Exelon Generation
4300 Winfield Road
Warrenville, IL 60555

www.exeloncorp.com

Exelon Nuclear

RS-08-155
December 9, 2008

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Quad Cities Nuclear Power Station, Units 1 and 2
Renewed Facility Operating License Nos. DPR-29 and DPR-30
NRC Docket Nos. 50-254 and 50-265

Subject: Additional Information Supporting Request for License Amendment to Establish Total Battery Connector Resistance Acceptance Criteria in Technical Specifications Surveillance Requirements 3.8.4.2 and 3.8.4.5

References:

1. Letter from J. L. Hansen (Exelon Generation Company, LLC) to U. S. NRC, "Request for License Amendment to Establish Total Battery Connector Resistance Acceptance Criteria in Technical Specifications Surveillance Requirements 3.8.4.2 and 3.8.4.5," dated December 21, 2007

2. Letter from J. S. Wiebe (U. S. NRC) to C. G. Pardee (Exelon Generation Company, LLC), "Quad Cities Nuclear Power Station, Units 1 and 2 – Request for Additional Information Related to License Amendment to Establish Total Battery Connector Resistance Acceptance Criteria in Technical Specifications (TAC Nos. MD7539 and MD7540)," dated July 18, 2008

3. Letter from J. L. Hansen (Exelon Generation Company, LLC) to U. S. NRC, "Additional Information Supporting Request for License Amendment to Establish Total Battery Connector Resistance Acceptance Criteria in Technical Specifications Surveillance Requirements 3.8.4.2 and 3.8.4.5," dated August 14, 2008

4. Letter from J. S. Wiebe (U. S. NRC) to C. G. Pardee (Exelon Generation Company, LLC), "Quad Cities Nuclear Power Station, Units 1 and 2 – Request for Additional Information Related to Total Battery Resistance Technical Specification Change (TAC Nos. MD7539 and MD7540)," dated October 7, 2008

5. Letter from J. L. Hansen (Exelon Generation Company, LLC) to U. S. NRC, "Additional Information Supporting Request for License Amendment to Establish Total Battery Connector Resistance Acceptance Criteria in Technical Specifications Surveillance Requirements 3.8.4.2 and 3.8.4.5," dated October 15, 2008

6. Letter from J. S. Wiebe (U. S. NRC) to C. G. Pardee (Exelon Generation Company, LLC), "Quad Cities Nuclear Power Station, Units 1 and 2 – Request for Additional Information Related to Total Battery Resistance Technical Specification Change (TAC Nos. MD7539 and MD7540)," dated October 28, 2008

In Reference 1, Exelon Generation Company, LLC (EGC) requested an amendment to Renewed Facility Operating License Nos. DPR-29 and DPR-30 for Quad Cities Nuclear Power Station (QCNPS), Units 1 and 2. The proposed change revises the battery acceptance criteria in Technical Specification (TS) Surveillance Requirements (SR) 3.8.4.2 and 3.8.4.5.

In References 2 and 4, the NRC requested additional information to complete its review. In response to References 2 and 4, EGC provided References 3 and 5, respectively. In Reference 6, the NRC requested additional information to complete its review. In response to Reference 6, EGC is providing the Attachment 1, which supplements EGC's initial Reference 1 request (Attachments 4 and 5) and includes a proposed license condition (Attachment 6). Attachments 2, 3, and 8 provide additional support discussed in Attachment 1.

EGC has reviewed the information supporting a finding of no significant hazards consideration that was previously provided to the NRC in Attachment 1 of Reference 1. The original no significant hazards consideration was revised to reflect the changes provided in Attachments 4 and 5. The revised no significant hazards consideration is provided in Attachment 7. This evaluation continues to demonstrate that the information provided in this submittal supports the conclusion that the proposed license amendment does not involve a significant hazards consideration.

In a telephone communication on November 19, 2008 between EGC and members of the NRC, it was agreed that the information requested in Reference 6 would be submitted by December 9, 2008. The attached response is being submitted in accordance with this agreement.

There are no regulatory commitments contained in this letter. Should you have any questions concerning this letter, please contact Michelle Yun at (630) 657-2818.

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 9th day of December 2008.

Respectfully,

Jeffrey L. Hansen
Manager – Licensing

cc: NRC Senior Resident Inspector
NRC Regional Administrator, Region III

Attachment 1: Response to Request for Additional Information
Attachment 2: Calculation QDC-8300-E-1587, Revision 001
Attachment 3: Engineering Change 365045, Revision 002
Attachment 4: Markup of Revised Proposed Technical Specifications Pages
Attachment 5: Markup of Revised Proposed Technical Specifications Bases Pages
Attachment 6: Proposed License Condition
Attachment 7: Updated No Significant Hazards Consideration Evaluation
Attachment 8: Excerpt from Calculation 9149-20-19-1, Revision 010

ATTACHMENT 1
Response to Request for Additional Information

NRC Request 1

Provide the operability limits for the QCNPS, Units 1 and 2, battery inter-cell connection resistance and the overall battery resistance. Provide supporting documentation and calculations that show how these values were determined.

Response

Inter-cell Connection Resistance Operability Limits

As discussed in Reference 1, the 150 micro-ohm resistance value was not initially established as an absolute limit for battery operability. The value was based on industry experience as a threshold for identifying localized degradation so that issues potentially affecting battery performance are promptly identified and corrected. As discussed in Reference 2, the industry is proposing to relocate Surveillance Requirements (SRs) related to verifying connection resistances to a licensee-controlled battery maintenance program. As stated in TSTF-500, these SRs do not necessarily verify that the equipment is capable of performing its safety function and are typically a preventive maintenance-type activity.

IEEE Std 450-1995 (Reference 3) states that resistance readings more than 20% above the installation value or ceiling value established by the manufacturer could indicate required corrective actions for corrosion or loose connections. Verifying inter-cell connection resistances and connection corrosion is discussed in Section 4 of IEEE Std 450, "Maintenance." Service tests, discussed in Section 5, "Test schedule," are used to determine if the battery: 1) meets its specification or manufacturer's rating, 2) performance is within acceptable limits, and 3) meets the design requirements of the system. NUREGs-1430 through -1434 define OPERABLE/OPERABILITY as when a system is "capable of performing its specified safety function(s)." In accordance with IEEE Std 450-1995, common industry practice, and the definition of operability, EGC establishes operability of the QCNPS safety-related batteries by service tests, which are executed via SRs 3.8.4.7 and 3.8.4.8.

Due to the fact that the existing surveillance requirement limit for inter-cell battery connections (i.e., 150 micro-ohms) does not directly establish operability, EGC is amending its license amendment request, submitted December 21, 2007, to remove the 150 micro-ohm surveillance requirement from TS 3.8.4. This individual connection resistance requirement will be replaced by a requirement to verify aggregate battery connection resistance, which is more representative of battery operability and satisfies 10 CFR 50.36 requirements. These revised proposed TS are provided in Attachment 4. As described in IEEE 450, limits associated with individual connection resistance will continue to be included in routine battery surveillances to ensure maintenance activities are performed as necessary.

Aggregate Battery Connection Resistance Operability Limits

The operability limits for the overall allowable battery resistance are contained in Table 3 of Calculation QDC-8300-E-1587, Revision 001 (Attachment 2). These values will be placed in the bases section of the TS. The applicable portions of this table are shown below.

Battery	$R_{Accept\text{-}Criteria}$
U1 125 VDC (Normal)	2900 μΩ
U1 125 VDC (Alternate)	2900 μΩ
U1 250 VDC	7000 μΩ
U2 125VDC (Normal)	2800 μΩ
U2 125VDC (Alternate)	2800 μΩ
U2 250 VDC	7000 μΩ

The values in this table are determined, in part, by the use of the Electrical Load Monitoring System (ELMS) computer program. The ELMS-DC program is used to determine the required size of the safety-related batteries at QCNPS and is based on the methodologies outlined in IEEE-485. This computer program, along with its implementing calculation, was prepared and is maintained under EGC's Quality Assurance Program.

The inputs to the ELMS-DC program are the currents drawn by the loads connected to the DC system and their time durations. ELMS-DC uses this information along with the battery manufacturer's discharge curves to verify that the selected battery cells are adequate to support the load profile and determine any remaining capacity (margin) left in the battery. In addition, ELMS-DC also calculates the worst-case voltage the battery will produce during the load profile. This voltage, when subtracted from the Updated Final Safety Analysis Report (UFSAR) required voltages of 105 VDC and 210 VDC for the 125 VDC and 250 VDC batteries, respectively, provides a voltage margin that can be used in conjunction with the load currents to determine how much inter-cell resistance is allowed (i.e., using Ohm's Law).

Since modifications to the plant occasionally add or remove loads connected to the batteries, these modifications can affect the amount of inter-cell resistance that is allowed. Modifications to the DC system, as well as the changes made to the battery sizing calculations discussed above (ELMS-DC), are controlled in accordance with 10 CFR 50.59, "Changes, tests, and experiments." To ensure sufficient control of aggregate battery connection resistance values, EGC is proposing a license condition to be included in the QCNPS renewed facility operating licenses DPR-29 and DPR-30 as described in Attachment 6.

NRC Request 2

Provide the full calculation for the 70 micro ohm [sic] inter-cell connection resistance value that was identified in your initial submittal and later summarized in your August 14, 2008, [sic] response to a staff request for information. Also, describe any assumptions that were made when preparing the calculation.

Response

The 70 micro-ohm inter-cell connection resistance value that is being used as an interim acceptance criteria was derived in Engineering Change (EC) 365045, Revision 002 (Attachment 3). The methodology used in this EC differs from that of Calculation QDC-8300-E-1587 discussed in Question 1 above. EC 365045 uses actual test data from the battery's latest service test to arrive at available margin left in the battery. Using this voltage margin, along with the maximum current draw by the battery, a total resistance can be determined via Ohm's Law which is then divided by the number of inter-cell connections to determine the 70 micro-ohm

value. Calculation QDC-8300-E-1587, however, uses the battery sizing program (ELMS-DC) to determine how much margin will be left in the battery at the end of its service life. From this remaining margin, along with the battery's maximum current, total inter-cell resistance values can be determined.

EC 365045 uses assumptions to simplify the analysis. The batteries are of a two post per polarity design. The resistance between posts A and B shown on Figure 2 of EC 365045 is extremely small and can be neglected. Since this resistance is accounted for in the battery manufacturer's discharge curve, this assumption is valid. To account for the battery's interconnecting cables, test equipment inaccuracies, and other parameters that may affect the inter-cell resistance values, a 120% design margin is incorporated into the 70 micro-ohm value. The 120% design margin is a conservative value based on the way the batteries are sized per IEEE 485 (i.e., all the inrush currents are assumed to occur simultaneously and last for a full minute).

NRC Request 3

Demonstrate that there is adequate voltage (after allowing for voltage drop through the conductors) for safe shutdown equipment to perform the required safety functions when the battery terminal voltage approaches the design limit of 105 volts.

Response

Per NRC clarification provided on October 27th, 2008, EGC is providing explanation of the assumptions related to the design voltage requirements. Calculation QDC-8300-E-1587, referenced in Question 1, demonstrates that there is adequate voltage by assuming that the 105 VDC minimum value (210 VDC for the 250 VDC batteries) is at the terminals of the 125 VDC batteries. The voltage drop calculations that ensure safe shutdown equipment will operate properly under accident conditions also assume 105 VDC at the battery terminals and account for the voltage drop in the cables that connect the battery to the first main DC bus. For example, voltage drop Calculation 9149-20-19-1 for the safety related switchgear breaker close and trip coils uses actual measured lengths for the cables that extend from the battery terminals to the main DC bus (Attachment 8).

References:

1) Letter from J. L. Hansen (Exelon Generation Company, LLC) to U. S. NRC, "Additional Information Supporting Request for License Amendment to Establish Total Battery Connector Resistance Acceptance Criteria in Technical Specifications Surveillance Requirements 3.8.4.2 and 3.8.4.5," dated August 14, 2008

2) TSTF-500, "DC Electrical Rewrite – Update to TSTF-360," Revision 1, transmitted to NRC on November 6, 2008

3) IEEE Std 450-1995

ATTACHMENT 2
Calculation QDC-8300-E-1587, Revision 001

Design Analysis (Major Revision)		**Last Page No.** [6] B1	
Analysis No.: [1]	QDC-8300-E-1587	**Revision:** [2]	001
Title: [3]	Determination of Battery Intercell Connector Resistance Limits		
EC/ECR No.: [4]	EC 372594	**Revision:** [5]	000

		Component(s): [14]	
Station(s): [7]	Quad Cities		
Unit No.: [8]	1 and 2	1-8300	
Discipline: [9]	E	2-8300	
Descrip. Code/Keyword: [10]	E13	1-8350	
Safety/QA Class: [11]	Safety Related	2-8350	
System Code: [12]	DC		
Structure: [13]	N/A		

CONTROLLED DOCUMENT REFERENCES [15]

Document No.:	**From/To**	**Document No.:**	**From/To**
PMED-891377-01	From	QDC-0203-E-0943	To
7318-32-19-1	From		
QDC-8350-E-0521	To		
9149-20-19-1	To		

Is this Design Analysis Safeguards Information? [16] **Yes** ☐ **No** ☒ If yes, see SY-AA-101-106

Does this Design Analysis contain Unverified Assumptions? [17] **Yes** ☐ **No** ☒ If yes, ATI/AR#:

This Design Analysis SUPERCEDES: [18] **N/A** **in its entirety.**

Description of Revision (list affected pages for partials): [19]

The purpose of this revision is to update the allowable intercell resistance values due to revisions to battery sizing calculations 7318-32-19-1 (Rev. 40) and PMED-891377-01 (Rev. 14). Pages 1, 2, 3, 6, 7, 8, and A1 thru A22 are affected by this revision.

Preparer: [20]	DAVID WOLF (Print Name)	(Sign Name)	11/11/08 (Date)
Method of Review: [21]	**Detailed Review** ☒	**Alternate Calculations (attached)** ☐	**Testing** ☐
Reviewer: [22]	Randy C. Buttke (Print Name)	(Sign Name)	11/11/08 (Date)
Review Notes: [23]	Independent review ☒	Peer review ☐	
(For External Analyses Only) **External Approver:** [24]	N/A (Print Name)	N/A (Sign Name)	N/A (Date)
Exelon Reviewer: [25]	N/A (Print Name)	N/A (Sign Name)	N/A (Date)

Independent 3rd Party Review Reqd? [26] **Yes** ☐ **No** ☒

Exelon Approver: [27]	JOSEPH P. THAR (Print Name)	(Sign Name)	11/19/08 (Date)

DESIGN ANALYSIS TABLE OF CONTENTS

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Purpose/Objective

This calculation is in response to a 2006 NRC Component Design Basis Inspection (CDBI) finding which concluded that the maximum intercell resistance value of 150 micro-ohms specified in surveillance requirement SR 3.8.4.5 of the Technical Specifications was non-conservative (Ref. 12). Specifically, if all the intercell connection resistances were allowed to reach their 150 micro-ohm limit, the voltage drop produced by the worst case battery loading would cause the battery terminal voltage to drop below its UFSAR requirement of 105 VDC and 210 VDC for the 125 and 250 VDC batteries respectively (UFSAR Section 8.3.2).

This calculation will determine a conservative, yet realistic, resistance value for each safety related battery in use at Quad Cities Station. The existing 150 micro-ohm value will remain in the Technical Specifications as a limit for each battery intercell connection. However, new resistance limits for the entire battery string will be calculated and will become an additional acceptance criteria in Technical Specifications SR 3.8.4.5 with the actual resistance values in the Bases. | R1

Methodology and Acceptance Criteria

Battery strings are formed by a series connection of the positive and negative terminal posts of individual cells. The positive post of one cell is connected to the negative post of the next cell by intercell connector plates which are bolted to each post. This intercell connection, however, produces a small resistance which drops the overall battery terminal voltage. Excessive corrosion on the battery posts can cause the intercell connection resistance to increase which could drop the terminal voltage to a point where the 105 VDC and 210 VDC minimum requirements may not be met. Per Reference 1, the battery cell manufacturer accounts for normal intercell connection resistance in it's battery cell discharge curves. Any resistance beyond this value must be accounted for by the DC system designer. This includes the added resistance from the following sources: | R1

1. Elevated intercell connector resistance due to corrosion
2. Resistance from the inter-rack jumper cable connections
3. Resistance from the inter-tier jumper cable connections
4. Resistance of the cable lug to post connection at the battery terminals

Figure 1 below is a representation of a typical battery configuration showing the various resistive elements. The number of cells is dependant on the battery's total voltage. Figure 2 is a schematic representation of this battery arrangement.

Figure 1

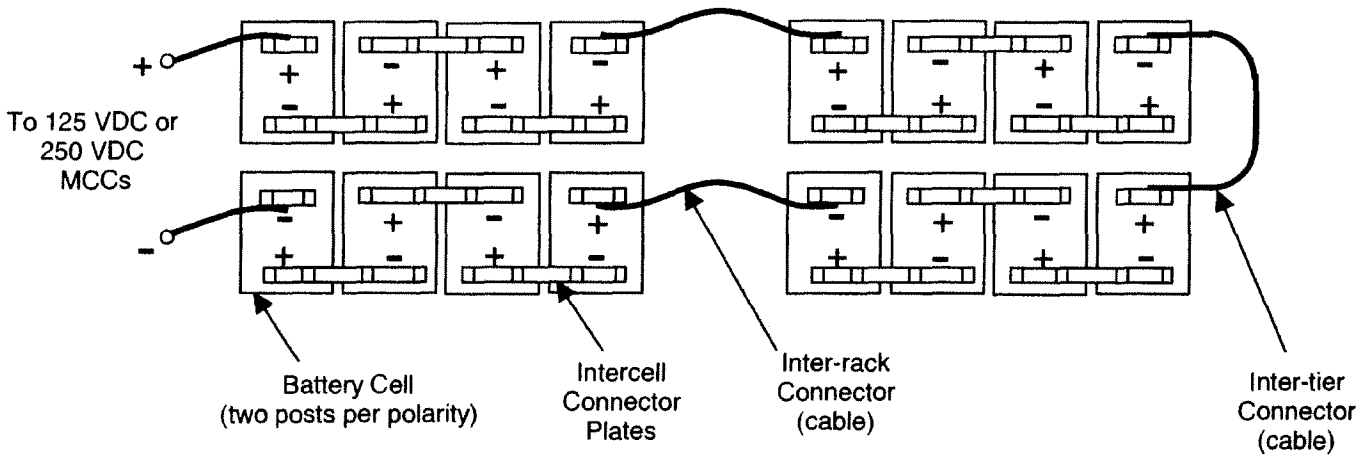
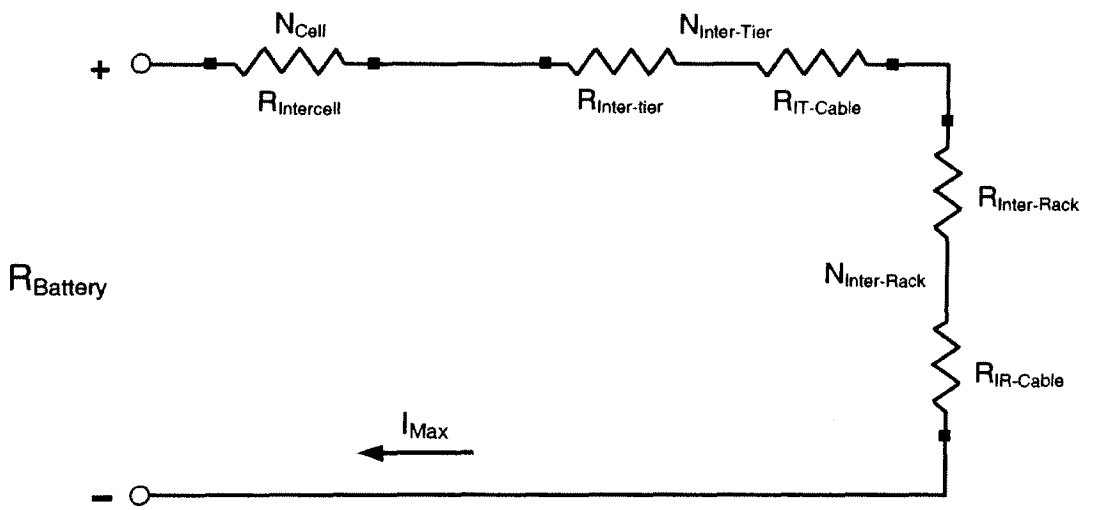


Figure 2



N_{Cell} = Number of intercell connectors
$N_{Inter\text{-}Tier}$ = Number of inter-tier connections
$N_{Inter\text{-}Rack}$ = Number of inter-rack connections
$R_{Battery}$ = Total battery resistance due to connections
I_{Max} = Maximum current from duty cycle

$R_{Intercell}$ = Resistance of intercell conn.
$R_{Inter\text{-}Tier}$ = Resistance of inter-tier conn.
$R_{Inter\text{-}Rack}$ = Resistance of inter-rack conn.
$R_{IT\text{-}Cable}$ = Resistance of inter-tier cables
$R_{IR\text{-}Cable}$ = Resistance of inter-rack cables

Basic Methodology

Maintenance personnel check battery intercell resistances with a micro-ohm meter. This is done by placing the micro-ohm meter across the positive post of one cell and the negative post of next adjacent cell. The resistance value obtained is actually the sum of the normal intercell connector resistance (which is already accounted for in the battery manufacturer's discharge curves) plus any additional resistance due to degradation of the plate-to-post connection (e.g. corrosion). It is this additional resistance that is a concern when maintaining the UFSAR minimum voltage requirement (105 VDC, 210 VDC). If this resistance becomes high enough, it would remove the remaining capacity in the battery and cause the battery terminal voltage to drop below the minimum requirement.

The ELMS-DC program will be used to determine the total allowable battery string resistance based on the remaining battery capacity of each of the six safety related batteries. The following steps will be used for each battery to determine this minimum allowable resistance:

1. From references 2 and 3, the latest ELMS-DC files will be identified for each battery.

2. From the applicable ELMS-DC file, the "Battery Minimum Volts" will be increased slightly until a positive remaining battery capacity (just above 0%) is found. The voltage that produces this result will be designated as V_{Min}. The difference between V_{Min} and the minimum required voltage (e.g. 105 VDC) is the amount of margin that exists to mitigate any increase resistance due to corrosion. This value will be designated as V_X. Therefore,

$$V_X = V_{Min} - V_{Required}$$

3. From reference 1, the battery manufacturer allows for a 0.020 volt drop across each intercell, inter-tier, and inter-rack connection. From references 2 and 3, both the 125 VDC and 250 VDC batteries utilize NCN-21 cells manufactured by GNB. From the data sheet for these batteries (Ref. 2, page R1), the NCN-21 cells have a 1-hour discharge rate of 750 amps when discharged to 1.75 volts/cell. From Ohm's Law, the cell manufacturer's design intercell resistance is,

$$R_{IC} = \frac{V_{Drop-Manuf}}{I_{1-Hour}} = \frac{0.020 \text{ Volts}}{750 \text{ Amps}} = 26.67\ \mu\Omega$$

4. To determine the total resistance accounted for in the vendor discharge curves, the intercell resistance R_{IC} will be multiplied by the number of intercell connectors, inter-tier connections, inter-rack connections, and the feed cable to lug connections. Since the vendor assumes the same voltage drop for each type of connection, the various connections will be combined into a single sum. The total vendor resistance is,

$$R_{Vendor} = (R_{IC})(N_{Cell} + N_{Inter\text{-}tier} + N_{Inter\text{-}Rack} + N_{lug\text{-}Post}) = (R_{IC})(N_{Total\text{-}Conn})$$

Where;

N_{Cell}	=	Number of intercell connections
$N_{Inter\text{-}Tier}$	=	Number of inter-tier connections
$N_{Inter\text{-}Rack}$	=	Number of inter-rack connections
$N_{lug\text{-}Post}$	=	Number of post to lug connections

5. The added allowable resistance due to the remaining margin in the battery is found from Ohm's Law,

$$R_{Margin} = \frac{V_X}{I_{Max}}$$

where, V_X = Voltage difference calculated in step 2

I_{MAX} = Maximum current from duty cycle.

6. The total allowable measured resistance, $R_{Total-Allow}$, is the sum of the vendor allowable resistance plus the extra allowable resistance due to the remaining battery capacity.

$$R_{Total-Allow} = R_{Vendor} + R_{Margin}$$

$R_{Total-Allow}$ is the resistance value that will be compared to the actual field measurements taken per the Technical Specification surveillance. Note that the measurements taken at the inter-tier and inter-rack connection points will include the resistance of the jumper cables that extend between the tiers and racks. Since they are included in the measurements, they are not involved in the above computations. $R_{Total-Allow}$ is the value that must be met to ensure the UFSAR required minimum voltage is maintained.

Assumptions / Engineering Judgments

1. The 125 VDC Alternate Batteries for Unit 1 and 2 utilize the same cell type and load profiles as the Normal 125 VDC Batteries. The Alternate batteries are also enveloped by the Normal batteries in regards to the number and type of connections. The acceptance criteria for the Unit 1(2) 125 VDC Alternate batteries will be the same as the Unit 1(2) Normal 125 VDC batteries. This is verified from references 2, 3, 4, 5, and 6.

Design Inputs

1. Table 1 contains the design inputs for each battery.

Table 1

Battery	ELMS-DC File	Number of Cells	Intercell Conn.	Inter-tier Conn.	Inter-Rack Conn.	Post-lug Conn.	Ref.
U1 125 VDC	Q1D5YLS.M67	58	56	1	0	2	2, 4
U1 250 VDC	Q1D6250V.M25	120	115	2	2	2	3, 4
U2 125VDC	Q2D5YLS.M69	58	52	2	3	2	2, 6
U2 250 VDC	Q2D6250V.M24	120	113	2	4	2	3, 7

R1

References

1. Telephone conversation regarding NCX/NCN cell characteristics dated 4/2/98 (Att. B)
2. Calculation 7318-32-19-1, Revision 40 (125 VDC Battery Sizing Calculation) R1
3. PMED-891377-01, Revision 14 (250 VDC Battery Sizing Calculation)
4. 4E-1067F, Rev. I, "Connection Layout 125V & 250V DC Battery Cells
5. 4E-1067J, Rev. A, "Cell Connection Layout 125V Alt Battery and 48/24 V DC Battery"
6. 4E-2067E, Rev. E, "125V DC Battery Cell Connection Layout"
7. 4E-2067F, Rev. D, "250V DC Battery Cell Connection Layout"
8. Unit 1 125 VDC Battery ELMS-DC Datafile Q1D5YLS.M67, 28KB, 6/5/08, 10:43 AM
9. Unit 1 250 VDC Battery ELMS-DC Datafile Q1D6250V.M25, 21KB, 7/18/08, 6:13 AM R1
10. Unit 2 125 VDC Battery ELMS-DC Datafile Q2D5YLS.M69, 29KB, 6/5/08, 10:58 AM
11. Unit 2 250 VDC Battery ELMS-DC Datafile Q2D6250V.M24, 21KB, 7/18/08, 6:47 AM
12. Issue Report (IR) 540524, "Basis for Battery Inter-Cell Resistance in Tech Specs"

Calculations

The total allowable resistance for each battery string will be calculated from steps 1 through 6 of the methodology as stated above. The following is a summary of this methodology along with a table of calculated values (Table 2).

Equation 1: $V_X = V_{Min} - V_{Required}$

V_X = Voltage margin available from ELMS
V_{Min} = Max voltage in ELMS that produces 0% (approx) remaining margin
$V_{Required}$ = Minimum required battery voltage per the UFSAR

Equation 2: $R_{Vendor} = (R_{IC})(N_{Conn})$

R_{Vendor} = resistance accounted for in the vendor's discharge curves
R_{IC} = voltage drop allowed by the vendor for each connection = 26.67 $\mu\Omega$
N_{Conn} = total number of cell connections

Equation 3: $R_{Margin} = \frac{V_X}{I_{Max}}$

R_{Margin} = extra resistance due to the margin in ELMS
I_{Max} = maximum current from the duty cycle

Equation 4: $R_{Total\text{-}Allow} = R_{Vendor} + R_{Margin}$

$R_{Total\text{-}Allow}$ = Maximum allowable resistance value when summing all intercell, inter-tier, inter-rack, post-lug micro-ohm measurements

Table 2

Battery	V_{Min}	V_{Req}	V_X	N_{Conn}	R_{Vendor}	I_{Max}	R_{Margin}	$R_{Total\text{-}Allow}$
U1 125 VDC	106.1 V	105 V	1.1 V	59	1573 μΩ	663 A	1659 μΩ	3232 μΩ
U1 250 VDC	217.1 V	210 V	7.1 V	121	3227 μΩ	773 A	9184 μΩ	12,411 μΩ
U2 125 VDC	106.0 V	105 V	1.0 V	59	1573 μΩ	676 A	1479 μΩ	3052 μΩ
U2 250 VDC	217.1 V	210 V	7.1 V	121	3227 μΩ	780 A	9102 μΩ	12,329 μΩ

R1

Summary and Conclusions

The latest ELMS-DC files were used to determine the minimum battery intercell, inter-tier, and inter-rack resistances to ensure that minimum battery voltage levels are maintained. Table 3 is a summary of these results along with recommended acceptance criteria to be used in the Technical Specification surveillances. Note that the recommended acceptance criteria are lower than the calculated total allowable resistances. This adds conservatism and allows for small changes in battery loading to occur without revising the surveillance procedure.

Table 3

Battery	ELMS-DC Base File	New ELMS-DC Intercell File	$R_{Total\text{-}Allow}$	$R_{Accept\text{-}Criteria}$
U1 125 VDC (Normal)	Q1D5YLS.M67	Q1D5YLS.I02	3232 μΩ	2900 μΩ
U1 125 VDC (Alternate)	Q1D5YLS.M67	Q1D5YLS.I02	3232 μΩ	2900 μΩ
U1 250 VDC	Q1D6250V.M25	Q1D6250V.I02	12,411 μΩ	7000 μΩ
U2 125VDC (Normal)	Q2D5YLS.M69	Q2D5YLS.I02	3052 μΩ	2800 μΩ
U2 125VDC (Alternate)	Q2D5YLS.M69	Q2D5YLS.I02	3052 μΩ	2800 μΩ
U2 250 VDC	Q2D6250V.M24	Q2D6250V.I02	12,329 μΩ	7000 μΩ

R1

Final
[Last Page]

Unit 1 125 VDC Battery

ELMS-DC File - Intercells

Q1D5YLS.I02

SARGENT & LUNDY, ENGINEERS CHICAGO, ILLINOIS ELMS-DC VERSION 2.00 PROJECT NUMBER: 08646 PAGE: 1
UTILITY: Commonwealth Edison Company STATION: QUAD CITIES UNIT: 1 USER: DWW
DATA FILE: c:\elmsdc\q1d5yls.i02 DATE: 10-22-08
Unit 1 125 VDC Battery Intercell Maximum Resistance Limits

BATTERY SIZING CALCULATION

Lowest Expected Electrolyte Temp: 65.00 Cell Mfg: GNB (IEEE-450,1987)
Minimum Battery Voltage.....: 106.10 Cell Type: NCX (MODELS NCX-17, NCX-21, AND NCX-27)
Minimum Cell Voltage.....: 1.829 No. Cells: 58 No. Pos. Plates: 10

Section	(1) Period	(2) Load (amperes)	(3) Change in Load (amperes)	(4) Duration of Period (minutes)	(5) Time to End of Section (minutes)	(6) Capacity at T min. rate Amps/Pos (RT)	(7) Req'd Section Size (3) / (6) Positive Plates
1	1	A1 = 662.137	A1 -0 = 662.137	M1 = 1	T = M1 = 1	90.246	7.337
							Total = 7.337
2	1	A1 = 662.137	A1 -0 = 662.137	M1 = 1	T = M1 +..+M2 = 2	89.828	7.371
	2	A2 = 270.039	A2 -A1 = -392.098	M2 = 1	T = M2 = 1	90.246	-4.345
							Total = 3.026
3	1	A1 = 662.137	A1 -0 = 662.137	M1 = 1	T = M1 +..+M3 = 5	88.574	7.476
	2	A2 = 270.039	A2 -A1 = -392.098	M2 = 1	T = M2 +..+M3 = 4	88.992	-4.406
	3	A3 = 365.089	A3 -A2 = 95.050	M3 = 3	T = M3 = 3	89.410	1.063
							Total = 4.133
4	1	A1 = 662.137	A1 -0 = 662.137	M1 = 1	T = M1 +..+M4 = 10	86.484	7.656
	2	A2 = 270.039	A2 -A1 = -392.098	M2 = 1	T = M2 +..+M4 = 9	86.902	-4.512
	3	A3 = 365.089	A3 -A2 = 95.050	M3 = 3	T = M3 +..+M4 = 8	87.320	1.089
	4	A4 = 270.039	A4 -A3 = -95.050	M4 = 5	T = M4 = 5	88.574	-1.073
							Total = 3.160
5	1	A1 = 662.137	A1 -0 = 662.137	M1 = 1	T = M1 +..+M5 = 11	86.066	7.693
	2	A2 = 270.039	A2 -A1 = -392.098	M2 = 1	T = M2 +..+M5 = 10	86.484	-4.534
	3	A3 = 365.089	A3 -A2 = 95.050	M3 = 3	T = M3 +..+M5 = 9	86.902	1.094
	4	A4 = 270.039	A4 -A3 = -95.050	M4 = 5	T = M4 +..+M5 = 6	88.156	-1.078
	5	A5 = 314.962	A5 -A4 = 44.923	M5 = 1	T = M5 = 1	90.246	.498
							Total = 3.673
6	1	A1 = 662.137	A1 -0 = 662.137	M1 = 1	T = M1 +..+M6 = 12	85.648	7.731
	2	A2 = 270.039	A2 -A1 = 392.098	M2 = 1	T = M2 +..+M6 = 11	86.066	-4.556
	3	A3 = 365.089	A3 -A2 = 95.050	M3 = 3	T = M3 +..+M6 = 10	86.484	1.099
	4	A4 = 270.039	A4 -A3 = 95.050	M4 = 5	T = M4 +..+M6 = 7	87.738	1.083
	5	A5 = 314.962	A5 -A4 = 44.923	M5 = 1	T = M5 +..+M6 = 2	89.828	.500
	6	A6 = 284.483	A6 -A5 = 30.479	M6 = 1	T = M6 = 1	90.246	.338
							Total = 3.353

BATTERY SIZING CALCULATION

Lowest Expected Electrolyte Temp: 65.00 Cell Mfg: GNB (IEEE-450,1987)
Minimum Battery Voltage.....: 106.10 Cell Type: NCX (MODELS NCX-17, NCX-21, AND NCX-27)
Minimum Cell Voltage.....: 1.829 No. Cells: 58 No. Pos. Plates: 10

Section	(1) Period	(2) Load (amperes)	(3) Change in Load (amperes)	(4) Duration of Period (minutes)	(5) Time to End of Section (minutes)	(6) Capacity at T min. rate Amps/Pos (RT)	(7) Req'd Section Size (3) / (6) Positive Plates
7	1	A1 = 662.137	A1 -0 = 662.137	M1 = 1	T = M1 +..+M7 = 15	84.395	7.846
	2	A2 = 270.039	A2 -A1 = -392.098	M2 = 1	T = M2 +..+M7 = 14	84.813	-4.623
	3	A3 = 365.089	A3 -A2 = 95.050	M3 = 3	T = M3 +..+M7 = 13	85.230	1.115
	4	A4 = 270.039	A4 -A3 = -95.050	M4 = 5	T = M4 +..+M7 = 10	86.484	-1.099
	5	A5 = 314.962	A5 -A4 = 44.923	M5 = 1	T = M5 +..+M7 = 5	88.574	.507
	6	A6 = 284.483	A6 -A5 = -30.479	M6 = 1	T = M6 +..+M7 = 4	88.992	-.342
	7	A7 = 269.329	A7 -A6 = -15.154	M7 = 3	T = M7 = 3	89.410	-.169
							Total = 3.234
8	1	A1 = 662.137	A1 -0 = 662.137	M1 = 1	T = M1 +..+M8 = 30	71.804	9.221
	2	A2 = 270.039	A2 -A1 = -392.098	M2 = 1	T = M2 +..+M8 = 29	72.643	-5.398
	3	A3 = 365.089	A3 -A2 = 95.050	M3 = 3	T = M3 +..+M8 = 28	73.482	1.294
	4	A4 = 270.039	A4 -A3 = -95.050	M4 = 5	T = M4 +..+M8 = 25	76.001	-1.251
	5	A5 = 314.962	A5 -A4 = 44.923	M5 = 1	T = M5 +..+M8 = 20	80.198	.560
	6	A6 = 284.483	A6 -A5 = -30.479	M6 = 1	T = M6 +..+M8 = 19	81.037	-.376
	7	A7 = 269.329	A7 -A6 = -15.154	M7 = 3	T = M7 +..+M8 = 18	81.876	-.185
	8	A8 = 259.449	A8 -A7 = -9.880	M8 = 15	T = M8 = 15	84.395	-.117
							Total = 3.749
9	1	A1 = 662.137	A1 -0 = 662.137	M1 = 1	T = M1 +..+M9 = 60	58.922	11.237
	2	A2 = 270.039	A2 -A1 = -392.098	M2 = 1	T = M2 +..+M9 = 59	59.352	-6.606
	3	A3 = 365.089	A3 -A2 = 95.050	M3 = 3	T = M3 +..+M9 = 58	59.781	1.590
	4	A4 = 270.039	A4 -A3 = -95.050	M4 = 5	T = M4 +..+M9 = 55	61.069	-1.556
	5	A5 = 314.962	A5 -A4 = 44.923	M5 = 1	T = M5 +..+M9 = 50	63.216	.711
	6	A6 = 284.483	A6 -A5 = -30.479	M6 = 1	T = M6 +..+M9 = 49	63.646	-.479
	7	A7 = 269.329	A7 -A6 = -15.154	M7 = 3	T = M7 +..+M9 = 48	64.075	-.237
	8	A8 = 259.449	A8 -A7 = -9.880	M8 = 15	T = M8 +..+M9 = 45	65.363	-.151
	9	A9 = 157.196	A9 -A8 = 102.253	M9 = 30	T = M9 = 30	71.804	-1.424
							Total = 3.085

SARGENT & LUNDY, ENGINEERS CHICAGO, ILLINOIS ELMS-DC VERSION 2.00 PROJECT NUMBER: 08646 PAGE: 3
UTILITY: Commonwealth Edison Company STATION: QUAD CITIES UNIT: 1 USER: DWW
DATA FILE: c:\elmsdc\q1d5yls.i02 DATE: 10-22-08
Unit 1 125 VDC Battery Intercell Maximum Resistance Limits

BATTERY SIZING CALCULATION

Lowest Expected Electrolyte Temp: 65.00 Cell Mfg: GNB (IEEE-450,1987)
Minimum Battery Voltage.....: 106.10 Cell Type: NCX (MODELS NCX-17, NCX-21, AND NCX-27)
Minimum Cell Voltage.....: 1.829 No. Cells: 58 No. Pos. Plates: 10

