Kovach

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

Design Analysis (Major Revision)			**Last Page No.** 14.0-7 and R105
Analysis No.:	9389-46-19-2	**Revision:** 003	
Title:	Calculation For Diesel Generator 2 Loading Under Design Bases Accident Condition		
EC/ECR No.:	EC 364066	**Revision:** 000	

		Components(s)	
Station(s):	Dresden		
Unit No.:	2	Various	
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	From		

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 1.0-4 for a description of this revision and a list of affected pages.

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

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

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

Review Notes: Independent Review ☒ Peer Review ☐

(For External Analyses Only)

External Approver Richard H. Low (Print Name) [signature] (Sign Name) 4-4-2007 (Date)

Exelon Reviewer J. G. Kovach (Print Name) [signature] (Sign Name) 04/04/07 (Date)

Independent 3rd Party Review Required? Yes ☐ No ☒ If yes, complete Attachment 3

Exelon Reviewer LOUIS MALLAVARAPU (Print Name) [signature] (Sign Name) 04/04/07 (Date)

Sargent & Lundy LLC

ORIGINAL

Calculation For Diesel Generator 2 Loading Under Design Bases Accident Condition			
X	Safety-Related		Non-Safety-Related

Calc. No. 9389-46-19-2	
Rev. 1	Date 10/17/96
Page 1.0 - 1	

Client ComEd	
Project Dresden Station Unit 2	
Proj. No. 9389-46	Equip. No.

Prepared by	Date 10/11/96
Reviewed by	Date 10/11/96
Approved by	Date 10/17/96

QA COPY MADE

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 7317-33-19-2 . The major differences between Calculation 7317-33-19-2 and this calculation are as follows:

1) Dresden Diesel Generator (DG) surveillance test strip charts (Reference 23) show that the first LPCI pump starts about 4 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 4 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 2 based on the latest base ELMS modified file D2A4.M24, including all modifications included in Revisions 0 through 14 of Calculation 7317-43-19-1 for Unit 2. 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-0861-00, 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 exists.

4) Created Table 4 for Unit 2 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, 1.0-2, 2.0-1, 2.0-2, 2.0-3, 4.0-7, 10.0-1 through 10.0-8, 11.0-1, 13.0-1, 14.0-1, 14.0-5, 14.0-7, A1 through A10, B4 through B13, C1 through C7, D2, E1, E2, Attachment F (ELMS-AC Reports), I2;

Note: all text pages are being re-issued to correct various typographical errors throughout the text. Revision bars were not used to denote changes made for typographical corrections only.

the following pages were added:

1.0-3, 2.0-4, Section 10.1 (10.1-0 through 10.1-26), Section 15.0 (15.0 through 15.34)

the following pages were deleted:

10.0-9 through 10.0-24, B14-B15.

This revision incorporates load parameter changes determined in Revision 18 of Calculation 7317-43-19-1 (Ref. 26) into the ELMS-AC datafile models used in this calculation to model diesel 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 datafiles so that file update can be made easily and accurately with the file 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 errors. ELMSCOMP reports showing data transfers and so forth will be added in a new section.

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 per Reference 26.

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 PowerStation (ETAP). All outstanding minor revisions have been incorporated. The parameters for valve 2-1501-22B 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, A3, A8, E1, H1, H2, R16-R19, R91

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, 4.0-7, 5.0-1, 7.0-1, 8.0-2, 8.0-4, 8.0-5, 9.0-1 – 9.0-6, 10.0-1 – 10.0-8, 10.1-0 – 10.1-26, 11.0-1, 14.0-1, 14.0-7, C1-C7 replaced by C1-C6, F1-F140 replaced by F1-F118, G0 replace by G1-G63

In this revision the following pages were added:

Design Analysis Cover Sheet (1.0-0), 2.0-5, R92-R100

In this revision the following pages were deleted:

15.0-0 – 15.0-34, Attachment I

Revision Summary and Review Method (cont'd)

Revision 3

This revision incorporates various changes to the EDG loading. Major changes include CS, LPCI and CCSW BHP values. Other changes include a reduction in the ESS UPS loading, removal of the 120/208V Xfmr Mag Tape Drive, decreasing the LOCA bhp value for the RPS MG Set, incorporating replacement of the DG cooling water pump and turning off the HPCI Aux Coolant pump. 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 65 to 70, 72, 73, 77 and 78. R3

In this revision the following pages were revised:

A5, A7, B8, B10, E1, R100

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, 4.0-7, 5.0-1, 7.0-1, 9.0-2, 9.0-3, 9.0-5, 10.0-1, 10.0-8, 10.1-1, 10.1-3, 10.1-4, 10.1-10, 10.1-11, 10.1-17, 10.1-18, 10.1-24, 10.1-25, 11.0-1, 12.0-1, 14.0-1, 14.0-7, C1, C3, Attachments F and G

In this revision the following pages were added:

1.0-4, 4.0-8, R101-R105

CALCULATION TABLE OF CONTENTS

CALC NO.: 9389-46-19-2	REV NO: 003 PAGE NO. 2.0-1	
SECTION	PAGE NO.:	SUB PAGE NO.:
II TABLE OF CONTENTS / FILE DESCRIPTION		

CALCULATION TABLE OF CONTENTS (Continued)

CALC NO.: 9389-46-19-2	REV NO: 003 PAGE NO. 2.0-2	
SECTION	**PAGE NO.:**	**SUB PAGE NO.:**

Note: Table 3 has not been created for this calculation. However, it is reserved for possible future use.

File Descriptions

Revision 0

File Name	Date	Time	File Description
D2A4DG2.G00	1/6/95	11:28:36a	General File - Original Issue
D2A4DG2R.G00	1/6/95	11:56:16a	General File - Original Issue - Reduced Voltage
D2A4DG2.I00	1/6/95	10:51:24a	Initial File - Original Issue
D2A4DG2R.I00	1/6/95	11:18:14a	Initial File - Original Issue - Reduced Voltage
D2TB1DG2.00	1/6/95	9:56:48a	Table 1 - Excel File
D2TB2DG2.00	1/6/95	10:31:24a	Table 2 - Excel File
D2TB4DG2.00	1/6/95	10:01:44a	Table 4 - Excel File
LDGRFDG2.00	1/6/95	10:40:12	Time vs. Load Graph
DRESDG2.00	12/19/94	6:34:02p	Flow Chart 1
DRESDG2.WP	1/6/95	7:41:08p	Calculation Text - Wordperfect

File Descriptions (cont)

Revision 1

File Name	Date	Time	File Description
D2A4DG2.G01	9/23/96	2:04p	General File - Data upgrade, see Revision Summary for details.
D2A4DG2R.G01	9/23/96	2:10p	General File - Reduced Voltage, see Revision Summary for details.
D2A4DG2.I01	10/11/96	10:01a	Initial File - Data upgrade, see Revision Summary for details.
D2A4DG2R.I01	10/11/96	10:08a	Initial File - Reduced Voltage, see Revision Summary for details.
D2EXCEL.XLS	10/11/96	1:26p	Excel Workbook for Tables 1, 2, 4, and the Time vs. Load Graph. This file replaces files D2TB1DG2.00, D2TB2DG2.00, D2TB4DG2.00, and LDGRFDG2.00
DG2MCAD.MCD	10/11/96	11:29a	Mathcad file for Section 10.1
DG2SLINE.PPT	10/11/96	1:39p	Single line - Attach E (Powerpoint)
DRESDG2.00	12/19/94	6:34p	Flow Chart 1 (ABC Flowcharter)
DRESDG2.WP	10/11/96		Calculation Text - Wordperfect

CALCULATION PAGE

File Descriptions (cont'd)

Revision 2

File Name	Size	Date	Time	File Description
9389-46-19-2 Rev. 2.doc	504320 bytes	8/9/06	7:52:35am	Text document
9389-46-19-2 Rev. 2 (section 10).xls	532480 bytes	7/31/06	2:13:14pm	Section 10.1
9389-46-19-2 Rev. 2 (table 4).xls	53248 bytes	4/21/06	9:05:56am	Table 4
DRE_Unit2_0003.mdb	1,7977,344 bytes	8/01/06	1:22:49pm	ETAP database
DRE_Unit2_0003.macros.xml	10595 bytes	8/01/06	10:17:20am	ETAP macros
DRE_Unit2_0003.scenarios.xml	11572 bytes	7/31/06	10:20:30am	ETAP Scenarios
DRE_Unit2_0003.oti	9728 bytes	8/01/06	1:22:48pm	ETAP "OTI" file

Revision 3

File Name	Size	Date	Time	File Description
9389-46-19-2 Rev. 3.doc	511488 bytes	3/22/07	11:38:07am	Text document
9389-46-19-2 Rev. 3 (section 10).xls	522752 bytes	3/2/07	7:25:52am	Section 10.1
9389-46-19-2 Rev. 3 (table 4).xls	55248 bytes	3/9/07	7:48:15am	Table 4
DRE_Unit2_0004.mdb	18,911,232 bytes	3/20/07	11:34:56pm	ETAP database
DRE_Unit2_0004.macros.xml	11206 bytes	3/20/07	9:46:37pm	ETAP macros
DRE_Unit2_0004.scenarios.xml	12862 bytes	2/12/07	3:49:12pm	ETAP Scenarios
DRE_Unit2_0004.oti	~~15306~~ bytes	3/21/07	9:37:49pm	ETAP "OTI" file

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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.

10) Determine the minimum power factor for the long term loading on the EDG. R3

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 2 is as follows (Reference 24):

Manufacturer	Electro - Motive Division (GM)
Model	A - 20 -C1
Serial No.	67 - K1 - 1008
Volts	2400 / 4160 v
Currents	782 / 452 Amps
Phase	3
Power Factor	0.8
RPM	900
Frequency	60
KVA	3125
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.	1157

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 2 is powering the Unit 2 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 2 is powering Unit 2, Division II loads (Attachment B).

I. Table 4: KW/KVAR/ KVA loading tables for total and individual starting load at each step when DG 2 is powering Unit 2, Division II loads (Attachment C).

J. Dresden DG 2 Calculation 7317-33-19-2, Revision 18 (superseded by this calculation).

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

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

M. Dresden Re-baselined Upated FSAR, Revision 0.

Input Data (cont'd)

N. 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).

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

P. Dresden Re-baselined Updated FSAR Figure 8.3-4 DG loading under accident and during loss of offsite ac power (Reference 31)

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

R. 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)

S. ETAP Loadflow summary for comparing loading and calculated KVA input of running loads at each step to DG capacity for Unit 2 (Attachments F & G). R2

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

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

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

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

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

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

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

Input Data (cont'd)

AA. Unit 2 ETAP file from Calculation DRE05-0038, Rev. 000 and 000A (Reference 60). See Section 2.0 for latest ETAP file. R3

AB. 125Vdc and 250Vdc Battery Charger, and 250Vdc UPS Models from Calculation 9189-18-19-2 used in ETAP (Reference 54)

AC. Single Line diagram showing the breaker position when the DG output breaker closes to 4-kV Bus 24-1 during LOOP concurrent with LOCA (Attachment D)

AD. Walkdown data for CCSW Pumps (Ref 35) (Attachment R)

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

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

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

AH. Western Engine letter dated 1/19/97 to Mr. Wayne Hoan identifying the voltage dip curve applicable to Dresden and Quad Cities (Attached)

AI. Strip Chart (1) for Diesel Generator Surveillance Test: Dated April 19, 1983

AJ. DIT DR-EPED-0861-00 (Attached)

AK. CIS-2: Tabulation for cable lengths

AL. Letter dated November 14, 1994 regarding NTS 925-201-94-PIF-01102 "CREFS Heating Coil – Dresden and Quad Cities" written by E. P. Ricohermoso

AM. DOP 0202-01, Revision 13; Unit 2 Reactor Recirculation System Startup

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

AO. Hand calculation to determine LRC for CCSW Pumps 2A, 2B, 2C and 2D

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

AQ. The maximum allowable time to start each LPCI Pump and Core Spray Pump is 5 Seconds (Reference 61)

CALCULATION PAGE

AR. The BHP values for the CS, LPCI and CCSW pumps after 10 minutes into a LOCA event are provided below (Ref. 65, 66, 67).

Core Spray Pump 2B	883.2 hp (879.6 hp after 2 hrs)
LPCI Pump 2C	639.7 hp (637.2 hp after 2 hrs)
LPCI Pump 2D	619.1 hp (616.6 hp after 2 hrs)
CCSW Pump 2C	575.0 hp with 1 pump running, 465 hp with both pumps running
CCSW Pump 2D	575.0 hp with 1 pump running, 465 hp with both pumps running

AS. The 2 EDG Cooling Water Pump has a BHP of 66.28kW with a power factor of 83.0. The efficiency, LRC and starting power factor are 100%, 400% and 31.5% respectively (Ref. 68 & 69)

R3

AT. 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. 70)

AU. The HPCI Aux Coolant Pump is manually controlled and not operated during a LOCA (Ref. 71)

AV. Dresden Technical Specification Section 3.8.1.16 allows a +2% tolerance on the nominal 60HZ EDG frequency (Ref. 74)

AW. The continuous rating of the EDG is 2600kW at a 0.8 pf (Ref. 75)

AX. For centrifugal pumps, the break horsepower varies as the cube of the speed (Ref. 76)

AY. The UPS load is 37.5kW at the 480V input (Ref. 77)

AZ. The Turbine & Radwaste Bldg Emergency Lighting Load is 27kW (Ref. 78)

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 is in Loop "A" and Loop "B" is selected for injection.

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. 76). Note that these pumps will operate on a different point on the performance curve and the BHP may actually increase less than 6%. Therefore, this assumption is conservative. 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 motor starting current is conservative and requires no further verification.

The above assumptions 1, 2, 3, 4, 5, 6, 7 & 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+ and after will be assumed to be started in the following order:

a) CCSW Pump 2D
b) CCSW Pump 2C
c) Train B Control Room HVAC

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. 76). R3

- EDG Power Factor during Time Sequence Steps DG2_T=10+m, DG2_T=10++m, and DG2_T=CRHVAC must be ≥88% (Ref. 79 and 80)

  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.AQ):

Service	Allowable-Starting Time (sec.)
LPCI Pump 2C	5
LPCI Pump 2D	5
Core Spray Pump 2B	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 timers 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 24-1, or
   - Breaker from Bus 24 to Bus 24-1 opens, or
   - Backup undervoltage on Bus 24-1 with a 7 second time delay under LOCA, or
   - Backup undervoltage on Bus 24-1 with a 5 minutes time delay without 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 24-1, 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 56 and 64):

- Appropriate loads on Bus 24 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 2B (2-1501-3B).
- 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.
- After both CCSW Pumps have been started, the operator will proceed to start the Control Room Standby HVAC.

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"), 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 <350psig 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 through 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 2C will start immediately after UV relay resets.
- LPCI Pump 2D 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.

R2

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 24 and will not auto start when the proper voltage is back on Bus 24.

ii) According to Dresden FSAR Section 8, Table 8.2.3:1 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 2D for this calculation] before the second CCSW pump is turned on (see References 56 and 64). 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 Pump is turned on, the operator has to open the CC Heat Exchanger Service Water Discharge Control Valve 1501-3B 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.) A Train in primary, B 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 standby, B Train in primary

If the A train of SBGT system is in standby, a timer is enabled which will initiate the A train of SBGT if a low flow is present on B 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 system trips the Normal Reactor Building Vent Supply and Exhaust Fans, and closes A0 valves. It also trips the drywell and torus purge fans. 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 7504A is normally open and interlocked closed on SBGT system initiation. Motor operated Butterfly Valve 7505A is normally closed and interlocked open upon SBGT system initiation. Motor Operated Butterfly Valve 7507A is normally closed and interlocked open on SBGT initiation. SBGT Fan 2/3-7506A will drive the filtered air out through the ventilating chimney.

5) Control Room Standby Air Conditioning and Emergency Filtration System

The Dresden Control Room should be provided with long term cooling and filtration for the operators to mitigate an accident situation and to maintain long-term operability of the control room equipment. The feed for this standby equipment is fed from MCC 29-8, which is tripped on LOOP to prevent initially overloading the DG, and remains open until is manually closed at the appropriate time. The Control Room Emergency Air Filtration Unit (AFU) in this system is required to operate starting 40 minutes after a postulated accident.

The procedure for securing Control Room HVAC according to DGA-12, Revision 16 is as follows:

1.) Reset UV relays on Bus 29.

2.) Close Bus 29 to MCC 29-8 at MCC 29-8.

3.) At Panel 923-5, start Air Filtration Unit by placing AIR FLTR UNIT BOOSTER FAN A/B control switch in either FAN A <u>or</u> FAN B position.

4.) At Panel 923-5, isolate Control Room by placing CONTROL ROOM ISOLATION switch in ISOLATE position.

5.) <u>If</u> Instrument Air is lost to Booster fan outlet dampers, <u>then</u> manually throttle flow to 2000 cubic feet per minute.

6.) Start Control Room Standby Air Handler Unit and Air Conditioner.

