	1.239	0	0	4KV SWGR 34-1	2.385	1.239	373.0	88.8	
HIGH SIDE OF XFMR 39	4.160	4.148	-0.1	0	0	0	0	4KV SWGR 34-1	-0.391	-0.286	67.3	80.7	
								480V SWGR 39	0.391	0.286	67.3	80.7	-2.500

* Indicates a voltage regulated bus (voltage controlled or swing type machine connected to it)

# Indicates a bus with a load mismatch of more than 0.1 MVA

Converted from ELMS PLUS

Diesel Generator connected using nominal voltage, Time period is 10 min or greater into the event, 2 CCSW pumps.

LOAD FLOW REPORT

Bus		Voltage		Generation		Load		Load Flow					XFMR
ID	kV	kV	Ang.	MW	Mvar	MW	Mvar	ID	MW	Mvar	Amp	%PF	% Tap
3-903-63 ESS UPS PNL	0.480	0.479	-1.6	0	0	0.050	0.037	480V SWGR 39	-0.050	-0.037	75.4	80.7	
4KV SWGR 34	4.160	4.145	-0.1	0	0	0.771	0.395	4KV SWGR 34-1	-0.771	-0.395	120.7	89.0	
4KV SWGR 34-1	4.160	4.148	-0.1	0	0	1.219	0.549	HIGH SIDE OF XFMR 39	0.391	0.286	67.3	80.7	
								4KV SWGR 34	0.772	0.396	120.7	89.0	
								DG 3 TERMINAL	-2.381	-1.231	373.0	88.8	
125V DC CHGR 3	0.480	0.453	-0.4	0	0	0.034	0.027	480V MCC 39-2	-0.034	-0.027	55.0	78.9	
250V DC CHGR 2/3	0.480	0.453	-0.9	0	0	0.066	0.051	480V MCC 39-2	-0.066	-0.051	106.6	78.9	
480V MCC 38-7	0.480	0.479	-1.6	0	0	0	0	480V MCC 39-7	0.000	0.000	0.0	0.0	
480V MCC 39-1	0.480	0.478	-1.6	0	0	0.041	0.020	480V SWGR 39	-0.041	-0.020	55.4	90.4	
480V MCC 39-2	0.480	0.469	-1.8	0	0	0.186	0.128	125V DC CHGR 3	0.036	0.027	55.0	80.3	
								250V DC CHGR 2/3	0.069	0.052	106.6	79.9	
								480V SWGR 39	-0.291	-0.207	439.1	81.5	
480V MCC 39-7	0.480	0.479	-1.6	0	0	0	0	480V MCC 38-7	0.000	0.000	0.0	0.0	
								480V SWGR 39	0.000	0.000	0.0	0.0	
480V SWGR 39	0.480	0.479	-1.6	0	0	0	0	480V MCC 39-7	0.000	0.000	0.0	0.0	
								480V MCC 39-2	0.297	0.212	439.1	81.3	
								3-903-63 ESS UPS PNL	0.050	0.037	75.4	80.7	
								480V MCC 39-1	0.042	0.020	55.4	90.4	
								HIGH SIDE OF XFMR 39	-0.389	-0.269	569.1	82.2	
* DG 3 TERMINAL	4.160	4.160	0.0	2.385	1.239	0	0	4KV SWGR 34-1	2.385	1.239	373.0	88.8	
HIGH SIDE OF XFMR 39	4.160	4.148	-0.1	0	0	0	0	4KV SWGR 34-1	-0.391	-0.286	67.3	80.7	
								480V SWGR 39	0.391	0.286	67.3	80.7	-2.500

* Indicates a voltage regulated bus (voltage controlled or swing type machine connected to it)

# Indicates a bus with a load mismatch of more than 0.1 MVA