Section	(1) Period	(2) Load (amperes)	(3) Change in Load (amperes)	(4) Duration of Period (minutes)	(5) Time to End of Section (minutes)	(6) Capacity at T min. rate Amps/Pos (RT)	(7) Req'd Section Size (3) / (6) Positive Plates
10	1	A1 = 662.137	A1 -0 = 662.137	M1 = 1	T = M1 +..+M10 = 240	28.477	23.251
	2	A2 = 270.039	A2 A1 = -392.098	M2 = 1	T = M2 +..+M10 = 239	28.575	-13.722
	3	A3 = 365.089	A3 -A2 = 95.050	M3 = 3	T = M3 +..+M10 = 238	28.672	3.315
	4	A4 = 270.039	A4 -A3 = -95.050	M4 = 5	T = M4 +..+M10 = 235	28.963	-3.282
	5	A5 = 314.962	A5 -A4 = 44.923	M5 = 1	T = M5 +..+M10 = 230	29.449	1.525
	6	A6 = 284.483	A6 -A5 = -30.479	M6 = 1	T = M6 +..+M10 = 229	29.546	-1.032
	7	A7 = 269.329	A7 -A6 = -15.154	M7 = 3	T = M7 +..+M10 = 228	29.644	-.511
	8	A8 = 259.449	A8 -A7 = -9.880	M8 = 15	T = M8 +..+M10 = 225	29.935	-.330
	9	A9 = 157.196	A9 -A8 = -102.253	M9 = 30	T = M9 +..+M10 = 210	31.393	-3.257
	10	A10= 155.889	A10 A9 = -1.307	M10 = 180	T = M10 = 180	34.308	-.038
							Total = 5.920

Maximum section size = Uncorrected size (US) = 7.337 from period 1

US	X TEMP. CORR.	X DESIGN MARGIN	X AGING FACTOR	= MINIMUM REQUIRED SIZE
7.337	1.08	1.00	1.25	9.905

Selected battery pos plates = 10 | Battery capacity remaining = .9%

BATTERY SIZING CALCULATION

RT curve points used to size battery:

TIME (MIN)	AMPS PER POS PLATE
0	90.73
1	90.25
15	84.39
30	71.80
60	58.92
90	48.47
120	43.66
180	34.31
240	28.48
300	24.49
480	17.26

Unit 1 250 VDC Battery

ELMS-DC File - Intercells

Q1D6250V.I02

SARGENT & LUNDY, ENGINEERS CHICAGO, ILLINOIS ELMS-DC VERSION 2.00 PROJECT NUMBER: PAGE: 1
UTILITY: Commonwealth Edison Company STATION: QUAD CITIES UNIT: 1 USER: DWW
DATA FILE: c:\elmsdc\q1d6250v.i02 DATE: 10-22-08
Unit 1 250 VDC Battery Intercell Maximum Resistance Limits

BATTERY SIZING CALCULATION

Lowest Expected Electrolyte Temp: 65.00 Cell Mfg: GNB (IEEE-450,1987)
Minimum Battery Voltage.....: 217.10 Cell Type: NCX (MODELS NCX-17, NCX-21, AND NCX-27)
Minimum Cell Voltage.....: 1.809 No. Cells: 120 No. Pos. Plates: 10

Section	(1) Period	(2) Load (amperes)	(3) Change in Load (amperes)	(4) Duration of Period (minutes)	(5) Time to End of Section (minutes)	(6) Capacity at T min. rate Amps/Pos (RT)	(7) Req'd Section Size (3) / (6) Positive Plates
1	1	A1 = 772.699	A1 -0 = 772.699	M1 = 1	T = M1 = 1	106.177	7.277
							Total = 7.277
2	1	A1 = 772.699	A1 -0 = 772.699	M1 = 1	T = M1 +..+M2 = 2	105.084	7.353
	2	A2 = 183.959	A2 -A1 = -588.740	M2 = 1	T = M2 = 1	106.177	-5.545
							Total = 1.808
3	1	A1 = 772.699	A1 -0 = 772.699	M1 = 1	T = M1 +..+M3 = 7	99.621	7.756
	2	A2 = 183.959	A2 -A1 = -588.740	M2 = 1	T = M2 +..+M3 = 6	100.714	-5.846
	3	A3 = 142.459	A3 -A2 = -41.500	M3 = 5	T = M3 = 5	101.806	-.408
							Total = 1.503
4	1	A1 = 772.699	A1 -0 = 772.699	M1 = 1	T = M1 +..+M4 = 9	97.435	7.930
	2	A2 = 183.959	A2 -A1 = -588.740	M2 = 1	T = M2 +..+M4 = 8	98.528	-5.975
	3	A3 = 142.459	A3 -A2 = -41.500	M3 = 5	T = M3 +..+M4 = 7	99.621	-.417
	4	A4 = 273.699	A4 -A3 = 131.240	M4 = 2	T = M4 = 2	105.084	1.249
							Total = 2.787
5	1	A1 = 772.699	A1 -0 = 772.699	M1 = 1	T = M1 +..+M5 = 30	81.243	9.511
	2	A2 = 183.959	A2 -A1 = -588.740	M2 = 1	T = M2 +..+M5 = 29	81.886	-7.190
	3	A3 = 142.459	A3 -A2 = -41.500	M3 = 5	T = M3 +..+M5 = 28	82.528	-.503
	4	A4 = 273.699	A4 -A3 = 131.240	M4 = 2	T = M4 +..+M5 = 23	85.740	1.531
	5	A5 = 166.639	A5 -A4 = -107.060	M5 = 21	T = M5 = 21	87.025	-1.230
							Total = 2.119
6	1	A1 = 772.699	A1 -0 = 772.699	M1 = 1	T = M1 +..+M6 = 120	46.445	16.637
	2	A2 = 183.959	A2 -A1 = -588.740	M2 = 1	T = M2 +..+M6 = 119	46.630	-12.626
	3	A3 = 142.459	A3 -A2 = -41.500	M3 = 5	T = M3 +..+M6 = 118	46.816	-.886
	4	A4 = 273.699	A4 -A3 = 131.240	M4 = 2	T = M4 +..+M6 = 113	47.744	2.749
	5	A5 = 166.639	A5 -A4 = -107.060	M5 = 21	T = M5 +..+M6 = 111	48.115	-2.225
	6	A6 = 162.639	A6 -A5 = -4.000	M6 = 90	T = M6 = 90	52.613	-.077
							Total = 3.572

BATTERY SIZING CALCULATION

Lowest Expected Electrolyte Temp: 65.00 Cell Mfg: GNB (IEEE-450,1987)
Minimum Battery Voltage.....: 217.10 Cell Type: NCX (MODELS NCX-17, NCX-21, AND NCX-27)
Minimum Cell Voltage.....: 1.809 No. Cells: 120 No. Pos. Plates: 10

Section	(1) Period	(2) Load (amperes)	(3) Change in Load (amperes)	(4) Duration of Period (minutes)	(5) Time to End of Section (minutes)	(6) Capacity at T min. rate Amps/Pos (RT)	(7) Req'd Section Size (3) / (6) Positive Plates
7	1	A1 = 772.699	A1 -0 = 772.699	M1 = 1	T = M1 +..+M7 = 121	46.264	16.702
	2	A2 = 183.959	A2 -A1 = -588.740	M2 = 1	T = M2 +..+M7 = 120	46.445	-12.676
	3	A3 = 142.459	A3 -A2 = -41.500	M3 = 5	T = M3 +..+M7 = 119	46.630	-.890
	4	A4 = 273.699	A4 -A3 = 131.240	M4 = 2	T = M4 +..+M7 = 114	47.558	2.760
	5	A5 = 166.639	A5 -A4 = -107.060	M5 = 21	T = M5 +..+M7 = 112	47.930	-2.234
	6	A6 = 162.639	A6 -A5 = -4.000	M6 = 90	T = M6 +..+M7 = 91	51.827	-.077
	7	A7 = 194.009	A7 -A6 = 31.370	M7 = 1	T = M7 = 1	106.177	.295
							Total = 3.880
8	1	A1 = 772.699	A1 -0 = 772.699	M1 = 1	T = M1 +..+M8 = 122	46.084	16.767
	2	A2 = 183.959	A2 -A1 = -588.740	M2 = 1	T = M2 +..+M8 = 121	46.264	-12.726
	3	A3 = 142.459	A3 -A2 = -41.500	M3 = 5	T = M3 +..+M8 = 120	46.445	-.894
	4	A4 = 273.699	A4 -A3 = 131.240	M4 = 2	T = M4 +..+M8 = 115	47.373	2.770
	5	A5 = 166.639	A5 -A4 = -107.060	M5 = 21	T = M5 +..+M8 = 113	47.744	-2.242
	6	A6 = 162.639	A6 -A5 = -4.000	M6 = 90	T = M6 +..+M8 = 92	51.642	-.077
	7	A7 = 194.009	A7 -A6 = 31.370	M7 = 1	T = M7 +..+M8 = 2	105.084	.299
	8	A8 = 150.259	A8 -A7 = -43.750	M8 = 1	T = M8 = 1	106.177	-.412
							Total = 3.485
9	1	A1 = 772.699	A1 -0 = 772.699	M1 = 1	T = M1 +..+M9 = 123	45.904	16.833
	2	A2 = 183.959	A2 -A1 = -588.740	M2 = 1	T = M2 +..+M9 = 122	46.084	-12.775
	3	A3 = 142.459	A3 -A2 = -41.500	M3 = 5	T = M3 +..+M9 = 121	46.264	-.897
	4	A4 = 273.699	A4 -A3 = 131.240	M4 = 2	T = M4 +..+M9 = 116	47.187	2.781
	5	A5 = 166.639	A5 -A4 = -107.060	M5 = 21	T = M5 +..+M9 = 114	47.558	-2.251
	6	A6 = 162.639	A6 -A5 = -4.000	M6 = 90	T = M6 +..+M9 = 93	51.456	-.078
	7	A7 = 194.009	A7 -A6 = 31.370	M7 = 1	T = M7 +..+M9 = 3	103.992	.302
	8	A8 = 150.259	A8 -A7 = -43.750	M8 = 1	T = M8 +..+M9 = 2	105.084	-.416
	9	A9 = 168.479	A9 -A8 = 18.220	M9 = 1	T = M9 = 1	106.177	.172
							Total = 3.670

BATTERY SIZING CALCULATION

Lowest Expected Electrolyte Temp: 65.00 Cell Mfg: GNB (IEEE-450,1987)
Minimum Battery Voltage.....: 217.10 Cell Type: NCX (MODELS NCX-17, NCX-21, AND NCX-27)
Minimum Cell Voltage.....: 1.809 No. Cells: 120 No. Pos. Plates: 10

Section	(1) Period	(2) Load (amperes)	(3) Change in Load (amperes)	(4) Duration of Period (minutes)	(5) Time to End of Section (minutes)	(6) Capacity at T min. rate Amps/Pos (RT)	(7) Req'd Section Size (3) / (6) Positive Plates
10	1	A1 = 772.699	A1 -0 = 772.699	M1 = 1	T = M1 +..+M10 = 124	45.723	16.899
	2	A2 = 183.959	A2 -A1 = -588.740	M2 = 1	T = M2 +..+M10 = 123	45.904	-12.826
	3	A3 = 142.459	A3 -A2 = -41.500	M3 = 5	T = M3 +..+M10 = 122	46.084	-.901
	4	A4 = 273.699	A4 -A3 = 131.240	M4 = 2	T = M4 +..+M10 = 117	47.002	2.792
	5	A5 = 166.639	A5 -A4 = -107.060	M5 = 21	T = M5 +..+M10 = 115	47.373	-2.260
	6	A6 = 162.639	A6 -A5 = -4.000	M6 = 90	T = M6 +..+M10 = 94	51.271	-.078
	7	A7 = 194.009	A7 -A6 = 31.370	M7 = 1	T = M7 +..+M10 = 4	102.899	.305
	8	A8 = 150.259	A8 -A7 = -43.750	M8 = 1	T = M8 +..+M10 = 3	103.992	-.421
	9	A9 = 168.479	A9 -A8 = 18.220	M9 = 1	T = M9 +..+M10 = 2	105.084	.173
	10	A10= 142.259	A10-A9 = -26.220	M10 = 1	T = M10 = 1	106.177	-.247
							Total = 3.438
11	1	A1 = 772.699	A1 -0 = 772.699	M1 = 1	T = M1 +..+M11 = 239	29.571	26.130
	2	A2 = 183.959	A2 -A1 = -588.740	M2 = 1	T = M2 +..+M11 = 238	29.674	-19.840
	3	A3 = 142.459	A3 -A2 = -41.500	M3 = 5	T = M3 +..+M11 = 237	29.776	-1.394
	4	A4 = 273.699	A4 -A3 = 131.240	M4 = 2	T = M4 +..+M11 = 232	30.289	4.333
	5	A5 = 166.639	A5 -A4 = -107.060	M5 = 21	T = M5 +..+M11 = 230	30.494	-3.511
	6	A6 = 162.639	A6 -A5 = -4.000	M6 = 90	T = M6 +..+M11 = 209	32.648	-.123
	7	A7 = 194.009	A7 -A6 = 31.370	M7 = 1	T = M7 +..+M11 = 119	46.630	.673
	8	A8 = 150.259	A8 -A7 = -43.750	M8 = 1	T = M8 +..+M11 = 118	46.816	-.935
	9	A9 = 168.479	A9 -A8 = 18.220	M9 = 1	T = M9 +..+M11 = 117	47.002	.388
	10	A10= 142.259	A10-A9 = -26.220	M10 = 1	T = M10+..+M11 = 116	47.187	-.556
	11	A11= 134.259	A11-A10 = -8.000	M11 = 115	T = M11 = 115	47.373	-.169
							Total = 4.997
12	1	A1 = 772.699	A1 -0 = 772.699	M1 = 1	T = M1 +..+M12 = 240	29.469	26.221
	2	A2 = 183.959	A2 -A1 = -588.740	M2 = 1	T = M2 +..+M12 = 239	29.571	-19.909
	3	A3 = 142.459	A3 -A2 = -41.500	M3 = 5	T = M3 +..+M12 = 238	29.674	-1.399
	4	A4 = 273.699	A4 -A3 = 131.240	M4 = 2	T = M4 +..+M12 = 233	30.187	4.348
	5	A5 = 166.639	A5 -A4 = -107.060	M5 = 21	T = M5 +..+M12 = 231	30.392	-3.523
	6	A6 = 162.639	A6 -A5 = -4.000	M6 = 90	T = M6 +..+M12 = 210	32.545	-.123
	7	A7 = 194.009	A7 -A6 = 31.370	M7 = 1	T = M7 +..+M12 = 120	46.445	.675
	8	A8 = 150.259	A8 -A7 = -43.750	M8 = 1	T = M8 +..+M12 = 119	46.630	-.938
	9	A9 = 168.479	A9 -A8 = 18.220	M9 = 1	T = M9 +..+M12 = 118	46.816	.389
	10	A10= 142.259	A10-A9 = -26.220	M10 = 1	T = M10+..+M12 = 117	47.002	-.558
	11	A11= 134.259	A11-A10 = -8.000	M11 = 115	T = M11+..+M12 = 116	47.187	-.170
	12	A12= 351.939	A12-A11 = 217.680	M12 = 1	T = M12 = 1	106.177	2.050
							Total = 7.064

BATTERY SIZING CALCULATION

Lowest Expected Electrolyte Temp: 65.00 Cell Mfg: GNB (IEEE-450,1987)
Minimum Battery Voltage.....: 217.10 Cell Type: NCX (MODELS NCX-17, NCX-21, AND NCX-27)
Minimum Cell Voltage.....: 1.809 No. Cells: 120 No. Pos. Plates: 10

Section	(1) Period	(2) Load (amperes)	(3) Change in Load (amperes)	(4) Duration of Period (minutes)	(5) Time to End of Section (minutes)	(6) Capacity at T min. rate Amps/Pos (RT)	(7) Req'd Section Size (3) / (6) Positive Plates

Maximum section size = Uncorrected size (US) = 7.277 from period 1

US	X TEMP. CORR.	X DESIGN MARGIN	X AGING FACTOR	= MINIMUM REQUIRED SIZE
7.277	1.08	1.00	1.25	9.825

Selected battery pos plates = 10 | Battery capacity remaining = 1.8%

BATTERY SIZING CALCULATION

RT curve points used to size battery:

TIME (MIN)	AMPS PER POS PLATE
0	106.66
1	106.18
15	90.88
30	81.24
60	63.92
90	52.01
120	46.44
180	35.62
240	29.47
300	25.40
480	17.59

Unit 2 125 VDC Battery

ELMS-DC File - Intercells

Q2D5YLS.I02

SARGENT & LUNDY, ENGINEERS CHICAGO, ILLINOIS ELMS-DC VERSION 2.00 PROJECT NUMBER: 08646 PAGE: 1
UTILITY: Commonwealth Edison Company STATION: QUAD CITIES UNIT: 2 USER: DWW
DATA FILE: c:\elmsdc\q2d5yls.i02 DATE: 10-22-08
Unit 2 125 VDC Battery Intercell Maximum Resistance Limits

BATTERY SIZING CALCULATION

Lowest Expected Electrolyte Temp: 65.00 Cell Mfg: GNB (IEEE-450,1987)
Minimum Battery Voltage.....: 106.00 Cell Type: NCX (MODELS NCX-17, NCX-21, AND NCX-27)
Minimum Cell Voltage.....: 1.828 No. Cells: 58 No. Pos. Plates: 10

Section	(1) Period	(2) Load (amperes)	(3) Change in Load (amperes)	(4) Duration of Period (minutes)	(5) Time to End of Section (minutes)	(6) Capacity at T min. rate Amps/Pos (RT)	(7) Req'd Section Size (3) / (6) Positive Plates
1	1	A1 = 675.385	A1 -0 = 675.385	M1 = 1	T = M1 = 1	91.626	7.371
							Total = 7.371
2	1	A1 = 675.385	A1 -0 = 675.385	M1 = 1	T = M1 +..+M2 = 2	91.149	7.410
	2	A2 = 256.991	A2 -A1 = -418.394	M2 = 1	T = M2 = 1	91.626	-4.566
							Total = 2.843
3	1	A1 = 675.385	A1 -0 = 675.385	M1 = 1	T = M1 +..+M3 = 5	89.717	7.528
	2	A2 = 256.991	A2 -A1 = -418.394	M2 = 1	T = M2 +..+M3 = 4	90.194	-4.639
	3	A3 = 352.041	A3 -A2 = 95.050	M3 = 3	T = M3 = 3	90.672	1.048
							Total = 3.937
4	1	A1 = 675.385	A1 -0 = 675.385	M1 = 1	T = M1 +..+M4 = 10	87.330	7.734
	2	A2 = 256.991	A2 -A1 = -418.394	M2 = 1	T = M2 +..+M4 = 9	87.807	-4.765
	3	A3 = 352.041	A3 -A2 = 95.050	M3 = 3	T = M3 +..+M4 = 8	88.285	1.077
	4	A4 = 256.991	A4 -A3 = -95.050	M4 = 5	T = M4 = 5	89.717	-1.059
							Total = 2.986
5	1	A1 = 675.385	A1 -0 = 675.385	M1 = 1	T = M1 +..+M5 = 11	86.852	7.776
	2	A2 = 256.991	A2 -A1 = -418.394	M2 = 1	T = M2 +..+M5 = 10	87.330	-4.791
	3	A3 = 352.041	A3 -A2 = 95.050	M3 = 3	T = M3 +..+M5 = 9	87.807	1.082
	4	A4 = 256.991	A4 -A3 = -95.050	M4 = 5	T = M4 +..+M5 = 6	89.239	-1.065
	5	A5 = 302.008	A5 -A4 = 45.017	M5 = 1	T = M5 = 1	91.626	.491
							Total = 3.494
6	1	A1 = 675.385	A1 -0 = 675.385	M1 = 1	T = M1 +..+M6 = 12	86.375	7.819
	2	A2 = 256.991	A2 -A1 = 418.394	M2 = 1	T = M2 +..+M6 = 11	86.852	-4.817
	3	A3 = 352.041	A3 -A2 = 95.050	M3 = 3	T = M3 +..+M6 = 10	87.330	1.088
	4	A4 = 256.991	A4 -A3 = -95.050	M4 = 5	T = M4 +..+M6 = 7	88.762	1.071
	5	A5 = 302.008	A5 -A4 = 45.017	M5 = 1	T = M5 +..+M6 = 2	91.149	.494
	6	A6 = 271.529	A6 -A5 = 30.479	M6 = 1	T = M6 = 1	91.626	.333
							Total = 3.181

BATTERY SIZING CALCULATION

Lowest Expected Electrolyte Temp: 65.00 Cell Mfg: GNB (IEEE-450,1987)
Minimum Battery Voltage.....: 106.00 Cell Type: NCX (MODELS NCX-17, NCX-21, AND NCX-27)
Minimum Cell Voltage.....: 1.828 No. Cells: 58 No. Pos. Plates: 10

Section	(1) Period	(2) Load (amperes)	(3) Change in Load (amperes)	(4) Duration of Period (minutes)	(5) Time to End of Section (minutes)	(6) Capacity at T min. rate Amps/Pos (RT)	(7) Req'd Section Size (3) / (6) Positive Plates
7	1	A1 = 675.385	A1 -0 = 675.385	M1 = 1	T = M1 +..+M7 = 15	84.943	7.951
	2	A2 = 256.991	A2 -A1 = -418.394	M2 = 1	T = M2 +..+M7 = 14	85.420	-4.898
	3	A3 = 352.041	A3 -A2 = 95.050	M3 = 3	T = M3 +..+M7 = 13	85.898	1.107
	4	A4 = 256.991	A4 -A3 = -95.050	M4 = 5	T = M4 +..+M7 = 10	87.330	-1.088
	5	A5 = 302.008	A5 -A4 = 45.017	M5 = 1	T = M5 +..+M7 = 5	89.717	.502
	6	A6 = 271.529	A6 -A5 = -30.479	M6 = 1	T = M6 +..+M7 = 4	90.194	-.338
	7	A7 = 256.375	A7 -A6 = -15.154	M7 = 3	T = M7 = 3	90.672	-.167
							Total = 3.068
8	1	A1 = 675.385	A1 -0 = 675.385	M1 = 1	T = M1 +..+M8 = 30	72.625	9.300
	2	A2 = 256.991	A2 -A1 = -418.394	M2 = 1	T = M2 +..+M8 = 29	73.446	-5.697
	3	A3 = 352.041	A3 -A2 = 95.050	M3 = 3	T = M3 +..+M8 = 28	74.268	1.280
	4	A4 = 256.991	A4 -A3 = -95.050	M4 = 5	T = M4 +..+M8 = 25	76.731	-1.239
	5	A5 = 302.008	A5 -A4 = 45.017	M5 = 1	T = M5 +..+M8 = 20	80.837	.557
	6	A6 = 271.529	A6 -A5 = -30.479	M6 = 1	T = M6 +..+M8 = 19	81.658	-.373
	7	A7 = 256.375	A7 -A6 = -15.154	M7 = 3	T = M7 +..+M8 = 18	82.479	-.184
	8	A8 = 244.935	A8 -A7 = -11.440	M8 = 15	T = M8 = 15	84.943	-.135
							Total = 3.509
9	1	A1 = 675.385	A1 0 = 675.385	M1 = 1	T = M1 +..+M9 = 60	59.353	11.379
	2	A2 = 256.991	A2 -A1 = -418.394	M2 = 1	T = M2 +..+M9 = 59	59.796	-6.997
	3	A3 = 352.041	A3 -A2 = 95.050	M3 = 3	T = M3 +..+M9 = 58	60.238	1.578
	4	A4 = 256.991	A4 -A3 = -95.050	M4 = 5	T = M4 +..+M9 = 55	61.565	-1.544
	5	A5 = 302.008	A5 -A4 = 45.017	M5 = 1	T = M5 +..+M9 = 50	63.777	.706
	6	A6 = 271.529	A6 -A5 = -30.479	M6 = 1	T = M6 +..+M9 = 49	64.220	-.475
	7	A7 = 256.375	A7 -A6 = -15.154	M7 = 3	T = M7 +..+M9 = 48	64.662	-.234
	8	A8 = 244.935	A8 -A7 = -11.440	M8 = 15	T = M8 +..+M9 = 45	65.989	-.173
	9	A9 = 148.245	A9 -A8 = -96.690	M9 = 30	T = M9 = 30	72.625	-1.331
							Total = 2.908

SARGENT & LUNDY, ENGINEERS CHICAGO, ILLINOIS ELMS-DC VERSION 2.00 PROJECT NUMBER: 08646 PAGE: 3
UTILITY: Commonwealth Edison Company STATION: QUAD CITIES UNIT: 2 USER: DWW
DATA FILE: c:\elmsdc\q2d5yls.i02 DATE: 10-22-08
Unit 2 125 VDC Battery Intercell Maximum Resistance Limits

BATTERY SIZING CALCULATION

Lowest Expected Electrolyte Temp: 65.00 Cell Mfg: GNB (IEEE-450,1987)
Minimum Battery Voltage.....: 106.00 Cell Type: NCX (MODELS NCX-17, NCX-21, AND NCX-27)
Minimum Cell Voltage.....: 1.828 No. Cells: 58 No. Pos. Plates: 10

Section	(1) Period	(2) Load (amperes)	(3) Change in Load (amperes)	(4) Duration of Period (minutes)	(5) Time to End of Section (minutes)	(6) Capacity at T min. rate Amps/Pos (RT)	(7) Req'd Section Size (3) / (6) Positive Plates
10	1	A1 = 675.385	A1 -0 = 675.385	M1 = 1	T = M1 +..+M10 = 240	28.563	23.645
	2	A2 = 256.991	A2 -A1 = -418.394	M2 = 1	T = M2 +..+M10 = 239	28.661	-14.598
	3	A3 = 352.041	A3 -A2 = 95.050	M3 = 3	T = M3 +..+M10 = 238	28.759	3.305
	4	A4 = 256.991	A4 -A3 = -95.050	M4 = 5	T = M4 +..+M10 = 235	29.052	-3.272
	5	A5 = 302.008	A5 -A4 = 45.017	M5 = 1	T = M5 +..+M10 = 230	29.540	1.524
	6	A6 = 271.529	A6 -A5 = -30.479	M6 = 1	T = M6 +..+M10 = 229	29.638	-1.028
	7	A7 = 256.375	A7 -A6 = -15.154	M7 = 3	T = M7 +..+M10 = 228	29.735	-.510
	8	A8 = 244.935	A8 -A7 = -11.440	M8 = 15	T = M8 +..+M10 = 225	30.028	-.381
	9	A9 = 148.245	A9 -A8 = -96.690	M9 = 30	T = M9 +..+M10 = 210	31.493	-3.070
	10	A10= 146.862	A10-A9 = -1.383	M10 = 180	T = M10 = 180	34.423	-.040
							Total = 5.575

Maximum section size = Uncorrected size (US) = 7.371 from period 1

US	X TEMP. CORR.	X DESIGN MARGIN	X AGING FACTOR	= MINIMUM REQUIRED SIZE
7.371	1.08	1.00	1.25	9.951

Selected battery pos plates = 10 | Battery capacity remaining = .5%

BATTERY SIZING CALCULATION

RT curve points used to size battery:

TIME (MIN)	AMPS PER POS PLATE
0	92.11
1	91.63
15	84.94
30	72.63
60	59.35
90	48.77
120	43.90
180	34.42
240	28.56
300	24.57
480	17.28

Unit 2 250 VDC Battery

ELMS-DC File - Intercells

Q2D6250V.I02

SARGENT & LUNDY, ENGINEERS CHICAGO, ILLINOIS ELMS-DC VERSION 2.00 PROJECT NUMBER: 1013202 PAGE: 1
UTILITY: Commonwealth Edison Company STATION: QUAD CITIES UNIT: 2 USER: DWW
DATA FILE: c:\elmsdc\q2d6250v.i02 DATE: 10-22-08
Unit 2 250 VDC Battery Intercell Maximum Resistance Limits

BATTERY SIZING CALCULATION

Lowest Expected Electrolyte Temp: 65.00 Cell Mfg: GNB (IEEE-450,1987)
Minimum Battery Voltage.....: 217.10 Cell Type: NCX (MODELS NCX-17, NCX-21, AND NCX-27)
Minimum Cell Voltage.....: 1.809 No. Cells: 120 No. Pos. Plates: 10

Section	(1) Period	(2) Load (amperes)	(3) Change in Load (amperes)	(4) Duration of Period (minutes)	(5) Time to End of Section (minutes)	(6) Capacity at T min. rate Amps/Pos (RT)	(7) Req'd Section Size (3) / (6) Positive Plates
1	1	A1 = 779.689	A1 -0 = 779.689	M1 = 1	T = M1 = 1	106.177	7.343
							Total = 7.343
2	1	A1 = 779.689	A1 -0 = 779.689	M1 = 1	T = M1 +..+M2 = 2	105.084	7.420
	2	A2 = 181.669	A2 -A1 = -598.020	M2 = 1	T = M2 = 1	106.177	-5.632
							Total = 1.787
3	1	A1 = 779.689	A1 -0 = 779.689	M1 = 1	T = M1 +..+M3 = 7	99.621	7.827
	2	A2 = 181.669	A2 -A1 = -598.020	M2 = 1	T = M2 +..+M3 = 6	100.714	-5.938
	3	A3 = 140.169	A3 -A2 = -41.500	M3 = 5	T = M3 = 5	101.806	-.408
							Total = 1.481
4	1	A1 = 779.689	A1 -0 = 779.689	M1 = 1	T = M1 +..+M4 = 9	97.435	8.002
	2	A2 = 181.669	A2 -A1 = -598.020	M2 = 1	T = M2 +..+M4 = 8	98.528	-6.070
	3	A3 = 140.169	A3 -A2 = -41.500	M3 = 5	T = M3 +..+M4 = 7	99.621	-.417
	4	A4 = 270.119	A4 -A3 = 129.950	M4 = 2	T = M4 = 2	105.084	1.237
							Total = 2.753
5	1	A1 = 779.689	A1 -0 = 779.689	M1 = 1	T = M1 +..+M5 = 30	81.243	9.597
	2	A2 = 181.669	A2 -A1 = -598.020	M2 = 1	T = M2 +..+M5 = 29	81.886	-7.303
	3	A3 = 140.169	A3 -A2 = -41.500	M3 = 5	T = M3 +..+M5 = 28	82.528	-.503
	4	A4 = 270.119	A4 -A3 = 129.950	M4 = 2	T = M4 +..+M5 = 23	85.740	1.516
	5	A5 = 164.349	A5 -A4 = -105.770	M5 = 21	T = M5 = 21	87.025	-1.215
							Total = 2.091
6	1	A1 = 779.689	A1 -0 = 779.689	M1 = 1	T = M1 +..+M6 = 120	46.445	16.787
	2	A2 = 181.669	A2 -A1 = -598.020	M2 = 1	T = M2 +..+M6 = 119	46.630	-12.825
	3	A3 = 140.169	A3 A2 = -41.500	M3 = 5	T = M3 +..+M6 = 118	46.216	-.886
	4	A4 = 270.119	A4 A3 = 129.950	M4 = 2	T = M4 +..+M6 = 113	47.744	2.722
	5	A5 = 164.349	A5 A4 = -105.770	M5 = 21	T = M5 +..+M6 = 111	48.1[illegible]	-2.198
	6	A6 = 160.349	A6 A5 = -4.000	M6 = 90	T = M6 = 90	52.[illegible]	-.077
							Total = 3.523

BATTERY SIZING CALCULATION

Lowest Expected Electrolyte Temp: 65.00 Cell Mfg: GNB (IEEE-450,1987)
Minimum Battery Voltage.....: 217.10 Cell Type: NCX (MODELS NCX-17, NCX-21, AND NCX-27)
Minimum Cell Voltage.....: 1.809 No. Cells: 120 No. Pos. Plates: 10

Section	(1) Period	(2) Load (amperes)	(3) Change in Load (amperes)	(4) Duration of Period (minutes)	(5) Time to End of Section (minutes)	(6) Capacity at T min. rate Amps/Pos (RT)	(7) Req'd Section Size (3) / (6) Positive Plates
7	1	A1 = 779.689	A1 -0 = 779.689	M1 = 1	T = M1 +..+M7 = 121	46.264	16.853
	2	A2 = 181.669	A2 -A1 = -598.020	M2 = 1	T = M2 +..+M7 = 120	46.445	-12.876
	3	A3 = 140.169	A3 -A2 = -41.500	M3 = 5	T = M3 +..+M7 = 119	46.630	-.890
	4	A4 = 270.119	A4 -A3 = 129.950	M4 = 2	T = M4 +..+M7 = 114	47.558	2.732
	5	A5 = 164.349	A5 -A4 = -105.770	M5 = 21	T = M5 +..+M7 = 112	47.930	-2.207
	6	A6 = 160.349	A6 -A5 = -4.000	M6 = 90	T = M6 +..+M7 = 91	51.827	-.077
	7	A7 = 191.779	A7 -A6 = 31.430	M7 = 1	T = M7 = 1	106.177	.296
							Total = 3.831
8	1	A1 = 779.689	A1 -0 = 779.689	M1 = 1	T = M1 +..+M8 = 122	46.084	16.919
	2	A2 = 181.669	A2 -A1 = -598.020	M2 = 1	T = M2 +..+M8 = 121	46.264	-12.926
	3	A3 = 140.169	A3 -A2 = -41.500	M3 = 5	T = M3 +..+M8 = 120	46.445	-.894
	4	A4 = 270.119	A4 -A3 = 129.950	M4 = 2	T = M4 +..+M8 = 115	47.373	2.743
	5	A5 = 164.349	A5 -A4 = -105.770	M5 = 21	T = M5 +..+M8 = 113	47.744	-2.215
	6	A6 = 160.349	A6 -A5 = -4.000	M6 = 90	T = M6 +..+M8 = 92	51.642	-.077
	7	A7 = 191.779	A7 -A6 = 31.430	M7 = 1	T = M7 +..+M8 = 2	105.084	.299
	8	A8 = 147.969	A8 -A7 = -43.810	M8 = 1	T = M8 = 1	106.177	-.413
							Total = 3.436
9	1	A1 = 779.689	A1 -0 = 779.689	M1 = 1	T = M1 +..+M9 = 123	45.904	16.985
	2	A2 = 181.669	A2 -A1 = -598.020	M2 = 1	T = M2 +..+M9 = 122	46.084	-12.977
	3	A3 = 140.169	A3 -A2 = -41.500	M3 = 5	T = M3 +..+M9 = 121	46.264	-.897
	4	A4 = 270.119	A4 -A3 = 129.950	M4 = 2	T = M4 +..+M9 = 116	47.187	2.754
	5	A5 = 164.349	A5 -A4 = -105.770	M5 = 21	T = M5 +..+M9 = 114	47.558	-2.224
	6	A6 = 160.349	A6 -A5 = -4.000	M6 = 90	T = M6 +..+M9 = 93	51.456	-.078
	7	A7 = 191.779	A7 -A6 = 31.430	M7 = 1	T = M7 +..+M9 = 3	103.992	.302
	8	A8 = 147.969	A8 -A7 = -43.810	M8 = 1	T = M8 +..+M9 = 2	105.084	-.417
	9	A9 = 166.349	A9 -A8 = 18.380	M9 = 1	T = M9 = 1	106.177	.173
							Total = 3.622

BATTERY SIZING CALCULATION

Lowest Expected Electrolyte Temp: 65.00 Cell Mfg: GNB (IEEE-450,1987)
Minimum Battery Voltage.....: 217.10 Cell Type: NCX (MODELS NCX-17, NCX-21, AND NCX-27)
Minimum Cell Voltage.....: 1.809 No. Cells: 120 No. Pos. Plates: 10

Section	(1) Period	(2) Load (amperes)	(3) Change in Load (amperes)	(4) Duration of Period (minutes)	(5) Time to End of Section (minutes)	(6) Capacity at T min. rate Amps/Pos (RT)	(7) Req'd Section Size (3) / (6) Positive Plates
10	1	A1 = 779.689	A1 -0 = 779.689	M1 = 1	T = M1 +..+M10 = 124	45.723	17.052
	2	A2 = 181.669	A2 -A1 = -598.020	M2 = 1	T = M2 +..+M10 = 123	45.904	-13.028
	3	A3 = 140.169	A3 -A2 = -41.500	M3 = 5	T = M3 +..+M10 = 122	46.084	-.901
	4	A4 = 270.119	A4 -A3 = 129.950	M4 = 2	T = M4 +..+M10 = 117	47.002	2.765
	5	A5 = 164.349	A5 -A4 = -105.770	M5 = 21	T = M5 +..+M10 = 115	47.373	-2.233
	6	A6 = 160.349	A6 -A5 = -4.000	M6 = 90	T = M6 +..+M10 = 94	51.271	-.078
	7	A7 = 191.779	A7 -A6 = 31.430	M7 = 1	T = M7 +..+M10 = 4	102.899	.305
	8	A8 = 147.969	A8 -A7 = -43.810	M8 = 1	T = M8 +..+M10 = 3	103.992	-.421
	9	A9 = 166.349	A9 -A8 = 18.380	M9 = 1	T = M9 +..+M10 = 2	105.084	.175
	10	A10= 139.969	A10-A9 = -26.380	M10 = 1	T = M10 = 1	106.177	-.248
							Total = 3.389
11	1	A1 = 779.689	A1 -0 = 779.689	M1 = 1	T = M1 +..+M11 = 239	29.571	26.366
	2	A2 = 181.669	A2 -A1 = -598.020	M2 = 1	T = M2 +..+M11 = 238	29.674	-20.153
	3	A3 = 140.169	A3 -A2 = -41.500	M3 = 5	T = M3 +..+M11 = 237	29.776	-1.394
	4	A4 = 270.119	A4 -A3 = 129.950	M4 = 2	T = M4 +..+M11 = 232	30.289	4.290
	5	A5 = 164.349	A5 -A4 = -105.770	M5 = 21	T = M5 +..+M11 = 230	30.494	-3.469
	6	A6 = 160.349	A6 -A5 = -4.000	M6 = 90	T = M6 +..+M11 = 209	32.648	-.123
	7	A7 = 191.779	A7 -A6 = 31.430	M7 = 1	T = M7 +..+M11 = 119	46.630	.674
	8	A8 = 147.969	A8 -A7 = -43.810	M8 = 1	T = M8 +..+M11 = 118	46.816	-.936
	9	A9 = 166.349	A9 -A8 = 18.380	M9 = 1	T = M9 +..+M11 = 117	47.002	.391
	10	A10= 139.969	A10-A9 = -26.380	M10 = 1	T = M10+..+M11 = 116	47.187	-.559
	11	A11= 131.969	A11-A10 = -8.000	M11 = 115	T = M11 = 115	47.373	-.169
							Total = 4.920
12	1	A1 = 779.689	A1 -0 = 779.689	M1 = 1	T = M1 +..+M12 = 240	29.469	26.458
	2	A2 = 181.669	A2 -A1 = -598.020	M2 = 1	T = M2 +..+M12 = 239	29.571	-20.223
	3	A3 = 140.169	A3 -A2 = -41.500	M3 = 5	T = M3 +..+M12 = 238	29.674	-1.399
	4	A4 = 270.119	A4 -A3 = 129.950	M4 = 2	T = M4 +..+M12 = 233	30.187	4.305
	5	A5 = 164.349	A5 -A4 = -105.770	M5 = 21	T = M5 +..+M12 = 231	30.392	-3.480
	6	A6 = 160.349	A6 -A5 = -4.000	M6 = 90	T = M6 +..+M12 = 210	32.545	-.123
	7	A7 = 191.779	A7 -A6 = 31.430	M7 = 1	T = M7 +..+M12 = 120	46.445	.677
	8	A8 = 147.969	A8 -A7 = -43.810	M8 = 1	T = M8 +..+M12 = 119	46.630	-.940
	9	A9 = 166.349	A9 -A8 = 18.380	M9 = 1	T = M9 +..+M12 = 118	46.816	.393
	10	A10= 139.969	A10-A9 = -26.380	M10 = 1	T = M10+..+M12 = 117	47.002	-.561
	11	A11= 131.969	A11-A10 = -8.000	M11 = 115	T = M11+..+M12 = 116	47.187	-.170
	12	A12= 356.739	A12-A11 = 224.770	M12 = 1	T = M12 = 1	106.177	2.117
							Total = 7.054

BATTERY SIZING CALCULATION

Lowest Expected Electrolyte Temp: 65.00 Cell Mfg: GNB (IEEE-450,1987)
Minimum Battery Voltage.....: 217.10 Cell Type: NCX (MODELS NCX-17, NCX-21, AND NCX-27)
Minimum Cell Voltage.....: 1.809 No. Cells: 120 No. Pos. Plates: 10

Section	(1) Period	(2) Load (amperes)	(3) Change in Load (amperes)	(4) Duration of Period (minutes)	(5) Time to End of Section (minutes)	(6) Capacity at T min. rate Amps/Pos (RT)	(7) Req'd Section Size (3) / (6) Positive Plates

Maximum section size = Uncorrected size (US) = 7.343 from period 1

US	X TEMP. CORR.	X DESIGN MARGIN	X AGING FACTOR	= MINIMUM REQUIRED SIZE
7.343	1.08	1.00	1.25	9.913

Selected battery pos plates = 10 | Battery capacity remaining = .9%

BATTERY SIZING CALCULATION

RT curve points used to size battery:

TIME (MIN)	AMPS PER POS PLATE
0	106.66
1	106.18
15	90.88
30	81.24
60	63.92
90	52.01
120	46.44
180	35.62
240	29.47
300	25.40
480	17.59

Record of telephone conversation

FAXED

APR 4 1998

Date: April 2, 1998 Time 10:30 am

Person Called: Archie Bell, Nuclear Logistics, Inc 817-284-0077

Person Calling: Bob Beavers, ComEd 630-663-7358

Subject:GNB NCX/NCN Cell characteristics

I called Mr. Bell to verify various vendor literature and and determine the characteristics for intercell connectors.