For conservatism, this calculation shows all of the associated CR HVAC to start simultaneously at 10+++ minutes.

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). R2

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. R2

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. R2

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. All scenarios use loading category "DG Loading". This loading category was 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 the "DG Loading" category. 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. R2

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

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 cases respectively. The Unit 2 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.

METHODOLOGY (cont'd)

Scenario	Configuration	Study Case	DG Voltage	Output Report	Study Macro	Description
DG2_Bkr_Cl	DG2_Bkr_Cl	DG_0_CCSW	4160V	DG2_Bkr_Close	DG2_Vnormal	Initial loading on DG due to 480V loads when DG breaker closes
DG2_UV_Reset	DG2_UV_Rst	DG_0_CCSW	4160V	DG2_UV_Reset	DG2_Vnormal	Scenario DG2_Bkr_Cl plus 1st LPCI pump and auxiliaries
DG2_T=5sec	DG2_T=5sec	DG_0_CCSW	4160V	DG2_T=5sec	DG2_Vnormal	Scenario DG2_UV_Reset plus 2nd LPCI pump
DG2_T=10sec	DG2_T=10sec	DG_0_CCSW	4160V	DG2_T=10sec	DG2_Vnormal	Scenario DG2_T=5sec plus Core Spray Pump and Auxiliaries
DG2_T=10-min	DG2_T=10-m	DG_0_CCSW	4160V	DG2_T=10-min	DG2_Vnormal	Scenario DG2_T=10sec minus MOV that have completed stroke
DG2_T=10+min	DG2_T=10+m	DG_1_CCSW	4160V	DG2_T=10+min	DG2_Vnormal	Scenario DG2_T=10-min plus 1st CCSW pump and Auxiliaries
DG2_T=10++mn	DG2_T10++m	DG_2_CCSW	4160V	DG2_T=10++min	DG2_Vnormal	Scenario DG2_T=10+min plus 2nd CCSW pump and Auxiliaries minus 1 LPCI pump.
DG2_CR_HVAC	DG2_CR_HVAC	DG_2_CCSW	4160V	DG2_CR_HVAC	DG2_Vnormal	Scenario DG2_T=10++min plus Control Room HVAC and all other long term loads.
DG2_Bkr_Vlow	DG2_Bkr_Cl	DG_Vreduced	2496V	DG2_Bkr_Vred	DG2_Vreduce	Scenario DG2_Bkr_Cl run at lowest expected voltage
DG2_UV_Vlow	DG2_UV_Rst	DG_Vreduced	2496V	DG2_UV_Vred	DG2_Vreduce	Scenario DG2_UV_Reset run at lowest expected voltage
DG2_T=5sVlo	DG2_T=5sec	DG_Vreduced	2496V	DG2_T=5sVred	DG2_Vreduce	Scenario DG2_T=5sec run at lowest expected voltage
DG2_T=10-mLo	DG2_T=10-m	DG_Vreduced	2496V	DG2_T=10-mred	DG2_Vreduce	Scenario DG2_T=10-min run at lowest expected voltage

R3

METHODOLOGY (cont'd)

C. Transient Loading Evaluation. R2

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

METHODOLOGY (cont'd)

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 auxiliary 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.

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 the 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 13 of Calculation 7317-33-19-2 shows that the voltage dip is 61.8% 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. R2

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 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 use 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 MCC 28/29-7 has been studied in S&L Calculation 8231-05-19-1

METHODOLOGY (Cont'd)

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:

$$T = [(Vterm)^2 / (Vrated)^2] \times \text{Motor Base Torque} \times \text{100\% Voltage Motor Torque from speed-torque curve}$$

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 to accelerate through an RPM increment is found using the following equation:

$$t = [WK^2(\text{pump + motor}) \times \text{RPM increment}] / (307.5 \times \text{Net Accelerating Torque})$$

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 2 is powering the Unit 2 buses.

A. Loading Scenarios:

Dresden Re-baselined Updated FSAR, Rev. 0, loading table 8.3-3 shows that the maximum DG 2 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 2 is **1541 kW**, which is adequate for Dresden Station (Note: Note 3 of Table 3.1-1 was considered when calculating this loading).

Also, the Dresden Re-baselined Updated FSAR, Rev. 0, Figure 8.3-4 shows that the maximum loading on DG 2 during LOOP concurrent with LOCA is **2247 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 24-1 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 2C showing the determination of motor starting kVA and starting time. It is shown for demonstrative purposes only (based on Rev. 2). Actual calculations for the Unit 2 4.16 kV motors is contained in Section 10.1. This sample calculation is based on use of the ETAP program. R3

Kovach

ATTACHMENT 1
Design Analysis Major Revision Cover Sheet

Design Analysis (Major Revision)		**Last Page No.** 14.0-7 and R105	
Analysis No.:	9389-46-19-2	**Revision:** 003	
Title:	Calculation For Diesel Generator 2 Loading Under Design Bases Accident Condition		
EC/ECR No.:	EC 364066	**Revision:** 000	

		Components(s)	
Station(s):	Dresden		
Unit No.:	2	Various	
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	From		

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 1.0-4 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	Richard H Low	4-4-2007
Exelon Reviewer	J. G. Kovach	J G Kovach	04/04/07

Independent 3rd Party Review Required? Yes ☐ No ☒ If yes, complete Attachment 3

	Print Name	Sign Name	Date
Exelon Reviewer	LOUIS MALLAVARAPU	[signature]	04/04/07

Sargent & Lundy LLC ORIGINAL	Calculation For Diesel Generator 2 Loading Under Design Bases Accident Condition				Calc. No. 9389-46-19-2	
	X	Safety-Related		Non-Safety-Related	Rev. 1	Date 10/17/96
					Page 1.0 - 1	

Client ComEd	Prepared by	Date 10/11/96
Project Dresden Station Unit 2	Reviewed by	Date 10/11/96
Proj. No. 9389-46 Equip. No.	Approved by	Date 10/17/96

QA COPY MADE

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 7317-33-19-2 . The major differences between Calculation 7317-33-19-2 and this calculation are as follows:

1) Dresden Diesel Generator (DG) surveillance test strip charts (Reference 23) show that the first LPCI pump starts about 4 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 4 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 2 based on the latest base ELMS modified file D2A4.M24, including all modifications included in Revisions 0 through 14 of Calculation 7317-43-19-1 for Unit 2. 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-0861-00, 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 exists.

4) Created Table 4 for Unit 2 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, 1.0-2, 2.0-1, 2.0-2, 2.0-3, 4.0-7, 10.0-1 through 10.0-8, 11.0-1, 13.0-1, 14.0-1, 14.0-5, 14.0-7, A1 through A10, B4 through B13, C1 through C7, D2, E1, E2, Attachment F (ELMS-AC Reports), I2;

Note: all text pages are being re-issued to correct various typographical errors throughout the text. Revision bars were not used to denote changes made for typographical corrections only.

the following pages were added:

1.0-3, 2.0-4, Section 10.1 (10.1-0 through 10.1-26), Section 15.0 (15.0 through 15.34)

the following pages were deleted:

10.0-9 through 10.0-24, B14-B15.

This revision incorporates load parameter changes determined in Revision 18 of Calculation 7317-43-19-1 (Ref. 26) into the ELMS-AC datafile models used in this calculation to model diesel 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 datafiles so that file update can be made easily and accurately with the file 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 errors. ELMSCOMP reports showing data transfers and so forth will be added in a new section.

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 per Reference 26.

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 PowerStation (ETAP). All outstanding minor revisions have been incorporated. The parameters for valve 2-1501-22B 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, A3, A8, E1, H1, H2, R16-R19, R91

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, 4.0-7, 5.0-1, 7.0-1, 8.0-2, 8.0-4, 8.0-5, 9.0-1 – 9.0-6, 10.0-1 – 10.0-8, 10.1-0 – 10.1-26, 11.0-1, 14.0-1, 14.0-7, C1-C7 replaced by C1-C6, F1-F140 replaced by F1-F118, G0 replace by G1-G63

In this revision the following pages were added:

Design Analysis Cover Sheet (1.0-0), 2.0-5, R92-R100

In this revision the following pages were deleted:

15.0-0 – 15.0-34, Attachment I

Revision Summary and Review Method (cont'd)

Revision 3

This revision incorporates various changes to the EDG loading. Major changes include CS, LPCI and CCSW BHP values. Other changes include a reduction in the ESS UPS loading, removal of the 120/208V Xfmr Mag Tape Drive, decreasing the LOCA bhp value for the RPS MG Set, incorporating replacement of the DG cooling water pump and turning off the HPCI Aux Coolant pump. 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 65 to 70, 72, 73, 77 and 78. R3

In this revision the following pages were revised:

A5, A7, B8, B10, E1, R100

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, 4.0-7, 5.0-1, 7.0-1, 9.0-2, 9.0-3, 9.0-5, 10.0-1, 10.0-8, 10.1-1, 10.1-3, 10.1-4, 10.1-10, 10.1-11, 10.1-17, 10.1-18, 10.1-24, 10.1-25, 11.0-1, 12.0-1, 14.0-1, 14.0-7, C1, C3, Attachments F and G

In this revision the following pages were added:

1.0-4, 4.0-8, R101-R105

CALCULATION TABLE OF CONTENTS

CALCULATION TABLE OF CONTENTS (Continued)

Note: Table 3 has not been created for this calculation. However, it is reserved for possible future use.

File Descriptions

Revision 0

File Name	Date	Time	File Description
D2A4DG2.G00	1/6/95	11:28:36a	General File - Original Issue
D2A4DG2R.G00	1/6/95	11:56:16a	General File - Original Issue - Reduced Voltage
D2A4DG2.I00	1/6/95	10:51:24a	Initial File - Original Issue
D2A4DG2R.I00	1/6/95	11:18:14a	Initial File - Original Issue - Reduced Voltage
D2TB1DG2.00	1/6/95	9:56:48a	Table 1 - Excel File
D2TB2DG2.00	1/6/95	10:31:24a	Table 2 - Excel File
D2TB4DG2.00	1/6/95	10:01:44a	Table 4 - Excel File
LDGRFDG2.00	1/6/95	10:40:12	Time vs. Load Graph
DRESDG2.00	12/19/94	6:34:02p	Flow Chart 1
DRESDG2.WP	1/6/95	7:41:08p	Calculation Text - Wordperfect

File Descriptions (cont)

Revision 1

File Name	Date	Time	File Description
D2A4DG2.G01	9/23/96	2:04p	General File - Data upgrade, see Revision Summary for details.
D2A4DG2R.G01	9/23/96	2:10p	General File - Reduced Voltage, see Revision Summary for details.
D2A4DG2.I01	10/11/96	10:01a	Initial File - Data upgrade, see Revision Summary for details.
D2A4DG2R.I01	10/11/96	10:08a	Initial File - Reduced Voltage, see Revision Summary for details.
D2EXCEL.XLS	10/11/96	1:26p	Excel Workbook for Tables 1, 2, 4, and the Time vs. Load Graph. This file replaces files D2TB1DG2.00, D2TB2DG2.00, D2TB4DG2.00, and LDGRFDG2.00
DG2MCAD.MCD	10/11/96	11:29a	Mathcad file for Section 10.1
DG2SLINE.PPT	10/11/96	1:39p	Single line - Attach E (Powerpoint)
DRESDG2.00	12/19/94	6:34p	Flow Chart 1 (ABC Flowcharter)
DRESDG2.WP	10/11/96		Calculation Text - Wordperfect

CALCULATION PAGE

File Descriptions (cont'd)

Revision 2

File Name	Size	Date	Time	File Description
9389-46-19-2 Rev. 2.doc	504320 bytes	8/9/06	7:52:35am	Text document
9389-46-19-2 Rev. 2 (section 10).xls	532480 bytes	7/31/06	2:13:14pm	Section 10.1
9389-46-19-2 Rev. 2 (table 4).xls	53248 bytes	4/21/06	9:05:56am	Table 4
DRE_Unit2_0003.mdb	1,7977,344 bytes	8/01/06	1:22:49pm	ETAP database
DRE_Unit2_0003.macros.xml	10595 bytes	8/01/06	10:17:20am	ETAP macros
DRE_Unit2_0003.scenarios.xml	11572 bytes	7/31/06	10:20:30am	ETAP Scenarios
DRE_Unit2_0003.oti	9728 bytes	8/01/06	1:22:48pm	ETAP "OTI" file

Revision 3

File Name	Size	Date	Time	File Description
9389-46-19-2 Rev. 3.doc	511488 bytes	3/22/07	11:38:07am	Text document
9389-46-19-2 Rev. 3 (section 10).xls	522752 bytes	3/2/07	7:25:52am	Section 10.1
9389-46-19-2 Rev. 3 (table 4).xls	55248 bytes	3/9/07	7:48:15am	Table 4
DRE_Unit2_0004.mdb	18,911,232 bytes	3/20/07	11:34:56pm	ETAP database
DRE_Unit2_0004.macros.xml	11206 bytes	3/20/07	9:46:37pm	ETAP macros
DRE_Unit2_0004.scenarios.xml	12862 bytes	2/12/07	3:49:12pm	ETAP Scenarios
DRE_Unit2_0004.oti	~~15306~~ bytes 15360	3/21/07	9:37:49pm	ETAP "OTI" file

R3

90K
4/4/07

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 2 is as follows (Reference 24):

Manufacturer	Electro - Motive Division (GM)
Model	A - 20 -C1
Serial No.	67 - K1 - 1008
Volts	2400 / 4160 v
Currents	782 / 452 Amps
Phase	3
Power Factor	0.8
RPM	900
Frequency	60
KVA	3125
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.	1157

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 2 is powering the Unit 2 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 2 is powering Unit 2, Division II loads (Attachment B).

I. Table 4: KW/KVAR/ KVA loading tables for total and individual starting load at each step when DG 2 is powering Unit 2, Division II loads (Attachment C).

J. Dresden DG 2 Calculation 7317-33-19-2, Revision 18 (superseded by this calculation).

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

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

M. Dresden Re-baselined Upated FSAR, Revision 0.

Input Data (cont'd)

N. 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).

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

P. Dresden Re-baselined Updated FSAR Figure 8.3-4 DG loading under accident and during loss of offsite ac power (Reference 31)

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

R. 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)

S. ETAP Loadflow summary for comparing loading and calculated KVA input of running loads at each step to DG capacity for Unit 2 (Attachments F & G). R2

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

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

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

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

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

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

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

Input Data (cont'd)

AA. Unit 2 ETAP file from Calculation DRE05-0038, Rev. 000 and 000A (Reference 60). See Section 2.0 for latest ETAP file. R3

AB. 125Vdc and 250Vdc Battery Charger, and 250Vdc UPS Models from Calculation 9189-18-19-2 used in ETAP (Reference 54)

AC. Single Line diagram showing the breaker position when the DG output breaker closes to 4-kV Bus 24-1 during LOOP concurrent with LOCA (Attachment D)

AD. Walkdown data for CCSW Pumps (Ref 35) (Attachment R)

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

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

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

AH. Western Engine letter dated 1/19/97 to Mr. Wayne Hoan identifying the voltage dip curve applicable to Dresden and Quad Cities (Attached)

AI. Strip Chart (1) for Diesel Generator Surveillance Test: Dated April 19, 1983

AJ. DIT DR-EPED-0861-00 (Attached)

AK. CIS-2: Tabulation for cable lengths

AL. Letter dated November 14, 1994 regarding NTS 925-201-94-PIF-01102 "CREFS Heating Coil – Dresden and Quad Cities" written by E. P. Ricohermoso

AM. DOP 0202-01, Revision 13; Unit 2 Reactor Recirculation System Startup

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

AO. Hand calculation to determine LRC for CCSW Pumps 2A, 2B, 2C and 2D

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

AQ. The maximum allowable time to start each LPCI Pump and Core Spray Pump is 5 Seconds (Reference 61)

AR. The BHP values for the CS, LPCI and CCSW pumps after 10 minutes into a LOCA event are provided below (Ref. 65, 66, 67).

Core Spray Pump 2B	883.2 hp (879.6 hp after 2 hrs)
LPCI Pump 2C	639.7 hp (637.2 hp after 2 hrs)
LPCI Pump 2D	619.1 hp (616.6 hp after 2 hrs)
CCSW Pump 2C	575.0 hp with 1 pump running, 465 hp with both pumps running
CCSW Pump 2D	575.0 hp with 1 pump running, 465 hp with both pumps running

AS. The 2 EDG Cooling Water Pump has a BHP of 66.28kW with a power factor of 83.0. The efficiency, LRC and starting power factor are 100%, 400% and 31.5% respectively (Ref. 68 & 69) R3

AT. 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. 70)

AU. The HPCI Aux Coolant Pump is manually controlled and not operated during a LOCA (Ref. 71)

AV. Dresden Technical Specification Section 3.8.1.16 allows a +2% tolerance on the nominal 60HZ EDG frequency (Ref. 74)

AW. The continuous rating of the EDG is 2600kW at a 0.8 pf (Ref. 75)

AX. For centrifugal pumps, the break horsepower varies as the cube of the speed (Ref. 76)

AY. The UPS load is 37.5kW at the 480V input (Ref. 77)

AZ. The Turbine & Radwaste Bldg Emergency Lighting Load is 27kW (Ref. 78)

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 is in Loop "A" and Loop "B" is selected for injection.