1. The GNB manual on page 3 item 7.4 Ventilation states that hydogen should be limited to <1% versus 2% listed in IEEE-484. Is there specific differences that require the lower concentration?

To the best of his knowledge, 2% is acceptable. 4+% is the flammable limit of hydrogen. There are no differences in the cells over the last 20+ years that would require a lower hyrogen limit.

2. What is the basis of the intercell connection resistance used in the published characteristics?

All intercell connection resistance is based on a 20 millivolt drop based on the 1 hour discharge rate to 1.75 vpc. This applies to all types of connections. Any additional resistance needs to be addressed by the designer.

3. The NCX-27 has 2 posts per polarity. How can the 20mv drop measured?

The suggestion is to measure the outside posts (A to D in IEEE-450) and divide by 2. IEEE 450 recommends that you measure A-C and B-D. This is acceptable as this method is more sensitive to individual post connection resistance changes. Following IEEE-450, these connections would be remade when they increase 20% beyond baseline values.

4. Do cell connections resistances change over time?

Connection resistances will change over time due to cold flow of lead, dryout of the NO-OX-ID grease, and post seal leakage. However, if the connections are cleaned as recommended per IEEE-450, then a value close to the original value can be obtained.

Concurred by Archie Bell

Archie Bell
NLI
Vice President

ATTACHMENT 1
Design Analysis Major Revision Cover Sheet
Page 1

Design Analysis (Major Revision)		**Last Page No.** [6] S12	
Analysis No.: [1]	7318-32-19-1	**Revision:** [2]	40
Title: [3]	Calculation for Inputting 125 Vdc Load Profiles into ELMS-DC for Units 1 and 2		
EC/ECR No.: [4]	EC 364141	**Revision:** [5]	000

		Component(s): [14]	
Station(s): [7]	Quad Cities		
Unit No.: [8]	1 and 2	1-8300 (B04)	
Discipline: [9]	E	2-8300 (B04)	
Descrip. Code/Keyword: [10]	E15		
Safety/QA Class: [11]	Safety Related		
System Code: [12]	DC		
Structure: [13]	N/A		

CONTROLLED DOCUMENT REFERENCES [15]

Document No.:	From/To	Document No.:	From/To
9149-20-19-1	To		
QDC-8300-E-1587	To		

Is this Design Analysis Safeguards Information? [16] **Yes** ☐ **No** ☒ If yes, see SY-AA-101-106

Does this Design Analysis contain Unverified Assumptions? [17] **Yes** ☐ **No** ☒ If yes, ATI/AR#:

This Design Analysis SUPERCEDES: [18] **N/A** **in its entirety.**

Description of Revision (list affected pages for partials): [19]

This major revision incorporates changes made by minor revision 39A, switchgear load table discrepancies identified by IR 771108, load changes per EC 364141, and margin recovery by a more detailed analysis of the ATS/ATWS Abacus inverters.

Preparer: [20] DAVID WOLF (Print Name) [signature] (Sign Name) 6/5/08 (Date)

Method of Review: [21] **Detailed Review** ☒ **Alternate Calculations (attached)** ☐ **Testing** ☐

Reviewer: [22] Randy C. Buttke (Print Name) [signature] (Sign Name) 6/5/08 (Date)

Review Notes: [23] Independent review ☒ Peer review ☐

(For External Analyses Only)

External Approver: [24] N/A (Print Name) N/A (Sign Name) N/A (Date)

Exelon Reviewer: [25] N/A (Print Name) N/A (Sign Name) N/A (Date)

Independent 3rd Party Review Reqd? [26] **Yes** ☐ **No** ☒

Exelon Approver: [27] Joseph P. Taff (Print Name) [signature] (Sign Name) 6/6/08 (Date)

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F – SBO Load, Battery Sizing, and Voltage Profiles	F1 – F16		
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H through Q – Future	H1 – Q1		
R – References	R1 – R324		R40
S – References – ATS / ATWS Panel Analysis	S1 – S12		R40

References:

1) IEEE-485-1983 IEEE Recommended Practice for Sizing Large Lead Storage Batteries for Generating ~~Stations~~ & Substations

2) MES.-3.10 (2-23-83) Control & Instrumentation Standard Service Designation Abbreviations

3) STD-EC-109 (2-6-81) Definition of Abbreviations

4) ESC-291 (5-28-85) Electrical Engineering Reference DC Auxiliary Power Systems

5) Program: ELMS-DC VER. 1.20 03.7.010-1.20
Copyright 1986, Sargent & Lundy
Program No. ELM037010120 IR9

6) ELMS-DC User's Manual Version 1.1

7) Calculation: 7056-00-19-1 Rev. 2; LOAD ESTIMATION FOR 125VDC BATTERY

8) Unit 1 Battery: Spec.: R-4409
Dwg #: 400320C rev. A

Unit 2 Battery: P.O. #: 296068
Dwg #: 058660B

9) Quad Cities Unit-1, 125 VDC battery performance test dated 10-31-87, results, 527A at 48 minutes, 7 seconds with a 71°F electrolyte temperature.

10) GNB Published Data for NCX-21 cells section 2-20

11) Quad Cities Station Load Shedding Procedures QOA-6900-7 REV 2.

12) Load data [illegible]

For HPCI MGU LSS control relay load.

13) Load data forms provided by Impell for additional load to annunciator load.

14) "Guidelines and technical bases for Numarc Initiative addressing Station Blackout at Light water Reactors", Numarc 87-00, May 1988

15) "Quad Cities Station Units 1 & 2 Station Blackout Analysis", Engineering Planning And Management, Inc, April 5, 1989

16) Telecon dated 10/20/89 between G. Matherwson of CECO & D. Kendall of S&L

17) DIT NO. QC-NSLD-0030-0

18) CECO calculation # RSA-Q-89-01, Rev. 1, Quad Cities Station Blackout Coping Analysis.

19) G.E. Control calalog Issued 1961 for heavy-duty Industrial solenoids

20) Environmental Qualification Report for Dresden Units 2 & 3, Dresser Electromatic Relief Valve solenoid Actuators 2(3)-203-3B through 3E (Shows type of solenoid actuator used is SE type CR9503-213C) project No. 6896-00, CQD-029309

21) Notes of Meeting - December 4, 1989 Held at Edison Building - Room 900, Station Blackout for Electromatic Relief Valve.

22) Regulatory Guide 1.155, Station Blackout, August 1988 | R11

Form GQ-3.08.1 Rev. 2 SL-F647 10-85 KPS

REFERENCES (Cont'd)

23.) ASEA BROWN BOVERI INSTRUCTION BOOK #IB 7.4.1.7-7, ISSUE D
#IB 7.4.1.7-5, ISSUE B

24.) AGASTAT TIMING RELAYS, E7000 SERIES CATALOG, PAGE 4

25.) G.E. CATALOG GEH-2024AA, TABLE III

26.) MOD. # M04-1-89-165

27.) LETTER DATED 7-27-90 TO H. MASSIN FROM S. OSZEWSKI (p.R24 OF THIS CALC.)

28.) LETTER DATED 8-16-90 TO H. MASSIN FROM S. OSZEWSKI (p.R32 OF THIS CALC.)

29.) IMPELL CALCULATION #0597-050-E-014

30.) IMPELL CALCULATION #0597-050-E-016

31.) LETTER DATED 9-14-90 TO S. SAHA FROM R.S. DOEBLER (p.R37 OF THIS CALC.)

32.) GE INSTRUCTIONS: CAT No. 12 HFA 151 A2H
CAT No. 12 HGA 111 J2
CAT No. 7012 PD

33.) DCR #4-90-088.

34.) AVCo Drawing, Part Identifier B6930-015

35.) MOD # M04-2-84-031; DC load data forms transmitted by CYGNA letter dated 1-21-91, from R.S. Doebler to S.K. Saha. R17

REFERENCES (CONT'D)

36.) MOD # M4-(1,2,1/2)-83-009

37.) PHONE MEMO OF CONVERSATION BETWEEN S.K. SAHA OF S&L AND RICHARD SKOGFELDT OF PANALARM DATED 9-13-90 REGARDING CURRENT REQUIREMENTS FOR NEW ANNUNCIATOR (12 to 24 WINDOW CHANGE) - PR56 Hi's calc.

38.) MINOR PLANT CHANGE P04-K(2)-91-105; REPLACEMENT OF U.V. RELAYS AT SWGR 13-1, 14-1, 23-1, 24-1

39.) MOD # M04-0-91-020; ADDITION OF BREAKER LOADS FOR DIV. I CROSSTIE TO UNIT 1&2 BATTERIES; LOAD REQUEST #s, 0192067, 0192068, 0192069, 0292068, 0292069, 0292010.

40.) MOD # M04-2-92-006H; DG 1/2 AUX LOAD TRANSFER INTERLOCK RELAY AND IND. LIGHT ADDITIONS TO UNIT 1-2 BATTERY LOADING; LOAD REQ. 0192010 - 0292011.

41.) DCR # 4-92-157

42. Telephone memorandum between K. Uhler of Commonwealth Edison Co. and S. Saha of Sargent and Lundy dated December 9, 1992 regarding changing the aging factor from 1.25 to 1.00.

43. Bechtel Corporation PAR B130-00191, Revision 0 received from Mr. Brian Edmark regarding HPCI & RCIC Failure relay addition to the 125 Vdc System.

44. Bechtel Corporation PAR B130-00199, Revision 0 originated from S.D. Medanic regarding the addition of one circuit breaker each to 4KV Switchgear 13-1 & 14-1. R25

REFERENCES (CONT'D)

45. Bechtel Corporation PAR B130-00232, Revision 0 originated from B. Edmark regarding the addition of a HPCI Failure Relay and a RCIC Failure Relay.

46. Bechtel Corporation PAR Nos. B130-00233, Revision 0 and B130-00234, Revision 0 originated from S.D. Medanic regarding the replacement of all circuit breakers for 4KV Switchgears 13 & 14.

47. Bechtel Corporation PAR Nos. B130-00235, Revision 0 and B130-00236, Revision 0 originated from S.D. Medanic regarding the replacement of all circuit breakers for 4KV Switchgears 23 & 24.

48. Fax from M.C. Warpehowski of S&L at Quad Cities to C. Tobias of S&L dated 6-25-93 regarding the replacement of Solenoid Operated Valves 1-2301-32 and 2-2301-32 (SESR #1598)

49. Memo from M.A. Zeidman of S&L to T.R. Eisenbart of S&L dated 6-25-93 regarding the replacement of a GE HEA type relay on the Generator Backup Relay Panel.

REFERENCES (CONT'D)

50. 4KV Switchgear analysis for Switchgears 13, 14, 23, & 24, and battery sizing calculations for computer files Q1D5YLS.S32, Q1D5YSBO.S32, Q2D5YLS.S35 and Q2D5YSBO.S35. Pages R99-R132. Included with the battery sizing calculations are load data showing the revised loads.

51. Memo from S.V. Tutich to S.K. Saha dated May 25, 1993 regarding the 125Vdc load additions for 4KV Switchgears 13-1 + 14-1 (reference also PAR B130-00199, Rev. 0).

52. MEMO FROM M.C. WARPEHOSKI TO S.K. SAHA DATED JULY 13, 1993, REGARDING INCORPORATION OF DCR # 4-92-298.

53. BECHTEL CORPORATION PAR B130-00262, REV. 0, ORIGINATED FROM D.L. EGAN REGARDING THE ADDITION OF ONE CIRCUIT BREAKER EACH TO 4KV SWITCHGEARS 23-1 AND 24-1 PER MODIFICATION M04-0-91-019, PARTIALS F & G

54. INTEROFFICE MEMORANDUM DATED OCT. 8, 1993 FROM M.A. ZEIDMAN TO S.K. SAHA REGARDING 125VDC CALCULATION REVISION FOR RESERVE AUX. TRANSFORMER REPLACEMENT EXEMPT CHANGE E04-1-93-230.

55. Interoffice memorandum from M.C. Warpehoski to D.A. Schroeder dated December 1, 1993 regarding the removal of the 345KV Switchyard 125Vdc loads from the Unit 1 + 2 125Vdc batteries. R29

REFERENCES (Cont.):

56.) DCR 4-93-009

57.) DCR 4-93-010

58.) Telephone Memorandum between S.V. Tutich of Sargent & Lundy and S. Peach of Behtel dated December 13, 1993 regarding the numbering of the SBO Diesel breakers and the add-on breakers.

59.) Engineering Change Notice 04-01043E regarding Exempt Change E04-1-93-335

60.) ELMS-DC Load Data Forms for the type SA-1 relay 187DG1/2, type HFA relay 159SD1/2X3, and IAC relays

61.) Impell PAR E101-00149, Revision 0

62.) Impell PAR E101-00150, Revision 0

63.) Impell PAR E101-00155, Revision 0

64.) Impell PAR E101-00156, Revision 0

65.) DCR 4-92-329

66.) DCR 4-92-149

67.) DCR 4-92-330

68.) DCR 4-92-071

69.) Interoffice Memorandum from S.D.Bhardwaj of S & L to D.A. Schroeder of S & L dated February 11, 1994 regarding the revision of AC and DC loads due to the Unit Auxiliary Transformer (UAT).

70.) Interoffice Memorandum from J.W. Hyrc of S & L to C.A. Tobias of S & L regarding the type and operation of the interposing relay being added to 4kV SWGRs 13-1 and 23-1.

71.) Hand calculations pertaining to the load estimate for Bus 1A-2, Circuit 8.

72.) Pages 2/23 and 5/45 of the Klockner Moeller Main Catalog 1993-1994.

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REFERENCES (Cont.):

73.) Photocopy of one page of Commonwealth Edison's Standard RT-117B.

74.) Smit Nymegen Operation and Maintence Manual for Quad Cities UAT.

75.) Telephone Memorandum between C.A. Tobias of Sargent & Lundy (S&L) and J. Bednarczyk of S&L dated February 28, 1994 regarding the close out of Exempt Change E04-1-93-335.

76.) Sargent & Lundy Interoffice Memorandum from M. C. Warpehoski to S. K. Saha dated August 10, 1994 regarding "Replacement of the Unit 2 Electromatic Relief Valves (ERVs) 2-0203-3B, 3C, 3D, and 3E". See Attachement R (page R173).

77.) Sargent & Lundy Interoffice Memorandum from G. J. Hinshaw to D. A. Schroeder and M. C. Warpehoski dated August 10, 1994 regarding "Solenoid Valve Circuit Design". See Attachement R (page R180).

78.) Telephone Memorandum between T. Clark of ComEd and D.A. Schroeder of S&L, dated 2/9/95, concerning the response times of Reverse Power (GGP) relays 23G1 and 92G1.

79.) Fax Page from J. Freeman of ComEd to D.A. Schroeder of S&L, dated 2/9/95, giving a Table of references for control of Relief [PORV} valves.

80.) S&L Calculation 9149-20-19-1, Rev. 2, entitled "125-Vdc Bus Voltage Calculations for Quad Citites Station", dated 8/30/94.

81.) S&L Calculation 9399-02-19-11, Rev. 0 entitled "Determining the Acceptability of Using Existing Circuitry for the Replacement Relief Valves", dated 10/6/94.

82.) Quad Citites Drawings 4E-1318B Rev. D; 4E-1337 Rev. S; 4E-1351B Sh. 1 Rev. P & SH. 2, Rev J; 4E-1240 Rev. D; 4E2218 Rev. Y; 4E-1221 Rev. AC; 4E-1239 Rev. AG; 4E-2217 Rev. U; 4E-1222 Rev. AF; 4E-2221 Rev. AJ; 4E-1353 Rev. G; 4E-1354 Rev. N; 4E-2353 Rev. G; 4E-1461 Sh. 2 Rev (AL).

83.) Sargent & Lundy Interoffice Memorandum from M. C. Warpehoski to D. R. Larson dated July 6, 1995 regarding "Replacement of the Unit 1 Electromatic Relief Valves (ERVs) 1-0203-3B, 3C, 3D, and 3E". See Attachement R (page R191).

84.) DCR 4-95-142, provides as-built status for bus 24 breaker upgrade.

85.) DCR 4-95-143, provides as-built status for bus 23 breaker upgrade

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References (Cont.):

86. Bechtel PAR Number B130-00524, Revision 0 regarding Modification M12-0-91-019, Partials D, E, F, and G. This is a Dresden PAR, however, some of the information within it is applicable to the new 4kV circuit breakers for Dresden and Quad Cities.

87. Telephone Memorandum between C. Tobias of Sargent & Lundy, and Bill Heinmiller of Bechtel and B. Whitney of ComEd dated October 12, 1995 regarding the trip coil ratings of the trip coils in the new Golden Gate 4kV circuit breakers.

88. ComEd NDIT EIC-99-001, "Evaluation of 125VDC Voltage for 4.16kV and 480V Switchgear Operation" (White Paper), dated 3/5/99.

89. Modification M04-1-91-033A, regarding replacement of switchgear 13 air magnetic circuit breakers with SF_6 circuit breakers (350 MVA rating).

90. Sargent & Lundy NDIT S040-QH-0448, Evaluation for Conversion of Switchgear 13-1 and 14-1 to Merlin-Gerin 350 MVA Circuit Breakers and adding one HFA relay to Panel 902-39", dated 3/27/98.

91. Modification M04-1-91-033B, regarding replacement of switchgear 14 circuit breakers.

92. Sargent & Lundy PI-83 Control No. 10003032A, regarding the effect of replacing specific control room indicating light lamps with new lamps, dated 11/1/96.

93. Sargent & Lundy NDIT S040-QH-0292, Evaluation for Conversion of Swgr. 23-1 and 24-1 to Merlin-Gerin 350MVA Circuit Breakers" dated 12/23/96.

94. SWEC Calculation 9149-20-19-1, Rev. 5, "125 Vdc Bus Voltage Calculations for Quad Cities Station", dated 10/4/99.

95. 4E-6577C, Rev. M, "Schematic Diagram ATWS Recirc Pump Trip System ECCS Init-FW, RCIC, HPCI and Turb Trips Div I and Div II – Part 3"

96. 4E-6577D, Rev. G, "Schematic Diagram ATWS Recirc. Pump Trip SYS. ECCS Init. – FW, RCIC, HPCI and Turb. Trips Div. I and II – Part 4"

97. 4E-6577E, Rev. G, "Schematic Diagram ATWS Recirc Pump Trip Sys ECCS Init-FW, RCIC, HPCI, and Turb Trips Div I and II – Part 5"

98. 4E-6577F, Rev. Q, "Schematic Diagram ATWS Recirc Pump Trip System ECCS Init/FW, RCIC, HPCI & Turb Trips Div I and II – Part 6"

99. 4E-6857, Rev. W, "Loop Schematic/Functional Block Diagram – Analog Trip System Class 1E Instrument Upgrade"

100. 4E-6857C, Revision A, "Loop Schematic Diagram SBGT Train B Heater Differential Temperature"

101. 4E-6860, Rev. W, "Wiring Diagram Panel 2201-73A Analog Trip System Division I"

102. 4E-6861, Rev. AE, "Wiring Diagram Analog Trip System Div II Panel 2201-73B"

103. 4E-7573C, Rev. O, "Schematic Diagram ATWS Recirc Pump Trip System ECCS Init-FW, RCIC, HPCI & Turb Trips Div I & Div II – Part 3"

104. 4E-7573D, Rev. H, "Schematic Diagram ATWS Recirc Pump Trip System ECCS Init-FW, RCIC, HPCI and Turb Trips Div I and II – Part 4"

105. 4E-7573E, Rev. H," Schematic Diagram ATWS Recirc Pump Trip System ECCS Init-FW, RCIC, HPCI and Turb Trips Div I and Div II – Part 5"

106. 4E-7573F, Rev. Y, "Schematic Diagram ATWS Recirc Pump Trip System ECCS Init/FW, RCIC, HPCI, and Turb Trips Div I and Div II – Part 6"

107. 4E-7850, Rev. V, "Loop Schematic & Functional Block Diagram Analog Trip System Class 1E Instr. Upgrade"

108. 4E-7850C, Rev. A, "Schematic & Loop Diagram, SBGT A Train Heater Differential Temperature"

109. 4E-7860, Rev. V, "Wiring Diagram Panel 2202-73A Analog Trip System Division I"

110. 4E-7861, Rev. Y, "Wiring Diagram Analog Trip System – Div. II Panel 2202-73B"

111. Abacus Control Inc. Quotation dated February 9, 2001 for Inverter Model 413-4-75M Specification (Attachment S)

112. GEK83408D, Analog Trip Unit, Operation and Maintenance Instructions, dated May 1998 (Attachment S)

113. Agastat Catalog EMD-1 (12/89), Page 17 for GP Series Relays. (Attachment S)

114. Tyco Catalog 1308242, page 723 for KU Series Relays (Attachment S)

115. EC 345167, Rev. 000, "Alternate Replacement Evaluation for Moore Signal Isloator"

List of Abbreviations

AMPS	Amperes
AUX	Auxiliary
BK	Blank
BKR	Breaker
BKUP	Backup
BLO	Blow
CKT	Circuit
CLG	Cooling
C	Closed
CW	Cooling Water
CCSWP	Containment Cooling Service Water Pump
CONT	Continued
COMPT	Compartment
DC	Direct Current
DG	Diesel Generator
ESC	Escape
EXCIT	Excitation
FD	Feed
FL	Flow
FR	Fire
GE	General Electric
HPCI	High Pressure Coolant Injection
I	Current
INJ	Injection
LGT	Lighting
LPCI	Low Pressure Coolant Injection
LOCA	Loss of Coolant Accident
LOOP	Loss of Offsite Power
MN	Main
NO	Number
Ω	Ohms
PROT	Protection
RB	Reactor Building
RECIRC	Recirculating
REF	Reference
RLY	Relay
REG	Regulator
RES	Reserve
RW	Radwaste
RWB	Radwaste Building
RX	Reactor
SEC	Second
SWP	Service Water Pump
SWGR	Switchgear
T	Trip
t	Time
TRANSF	Transformer
UV	Undervoltage
VENT	Ventilation
W	Watts
WTR	Water

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PANEL LOAD SUMMARY

As described in the Revision Summaries Section for Rev. 36 (page 2.19), the load for each of the 4 kV switchgear was previously calculated for a Loss of Power Only (LOOP) condition and for a Loss of Coolant Accident (LOCA) coincident with a LOOP condition. The contributions from the four switchgear, on each battery, were added together, thus causing the inrush peak currents of different switchgear to be added. To resolve this, two scenarios were compared for each battery and it was determined that the bounding model for the Unit 1 battery would reflect a LOOP coincident with a LOCA on 4 kV switchgear 13 and 13-1 with a LOOP only for switchgear 24 and 24-1. For the Unit 2 battery, the bounding model is a LOOP coincident with a LOCA on 23 and 23-1 and a LOOP only on 14 and 14-1. The comparison to support this conclusion is included in Attachment C of this calculation.

Below is a table summary for the 125 VDC distribution panels:

TABLE	BUS or PANEL	PAGES
1	Turbine Bldg. 125 VDC Main Bus 1A-1	19
2	Turbine Bldg. 125 VDC Main Bus 1A-2	20
3	Reactor Bldg. 125 VDC Distr. Pnl. # 1	21
4	Turbine Bldg. 125 VDC Res. Bus 2B-1	22 – 23
5	Turbine Bldg. 125 VDC Res. Bus 2B-2	24
6	Turbine Bldg. 125 VDC Main Bus 2A-1	25
7	Turbine Bldg. 125 VDC Main Bus 2A-2	26
8	Reactor Bldg. 125 VDC Distr. Pnl. # 2	27
9	Turbine Bldg. 125 VDC Res. Bus 1B-1	28 – 29
10	Turbine Bldg. 125 VDC Res. Bus 1B-2	30

Table: 1 (1 of 1) Bus : Turbine Bldg. 125 VDC Main Bus 1A-1

Ckt. #	1 min.				4 min.	10 min.	15 min.	30 min.	90 min.	30 min.	60 min.
	0 - 5 sec.	5 - 10 sec.	10 - 50 sec.	50 - 60 sec.	1 - 5 min.	5 - 15 min.	15 - 30 min.	30 - 60 min.	60 - 150min.	150 - 180 min.	180 - 240 min.
1	SWGR 13 (Note 1)										
2	0	0	0	0	0	0	0	0	0	0	0
3	0.768	0.768	0.768	0.768	0.768	0.768	0.768	0.768	0.384	0.384	0.384
5	2.64	2.64	2.64	2.64	2.64	2.64	2.64	2.64	2.64	2.64	2.64
6	2.709	2.709	2.709	2.709	2.709	2.709	2.709	2.709	2.709	2.709	2.709
7	0.1	0.1	0.18	0.1	0.18	0.18	0.1	0.1	0.1	0.1	0.1
8	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42
11	3.245	3.245	2.405	2.405	3.245	3.245	1.205	1.205	1.205	1.205	1.205
16	6.032	6.032	6.032	6.032	6.032	6.032	6.032	6.032	6.032	6.032	6.032
18	0.725	0.725	0.725	0.725	0.725	0.725	0.725	0.725	0.725	0.725	0.725

R40

Note 1 : SWGR 13 Load profile for LOOP and LOCA, refer to pages 74.0-75.

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Table: 2 (1 of 1) Bus : Turbine Bldg. 125 VDC Main Bus 1A-2

Ckt. #	1 min.				4 min.	10 min.	15 min.	30 min.	90 min.	30 min.	60 min.	
	0 - 5 sec.	5 - 10 sec.	10 - 50 sec.	50 - 60 sec.	1 - 5 min.	5 - 15 min.	15 - 30 min.	30 - 60 min.	60 - 150min.	150 - 180 min.	180 - 240 min.	
1	19.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	
2	0	0	0	0	0	0	0	0	0	0	0	
3	3.31	3.31	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	
4	0	0	0	0	0	0	0	0	0	0	0	
5	0	0	0	0	0	0	0	0	0	0	0	
6	12.932	0.932	0.932	0.932	0.932	0.932	0.932	0	0	0	0	
7	54	54	54	54	54	54	54	54	54	54	54	
8	9.223	7.147	7.147	7.147	7.147	7.147	7.147	0	0	0	0	
9	0	0	0	0	0	0	0	0	0	0	0	R40
10	8.21	6.96	6.96	6.96	6.96	6.96	6.96	0	0	0	0	
11	0	0	0	0	0	0	0	0	0	0	0	
14	29.6	29.6	29.6	29.6	29.6	29.6	29.6	0	0	0	0	R40
15	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58	
16	21.6	21.6	21.6	21.6	21.6	21.6	21.6	0	0	0	0	
17	12.8	12.8	12.8	12.8	12.8	12.8	12.8	0	0	0	0	
18	0	0	0	0	0	0	0	0	0	0	0	
19	0	0	0	0	0	0	0	0	0	0	0	
20	1.023	1.023	1.023	1.023	1.023	1.023	1.023	1.023	1.023	1.023	1.023	
21	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0	0	0	0	
22	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0	0	0	0	
23	5	5	5	5	5	5	5	0	0	0	0	

Table: 3 (1 of 1) Bus : Reactor Bldg. 125 VDC Distr. Pnl. # 1

Ckt. #	1 min.				4 min.	10 min.	15 min.	30 min.	90 min.	30 min.	60 min.
	0 - 5 sec.	5 - 10 sec.	10 - 50 sec.	50 - 60 sec.	1 - 5 min.	5 - 15 min.	15 - 30 min.	30 - 60 min.	60 - 150min.	150 - 180 min.	180 - 240 min.
1	SWGR 13-1 (Note 1)										
2	0	0	0	0	0	0	0	0	0	0	0
3	57.14	3.26	5.24	3.34	5.26	5.26	3.34	3.34	3.34	3.34	3.34
4	0	0	0	0	0	0	0	0	0	0	0
5	36.8	36.8	36.8	36.8	36.8	36.8	36.8	36.8	36.8	36.8	36.8 R40
6	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0	0	0	0
7	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
8	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0	0	0	0
10	PNL 2201-32 (Note 2)										
12	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
13	66.772	30.783	22.177	2.917	0.464	0.464	0.464	0.464	0.464	0.464	0.464
15	0	0	0	0	0	0	0	0	0	0	0
17	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
18	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5

Note 1 : SWGR 13-1 Load profile for LOOP and LOCA, refer to pages 82-86.

Note 2 : Refer to page 31.

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Table: 4 (1 of 2) Bus : Turbine Bldg. 125 VDC Res. Bus 2B-1

Ckt. #	1 min.				4 min.	10 min.	15 min.	30 min.	90 min.	30 min.	60 min.	
	0 - 5 sec.	5 - 10 sec.	10 - 50 sec.	50 - 60 sec.	1 - 5 min.	5 - 15 min.	15 - 30 min.	30 - 60 min.	60 - 150min.	150 - 180 min.	180 - 240 min.	
1	65.266	3.23	4.91	3.29	5.13	5.13	3.41	3.41	3.41	3.41	3.41	
2	0	0	0	0	0	0	0	0	0	0	0	
3	0	0	0	0	0	0	0	0	0	0	0	
4	SWGR 24-1 (Note 1)											
5	0	0	0	0	0	0	0	0	0	0	0	
6	SWGR 24 (Note 2)											
7	0	0	0	0	0	0	0	0	0	0	0	
8	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	
9	0.1	0.1	0.18	0.1	0.18	0.18	0.1	0.1	0.1	0.1	0.1	
10	2.16	2.16	2.16	2.16	2.16	2.16	0.1	0	0	0	0	
12	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	
13	66.621	30.834	21.564	2..328	2..328	2..328	2..328	2..328	2..328	2..328	2..328	R39
14	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0	0	0	0	
16	1.95	1.95	1.95	1.95	1.95	1.95	1.95	0	0	0	0	
18	1.3	1.3	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	R39

Note 1 : SWGR 24 Load profile for LOOP only, refer to pages 133-138.
Note 2 : SWGR 24-1 Load profile for LOOP only, refer to pages 144-148.

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Table: 4 (2 of 2) Bus : Turbine Bldg. 125 VDC Res. Bus 2B-1

Ckt. #	1 min.				4 min.	10 min.	15 min.	30 min.	90 min.	30 min.	60 min.	
	0 - 5 sec.	5 - 10 sec.	10 - 50 sec.	50 - 60 sec.	1 - 5 min.	5 - 15 min.	15 - 30 min.	30 - 60 min.	60 - 150min.	150 - 180 min.	180 - 240 min.	
19	0	0	0	0	0	0	0	0	0	0	0	
20	0.232	0.232	0.232	0.232	0.232	0.232	0.232	0.232	0.116	0.116	0.116	
21	2.96	2.96	2.12	2.12	2.12	2.12	1.3	1.3	1.3	1.3	1.3	
22	2.96	2.96	2.12	2.12	2.12	2.12	1.3	1.3	1.3	1.3	1.3	
23	2.917	2.917	2.917	2.917	2.957	2.957	2.957	2.957	2.957	2.957	2.957	
27	0.68	0.68	0.68	0.68	0.68	0.68	0.34	0	0	0	0	
28	4.77	4.77	4.77	4.77	4.77	4.77	4.77	0	0	0	0	
31	1.456	1.456	1.456	1.456	1.456	1.456	1.456	1.456	1.456	1.456	1.456	R40
32	6.56	6.56	6.56	6.56	6.56	6.56	6.56	6.56	6.56	6.56	6.56	
33	5.2	5.2	5.2	5.2	5.2	5.2	5.2	0	0	0	0	

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Table: 5 (1 of 1) Bus : Turbine Bldg. 125 VDC Res. Bus 2B-2

Ckt. #	1 min.				4 min.	10 min.	15 min.	30 min.	90 min.	30 min.	60 min.
	0 - 5 sec.	5 - 10 sec.	10 - 50 sec.	50 - 60 sec.	1 - 5 min.	5 - 15 min.	15 - 30 min.	30 - 60 min.	60 - 150min.	150 - 180 min.	180 - 240 min.
1	0	0	0	0	0	0	0	0	0	0	0
2	19.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24
5	72.9	12.9	5.67	5.67	5.67	5.67	5.67	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0

R39

Table: 6 (1 of 1) Bus : Turbine Bldg. 125 VDC Main Bus 2A-1

Ckt. #	1 min.				4 min.	10 min.	15 min.	30 min.	90 min.	30 min.	60 min.	
	0 - 5 sec.	5 - 10 sec.	10 - 50 sec.	50 - 60 sec.	1 - 5 min.	5 - 15 min.	15 - 30 min.	30 - 60 min.	60 - 150min.	150 - 180 min.	180 - 240 min.	
1	SWGR 23 (Note 1)											
3	0.803	0.803	0.803	0.803	0.803	0.803	0.803	0.803	0.401	0.401	0.401	
4	0	0	0	0	0	0	0	0	0	0	0	
5	1.3	1.3	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	
6	2.769	2.769	2.769	2.769	2.769	2.769	2.769	2.769	2.769	2.769	2.769	
7	0.1	0.1	0.18	0.1	0.18	0.18	0.1	0.1	0.1	0.1	0.1	
8	20.42	20.42	20.42	20.42	20.42	20.42	20.42	0.42	0.42	0.42	0.42	
11	2.96	2.96	2.12	2.12	2.12	2.12	0.92	0.92	0.92	0.92	0.92	
16	6.176	6.176	6.176	6.176	6.176	6.176	6.176	6.176	6.176	6.176	6.176	R40
18	0.725	0.725	0.725	0.725	0.725	0.725	0.725	0.725	0.725	0.725	0.725	

Note 1 : SWGR 23 Load profile for LOOP & LOCA, refer to pages 118.0-119.

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Table: 7 (1 of 1) Bus : Turbine Bldg. 125 VDC Main Bus 2A-2

Ckt. #	1 min.				4 min.	10 min.	15 min.	30 min.	90 min.	30 min.	60 min.	
	0 - 5 sec.	5 - 10 sec.	10 - 50 sec.	50 - 60 sec.	1 - 5 min.	5 - 15 min.	15 - 30 min.	30 - 60 min.	60 - 150min.	150 - 180 min.	180 - 240 min.	
1	19.24	1.24	1.24	1.24	1.24	1.24	1.24	0	0	0	0	
3	33.31	3.31	1.41	1.41	1.41	1.41	1.41	0	0	0	0	
6	12.932	0.932	0.932	0.932	0.932	0.932	0.932	0.064	0.064	0.064	0.064	
7	3	3	3	3	3	3	3	3	3	3	3	
8	9.668	8.128	8.128	8.128	8.128	8.128	8.128	0	0	0	0	
9	0	0	0	0	0	0	0	0	0	0	0	R40
10	8.743	6.675	6.675	6.675	6.675	6.675	6.675	0	0	0	0	
11	47	47	47	47	47	47	47	47	47	47	47	
13	30	30	30	30	30	30	30	0	0	0	0	R40
15	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58	
20	1.023	1.023	1.023	1.023	1.023	1.023	0.553	0.553	0.553	0.553	0.553	
21	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0	0	0	0	

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Table: 8 (1 of 1) Bus : Reactor Bldg. 125 VDC Distr. Pnl. #2

Ckt. #	1 min.				4 min.	10 min.	15 min.	30 min.	90 min.	30 min.	60 min.
	0 - 5 sec.	5 - 10 sec.	10 - 50 sec.	50 - 60 sec.	1 - 5 min.	5 - 15 min.	15 - 30 min.	30 - 60 min.	60 - 150min.	150 - 180 min.	180 - 240 min.
1	SWGR 23-1 (Note 1)										
3	49.16	3.26	5.24	3.34	5.26	5.26	3.34	3.34	3.34	3.34	3.34
5	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2 R40
6	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0	0	0	0
7	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
8	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0	0	0	0
9	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
10	PNL 2202-32 (Note 2)										
11	0	0	0	0	0	0	0	0	0	0	0
12	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
13	66.93	30.943	22.337	3.037	1.008	1.008	1.008	1.008	1.008	1.008	1.008
14	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
15	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08

Note 1 : SWGR 23-1 Load profile for LOOP & LOCA, refer to pages 126-130.

Note 2 : Refer to pages 31.