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. 76). Note that these pumps will operate on a different point on the performance curve and the BHP may actually increase less than 6%. Therefore, this assumption is conservative. 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 motor starting current is conservative and requires no further verification.

The above assumptions 1, 2, 3, 4, 5, 6, 7 & 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+ and after will be assumed to be started in the following order:
   a) CCSW Pump 2D
   b) CCSW Pump 2C
   c) Train B Control Room HVAC

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. 76). R3

- EDG Power Factor during Time Sequence Steps DG2_T=10+m, DG2_T=10++m, and DG2_T=CRHVAC must be ≥88% (Ref. 79 and 80)

  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.AQ):

Service	Allowable-Starting Time (sec.)
LPCI Pump 2C	5
LPCI Pump 2D	5
Core Spray Pump 2B	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 timers 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 24-1, or
- Breaker from Bus 24 to Bus 24-1 opens, or
- Backup undervoltage on Bus 24-1 with a 7 second time delay under LOCA, or
- Backup undervoltage on Bus 24-1 with a 5 minutes time delay without 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 24-1, 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 56 and 64):

- Appropriate loads on Bus 24 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 2B (2-1501-3B).
- 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.
- After both CCSW Pumps have been started, the operator will proceed to start the Control Room Standby HVAC.

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"), 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 <350psig 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 through 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 2C will start immediately after UV relay resets.
- LPCI Pump 2D 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.

R2

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 24 and will not auto start when the proper voltage is back on Bus 24.

ii) According to Dresden FSAR Section 8, Table 8.2.3:1 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 2D for this calculation] before the second CCSW pump is turned on (see References 56 and 64). 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 Pump is turned on, the operator has to open the CC Heat Exchanger Service Water Discharge Control Valve 1501-3B 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.) A Train in primary, B 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 standby, B Train in primary

If the A train of SBGT system is in standby, a timer is enabled which will initiate the A train of SBGT if a low flow is present on B 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 system trips the Normal Reactor Building Vent Supply and Exhaust Fans, and closes A0 valves. It also trips the drywell and torus purge fans. 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 7504A is normally open and interlocked closed on SBGT system initiation. Motor operated Butterfly Valve 7505A is normally closed and interlocked open upon SBGT system initiation. Motor Operated Butterfly Valve 7507A is normally closed and interlocked open on SBGT initiation. SBGT Fan 2/3-7506A will drive the filtered air out through the ventilating chimney.

5) Control Room Standby Air Conditioning and Emergency Filtration System

The Dresden Control Room should be provided with long term cooling and filtration for the operators to mitigate an accident situation and to maintain long-term operability of the control room equipment. The feed for this standby equipment is fed from MCC 29-8, which is tripped on LOOP to prevent initially overloading the DG, and remains open until is manually closed at the appropriate time. The Control Room Emergency Air Filtration Unit (AFU) in this system is required to operate starting 40 minutes after a postulated accident.

The procedure for securing Control Room HVAC according to DGA-12, Revision 16 is as follows:

1.) Reset UV relays on Bus 29.

2.) Close Bus 29 to MCC 29-8 at MCC 29-8.

3.) At Panel 923-5, start Air Filtration Unit by placing AIR FLTR UNIT BOOSTER FAN A/B control switch in either FAN A or FAN B position.

4.) At Panel 923-5, isolate Control Room by placing CONTROL ROOM ISOLATION switch in ISOLATE position.

5.) If Instrument Air is lost to Booster fan outlet dampers, then manually throttle flow to 2000 cubic feet per minute.

6.) Start Control Room Standby Air Handler Unit and Air Conditioner.

For conservatism, this calculation shows all of the associated CR HVAC to start simultaneously at 10+++ minutes.

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). R2

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. R2

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. R2

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. All scenarios use loading category "DG Loading". This loading category was 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 the "DG Loading" category. 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. R2

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

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 cases respectively. The Unit 2 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
DG2_Bkr_Cl	DG2_Bkr_Cl	DG_0_CCSW	4160V	DG2_Bkr_Close	DG2_Vnormal	Initial loading on DG due to 480V loads when DG breaker closes
DG2_UV_Reset	DG2_UV_Rst	DG_0_CCSW	4160V	DG2_UV_Reset	DG2_Vnormal	Scenario DG2_Bkr_Cl plus 1st LPCI pump and auxiliaries
DG2_T=5sec	DG2_T=5sec	DG_0_CCSW	4160V	DG2_T=5sec	DG2_Vnormal	Scenario DG2_UV_Reset plus 2nd LPCI pump
DG2_T=10sec	DG2_T=10sec	DG_0_CCSW	4160V	DG2_T=10sec	DG2_Vnormal	Scenario DG2_T=5sec plus Core Spray Pump and Auxiliaries
DG2_T=10-min	DG2_T=10-m	DG_0_CCSW	4160V	DG2_T=10-min	DG2_Vnormal	Scenario DG2_T=10sec minus MOV that have completed stroke
DG2_T=10+min	DG2_T=10+m	DG_1_CCSW	4160V	DG2_T=10+min	DG2_Vnormal	Scenario DG2_T=10-min plus 1st CCSW pump and Auxiliaries
DG2_T=10++mn	DG2_T10++m	DG_2_CCSW	4160V	DG2_T=10++min	DG2_Vnormal	Scenario DG2_T=10+min plus 2nd CCSW pump and Auxiliaries minus 1 LPCI pump.
DG2_CR_HVAC	DG2_CR_HVAC	DG_2_CCSW	4160V	DG2_CR_HVAC	DG2_Vnormal	Scenario DG2_T=10++min plus Control Room HVAC and all other long term loads.
DG2_Bkr_Vlow	DG2_Bkr_Cl	DG_Vreduced	2496V	DG2_Bkr_Vred	DG2_Vreduce	Scenario DG2_Bkr_Cl run at lowest expected voltage
DG2_UV_Vlow	DG2_UV_Rst	DG_Vreduced	2496V	DG2_UV_Vred	DG2_Vreduce	Scenario DG2_UV_Reset run at lowest expected voltage
DG2_T=5sVlo	DG2_T=5sec	DG_Vreduced	2496V	DG2_T=5sVred	DG2_Vreduce	Scenario DG2_T=5sec run at lowest expected voltage
DG2_T=10-mLo	DG2_T=10-m	DG_Vreduced	2496V	DG2_T=10-mred	DG2_Vreduce	Scenario DG2_T=10-min run at lowest expected voltage

R3

METHODOLOGY (cont'd)

C. Transient Loading Evaluation. R2

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

METHODOLOGY (cont'd)

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 auxiliary 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.

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 the 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 13 of Calculation 7317-33-19-2 shows that the voltage dip is 61.8% 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. R2

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 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 use 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 MCC 28/29-7 has been studied in S&L Calculation 8231-05-19-1

METHODOLOGY (Cont'd)

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:

   $T = [(Vterm)^2 / (Vrated)^2] \times$ 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 to accelerate through an RPM increment is found using the following equation:

   $t = [WK^2(\text{pump + motor}) \times \text{RPM increment}] / (307.5 \times \text{Net Accelerating Torque})$

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 2 is powering the Unit 2 buses.

A. Loading Scenarios:

Dresden Re-baselined Updated FSAR, Rev. 0, loading table 8.3-3 shows that the maximum DG 2 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 2 is **1541 kW,** which is adequate for Dresden Station (Note: Note 3 of Table 3.1-1 was considered when calculating this loading).

Also, the Dresden Re-baselined Updated FSAR, Rev. 0, Figure 8.3-4 shows that the maximum loading on DG 2 during LOOP concurrent with LOCA is **2247 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 24-1 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 2C showing the determination of motor starting kVA and starting time. It is shown for demonstrative purposes only (based on Rev. 2). Actual calculations for the Unit 2 4.16 kV motors is contained in Section 10.1. This sample calculation is based on use of the ETAP program. R3

Table 1

Automatically Turn On and Off Devices Under the
Design Basis Accident Condition
Dresden Station - Unit 2

Bus No./ Cub. No.	Equipment Description/No.	Load Shed	Known Fact	Assumption / Eng. Judgement	Dwg. Ref.	Rev.	Other Ref. (P & ID)
24-1 1	Reactor Bldg. Cooling Water Pump 2/3 (2/3-3701)	Yes	Trip due to bus undervoltage and does not auto start.		12E-2397	H	M20
24-1 6	LP Coolant Injection Pump 2C (2-1502-C)	No	Trip due to bus undervoltage and auto starts 0 seconds after UV relay reset.		12E-2436 Sh. 2	W	M29 Sh. 1
24-1 8	LP Coolant Injection Pump 2D (2-1502-D)	No	Trip due to bus undervoltage and auto starts 5 seconds after UV relay reset.		12E-2436 Sh.2	W	M29 Sh.1
24 -1 9	Reactor Shutdown Cooling Pump 2B (2-1002-B)	Yes	Trip due to bus undervoltage and will not auto start.		12E-2516	G	M32
24-1 10	Core Spray Pump 2B (2-1401-B)	No	Trip due to bus undervoltage and auto starts 10 seconds after UV relay reset.		12E-2429 Sh.2	X	M27
24-1 12	Reactor Clean-Up Recirculation Pump 2B (2-1205-B)	Yes	Trip due to bus undervoltage and will not auto start.		12E-2520	P	M30
24-1 13	Bus Tie 24-1/34-1 ACB 152-2432 (3-6734-21)	No	N.O. breaker and does not auto close.		12E-2328	L	
24-1 14	Reactor Bldg. Cooling Water Pump 2B (2-3701-B)	Yes	Trip due to LPCI Initiation and no auto mode for starting.		12E-2397	H	M20
29 293A	Fuel Pool Cooling Water Pump 2B (2-1902-B)	Yes	Trip due to bus undervoltage, and no auto mode for starting.		12E-2548	R	M31
29 293C	2-902-63 ESS UPS Panel (Normal feed)	No	Starts as soon as voltage is restored to Switchgear 29 (0 seconds).		12E-2811B	E	
29 294A	Recirculation MG Sets Vent Fan 2B (2B-5701)	Yes	Trips due to UV relay and does not restart.		12E-2420C	K	
29 294B	480V MCC 29-3 (Main feed)	Yes	Trip due to UV and will not auto close.		12E-2374	S	

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Automatically Turn On and Off Devices Under the
Design Basis Accident Condition
Dresden Station - Unit 2

Bus No./ Cub. No.	Equipment Description/No.	Load Shed	Known Fact	Assumption / Eng. Judgement	Dwg. Ref.	Rev.	Other Ref. (P & ID)
29 294D	480V MCC 29-8 Main Feed (2/3-7829-81A)	Yes	Trip due to UV and will be manually closed by the operator at 10 min.		12E-6811C		
29 295A	S.Turb Room Vent Fan (2B-5702)	Yes	Trip due to bus undervoltage, and will not auto start.		12E-2387B	G	M270
29 295B	Reactor Building Vent Fan 2B (2B-5703)	Yes	Trip due to bus undervoltage, and will not auto start.		12E-2399A	K	M269
29 295C	Reactor Bldg. Exhaust Fan 2B (2B-5704)	Yes	Trip due to bus undervoltage, and will not auto start.		12E-2399A	K	M269
29 295D	Reactor Bldg. Exhaust Fan 2C (2C-5704)	Yes	Trip due to bus undervoltage, and will not auto start.		12E-2399A	K	M269
29 296A	Drywell Cooler Blower 2C (2C-5734)	Yes	Trip due to core spray initiation and will not auto start.		12E-2393	N	M273
29 296B	Drywell Cooler Blower 2D (2D-5734)	Yes	Trip due to core spray initiation and will not auto start.		12E-2393	N	M273
29 296C	Drywell Cooler Blower 2E (2E-5734)	Yes	Trip due to core spray initiation and will not auto start.		12E-2393	N	M273
29 296D	480V MCC 29-5 & 29-6 Main Feed (2-7829-5A1) (2-7829-6A1)	Yes	Trip due to UV and will not auto close.		12E-2661M		
29-1 A4	120/208V Distr Xfmr 29-1	No	Turn on when MCC 29-1 has full voltage starts at 0 sec.		12E-2677A	AF	
29-1 B1	Drywell Air Compressor (2-4710-A/B)	No	Will operate at 0 seconds.		12E-2514	C	
29-1 B2	Standby Liquid Control Tank Heater (2-1103)	No	It will turn on according to a tank thermistor and off by a tank low level cut off switch.	Considering worst case, this equipment will start at 0 seconds.	12E-2460 Sh. 1	W	

Automatically Turn On and Off Devices Under the
Design Basis Accident Condition
Dresden Station - Unit 2

Bus No./ Cub. No.	Equipment Description/No.	Load Shed	Known Fact	Assumption / Eng. Judgement	Dwg. Ref.	Rev.	Other Ref. (P & ID)
29-1 B3	Standby Liquid Control Pump 2B (2-1102-B)	Yes	Normal position of control sw. is "off" and is not expected to operate.		12E-2460 Sh.1	W	M33
29-1 C1	HPCI Floor Drain Sump Pump (2-2301-250)	No	Turn on and off by the level switch.	Water level in the sump pump is not expected to go up, pump will not run.	12E-2533	T	
29-1 C3	Drywell and Torus Purge Exhaust Fan 2B (2-5708B)	Yes	Load trips due to LPCI initiation and fan will not be started.		12E-2393	N	M269
~~29-1 C4~~	~~AGAD Air Compressor (2-2501)~~	~~No~~	~~Normally isolated and de-energized (see UFSAR).~~	~~Considering worst case, this equipment will be used for long term stabilization.~~	~~12E-6556~~	~~E~~	
29-1 D1	HPCI Turb. Inlet Isolation Valve (2-2301-4)	No	N.O. valve and interlocked closed with isolation signal at 0 seconds.		12E-2529 Sh.2	AF	M51
29-1 D2	Car Puller	No	Does not operate in auto mode.	This equipment is not expected to be used during accident conditions.	12E-2677B	W	
29-1 D3	Shutdown Heat Exch. Close Cooling Water Isolation Valve (2-3704)	Yes	N.O. and is manually operated only.	It is not expected to operate.	12E-2677B	W	M20
29-1 D4	LPCI Drywell Spray Valve 2C (2-1501-27B)	Yes	N.C. & interlocked closed by LPCI initiation.		12E-2440	S	M29 Sh.1
29-1 E1	Core Spray Outboard Isolation Valve 2B (2-1402-24B)	Yes	N.O. and interlocked open with low Rx. pressure (325 psig).		12E-2431 Sh.2	X	M27
29-1 E2	Core Spray Inboard Isolation Valve 2B (2-1402-25B)	No	N.C. and interlocked open with core spray initiation at 10 seconds.		12E-2431 Sh.2	X	M27

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Automatically Turn On and Off Devices Under the
Design Basis Accident Condition
Dresden Station - Unit 2

Bus No./ Cub. No.	Equipment Description/No.	Load Shed	Known Fact	Assumption / Eng. Judgement	Dwg. Ref.	Rev.	Other Ref. (P & ID)
29-1 E3	West LPCI/Core Spray Room Sump Pump 2A (2-2001-511A)	Yes	Pump operates on a level switch.	Water level in Core Spray area is not expected to go up.	12E-2677C	V	
29-1 E4	120/208V Rail Cask Xfmr (Receptacle)	No	During DBA condition, this receptacle is not used.		12E-2677C	V	
29-1 E5	East LPCI/Core Spray Room Area Sump Pump (2001-510B)	No	Pump operates on a level switch.	Water level in core spray area is not expected to go up.	12E-2677C	V	
29-1 E6	Post LOCA H2 And O2 Monitoring Sample Pump 2B (2-2400-2B)	No	Load will operate at 0 seconds.		12E-6555A	E	
29-1 F1	LPCI Pump Drywell Spray Discharge Valve 2D (2-1501-28B)	Yes	N.C. and interlocked closed by LPCI initiaton.		12E-2441 Sh.3	W	M29, A-4 Sh.1
29-1 F3	Closed Cooling Water Drywell Return Valve 2A (2-3703A)	No	N.O. and remains open.		12E-2398	D	M20
29-1 F4	Drywell / Torus Air Comp. 2B (2-8549-B)	Yes	Will not operate, switch is in off position.	Assume in off position.	12E-2372B	M	
29-2 A1	125 V Battery Charger 2 (2-8300-2)	No	Start at 0 seconds.		12E-2389D	C	
29-2 A2	Diesel Cooling Water Sump Pump 2 (2-3903)	No	Turns on by the the diesel engine shutdown relay at 0 seconds.		12E-2350B Sh.1	U	M22
29-2 A3	Diesel Starting Air Compressor 2B (2-4611-B)	No	Turns on and off by the pressure switches starts at 0 seconds.		12E-2350B Sh.1	U	M173
29-2 A4	Condensate Transfer Pump 2B (2B-4301)	Yes	Trip by power loss and will not auto start.		12E-2370	R	

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Automatically Turn On and Off Devices Under the
Design Basis Accident Condition
Dresden Station - Unit 2

Bus No./ Cub. No.	Equipment Description/No.	Load Shed	Known Fact	Assumption / Eng. Judgement	Dwg. Ref.	Rev.	Other Ref. (P & ID)
~~29-2 B1~~	~~120/208V Xfmr Mag Tape Drive~~	~~No~~	~~Start at 0 seconds.~~		~~12E-2678B~~	~~S~~	
29-2 B2	Diesel Oil Transfer Pump 2 (2-5203)	No		Even though day tank has enough fuel for first few hours, for conservatism,this pump is considered to start at time 0 seconds.	12E-2350B Sh.1	U	M41 Sh.2
29-2 B5	Turbine Deck Vertical Milling Machine	No	Power available when MCC 29-2 is re-energized.	Not expected to used during a DBA Condition.	12E-2678B	X	
29-2 B6	250 V Battery Charger 2 / 3 (2/3-8350-2/3)	No	Start at 0 seconds.		12E-2678B	X	
29-2 B7	Turbine and Radwaste Building Emergency Lighting (2-7902)	No	Auto starts after 1 minute.	Considering the load to operate at 10 seconds after UV relay reset.	12E-2678B	S	
29-2 C2	RX. Protection System M - G Set 2B (2-8001-B)	No	Stops due to power loss and will auto start at 0 seconds.		12E-2592	J	
29-2 C4	480V MCC 115 Reserve Feed (Temporary)	No	Reserve Feed is normally de-energized.	Assume Reserve Feed is not operating.	12E-2678B	X	
29-2 D1	Containment Cooling Service Water Pump Cubicle Cooler C Fan 1 (2-5700-30C)	No	Turns on by operating the CCSWP 2C (starts at 10++ minutes).		12E-2678C	E	M274
29-2 D2	Containment Cooling Service Water Pump Cubicle Cooler C Fan 2 (2-5700-30C)	No	Turns on by operating the CCSWP 2C (starts at 10++ minutes).		12E-2678C	E	M274
29-2 D3	Containment Cooling Service Water Pump Cubicle Cooler D Fan 1 (2-5700-30D)	No	Turns on by operating the CCSWP 2C (starts at 10++ minutes).		12E-2678C	E	M274

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Table 1
Automatically Turn On and Off Devices Under the
Design Basis Accident Condition
Dresden Station - Unit 2

Bus No./ Cub. No.	Equipment Description/No.	Load Shed	Known Fact	Assumption / Eng. Judgement	Dwg. Ref.	Rev.	Other Ref. (P & ID)
29-2 D4	Containment Cooling Service Water Pump Cubicle Cooler D Fan 2 (2-5700-30D)	No	Turns on by operating the CCSWP 2C (starts at 10++ minutes).		12E-2678C	E	M274
29-2 D5	Diesel Ventilating Fan 2 (2-5790)	No	Turns on when engine speed is 800 rpm. or greater, start at 0 sec.		12E-2350B Sh.1	U	M1297
29-4 A1	Core Spray Pump Suction Valve 2B (2-1402-3B)	Yes	N.O. & interlocked open by core spray initiation.		12E-2432	W	M27
29-4 A2	Core Spray Test Bypass Valve 2B (2-1402-4B)	Yes	N.C & interlocked closed by Core Spray initiation.		12E-2433	M	M27
29-4 A3	LPCI Pump 2C Suction Valve (2-1501-5C)	Yes	N.O. interlocked open by LPCI initiation.		12E-2440	S	M29 Sh. 1
29-4 A4	LPCI Pump 2D Suction Valve (2-1501-5D)	Yes	N.O. interlocked open by LPCI initiation.		12E-2440	S	M29 Sh.1
29-4 B1	LPCI Torus Spray Valve 2C (2-1501-38B)	Yes	N.C. & interlocked closed by LPCI initiation.		12E-2441 Sh.1	W	M29 Sh.1
29-4 B2	LPCI Torus Spray Valve 2D (2-1501-20B)	Yes	N.C. & interlocked closed by LPCI initiation.		12E-2441 Sh.2	W	M29 Sh. 1
29-4 B3	LPCI Torus Ring Spray Valve 2C (2-1501-18B)	Yes	N.C. & interlocked closed by LPCI initiation.		12E-2441 Sh.1	W	M29 Sh.1
29-4 B4	LPCI Torus Ring Spray Valve 2D (2-1501-19B)	Yes	N.C. & interlocked closed by LPCI initiation.		12E-2441 Sh.2	W	M29 Sh.1
29-4 C1	Refueling Floor JIB Cranes (2-899)	No		It is expected that the refueling JIB cranes will not be used during DBA.	12E-2680B	N	

Bus No./ Cub. No.	Equipment Description/No.	Load Shed	Known Fact	Assumption / Eng. Judgement	Dwg. Ref.	Rev.	Other Ref. (P & ID)
29-4 C2	Containment Cooling Heat Exchanger Discharge Valve 2B (2-1501-3B)	No	N.O. and intlocked closed when service water pump is not running, operator has to open valve before starting CCSWP at 10 min.		12E-2440	S	M29 Sh.1
29-4 C3	LPCI Header Cross-Tie Isolation Valve 2B (2-1501-32B)	Yes	N.O. and intlocked open.		12E-2440	S	M29 Sh.1
29-4 C4	LPCI Pump Flow Bypass Valve 2B (2-1501-13B)	No	N.O. and remains open until flow is above set point and then it will close.	Consider the valve to start operating concurrent with LPCI Pump 2C (0 seconds after UV reset).	12E-2440	S	M29 Sh.1
29-4 D2	HPCI Auxiliary Coolant Pump (2-2301-57)	No	Manually Operated	Not operated during a LOCA	12E-2531	AB	M51 R.071.
29-4 D3	HPCI Pump 2 Area Cooling Unit (2-5747)	No	Start at 0 seconds.		12E-2393	N	
29-4 D4	LPCI / Core Spray Pump Area Cooling Unit 2B (2-5746B)	No	Start at 0 seconds after UV relay reset.		12E-2393	N	
29-4 E2	Diesel Circulating Water Heater 2/3	No	Will operate at 0 seconds.		12E-2351B Sh. 2	AL	
29-4 E2	Engine Lube Oil Circulating Pump Motor (1HP) (2/3-6699-111/113)	No	Lube oil pump starts at 0 sec.		12E-2351B Sh. 2	AL	
29-4 E2	Engine Lube Oil Circulating Pump Motor (3/4HP) (2/3-6699-111/113)	No	Lube oil pump starts at 0 sec.		12E-2351B Sh. 2	AL	

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Automatically Turn On and Off Devices Under the
Design Basis Accident Condition
Dresden Station - Unit 2

Bus No./ Cub. No.	Equipment Description/No.	Load Shed	Known Fact	Assumption / Eng. Judgement	Dwg. Ref.	Rev.	Other Ref. (P & ID)
29-4 E3	Core Spray Pump Recirc. Isolation Valve 2B (2B-1402-38B)	No	N.O. and if selected by the loop selection logic for injection, closes when Core Spray injection is sensed.	Considering worst condition, valve will close concurrent with Core Spray Pump start (10 seconds).	12E-2433	M	M27
29-4 E4	LPCI Heat Exch.By pass Valve 2B (2-1501-11B)	No	N.O. and remains open.		12E-2440	N	M29 Sh.1
29-4 E5	HPCI Turbine Oil Tank Heater.	No	Turn on or off by the thermostat setting. Consider worst case starting at 0 seconds.		12E-2532	V	
29-7 A3	LPCI Outboard Isolation Valve 2B (2-1501-21B)	No	N.O. and remains open.	Remains open because break is assumed in Loop "A" and Loop "B" is selected to operate.	12E-2441A	W	M29 Sh.1
29-7 B1	Recirc. Pump 2B Discharge Bypass Valve (2-202-7B)	Yes	N.C. and interlocked closed by RX. pressure below set point.		12E-2420B	M	M26 Sh.2
29-7 B2	Recirc. Pump 2B Discharge Valve (2-202-5B)	No	N.O. & interlocked closed by LPCI initiation if selected by the loop selection logic.	It was assumed that the break occurred at Loop "A" and the loop selection logic selected Loop "B" to operate.	12E-2420B	M	M26 Sh.2
29-7 B3	Recirc.Loop Equalizing Valve 2B (2-202-6B)	Yes	N.C. and interlocked closed by RX. low water level and drywell high pressure	It was assumed that the break occurred at Loop "A" and the loop selection logic selected Loop "B" to operate.	12E-2420B	M	M26 Sh.2
~~29-7 B4~~	~~Recirc. Equalizing Bypass Valve 2B (2-202-9B)~~	~~No~~	~~N.O. and interlocked closed by RX. low water level and drywell high pressure.~~	~~This is assumed to be the N.O. bypass valve.~~	~~12E-2420B~~	~~M~~	~~M26 Sh.2~~
29-7 C2	Recirc. Pump 2B Suction Valve (2-202-4B)	No	N.O. and remains open.		12E-2420B	M	M26 Sh.1

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Automatically Turn On and Off Devices Under the
Design Basis Accident Condition
Dresden Station - Unit 2

Bus No./ Cub. No.	Equipment Description/No.	Load Shed	Known Fact	Assumption / Eng. Judgement	Dwg. Ref.	Rev.	Other Ref. (P & ID)
29-7 C3	LPCI Inboard Isolation Valve 2B (2-1501-22B)	No	N.C. and interlocked open by LPCI initiation when selected by the loop selection logic circuit.	It was assumed that the break occurred at Loop "A" and the loop selection logic selected Loop "B" to operate.	12E-2441A	W	M29 Sh.1
28-7 B3	LPCI Inboard Isolation Valve 2A (2-1501-22A)	No	N.C. and interlocked closed with LPCI initiation, when it is not selected by LOOP logic ckt.	It was assumed that the break occurred at Loop "A" and the loop selection logic selected Loop "B" to operate.	12E-2441 Sh.4	W	M29 Sh.1
28-7 B4	Recirc. Loop Bypass Valve 2A (2-202-9A)	Yes	N.C. and interlocked closed at LPCI initiation.	This is assumed to be the N.C. bypass valve.	12E-2420A	P	M26 Sh.2
28-7 C1	Recirc. Pump 2A Suction Valve (2-202-4A)	No	N.O. and interlocked open (no auto mode).		12E-2420A	P	M26 Sh.2
28-7 C2	Recirc. Pump 2A Discharge Valve (2-202-5A)	No	N.O. and interlocked open with LPCI initiation if not selected by the loop selection logic.	It was assumed that the break occurred at Loop "A" and the loop selection logic selected Loop "B" to operate.	12E-2420A	P	M26 Sh.2
28-7 C3	Recirc. Pump 2A Discharge Bypass Valve (2-202-7A)	Yes	N.C. and interlocked closed by LPCI initiation.		12E-2420A	P	M26 Sh.2
28-7 C4	Recirc. Loop Equalizing Valve 2A (2-202-6A)	Yes	N.C. and interlocked closed if selected by the loop selection logic.	It was assumed that the break occurred at Loop "A" and the loop selection logic selected Loop "B" to operate.	12E-2420A	P	M26 Sh.2
28-7 D2	LPCI Outboard Isolation Valve 2A (2-1501-21A)	No	N.O. and interlocked closed by LPCI initiation when selected by the loop selection logic.	It was assumed that the break occurred at Loop "A" and the loop selection logic selected Loop "B" to operate.	12E-2441 Sh.3	W	M29 Sh.1

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Automatically Turn On and Off Devices Under the
Design Basis Accident Condition
Dresden Station - Unit 2

Bus No./ Cub. No.	Equipment Description/No.	Load Shed	Known Fact	Assumption / Eng. Judgement	Dwg. Ref.	Rev.	Other Ref. (P & ID)
29-9 B4	Standby Gas Treatment Inlet Damper 2/3A (2/3-7505A)	No	N.C. and opens upon SBGT initiation. Starts operating at 0 seconds.		12E-2400D Sh. 1	A	
29-9 B5	Standby Gas Treatment Outside Air Supply Damper 2/3A (2/3-7504A)	No	N.O. and closes upon SBGT initiation. Starts operating at 0 seconds.		12E-2400D Sh. 1	A	
29-9 C4	Standby Gas Treatment Air Heater 2/3A (2/3-A-7503)	No	Starts operation upon iniation of SBGT (0 seconds).		12E-2400D Sh. 2	A	
29-9 D2	Standby Gas Treatment Fan Discharge Damper 2/3A (2/3-7507A)	No	N.C. and opens upon SBGT initiation. Starts operating at 0 seconds.		12E-2400D Sh. 1	A	
29-9 D3	Standby Gas Treatment Fan 2/3A (2/3-A-7506)	No	Starts operation upon iniation of SBGT (0 seconds).		12E-2400D Sh. 2	A	

N.O. - Normally Open
N.C. - Normally Closed
N/A - Not Available
Note: 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 and do not operate (i.e. an MOV that is N.O. and remains open) are considered NOT load shed.

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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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TABLE 2

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 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.

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TA[illegible] 2
AFFECTS OF [illegible]LTAGE DIP
Dresden Station - Unit 2

Bus No.	Equipment Description/No.	Load Shed	Will the voltage dips @ 5s, 10s, & 10min. 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.
24-1 1	Reactor Bldg. Cooling Water Pump 2/3 (2/3-3701)	Yes	No	N/A	N/A	N/A	12E-2397	H	M 20
24-1 6	LP Coolant Injection Pump 2C (2-1502-C)	No	Yes. The pump might slow down momentarily	Yes. Interlock relay controlled by 125V Dc	No	No	12E-2436 Sh.2	W	M 29 Sh. 1
24-1 8	LP Coolant Injection Pump 2D (2-1502-D)	No	Yes. The pump might slow down momentarily	Yes. Interlock relay controlled by 125V Dc	No	No	12E-2436 Sh. 2	W	M 29 Sh. 1
24-1 9	Reactor Shutdown Cooling Pump 2B (2-1002-B)	Yes	No	N/A	N/A	N/A	12E-2516	G	M 32
24-1 10	Core Spray Pump 2B (2-1401-B)	No	Yes. The pump might slow down momentarily.	Yes. Interlock relay controlled by 125V DC.	No	No	12E-2429 Sh.2	X	M 27
24-1 12	Reactor Clean-Up Recirculation Pump 2B (2-1205-B)	Yes	No	N/A	N/A	N/A	12E-2520	P	M 30
24-1 13	Bus Tie 24-1/34-1 ACB 152-2432 (3-6734-21)	No	No	N/A	N/A	N/A	12E-2346 Sh.1	AC	
24-1 14	Reactor Bldg. Cooling Water Pump 2B (2-3701-B)	Yes	No	N/A	N/A	N/A	12E-2397	H	M 20
29 293A	Fuel Pool Cooling Water Pump 2B (2-1902-B)	Yes	No	N/A	N/A	N/A	12E-2548	R	M 31
29 293C	2-902-63 ESS UPS Panel (Normal feed)	No	No. The back-up power supply is from 250Vdc Battery	Yes	No	No	12E-2811B	E	
29 294A	Recirculation MG Sets Vent Fan 2B (2B-5701)	Yes	No	N/A	N/A	N/A	12E-2420C	K	

TABLE 2
AFFECTS OF VOLTAGE DIP
Dresden Station - Unit 2

Bus No.	Equipment Description/No.	Load Shed	Will the voltage dips @ 5s, 10s, & 10min. 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.
29 295A	S.Turb Room Vent Fan (2B-5702)	Yes	No	N/A	N/A	N/A	12E-2387B	G	M 270
29 295B	Reactor Building Vent Fan 2B (2B-5703)	Yes	No	N/A	N/A	N/A	12E-2399A	K	M 269
29 295C	Reactor Buildg Exhaust Fan 2B (2B-5704)	Yes	No	N/A	N/A	N/A	12E-2399A	K	M 269
29 295D	Reactor Bldg. Exhaust Fan 2C (2C-5704)	Yes	No	N/A	N/A	N/A	12E-2399A	K	M 269
29 296A	Drywell Cooler Blower 2C (2C-5734)	Yes	N/A	N/A	N/A	N/A	12E-2393	N	M 273
29 296B	Drywell Cooler Blower 2D (2D-5734)	Yes	N/A	N/A	N/A	N/A	12E-2393	N	M 273
29 296C	Drywell Cooler Blower 2E (2E-5734)	Yes	N/A	N/A	N/A	N/A	12E-2393	N	M 273
29-1 A4	120/208V Distr Xfmr 29-1	No	Yes. Transformer might be momentarily interrupted.	Yes. No auxiliary relay interlock.	No	No	12E-2677A	AF	
29-1 B1	Drywell Air Compressor (2-4710-A/B)	No	Yes. Compressor might slow down momentarily.	Yes. Interlocked with vacuum switch.	No	No	12E-2514	C	
29-1 B2	Standby Liquid Control Heater (2-1103)	No	Yes. Heater output might decrease momentarily.	Yes. Interlocked with tank thermistor.	No	No	12E-2460 Sh. 1	W	
29-1 B3	Standby Liquid Control Pump 2B (2-1102-B)	Yes	N/A	N/A	N/A	N/A	12E-2460 SH. 1	W	M 33