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Table: 9 (1 of 2) Bus : Turbine Bldg. 125 VDC Res. Bus 1B-1

Ckt. #	1 min.				4 min.	10 min.	15 min.	30 min.	90 min.	30 min.	60 min.
	0 - 5 sec.	5 - 10 sec.	10 - 50 sec.	50 - 60 sec.	1 - 5 min.	5 - 15 min.	15 - 30 min.	30 - 60 min.	60 - 150min.	150 - 180 min.	180 - 240 min.
1	60.49	3.19	4.87	3.25	5.09	5.09	3.37	3.37	3.37	3.37	3.37
4	SWGR 14-1 (Note 1)										
6	SWGR14 (Note 2)										
7	7.07	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08
8	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
9	0.1	0.1	0.18	0.1	0.18	0.18	0.1	0.1	0.1	0.1	0.1
10	5.25	5.25	5.25	5.25	5.25	5.25	0.1	0	0	0	0
11	1.28	1.28	1.28	1.28	1.28	1.28	1.28	0	0	0	0
12	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38
13	66.621	30.832	21.564	2.264	2.264	2.264	2.264	2.264	2.264	2.264	2.264
14	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0	0	0	0
16	1.95	1.95	1.95	1.95	1.95	1.95	1.95	0	0	0	0
17	4.76	4.76	4.76	4.76	4.76	4.76	4.76	0	0	0	0

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Note 1 : SWGR 14 Load profile for LOOP only, refer to pages 89-94.

Note 2 : SWGR 14-1 Load profile for LOOP only, refer to pages 99-103.

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Table: 9 (2 of 2) Bus : Turbine Bldg. 125 VDC Res. Bus 1B-1

Ckt. #	1 min.				4 min.	10 min.	15 min.	30 min.	90 min.	30 min.	60 min.	
	0 - 5 sec.	5 - 10 sec.	10 - 50 sec.	50 - 60 sec.	1 - 5 min.	5 - 15 min.	15 - 30 min.	30 - 60 min.	60 - 150min.	150 - 180 min.	180 - 240 min.	
18	3.046	3.046	3.046	3.046	3.046	3.046	3.046	3.046	3.046	3.046	3.046	R40
20	0.348	0.348	0.348	0.348	0.348	0.348	0.348	0.348	0.174	0.174	0.174	
21	2.96	2.12	2.12	2.12	1.3	1.3	1.3	1.3	1.3	1.3	1.3	
22	3.245	3.245	2.405	2.405	2.405	2.405	1.585	1.3	1.3	1.3	1.3	
23	2.892	2.892	2.892	2.892	2.892	2.892	2.892	2.892	2.892	2.892	2.892	
27	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0	0	0	0	
28	4.77	4.77	4.77	4.77	4.77	4.77	4.77	0	0	0	0	
31	1.456	1.456	1.456	1.456	1.456	1.456	1.456	1.456	1.456	1.456	1.456	R40
32	6.416	6.416	6.416	6.416	6.416	6.416	6.416	6.416	6.416	6.416	6.416	
33	11.7	11.7	11.7	11.7	9.3	9.3	9.3	0	0	0	0	
36	1.4	1.4	1.4	1.4	1.4	1.4	1.4	0	0	0	0	
38	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0	0	0	0	

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Table: 10 (1 of 1) Bus : Turbine Bldg. 125 VDC Res. Bus 1B-2

Ckt. #	1 min.				4 min.	10 min.	15 min.	30 min.	90 min.	30 min.	60 min.
	0 - 5 sec.	5 - 10 sec.	10 - 50 sec.	50 - 60 sec.	1 - 5 min.	5 - 15 min.	15 - 30 min.	30 - 60 min.	60 - 150min.	150 - 180 min.	180 - 240 min.
2	19.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24
5	72.9	12.9	5.67	5.67	5.67	5.67	5.67	0	0	0	0

R39

Panel Load Summary (Cont.)

The Auto Blowdown Panel 2201-32 profile is as described below, per PI-83 S040-QH-0507. The existing power operated relief valves (PORV) that were installed on Unit 2 were removed under EC 343933 and replaced with electromatic relief valves (ERV) due to reliability issues. EC 343933 restored Unit 2 to its pre-PORV configuration including the control logic. The Unit 2 Auto Blowdown loading is therefore, the same as the Unit 1 Auto Blowdown logic as shown below. Note that the Unit 2 loading is slightly higher due to solenoid 2-0203-3A replacement per EC 360191. Rev. 40

Panel 2201-32 Rev. 40

Time	Current
0 – 2 minutes (min)	1.61 A
2 min – 4 min 30 seconds (sec)	96.66 A
4 min 30 sec – 60 min	1.61 A
60 min – 240 min	0.803 A

Panel 2202-32

Time	Current
0 – 2 minutes (min)	1.67 A
2 min – 4 min 30 seconds (sec)	96.72 A
4 min 30 sec – 60 min	1.67 A
60 min – 240 min	0.863 A

Rev. 40

Summary:

The following is a summary of the buses per battery for Quad Cities Unit 1 and 2.

Battery 1 buses:

Turbine Bldg. Main Bus 1A-1
" " " " 1A-2
Rx Bldg Distr. Pnl #1
Turbine Bldg. Reserve Bus 2B-1
" " " " 2B-2

Battery 2 buses:

Turbine Bldg. Main Bus 2A-1
" " " " 2A-2
Rx Bldg Distr. Pnl #2
Turbine Bldg. Reserve Bus 1B-1
" " " " 1B-2

The bus arrangements for each of the 125VDC Batteries for Quad Cities Units 1 & 2 are based on Key Diagram Drawing 4E-1318B Rev. C. dated 1-13-86.

The information contained in the load profile tables contained in this calculation was entered into the ELMSDC program for each battery in the order of the buses listed above. The way the data was entered was per the procedure described in the "methodology" section of this calculation.

The load shed data files are based on operator actions identified in DAA 1990-07 [illegible] R36

Conclusion (Cont.)

Revision 38:

The results of the updated runs show that the battery capacity is not exceeded for Quad Cities Units One or Two.

Dataset	Condition	Unit	Min Req'd Size	Actual Size	Remaining Margin
Q1D5YLS.E11	Load Shed	1	7.639	10	23.6%
Q1D5YLS.M51	Load Shed	1	8.183	10	18.2%
Q2D5YLS.E11	Load Shed	2	7.760	10	22.4%
Q2D5YLS.M53	Load Shed	2	8.019	10	19.8%

Revision 39:

The results of the updated runs show that the battery capacity is not exceeded for Quad Cities Units One or Two.

Dataset	Condition	Unit	Min Req'd Size	Actual Size	Remaining Margin
Q1D5YLS.E12	Load Shed	1	9.203	10	8.0%
Q1D5YLS.M64	Load Shed	1	9.183	10	8.2%
Q2D5YLS.E12	Load Shed	2	9.124	10	8.8%
Q2D5YLS.M66	Load Shed	2	8.936	10	10.6%

Revision 40:

The results of the updated runs show that the battery capacity is not exceeded for Quad Cities Units One or Two under Load Shed conditions.

Dataset	File Size	File Date	Time	Unit	Min Req'd Size	Actual Size	Remaining Margin
Q1D5YLS.E13	28 KB	6/5/08	10:52 AM	1	8.478	10	15.2%
Q1D5YLS.M67	28 KB	6/5/08	10:43 AM	1	8.478	10	15.2%
Q2D5YLS.E13	29 KB	6/5/08	11:06 AM	2	8.648	10	13.5%
Q2D5YLS.M69	29 KB	6/5/08	10:58 AM	2	8.648	10	13.5%

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ATS / ATWS PANEL LOADING ANALYSIS

The Analog Trip System (ATS) and Anticipated Transient Without Scram (ATWS) system panels are powered from the Unit 1 and Unit 2 125 VDC Batteries. These panels contain various circuit cards, relays, and indicating lights which operate at the 24 VDC level. They also provide power to process transmitters and signal isolators. These panels are powered from 125 VDC buses via inverters and internal power supplies which drop the voltage to 24 VDC.

The purpose of this section of the calculation is to determine the loading on the 125 VDC batteries from the above referenced components. For conservatism, all components will be assumed energized and all 4-20 ma signal loops will be assumed to be fully loaded at 20 ma.

Figures 1 and 2 below are simplified one-line diagrams of the ATS and ATWS panels in relation to their associated power feeds. The reference drawings on the figures are the source documents where the loading information was obtained. All load elements are then tabulated to determine the total loading at 24 VDC and then scaled to the 125 VDC system. The scaled 125 VDC load values are the load currents used in the ELMS-DC files.

Design Input 1: The master trip units (MTU) have a maximum power consumption of **260 ma** (24 VDC) per Reference 112.

Design Input 2: The slave trip units (STU) have a maximum power consumption of **75 ma** (24 VDC) per Reference 112.

Design Input 3: The trip relays at Panels -70A(B) and -73A(B) are Agastat EGP series relays per drawings 4E-6857 (Rev. W) and 4E-7850 (Rev. V). These relay have a 6 watt power consumption, or, 6W / 24 Volts = **250 ma** per Reference 113.

Design input 4: The trip relays at Panels –73AA(BB) are Potter and Brumfield KUP14D15-24 type relays per drawings 4E-6857 (Rev. W) and 4E-7850 (Rev. V). These relays have a power consumption of 1.8 watts, or, 1.8 W / 24 Volts = **75 ma** per Reference 114.

Design Input 5: From Reference 115, the signal isolators have a maximum power requirement of 5 watts, or, 5 W / 24 Volts = **208 ma**.

Design Input 6: Based on panel walkdowns, the indicating lights are of the panel mounted type similar to General Electric Model ET-16. These lights utilize #1819 bulbs which have a load of 0.04 amps (via Grainger website). For conservatism, a value of **250 ma** will be used.

Design Input 7: Panels –70A(B) and –73AA(BB) contain internal power supplies which convert 120 VAC and 125 VDC power to 24 VDC. A review of typical manufacturer's data sheets for these types of power supplies (e.g. Lambda) shows power supply efficiencies of 70-75%. A 70% efficiency will be assumed for this evaluation. This value is conservative due to the fact that all components are assumed energized and fully loaded.

Design Input 8: The 125 VDC to 120 VAC 1000 VA inverters (PS3A, PS3B, and PS4) have a full load output rating of **8.3 amps AC** with an input of **16 amps DC** @75VDC. (Reference 111)

ATS / ATWS Panel Loading Analysis (Cont.)

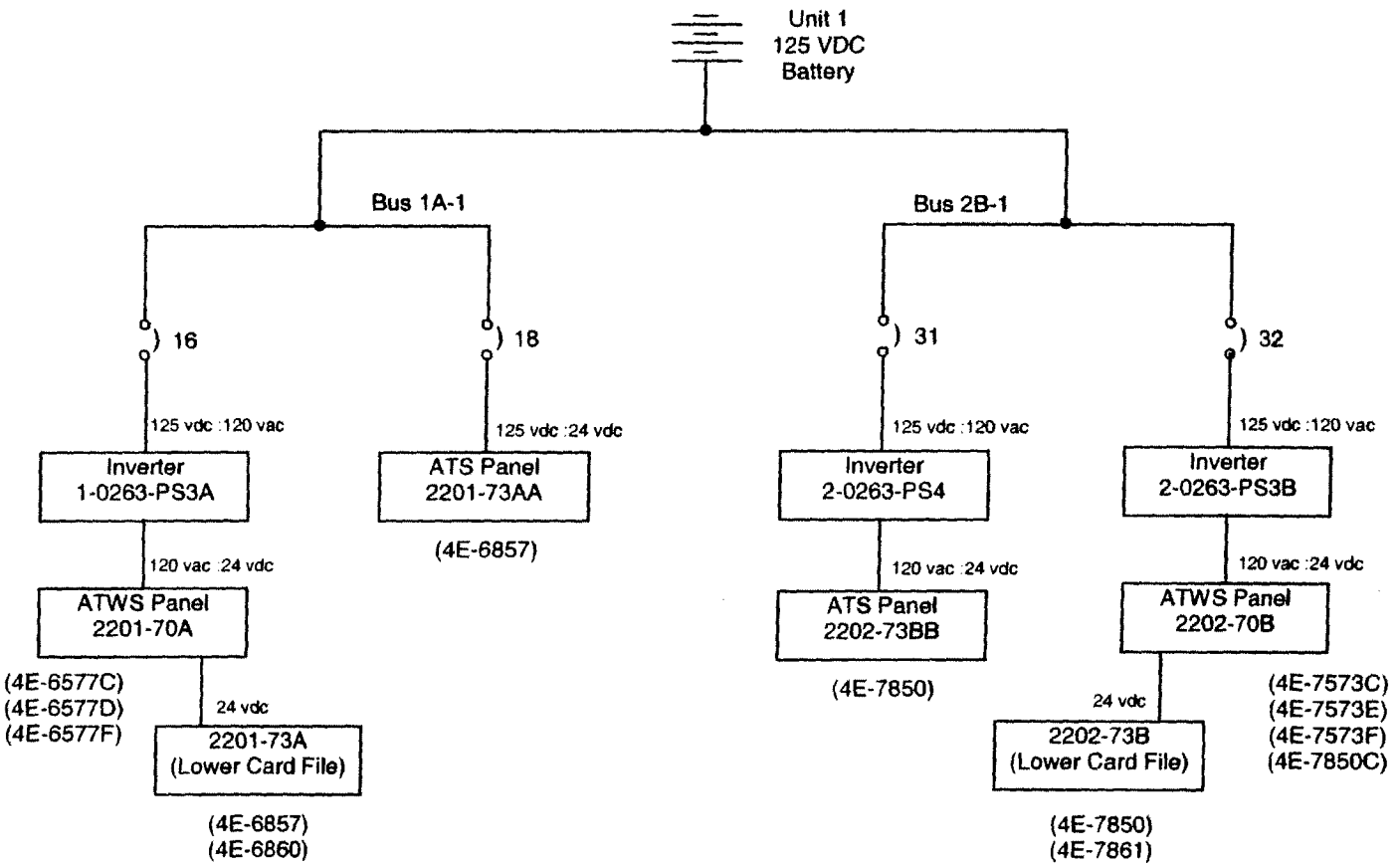

Figure 1

ATS / ATWS Panel Loading Analysis (Cont.)

The following tables are tabulations of all the load elements at each panel:

Bus 1A-1, Circuit 16

Panel	Load Element	Reference Drawing	Current (Amps @ 24 VDC)	Quantity	Total Current (Amps @ 24 VDC)
2201-70A	Indicating Light	4E-6577C	0.250	2	0.500
2201-70A	Relay (Agastat)	4E-6577C	0.250	1	0.250
2201-70A	Signal Isolator	4E-6577C	0.208	1	0.208
2201-70A	Master Trip Unit	4E-6577D	0.260	4	1.040
2201-70A	Slave Trip Unit	4E-6577D	0.075	8	0.600
2201-70A	Relay (Agastat)	4E-6577D	0.250	14	3.500
2201-70A	Relay (Agastat)	4E-6577F	0.250	2	0.500
2201-73A	Master Trip Unit	4E-6857	0.260	8	2.080
2201-73A	Slave Trip Unit	4E-6857	0.075	1	0.075
2201-73A	Relay (Agastat)	4E-6857	0.250	8	2.000
2201-73A	Signal Isolator	4E-6857	0.208	1	0.208
				Total	**10.961 Amps**

The total loading on the 120 VAC to 24 VDC power supply at Panel 2201-70A is 10.961 amps. Converting this to the 120 VAC level and using a 70% efficiency (design input 7), the total loading on upstream inverter 1-0263-PS3A will be,

$$I_{120\,VAC} = \left(\frac{24\ VDC}{120\ VAC}\right)\left(\frac{1}{0.7}\right)(10.961\ \text{amps}) = 3.132\ \text{amps AC}$$

To reflect this load value to the 125 VDC input to PS3A, design input 8 is used as shown below,

$$\text{Inverter } \underline{\text{Output}} \text{ Loading} = \frac{3.132\ \text{amps}}{8.3\ \text{amps}} = 37.7\%$$

Inverter <u>Input</u> Loading = (0.377)(16 Amps DC) = 6.032 Amps DC

The loading at Bus 1A-1, Circuit 16 = **<u>6.032 amps DC</u>**

ATS / ATWS Panel Loading Analysis (Cont.)

Bus 1A-1, Circuit 18

Panel	Load Element	Reference Drawing	Current (Amps @ 24 VDC)	Quantity	Total Current (Amps @ 24 VDC)
2201-73AA	Master Trip Unit	4E-6857	0.260	7	1.820
2201-73AA	Slave Trip Unit	4E-6857	0.075	2	0.150
2201-73AA	Relay (KUP)	4E-6857	0.075	9	0.675
				Total	**Amps 2.645**

The total loading on the 125 VDC to 24 VDC power supply at Panel 2201-73AA is 2.645 amps. Converting this to the 125 VDC level and using a 70% efficiency (design input 7), the total loading on Bus 1A-1, Circuit 18 will be,

$$I_{125\ VDC} = \left(\frac{24\ VDC}{125\ VDC}\right)\left(\frac{1}{0.7}\right)(2.645\ \text{amps}) = 0.725\ \text{amps DC}$$

The loading at Bus 1A-1, Circuit 18 = **0.725 amps DC**

ATS / ATWS Panel Loading Analysis (Cont.)

Bus 2B-1, Circuit 31

Panel	Load Element	Reference Drawing	Current (Amps @ 24 VDC)	Quantity	Total Current (Amps @ 24 VDC)
2202-73BB	Master Trip Unit	4E-7850	0.260	7	1.820
2202-73BB	Slave Trip Unit	4E-7850	0.075	2	0.150
2202-73BB	Relay (KUP)	4E-7850	0.075	9	0.675
				Total	**2.645 Amps**

The total loading on the 120 VAC to 24 VDC power supply at Panel 2202-73BB is 2.645 amps. Converting this to the 120 VAC level and using a 70% efficiency (design input 7), the total loading on upstream inverter 2-0263-PS4 will be,

$$I_{120\,VAC} = \left(\frac{24\ VDC}{120\ VAC}\right)\left(\frac{1}{0.7}\right)(2.645\ \text{amps}) = 0.756\ \text{amps AC}$$

To reflect this load value to the 125 VDC input to PS4, design input 8 is used as shown below,

$$\text{Inverter } \underline{\text{Output}} \text{ Loading} = \frac{0.756\ \text{amps}}{8.3\ \text{amps}} = 9.1\%$$

Inverter Input Loading = (0.091)(16 Amps DC) = 1.456 Amps DC

The loading at Bus 2B-1, Circuit 31 = **1.456 amps DC**

ATS / ATWS Panel Loading Analysis (Cont.)

Bus 2B-1, Circuit 32

Panel	Load Element	Reference Drawing	Current (Amps @ 24 VDC)	Quantity	Total Current (Amps @ 24 VDC)
2202-70B	Indicating Light	4E-7573C	0.250	2	0.500
2202-70B	Relay (Agastat)	4E-7573C	0.250	2	0.500
2202-70B	Signal Isolator	4E-7573C	0.208	1	0.208
2202-70B	Master Trip Unit	4E-7573E	0.260	4	1.040
2202-70B	Slave Trip Unit	4E-7573E	0.075	8	0.600
2202-70B	Relay (Agastat)	4E-7573E	0.250	14	3.500
2202-70B	Relay (Agastat)	4E-7573F	0.250	2	0.500
2202-70B	Relay (Agastat)	4E-7850C	0.250	1	0.250
2202-73B	Master Trip Unit	4E-7850	0.260	7	1.820
2202-73B	Slave Trip Unit	4E-7850	0.075	2	0.150
2202-73B	Relay (Agastat)	4E-7850	0.250	8	2.000
2202-73B	Signal Isolator	4E-7850	0.208	4	0.832
				Total	**11.900 Amps**

The total loading on the 120 VAC to 24 VDC power supply at Panel 2202-70B is 11.900 amps. Converting this to the 120 VAC level and using a 70% efficiency (design input 7), the total loading on upstream inverter 2-0263-PS3B will be,

$$I_{120\ VAC} = \left(\frac{24\ VDC}{120\ VAC}\right)\left(\frac{1}{0.7}\right)(11.900\ \text{amps}) = 3.4\ \text{amps AC}$$

To reflect this load value to the 125 VDC input to PS3B, design input 8 is used as shown below,

$$\text{Inverter } \underline{\text{Output}} \text{ Loading} = \frac{3.4\ \text{amps}}{8.3\ \text{amps}} = 41.0\%$$

Inverter <u>Input</u> Loading = (0.410)(16 Amps DC) = 6.56 Amps DC

The loading at Bus 2B-1, Circuit 32 = **<u>6.56 amps DC</u>**

ATS / ATWS Panel Loading Analysis (Cont.)

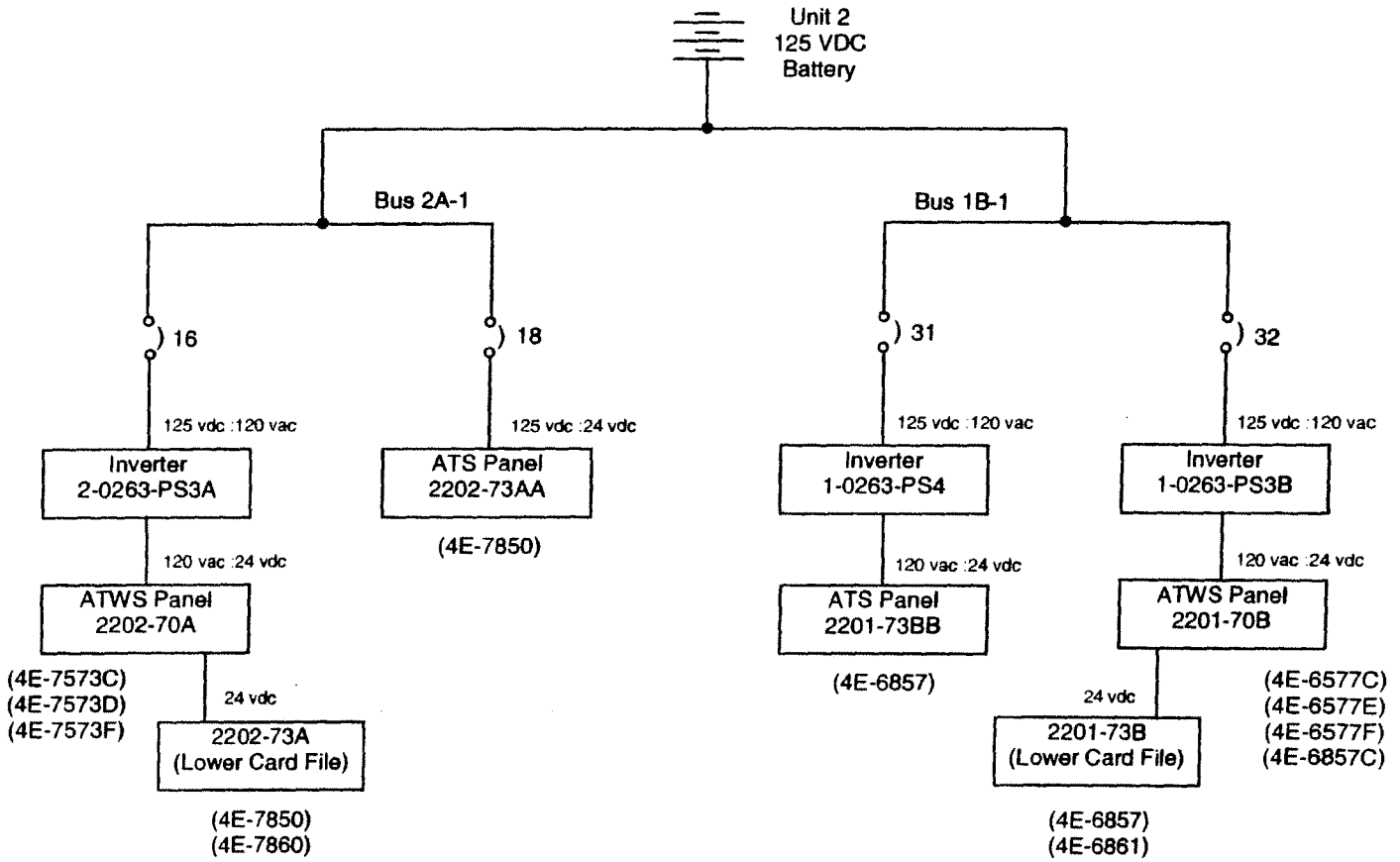

Figure 2

ATS / ATWS Panel Loading Analysis (Cont.)

Bus 2A-1, Circuit 16

Panel	Load Element	Reference Drawing	Current (Amps @ 24 VDC)	Quantity	Total Current (Amps @ 24 VDC)
2202-70A	Indicating Light	4E-7573C	0.250	2	0.500
2202-70A	Relay (Agastat)	4E-7573C	0.250	2	0.500
2202-70A	Signal Isolator	4E-7573C	0.208	1	0.208
2202-70A	Master Trip Unit	4E-7573D	0.260	4	1.040
2202-70A	Slave Trip Unit	4E-7573D	0.075	8	0.600
2202-70A	Relay (Agastat)	4E-7573D	0.250	14	3.500
2202-70A	Relay (Agastat)	4E-7573F	0.250	2	0.500
2202-73A	Master Trip Unit	4E-7850	0.260	8	2.080
2202-73A	Slave Trip Unit	4E-7850	0.075	1	0.075
2202-73A	Relay (Agastat)	4E-7850	0.250	8	2.000
2202-73A	Signal Isolator	4E-7850	0.208	1	0.208
				Total	**11.211 Amps**

The total loading on the 120 VAC to 24 VDC power supply at Panel 2202-70A is 11.211 amps. Converting this to the 120 VAC level and using a 70% efficiency (design input 7), the total loading on upstream inverter 2-0263-PS3A will be,

$$I_{120\,VAC} = \left(\frac{24\ VDC}{120\ VAC}\right)\left(\frac{1}{0.7}\right)(11.211\ \text{amps}) = 3.203\ \text{amps AC}$$

To reflect this load value to the 125 VDC input to PS3A, design input 8 is used as shown below,

$$\text{Inverter } \underline{\text{Output}} \text{ Loading} = \frac{3.203\ \text{amps}}{8.3\ \text{amps}} = 38.6\%$$

Inverter Input Loading = (0.386)(16 Amps DC) = 6.176 Amps DC

The loading at Bus 2A-1, Circuit 16 = **6.176 amps DC**

ATS / ATWS Panel Loading Analysis (Cont.)

Bus 2A-1, Circuit 18

Panel	Load Element	Reference Drawing	Current (Amps @ 24 VDC)	Quantity	Total Current (Amps @ 24 VDC)
2202-73AA	Master Trip Unit	4E-7850	0.260	7	1.820
2202-73AA	Slave Trip Unit	4E-7850	0.075	2	0.150
2202-73AA	Relay (KUP)	4E-7850	0.075	9	0.675
				Total	**Amps 2.645**

The total loading on the 125 VDC to 24 VDC power supply at Panel 2202-73AA is 2.645 amps. Converting this to the 125 VDC level and using a 70% efficiency (design input 7), the total loading on Bus 2A-1, Circuit 18 will be,

$$I_{125\,VDC} = \left(\frac{24\ VDC}{125\ VDC}\right)\left(\frac{1}{0.7}\right)(2.645\ \text{amps}) = 0.725\ \text{amps DC}$$

The loading at Bus 2A-1, Circuit 18 = **0.725 amps DC**

ATS / ATWS Panel Loading Analysis (Cont.)

Bus 1B-1, Circuit 31

Panel	Load Element	Reference Drawing	Current (Amps @ 24 VDC)	Quantity	Total Current (Amps @ 24 VDC)
2201-73BB	Master Trip Unit	4E-6857	0.260	7	1.820
2201-73BB	Slave Trip Unit	4E-6857	0.075	2	0.150
2201-73BB	Relay (KUP)	4E-6857	0.075	9	0.675
				Total	**2.645 Amps**

The total loading on the 120 VAC to 24 VDC power supply at Panel 2201-73BB is 2.645 amps. Converting this to the 120 VAC level and using a 70% efficiency (design input 7), the total loading on upstream inverter 1-0263-PS4 will be,

$$I_{120\ VAC} = \left(\frac{24\ VDC}{120\ VAC}\right)\left(\frac{1}{0.7}\right)(2.645\ \text{amps}) = 0.756\ \text{amps AC}$$

To reflect this load value to the 125 VDC input to PS4, design input 8 is used as shown below,

$$\text{Inverter } \underline{\text{Output}} \text{ Loading} = \frac{0.756\ \text{amps}}{8.3\ \text{amps}} = 9.1\%$$

Inverter <u>Input</u> Loading = (0.091)(16 Amps DC) = 1.456 Amps DC

The loading at Bus 1B-1, Circuit 31 = **<u>1.456 amps DC</u>**

ATS / ATWS Panel Loading Analysis (Cont.)

Bus 1B-1, Circuit 32

Panel	Load Element	Reference Drawing	Current (Amps @ 24 VDC)	Quantity	Total Current (Amps @ 24 VDC)
2201-70B	Indicating Light	4E-6577C	0.250	2	0.500
2201-70B	Relay (Agastat)	4E-6577C	0.250	1	0.250
2201-70B	Signal Isolator	4E-6577C	0.208	1	0.208
2201-70B	Master Trip Unit	4E-6577E	0.260	4	1.040
2201-70B	Slave Trip Unit	4E-6577E	0.075	8	0.600
2201-70B	Relay (Agastat)	4E-6577E	0.250	14	3.500
2201-70B	Relay (Agastat)	4E-6857C	0.250	1	0.250
2201-70B	Relay (Agastat)	4E-6577F	0.250	2	0.500
2201-73B	Master Trip Unit	4E-6857	0.260	7	1.820
2201-73B	Slave Trip Unit	4E-6857	0.075	2	0.150
2201-73B	Relay (Agastat)	4E-6857	0.250	8	2.00
2201-73B	Signal Isolator	4E-6857	0.208	4	0.832
				Total	**11.65 Amps**

The total loading on the 120 VAC to 24 VDC power supply at Panel 2201-70B is 11.65 amps. Converting this to the 120 VAC level and using a 70% efficiency (design input 7), the total loading on upstream inverter 1-0263-PS3B will be,

$$I_{120\,VAC} = \left(\frac{24\ VDC}{120\ VAC}\right)\left(\frac{1}{0.7}\right)(11.65\ \text{amps}) = 3.329\ \text{amps AC}$$

To reflect this load value to the 125 VDC input to PS3B, design input 8 is used as shown below,

$$\text{Inverter } \underline{\text{Output}} \text{ Loading} = \frac{3.329\ \text{amps}}{8.3\ \text{amps}} = 40.1\%$$

Inverter <u>Input</u> Loading = (0.401)(16 Amps DC) = 6.416 Amps DC

The loading at Bus 1B-1, Circuit 32 = **<u>6.416 amps DC</u>**

ATS / ATWS Panel Loading Analysis (Cont.)

The following table contains a summary of the loading values for the ATS and ATWS panels. These are the continuous current values that were used as inputs for the applicable ELMS-DC data files.

125 VDC Battery	125 VDC Bus	Circuit	Current (Amps DC)
Unit 1	1A-1	16	6.032 Amps
Unit 1	1A-1	18	0.725 Amps
Unit 1	2B-1	31	1.456 Amps
Unit 1	2B-1	32	6.56 Amps
Unit 2	2A-1	16	6.176 Amps
Unit 2	2A-1	18	0.725 Amps
Unit 2	1B-1	31	1.456 Amps
Unit 2	1B-1	32	6.416 Amps

4 kV SWITCHGEAR LOAD ANALYSIS

The relay analysis for 4 kV Switchgear Buses 13, 13-1, 14, 14-1, 23, 23-1, 24, and 24-1 revealed that the relay schemes for 4 kV Switchgear Buses 13 and 23, Switchgear 14 and 24, Switchgear 13-1 and 23-1, and Switchgear 14-1 and 24-1 are similar. It should be noted that 4 kV Switchgear 14-1 only has 3 HFA relays in the undervoltage (UV) circuit, whereas Switchgear 24-1 has 4 HFA relays. Also, 4 kV Switchgear 14-1 had one additional Agastat relay energized from 10 s to the duration than Switchgear 24-1. Therefore, an enveloping case was developed for Switchgear 14-1 and 24-1. The tables below show the relays present in the various Switchgear Buses. Revision 36 modified the 4 kV switchgear breaker operation times as detailed in Attachment B. In conjunction with this review, the relay quantities shown below were reviewed on a sample basis and found to be consistent/bounding with the current configuration. Based on Assumption 3.0, all the relays in each switchgear are energized during the entire duration of the load cycle. This is a conservatism method of modeling the switchgear circuits, however, the relay loads are small compared to the total switchgear loads; therefore, this approach does not introduce an excessive conservatism on the total loading of the switchgear/battery.

4 kV Switchgear 13 (used for Swgr 13 and 23)

Qty.	Relay Type
3	HFA Relay
1	HGA Relay
2	UV Relay

4 kV Switchgear 24 (used for Swgr 14 and 24)

Qty.	Relay Type
4	HFA Relay
1	HGA Relay
2	UV Relay
2	UV Relay
1	HFA Relay
1	Miscellaneous Relay

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4 kV SWITCHGEAR LOAD ANALYSIS (cont.)

4 kV Switchgear 13-1 R40

Qty.	Relay Type
3	HFA Relay
1	Joslyn Clark Relay
2	UV Relay
2	Agastat T.D. Relay
1	Agastat Continuous Relay
1	Agastat Continuous Relay
1	HGA Relay
2	UV Relay (2nd Level UV Relay ITE-27N)
1	HGA Relay (Interposing Relay)

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4 kV Switchgear 23-1

Qty.	Relay Type
4	HFA Relay
2	UV Relay
2	Agastat T.D. Relay
1	Agastat Continuous Relay
1	Agastat Continuous Relay
1	HGA Relay
2	UV Relay (2nd Level UV Relay ITE-27N)
1	HGA Relay (Interposing Relay)

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4 kV SWITCHGEAR LOAD ANALYSIS (cont.)

Enveloping Case for Switchgear 14-1 and 24-1 (used for Swgr 14-1 and 24-1)

Qty.	Relay Type
4	HFA Relay
2	UV Relay
2	Agastat T.D. Relay
1	Agastat Continuous Relay
2	Agastat Continuous Relay
1	HFA Relay
1	HGA Relay
2	UV Relay (2nd Level UV Relay ITE-27N)
2	IAC Relay
1	SA-1 Relay

The SBO breaker remains tripped when there is a LOCA on either unit. Since the scenario modeled is a LOOP on both Units 1 and 2 and a LOCA on one unit, SBO breaker is not modeled as closing.

For simplicity, any SBO diesel generator relay included in the previous tables was not removed. This approach does not introduce excessive conservatism on the total loading of the switchgear.

DESCRIPTION OF THE TABLE HEADINGS

On-Line

The On-Line condition is the condition the plant was operating at when the LOOP/LOCA condition was sensed. If 2 out of 3 pumps normally operate under a full power condition but all 3 could be operating, 3 were shown to be operating for conservatism. The numbers used here were shown as an example and may differ from what is actually shown in the tables.

LOOP/LOOP and LOCA (t=1sec.)

This column shows the breaker status for the equipment after all the breakers complete their actuation (i.e. t=1sec.) on a LOOP or LOOP and LOCA signal.

LOOP/LOOP and LOCA (After)

This column reflects the breaker status of the equipment after the 4 kV Buses have reloaded to deal with the Design Base Accident (LOOP or a LOOP and LOCA scenario).

Bus 1A-1 Circuit 1
4kV Switchgear Bus 13 Main Feed

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4kV Switchgear 13 AC Loads

Bkr. #	Service	AC Bkr. Status			S/D	Rev.
		On-Line	LOOP/ LOOP & LOCA (t=1)	LOOP/ LOOP & LOCA (After)		
152-1301	480V Switchgear 15	C	T	T/T	4E-1347	J
152-1302	Cond. & Booster Pump 1A	C	T	T/T	4E-1370	M
152-1303	Main Feed	T	T	T/T	4E-1342	X
152-1304	CRD Feed Pump 1A	C	T	C/T	4E-1416	Q
152-1305	Service Water Pump 1A	C	T	C/T	4E-1391	H
152-1306	Circ. Water Pump 1A	C	T	T/T	4E-1368	K
152-1307	Cond. & Booster Pump 1B	C	T	T/T	4E-1370	M
152-1308	RHR SWP 1B	T	T	C*/C*	4E-1438P	R
152-1309	Reserve Feed	C	T	T/T	4E-1342	X
152-1310	Circ. Water Pump 1B	C	T	T/T	4E-1368	K
152-1311	RHR SWP 1A	T	T	C*/C*	4E-1438P	R
152-1312	Bus 13-1 Feed	C	T	C/C	4E-1344	SH. 1, C
152-1313	480V Switchgear 1A	C	T	T/T	4E-685	F
152-1314	Spare Breaker	$	$	$	---	---

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$ - This is a spare breaker with the control power fuses pulled. No dc load is assumed.
* Only 1 pump is energized when the EDG is supplying power. R36

4kV Switchgear 13 **Page 2 of 12** R36

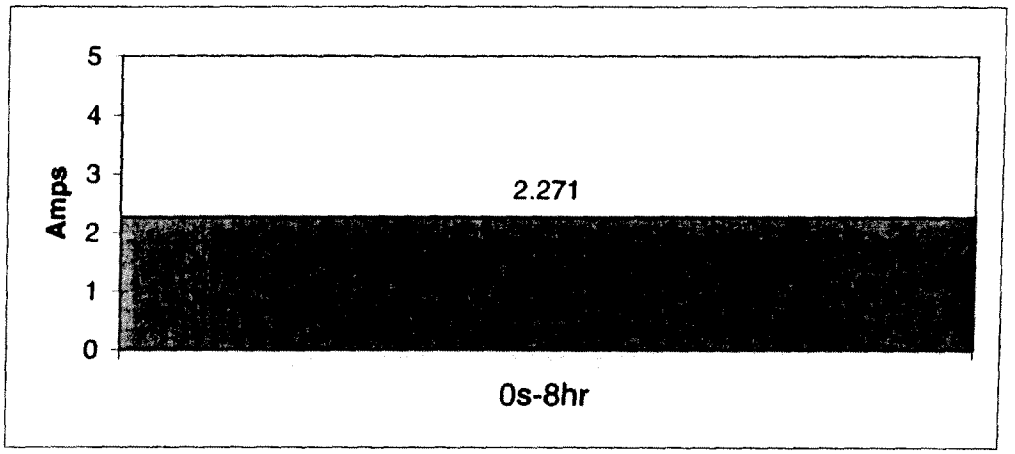
NORMAL CONDITION

The maximum dc load on the circuit under normal condition is:

							Time	
10	lights for closed breakers (@ 0.154 each)	10	x	0.154	=	1.540	0s-8hr	R36
3	lights for tripped breakers (@ 0.231 each)	3	x	0.231	=	0.693		R36
	No switching of breakers							
	Relays energized:							
0	HEA	0	x	5.400	=	0.000		
0	HFA	0	x	0.062	=	0.000		
1	HGA	1	x	0.038	=	0.038		
0	UV Relay	0	x	0.070	=	0.000		
			TOTAL		=	2.271	Amps	

NOTES

1.) The UV relay circuit would have one HGA relay energized.