TA[illegible]E 2
AFFECTS OF [illegible]LTAGE DIP
Dresden Station - Unit 2

Bus No.	Equipment Description/No.	Load Shed	Will the voltage dips @ 5s, 10s, & 10min. 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.
29-1 C1	HPCI Floor Drain Sump Pump (2-2301-250)	No	No. Pump is not operating. Float switch on low level.	N/A	N/A	N/A	12E-2533	T	
29-1 C3	Drywell and Torus Purge Exhaust Fan 2B (2-5708B)	Yes	N/A	N/A	N/A	N/A	12E-2393	N	M 269
29-1 C4	ACAD Air Compressor (2-2501)	No	No. Compressor is shown to start after 10 minutes.	Yes.	No	N/A	12E-6556	E	
29-1 D1	HPCI Turb. Inlet Isolation Valve (2-2301-4)	No	Yes. Valve might stop momentarily.	Yes. Interlock relay is powered by 125Vdc. Interlock relay will energize with low RX pressure, steam line break ETC.	No	No. Increased operating time is within acceptable limit.	12E-2529 Sh.2	AF	M 51
29-1 D2	Car Puller	No	No. Not required.	N/A	N/A	N/A	12E-2677B	W	
29-1 D3	Shutdown Heat Exch. Closed Cooling Water Isolation Valve (2-3704)	Yes	N/A	N/A	N/A	N/A	12E-2677B	W	M 20
29-1 D4	LPCI Drywell Spray Valve 2C (2-1501-27B)	Yes	N/A	N/A	N/A	N/A	12E-2440	S	M 29 Sh.1
29-1 E1	Core Spray Outboard Isolation Valve 2B	Yes	N/A	N/A	N/A	N/A	12E-2431 Sh.2	X	M 27
29-1 E2	Core Spray Inboard Isolation Valve 2B (2-1402-25B)	No	Yes. Valve might stop operating momentarily.	Yes. Interlock relay controlled by 125V DC.	No	No. The increased operating time is within the acceptable limit.	12E-2431 Sh.2	X	M 27

TABLE 2
AFFECTS OF VOLTAGE DIP
Dresden Station - Unit 2

Bus No.	Equipment Description/No.	Load Shed	Will the voltage dips @ 5s, 10s, & 10min. 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.
29-1 E3	West LPCI/Core Spray Room Sump Pump 2A (2-2001-511A)	Yes	N/A	N/A	N/A	N/A	12E-2677C	V	
29-1 E4	120/208V Rail Cask Xfmr (Receptacle)	No	No. Receptacle is not used during plant DBA condition.	N/A	N/A	N/A	12E-2677C	V	
29-1 E5	East LPCI/Core Spray Room Area Sump Pump (2001-510B)	No	No. Pump is not operating. Level switch at low level.	No. Not required.	N/A	N/A	12E-2677C	V	
29-1 E6	Post LOCA H2 & O2 Monitoring Sample Pump 2B (2-2400-2B)	No	No. Pump may slow down momentarily.	Yes	No	N/A	12E-6555A	E	
29-1 F1	LPCI Pump Drywell Spray Discharge Valve 2D (2-1501-28B)	Yes	N/A	N/A	N/A	N/A	12E-2441 Sh.3	W	
29-1 F3	Closed Cooling Water Drywell Return Valve 2A (2-3703)	No	No.	N/A	N/A	N/A	12E-2398	D	M 20
29-1 F4	Drywell / Torus Air Comp. 2B (2-8549-B)	Yes	N/A	N/A	N/A	N/A	12E-2372B	M	
29-2 A1	125 V Battery Charger 2 (2-8300-2)	No	Yes. Charger output might decrease momentarily.	Yes. No auxiliary relay interlock.	No	No	12E-2389D	C	
29-2 A2	Diesel Cooling Water Sump Pump 2 (2-3903)	No	Yes. Pump might stop momentarily.	Yes. Interlock relay controlled by 125 Vdc.	No	No	12E-2350B Sh.1	U	M 22

E 2

AFFECTS OF [illegible]TAGE DIP

Dresden Station - Unit 2

Bus No.	Equipment Description/No.	Load Shed	Will the voltage dips @ 5s, 10s, & 10min. 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.
29-2 A3	Diesel Starting Air Compressor 2B (2-4611-B)	No	Yes. Compressor might stop momentarily.	Yes. Interlocked with pressure switch only.	No	No	12E-2350B Sh.1	U	M 173
29-2 A4	Condensate Transfer Pump 2B (2B-3319)	Yes	No	N/A	N/A	N/A	12E-2370	R	
29-2 B1	~~120/208V Xfmr Mag Tape Drive~~	~~No~~	~~Yes. Transformer might be momentarily interrupted.~~	~~Yes. No auxiliary relay interlock.~~	~~No~~	~~No~~	~~12E-2678B~~	~~S~~	
29-2 B2	Diesel Oil Transfer Pump 2 (2-5203)	No	No. This pump will not operate for the first 2 hours. See Assumption 2 in text.	Interlocked with level switch only.	N/A	N/A	12-2350B Sh.1	U	M 41 Sh.2
29-2 B5	Turbine Deck Vertical Milling Machine	No	No	No. Not expected to be used during DBA Condition.	N/A	N/A	12E-2678B	X	
29-2 B6	250 V Battery Charger 2/3 (2/3-8350-2/3)	No	Yes. Charger output might drop momentarily.	Yes. No auxiliary relay interlock.	No	No	12E-2678B	X	
29-2 B7	Turbine and Radwaste Building Emergency Lighting (2-7902)	No	Yes. Lighting might dim momentarily.	Yes. Interlock relay will energize when voltage is back.	No	No	12E-2678B	S	
29-2 C2	RX. Protection System M-G Set 2B (2-8001-B)	No	Yes. Motor might slow down momentarily.	Yes.	No.	N/A	12E-2592	J	
29-2 C4	480V MCC 115 Reserve Feed (Temporary)	No	No.	No. Normal Feed is assumed to feed this MCC.	N/A	N/A	12E-2678B	X	

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DG2EXCEL.XLS
Table 2

TABLE 2
AFFECTS OF VOLTAGE DIP
Dresden Station - Unit 2

Bus No.	Equipment Description/No.	Load Shed	Will the voltage dips @ 5s, 10s, & 10min. 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.
29-2 D1	Containment Cooling Service Water Pump Cubicle Cooler C Fan 1 (2-5700-30C)	No	No. Fan will operate after the second CCSWP is operating at 10++ minutes.	N/A	N/A	N/A	12E-2678C	E	M 274
29-2 D2	Containment Cooling Service Water Pump Cubicle Cooler C Fan 2 (2-5700-30C)	No	No. Fan will operate after the second CCSWP is operating at 10++ minutes.	N/A	N/A	N/A	12E-2678C	E	M 274
29-2 D3	Containment Cooling Service Water Pump Cubicle Cooler D Fan 1 (2-5700-30D)	No	No. Fan will operate after the second CCSWP is operating at 10++ minutes.	N/A	N/A	N/A	12E-2678C	E	M 274
29-2 D4	Containment Cooling Service Water Pump Cubicle Cooler D Fan 2 (2-5700-30D)	No	No. Fan will operate after the second CCSWP is operating at 10++ minutes.	N/A	N/A	N/A	12E-2678C	E	M 274
29-2 D5	Diesel Ventilating Fan 2 (2-5790)	No	Yes. Fan might stop momentarily.	Yes. Interlock relay energizes when voltage is back.	No	No	12E-2350B Sh.1	U	
29-4 A1	Core Spray Pump Suction Valve 2B (2-1402-3B)	Yes	N/A	N/A	N/A	N/A	12-2432	W	M 27
29-4 A2	Core Spray Test Bypass Valve 2B (2-1402-4B)	Yes	N/A	N/A	N/A	N/A	12E-2433	M	M 27
29-4 A3	LPCI Pump 2C Suction Valve (2-1501-5C)	Yes	N/A	N/A	N/A	N/A	12E-2440	S	M 29 Sh.1
29-4 A4	LPCI Pump 2D Suction Valve (2-1501-5D)	Yes	N/A	N/A	N/A	N/A	12E-2440	S	M 29 Sh.1

[illegible] 2
AFFECTS OF V[illegible]LTAGE DIP
Dresden Station - Unit 2

Bus No.	Equipment Description/No.	Load Shed	Will the voltage dips @ 5s, 10s, & 10min. 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.
29-4 B1	LPCI Torus Spray Valve 2C (2-1501-38B)	Yes	N/A	N/A	N/A	N/A	12E-2441 Sh. 1	W	M 29 Sh.1
29-4 B2	LPCI Torus Spray Valve 2D (2-1501-20B)	Yes	N/A	N/A	N/A	N/A	12E-2441 Sh.2	W	M 29 Sh.1
29-4 B3	LPCI Torus Ring Spray Valve 2C (2-1501-18B)	Yes	N/A	N/A	N/A	N/A	12E-2441 Sh. 1	W	M 29 Sh.1
29-4 B4	LPCI Torus Ring Spray Valve 2D (2-1501-19B)	Yes	N/A	N/A	N/A	N/A	12E-2441 Sh.2	W	M 29 Sh.1
29-4 C1	Refueling Floor JIB Cranes (2-899)	No	No. Equipment is not operating.	N/A	N/A	N/A	12E-2680B	N	
29-4 C2	Containment Cooling Heat Exchanger Discharge Valve 2B (2-1501-3B)	No	Yes. Valve might stop momentarily.	Yes. Interlock relay controlled by 125 Vdc.	No	No	12E-2440	S	M 29 Sh.1
29-4 C3	LPCI Header Cross-Tie Isolation Valve 2B (2-1501-32B)	Yes	N/A	N/A	N/A	N/A	12E-2440	S	M 29 Sh.1
29-4 C4	LPCI Pump Flow Bypass Valve 2B (2-1501-13B)	No	No. N.O. & remains open. Valve is not operating.	Yes. Interlock relay controlled by 125Vdc.	No	No	12E-2440	S	M 29 Sh.1
29-4 D2	HPCI Auxiliary Coolant Pump (2-2301-57)	No	No. Equipment is not operating	N/A	No	No	12E-2531	AB	M 51 [illegible]
29-4 D3	HPCI Pump 2 Area Cooling Unit (2-5747)	No	Yes. Pump might stop momentarily.	Yes. Interlocked only with a temperature	No	No	12E-2393	N	
29-4 D4	LPCI / Core Spray Pump Area Cooling Unit 2B (2-5746B)	No	Yes. Pump might stop momentarily.	Yes. Interlocked only with a temperature switch.	No	No	12E-2393	N	

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TABLE 2
AFFECTS OF VOLTAGE DIP
Dresden Station - Unit 2

Bus No.	Equipment Description/No.	Load Shed	Will the voltage dips @ 5s, 10s, & 10min. 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.
29-4 E2	Diesel Circulating Water Heater 2/3	No	Yes. Heater's output might decrease momentarily.	Yes	No	N/A	12E-2351B Sh. 2	AL	
29-4 E2	Engine Lube Oil Circulating Pump Motor (1HP) (2/3-6699-111/113)	No	Yes. Pump might stop momentarily.	Yes. Pumps restart when voltage is available.	No	No	12E-2351B Sh. 2	AL	
29-4 E2	Engine Lube Oil Circulating Pump Motor (3/4HP) (2/3-6699-111/113)	No	Yes. Pump might stop momentarily.	Yes. Pumps restart when voltage is available.	No	No	12E-2351B Sh. 2	AL	
29-4 E3	Core Spray Pump Recirc. Isolation Valve 2B (2-1402-38B)	No	Yes. Valve might stop momentarily.	Yes. Interlock relay controlled by 125 Vdc.	No	No. The increased operating time is within the acceptable limit.	12E-2433	M	M 27
29-4 E4	LPCI Heat Exch.By pass Valve 2B (2-1501-11B)	No	No.	No.	No	N/A	12E-2440	S	M 29 Sh.1
29-4 E5	HPCI Turbine Oil Tank Heater	No	Yes. Heater's output might decrease momentarily.	Yes. Interlocked with a temperature switch.	No	No	12E-2532	V	
29-7 A3	LPCI Outboard Isolation Valve 2B (2-1501-21B)	No	Yes. Valve might stop operating momentarily.	Yes. Interlock relay controlled by 125 Vdc.	No	No. The increased operating time is within the acceptable limit.	12E-2441A	W	M 29 Sh.1
29-7 B1	Recirc. Pump 2B Discharge Bypass Valve (2-202-7B)	Yes	N/A	N/A	N/A	N/A	12E-2420B	M	M 26 Sh.2
29-7 B2	Recirc. Pump 2B Discharge Valve (2-202-5B)	No	Yes. Valve might stop operating momentarily.	Yes. Interlock relay controlled by 125 Vdc.	No	No. The increased operating time is within the acceptable limit.	12E-2420B	M	M 26 Sh.2
29-7 B3	Recirc.Loop Equalizing Valve 2B (2-202-6B)	Yes	N/A	N/A	N/A	N/A	12E-2420B	M	M 26 Sh.2

T.   E 2
AFFECTS OF   LTAGE DIP
Dresden Station - Unit 2

Bus No.	Equipment Description/No.	Load Shed	Will the voltage dips @ 5s, 10s, & 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.
29-7 B4	Recirc. Equalizing Bypass Valve 2B (2-202-9B)	No	Yes. Valve might stop operating momentarily.	Yes. Interlock relay controlled by 125 Vdc.	No	No. The increased operating time is within the acceptable limit.	12E-2420B	M	M 26 Sh.2
29-7 C2	Recirc. Pump 2B Suction Valve (2-202-4B)	No	No. N.O. & interlocked open. Valve is not operating.	No. Not required.	No	No	12E-2420B	M	M 26 Sh.2
29-7 C3	LPCI Inboard Isolation Valve 2B (2-1502-22B)	No	Yes. Valve might stop operating momentarily.	Yes. Interlock relay controlled by 125 Vdc.	No	No. The increased operating time is within the acceptable limit.	12E-2441A	W	M 29 Sh.1
28-7 B3	LPCI Inboard Isolation Valve 2A (2-1501-22A)	Yes	N/A	N/A	N/A	N/A	12E-2441 Sh.4	W	M 29 Sh.1
28-7 B4	Recirc. Loop Bypass Valve 2A (2-202-9A)	Yes	N/A	N/A	N/A	N/A	12E-2420A	P	M 26 Sh.2
28-7 C1	Recirc. Pump 2A Suction Valve (2-202-4A)	Yes	N/A	N/A	N/A	N/A	12E-2420A	P	M 26 Sh.2
28-7 C2	Recirc. Pump 2A Discharge Valve (2-202-5A)	Yes	N/A	N/A	N/A	N/A	12E-2420A	P	M 26 Sh.2
28-7 C3	Recirc. Pump 2A Discharge Bypass Valve (2-202-7A)	Yes	N/A	N/A	N/A	N/A	12E-2420A	P	M 26 Sh.2
28-7 C4	Recirc. Loop Equalizing Valve 2A (2-202-6A)	Yes	N/A	N/A	N/A	N/A	12E-2420A	P	M 26 Sh.2
28-7 D2	LPCI Outboard Isolation Valve 2A (2-1501-21A)	No	Yes. Valve might stop operating momentarily.	Yes. Interlock relay controlled by 125 Vdc.	No	No. The increased operating time is within the acceptable limit.	12E-2441 Sh. 3	W	M29 Sh. 1
29-9 B4	Standby Gas Treatment Inlet Damper 2/3A (2/3-7505A)	No	Yes. Valve might stop operating momentarily.	Yes	No	No. The increased operating time is within the acceptable limit.	12E-2400D Sh. 1	A	

TABLE 2
AFFECTS OF VOLTAGE DIP
Dresden Station - Unit 2

Bus No.	Equipment Description/No.	Load Shed	Will the voltage dips @ 5s, 10s, & 10min. 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.
29-9 B5	Standby Gas Treatment Outside Air Supply Damper 2/3A (2/3-7504A)	No	Yes. Valve might stop operating momentarily.	No.	No	No. The increased operating time is within the acceptable limit.	12E-2400D Sh. 1	A	
29-9 C4	Standby Gas Treatment Air Heater 2/3A (2/3-A-7503)	No	Yes. Heater output might decrease momentarily.	Yes	No	N/A	12E-2400D Sh. 2	A	
29-9 D2	Standby Gas Treatment Fan Discharge Damper 2/3A (2/3-7507A)	No	Yes. Valve might stop operating momentarily.	Yes	No	No. The increased operating time is within the acceptable limit.	12E-2400D Sh. 1	A	
29-9 D3	Standby Gas Treatment Fan 2/3A (2/3-A-7506)	No	Yes. Motor might slow down momentarily.	Yes	No	N/A	12E-2400D Sh. 2	A	