4kV Switchgear 13 **Page 3 of 12** R36

LOOP Condition

The maximum dc load on the circuit under LOOP condition is:

						Time		
0	lights for closed breakers (@ 0.154 each)	0 x 0.154 =	0.000			0s-1s	R36	
0	breaker closing coils	0 x 15.000 =	0.000				R36	(Ref. 88 & 89)
0	lights for closing breakers (@ 0.231 each)	0 x 0.231 =	0.000				R36	
3	lights for tripped breakers (@ 0.231 each)	3 x 0.231 =	0.693				R36	
10	breaker tripping coils	10 x 1.080 =	10.800				R36	(Ref. 88 & 89)
10	lights for tripping breakers (@ 0.231 each)	10 x 0.231 =	2.310				R36	
	Relays energized:							
0	HEA	0 x 5.400 =	0.000					
3	HFA	3 x 0.062 =	0.186					
1	HGA	1 x 0.038 =	0.038					
2	UV Relay	2 x 0.070 =	0.140					
		TOTAL =	14.167	Amps			R36	
						Time		
0	lights for closed breakers (@ 0.154 each)	0 x 0.154 =	0.000			1s-10m	R36	
0	breaker closing coils	0 x 15.000 =	0.000				R36	(Ref. 88 & 89)
0	lights for closing breakers (@ 0.231 each)	0 x 0.231 =	0.000				R36	
13	lights for tripped breakers (@ 0.231 each)	13 x 0.231 =	3.003				R36	
0	breaker tripping coils	0 x 1.080 =	0.000				R36	(Ref. 88 & 89)
0	lights for tripping breakers (@ 0.231 each)	0 x 0.231 =	0.000				R36	
	Relays energized:							
0	HEA	0 x 5.400 =	0.000					
3	HFA	3 x 0.062 =	0.186					
1	HGA	1 x 0.038 =	0.038					
2	UV Relay	2 x 0.070 =	0.140					
		TOTAL =	3.367	Amps			R36	
						Time	R36	
0	lights for closed breakers (@ 0.154 each)	0 x 0.154 =	0.000			10m-10m2s	R36	
1	breaker closing coils (Peak)	1 x 15.000 =	15.000				R36	(Ref. 88 & 89)
0	breaker closing coils (Continuous)	0 x 5.000 =	0.000				R36	
1	lights for closing breakers (@ 0.231 each)	1 x 0.231 =	0.231				R36	
12	lights for tripped breakers (@ 0.231 each)	12 x 0.231 =	2.772				R36	
0	breaker tripping coils	0 x 1.080 =	0.000				R36	(Ref. 88 & 89)
0	lights for tripping breakers (@ 0.231 each)	0 x 0.231 =	0.000				R36	
	Relays energized:							
0	HEA	0 x 5.400 =	0.000				R36	
3	HFA	3 x 0.062 =	0.186				R36	
1	HGA	1 x 0.038 =	0.038					
2	UV Relay	2 x 0.070 =	0.140				R36	
		TOTAL =	18.367	Amps			R36	

4kV Switchgear 13 **Page 4 of 12** R36

LOOP Condition

						Time		
0	lights for closed breakers (@ 0.154 each)	0 x 0.154	=	0.000		10m2s-10m15s	R36	
0	breaker closing coils (Peak)	0 x 15.000	=	0.000			R36	(Ref. 88 & 89)
1	breaker closing coils (Continuous)	1 x 5.000	=	5.000			R36	
1	lights for closing breakers (@ 0.231 each)	1 x 0.231	=	0.231			R36	
12	lights for tripped breakers (@ 0.231 each)	12 x 0.231	=	2.772			R36	
0	breaker tripping coils	0 x 1.080	=	0.000			R36	(Ref. 88 & 89)
0	lights for tripping breakers (@ 0.231 each)	0 x 0.231	=	0.000			R36	
	Relays energized:							
0	HEA	0 x 5.400	=	0.000			R36	
3	HFA	3 x 0.062	=	0.186			R36	
1	HGA	1 x 0.038	=	0.038				
2	UV Relay	2 x 0.070	=	0.140			R36	
		TOTAL	=	8.367	Amps		R36	

						Time		
1	lights for closed breakers (@ 0.154 each)	1 x 0.154	=	0.154		10m15s-10m17s	R36	
1	breaker closing coils (Peak)	1 x 15.000	=	15.000			R36	(Ref. 88 & 89)
0	breaker closing coils (Continuous)	0 x 5.000	=	0.000			R36	
1	lights for closing breakers (@ 0.231 each)	1 x 0.231	=	0.231			R36	
11	lights for tripped breakers (@ 0.231 each)	11 x 0.231	=	2.541			R36	
0	breaker tripping coils	0 x 1.080	=	0.000			R36	(Ref. 88 & 89)
0	lights for tripping breakers (@ 0.231 each)	0 x 0.231	=	0.000			R36	
	Relays energized:							
0	HEA	0 x 5.400	=	0.000			R36	
3	HFA	3 x 0.062	=	0.186			R36	
1	HGA	1 x 0.038	=	0.038				
2	UV Relay	2 x 0.070	=	0.140			R36	
		TOTAL	=	18.290	Amps		R36	

						Time	R36	
1	lights for closed breakers (@ 0.154 each)	1 x 0.154	=	0.154		10m17s-10m30s	R36	
0	breaker closing coils (Peak)	0 x 15.000	=	0.000			R36	(Ref. 88 & 89)
1	breaker closing coils (Continuous)	1 x 5.000	=	5.000			R36	
1	lights for closing breakers (@ 0.231 each)	1 x 0.231	=	0.231			R36	
11	lights for tripped breakers (@ 0.231 each)	11 x 0.231	=	2.541			R36	
0	breaker tripping coils	0 x 1.080	=	0.000			R36	(Ref. 88 & 89)
0	lights for tripping breakers (@ 0.231 each)	0 x 0.231	=	0.000			R36	
	Relays energized:						R36	
0	HEA	0 x 5.400	=	0.000			R36	
3	HFA	3 x 0.062	=	0.186			R36	
1	HGA	1 x 0.038	=	0.038			R36	
2	UV Relay	2 x 0.070	=	0.140			R36	
		TOTAL	=	8.290	Amps		R36	

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LOOP Condition R36

							Time	R36	
2	lights for closed breakers (@ 0.154 each)	2	x	0.154	=	0.308		10m30s-10m45s	R36	
0	breaker closing coils (Peak)	0	x	15.000	=	0.000			R36	(Ref. 88 & 89)
0	breaker closing coils (Continuous)	0	x	5.000	=	0.000			R36	
0	lights for closing breakers (@ 0.231 each)	0	x	0.231	=	0.000			R36	
11	lights for tripped breakers (@ 0.231 each)	11	x	0.231	=	2.541			R36	
0	breaker tripping coils	0	x	1.080	=	0.000			R36	(Ref. 88 & 89)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000			R36	
	Relays energized:								R36	
0	HEA	0	x	5.400	=	0.000			R36	
3	HFA	3	x	0.062	=	0.186			R36	
1	HGA	1	x	0.038	=	0.038			R36	
2	UV Relay	2	x	0.070	=	0.140			R36	
			TOTAL		=	3.213	Amps		R36	

							Time	R36	
2	lights for closed breakers (@ 0.154 each)	2	x	0.154	=	0.308		10m45s-10m47s	R36	
1	breaker closing coils (Peak)	1	x	15.000	=	15.000			R36	(Ref. 88 & 89)
0	breaker closing coils (Continuous)	0	x	5.000	=	0.000			R36	
1	lights for closing breakers (@ 0.231 each)	1	x	0.231	=	0.231			R36	
10	lights for tripped breakers (@ 0.231 each)	10	x	0.231	=	2.310			R36	
0	breaker tripping coils	0	x	1.080	=	0.000			R36	(Ref. 88 & 89)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000			R36	
	Relays energized:								R36	
0	HEA	0	x	5.400	=	0.000			R36	
3	HFA	3	x	0.062	=	0.186			R36	
1	HGA	1	x	0.038	=	0.038			R36	
2	UV Relay	2	x	0.070	=	0.140			R36	
			TOTAL		=	18.213	Amps		R36	

							Time	R36	
2	lights for closed breakers (@ 0.154 each)	2	x	0.154	=	0.308		10m47s-11m	R36	
0	breaker closing coils (Peak)	0	x	15.000	=	0.000			R36	(Ref. 88 & 89)
1	breaker closing coils (Continuous)	1	x	5.000	=	5.000			R36	
1	lights for closing breakers (@ 0.231 each)	1	x	0.231	=	0.231			R36	
10	lights for tripped breakers (@ 0.231 each)	10	x	0.231	=	2.310			R36	
0	breaker tripping coils	0	x	1.080	=	0.000			R36	(Ref. 88 & 89)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000			R36	
	Relays energized:								R36	
0	HEA	0	x	5.400	=	0.000			R36	
3	HFA	3	x	0.062	=	0.186			R36	
1	HGA	1	x	0.038	=	0.038			R36	
2	UV Relay	2	x	0.070	=	0.140			R36	
			TOTAL		=	8.213	Amps		R36	

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LOOP Condition

							Time	R36	
3	lights for closed breakers (@ 0.154 each)	3	x	0.154	=	0.462	11m-11m15s	R36	
0	breaker closing coils (Peak)	0	x	15.000	=	0.000		R36	(Ref. 88 & 89)
0	breaker closing coils (Continuous)	0	x	5.000	=	0.000		R36	
0	lights for closing breakers (@ 0.231 each)	0	x	0.231	=	0.000		R36	
10	lights for tripped breakers (@ 0.231 each)	10	x	0.231	=	2.310		R36	
0	breaker tripping coils	0	x	1.080	=	0.000		R36	(Ref. 88 & 89)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		R36	
	Relays energized:							R36	
0	HEA	0	x	5.400	=	0.000		R36	
3	HFA	3	x	0.062	=	0.186		R36	
1	HGA	1	x	0.038	=	0.038		R36	
2	UV Relay	2	x	0.070	=	0.140		R36	
			TOTAL		=	3.136	Amps	R36	

							Time	R36	
3	lights for closed breakers (@ 0.154 each)	3	x	0.154	=	0.462	11m15s-11m17s	R36	
1	breaker closing coils (Peak)	1	x	15.000	=	15.000		R36	(Ref. 88 & 89)
0	breaker closing coils (Continuous)	0	x	5.000	=	0.000		R36	
1	lights for closing breakers (@ 0.231 each)	1	x	0.231	=	0.231		R36	
9	lights for tripped breakers (@ 0.231 each)	9	x	0.231	=	2.079		R36	
0	breaker tripping coils	0	x	1.080	=	0.000		R36	(Ref. 88 & 89)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		R36	
	Relays energized:							R36	
0	HEA	0	x	5.400	=	0.000		R36	
3	HFA	3	x	0.062	=	0.186		R36	
1	HGA	1	x	0.038	=	0.038		R36	
2	UV Relay	2	x	0.070	=	0.140		R36	
			TOTAL		=	18.136	Amps	R36	

							Time	R36	
3	lights for closed breakers (@ 0.154 each)	3	x	0.154	=	0.462	11m17s-11m30s	R36	
0	breaker closing coils (Peak)	0	x	15.000	=	0.000		R36	(Ref. 88 & 89)
1	breaker closing coils (Continuous)	1	x	5.000	=	5.000		R36	
1	lights for closing breakers (@ 0.231 each)	1	x	0.231	=	0.231		R36	
9	lights for tripped breakers (@ 0.231 each)	9	x	0.231	=	2.079		R36	
0	breaker tripping coils	0	x	1.080	=	0.000		R36	(Ref. 88 & 89)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		R36	
	Relays energized:							R36	
0	HEA	0	x	5.400	=	0.000		R36	
3	HFA	3	x	0.062	=	0.186		R36	
1	HGA	1	x	0.038	=	0.038		R36	
2	UV Relay	2	x	0.070	=	0.140		R36	
			TOTAL		=	8.136	Amps	R36	

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LOOP Condition R36

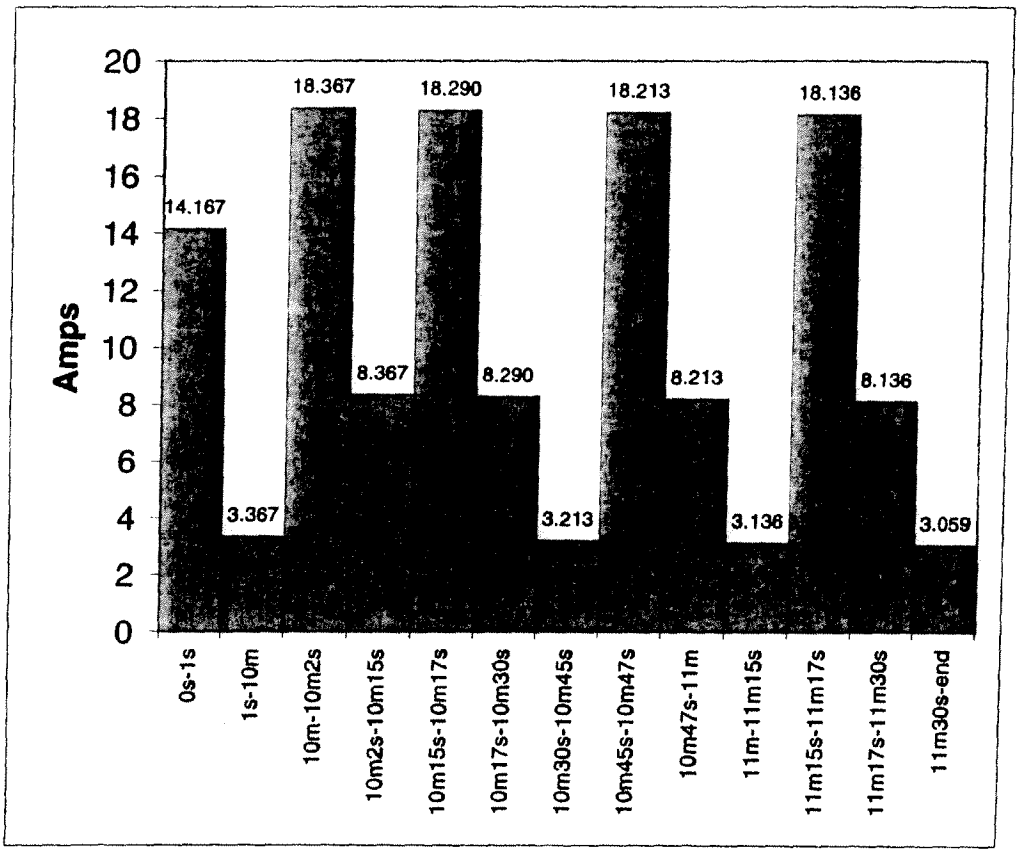
							Time	R36	
4	lights for closed breakers (@ 0.154 each)	4	x	0.154	=	0.616	11m30s-end	R36	
0	breaker closing coils (Peak)	0	x	15.000	=	0.000		R36	(Ref. 88 & 89)
0	breaker closing coils (Continuous)	0	x	5.000	=	0.000		R36	
0	lights for closing breakers (@ 0.231 each)	0	x	0.231	=	0.000		R36	
9	lights for tripped breakers (@ 0.231 each)	9	x	0.231	=	2.079		R36	
0	breaker tripping coils	0	x	1.080	=	0.000		R36	(Ref. 88 & 89)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		R36	
	Relays energized:							R36	
0	HEA	0	x	5.400	=	0.000		R36	
3	HFA	3	x	0.062	=	0.186		R36	
1	HGA	1	x	0.038	=	0.038		R36	
2	UV Relay	2	x	0.070	=	0.140		R36	
			TOTAL		=	3.059	Amps	R36	

4kV Switchgear 13 **Page 8 of 12** R36

LOOP Condition

NOTES

1.) At t=0s all closed breakers trip. 4kV SWGR 13 sheds all load.
2.) At t=1s all 4kV SWGR 13 loads have been shed (i.e. all breakers have completed tripping).
3.) At t=10m feed breaker to 4kV SWGR 13-1 closes. R36
4.) At t=10m15s feed breaker to RHR SWP 1A or 1B closes. R36
5.) At t=10m45s feed breaker to SW Pump 1A closes. R36
6.) At t=11m15s feed breaker to CRD Feed Pump 1A closes. R36



R36

4kV Switchgear 13 **Page 9 of 12** R36

LOOP & LOCA Condition

The maximum dc load on the circuit under LOOP & LOCA condition is:

						Time		
0	lights for closed breakers (@ 0.154 each)	0 x	0.154	=	0.000	0s-1s	R36	
0	breaker closing coils	0 x	15.000	=	0.000		R36	(Ref. 88 & 89)
0	lights for closing breakers (@ 0.231 each)	0 x	0.231	=	0.000		R36	
3	lights for tripped breakers (@ 0.231 each)	3 x	0.231	=	0.693		R36	
10	breaker tripping coils	10 x	1.080	=	10.800		R36	(Ref. 88 & 89)
10	lights for tripping breakers (@ 0.231 each)	10 x	0.231	=	2.310		R36	
	Relays energized:							
0	HEA	0 x	5.400	=	0.000			
3	HFA	3 x	0.062	=	0.186			
1	HGA	1 x	0.038	=	0.038			
2	UV Relay	2 x	0.070	=	0.140			
		TOTAL		=	14.167	Amps	R36	

						Time		
0	lights for closed breakers (@ 0.154 each)	0 x	0.154	=	0.000	1s-10m15s	R36	
0	breaker closing coils	0 x	15.000	=	0.000		R36	(Ref. 88 & 89)
0	lights for closing breakers (@ 0.231 each)	0 x	0.231	=	0.000		R36	
13	lights for tripped breakers (@ 0.231 each)	13 x	0.231	=	3.003		R36	
0	breaker tripping coils	0 x	1.080	=	0.000		R36	(Ref. 88 & 89)
0	lights for tripping breakers (@ 0.231 each)	0 x	0.231	=	0.000		R36	
	Relays energized:							
0	HEA	0 x	5.400	=	0.000			
3	HFA	3 x	0.062	=	0.186			
1	HGA	1 x	0.038	=	0.038			
2	UV Relay	2 x	0.070	=	0.140			
		TOTAL		=	3.367	Amps	R36	

						Time		
0	lights for closed breakers (@ 0.154 each)	0 x	0.154	=	0.000	10m15s-10m17s	R36	
1	breaker closing coils (Peak)	1 x	15.000	=	15.000		R36	(Ref. 88 & 89)
0	breaker closing coils (Continuous)	0 x	5.000	=	0.000		R36	
1	lights for closing breakers (@ 0.231 each)	1 x	0.231	=	0.231		R36	
12	lights for tripped breakers (@ 0.231 each)	12 x	0.231	=	2.772		R36	
0	breaker tripping coils	0 x	1.080	=	0.000		R36	(Ref. 88 & 89)
0	lights for tripping breakers (@ 0.231 each)	0 x	0.231	=	0.000		R36	
	Relays energized:							
0	HEA	0 x	5.400	=	0.000		R36	
3	HFA	3 x	0.062	=	0.186		R36	
1	HGA	1 x	0.038	=	0.038			
2	UV Relay	2 x	0.070	=	0.140		R36	
		TOTAL		=	18.367	Amps	R36	

4kV Switchgear 13 **Page 10 of 12** R36

LOOP & LOCA Condition

							Time		
0	lights for closed breakers (@ 0.154 each)	0	x	0.154	=	0.000	10m17s-10m30s	R36	
0	breaker closing coils (Peak)	0	x	15.000	=	0.000		R36	(Ref. 88 & 89)
1	breaker closing coils (Continuous)	1	x	5.000	=	5.000		R36	
1	lights for closing breakers (@ 0.231 each)	1	x	0.231	=	0.231		R36	
12	lights for tripped breakers (@ 0.231 each)	12	x	0.231	=	2.772		R36	
0	breaker tripping coils	0	x	1.080	=	0.000		R36	(Ref. 88 & 89)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		R36	
	Relays energized:								
0	HEA	0	x	5.400	=	0.000		R36	
3	HFA	3	x	0.062	=	0.186		R36	
1	HGA	1	x	0.038	=	0.038			
2	UV Relay	2	x	0.070	=	0.140		R36	
			TOTAL		=	8.367 Amps		R36	
							Time		
1	lights for closed breakers (@ 0.154 each)	1	x	0.154	=	0.154	10m30s-10m32s	R36	
1	breaker closing coils (Peak)	1	x	15.000	=	15.000		R36	(Ref. 88 & 89)
0	breaker closing coils (Continuous)	0	x	5.000	=	0.000		R36	
1	lights for closing breakers (@ 0.231 each)	1	x	0.231	=	0.231		R36	
11	lights for tripped breakers (@ 0.231 each)	11	x	0.231	=	2.541		R36	
0	breaker tripping coils	0	x	1.080	=	0.000		R36	(Ref. 88 & 89)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		R36	
	Relays energized:								
0	HEA	0	x	5.400	=	0.000		R36	
3	HFA	3	x	0.062	=	0.186		R36	
1	HGA	1	x	0.038	=	0.038			
2	UV Relay	2	x	0.070	=	0.140		R36	
			TOTAL		=	18.290 Amps		R36	
							Time	R36	
1	lights for closed breakers (@ 0.154 each)	1	x	0.154	=	0.154	10m32s-10m45s	R36	
0	breaker closing coils (Peak)	0	x	15.000	=	0.000		R36	(Ref. 88 & 89)
1	breaker closing coils (Continuous)	1	x	5.000	=	5.000		R36	
1	lights for closing breakers (@ 0.231 each)	1	x	0.231	=	0.231		R36	
11	lights for tripped breakers (@ 0.231 each)	11	x	0.231	=	2.541		R36	
0	breaker tripping coils	0	x	1.080	=	0.000		R36	(Ref. 88 & 89)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		R36	
	Relays energized:							R36	
0	HEA	0	x	5.400	=	0.000		R36	
3	HFA	3	x	0.062	=	0.186		R36	
1	HGA	1	x	0.038	=	0.038		R36	
2	UV Relay	2	x	0.070	=	0.140		R36	
			TOTAL		=	8.290 Amps		R36	

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LOOP & LOCA Condition R36

						Time	R36	
2	lights for closed breakers (@ 0.154 each)	2	x	0.154	=	0.308	10m45s-end	R36	
0	breaker closing coils (Peak)	0	x	15.000	=	0.000		R36	(Ref. 88 & 89)
0	breaker closing coils (Continuous)	0	x	5.000	=	0.000		R36	
0	lights for closing breakers (@ 0.231 each)	0	x	0.231	=	0.000		R36	
11	lights for tripped breakers (@ 0.231 each)	11	x	0.231	=	2.541		R36	
0	breaker tripping coils	0	x	1.080	=	0.000		R36	(Ref. 88 & 89)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		R36	
	Relays energized:							R36	
0	HEA	0	x	5.400	=	0.000		R36	
3	HFA	3	x	0.062	=	0.186		R36	
1	HGA	1	x	0.038	=	0.038		R36	
2	UV Relay	2	x	0.070	=	0.140		R36	
			TOTAL		=	3.213	Amps	R36	

4kV Switchgear 13 **Page 12 of 12** R36

LOOP & LOCA Condition

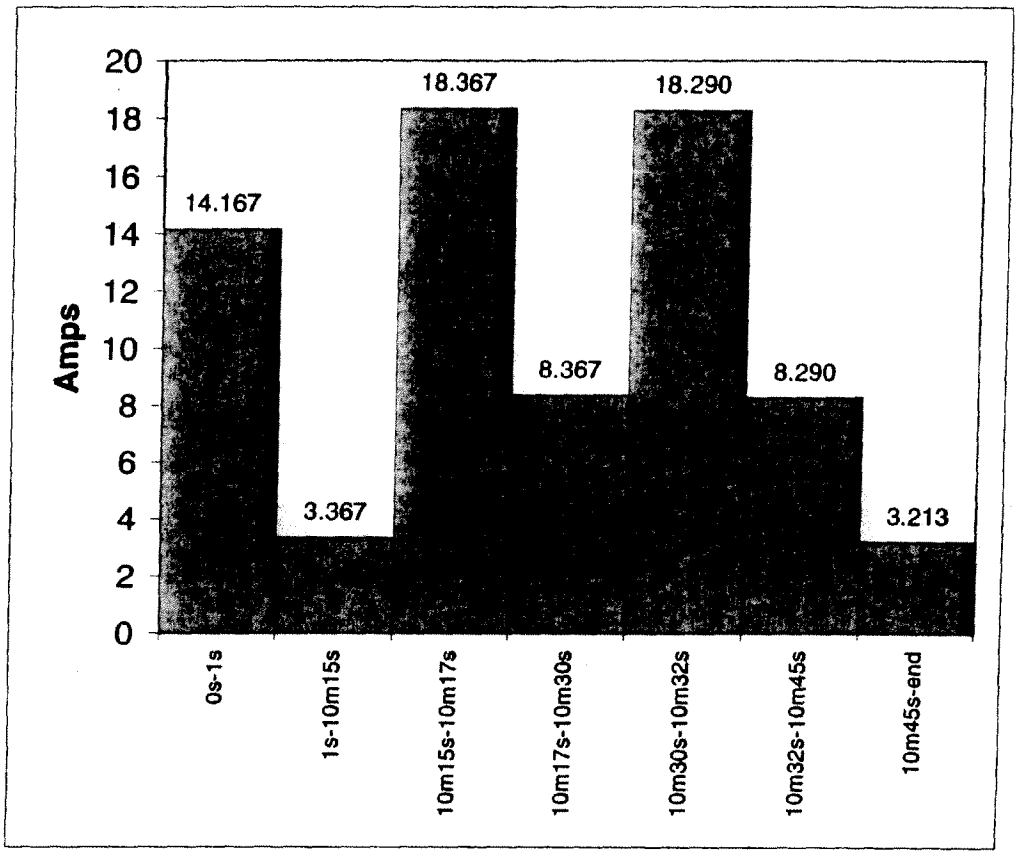
NOTES

1.) At t=0s all closed breakers trip. 4kV SWGR 13 sheds all load.

2.) At t=1s all 4kV SWGR 13 loads have been shed (i.e. all breakers have completed tripping).

3.) At t=10m15s feed breaker to 4kV SWGR 13-1 closes. R36

4.) At t=10m30s feed breaker to RHR SWP 1A or 1B closes. R36



R36

Bus Panel #1 Circuit 1
4kV Switchgear Bus 13-1 Main Feed

 R36

4kV Switchgear 13-1 AC Loads

Bkr. #	Service	AC Bkr. Status			S/D	Rev.
		On-Line	LOOP/ LOOP & LOCA (t=1)	LOOP/ LOOP & LOCA (After)		
152-1321	DG 1/2	T	T	C/C	4E-1345	SH.1, BB
152-1322	Core Spray Pump 1A	T	T	T/C	4E-1429	M
152-1323	Pump House	C	T	T/T	4E-1387D	H
152-1324	RHR Pump 1B	T	T	T/C**	4E-1438Q	Q
152-1325	480V Switchgear 18	C	C	C/C	4E-1349	SH.1, Q
152-1326	480V Transformer 10	C	T	T/T	4E-6230	B
152-1327	Main Feed	C	T	C/C	4E-1344	SH.3, E
152-1328	RHR Pump 1A	T	T	T/C**	4E-1438Q	Q
152-1329	Div. I Cross-Tie to Bus 23-1	T	T	T/T	4E-1345	SH.4, A
152-1330	SBO DG*	T	T	T/T	---	---

R36

*NOTE: The SBO breaker remains tripped when there is a LOCA on either unit. Since the scenario modeled is a LOOP on both units 1 & 2 and a LOCA on one unit, the SBO breaker is not modeled as closing.

** Only 1 pump remains energized at the end of the LOOP & LOCA scenario.

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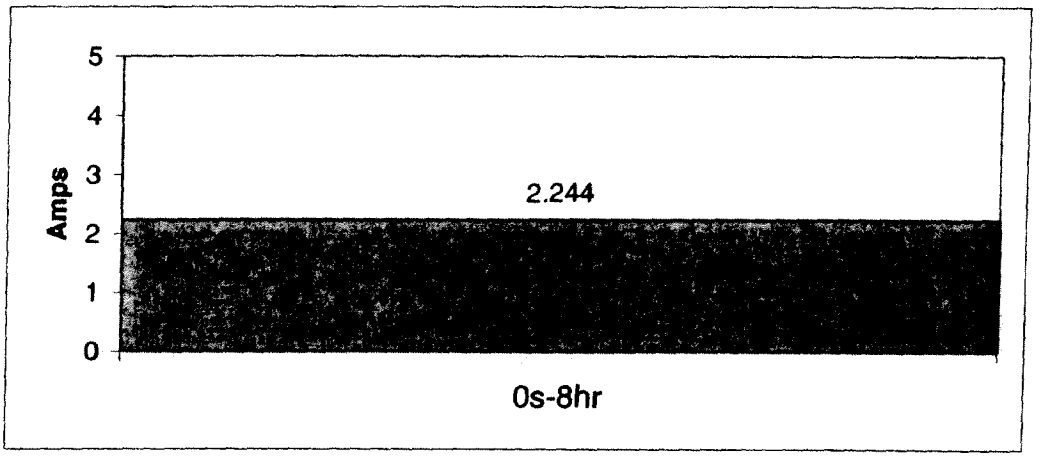
NORMAL CONDITION

The maximum dc load on the circuit under normal condition is:

						Time	
4	lights for closed breakers (@ 0.154 each)	4 x	0.154	=	0.616	0s-8hr	R36
6	lights for tripped breakers (@ 0.231 each)	6 x	0.231	=	1.386		R36
	No switching of breakers						
	Relays energized:						
0	SA-1 Relay	0 x	0.055	=	0.000		
1	Agastat Relay	1 x	0.064	=	0.064		
0	HFA	0 x	0.062	=	0.000		
1	HGA	1 x	0.038	=	0.038		
2	UV Relay	2 x	0.070	=	0.140		
		TOTAL		=	2.244 Amps		



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LOOP Condition

The maximum dc load on the circuit under LOOP condition is:

						Time		
1	lights for closed breakers (@ 0.154 each)	1 x	0.154	=	0.154	0s-1s		
0	breaker closing coils	0 x	15.000	=	0.000			(Ref. 90)
0	lights for closing breakers (@ 0.231 each)	0 x	0.231	=	0.000			
6	lights for tripped breakers (@ 0.231 each)	6 x	0.231	=	1.386			
3	breaker tripping coils	3 x	1.080	=	3.240			(Ref. 90)
3	lights for tripping breakers (@ 0.231 each)	3 x	0.231	=	0.693			
	Relays energized:							
0	SA-1 Relay	0 x	0.055	=	0.000			
4	Agastat Relay	4 x	0.064	=	0.256			
3	HFA	3 x	0.062	=	0.186		R40	
1	HGA	1 x	0.038	=	0.038			
4	UV Relay	4 x	0.070	=	0.280			
1	Joslyn Clark Relay	1 x	0.150	=	0.150		R40	
		TOTAL		=	6.383 Amps		R40	
						Time		
1	lights for closed breakers (@ 0.154 each)	1 x	0.154	=	0.154	1s-10s		
0	breaker closing coils	0 x	15.000	=	0.000			(Ref. 90)
0	lights for closing breakers (@ 0.231 each)	0 x	0.231	=	0.000			
9	lights for tripped breakers (@ 0.231 each)	9 x	0.231	=	2.079			
0	breaker tripping coils	0 x	1.080	=	0.000			(Ref. 90)
0	lights for tripping breakers (@ 0.231 each)	0 x	0.231	=	0.000			
	Relays energized:							
0	SA-1 Relay	0 x	0.055	=	0.000			
4	Agastat Relay	4 x	0.064	=	0.256			
3	HFA	3 x	0.062	=	0.186		R40	
1	HGA	1 x	0.038	=	0.038			
4	UV Relay	4 x	0.070	=	0.280			
1	Joslyn Clark Relay	1 x	0.150	=	0.150		R40	
		TOTAL		=	3.143 Amps		R40	
						Time		
1	lights for closed breakers (@ 0.154 each)	1 x	0.154	=	0.154	10s-12s		
1	breaker closing coils (Peak)	1 x	15.000	=	15.000			(Ref. 90)
0	breaker closing coils (Continuous)	0 x	5.000	=	0.000			
1	lights for closing breakers (@ 0.231 each)	1 x	0.231	=	0.231			
8	lights for tripped breakers (@ 0.231 each)	8 x	0.231	=	1.848			
0	breaker tripping coils	0 x	1.080	=	0.000			(Ref. 90)
0	lights for tripping breakers (@ 0.231 each)	0 x	0.231	=	0.000			
	Relays energized:							
1	Interposing Relay	1 x	0.235	=	0.235			
0	SA-1 Relay	0 x	0.055	=	0.000			
4	Agastat Relay	4 x	0.064	=	0.256			
3	HFA	3 x	0.062	=	0.186		R40	
1	HGA	1 x	0.038	=	0.038			
4	UV Relay	4 x	0.070	=	0.280			
1	Joslyn Clark Relay	1 x	0.150	=	0.150		R40	
		TOTAL		=	18.378 Amps		R40	

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LOOP Condition

							Time		
1	lights for closed breakers (@ 0.154 each)	1	x	0.154	=	0.154	12s-25s		
0	breaker closing coils (Peak)	0	x	15.000	=	0.000			(Ref. 90)
1	breaker closing coils (Continuous)	1	x	5.000	=	5.000			
1	lights for closing breakers (@ 0.231 each)	1	x	0.231	=	0.231			
8	lights for tripped breakers (@ 0.231 each)	8	x	0.231	=	1.848			
0	breaker tripping coils	0	x	1.080	=	0.000			(Ref. 90)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000			
	Relays energized:								
0	SA-1 Relay	0	x	0.055	=	0.000			
4	Agastat Relay	4	x	0.064	=	0.256			
3	HFA	3	x	0.062	=	0.186		R40	
1	HGA	1	x	0.038	=	0.038			
4	UV Relay	4	x	0.070	=	0.280			
1	Joslyn Clark Relay	1	x	0.150	=	0.150		R40	
			TOTAL		=	8.143 Amps		R40	
							Time		
2	lights for closed breakers (@ 0.154 each)	2	x	0.154	=	0.308	25s-10m		
0	breaker closing coils (Peak)	0	x	15.000	=	0.000			(Ref. 90)
0	breaker closing coils (Continuous)	0	x	5.000	=	0.000			
0	lights for closing breakers (@ 0.231 each)	0	x	0.231	=	0.000			
8	lights for tripped breakers (@ 0.231 each)	8	x	0.231	=	1.848			
0	breaker tripping coils	0	x	1.080	=	0.000			(Ref. 90)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000			
	Relays energized:								
0	SA-1 Relay	0	x	0.055	=	0.000			
4	Agastat Relay	4	x	0.064	=	0.256			
3	HFA	3	x	0.062	=	0.186		R40	
1	HGA	1	x	0.038	=	0.038			
4	UV Relay	4	x	0.070	=	0.280			
1	Joslyn Clark Relay	1	x	0.150	=	0.150		R40	
			TOTAL		=	3.066 Amps		R40	
							Time		
2	lights for closed breakers (@ 0.154 each)	2	x	0.154	=	0.308	10m-10m2s		
1	breaker closing coils (Peak)	1	x	15.000	=	15.000			(Ref. 90)
0	breaker closing coils (Continuous)	0	x	5.000	=	0.000			
1	lights for closing breakers (@ 0.231 each)	1	x	0.231	=	0.231			
8	lights for tripped breakers (@ 0.231 each)	8	x	0.231	=	1.848			
0	breaker tripping coils	0	x	1.080	=	0.000			(Ref. 90)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000			
	Relays energized:								
0	SA-1 Relay	0	x	0.055	=	0.000			
4	Agastat Relay	4	x	0.064	=	0.256			
3	HFA	3	x	0.062	=	0.186		R40	
1	HGA	1	x	0.038	=	0.038			
4	UV Relay	4	x	0.070	=	0.280			
1	Joslyn Clark Relay	1	x	0.150	=	0.150		R40	
			TOTAL		=	18.297 Amps		R40	

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LOOP Condition

							Time		
2	lights for closed breakers (@ 0.154 each)	2	x	0.154	=	0.308	10m2s-10m15s		
0	breaker closing coils (Peak)	0	x	15.000	=	0.000			(Ref. 90)
1	breaker closing coils (Continuous)	1	x	5.000	=	5.000			
1	lights for closing breakers (@ 0.231 each)	1	x	0.231	=	0.231			
8	lights for tripped breakers (@ 0.231 each)	8	x	0.231	=	1.848			
0	breaker tripping coils	0	x	1.080	=	0.000			(Ref. 90)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000			
	Relays energized:								
0	SA-1 Relay	0	x	0.055	=	0.000			
4	Agastat Relay	4	x	0.064	=	0.256			
3	HFA	3	x	0.062	=	0.186		R40	
1	HGA	1	x	0.038	=	0.038			
4	UV Relay	4	x	0.070	=	0.280			
1	Joslyn Clark Relay	1	x	0.150	=	0.150		R40	
			TOTAL		=	8.297 Amps		R40	
							Time		
3	lights for closed breakers (@ 0.154 each)	3	x	0.154	=	0.462	10m15s-end		
0	breaker closing coils (Peak)	0	x	15.000	=	0.000			(Ref. 90)
0	breaker closing coils (Continuous)	0	x	5.000	=	0.000			
0	lights for closing breakers (@ 0.231 each)	0	x	0.231	=	0.000			
8	lights for tripped breakers (@ 0.231 each)	8	x	0.231	=	1.848			
0	breaker tripping coils	0	x	1.080	=	0.000			(Ref. 90)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000			
	Relays energized:								
0	SA-1 Relay	0	x	0.055	=	0.000			
4	Agastat Relay	4	x	0.064	=	0.256			
3	HFA	3	x	0.062	=	0.186		R40	
1	HGA	1	x	0.038	=	0.038			
4	UV Relay	4	x	0.070	=	0.280			
1	Joslyn Clark Relay	1	x	0.150	=	0.150		R40	
			TOTAL		=	3.220 Amps		R40	

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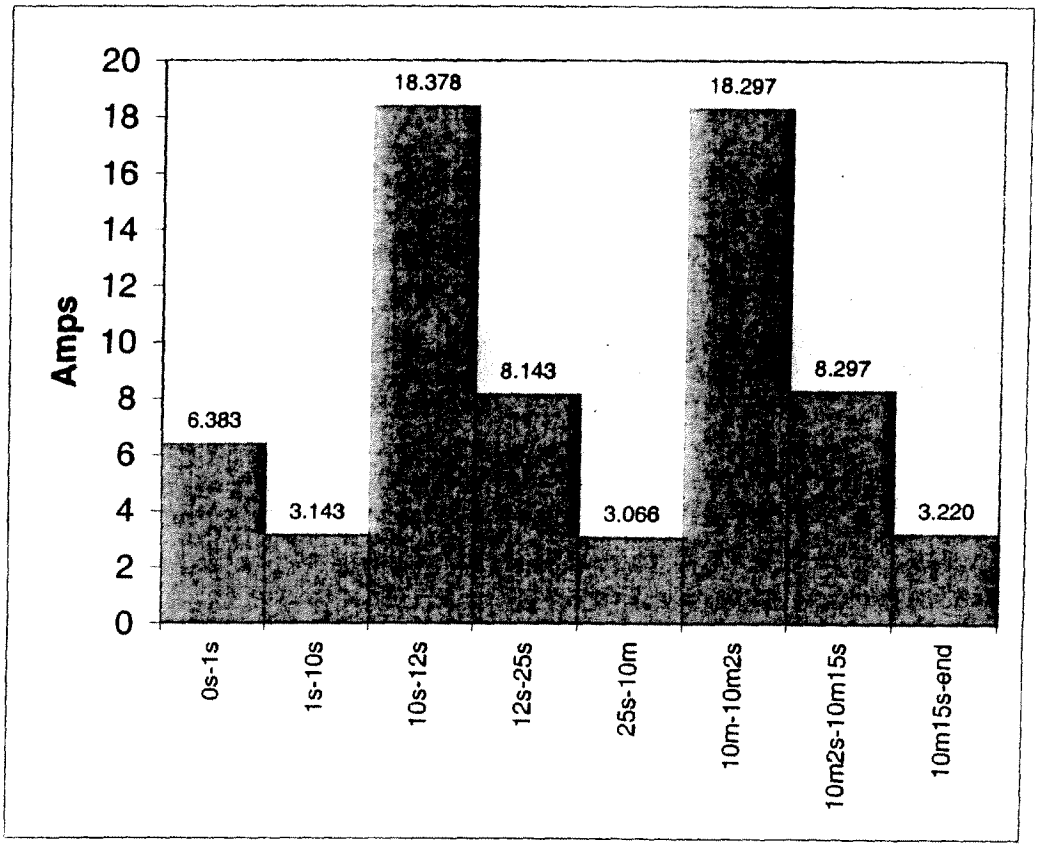
LOOP Condition

NOTES

1.) At t=0s all closed breakers trip except for 480V SWGR 18 feed. 4kV SWGR 13-1 sheds loads.
2.) At t=1s all 4kV SWGR 13-1 loads have been shed except for 480V SWGR 18
(i.e. all breakers have completed tripping).
3.) At t=10s DG 1/2 breaker closes.
4.) At t=10m close Main Feed breaker to 4kV SWGR 13.

NOTE:
The SBO breaker remains tripped when there is a LOCA on either unit.
Since the scenario modeled is a LOOP on both units 1 & 2 and a LOCA on
one unit, the SBO breaker is not modeled as closing.



R40

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LOOP & LOCA Condition

The maximum dc load on the circuit under LOOP & LOCA condition is:

						Time		
1	lights for closed breakers (@ 0.154 each)	1	x	0.154	=	0.154	0s-1s	
0	breaker closing coils (Peak)	0	x	15.000	=	0.000		(Ref. 90)
0	breaker closing coils (Continuous)	0	x	5.000	=	0.000		
0	lights for closing breakers (@ 0.231 each)	0	x	0.231	=	0.000		
6	lights for tripped breakers (@ 0.231 each)	6	x	0.231	=	1.386		
3	breaker tripping coils	3	x	1.080	=	3.240		(Ref. 90)
3	lights for tripping breakers (@ 0.231 each)	3	x	0.231	=	0.693		
	Relays energized:							
0	SA-1 Relay	0	x	0.055	=	0.000		
4	Agastat Relay	4	x	0.064	=	0.256		
3	HFA	3	x	0.062	=	0.186	R40	
1	HGA	1	x	0.038	=	0.038		
4	UV Relay	4	x	0.070	=	0.280		
1	Joslyn Clark Relay	1	x	0.150	=	0.150	R40	
			TOTAL		=	6.383 Amps	R40	
						Time		
1	lights for closed breakers (@ 0.154 each)	1	x	0.154	=	0.154	1s-10s	
0	breaker closing coils (Peak)	0	x	15.000	=	0.000		(Ref. 90)
0	breaker closing coils (Continuous)	0	x	5.000	=	0.000		
0	lights for closing breakers (@ 0.231 each)	0	x	0.231	=	0.000		
9	lights for tripped breakers (@ 0.231 each)	9	x	0.231	=	2.079		
0	breaker tripping coils	0	x	1.080	=	0.000		(Ref. 90)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		
	Relays energized:							
0	SA-1 Relay	0	x	0.055	=	0.000		
4	Agastat Relay	4	x	0.064	=	0.256		
3	HFA	3	x	0.062	=	0.186	R40	
1	HGA	1	x	0.038	=	0.038		
4	UV Relay	4	x	0.070	=	0.280		
1	Joslyn Clark Relay	1	x	0.150	=	0.150	R40	
			TOTAL		=	3.143 Amps	R40	
						Time		
1	lights for closed breakers (@ 0.154 each)	1	x	0.154	=	0.154	10s-12s	
1	breaker closing coils (Peak)	1	x	15.000	=	15.000		(Ref. 90)
0	breaker closing coils (Continuous)	0	x	5.000	=	0.000		
1	lights for closing breakers (@ 0.231 each)	1	x	0.231	=	0.231		
8	lights for tripped breakers (@ 0.231 each)	8	x	0.231	=	1.848		
0	breaker tripping coils	0	x	1.080	=	0.000		(Ref. 90)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		
	Relays energized:							
1	Interposing Relay	1	x	0.235	=	0.235		
0	SA-1 Relay	0	x	0.055	=	0.000		
4	Agastat Relay	4	x	0.064	=	0.256		
3	HFA	3	x	0.062	=	0.186	R40	
1	HGA	1	x	0.038	=	0.038		
4	UV Relay	4	x	0.070	=	0.280		
1	Joslyn Clark Relay	1	x	0.150	=	0.150	R40	
			TOTAL		=	18.378 Amps	R40	

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LOOP & LOCA Condition

						Time 12s-13s		
1	lights for closed breakers (@ 0.154 each)	1	x	0.154	=	0.154		
0	breaker closing coils (Peak)	0	x	15.000	=	0.000		(Ref. 90)
1	breaker closing coils (Continuous)	1	x	5.000	=	5.000		
1	lights for closing breakers (@ 0.231 each)	1	x	0.231	=	0.231		
8	lights for tripped breakers (@ 0.231 each)	8	x	0.231	=	1.848		
0	breaker tripping coils	0	x	1.080	=	0.000		(Ref. 90)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		
	Relays energized:							
0	SA-1 Relay	0	x	0.055	=	0.000		
4	Agastat Relay	4	x	0.064	=	0.256		
3	HFA	3	x	0.062	=	0.186	R40	
1	HGA	1	x	0.038	=	0.038		
4	UV Relay	4	x	0.070	=	0.280		
1	Joslyn Clark Relay	1	x	0.150	=	0.150	R40	
			TOTAL		=	8.143 Amps	R40	
						Time 13s-15s		
1	lights for closed breakers (@ 0.154 each)	1	x	0.154	=	0.154		
1	breaker closing coils (Peak)	1	x	15.000	=	15.000		(Ref. 90)
1	breaker closing coils (Continuous)	1	x	5.000	=	5.000		
2	lights for closing breakers (@ 0.231 each)	2	x	0.231	=	0.462		
7	lights for tripped breakers (@ 0.231 each)	7	x	0.231	=	1.617		
0	breaker tripping coils	0	x	1.080	=	0.000		(Ref. 90)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		
	Relays energized:							
0	SA-1 Relay	0	x	0.055	=	0.000		
4	Agastat Relay	4	x	0.064	=	0.256		
3	HFA	3	x	0.062	=	0.186	R40	
1	HGA	1	x	0.038	=	0.038		
4	UV Relay	4	x	0.070	=	0.280		
1	Joslyn Clark Relay	1	x	0.150	=	0.150	R40	
			TOTAL		=	23.143 Amps	R40	
						Time 15s-18s		
1	lights for closed breakers (@ 0.154 each)	1	x	0.154	=	0.154		
0	breaker closing coils (Peak)	0	x	15.000	=	0.000		(Ref. 90)
2	breaker closing coils (Continuous)	2	x	5.000	=	10.000		
2	lights for closing breakers (@ 0.231 each)	2	x	0.231	=	0.462		
7	lights for tripped breakers (@ 0.231 each)	7	x	0.231	=	1.617		
0	breaker tripping coils	0	x	1.080	=	0.000		(Ref. 90)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		
	Relays energized:							
0	SA-1 Relay	0	x	0.055	=	0.000		
4	Agastat Relay	4	x	0.064	=	0.256		
3	HFA	3	x	0.062	=	0.186	R40	
1	HGA	1	x	0.038	=	0.038		
4	UV Relay	4	x	0.070	=	0.280		
1	Joslyn Clark Relay	1	x	0.150	=	0.150	R40	
			TOTAL		=	13.143 Amps	R40	

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LOOP & LOCA Condition

						Time		
1	lights for closed breakers (@ 0.154 each)	1 x	0.154	=	0.154	18s-20s		
1	breaker closing coils (Peak)	1 x	15.000	=	15.000			(Ref. 90)
2	breaker closing coils (Continuous)	2 x	5.000	=	10.000			
3	lights for closing breakers (@ 0.231 each)	3 x	0.231	=	0.693			
6	lights for tripped breakers (@ 0.231 each)	6 x	0.231	=	1.386			
0	breaker tripping coils	0 x	1.080	=	0.000			(Ref. 90)
0	lights for tripping breakers (@ 0.231 each)	0 x	0.231	=	0.000			
	Relays energized:							
0	SA-1 Relay	0 x	0.055	=	0.000			
4	Agastat Relay	4 x	0.064	=	0.256			
3	HFA	3 x	0.062	=	0.186		R40	
1	HGA	1 x	0.038	=	0.038			
4	UV Relay	4 x	0.070	=	0.280			
1	Joslyn Clark Relay	1 x	0.150	=	0.150		R40	
		TOTAL		=	28.143 Amps		R40	
						Time		
1	lights for closed breakers (@ 0.154 each)	1 x	0.154	=	0.154	20s-23s		
0	breaker closing coils (Peak)	0 x	15.000	=	0.000			(Ref. 90)
3	breaker closing coils (Continuous)	3 x	5.000	=	15.000			
3	lights for closing breakers (@ 0.231 each)	3 x	0.231	=	0.693			
6	lights for tripped breakers (@ 0.231 each)	6 x	0.231	=	1.386			
0	breaker tripping coils	0 x	1.080	=	0.000			(Ref. 90)
0	lights for tripping breakers (@ 0.231 each)	0 x	0.231	=	0.000			
	Relays energized:							
0	SA-1 Relay	0 x	0.055	=	0.000			
4	Agastat Relay	4 x	0.064	=	0.256			
3	HFA	3 x	0.062	=	0.186		R40	
1	HGA	1 x	0.038	=	0.038			
4	UV Relay	4 x	0.070	=	0.280			
1	Joslyn Clark Relay	1 x	0.150	=	0.150		R40	
		TOTAL		=	18.143 Amps		R40	
						Time		
1	lights for closed breakers (@ 0.154 each)	1 x	0.154	=	0.154	23-25s		
1	breaker closing coils (Peak)	1 x	15.000	=	15.000			(Ref. 90)
3	breaker closing coils (Continuous)	3 x	5.000	=	15.000			
4	lights for closing breakers (@ 0.231 each)	4 x	0.231	=	0.924			
5	lights for tripped breakers (@ 0.231 each)	5 x	0.231	=	1.155			
0	breaker tripping coils	0 x	1.080	=	0.000			(Ref. 90)
0	lights for tripping breakers (@ 0.231 each)	0 x	0.231	=	0.000			
	Relays energized:							
0	SA-1 Relay	0 x	0.055	=	0.000			
4	Agastat Relay	4 x	0.064	=	0.256			
3	HFA	3 x	0.062	=	0.186		R40	
1	HGA	1 x	0.038	=	0.038			
4	UV Relay	4 x	0.070	=	0.280			
1	Joslyn Clark Relay	1 x	0.150	=	0.150		R40	
		TOTAL		=	33.143 Amps		R40	

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LOOP & LOCA Condition

						Time 25s-28s		
2	lights for closed breakers (@ 0.154 each)	2	x	0.154	=	0.308		
0	breaker closing coils (Peak)	0	x	15.000	=	0.000		(Ref. 90)
3	breaker closing coils (Continuous)	3	x	5.000	=	15.000		
3	lights for closing breakers (@ 0.231 each)	3	x	0.231	=	0.693		
5	lights for tripped breakers (@ 0.231 each)	5	x	0.231	=	1.155		
0	breaker tripping coils	0	x	1.080	=	0.000		(Ref. 90)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		
	Relays energized:							
0	SA-1 Relay	0	x	0.055	=	0.000		
4	Agastat Relay	4	x	0.064	=	0.256		
3	HFA	3	x	0.062	=	0.186	R40	
1	HGA	1	x	0.038	=	0.038		
4	UV Relay	4	x	0.070	=	0.280		
1	Joslyn Clark Relay	1	x	0.150	=	0.150	R40	
					=	18.066 Amps	R40	
						Time 28s-33s		
3	lights for closed breakers (@ 0.154 each)	3	x	0.154	=	0.462		
0	breaker closing coils (Peak)	0	x	15.000	=	0.000		(Ref. 90)
2	breaker closing coils (Continuous)	2	x	5.000	=	10.000		
2	lights for closing breakers (@ 0.231 each)	2	x	0.231	=	0.462		
5	lights for tripped breakers (@ 0.231 each)	5	x	0.231	=	1.155		
0	breaker tripping coils	0	x	1.080	=	0.000		(Ref. 90)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		
	Relays energized:							
0	SA-1 Relay	0	x	0.055	=	0.000		
4	Agastat Relay	4	x	0.064	=	0.256		
3	HFA	3	x	0.062	=	0.186	R40	
1	HGA	1	x	0.038	=	0.038		
4	UV Relay	4	x	0.070	=	0.280		
1	Joslyn Clark Relay	1	x	0.150	=	0.150	R40	
		TOTAL			=	12.989 Amps	R40	
						Time 33s-38s		
4	lights for closed breakers (@ 0.154 each)	4	x	0.154	=	0.616		
0	breaker closing coils (Peak)	0	x	15.000	=	0.000		(Ref. 90)
1	breaker closing coils (Continuous)	1	x	5.000	=	5.000		
1	lights for closing breakers (@ 0.231 each)	1	x	0.231	=	0.231		
5	lights for tripped breakers (@ 0.231 each)	5	x	0.231	=	1.155		
0	breaker tripping coils	0	x	1.080	=	0.000		(Ref. 90)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		
	Relays energized:							
0	SA-1 Relay	0	x	0.055	=	0.000		
4	Agastat Relay	4	x	0.064	=	0.256		
3	HFA	3	x	0.062	=	0.186	R40	
1	HGA	1	x	0.038	=	0.038		
4	UV Relay	4	x	0.070	=	0.280		
1	Joslyn Clark Relay	1	x	0.150	=	0.150	R40	
		TOTAL			=	7.912 Amps	R40	

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LOOP & LOCA Condition

						Time		
5	lights for closed breakers (@ 0.154 each)	5	x	0.154	=	0.770	38s-10m	
0	breaker closing coils (Peak)	0	x	15.000	=	0.000		(Ref. 90)
0	breaker closing coils (Continuous)	0	x	5.000	=	0.000		
0	lights for closing breakers (@ 0.231 each)	0	x	0.231	=	0.000		
5	lights for tripped breakers (@ 0.231 each)	5	x	0.231	=	1.155		
0	breaker tripping coils	0	x	1.080	=	0.000		(Ref. 90)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		
	Relays energized:							
0	SA-1 Relay	0	x	0.055	=	0.000		
4	Agastat Relay	4	x	0.064	=	0.256		
3	HFA	3	x	0.062	=	0.186	R40	
1	HGA	1	x	0.038	=	0.038		
4	UV Relay	4	x	0.070	=	0.280		
1	Joslyn Clark Relay	1	x	0.150	=	0.150	R40	
			TOTAL		=	2.835 Amps	R40	
						Time		
4	lights for closed breakers (@ 0.154 each)	4	x	0.154	=	0.616	10m-10m1s	
0	breaker closing coils (Peak)	0	x	15.000	=	0.000		(Ref. 90)
0	breaker closing coils (Continuous)	0	x	5.000	=	0.000		
0	lights for closing breakers (@ 0.231 each)	0	x	0.231	=	0.000		
5	lights for tripped breakers (@ 0.231 each)	5	x	0.231	=	1.155		
1	breaker tripping coils	1	x	1.080	=	1.080		(Ref. 90)
1	lights for tripping breakers (@ 0.231 each)	1	x	0.231	=	0.231		
	Relays energized:							
0	SA-1 Relay	0	x	0.055	=	0.000		
4	Agastat Relay	4	x	0.064	=	0.256		
3	HFA	3	x	0.062	=	0.186	R40	
1	HGA	1	x	0.038	=	0.038		
4	UV Relay	4	x	0.070	=	0.280		
1	Joslyn Clark Relay	1	x	0.150	=	0.150	R40	
			TOTAL		=	3.992 Amps	R40	
						Time		
4	lights for closed breakers (@ 0.154 each)	4	x	0.154	=	0.616	10m1s-10m15s	
0	breaker closing coils (Peak)	0	x	15.000	=	0.000		(Ref. 90)
0	breaker closing coils (Continuous)	0	x	5.000	=	0.000		
0	lights for closing breakers (@ 0.231 each)	0	x	0.231	=	0.000		
6	lights for tripped breakers (@ 0.231 each)	6	x	0.231	=	1.386		
0	breaker tripping coils	0	x	1.080	=	0.000		(Ref. 90)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		
	Relays energized:							
0	SA-1 Relay	0	x	0.055	=	0.000		
4	Agastat Relay	4	x	0.064	=	0.256		
3	HFA	3	x	0.062	=	0.186	R40	
1	HGA	1	x	0.038	=	0.038		
4	UV Relay	4	x	0.070	=	0.280		
1	Joslyn Clark Relay	1	x	0.150	=	0.150	R40	
			TOTAL		=	2.912 Amps	R40	

4kV Switchgear 13-1

LOOP & LOCA Condition

						Time		
4	lights for closed breakers (@ 0.154 each)	4	x	0.154	=	0.616	10m15s-10m17s	
1	breaker closing coils (Peak)	1	x	15.000	=	15.000		(Ref. 90)
0	breaker closing coils (Continuous)	0	x	5.000	=	0.000		
1	lights for closing breakers (@ 0.231 each)	1	x	0.231	=	0.231		
5	lights for tripped breakers (@ 0.231 each)	5	x	0.231	=	1.155		
0	breaker tripping coils	0	x	1.080	=	0.000		(Ref. 90)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		
	Relays energized:							
0	SA-1 Relay	0	x	0.055	=	0.000		
4	Agastat Relay	4	x	0.064	=	0.256		
3	HFA	3	x	0.062	=	0.186	R40	
1	HGA	1	x	0.038	=	0.038		
4	UV Relay	4	x	0.070	=	0.280		
1	Joslyn Clark Relay	1	x	0.150	=	0.150	R40	
			TOTAL		=	17.912 Amps	R40	
						Time		
4	lights for closed breakers (@ 0.154 each)	4	x	0.154	=	0.616	10m17s-10m30s	
0	breaker closing coils (Peak)	0	x	15.000	=	0.000		(Ref. 90)
1	breaker closing coils (Continuous)	1	x	5.000	=	5.000		
1	lights for closing breakers (@ 0.231 each)	1	x	0.231	=	0.231		
5	lights for tripped breakers (@ 0.231 each)	5	x	0.231	=	1.155		
0	breaker tripping coils	0	x	1.080	=	0.000		(Ref. 90)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		
	Relays energized:							
0	SA-1 Relay	0	x	0.055	=	0.000		
4	Agastat Relay	4	x	0.064	=	0.256		
3	HFA	3	x	0.062	=	0.186	R40	
1	HGA	1	x	0.038	=	0.038		
4	UV Relay	4	x	0.070	=	0.280		
1	Joslyn Clark Relay	1	x	0.150	=	0.150	R40	
			TOTAL		=	7.912 Amps	R40	
						Time		
5	lights for closed breakers (@ 0.154 each)	5	x	0.154	=	0.770	10m30s-end	
0	breaker closing coils (Peak)	0	x	15.000	=	0.000		(Ref. 90)
0	breaker closing coils (Continuous)	0	x	5.000	=	0.000		
0	lights for closing breakers (@ 0.231 each)	0	x	0.231	=	0.000		
5	lights for tripped breakers (@ 0.231 each)	5	x	0.231	=	1.155		
0	breaker tripping coils	0	x	1.080	=	0.000		(Ref. 90)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		
	Relays energized:							
0	SA-1 Relay	0	x	0.055	=	0.000		
4	Agastat Relay	4	x	0.064	=	0.256		
3	HFA	3	x	0.062	=	0.186	R40	
1	HGA	1	x	0.038	=	0.038		
4	UV Relay	4	x	0.070	=	0.280		
1	Joslyn Clark Relay	1	x	0.150	=	0.150	R40	
			TOTAL			2.835 Amps	R40	

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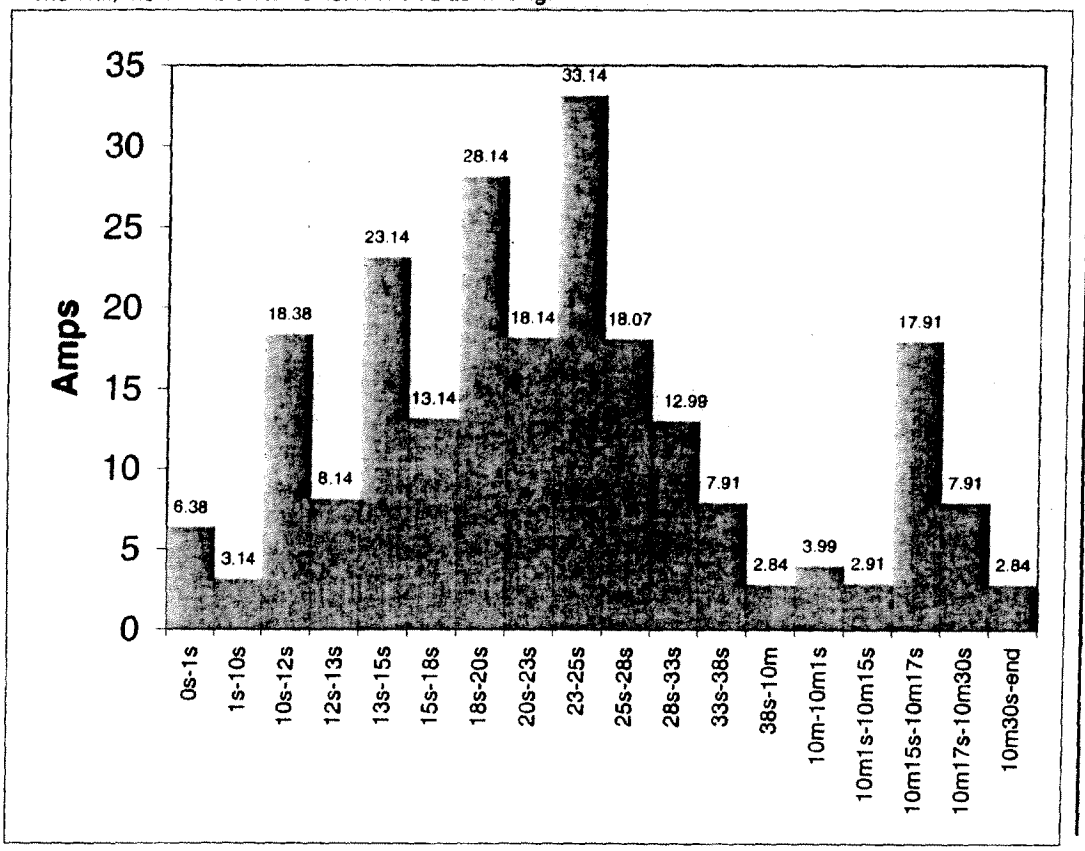
LOOP & LOCA Condition

NOTES

1.) At t=0s all closed breakers trip except for 480V SWGR 18 feed. 4kV SWGR 13-1 sheds loads.
2.) At t=1s all 4kV SWGR 13-1 loads have been shed except for 480V SWGR 18
(i.e. all breakers have completed tripping).
3.) At t=10s DG 1/2 breaker closes.
4.) At t=13s close breaker for RHR Pump 1A.
5.) At t=18s close breaker for RHR Pump 1B
6.) At t=23s close breaker for Core Spray Pump 1A.
7.) At t=10m trip RHR Pump 1A or 1B.
8.) At t=10m15s close Main Feeder breaker to 4kV SWGR 13.

NOTE:
The SBO breaker remains tripped when there is a LOCA on either unit.
Since the scenario modeled is a LOOP on both units 1 & 2 and a LOCA on one unit, the SBO breaker is not modeled as closing.



R40

Bus 1B-1 Circuit 6
4kV Switchgear Bus 14 Main Feed

 R36

4kV Switchgear 14 AC Loads

Bkr. #	Service	AC Bkr. Status			S/D	Rev.
		On-Line	LOOP/ LOOP & LOCA (t=1)	LOOP/ LOOP & LOCA (After)		
152-1401	Fish House Transformer	C	T	T/T	4E-1387E	A
152-1402	Cond. & Booster Pump 1D	C	T	T/T	4E-1370	M
152-1403	CRD Feed Pump 1B	C	T	C/T	4E-1416	Q
152-1404	480V Switchgear 17	C	T	T/T	4E-1348	F
152-1405	Reserve Feed	T	T	T/T	4E-1343	S
152-1406	Service Water Pump 1B	C	T	C/T	4E-1391	H
152-1407	Cond. & Booster Pump 1C	C	T	T/T	4E-1370	M
152-1408	Service Water Pump 1/2	C	T	T/T	4E-1391	H
152-1409	RHR SWP 1C	T	T	C*/C*	4E-1438P	R
152-1410	Bus 14-1 Feed	C	T	C/C	4E-1344	SH.2, B
152-1411	Circ. Water Pump 1C	C	T	T/T	4E-1368	K
152-1412	Main Feed	C	T	T/T	4E-1343	S
152-1413	RHR SWP 1D	T	T	C*/C*	4E-1438P	R
152-1414	480V Switchgear 16	C	T	T/T	4E-1348	F
152-1415	Spare Breaker	$	$	$	—	---

R36

$ - This is a spare breaker with the control power fuses pulled. No dc load is assumed.
* Only 1 pump is energized. R36

4kV Switchgear 14 **Page 2 of 12**

NORMAL CONDITION

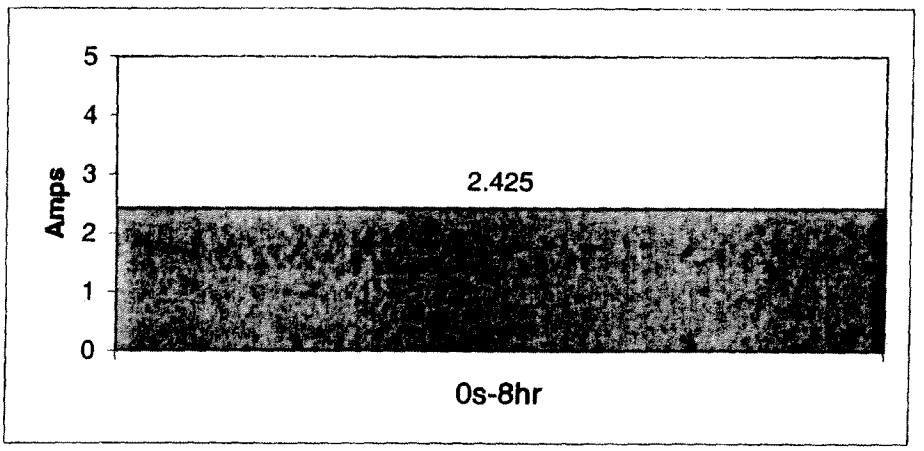
The maximum dc load on the circuit under normal condition is:

							Time
11	lights for closed breakers (@ 0.154 each)	11	x	0.154	=	1.694	0s-8hr
3	lights for tripped breakers (@ 0.231 each)	3	x	0.231	=	0.693	
	No switching of breakers						
	Relays energized:						
0	HEA	0	x	5.400	=	0.000	
0	HFA	0	x	0.062	=	0.000	
1	HGA	1	x	0.038	=	0.038	
0	UV Relay	0	x	0.070	=	0.000	
			TOTAL		=	2.425 Amps	

NOTE

1.) The UV circuit would have one HGA relay energized.

R39



4kV Switchgear 14 **Page 3 of 12**

LOOP Condition

The maximum dc load on the circuit under LOOP condition is:

						Time		
0	lights for closed breakers (@ 0.154 each)	0	x	0.154	=	0.000	0s-1s	
0	breaker closing coils	0	x	15.000	=	0.000		(Ref. 88 & 91)
0	lights for closing breakers (@ 0.231 each)	0	x	0.231	=	0.000		
3	lights for tripped breakers (@ 0.231 each)	3	x	0.231	=	0.693		
11	breaker tripping coils	11	x	1.080	=	11.880		(Ref. 88 & 91)
11	lights for tripping breakers (@ 0.231 each)	11	x	0.231	=	2.541		
	Relays energized:							
1	Misc. Relay	1	x	0.080	=	0.080		
5	HFA	5	x	0.062	=	0.310		
							R39	
1	HGA	1	x	0.038	=	0.038		
4	UV Relay	4	x	0.070	=	0.280		
			TOTAL		=	15.822 Amps	R39	

						Time		
0	lights for closed breakers (@ 0.154 each)	0	x	0.154	=	0.000	1s-10m	
0	breaker closing coils	0	x	15.000	=	0.000		(Ref. 88 & 91)
0	lights for closing breakers (@ 0.231 each)	0	x	0.231	=	0.000		
14	lights for tripped breakers (@ 0.231 each)	14	x	0.231	=	3.234		
0	breaker tripping coils	0	x	1.080	=	0.000		(Ref. 88 & 91)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		
	Relays energized:							
1	Misc. Relay	1	x	0.080	=	0.080		
5	HFA	5	x	0.062	=	0.310		
							R39	
1	HGA	1	x	0.038	=	0.038		
4	UV Relay	4	x	0.070	=	0.280		
			TOTAL		=	3.942 Amps	R39	

						Time		
0	lights for closed breakers (@ 0.154 each)	0	x	0.154	=	0.000	10m-10m2s	
1	breaker closing coils (Peak)	1	x	15.000	=	15.000		(Ref. 88 & 91)
0	breaker closing coils (Continuous)	0	x	5.000	=	0.000		
1	lights for closing breakers (@ 0.231 each)	1	x	0.231	=	0.231		
13	lights for tripped breakers (@ 0.231 each)	13	x	0.231	=	3.003		
0	breaker tripping coils	0	x	1.080	=	0.000		(Ref. 88 & 91)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		
	Relays energized:							
1	Misc. Relay	1	x	0.080	=	0.080		
5	HFA	5	x	0.062	=	0.310		
							R39	
1	HGA	1	x	0.038	=	0.038		
4	UV Relay	4	x	0.070	=	0.280		
			TOTAL		=	18.942 Amps	R39	

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LOOP Condition

						Time		
0	lights for closed breakers (@ 0.154 each)	0	x	0.154	=	0.000	10m2s-10m15s	
0	breaker closing coils (Peak)	0	x	15.000	=	0.000		(Ref. 88 & 91)
1	breaker closing coils (Continuous)	1	x	5.000	=	5.000		
1	lights for closing breakers (@ 0.231 each)	1	x	0.231	=	0.231		
13	lights for tripped breakers (@ 0.231 each)	13	x	0.231	=	3.003		
0	breaker tripping coils	0	x	1.080	=	0.000		(Ref. 88 & 91)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		
	Relays energized:							
1	Misc. Relay	1	x	0.080	=	0.080		
5	HFA	5	x	0.062	=	0.310	R39	
1	HGA	1	x	0.038	=	0.038		
4	UV Relay	4	x	0.070	=	0.280		
			TOTAL		=	8.942 Amps	R39	

						Time		
1	lights for closed breakers (@ 0.154 each)	1	x	0.154	=	0.154	10m15s-10m17s	
1	breaker closing coils (Peak)	1	x	15.000	=	15.000		(Ref. 88 & 91)
0	breaker closing coils (Continuous)	0	x	5.000	=	0.000		
1	lights for closing breakers (@ 0.231 each)	1	x	0.231	=	0.231		
12	lights for tripped breakers (@ 0.231 each)	12	x	0.231	=	2.772		
0	breaker tripping coils	0	x	1.080	=	0.000		(Ref. 88 & 91)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		
	Relays energized:							
1	Misc. Relay	1	x	0.080	=	0.080		
5	HFA	5	x	0.062	=	0.310	R39	
1	HGA	1	x	0.038	=	0.038		
4	UV Relay	4	x	0.070	=	0.280		
			TOTAL		=	18.865 Amps	R39	

						Time		
1	lights for closed breakers (@ 0.154 each)	1	x	0.154	=	0.154	10m17s-10m30s	
0	breaker closing coils (Peak)	0	x	15.000	=	0.000		(Ref. 88 & 91)
1	breaker closing coils (Continuous)	1	x	5.000	=	5.000		
1	lights for closing breakers (@ 0.231 each)	1	x	0.231	=	0.231		
12	lights for tripped breakers (@ 0.231 each)	12	x	0.231	=	2.772		
0	breaker tripping coils	0	x	1.080	=	0.000		(Ref. 88 & 91)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		
	Relays energized:							
1	Misc. Relay	1	x	0.080	=	0.080		
5	HFA	5	x	0.062	=	0.310	R39	
1	HGA	1	x	0.038	=	0.038		
4	UV Relay	4	x	0.070	=	0.280		
			TOTAL		=	8.865 Amps	R39	

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LOOP Condition

						Time		
2	lights for closed breakers (@ 0.154 each)	2	x	0.154	=	0.308	10m30s-10m45s	
0	breaker closing coils (Peak)	0	x	15.000	=	0.000		(Ref. 88 & 91)
0	breaker closing coils (Continuous)	0	x	5.000	=	0.000		
0	lights for closing breakers (@ 0.231 each)	0	x	0.231	=	0.000		
12	lights for tripped breakers (@ 0.231 each)	12	x	0.231	=	2.772		
0	breaker tripping coils	0	x	1.080	=	0.000		(Ref. 88 & 91)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		
	Relays energized:							
1	Misc. Relay	1	x	0.080	=	0.080		
5	HFA	5	x	0.062	=	0.310	R39	
1	HGA	1	x	0.038	=	0.038		
4	UV Relay	4	x	0.070	=	0.280		
			TOTAL		=	3.788 Amps	R39	

						Time		
2	lights for closed breakers (@ 0.154 each)	2	x	0.154	=	0.308	10m45s-10m47s	
1	breaker closing coils (Peak)	1	x	15.000	=	15.000		(Ref. 88 & 91)
0	breaker closing coils (Continuous)	0	x	5.000	=	0.000		
1	lights for closing breakers (@ 0.231 each)	1	x	0.231	=	0.231		
11	lights for tripped breakers (@ 0.231 each)	11	x	0.231	=	2.541		
0	breaker tripping coils	0	x	1.080	=	0.000		(Ref. 88 & 91)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		
	Relays energized:							
1	Misc. Relay	1	x	0.080	=	0.080		
5	HFA	5	x	0.062	=	0.310	R39	
1	HGA	1	x	0.038	=	0.038		
4	UV Relay	4	x	0.070	=	0.280		
			TOTAL		=	18.788 Amps	R39	

						Time		
2	lights for closed breakers (@ 0.154 each)	2	x	0.154	=	0.308	10m47s-11m	
0	breaker closing coils (Peak)	0	x	15.000	=	0.000		(Ref. 88 & 91)
1	breaker closing coils (Continuous)	1	x	5.000	=	5.000		
1	lights for closing breakers (@ 0.231 each)	1	x	0.231	=	0.231		
11	lights for tripped breakers (@ 0.231 each)	11	x	0.231	=	2.541		
0	breaker tripping coils	0	x	1.080	=	0.000		(Ref. 88 & 91)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		
	Relays energized:							
1	Misc. Relay	1	x	0.080	=	0.080		
5	HFA	5	x	0.062	=	0.310	R39	
1	HGA	1	x	0.038	=	0.038		
4	UV Relay	4	x	0.070	=	0.280		
			TOTAL		=	8.788 Amps	R39	

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LOOP Condition

						Time		
3	lights for closed breakers (@ 0.154 each)	3	x	0.154	=	0.462	11m-11m15s	
0	breaker closing coils (Peak)	0	x	15.000	=	0.000		(Ref. 88 & 91)
0	breaker closing coils (Continuous)	0	x	5.000	=	0.000		
0	lights for closing breakers (@ 0.231 each)	0	x	0.231	=	0.000		
11	lights for tripped breakers (@ 0.231 each)	11	x	0.231	=	2.541		
0	breaker tripping coils	0	x	1.080	=	0.000		(Ref. 88 & 91)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		
	Relays energized:							
1	Misc. Relay	1	x	0.080	=	0.080		
5	HFA	5	x	0.062	=	0.310	R39	
1	HGA	1	x	0.038	=	0.038		
4	UV Relay	4	x	0.070	=	0.280		
			TOTAL		=	3.711 Amps	R39	

						Time		
3	lights for closed breakers (@ 0.154 each)	3	x	0.154	=	0.462	11m15s-11m17s	
1	breaker closing coils (Peak)	1	x	15.000	=	15.000		(Ref. 88 & 91)
0	breaker closing coils (Continuous)	0	x	5.000	=	0.000		
1	lights for closing breakers (@ 0.231 each)	1	x	0.231	=	0.231		
10	lights for tripped breakers (@ 0.231 each)	10	x	0.231	=	2.310		
0	breaker tripping coils	0	x	1.080	=	0.000		(Ref. 88 & 91)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		
	Relays energized:							
1	Misc. Relay	1	x	0.080	=	0.080		
5	HFA	5	x	0.062	=	0.310	R39	
1	HGA	1	x	0.038	=	0.038		
4	UV Relay	4	x	0.070	=	0.280		
			TOTAL		=	18.711 Amps	R39	

						Time		
3	lights for closed breakers (@ 0.154 each)	3	x	0.154	=	0.462	11m17s-11m30s	
0	breaker closing coils (Peak)	0	x	15.000	=	0.000		(Ref. 88 & 91)
1	breaker closing coils (Continuous)	1	x	5.000	=	5.000		
1	lights for closing breakers (@ 0.231 each)	1	x	0.231	=	0.231		
10	lights for tripped breakers (@ 0.231 each)	10	x	0.231	=	2.310		
0	breaker tripping coils	0	x	1.080	=	0.000		(Ref. 88 & 91)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		
	Relays energized:							
1	Misc. Relay	1	x	0.080	=	0.080		
5	HFA	5	x	0.062	=	0.310	R39	
1	HGA	1	x	0.038	=	0.038		
4	UV Relay	4	x	0.070	=	0.280		
			TOTAL		=	8.711 Amps	R39	

4kV Switchgear 14 **Page 7 of 12**

LOOP Condition

						Time		
4	lights for closed breakers (@ 0.154 each)	4	x	0.154	=	0.616	11m30s-end	
0	breaker closing coils (Peak)	0	x	15.000	=	0.000		(Ref. 88 & 91)
0	breaker closing coils (Continuous)	0	x	5.000	=	0.000		
0	lights for closing breakers (@ 0.231 each)	0	x	0.231	=	0.000		
10	lights for tripped breakers (@ 0.231 each)	10	x	0.231	=	2.310		
0	breaker tripping coils	0	x	1.080	=	0.000		(Ref. 88 & 91)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		
	Relays energized:							
1	Misc. Relay	1	x	0.080	=	0.080		
5	HFA	5	x	0.062	=	0.310		R39
1	HGA	1	x	0.038	=	0.038		
4	UV Relay	4	x	0.070	=	0.280		
			TOTAL		=	3.634 Amps		R39

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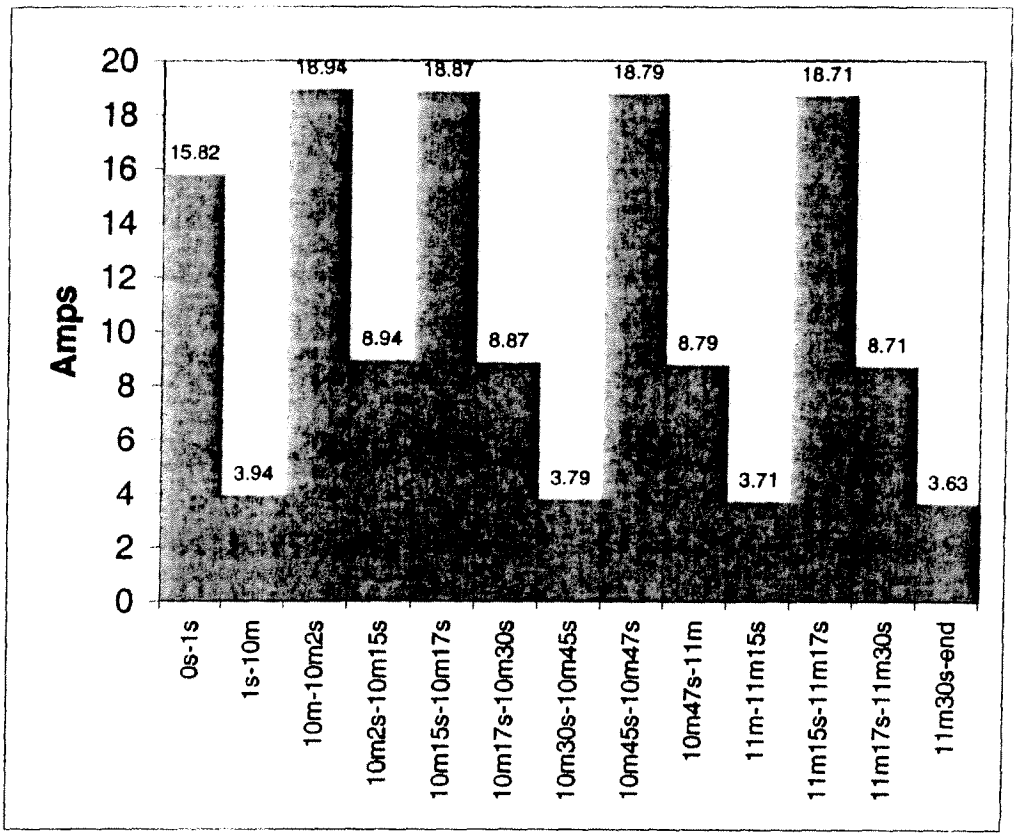
LOOP Condition

NOTES

1.) At t=0s all closed breakers trip. 4kV SWGR 14 sheds all load.
2.) At t=1s all 4kV SWGR 14 loads have been shed (i.e. all breakers have completed tripping).
3.) At t=10m feed breaker to 4kV SWGR 14-1 closes.
4.) At t=10m15s feed breaker to RHR SWP 1C or 1D closes.
5.) At t=10m45s feed breaker to SW Pump 1C closes.
6.) At t=11m15s feed breaker to CRD Feed Pump 1C closes.