NC - Normally Closed NO - Normally Open N/A - Not Applicable

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	
2-902-63	2-902-63 ESS UPS Panel	29	From ETAP								37.9	27.9	R003
	120/208V Distr Xfmr 29-1	29-1	9	KVA	480	75	100	10.8	100	75	6.8	6.0	
2-1103	Stand-by Liquid Control Heater	29-1	25	KW	440	100	100	32.8	100	100	25.0	0.0	
2-2301-4	HPCI Turbine Inlet Isolation Valve	29-1	7.8	HP	460	85	80	10.7	827	54	38.2	59.6	
2-2400-2B	Post LOCA H2 & O2 Monitoring Sample Pump 2B	29-1	1	HP	460	80	75	1.6	625	79	6.1	4.8	
2-8300-2	125V Battery Charger 2	29-2	From ETAP								34.1	30.6	
2-3903	Diesel Cooling Water Pump 2	29-2	87	KW	460	83	100	131.6	400	31.5	132.1	397.9	R003
2-4611-B	Diesel Starting Air Compressor 2B	29-2	5	HP	460	85	80	6.9	625	58	19.9	27.9	R003
2-5203	Diesel Oil Transfer Pump 2	29-2	1.5	HP	460	80	75	2.3	625	75	8.7	7.7	
2/3-8350-2/3	250Vdc Battery Charger 2/3	29-2	From ETAP								66.1	58.0	
2-5790	Diesel Ventilating Fan 2	29-2	30	HP	440	85	85	40.6	625	42	81.3	175.7	
2-8001-B	RX Protection System M-G Set 2B	29-2	25	HP	440	85	85	33.9	625	43	69.4	145.7	R003
2-5747	HPCI Pump 2 Area Cooling Unit	29-4	3	HP	460	85	80	4.1	625	68	14.0	15.1	
	Diesel Circulating Water Heater 2/3	29-4	15	KW	480	100	100	18.0	100	100	15.0	0.0	
2/3-6699-111/113	Engine Lube Oil Circulation Pump Motor (1HP)	29-4	1	HP	460	80	75	1.6	625	79	6.1	4.8	
2/3-6699-111/113	Engine Lube Oil Circulation Pump Motor (3/4HP)	29-4	0.75	HP	460	80	75	1.2	546	83	4.2	2.8	
	HPCI Turbine Oil Tank Heater	29-4	9	KW	480	100	100	10.8	100	100	9.0	0.0	
2-202-5B	Recir. Pump 2B Discharge Valve	29-7	13	HP	460	85	85	16.8	797	49	52.4	93.3	
2-1501-22B	LPCI Inboard Isolation Valve 2B	29-7	10.5	HP	460	85	83.78	13.8	826	43	39.1	82.0	
2-1501-21A	LPCI Outboard Isolation Valve 2A	28-7	16.2	HP	460	85	85	21.0	723	44	53.2	108.6	
2/3-7504A	Stand-by Gas Treatment Outside Air Supply Damper 2/3A	29-9	0.61	HP	440	80	75	1.0	625	85	4.0	2.5	
2/3-7505A	Stand-by Gas Treatment Inlet Damper	29-9	1.4	HP	440	80	75	2.3	625	75	8.2	7.2	
2/3-A-7503	Stand-by Gas Treatment Air Heater 2/3A	29-9	30	KW	440	100	100	39.4	100	100	30.0	0.0	
2/3-7507A	Stand-by Gas Treatment Fan Discharge Damper 2/3A	29-9	4.2	HP	460	85	80	5.8	625	58	16.7	23.5	
2/3-A-7506	Stand-by Gas Treatment Fan 2/3A	29-9	20	HP	460	85	85	25.9	625	44	56.8	115.9	
									TOTAL STARTING KW & KVAR		834.3	1397.3	R003

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
2-1501-13B	LPCI Pump Flow Bypass Valve 2B	29-4	0.13	HP	440	80	75	0.2	527	85	0.7	0.4
2-5746B	LPCI/Core Spray Pump Area Cooling Unit 2B	29-4	5	HP	460	85	80	6.9	625	58	19.9	27.9
									TOTAL STARTING KW & KVAR		20.6	28.4

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))

R002

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	
2-1401-25B	Core Spray Inboard Isolation Valve 2B	29-1	4	HP	440	85	80	5.8	829.6	58	21.1	29.7	
2-7902	Turbine & Radwaste Building Emergency Lighting	29-2	33.78	KW	480	90	100	36.1*	100	90	27.0	13.1	R003
2-1402-38B	Core Spray Pump Recirc Isolation Valve 2B	29-4	0.13	HP	440	80	75	0.2	527	85	0.7	0.4	
									TOTAL STARTING KW & KVAR		48.9	43.2	R003

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))

* From ETAP

R003

Table 4

DG Auxiliaries and Other 480V Loads Starting at 10+ Minutes (First CCSW Pump)

Load No.	Load Description	Bus No.	Rating	Unit	Vrated	PF%	Eff. %	FLC	LRC%	SPF%	SKW	SKVAR
2-1501-3B	Containment Cooling Heat Exchanger Discharge Valve 2B	29-4	0.33	HP	460	80	75	0.5	273	85	1.0	0.6
								TOTAL STARTING KW & KVAR			1.0	0.6

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))

R002

Table 4

DG Auxiliaries and Other 480V Loads Starting at 10++ Minutes (Second CCSW Pump)

Load No.	Load Description	Bus No.	Rating	Unit	Vrated	PF%	Eff. %	FLC	LRC%	SPF%	SKW	SKVAR
2-5700-30C1	Containment Cooling Service Water Pump Cooler C Fan 1	29-2	3	HP	460	85	80	4.1	625	68	14.0	15.1
2-5700-30C2	Containment Cooling Service Water Pump Cooler C Fan 2	29-2	3	HP	460	85	80	4.1	625	68	14.0	15.1
2-5700-30D1	Containment Cooling Service Water Pump Cooler D Fan 1	29-2	3	HP	460	85	80	4.1	625	68	14.0	15.1
2-5700-30D2	Containment Cooling Service Water Pump Cooler D Fan 2	29-2	3	HP	460	85	80	4.1	625	68	14.0	15.1
									TOTAL STARTING KW & KVAR		56.0	60.3

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))

R002

Table 4

DG Auxiliaries and Other 480V Loads Starting after 10 Minutes

Load No.	Load Description	Bus No.	Rating	Unit	Vrated	PF%	Eff. %	FLC	LRC%	SPF%	SKW	SKVAR	
	120/208V Distr Xfmr 29-8	29-8	15.00	KVA	480	75	100	18.0	100	75	11.3	9.9	R002
2/3-9400-102	Control Room Standby AC	29-8	150.00	HP	460	89.5	93	168.7	578	32.2	250.2	735.7	
2/3-9400-104A	Control Room AFU Booster Fan A	29-8	7.50	HP	480	85	80	9.9	625	56	28.8	42.6	
2/3-9400-100	Control Room Standby AHU	29-8	50.00	HP	480	85	90	58.6	625	38	115.8	281.9	
2/3-9400-101	Control Room AFU Heater	29-8	12.00	KW	480	100	100	14.4	100	100	12.0	0.0	
										TOTAL STARTING KW & KVAR	418.1	1070.1	R002

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)) R002

Attachment D

Calc. No. 9389-46-19-2
Rev. 1
Page D2 / Final

Dresden

Diesel Generator 2

LOCA & LOOP Conditions

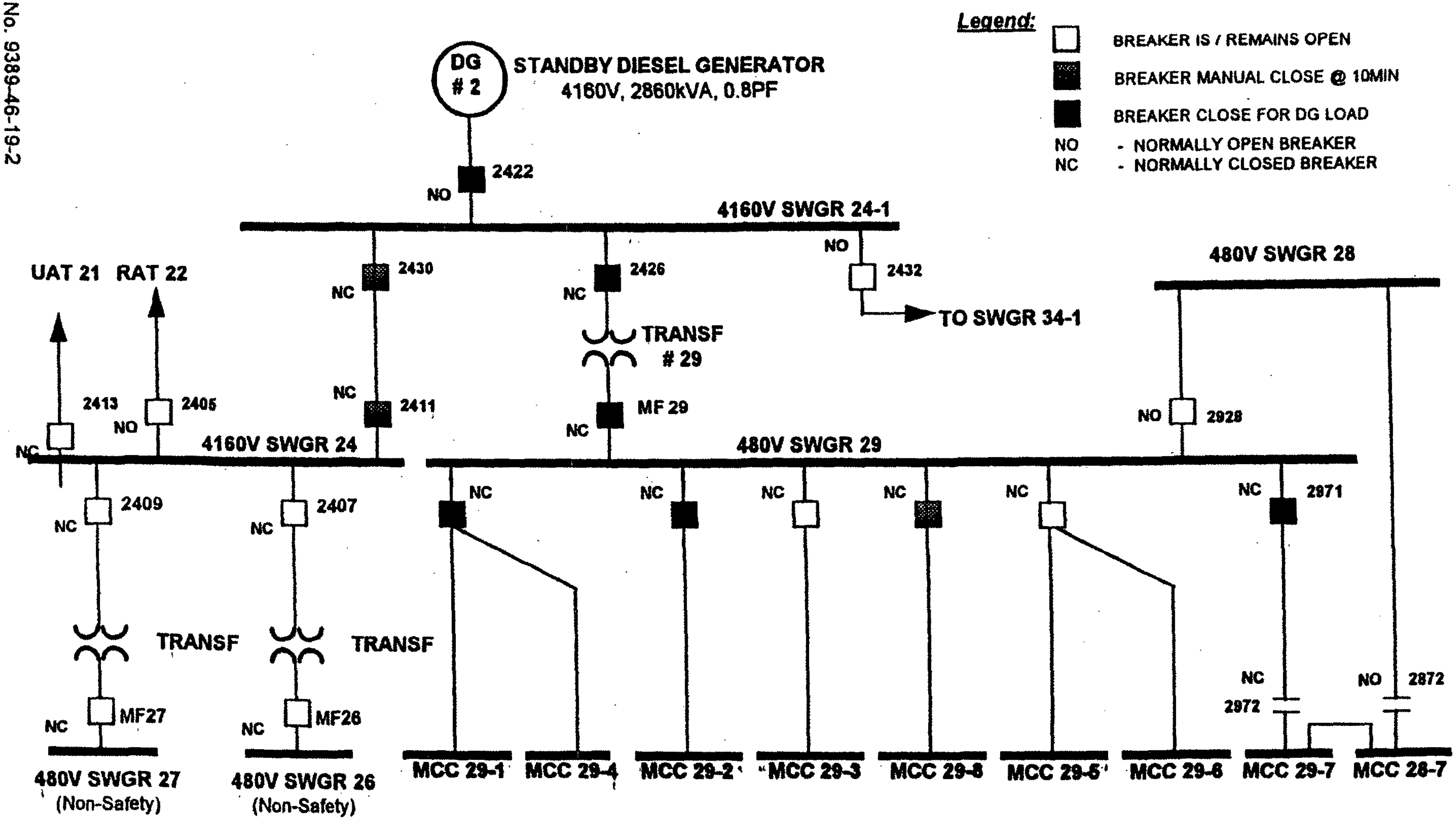
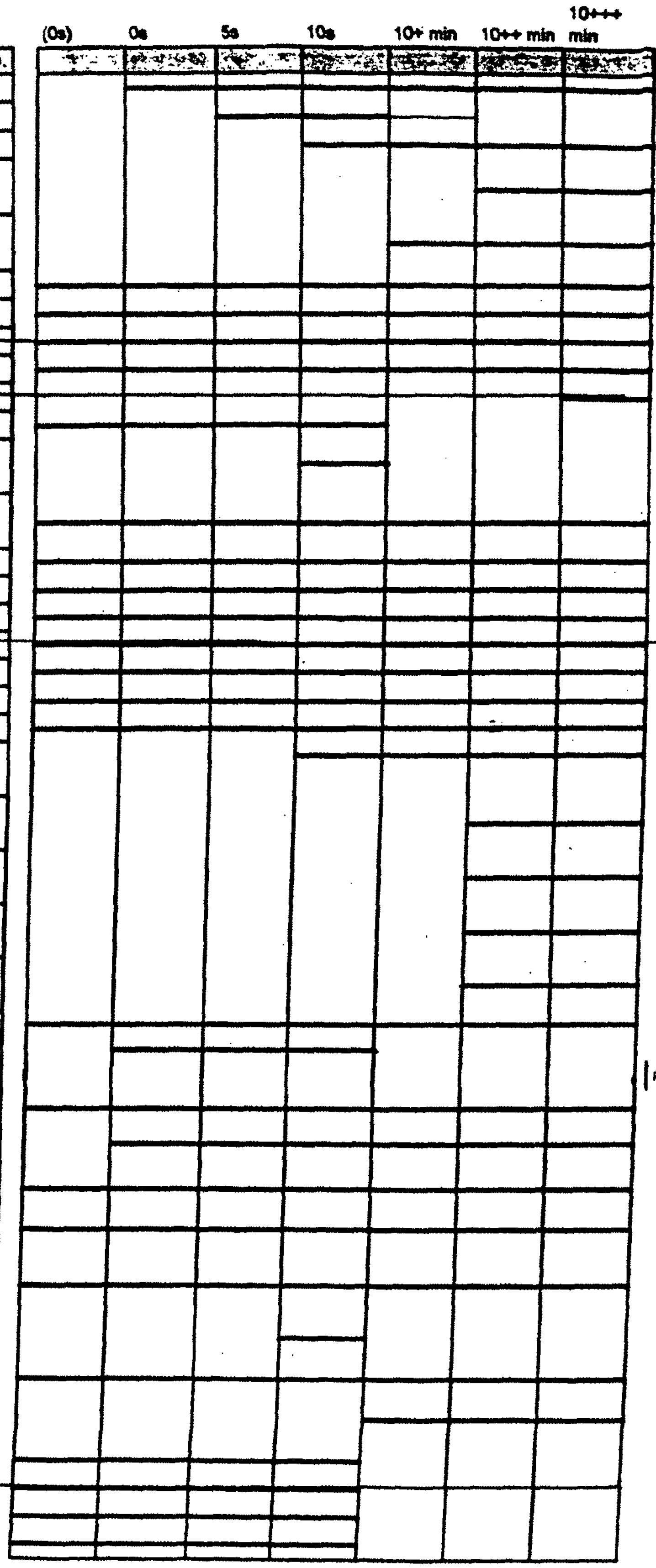


Figure 1

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

Load No.	Load Description	Bus No.
2-1502-C	LPCI Pump 2C	24-1
1502-D	LPCI Pump 2D	24-1
-1401-B	Core Spray Pump 2B	24-1
	Containment Cooling Service Water Pump 2C	24
	Containment Cooling Service Water Pump 2D	24
2-902-63	2-902-63 ESS UPS Panel	29
	120/208V Distr Xfmr 29-1	29-1
~~2-4710-A/B~~	~~Drywell Air Compressor~~	~~29-1~~
2-1103	Stand-by Liquid Control Heater	29-1
~~2-2501~~	~~ACAD Air Compressor~~	~~29-1~~
2-2301-4	HPCI Turbine Inlet Isolation Valve	29-1
2-1402-25B	Core Spray Inboard Isolation Valve 2B	29-1
2-2400-2B	Post LOCA H_2 & O_2 Monitoring Sample Pump 2B	29-1
2-8300-2	125V Battery Charger 2	29-2
2-3903	Diesel Cooling Water Pump 2	29-2
2-4611-B	Diesel Starting Air Compressor 2B	29-2
	~~120/208V Xfmr Mag Tape Drive~~	~~29-2~~
2-5203	Diesel Oil Transfer Pump 2	29-2
2/3-8350-2/3	250Vdc Battery Charger 2/3	29-2
2-5790	Diesel Ventilating Fan 2	29-2
2-7902	Turbine & Radwaste Building Emergency Lighting	29-2
2-5700-30C1	Containment Cooling Service Water Pump Cooler C Fan 1	29-2
700-30C2	Containment Cooling Service Water Pump Cooler C Fan 2	29-2
2-5700-30D1	Containment Cooling Service Water Pump Cooler D Fan 1	29-2
2-5700-30D2	Containment Cooling Service Water Pump Cooler D Fan 2	29-2
2-8001-B	RX Protection M-G Set 2B	29-2
2-1501-13B	LPCI Pump Flow Bypass Valve 2B	29-4
~~2-2301-57~~	~~HPCI Auxiliary Coolant Pump~~	~~29-4~~
2-5747	HPCI Pump 2 Area Cooling Unit	29-4
2-5746B	LPCI/Core Spray Pump Area Cooling Unit 2B	29-4
	Diesel Circulating Water Heater 2/3	29-4
2/3-6699-111/113	Engine Lube Oil Circulating Pump Motor (1HP)	29-4
2/3-6699-111/113	Engine Lube Oil Circulating Pump Motor (3/4HP)	29-4
2-1402-38B	Core Spray Pump Recirc. Isolation Valve 2B	29-4
	HPCI Turbine Oil Tank Heater	29-4
2-1501-3B	Containment Cooling Heat Exchanger Discharge Valve 2B	29-4
2-202-5B	Recirc. Pump 2B Discharge Valve	29-7
~~2-202-9B~~	~~Recirculation Equalizing Bypass Valve 2B~~	~~29-7~~
2-1501-22B	LPCI Inboard Isolation Valve 2B	29-7
-21A	LPCI Outboard Isolation Valve 2A	28-7