R39

4kV Switchgear 14 **Page 9 of 12**

LOOP & LOCA Condition

The maximum dc load on the circuit under LOOP & LOCA condition is:

						Time		
0	lights for closed breakers (@ 0.154 each)	0	x	0.154	=	0.000	0s-1s	
0	breaker closing coils	0	x	15.000	=	0.000		(Ref. 88 & 91)
0	lights for closing breakers (@ 0.231 each)	0	x	0.231	=	0.000		
3	lights for tripped breakers (@ 0.231 each)	3	x	0.231	=	0.693		
11	breaker tripping coils	11	x	1.080	=	11.880		(Ref. 88 & 91)
11	lights for tripping breakers (@ 0.231 each)	11	x	0.231	=	2.541		
	Relays energized:							
1	Misc. Relay	1	x	0.080	=	0.080		
5	HFA	5	x	0.062	=	0.310		
							R39	
1	HGA	1	x	0.038	=	0.038		
4	UV Relay	4	x	0.070	=	0.280		
			TOTAL		=	15.822 Amps	R39	
						Time		
0	lights for closed breakers (@ 0.154 each)	0	x	0.154	=	0.000	1s-10m15s	
0	breaker closing coils	0	x	15.000	=	0.000		(Ref. 88 & 91)
0	lights for closing breakers (@ 0.231 each)	0	x	0.231	=	0.000		
14	lights for tripped breakers (@ 0.231 each)	14	x	0.231	=	3.234		
0	breaker tripping coils	0	x	1.080	=	0.000		(Ref. 88 & 91)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		
	Relays energized:							
1	Misc. Relay	1	x	0.080	=	0.080		
5	HFA	5	x	0.062	=	0.310		
							R39	
1	HGA	1	x	0.038	=	0.038		
4	UV Relay	4	x	0.070	=	0.280		
			TOTAL		=	3.942 Amps	R39	
						Time		
0	lights for closed breakers (@ 0.154 each)	0	x	0.154	=	0.000	10m15s-10m17s	
1	breaker closing coils (Peak)	1	x	15.000	=	15.000		(Ref. 88 & 91)
0	breaker closing coils (Continuous)	0	x	5.000	=	0.000		
1	lights for closing breakers (@ 0.231 each)	1	x	0.231	=	0.231		
13	lights for tripped breakers (@ 0.231 each)	13	x	0.231	=	3.003		
0	breaker tripping coils	0	x	1.080	=	0.000		(Ref. 88 & 91)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		
	Relays energized:							
1	Misc. Relay	1	x	0.080	=	0.080		
5	HFA	5	x	0.062	=	0.310		
							R39	
1	HGA	1	x	0.038	=	0.038		
4	UV Relay	4	x	0.070	=	0.280		
			TOTAL		=	18.942 Amps	R39	

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LOOP & LOCA Condition

						Time		
0	lights for closed breakers (@ 0.154 each)	0	x	0.154	=	0.000	10m17s-10m30s	
0	breaker closing coils (Peak)	0	x	15.000	=	0.000		(Ref. 88 & 91)
1	breaker closing coils (Continuous)	1	x	5.000	=	5.000		
1	lights for closing breakers (@ 0.231 each)	1	x	0.231	=	0.231		
13	lights for tripped breakers (@ 0.231 each)	13	x	0.231	=	3.003		
0	breaker tripping coils	0	x	1.080	=	0.000		(Ref. 88 & 91)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		
	Relays energized:							
1	Misc. Relay	1	x	0.080	=	0.080		
5	HFA	5	x	0.062	=	0.310	R39	
1	HGA	1	x	0.038	=	0.038		
4	UV Relay	4	x	0.070	=	0.280		
		TOTAL			=	8.942 Amps	R39	

						Time		
1	lights for closed breakers (@ 0.154 each)	1	x	0.154	=	0.154	10m30s-10m32s	
1	breaker closing coils (Peak)	1	x	15.000	=	15.000		(Ref. 88 & 91)
0	breaker closing coils (Continuous)	0	x	5.000	=	0.000		
1	lights for closing breakers (@ 0.231 each)	1	x	0.231	=	0.231		
12	lights for tripped breakers (@ 0.231 each)	12	x	0.231	=	2.772		
0	breaker tripping coils	0	x	1.080	=	0.000		(Ref. 88 & 91)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		
	Relays energized:							
1	Misc. Relay	1	x	0.080	=	0.080		
5	HFA	5	x	0.062	=	0.310	R39	
1	HGA	1	x	0.038	=	0.038		
4	UV Relay	4	x	0.070	=	0.280		
		TOTAL			=	18.865 Amps	R39	

						Time		
1	lights for closed breakers (@ 0.154 each)	1	x	0.154	=	0.154	10m32s-10m45s	
0	breaker closing coils (Peak)	0	x	15.000	=	0.000		(Ref. 88 & 91)
1	breaker closing coils (Continuous)	1	x	5.000	=	5.000		
1	lights for closing breakers (@ 0.231 each)	1	x	0.231	=	0.231		
12	lights for tripped breakers (@ 0.231 each)	12	x	0.231	=	2.772		
0	breaker tripping coils	0	x	1.080	=	0.000		(Ref. 88 & 91)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		
	Relays energized:							
1	Misc. Relay	1	x	0.080	=	0.080		
5	HFA	5	x	0.062	=	0.310	R39	
1	HGA	1	x	0.038	=	0.038		
4	UV Relay	4	x	0.070	=	0.280		
		TOTAL			=	8.865 Amps	R39	

4kV Switchgear 14 **Page 11 of 12**

LOOP & LOCA Condition

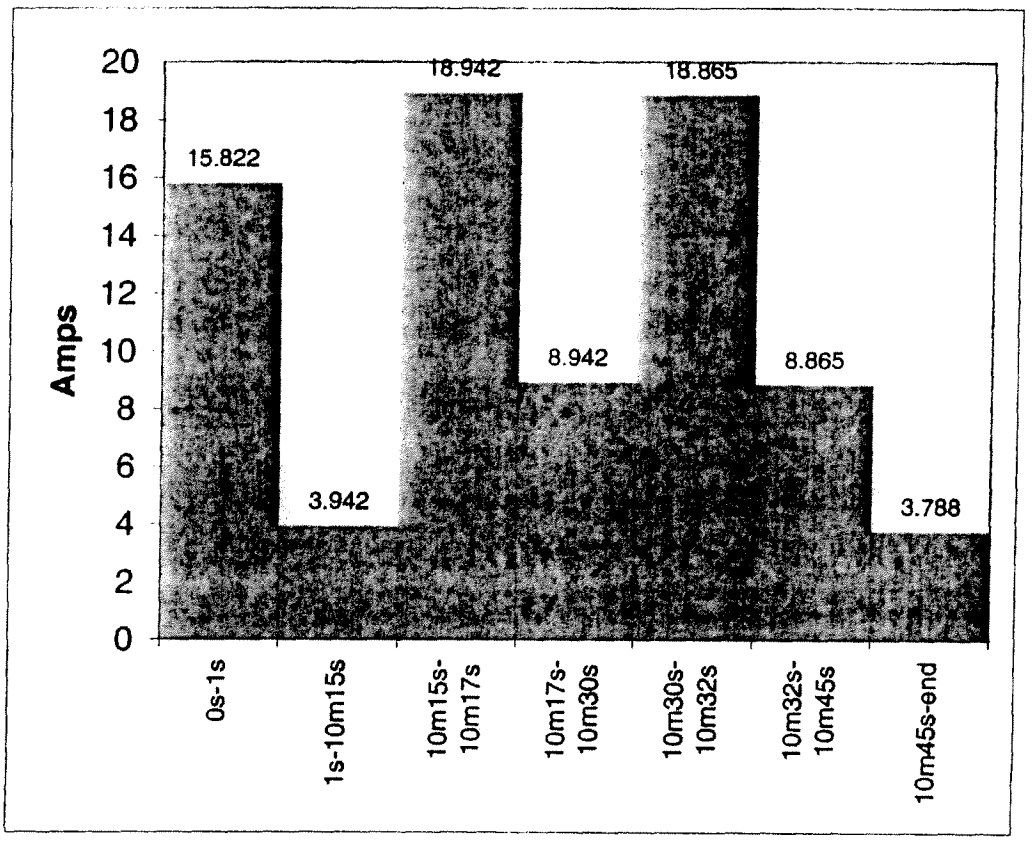
						Time		
2	lights for closed breakers (@ 0.154 each)	2	x	0.154	=	0.308	10m45s-end	
0	breaker closing coils (Peak)	0	x	15.000	=	0.000		(Ref. 88 & 91)
0	breaker closing coils (Continuous)	0	x	5.000	=	0.000		
0	lights for closing breakers (@ 0.231 each)	0	x	0.231	=	0.000		
12	lights for tripped breakers (@ 0.231 each)	12	x	0.231	=	2.772		
0	breaker tripping coils	0	x	1.080	=	0.000		(Ref. 88 & 91)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		
	Relays energized:							
1	Misc. Relay	1	x	0.080	=	0.080		
5	HFA	5	x	0.062	=	0.310	R39	
1	HGA	1	x	0.038	=	0.038		
4	UV Relay	4	x	0.070	=	0.280		
			TOTAL		=	3.788 Amps	R39	

4kV Switchgear 14 **Page 12 of 12**

LOOP/LOCA Condition

NOTES

1.) At t=0s all closed breakers trip. 4kV SWGR 14 sheds all load.
2.) At t=1s all 4kV SWGR 14 loads have been shed (i.e. all breakers have completed tripping).
3.) At t=10m15s feed breaker to 4kV SWGR 14-1 closes.
4.) At t=10m30s feed breaker to RHR SWP 1C or 1D closes.



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Bus 1B-1 Circuit 4 **Page 1 of 14** R38

4kV Switchgear Bus 14-1 Main Feed

4kV Switchgear 14-1 AC Loads

Bkr. #	Service	AC Bkr. Status			S/D	Rev.
		On-Line	LOOP/ LOCA	After LOOP/ LOCA		
152-1421	Div. II Cross-Tie to Bus 24-1	T	T	T	4E-1346	SH.1, AK
152-1422	Core Spray Pump 1B	T	T	C	4E-1429	M
152-1423	480V Switchgear 19	C	C	C	4E-1349	SH.2, P
152-1424	RHR Pump 1D	T	T	C	4E-1438Q	Q
152-1425	Normal Feed to Bus 31	C	T	C	4E-1346A	D
152-1426	Security Gate House Feed	C	T	T	RE-55-Q	E
152-1427	Main Feed from Bus 14	C	T	C	4E-1344	SH.4, E
152-1428	RHR Pump 1C	T	T	C	4E-1438Q	Q
152-1429	DG-1	T	T	C	4E-1346	SH.2, AS
152-1430	SBO DG*	T	T	T	—	—
152-1431	Spare	$	$	$	—	—

$ - This is a spare breaker with the control power fuses pulled. No dc load is assumed.

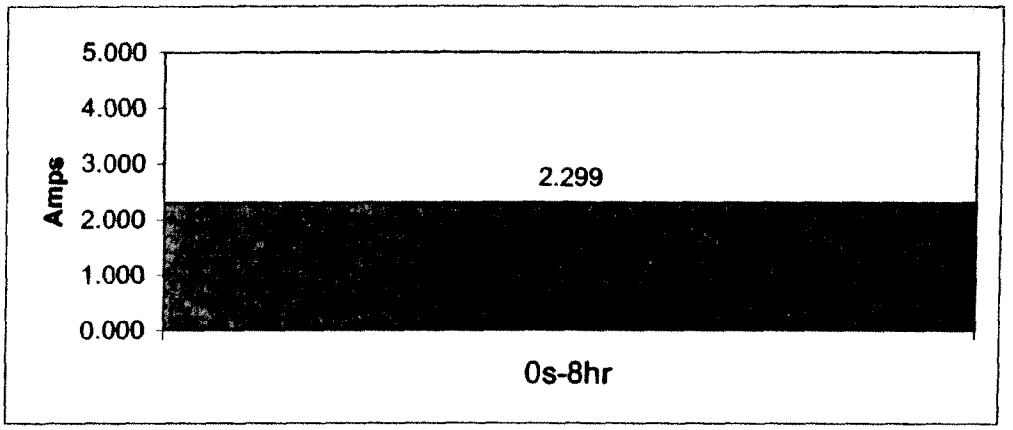
*NOTE: The SBO breaker remains tripped when there is a LOCA on either unit. Since the scenario modeled is a LOOP on both units 1 & 2 and a LOCA on one unit, the SBO breaker is not modeled as closing.

4kV Switchgear 14-1 **Page 2 of 14** R38

NORMAL CONDITION

The maximum dc load on the circuit under normal condition is:

						Time
4	lights for closed breakers (@ 0.154 each)	4 x	0.154	=	0.616	0s-8hr
6	lights for tripped breakers (@ 0.231 each)	6 x	0.231	=	1.386	
	No switching of breakers					
	Relays energized:					
0	IAC Relay	0 x	0.200	=	0.000	
1	SA-1 Relay	1 x	0.055	=	0.055	
1	Agastat Relay	1 x	0.064	=	0.064	
0	HFA	0 x	0.062	=	0.000	
1	HGA	1 x	0.038	=	0.038	
2	UV Relay	2 x	0.070	=	0.140	
		TOTAL		=	2.299 Amps	



4kV Switchgear 14-1 **Page 3 of 14** R38

LOOP Condition

The maximum dc load on the circuit under LOOP condition is:

						Time 0s-1s		
1	lights for closed breakers (@ 0.154 each)	1 x	0.154	=	0.154			
0	breaker closing coils	0 x	15.00	=	0.000		R38	Ref 90
0	lights for closing breakers (@ 0.231 each)	0 x	0.231	=	0.000			
6	lights for tripped breakers (@ 0.231 each)	6 x	0.231	=	1.386			
3	breaker tripping coils	3 x	1.080	=	3.24		R38	
3	lights for tripping breakers (@ 0.231 each)	3 x	0.231	=	0.693			
	Relays energized:							
2	IAC Relay	2 x	0.200	=	0.400			
1	SA-1 Relay	1 x	0.055	=	0.055			
5	Agastat Relay	5 x	0.064	=	0.320			
5	HFA	5 x	0.062	=	0.310			
1	HGA	1 x	0.038	=	0.038			
4	UV Relay	4 x	0.070	=	0.280			
		TOTAL		=	6.876 Amps			

						Time 1s-10s		
1	lights for closed breakers (@ 0.154 each)	1 x	0.154	=	0.154			
0	breaker closing coils (Peak)	0 x	15.00	=	0.000		R38	Ref 90
0	breaker closing coils (Continuous)	0 x	5.000	=	0.000			
0	lights for closing breakers (@ 0.231 each)	0 x	0.231	=	0.000			
9	lights for tripped breakers (@ 0.231 each)	9 x	0.231	=	2.079			
0	breaker tripping coils	0 x	1.080	=	0.000		R38	
0	lights for tripping breakers (@ 0.231 each)	0 x	0.231	=	0.000			
	Relays energized:							
2	IAC Relay	2 x	0.200	=	0.400			
1	SA-1 Relay	1 x	0.055	=	0.055			
5	Agastat Relay	5 x	0.064	=	0.320			
5	HFA	5 x	0.062	=	0.310			
1	HGA	1 x	0.038	=	0.038			
4	UV Relay	4 x	0.070	=	0.280			
		TOTAL		=	3.636 Amps			

						Time 10s-12s		
1	lights for closed breakers (@ 0.154 each)	1 x	0.154	=	0.154			
1	breaker closing coils (Peak)	1 x	15.00	=	15.000		R38	Ref 90
0	breaker closing coils (Continuous)	0 x	5.000	=	0.000			
1	lights for closing breakers (@ 0.231 each)	1 x	0.231	=	0.231			
8	lights for tripped breakers (@ 0.231 each)	8 x	0.231	=	1.848			
0	breaker tripping coils	0 x	1.080	=	0.000		R38	
0	lights for tripping breakers (@ 0.231 each)	0 x	0.231	=	0.000			
	Relays energized:							
2	IAC Relay	2 x	0.200	=	0.400			
1	SA-1 Relay	1 x	0.055	=	0.055			
5	Agastat Relay	5 x	0.064	=	0.320			
5	HFA	5 x	0.062	=	0.310			
1	HGA	1 x	0.038	=	0.038			
4	UV Relay	4 x	0.070	=	0.280			
		TOTAL		=	18.636 Amps		R38	

4kV Switchgear 14-1 **Page 4 of 14** R38

LOOP Condition

						Time		
1	lights for closed breakers (@ 0.154 each)	1 x	0.154	=	0.154	12s-25s		
0	breaker closing coils (Peak)	0 x	15.00	=	0.000		R38	Ref 90
1	breaker closing coils (Continuous)	1 x	5.000	=	5.000			
1	lights for closing breakers (@ 0.231 each)	1 x	0.231	=	0.231			
8	lights for tripped breakers (@ 0.231 each)	8 x	0.231	=	1.848			
0	breaker tripping coils	0 x	1.080	=	0.000		R38	
0	lights for tripping breakers (@ 0.231 each)	0 x	0.231	=	0.000			
	Relays energized:							
2	IAC Relay	2 x	0.200	=	0.400			
1	SA-1 Relay	1 x	0.055	=	0.055			
5	Agastat Relay	5 x	0.064	=	0.320			
5	HFA	5 x	0.062	=	0.310			
1	HGA	1 x	0.038	=	0.038			
4	UV Relay	4 x	0.070	=	0.280			
		TOTAL		=	8.636 Amps		R38	
						Time		
2	lights for closed breakers (@ 0.154 each)	2 x	0.154	=	0.308	25s-10m		
0	breaker closing coils (Peak)	0 x	15.00	=	0.000		R38	Ref 90
0	breaker closing coils (Continuous)	0 x	5.000	=	0.000			
0	lights for closing breakers (@ 0.231 each)	0 x	0.231	=	0.000			
8	lights for tripped breakers (@ 0.231 each)	8 x	0.231	=	1.848			
0	breaker tripping coils	0 x	1.080	=	0.000		R38	
0	lights for tripping breakers (@ 0.231 each)	0 x	0.231	=	0.000			
	Relays energized:							
2	IAC Relay	2 x	0.200	=	0.400			
1	SA-1 Relay	1 x	0.055	=	0.055			
5	Agastat Relay	5 x	0.064	=	0.320			
5	HFA	5 x	0.062	=	0.310			
1	HGA	1 x	0.038	=	0.038			
4	UV Relay	4 x	0.070	=	0.280			
		TOTAL		=	3.559 Amps			
						Time		
2	lights for closed breakers (@ 0.154 each)	2 x	0.154	=	0.308	10m-10m2s		
1	breaker closing coils (Peak)	1 x	15.00	=	15.000		R38	Ref 90
0	breaker closing coils (Continuous)	0 x	5.000	=	0.000			
1	lights for closing breakers (@ 0.231 each)	1 x	0.231	=	0.231			
7	lights for tripped breakers (@ 0.231 each)	7 x	0.231	=	1.617			
0	breaker tripping coils	0 x	1.080	=	0.000		R38	
0	lights for tripping breakers (@ 0.231 each)	0 x	0.231	=	0.000			
	Relays energized:							
2	IAC Relay	2 x	0.200	=	0.400			
1	SA-1 Relay	1 x	0.055	=	0.055			
5	Agastat Relay	5 x	0.064	=	0.320			
5	HFA	5 x	0.062	=	0.310			
1	HGA	1 x	0.038	=	0.038			
4	UV Relay	4 x	0.070	=	0.280			
		TOTAL		=	18.559 Amps		R38	

4kV Switchgear 14-1 **Page 5 of 14** R38

LOOP Condition

						Time		
2	lights for closed breakers (@ 0.154 each)	2 x 0.154 =	0.308			10m2s-10m15s		
0	breaker closing coils (Peak)	0 x 15.00 =	0.000				R38	Ref 90
1	breaker closing coils (Continuous)	1 x 5.000 =	5.000					
1	lights for closing breakers (@ 0.231 each)	1 x 0.231 =	0.231					
7	lights for tripped breakers (@ 0.231 each)	7 x 0.231 =	1.617					
0	breaker tripping coils	0 x 1.080 =	0.000				R38	
0	lights for tripping breakers (@ 0.231 each)	0 x 0.231 =	0.000					
	Relays energized:							
2	IAC Relay	2 x 0.200 =	0.400					
1	SA-1 Relay	1 x 0.055 =	0.055					
5	Agastat Relay	5 x 0.064 =	0.320					
5	HFA	5 x 0.062 =	0.310					
1	HGA	1 x 0.038 =	0.038					
4	UV Relay	4 x 0.070 =	0.280					
		TOTAL =	8.559 Amps				R38	
						Time		
3	lights for closed breakers (@ 0.154 each)	3 x 0.154 =	0.462			10m15s-11m30s		
0	breaker closing coils (Peak)	0 x 15.00 =	0.000				R38	Ref 90
0	breaker closing coils (Continuous)	0 x 5.000 =	0.000					
0	lights for closing breakers (@ 0.231 each)	0 x 0.231 =	0.000					
7	lights for tripped breakers (@ 0.231 each)	7 x 0.231 =	1.617					
0	breaker tripping coils	0 x 1.080 =	0.000				R38	
0	lights for tripping breakers (@ 0.231 each)	0 x 0.231 =	0.000					
	Relays energized:							
2	IAC Relay	2 x 0.200 =	0.400					
1	SA-1 Relay	1 x 0.055 =	0.055					
5	Agastat Relay	5 x 0.064 =	0.320					
5	HFA	5 x 0.062 =	0.310					
1	HGA	1 x 0.038 =	0.038					
4	UV Relay	4 x 0.070 =	0.280					
		TOTAL =	3.482 Amps					
						Time		
3	lights for closed breakers (@ 0.154 each)	3 x 0.154 =	0.462			11m30s-11m32s		
1	breaker closing coils (Peak)	1 x 15.00 =	15.000				R38	Ref 90
0	breaker closing coils (Continuous)	0 x 5.000 =	0.000					
1	lights for closing breakers (@ 0.231 each)	1 x 0.231 =	0.231					
6	lights for tripped breakers (@ 0.231 each)	6 x 0.231 =	1.386					
0	breaker tripping coils	0 x 1.080 =	0.000				R38	
0	lights for tripping breakers (@ 0.231 each)	0 x 0.231 =	0.000					
	Relays energized:							
2	IAC Relay	2 x 0.200 =	0.400					
1	SA-1 Relay	1 x 0.055 =	0.055					
5	Agastat Relay	5 x 0.064 =	0.320					
5	HFA	5 x 0.062 =	0.310					
1	HGA	1 x 0.038 =	0.038					
4	UV Relay	4 x 0.070 =	0.280					
		TOTAL =	18.482 Amps				R38	

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LOOP Condition

					Time		
3 lights for closed breakers (@ 0.154 each)	3 x 0.154 =	0.462		11m32s-11m45s			
0 breaker closing coils (Peak)	0 x 15.00 =	0.000			R38	Ref 90	
1 breaker closing coils (Continuous)	1 x 5.000 =	5.000					
1 lights for closing breakers (@ 0.231 each)	1 x 0.231 =	0.231					
6 lights for tripped breakers (@ 0.231 each)	6 x 0.231 =	1.386					
0 breaker tripping coils	0 x 1.080 =	0.000			R38		
0 lights for tripping breakers (@ 0.231 each)	0 x 0.231 =	0.000					
Relays energized:							
2 IAC Relay	2 x 0.200 =	0.400					
1 SA-1 Relay	1 x 0.055 =	0.055					
5 Agastat Relay	5 x 0.064 =	0.320					
5 HFA	5 x 0.062 =	0.310					
1 HGA	1 x 0.038 =	0.038					
4 UV Relay	4 x 0.070 =	0.280					
	TOTAL =	8.482	Amps		R38		

					Time		
4 lights for closed breakers (@ 0.154 each)	4 x 0.154 =	0.616		11m45s-end			
0 breaker closing coils (Peak)	0 x 15.00 =	0.000			R38	Ref 90	
0 breaker closing coils (Continuous)	0 x 5.000 =	0.000					
0 lights for closing breakers (@ 0.231 each)	0 x 0.231 =	0.000					
6 lights for tripped breakers (@ 0.231 each)	6 x 0.231 =	1.386					
0 breaker tripping coils	0 x 1.080 =	0.000			R38		
0 lights for tripping breakers (@ 0.231 each)	0 x 0.231 =	0.000					
Relays energized:							
2 IAC Relay	2 x 0.200 =	0.400					
1 SA-1 Relay	1 x 0.055 =	0.055					
5 Agastat Relay	5 x 0.064 =	0.320					
5 HFA	5 x 0.062 =	0.310					
1 HGA	1 x 0.038 =	0.038					
4 UV Relay	4 x 0.070 =	0.280					
	TOTAL =	3.405	Amps				

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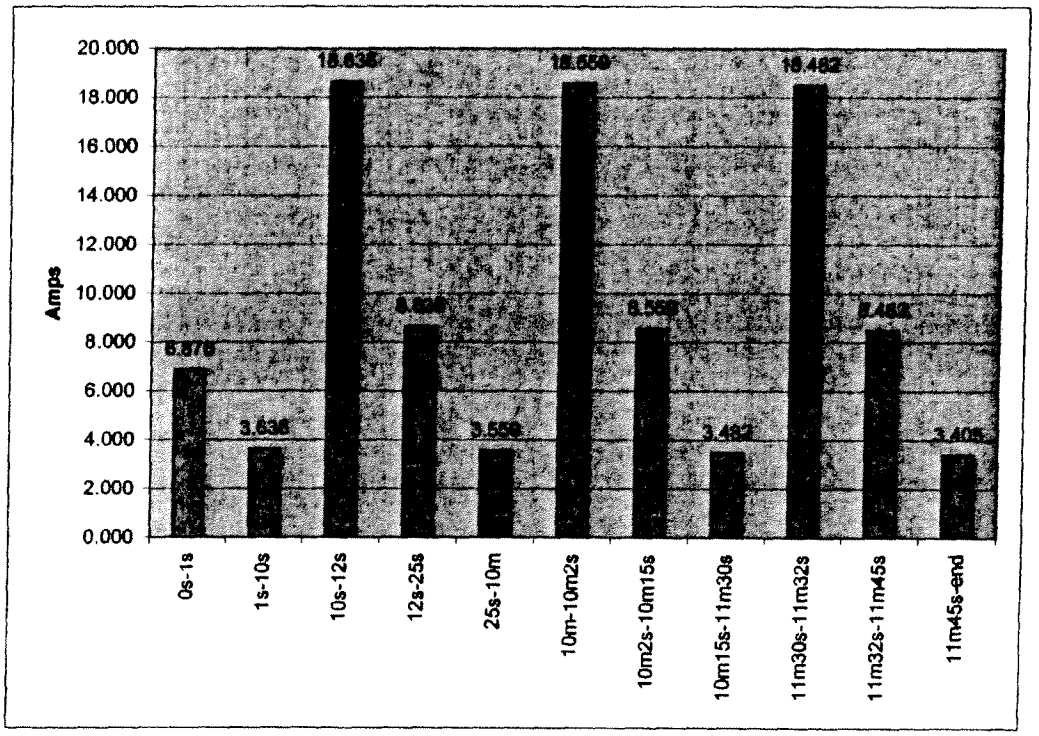
LOOP Condition

NOTES

1.) At t=0s all closed breakers trip except for 480V SWGR 19 feed. 4kV SWGR 14-1 sheds loads.
2.) At t=1s all 4kV SWGR 14-1 loads have been shed except for 480V SWGR 19
(i.e. all breakers have completed tripping).
3.) At t=10s DG 1 breaker closes.
4.) At t=10m close Main Feed breaker.
5.) At t=11m30s close 4kV SWGR 31breaker (Safe Shutdown System).

NOTE:

The SBO breaker remains tripped when there is a LOCA on either unit. Since the scenario modeled is a LOOP on both units 1 & 2 and a LOCA on one unit, the SBO breaker is not modeled as closing.



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LOOP & LOCA Condition

The maximum dc load on the circuit under LOOP & LOCA condition is:

						Time 0s-1s		
1	lights for closed breakers (@ 0.154 each)	1	x	0.154	=	0.154		
0	breaker closing coils	0	x	15.00	=	0.000	R38	Ref 90
0	lights for closing breakers (@ 0.231 each)	0	x	0.231	=	0.000		
6	lights for tripped breakers (@ 0.231 each)	6	x	0.231	=	1.386		
3	breaker tripping coils	3	x	1.080	=	3.24	R38	
3	lights for tripping breakers (@ 0.231 each)	3	x	0.231	=	0.693		
	Relays energized:							
2	IAC Relay	2	x	0.200	=	0.400		
1	SA-1 Relay	1	x	0.055	=	0.055		
5	Agastat Relay	5	x	0.064	=	0.320		
5	HFA	5	x	0.062	=	0.310		
1	HGA	1	x	0.038	=	0.038		
4	UV Relay	4	x	0.070	=	0.280		
		TOTAL			=	6.876 Amps		

						Time 1s-10s		
1	lights for closed breakers (@ 0.154 each)	1	x	0.154	=	0.154		
0	breaker closing coils	0	x	15.00	=	0.000	R38	Ref 90
0	lights for closing breakers (@ 0.231 each)	0	x	0.231	=	0.000		
9	lights for tripped breakers (@ 0.231 each)	9	x	0.231	=	2.079		
0	breaker tripping coils	0	x	1.080	=	0.000	R38	
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		
	Relays energized:							
2	IAC Relay	2	x	0.200	=	0.400		
1	SA-1 Relay	1	x	0.055	=	0.055		
5	Agastat Relay	5	x	0.064	=	0.320		
5	HFA	5	x	0.062	=	0.310		
1	HGA	1	x	0.038	=	0.038		
4	UV Relay	4	x	0.070	=	0.280		
		TOTAL			=	3.636 Amps	R38	

						Time 10s-12s		
1	lights for closed breakers (@ 0.154 each)	1	x	0.154	=	0.154		
1	breaker closing coils (Peak)	1	x	15.00	=	15.000	R38	Ref 90
0	breaker closing coils (Continuous)	0	x	5.000	=	0.000		
1	lights for closing breakers (@ 0.231 each)	1	x	0.231	=	0.231		
8	lights for tripped breakers (@ 0.231 each)	8	x	0.231	=	1.848		
0	breaker tripping coils	0	x	1.080	=	0.000	R38	
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		
	Relays energized:							
2	IAC Relay	2	x	0.200	=	0.400		
1	SA-1 Relay	1	x	0.055	=	0.055		
5	Agastat Relay	5	x	0.064	=	0.320		
5	HFA	5	x	0.062	=	0.310		
1	HGA	1	x	0.038	=	0.038		
4	UV Relay	4	x	0.070	=	0.280		
		TOTAL			=	18.636 Amps	R38	

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LOOP & LOCA Condition

					Time 12s-13s		
1	lights for closed breakers (@ 0.154 each)	1 x 0.154	=	0.154			
0	breaker closing coils (Peak)	0 x 15.00	=	0.000		R38	Ref 90
1	breaker closing coils (Continuous)	1 x 5.000	=	5.000			
1	lights for closing breakers (@ 0.231 each)	1 x 0.231	=	0.231			
8	lights for tripped breakers (@ 0.231 each)	8 x 0.231	=	1.848			
0	breaker tripping coils	0 x 1.080	=	0.000		R38	
0	lights for tripping breakers (@ 0.231 each)	0 x 0.231	=	0.000			
	Relays energized:						
2	IAC Relay	2 x 0.200	=	0.400		R38	
1	SA-1 Relay	1 x 0.055	=	0.055			
5	Agastat Relay	5 x 0.064	=	0.320			
5	HFA	5 x 0.062	=	0.310			
1	HGA	1 x 0.038	=	0.038			
4	UV Relay	4 x 0.070	=	0.280			
		TOTAL	=	8.636 Amps		R38	
					Time 13s-15s		
1	lights for closed breakers (@ 0.154 each)	1 x 0.154	=	0.154			
1	breaker closing coils (Peak)	1 x 15.00	=	15.000		R38	Ref 90
1	breaker closing coils (Continuous)	1 x 5.000	=	5.000			
2	lights for closing breakers (@ 0.231 each)	2 x 0.231	=	0.462			
7	lights for tripped breakers (@ 0.231 each)	7 x 0.231	=	1.617			
0	breaker tripping coils	0 x 1.080	=	0.000		R38	
0	lights for tripping breakers (@ 0.231 each)	0 x 0.231	=	0.000			
	Relays energized:						
2	IAC Relay	2 x 0.200	=	0.400			
1	SA-1 Relay	1 x 0.055	=	0.055			
5	Agastat Relay	5 x 0.064	=	0.320			
5	HFA	5 x 0.062	=	0.310			
1	HGA	1 x 0.038	=	0.038			
4	UV Relay	4 x 0.070	=	0.280			
		TOTAL	=	23.636 Amps		R38	
					Time 15s-18s		
2	lights for closed breakers (@ 0.154 each)	2 x 0.154	=	0.308			
0	breaker closing coils (Peak)	0 x 15.00	=	0.000		R38	Ref 90
2	breaker closing coils (Continuous)	2 x 5.000	=	10.000			
2	lights for closing breakers (@ 0.231 each)	2 x 0.231	=	0.462			
7	lights for tripped breakers (@ 0.231 each)	7 x 0.231	=	1.617			
0	breaker tripping coils	0 x 1.080	=	0.000		R38	
0	lights for tripping breakers (@ 0.231 each)	0 x 0.231	=	0.000			
	Relays energized:						
2	IAC Relay	2 x 0.200	=	0.400			
1	SA-1 Relay	1 x 0.055	=	0.055			
5	Agastat Relay	5 x 0.064	=	0.320			
5	HFA	5 x 0.062	=	0.310			
1	HGA	1 x 0.038	=	0.038			
4	UV Relay	4 x 0.070	=	0.280			
		TOTAL	=	13.790 Amps		R38	

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LOOP & LOCA Condition

						Time 18s-20s		
1	lights for closed breakers (@ 0.154 each)	1	x	0.154	=	0.154		
1	breaker closing coils (Peak)	1	x	15.00	=	15.000	R38	Ref 90
2	breaker closing coils (Continuous)	2	x	5.000	=	10.000		
3	lights for closing breakers (@ 0.231 each)	3	x	0.231	=	0.693		
6	lights for tripped breakers (@ 0.231 each)	6	x	0.231	=	1.386		
0	breaker tripping coils	0	x	1.080	=	0.000		
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		
	Relays energized:							
2	IAC Relay	2	x	0.200	=	0.400		
1	SA-1 Relay	1	x	0.055	=	0.055		
5	Agastat Relay	5	x	0.064	=	0.320		
5	HFA	5	x	0.062	=	0.310		
1	HGA	1	x	0.038	=	0.038		
4	UV Relay	4	x	0.070	=	0.280		
		TOTAL			=	28.636 Amps	R38	