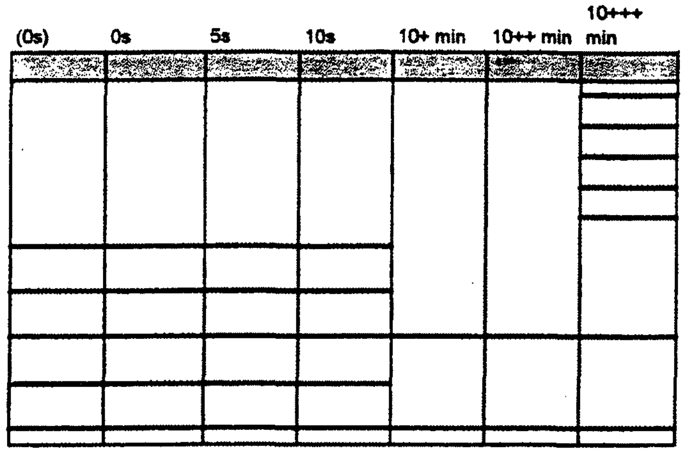
R
R
R3

DG2EXCEL.XLS
Load v. Time (fig 2)

Calculation: 9389-46-19-2
Attachment: E
Revision: 003
Page E1 of E2

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

ad No.	Load Description	Bus No.
	120/208V Distr Xfmr 29-8	29-8
2/3-9400-102	Control Room Standby AC	29-8
2/3-9400-104	Control Room AFU Booster Fan A	29-8
2/3-9400-100	Control Room Standby AHU	29-8
2/3-9400-101	Control Room AFU Heater	29-8
2/3-7505A	Stand-by Gas Treatment Inlet Damper 2/3A	29-9
2/3-7504A	Stand-by Gas Treatment Outside Air Supply Damper 2/3A	29-9
2/3-A-7503	Stand-by Gas Treatment Air Heater 2/3A	29-9
2/3-7507A	Stand-by Gas Treatment Fan Discharge Damper 2/3A	29-9
2/3-A-7506	Stand-by Gas Treatment Fan 2/3A	29-9



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

10+min - All loads that automatically stop before 10 minutes are shown off and first CCSW Pump is started with its Auxiliaries.
10++min - The second CCSW Pump is started.
10+++min - Both CCSW Pumps are running and Control Room HVAC is started.

Attachment F

DG Unit 2 Division II ETAP Output Reports – Nominal Voltage

Scenario	**Page #'s**
DG2_Bkr_Cl	F2-F15
DG2_UV_Rst	F16-F29
DG2_T=5sec	F30-F44
DG2_T=10sec	F45-F59
DG2_T=10-min	F60-F73
DG2_T=10+min	F74-F87
DG2_T=10++m	F88-F101
DG2_CR_HVAC	F102-F116

Only the Load Flow Report (Page 8) of these Scenarios have been included [initials] 4/26/07

Converted from ELMS PLUS
Diesel Generator connected using nominal voltage,2 LPCI, This time period is less than 10 min into 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
2-902-63 ESS UPS PNL	0.480	0.481	-1.6	0	0	0.038	0.028	480V SWGR 29	-0.038	-0.028	56.5	80.5	
4KV SWGR 24-1	4.160	4.158	0.0	0	0	0	0	HIGH SIDE OF XFMR 29	0.414	0.284	69.7	82.4	
								DG 2 TERMINAL	-0.414	-0.284	69.7	82.4	
125V DC CHGR 2	0.480	0.463	-0.8	0	0	0.034	0.028	480V MCC 29-2	-0.034	-0.028	55.0	77.2	
250V DC CHGR 2/3	0.480	0.467	-1.3	0	0	0.066	0.055	480V MCC 29-2	-0.066	-0.055	106.1	76.9	
480V MCC 28-7	0.480	0.479	-1.5	0	0	0.014	0.009	480V MCC 29-7	-0.014	-0.009	20.2	85.1	
480V MCC 29-1	0.480	0.479	-1.6	0	0	0.044	0.011	BKR 29-4C BIFURC	-0.044	-0.011	54.2	96.9	
480V MCC 29-2	0.480	0.472	-1.6	0	0	0.105	0.103	BKR 29-3D BIFURC	-0.207	-0.187	340.9	74.3	
								250V DC CHGR 2/3	0.067	0.055	106.1	77.2	
								125V DC CHGR 2	0.035	0.028	55.0	78.1	
480V MCC 29-4	0.480	0.480	-1.6	0	0	0.027	0.002	BKR 29-3D BIFURC	-0.027	-0.002	32.7	99.7	
480V MCC 29-7	0.480	0.479	-1.6	0	0	0.021	0.013	480V MCC 28-7	0.014	0.009	20.2	85.1	
								480V SWGR 29	-0.036	-0.022	50.3	85.4	
480V MCC 29-8	0.480	0.481	-1.6	0	0	0	0	480V SWGR 29	0.000	0.000	0.0	0.0	
480V MCC 29-9	0.480	0.479	-1.7	0	0	0.056	0.013	BKR 29-4C BIFURC	-0.056	-0.013	69.4	97.3	
480V SWGR 29	0.480	0.481	-1.6	0	0	0	0	BKR 29-3D BIFURC	0.238	0.192	367.4	77.8	
								480V MCC 29-7	0.036	0.022	50.3	85.4	
								480V MCC 29-8	0.000	0.000	0.0	0.0	
								BKR 29-4C BIFURC	0.100	0.025	123.6	97.1	
								2-902-63 ESS UPS PNL	0.038	0.028	56.5	80.5	
								HIGH SIDE OF XFMR 29	-0.411	-0.267	589.0	83.9	
BKR 29-3D BIFURC	0.480	0.481	-1.6	0	0	0	0	480V MCC 29-2	0.211	0.190	340.9	74.3	
								480V MCC 29-4	0.027	0.002	32.7	99.7	
								480V SWGR 29	-0.238	-0.192	367.4	77.8	
BKR 29-4C BIFURC	0.480	0.481	-1.6	0	0	0	0	480V MCC 29-1	0.044	0.011	54.2	96.8	
								480V MCC 29-9	0.056	0.014	69.4	97.2	
								480V SWGR 29	-0.100	-0.025	123.6	97.1	
* DG 2 TERMINAL	4.160	4.160	0.0	0.414	0.285	0	0	4KV SWGR 24-1	0.414	0.285	69.7	82.4	
HIGH SIDE OF XFMR 29	4.160	4.157	0.0	0	0	0	0	4KV SWGR 24-1	-0.414	-0.284	69.7	82.4	
								480V SWGR 29	0.414	0.284	69.7	82.4	-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 than0.1 MVA

Converted from ELMS PLUS

Diesel Generator connected using nominal voltage,2 LPCI, This time period is less than 10 min into 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
2-902-63 ESS UPS PNL	0.480	0.480	-1.6	0	0	0.038	0.028	480V SWGR 29	-0.038	-0.028	56.5	80.5	
4KV SWGR 24-1	4.160	4.155	0.0	0	0	0.520	0.252	HIGH SIDE OF XFMR 29	0.418	0.287	70.5	82.4	
								DG 2 TERMINAL	-0.938	-0.539	150.3	86.7	
125V DC CHGR 2	0.480	0.463	-0.8	0	0	0.034	0.028	480V MCC 29-2	-0.034	-0.028	55.0	77.3	
250V DC CHGR 2/3	0.480	0.467	-1.4	0	0	0.066	0.055	480V MCC 29-2	-0.066	-0.055	106.1	77.0	
480V MCC 28-7	0.480	0.478	-1.6	0	0	0.014	0.009	480V MCC 29-7	-0.014	-0.009	20.2	85.1	
480V MCC 29-1	0.480	0.479	-1.6	0	0	0.044	0.011	BKR 29-4C BIFURC	-0.044	-0.011	54.2	96.9	
480V MCC 29-2	0.480	0.472	-1.6	0	0	0.105	0.103	BKR 29-3D BIFURC	-0.207	-0.186	341.0	74.3	
								250V DC CHGR 2/3	0.067	0.055	106.1	77.3	
								125V DC CHGR 2	0.035	0.028	55.0	78.1	
480V MCC 29-4	0.480	0.479	-1.6	0	0	0.031	0.005	BKR 29-3D BIFURC	-0.031	-0.005	38.4	98.8	
480V MCC 29-7	0.480	0.478	-1.6	0	0	0.021	0.013	480V MCC 28-7	0.014	0.009	20.2	85.1	
								480V SWGR 29	-0.036	-0.022	50.3	85.4	
480V MCC 29-8	0.480	0.480	-1.6	0	0	0	0	480V SWGR 29	0.000	0.000	0.0	0.0	
480V MCC 29-9	0.480	0.478	-1.7	0	0	0.056	0.013	BKR 29-4C BIFURC	-0.056	-0.013	69.4	97.3	
480V SWGR 29	0.480	0.480	-1.6	0	0	0	0	BKR 29-3D BIFURC	0.242	0.195	373.8	77.9	
								480V MCC 29-7	0.036	0.022	50.3	85.4	
								480V MCC 29-8	0.000	0.000	0.0	0.0	
								BKR 29-4C BIFURC	0.100	0.025	123.6	97.1	
								2-902-63 ESS UPS PNL	0.038	0.028	56.5	80.5	
								HIGH SIDE OF XFMR 29	-0.416	-0.269	595.5	83.9	
BKR 29-3D BIFURC	0.480	0.480	-1.6	0	0	0	0	480V MCC 29-2	0.211	0.190	341.0	74.3	
								480V MCC 29-4	0.032	0.005	38.4	98.8	
								480V SWGR 29	-0.242	-0.195	373.8	77.9	
BKR 29-4C BIFURC	0.480	0.480	-1.6	0	0	0	0	480V MCC 29-1	0.044	0.011	54.2	96.8	
								480V MCC 29-9	0.056	0.014	69.4	97.2	
								480V SWGR 29	-0.100	-0.025	123.6	97.1	
* DG 2 TERMINAL	4.160	4.160	0.0	0.939	0.540	0	0	4KV SWGR 24-1	0.939	0.540	150.3	86.7	
HIGH SIDE OF XFMR 29	4.160	4.155	0.0	0	0	0	0	4KV SWGR 24-1	-0.418	-0.287	70.5	82.4	
								480V SWGR 29	0.418	0.287	70.5	82.4	-2.500

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

\# Indicates a bus with a load mismatch of more than0.1 MVA

Converted from ELMS PLUS

Diesel Generator connected using nominal voltage,2 LPCI, This time period is less than 10 min into 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
2-902-63 ESS UPS PNL	0.480	0.480	-1.6	0	0	0.038	0.028	480V SWGR 29	-0.038	-0.028	56.5	80.6	
4KV SWGR 24-1	4.160	4.153	-0.1	0	0	1.025	0.496	HIGH SIDE OF XFMR 29	0.418	0.287	70.5	82.4	
								DG 2 TERMINAL	-1.443	-0.783	228.2	87.9	
125V DC CHGR 2	0.480	0.462	-0.9	0	0	0.034	0.028	480V MCC 29-2	-0.034	-0.028	55.0	77.3	
250V DC CHGR 2/3	0.480	0.467	-1.4	0	0	0.066	0.055	480V MCC 29-2	-0.066	-0.055	106.1	77.0	
480V MCC 28-7	0.480	0.478	-1.6	0	0	0.014	0.009	480V MCC 29-7	-0.014	-0.009	20.3	85.1	
480V MCC 29-1	0.480	0.479	-1.7	0	0	0.044	0.011	BKR 29-4C BIFURC	-0.044	-0.011	54.2	96.9	
480V MCC 29-2	0.480	0.471	-1.7	0	0	0.105	0.103	BKR 29-3D BIFURC	-0.207	-0.186	341.1	74.4	
								250V DC CHGR 2/3	0.067	0.055	106.1	77.3	
								125V DC CHGR 2	0.035	0.028	55.0	78.2	
480V MCC 29-4	0.480	0.479	-1.7	0	0	0.031	0.005	BKR 29-3D BIFURC	-0.031	-0.005	38.4	98.8	
480V MCC 29-7	0.480	0.478	-1.6	0	0	0.021	0.013	480V MCC 28-7	0.014	0.009	20.3	85.1	
								480V SWGR 29	-0.036	-0.022	50.4	85.4	
480V MCC 29-8	0.480	0.480	-1.6	0	0	0	0	480V SWGR 29	0.000	0.000	0.0	0.0	
480V MCC 29-9	0.480	0.478	-1.8	0	0	0.056	0.013	BKR 29-4C BIFURC	-0.056	-0.013	69.4	97.3	
480V SWGR 29	0.480	0.480	-1.6	0	0	0	0	BKR 29-3D BIFURC	0.242	0.195	373.9	77.9	
								480V MCC 29-7	0.036	0.022	50.4	85.4	
								480V MCC 29-8	0.000	0.000	0.0	0.0	
								BKR 29-4C BIFURC	0.100	0.025	123.6	97.1	
								2-902-63 ESS UPS PNL	0.038	0.028	56.5	80.6	
								HIGH SIDE OF XFMR 29	-0.416	-0.269	595.6	83.9	
BKR 29-3D BIFURC	0.480	0.480	-1.6	0	0	0	0	480V MCC 29-2	0.211	0.190	341.1	74.3	
								480V MCC 29-4	0.032	0.005	38.4	98.7	
								480V SWGR 29	-0.242	-0.195	373.9	77.9	
BKR 29-4C BIFURC	0.480	0.480	-1.6	0	0	0	0	480V MCC 29-1	0.044	0.011	54.2	96.8	
								480V MCC 29-9	0.056	0.014	69.4	97.2	
								480V SWGR 29	-0.100	-0.025	123.6	97.1	
* DG 2 TERMINAL	4.160	4.160	0.0	1.444	0.786	0	0	4KV SWGR 24-1	1.444	0.786	228.2	87.8	
HIGH SIDE OF XFMR 29	4.160	4.152	-0.1	0	0	0	0	4KV SWGR 24-1	-0.418	-0.287	70.5	82.4	
								480V SWGR 29	0.418	0.287	70.5	82.4	-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 than0.1 MVA

Converted from ELMS PLUS

Diesel Generator connected using nominal voltage,2 LPCI, This time period is less than 10 min into 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
2-902-63 ESS UPS PNL	0.480	0.479	-1.8	0	0	0.038	0.028	480V SWGR 29	-0.038	-0.028	56.5	80.7	
4KV SWGR 24-1	4.160	4.150	-0.1	0	0	1.738	0.796	HIGH SIDE OF XFMR 29	0.448	0.304	75.4	82.7	
								DG 2 TERMINAL	-2.186	-1.101	340.6	89.3	
125V DC CHGR 2	0.480	0.460	-1.1	0	0	0.034	0.028	480V MCC 29-2	-0.034	-0.028	55.0	77.6	
250V DC CHGR 2/3	0.480	0.465	-1.6	0	0	0.066	0.054	480V MCC 29-2	-0.066	-0.054	106.2	77.3	
480V MCC 28-7	0.480	0.477	-1.8	0	0	0.014	0.009	480V MCC 29-7	-0.014	-0.009	20.3	85.1	
480V MCC 29-1	0.480	0.477	-1.8	0	0	0.047	0.013	BKR 29-4C BIFURC	-0.047	-0.013	59.2	96.1	
480V MCC 29-2	0.480	0.469	-1.9	0	0	0.131	0.116	BKR 29-3D BIFURC	-0.233	-0.198	376.0	76.2	
								250V DC CHGR 2/3	0.067	0.054	106.2	77.6	
								125V DC CHGR 2	0.035	0.028	55.0	78.5	
480V MCC 29-4	0.480	0.478	-1.8	0	0	0.031	0.005	BKR 29-3D BIFURC	-0.031	-0.005	38.5	98.7	
480V MCC 29-7	0.480	0.477	-1.8	0	0	0.021	0.013	480V MCC 28-7	0.014	0.009	20.3	85.1	
								480V SWGR 29	-0.036	-0.022	50.5	85.4	
480V MCC 29-8	0.480	0.479	-1.8	0	0	0	0	480V SWGR 29	0.000	0.000	0.0	0.0	
480V MCC 29-9	0.480	0.477	-1.9	0	0	0.056	0.013	BKR 29-4C BIFURC	-0.056	-0.013	69.4	97.3	
480V SWGR 29	0.480	0.479	-1.8	0	0	0	0	BKR 29-3D BIFURC	0.269	0.207	409.4	79.2	
								480V MCC 29-7	0.036	0.022	50.5	85.4	
								480V MCC 29-8	0.000	0.000	0.0	0.0	
								BKR 29-4C BIFURC	0.103	0.027	128.5	96.7	
								2-902-63 ESS UPS PNL	0.038	0.028	56.5	80.7	
								HIGH SIDE OF XFMR 29	-0.446	-0.284	637.1	84.3	
BKR 29-3D BIFURC	0.480	0.479	-1.8	0	0	0	0	480V MCC 29-2	0.237	0.202	376.0	76.1	
								480V MCC 29-4	0.032	0.005	38.5	98.7	
								480V SWGR 29	-0.269	-0.207	409.4	79.2	
BKR 29-4C BIFURC	0.480	0.479	-1.8	0	0	0	0	480V MCC 29-1	0.047	0.014	59.2	96.1	
								480V MCC 29-9	0.056	0.014	69.4	97.2	
								480V SWGR 29	-0.103	-0.027	128.5	96.7	
* DG 2 TERMINAL	4.160	4.160	0.0	2.190	1.107	0	0	4KV SWGR 24-1	2.190	1.107	340.6	89.2	
HIGH SIDE OF XFMR 29	4.160	4.149	-0.1	0	0	0	0	4KV SWGR 24-1	-0.448	-0.304	75.4	82.7	
								480V SWGR 29	0.448	0.304	75.4	82.7	-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 than0.1 MVA

Converted from ELMS PLUS

Diesel Generator connected using nominal voltage,2 LPCI, This time period is less than 10 min into 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
2-902-63 ESS UPS PNL	0.480	0.480	-1.6	0	0	0.038	0.028	480V SWGR 29	-0.038	-0.028	56.5	80.5	
4KV SWGR 24-1	4.160	4.150	-0.1	0	0	1.738	0.796	HIGH SIDE OF XFMR 29	0.396	0.268	66.5	82.8	
								DG 2 TERMINAL	-2.134	-1.065	331.7	89.5	
125V DC CHGR 2	0.480	0.462	-0.9	0	0	0.034	0.028	480V MCC 29-2	-0.034	-0.028	55.0	77.4	
250V DC CHGR 2/3	0.480	0.466	-1.4	0	0	0.066	0.055	480V MCC 29-2	-0.066	-0.055	106.1	77.1	
480V MCC 28-7	0.480	0.480	-1.6	0	0	0	0	480V MCC 29-7	0.000	0.000	0.0	0.0	
480V MCC 29-1	0.480	0.479	-1.6	0	0	0.036	0.007	BKR 29-4C BIFURC	-0.036	-0.007	44.3	98.3	
480V MCC 29-2	0.480	0.471	-1.6	0	0	0.131	0.116	BKR 29-3D BIFURC	-0.233	-0.199	375.5	76.1	
								250V DC CHGR 2/3	0.067	0.055	106.1	77.4	
								125V DC CHGR 2	0.035	0.028	55.0	78.3	
480V MCC 29-4	0.480	0.480	-1.6	0	0	0.032	0.005	BKR 29-3D BIFURC	-0.032	-0.005	38.7	98.7	
480V MCC 29-7	0.480	0.480	-1.6	0	0	0	0	480V MCC 28-7	0.000	0.000	0.0	0.0	
								480V SWGR 29	0.000	0.000	0.0	0.0	
480V MCC 29-8	0.480	0.480	-1.6	0	0	0	0	480V SWGR 29	0.000	0.000	0.0	0.0	
480V MCC 29-9	0.480	0.479	-1.7	0	0	0.050	0.009	BKR 29-4C BIFURC	-0.050	-0.009	61.4	98.3	
480V SWGR 29	0.480	0.480	-1.6	0	0	0	0	BKR 29-3D BIFURC	0.269	0.208	409.1	79.1	
								480V MCC 29-7	0.000	0.000	0.0	0.0	
								480V MCC 29-8	0.000	0.000	0.0	0.0	
								BKR 29-4C BIFURC	0.086	0.016	105.7	98.3	
								2-902-63 ESS UPS PNL	0.038	0.028	56.5	80.5	
								HIGH SIDE OF XFMR 29	-0.394	-0.252	561.9	84.2	
BKR 29-3D BIFURC	0.480	0.480	-1.6	0	0	0	0	480V MCC 29-2	0.238	0.203	375.5	76.1	
								480V MCC 29-4	0.032	0.005	38.7	98.7	
								480V SWGR 29	-0.269	-0.208	409.1	79.1	
BKR 29-4C BIFURC	0.480	0.480	-1.6	0	0	0	0	480V MCC 29-1	0.036	0.007	44.3	98.3	
								480V MCC 29-9	0.050	0.010	61.4	98.2	
								480V SWGR 29	-0.086	-0.016	105.7	98.3	
* DG 2 TERMINAL	4.160	4.160	0.0	2.137	1.071	0	0	4KV SWGR 24-1	2.137	1.071	331.7	89.4	
HIGH SIDE OF XFMR 29	4.160	4.150	-0.1	0	0	0	0	4KV SWGR 24-1	-0.396	-0.268	66.5	82.8	
								480V SWGR 29	0.396	0.268	66.5	82.8	-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 than0.1 MVA

Converted from ELMS PLUS

Diesel Generator connected using nominal voltage,2 LPCI Pump, 1 CCSW, This time period is 10+ min into 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
2-902-63 ESS UPS PNL	0.480	0.480	-1.6	0	0	0.038	0.028	480V SWGR 29	-0.038	-0.028	56.5	80.6	
4KV SWGR 24	4.160	4.146	-0.1	0	0	0.477	0.212	4KV SWGR 24-1	-0.477	-0.212	72.7	91.4	
4KV SWGR 24-1	4.160	4.148	-0.1	0	0	1.716	0.790	4KV SWGR 24	0.477	0.213	72.7	91.3	
								HIGH SIDE OF XFMR 29	0.396	0.268	66.5	82.8	
								DG 2 TERMINAL	-2.589	-1.270	401.4	89.8	
125V DC CHGR 2	0.480	0.461	-0.9	0	0	0.034	0.028	480V MCC 29-2	-0.034	-0.028	55.0	77.4	
250V DC CHGR 2/3	0.480	0.466	-1.4	0	0	0.066	0.055	480V MCC 29-2	-0.066	-0.055	106.1	77.1	
480V MCC 28-7	0.480	0.480	-1.6	0	0	0	0	480V MCC 29-7	0.000	0.000	0.0	0.0	
480V MCC 29-1	0.480	0.479	-1.6	0	0	0.036	0.007	BKR 29-4C BIFURC	-0.036	-0.007	44.3	98.3	
480V MCC 29-2	0.480	0.471	-1.7	0	0	0.131	0.116	BKR 29-3D BIFURC	-0.233	-0.199	375.6	76.1	
								250V DC CHGR 2/3	0.067	0.055	106.1	77.4	
								125V DC CHGR 2	0.035	0.028	55.0	78.3	
480V MCC 29-4	0.480	0.479	-1.6	0	0	0.032	0.005	BKR 29-3D BIFURC	-0.032	-0.005	38.6	98.7	
480V MCC 29-7	0.480	0.480	-1.6	0	0	0	0	480V MCC 28-7	0.000	0.000	0.0	0.0	
								480V SWGR 29	0.000	0.000	0.0	0.0	
480V MCC 29-8	0.480	0.480	-1.6	0	0	0	0	480V SWGR 29	0.000	0.000	0.0	0.0	
480V MCC 29-9	0.480	0.479	-1.7	0	0	0.050	0.009	BKR 29-4C BIFURC	-0.050	-0.009	61.4	98.3	
480V SWGR 29	0.480	0.480	-1.6	0	0	0	0	BKR 29-3D BIFURC	0.269	0.208	409.1	79.1	
								480V MCC 29-7	0.000	0.000	0.0	0.0	
								480V MCC 29-8	0.000	0.000	0.0	0.0	
								BKR 29-4C BIFURC	0.086	0.016	105.7	98.3	
								2-902-63 ESS UPS PNL	0.038	0.028	56.5	80.6	
								HIGH SIDE OF XFMR 29	-0.394	-0.252	562.0	84.2	
BKR 29-3D BIFURC	0.480	0.480	-1.6	0	0	0	0	480V MCC 29-2	0.238	0.203	375.6	76.1	
								480V MCC 29-4	0.032	0.005	38.6	98.7	
								480V SWGR 29	-0.269	-0.208	409.1	79.2	
BKR 29-4C BIFURC	0.480	0.480	-1.6	0	0	0	0	480V MCC 29-1	0.036	0.007	44.3	98.3	
								480V MCC 29-9	0.050	0.010	61.4	98.2	
								480V SWGR 29	-0.086	-0.016	105.7	98.3	
*DG 2 TERMINAL	4.160	4.160	0.0	2.594	1.279	0	0	4KV SWGR 24-1	2.594	1.279	401.4	89.7	
HIGH SIDE OF XFMR 29	4.160	4.147	-0.1	0	0	0	0	4KV SWGR 24-1	-0.395	-0.268	66.5	82.8	
								480V SWGR 29	0.395	0.268	66.5	82.8	-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 than0.1 MVA

Converted from ELMS PLUS

Diesel Generator connected using nominal voltage,1 LPCI Pump, 2 CCSW, This time period is 10+ min into 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
2-902-63 ESS UPS PNL	0.480	0.480	-1.6	0	0	0.038	0.028	480V SWGR 29	-0.038	-0.028	56.5	80.6	
4KV SWGR 24	4.160	4.145	-0.1	0	0	0.772	0.395	4KV SWGR 24-1	-0.772	-0.395	120.8	89.0	
4KV SWGR 24-1	4.160	4.149	-0.1	0	0	1.218	0.549	4KV SWGR 24	0.772	0.396	120.8	89.0	
								HIGH SIDE OF XFMR 29	0.407	0.276	68.5	82.8	
								DG 2 TERMINAL	-2.398	-1.221	374.5	89.1	
125V DC CHGR 2	0.480	0.461	-0.9	0	0	0.034	0.028	480V MCC 29-2	-0.034	-0.028	55.0	77.5	
250V DC CHGR 2/3	0.480	0.465	-1.4	0	0	0.066	0.054	480V MCC 29-2	-0.066	-0.054	106.2	77.2	
480V MCC 28-7	0.480	0.480	-1.6	0	0	0	0	480V MCC 29-7	0.000	0.000	0.0	0.0	
480V MCC 29-1	0.480	0.479	-1.7	0	0	0.036	0.007	BKR 29-4C BIFURC	-0.036	-0.007	44.3	98.3	
480V MCC 29-2	0.480	0.470	-1.7	0	0	0.142	0.123	BKR 29-3D BIFURC	-0.244	-0.205	392.0	76.6	
								250V DC CHGR 2/3	0.067	0.055	106.2	77.5	
								125V DC CHGR 2	0.035	0.028	55.0	78.4	
480V MCC 29-4	0.480	0.479	-1.7	0	0	0.032	0.005	BKR 29-3D BIFURC	-0.032	-0.005	38.6	98.7	
480V MCC 29-7	0.480	0.480	-1.6	0	0	0	0	480V MCC 28-7	0.000	0.000	0.0	0.0	
								480V SWGR 29	0.000	0.000	0.0	0.0	
480V MCC 29-8	0.480	0.480	-1.6	0	0	0	0	480V SWGR 29	0.000	0.000	0.0	0.0	
480V MCC 29-9	0.480	0.478	-1.8	0	0	0.050	0.009	BKR 29-4C BIFURC	-0.050	-0.009	61.4	98.3	
480V SWGR 29	0.480	0.480	-1.6	0	0	0	0	BKR 29-3D BIFURC	0.281	0.215	425.6	79.4	
								480V MCC 29-7	0.000	0.000	0.0	0.0	
								480V MCC 29-8	0.000	0.000	0.0	0.0	
								BKR 29-4C BIFURC	0.086	0.016	105.7	98.3	
								2-902-63 ESS UPS PNL	0.038	0.028	56.5	80.6	
								HIGH SIDE OF XFMR 29	-0.405	-0.259	578.6	84.3	
BKR 29-3D BIFURC	0.480	0.480	-1.6	0	0	0	0	480V MCC 29-2	0.249	0.210	392.0	76.5	
								480V MCC 29-4	0.032	0.005	38.6	98.7	
								480V SWGR 29	-0.281	-0.215	425.6	79.4	
BKR 29-4C BIFURC	0.480	0.480	-1.6	0	0	0	0	480V MCC 29-1	0.036	0.007	44.3	98.3	
								480V MCC 29-9	0.050	0.010	61.4	98.2	
								480V SWGR 29	-0.086	-0.016	105.7	98.3	
* DG 2 TERMINAL	4.160	4.160	0.0	2.402	1.229	0	0	4KV SWGR 24-1	2.402	1.229	374.5	89.0	
HIGH SIDE OF XFMR 29	4.160	4.148	-0.1	0	0	0	0	4KV SWGR 24-1	-0.407	-0.276	68.5	82.8	
								480V SWGR 29	0.407	0.276	68.5	82.8	-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 than0.1 MVA

Project:	Dresden Unit2	**ETAP**	Page: 8
Location:	OTI	5.5.0N	Date: 03-01-2007
Contract:			SN: WASHTNGRPN
Engineer:	OTI	Study Case: DG_2_CCSW	Revision: Base
Filename:	DRE_Unit2_0004		Config.: DG2_CR_HVAC

Converted from ELMS PLUS

Diesel Generator connected using nominal voltage,1 LPCI Pump, 2 CCSW. This time period is 10+ min into 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
2-902-63 ESS UPS PNL	0.480	0.475	-2.4	0	0	0.038	0.027	480V SWGR 29	-0.038	-0.027	56.6	81.3	
4KV SWGR 24	4.160	4.144	-0.2	0	0	0.772	0.395	4KV SWGR 24-1	-0.772	-0.395	120.8	89.0	
4KV SWGR 24-1	4.160	4.148	-0.1	0	0	1.218	0.549	4KV SWGR 24	0.772	0.396	120.8	89.0	
								HIGH SIDE OF XFMR 29	0.597	0.392	99.4	83.6	
								DG 2 TERMINAL	-2.587	-1.337	405.4	88.8	
125V DC CHGR 2	0.480	0.456	-1.7	0	0	0.034	0.027	480V MCC 29-2	-0.034	-0.027	55.0	78.3	
250V DC CHGR 2/3	0.480	0.461	-2.2	0	0	0.066	0.053	480V MCC 29-2	-0.066	-0.053	106.3	77.9	
480V MCC 28-7	0.480	0.475	-2.4	0	0	0	0	480V MCC 29-7	0.000	0.000	0.0	0.0	
480V MCC 29-1	0.480	0.474	-2.4	0	0	0.035	0.007	BKR 29-4C BIFURC	-0.035	-0.007	43.9	98.3	
480V MCC 29-2	0.480	0.465	-2.5	0	0	0.142	0.123	BKR 29-3D BIFURC	-0.244	-0.203	393.8	76.9	
								250V DC CHGR 2/3	0.067	0.053	106.3	78.2	
								125V DC CHGR 2	0.035	0.027	55.0	79.2	
480V MCC 29-4	0.480	0.474	-2.4	0	0	0.031	0.005	BKR 29-3D BIFURC	-0.031	-0.005	38.5	98.7	
480V MCC 29-7	0.480	0.475	-2.4	0	0	0	0	480V MCC 28-7	0.000	0.000	0.0	0.0	
								480V SWGR 29	0.000	0.000	0.0	0.0	
480V MCC 29-8	0.480	0.467	-2.7	0	0	0.187	0.097	480V SWGR 29	-0.187	-0.097	260.1	88.7	
480V MCC 29-9	0.480	0.474	-2.5	0	0	0.049	0.009	BKR 29-4C BIFURC	-0.049	-0.009	61.2	98.2	
480V SWGR 29	0.480	0.475	-2.4	0	0	0	0	BKR 29-3D BIFURC	0.280	0.213	427.5	79.6	
								480V MCC 29-7	0.000	0.000	0.0	0.0	
								480V MCC 29-8	0.189	0.100	260.1	88.5	
								BKR 29-4C BIFURC	0.085	0.016	105.1	98.2	
								2-902-63 ESS UPS PNL	0.038	0.027	56.6	81.3	
								HIGH SIDE OF XFMR 29	-0.592	-0.356	839.6	85.7	
BKR 29-3D BIFURC	0.480	0.475	-2.4	0	0	0	0	480V MCC 29-2	0.249	0.208	393.8	76.8	
								480V MCC 29-4	0.031	0.005	38.5	98.7	
								480V SWGR 29	-0.280	-0.213	427.5	79.6	
BKR 29-4C BIFURC	0.480	0.475	-2.4	0	0	0	0	480V MCC 29-1	0.036	0.007	43.9	98.3	
								480V MCC 29-9	0.049	0.010	61.2	98.2	
								480V SWGR 29	-0.085	-0.016	105.1	98.2	
* DG 2 TERMINAL	4.160	4.160	0.0	2.592	1.346	0	0	4KV SWGR 24-1	2.592	1.346	405.4	88.8	
HIGH SIDE OF XFMR 29	4.160	4.147	-0.1	0	0	0	0	4KV SWGR 24-1	-0.597	-0.392	99.4	83.6	
								480V SWGR 29	0.597	0.392	99.4	83.6	-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 than0.1 MVA