						Time 20s-23s		
1	lights for closed breakers (@ 0.154 each)	1	x	0.154	=	0.154		
0	breaker closing coils (Peak)	0	x	15.00	=	0.000	R38	Ref 90
3	breaker closing coils (Continuous)	3	x	5.000	=	15.000		
3	lights for closing breakers (@ 0.231 each)	3	x	0.231	=	0.693		
6	lights for tripped breakers (@ 0.231 each)	6	x	0.231	=	1.386		
0	breaker tripping coils	0	x	1.080	=	0.000		
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		
	Relays energized:							
2	IAC Relay	2	x	0.200	=	0.400		
1	SA-1 Relay	1	x	0.055	=	0.055		
5	Agastat Relay	5	x	0.064	=	0.320		
5	HFA	5	x	0.062	=	0.310		
1	HGA	1	x	0.038	=	0.038		
4	UV Relay	4	x	0.070	=	0.280		
		TOTAL			=	18.636 Amps	R38	

						Time 23s-25s		
1	lights for closed breakers (@ 0.154 each)	1	x	0.154	=	0.154		
1	breaker closing coils (Peak)	1	x	15.00	=	15.000	R38	Ref 90
3	breaker closing coils (Continuous)	3	x	5.000	=	15.000		
4	lights for closing breakers (@ 0.231 each)	4	x	0.231	=	0.924		
5	lights for tripped breakers (@ 0.231 each)	5	x	0.231	=	1.155		
0	breaker tripping coils	0	x	1.080	=	0.000		
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		
	Relays energized:							
2	IAC Relay	2	x	0.200	=	0.400		
1	SA-1 Relay	1	x	0.055	=	0.055		
5	Agastat Relay	5	x	0.064	=	0.320		
5	HFA	5	x	0.062	=	0.310		
1	HGA	1	x	0.038	=	0.038		
4	UV Relay	4	x	0.070	=	0.280		
		TOTAL			=	33.636 Amps	R38	

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LOOP & LOCA Condition

					Time		
2	lights for closed breakers (@ 0.154 each)	2 x 0.154 =	0.308		25s-28s		
0	breaker closing coils (Peak)	0 x 15.00 =	0.000			R38	Ref 90
3	breaker closing coils (Continuous)	3 x 5.000 =	15.000				
3	lights for closing breakers (@ 0.231 each)	3 x 0.231 =	0.693				
5	lights for tripped breakers (@ 0.231 each)	5 x 0.231 =	1.155				
0	breaker tripping coils	0 x 1.080 =	0.000			R38	
0	lights for tripping breakers (@ 0.231 each)	0 x 0.231 =	0.000				
	Relays energized:						
2	IAC Relay	2 x 0.200 =	0.400				
1	SA-1 Relay	1 x 0.055 =	0.055				
5	Agastat Relay	5 x 0.064 =	0.320				
5	HFA	5 x 0.062 =	0.310				
1	HGA	1 x 0.038 =	0.038				
4	UV Relay	4 x 0.070 =	0.280				
		TOTAL =	18.559 Amps			R38	

					Time		
3	lights for closed breakers (@ 0.154 each)	3 x 0.154 =	0.462		28s-33s		
0	breaker closing coils (Peak)	0 x 15.00 =	0.000			R38	Ref 90
2	breaker closing coils (Continuous)	2 x 5.000 =	10.000				
2	lights for closing breakers (@ 0.231 each)	2 x 0.231 =	0.462				
5	lights for tripped breakers (@ 0.231 each)	5 x 0.231 =	1.155				
0	breaker tripping coils	0 x 1.080 =	0.000				
0	lights for tripping breakers (@ 0.231 each)	0 x 0.231 =	0.000				
	Relays energized:						
2	IAC Relay	2 x 0.200 =	0.400				
1	SA-1 Relay	1 x 0.055 =	0.055				
5	Agastat Relay	5 x 0.064 =	0.320				
5	HFA	5 x 0.062 =	0.310				
1	HGA	1 x 0.038 =	0.038				
4	UV Relay	4 x 0.070 =	0.280				
		TOTAL =	13.482 Amps			R38	

					Time		
4	lights for closed breakers (@ 0.154 each)	4 x 0.154 =	0.616		33s-38s		
0	breaker closing coils (Peak)	0 x 15.00 =	0.000			R38	Ref 90
1	breaker closing coils (Continuous)	1 x 5.000 =	5.000				
1	lights for closing breakers (@ 0.231 each)	1 x 0.231 =	0.231				
5	lights for tripped breakers (@ 0.231 each)	5 x 0.231 =	1.155				
0	breaker tripping coils	0 x 1.080 =	0.000				
0	lights for tripping breakers (@ 0.231 each)	0 x 0.231 =	0.000				
	Relays energized:						
2	IAC Relay	2 x 0.200 =	0.400				
1	SA-1 Relay	1 x 0.055 =	0.055				
5	Agastat Relay	5 x 0.064 =	0.320				
5	HFA	5 x 0.062 =	0.310				
1	HGA	1 x 0.038 =	0.038				
4	UV Relay	4 x 0.070 =	0.280				
		TOTAL =	8.405 Amps			R38	

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LOOP & LOCA Condition

					Time		
5	lights for closed breakers (@ 0.154 each)	5 x 0.154 =	0.770		38s-10m		
0	breaker closing coils (Peak)	0 x 15.00 =	0.000			R38	Ref 90
0	breaker closing coils (Continuous)	0 x 5.000 =	0.000				
0	lights for closing breakers (@ 0.231 each)	0 x 0.231 =	0.000				
5	lights for tripped breakers (@ 0.231 each)	5 x 0.231 =	1.155				
0	breaker tripping coils	0 x 1.080 =	0.000			R38	
0	lights for tripping breakers (@ 0.231 each)	0 x 0.231 =	0.000				
	Relays energized:						
2	IAC Relay	2 x 0.200 =	0.400				
1	SA-1 Relay	1 x 0.055 =	0.055				
5	Agastat Relay	5 x 0.064 =	0.320				
5	HFA	5 x 0.062 =	0.310				
1	HGA	1 x 0.038 =	0.038				
4	UV Relay	4 x 0.070 =	0.280				
		TOTAL =	3.328	Amps		R38	

					Time		
4	lights for closed breakers (@ 0.154 each)	4 x 0.154 =	0.616		10m-10m1s		
0	breaker closing coils (Peak)	0 x 15.00 =	0.000			R38	Ref 90
0	breaker closing coils (Continuous)	0 x 5.000 =	0.000				
0	lights for closing breakers (@ 0.231 each)	0 x 0.231 =	0.000				
5	lights for tripped breakers (@ 0.231 each)	5 x 0.231 =	1.155				
1	breaker tripping coils	1 x 1.080 =	1.080				
1	lights for tripping breakers (@ 0.231 each)	1 x 0.231 =	0.231			R38	
	Relays energized:						
2	IAC Relay	2 x 0.200 =	0.400				
1	SA-1 Relay	1 x 0.055 =	0.055				
5	Agastat Relay	5 x 0.064 =	0.320				
5	HFA	5 x 0.062 =	0.310				
1	HGA	1 x 0.038 =	0.038				
4	UV Relay	4 x 0.070 =	0.280				
		TOTAL =	4.485	Amps		R38	

					Time		
4	lights for closed breakers (@ 0.154 each)	4 x 0.154 =	0.616		10m1s-10m15s		
0	breaker closing coils (Peak)	0 x 15.00 =	0.000			R38	Ref 90
0	breaker closing coils (Continuous)	0 x 5.000 =	0.000				
0	lights for closing breakers (@ 0.231 each)	0 x 0.231 =	0.000				
6	lights for tripped breakers (@ 0.231 each)	6 x 0.231 =	1.386				
0	breaker tripping coils	0 x 1.080 =	0.000			R38	
0	lights for tripping breakers (@ 0.231 each)	0 x 0.231 =	0.000				
	Relays energized:						
2	IAC Relay	2 x 0.200 =	0.400				
1	SA-1 Relay	1 x 0.055 =	0.055				
5	Agastat Relay	5 x 0.064 =	0.320				
5	HFA	5 x 0.062 =	0.310				
1	HGA	1 x 0.038 =	0.038				
4	UV Relay	4 x 0.070 =	0.280				
		TOTAL =	3.405	Amps		R38	

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LOOP & LOCA Condition

					Time		
4	lights for closed breakers (@ 0.154 each)	4 x 0.154 =	0.616		10m1s-10m17s		
1	breaker closing coils (Peak)	1 x 15.00 =	15.000			R38	Ref 90
0	breaker closing coils (Continuous)	0 x 5.000 =	0.000				
1	lights for closing breakers (@ 0.231 each)	1 x 0.231 =	0.231				
5	lights for tripped breakers (@ 0.231 each)	5 x 0.231 =	1.155				
0	breaker tripping coils	0 x 1.080 =	0.000				
0	lights for tripping breakers (@ 0.231 each)	0 x 0.231 =	0.000				
	Relays energized:						
2	IAC Relay	2 x 0.200 =	0.400				
1	SA-1 Relay	1 x 0.055 =	0.055				
5	Agastat Relay	5 x 0.064 =	0.320				
5	HFA	5 x 0.062 =	0.310				
1	HGA	1 x 0.038 =	0.038				
4	UV Relay	4 x 0.070 =	0.280				
		TOTAL =	18.405 Amps			R38	

					Time		
4	lights for closed breakers (@ 0.154 each)	4 x 0.154 =	0.616		10m17s-10m30s		
0	breaker closing coils (Peak)	0 x 15.00 =	0.000			R38	Ref 90
1	breaker closing coils (Continuous)	1 x 5.000 =	5.000				
1	lights for closing breakers (@ 0.231 each)	1 x 0.231 =	0.231				
5	lights for tripped breakers (@ 0.231 each)	5 x 0.231 =	1.155				
0	breaker tripping coils	0 x 1.080 =	0.000			R38	
0	lights for tripping breakers (@ 0.231 each)	0 x 0.231 =	0.000				
	Relays energized:						
2	IAC Relay	2 x 0.200 =	0.400				
1	SA-1 Relay	1 x 0.055 =	0.055				
5	Agastat Relay	5 x 0.064 =	0.320				
5	HFA	5 x 0.062 =	0.310				
1	HGA	1 x 0.038 =	0.038				
4	UV Relay	4 x 0.070 =	0.280				
		TOTAL =	8.405 Amps			R38	

					Time		
5	lights for closed breakers (@ 0.154 each)	5 x 0.154 =	0.770		10m30s-end		
0	breaker closing coils (Peak)	0 x 15.00 =	0.000			R38	Ref 90
0	breaker closing coils (Continuous)	0 x 5.000 =	0.000				
0	lights for closing breakers (@ 0.231 each)	0 x 0.231 =	0.000				
5	lights for tripped breakers (@ 0.231 each)	5 x 0.231 =	1.155				
0	breaker tripping coils	0 x 1.080 =	0.000			R38	
0	lights for tripping breakers (@ 0.231 each)	0 x 0.231 =	0.000				
	Relays energized:						
2	IAC Relay	2 x 0.200 =	0.400				
1	SA-1 Relay	1 x 0.055 =	0.055				
5	Agastat Relay	5 x 0.064 =	0.320				
5	HFA	5 x 0.062 =	0.310				
1	HGA	1 x 0.038 =	0.038				
4	UV Relay	4 x 0.070 =	0.280				
		TOTAL =	3.328 Amps			R38	

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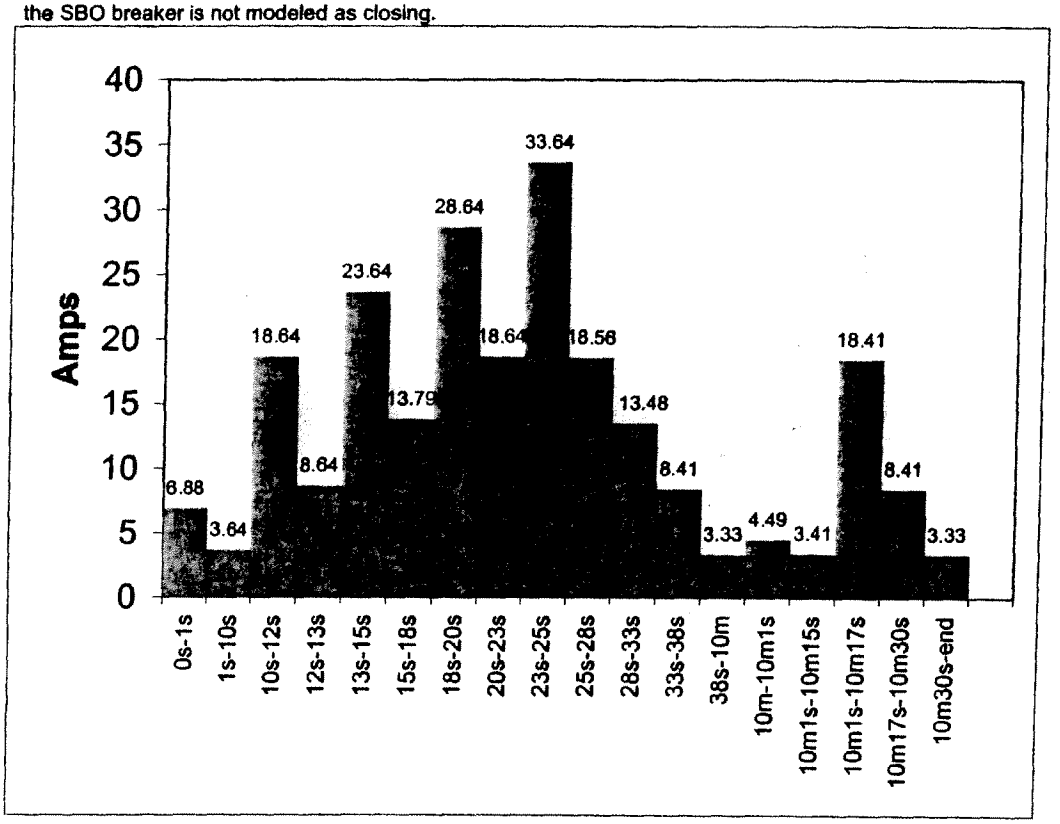
LOOP & LOCA Condition

NOTES

1.) At t=0s all closed breakers trip except for 480V SWGR 19 feed. 4kV SWGR 14-1 sheds loads.
2.) At t=1s all 4kV SWGR 14-1 loads have been shed except for 480V SWGR 19
(i.e. all breakers have completed tripping).
3.) At t=10s DG 1 breaker closes.
4.) At t=13s close breaker for RHR Pump 1C.
5.) At t=18s close breaker for RHR Pump 1D.
6.) At t=23s close breaker for Core Spray Pump 1B.
7.) At t=10m trip RHR Pump 1C or 1D.
8.) At t=10m15s close Main Feeder breaker to 4kV SWGR 14.

NOTE:
The SBO breaker remains tripped when there is a LOCA on either unit. Since the scenario modeled is a LOOP on both units 1 & 2 and a LOCA on one unit, the SBO breaker is not modeled as closing.



R38

Bus 2A-1 Circuit 1
4kV Switchgear Bus 23 Main Feed

 R36

4kV Switchgear 23 AC Loads

Bkr. #	Service	AC Bkr. Status			S/D	Rev.
		On-Line	LOOP/ LOOP & LOCA (t=1)	LOOP/ LOOP & LOCA (After)		
152-2301	Feed to 23-1	C	T	C/C	4E-2344	SH. 1, B
152-2302	CRD Feed Pump 2A	C	T	C/T	4E-2416	J
152-2303	Circ. Water Pump 2A	C	T	T/T	4E-2368	J
152-2304	Reserve Feed	C	T	T/T	4E-2342	V
152-2305	RHR SWP 2A	T	T	C*/C*	4E-2438P	SH. 1, J
152-2306	Cond. & Booster Pump 2A	C	T	T/T	4E-2370	J
152-2307	Circ. Water Pump 2B	C	T	T/T	4E-2368	J
152-2308	Service Water Pump 2A	C	T	C/T	4E-2391	C
152-2309	RHR SWP 2B	T	T	C*/C*	4E-2438P	SH. 1, J
152-2310	Main Feed	T	T	T/T	4E-2342	V
152-2311	Cond. & Booster Pump 2B	C	T	T/T	4E-2370	J
152-2312	480V Switchgear 25	C	T	T/T	4E-2347	E
152-2313	480V Transformer 2A	C	T	T/T	4E-685	F
152-2314	ILRT Compressor	T	T	T/T	4E-2653E	G

R36

* Only 1 pump is energized.

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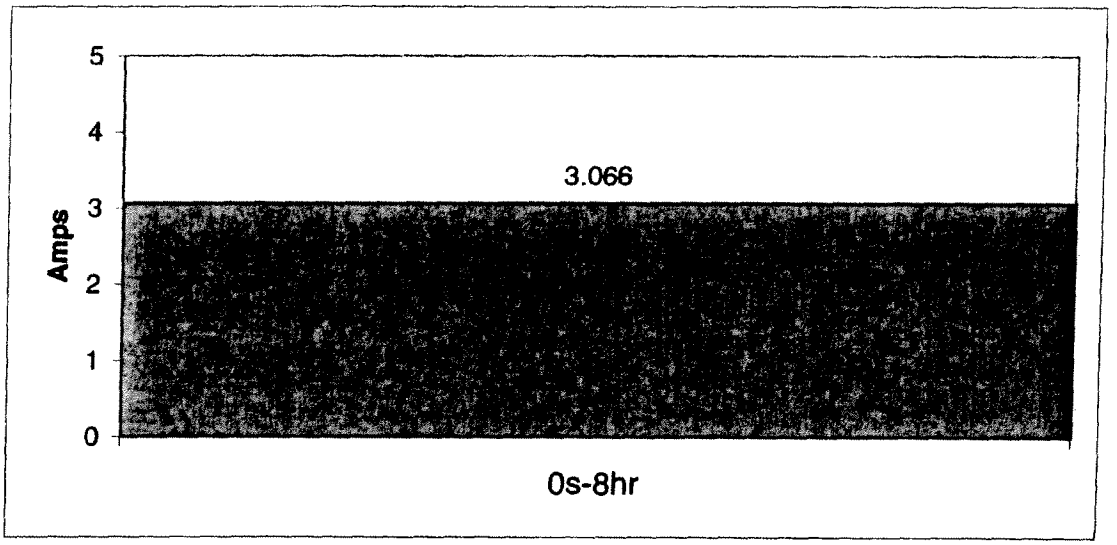
Normal Condition

The maximum dc load on the circuit under Normal condition is:

						Time	
10	lights for closed breakers (@ 0.154 each)	10 x	0.154 =	1.540		0s-8hr	R36
0	lights for closed breakers (@ 0.342 each)	0 x	0.342 =	0.000			R36
2	lights for tripped breakers (@ 0.231 each)	2 x	0.231 =	0.462			R36 (Ref. 92)
2	lights for tripped breakers (@ 0.513 each)	2 x	0.513 =	1.026			R36 (Ref. 92)
	No switching of breakers						
	Relays energized:						
0	HEA	0 x	5.400 =	0.000			
0	HFA	0 x	0.062 =	0.000			
1	HGA	1 x	0.038 =	0.038			
0	UV Relay	0 x	0.070 =	0.000			
		TOTAL	=	3.066	Amps		R36

NOTE

1.) The UV relay circuit would have one HGA relay energized.



4kV Switchgear 23 R36

LOOP Condition

The maximum dc load on the circuit under LOOP condition is:

						Time		
0	lights for closed breakers (@ 0.154 each)	0	x	0.154	=	0.000	0s-1s	R36
0	lights for closed breakers (@ 0.342 each)	0	x	0.342	=	0.000		R36
0	breaker closing coils	0	x	15.000	=	0.000		R36
0	lights for closing breakers (@ 0.231 each)	0	x	0.231	=	0.000		R36
0	lights for closing breakers (@ 0.513 each)	0	x	0.513	=	0.000		R36
2	lights for tripped breakers (@ 0.231 each)	2	x	0.231	=	0.462		R36 (Ref. 92)
2	lights for tripped breakers (@ 0.513 each)	2	x	0.513	=	1.026		R36 (Ref. 92)
10	breaker tripping coils	10	x	1.080	=	10.800		R36 (Ref. 88 & 93)
10	lights for tripping breakers (@ 0.231 each)	10	x	0.231	=	2.310		R36
	Relays energized:							
0	HEA	0	x	5.400	=	0.000		
3	HFA	3	x	0.062	=	0.186		
1	HGA	1	x	0.038	=	0.038		
2	UV Relay	2	x	0.070	=	0.140		
			TOTAL		=	14.962 Amps		R36

						Time	
0	lights for closed breakers (@ 0.154 each)	0	x	0.154	=	0.000	1s-10m	R36
0	lights for closed breakers (@ 0.342 each)	0	x	0.342	=	0.000		R36
0	breaker closing coils	0	x	15.000	=	0.000		R36
0	lights for closing breakers (@ 0.231 each)	0	x	0.231	=	0.000		R36
0	lights for closing breakers (@ 0.513 each)	0	x	0.513	=	0.000		R36
12	lights for tripped breakers (@ 0.231 each)	12	x	0.231	=	2.772		R36 (Ref. 92)
2	lights for tripped breakers (@ 0.513 each)	2	x	0.513	=	1.026		R36 (Ref. 92)
0	breaker tripping coils	0	x	1.080	=	0.000		R36 (Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		R36
	Relays energized:							
0	HEA	0	x	5.400	=	0.000		
3	HFA	3	x	0.062	=	0.186		
1	HGA	1	x	0.038	=	0.038		
2	UV Relay	2	x	0.070	=	0.140		
			TOTAL		=	4.162 Amps		R36

						Time	
0	lights for closed breakers (@ 0.154 each)	0	x	0.154	=	0.000	10m-10m2s	R36
0	lights for closed breakers (@ 0.342 each)	0	x	0.342	=	0.000		R36
1	breaker closing coils (Peak)	1	x	15.000	=	15.000		R36
0	breaker closing coils (Continuous)	0	x	5.000	=	0.000		R36
1	lights for closing breakers (@ 0.231 each)	1	x	0.231	=	0.231		R36
0	lights for closing breakers (@ 0.513 each)	0	x	0.513	=	0.000		R36
11	lights for tripped breakers (@ 0.231 each)	11	x	0.231	=	2.541		R36 (Ref. 92)
2	lights for tripped breakers (@ 0.513 each)	2	x	0.513	=	1.026		R36 (Ref. 92)
0	breaker tripping coils	0	x	1.080	=	0.000		R36 (Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		R36
	Relays energized:							
0	HEA	0	x	5.400	=	0.000		
3	HFA	3	x	0.062	=	0.186		R36
1	HGA	1	x	0.038	=	0.038		
2	UV Relay	2	x	0.070	=	0.140		R36
			TOTAL		=	19.162 Amps		R36

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LOOP Condition

						Time		
0	lights for closed breakers (@ 0.154 each)	0	x	0.154	=	0.000	10m2s-10m15s	R36
0	lights for closed breakers (@ 0.342 each)	0	x	0.342	=	0.000		R36
0	breaker closing coils (Peak)	0	x	15.000	=	0.000		R36
1	breaker closing coils (Continuous)	1	x	5.000	=	5.000		R36
1	lights for closing breakers (@ 0.231 each)	1	x	0.231	=	0.231		R36 (Ref. 92)
0	lights for closing breakers (@ 0.513 each)	0	x	0.513	=	0.000		R36 (Ref. 92)
11	lights for tripped breakers (@ 0.231 each)	11	x	0.231	=	2.541		R36
2	lights for tripped breakers (@ 0.513 each)	2	x	0.513	=	1.026		R36
0	breaker tripping coils	0	x	1.080	=	0.000		R36 (Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		R36
	Relays energized:							
0	HEA	0	x	5.400	=	0.000		
3	HFA	3	x	0.062	=	0.186		R36
1	HGA	1	x	0.038	=	0.038		
2	UV Relay	2	x	0.070	=	0.140		R36
			TOTAL		=	9.162 Amps		R36
						Time		
1	lights for closed breakers (@ 0.154 each)	1	x	0.154	=	0.154	10m15s-10m17s	R36 (Ref. 92)
0	lights for closed breakers (@ 0.342 each)	0	x	0.342	=	0.000		R36 (Ref. 92)
1	breaker closing coils (Peak)	1	x	15.000	=	15.000		R36
0	breaker closing coils (Continuous)	0	x	5.000	=	0.000		R36
0	lights for closing breakers (@ 0.231 each)	0	x	0.231	=	0.000		R36
1	lights for closing breakers (@ 0.513 each)	1	x	0.513	=	0.513		R36
11	lights for tripped breakers (@ 0.231 each)	11	x	0.231	=	2.541		R36 (Ref. 92)
1	lights for tripped breakers (@ 0.513 each)	1	x	0.513	=	0.513		R36 (Ref. 92)
0	breaker tripping coils	0	x	1.080	=	0.000		R36 (Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		R36
	Relays energized:							
0	HEA	0	x	5.400	=	0.000		
3	HFA	3	x	0.062	=	0.186		R36
1	HGA	1	x	0.038	=	0.038		
2	UV Relay	2	x	0.070	=	0.140		R36
			TOTAL		=	19.085 Amps		R36
						Time		R36
1	lights for closed breakers (@ 0.154 each)	1	x	0.154	=	0.154	10m17s-10m30s	R36 (Ref. 92)
0	lights for closed breakers (@ 0.342 each)	0	x	0.342	=	0.000		R36 (Ref. 92)
0	breaker closing coils (Peak)	0	x	15.000	=	0.000		R36
1	breaker closing coils (Continuous)	1	x	5.000	=	5.000		R36
0	lights for closing breakers (@ 0.231 each)	0	x	0.231	=	0.000		R36
1	lights for closing breakers (@ 0.513 each)	1	x	0.513	=	0.513		R36
11	lights for tripped breakers (@ 0.231 each)	11	x	0.231	=	2.541		R36 (Ref. 92)
1	lights for tripped breakers (@ 0.513 each)	1	x	0.513	=	0.513		R36 (Ref. 92)
0	breaker tripping coils	0	x	1.080	=	0.000		R36 (Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		R36
	Relays energized:							R36
0	HEA	0	x	5.400	=	0.000		R36
3	HFA	3	x	0.062	=	0.186		R36
1	HGA	1	x	0.038	=	0.038		R36
2	UV Relay	2	x	0.070	=	0.140		R36
			TOTAL		=	9.085 Amps		R36

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LOOP Condition

						Time	R36	
1	lights for closed breakers (@ 0.154 each)	1	x	0.154	=	0.154	10m30s-10m45s R36	
1	lights for closed breakers (@ 0.342 each)	1	x	0.342	=	0.342	R36	
0	breaker closing coils (Peak)	0	x	15.000	=	0.000	R36	
0	breaker closing coils (Continuous)	0	x	5.000	=	0.000	R36	
0	lights for closing breakers (@ 0.231 each)	0	x	0.231	=	0.000	R36	(Ref. 92)
0	lights for closing breakers (@ 0.513 each)	0	x	0.513	=	0.000	R36	(Ref. 92)
11	lights for tripped breakers (@ 0.231 each)	11	x	0.231	=	2.541	R36	
1	lights for tripped breakers (@ 0.513 each)	1	x	0.513	=	0.513	R36	
0	breaker tripping coils	0	x	1.080	=	0.000	R36	(Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000	R36	
	Relays energized:						R36	
0	HEA	0	x	5.400	=	0.000	R36	
3	HFA	3	x	0.062	=	0.186	R36	
1	HGA	1	x	0.038	=	0.038	R36	
2	UV Relay	2	x	0.070	=	0.140	R36	
			TOTAL		=	3.914 Amps	R36	
						Time	R36	
1	lights for closed breakers (@ 0.154 each)	1	x	0.154	=	0.154	10m45s-10m47s R36	(Ref. 92)
1	lights for closed breakers (@ 0.342 each)	1	x	0.342	=	0.342	R36	(Ref. 92)
1	breaker closing coils (Peak)	1	x	15.000	=	15.000	R36	
0	breaker closing coils (Continuous)	0	x	5.000	=	0.000	R36	
1	lights for closing breakers (@ 0.231 each)	1	x	0.231	=	0.231	R36	
0	lights for closing breakers (@ 0.513 each)	0	x	0.513	=	0.000	R36	
10	lights for tripped breakers (@ 0.231 each)	10	x	0.231	=	2.310	R36	(Ref. 92)
1	lights for tripped breakers (@ 0.513 each)	1	x	0.513	=	0.513	R36	(Ref. 92)
0	breaker tripping coils	0	x	1.080	=	0.000	R36	(Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000	R36	
	Relays energized:						R36	
0	HEA	0	x	5.400	=	0.000	R36	
3	HFA	3	x	0.062	=	0.186	R36	
1	HGA	1	x	0.038	=	0.038	R36	
2	UV Relay	2	x	0.070	=	0.140	R36	
			TOTAL		=	18.914 Amps	R36	
						Time	R36	
1	lights for closed breakers (@ 0.154 each)	1	x	0.154	=	0.154	10m47s-11m R36	(Ref. 92)
1	lights for closed breakers (@ 0.342 each)	1	x	0.342	=	0.342	R36	(Ref. 92)
0	breaker closing coils (Peak)	0	x	15.000	=	0.000	R36	
1	breaker closing coils (Continuous)	1	x	5.000	=	5.000	R36	
1	lights for closing breakers (@ 0.231 each)	1	x	0.231	=	0.231	R36	
0	lights for closing breakers (@ 0.513 each)	0	x	0.513	=	0.000	R36	
10	lights for tripped breakers (@ 0.231 each)	10	x	0.231	=	2.310	R36	(Ref. 92)
1	lights for tripped breakers (@ 0.513 each)	1	x	0.513	=	0.513	R36	(Ref. 92)
0	breaker tripping coils	0	x	1.080	=	0.000	R36	(Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000	R36	
	Relays energized:						R36	
0	HEA	0	x	5.400	=	0.000	R36	
3	HFA	3	x	0.062	=	0.186	R36	
1	HGA	1	x	0.038	=	0.038	R36	
2	UV Relay	2	x	0.070	=	0.140	R36	
			TOTAL		=	8.914 Amps	R36	

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LOOP Condition R36

						Time	R36	
2	lights for closed breakers (@ 0.154 each)	2	x	0.154	=	0.308	11m-11m15s R36	
1	lights for closed breakers (@ 0.342 each)	1	x	0.342	=	0.342	R36	
0	breaker closing coils (Peak)	0	x	15.000	=	0.000	R36	
0	breaker closing coils (Continuous)	0	x	5.000	=	0.000	R36	
0	lights for closing breakers (@ 0.231 each)	0	x	0.231	=	0.000	R36	(Ref. 92)
0	lights for closing breakers (@ 0.513 each)	0	x	0.513	=	0.000	R36	(Ref. 92)
10	lights for tripped breakers (@ 0.231 each)	10	x	0.231	=	2.310	R36	
1	lights for tripped breakers (@ 0.513 each)	1	x	0.513	=	0.513	R36	
0	breaker tripping coils	0	x	1.080	=	0.000	R36	(Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000	R36	
	Relays energized:						R36	
0	HEA	0	x	5.400	=	0.000	R36	
3	HFA	3	x	0.062	=	0.186	R36	
1	HGA	1	x	0.038	=	0.038	R36	
2	UV Relay	2	x	0.070	=	0.140	R36	
				TOTAL	=	3.837 Amps	R36	
						Time	R36	
2	lights for closed breakers (@ 0.154 each)	2	x	0.154	=	0.308	11m15s-11m17s R36	(Ref. 92)
1	lights for closed breakers (@ 0.342 each)	1	x	0.342	=	0.342	R36	(Ref. 92)
1	breaker closing coils (Peak)	1	x	15.000	=	15.000	R36	
0	breaker closing coils (Continuous)	0	x	5.000	=	0.000	R36	
1	lights for closing breakers (@ 0.231 each)	1	x	0.231	=	0.231	R36	
0	lights for closing breakers (@ 0.513 each)	0	x	0.513	=	0.000	R36	
9	lights for tripped breakers (@ 0.231 each)	9	x	0.231	=	2.079	R36	(Ref. 92)
1	lights for tripped breakers (@ 0.513 each)	1	x	0.513	=	0.513	R36	(Ref. 92)
0	breaker tripping coils	0	x	1.080	=	0.000	R36	(Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000	R36	
	Relays energized:						R36	
0	HEA	0	x	5.400	=	0.000	R36	
3	HFA	3	x	0.062	=	0.186	R36	
1	HGA	1	x	0.038	=	0.038	R36	
2	UV Relay	2	x	0.070	=	0.140	R36	
				TOTAL	=	18.837 Amps	R36	
						Time	R36	
2	lights for closed breakers (@ 0.154 each)	2	x	0.154	=	0.308	11m17s-11m30s R36	(Ref. 92)
1	lights for closed breakers (@ 0.342 each)	1	x	0.342	=	0.342	R36	(Ref. 92)
0	breaker closing coils (Peak)	0	x	15.000	=	0.000	R36	
1	breaker closing coils (Continuous)	1	x	5.000	=	5.000	R36	
1	lights for closing breakers (@ 0.231 each)	1	x	0.231	=	0.231	R36	
0	lights for closing breakers (@ 0.513 each)	0	x	0.513	=	0.000	R36	
9	lights for tripped breakers (@ 0.231 each)	9	x	0.231	=	2.079	R36	(Ref. 92)
1	lights for tripped breakers (@ 0.513 each)	1	x	0.513	=	0.513	R36	(Ref. 92)
0	breaker tripping coils	0	x	1.080	=	0.000	R36	(Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000	R36	
	Relays energized:						R36	
0	HEA	0	x	5.400	=	0.000	R36	
3	HFA	3	x	0.062	=	0.186	R36	
1	HGA	1	x	0.038	=	0.038	R36	
2	UV Relay	2	x	0.070	=	0.140	R36	
				TOTAL	=	8.837 Amps	R36	

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LOOP Condition R36

						Time	R36	
3	lights for closed breakers (@ 0.154 each)	3	x	0.154	=	0.462	11m30s-end R36	
1	lights for closed breakers (@ 0.342 each)	1	x	0.342	=	0.342	R36	
0	breaker closing coils (Peak)	0	x	15.000	=	0.000	R36	
0	breaker closing coils (Continuous)	0	x	5.000	=	0.000	R36	
0	lights for closing breakers (@ 0.231 each)	0	x	0.231	=	0.000	R36	(Ref. 92)
0	lights for closing breakers (@ 0.513 each)	0	x	0.513	=	0.000	R36	(Ref. 92)
9	lights for tripped breakers (@ 0.231 each)	9	x	0.231	=	2.079	R36	
1	lights for tripped breakers (@ 0.513 each)	1	x	0.513	=	0.513	R36	
0	breaker tripping coils	0	x	1.080	=	0.000	R36	(Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000	R36	
	Relays energized:						R36	
0	HEA	0	x	5.400	=	0.000	R36	
3	HFA	3	x	0.062	=	0.186	R36	
1	HGA	1	x	0.038	=	0.038	R36	
2	UV Relay	2	x	0.070	=	0.140	R36	
			TOTAL		=	3.760 Amps	R36	

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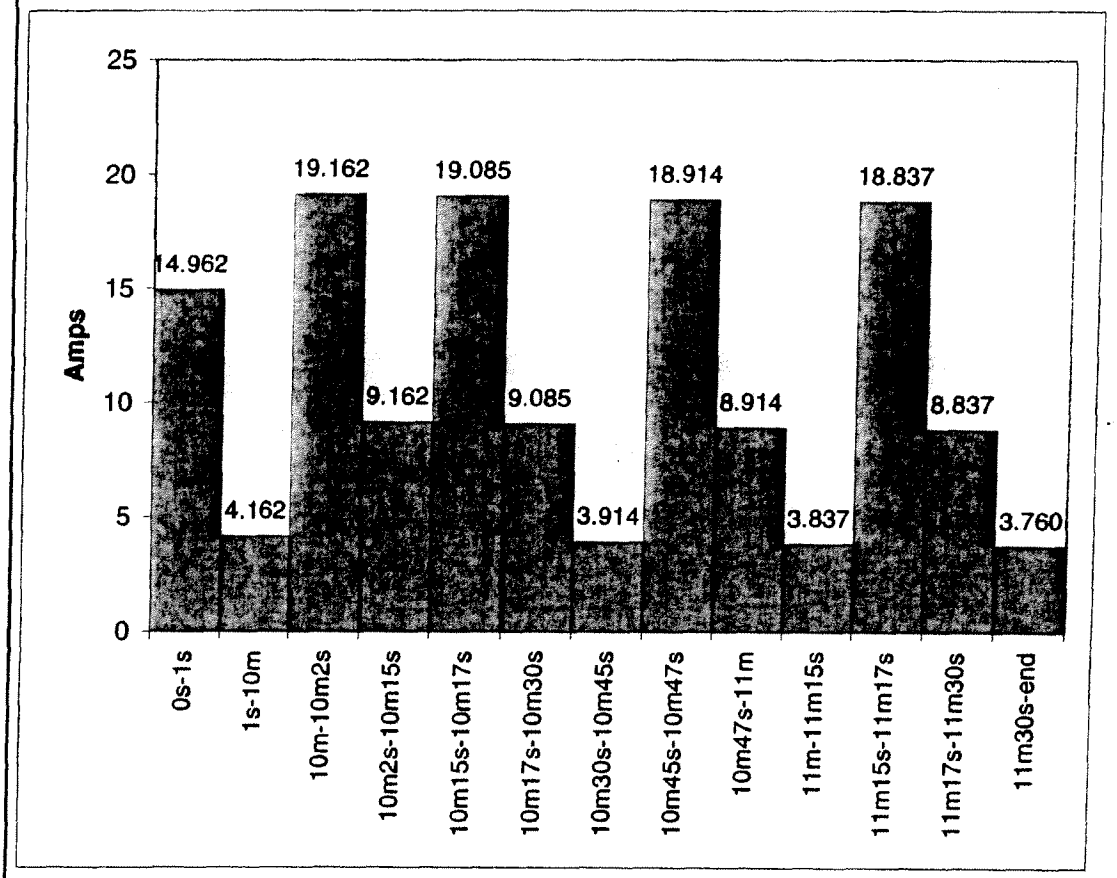
LOOP Condition

NOTES

1.) At t=0s all closed breakers trip. 4kV SWGR 23 sheds all load.
2.) At t=1s all 4kV SWGR 23 loads have been shed (i.e. all breakers have completed tripping).
3.) At t=10m feed breaker to 4kV SWGR 23-1 closes. R36
4.) At t=10m15s feed breaker to RHR SWP 2A or 2B closes. R36
5.) At t=10m45s feed breaker to SW Pump 2A closes. R36
6.) At t=11m15s feed breaker to CRD Feed Pump 2A closes. R36



R36

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LOOP & LOCA Condition

The maximum dc load on the circuit under LOOP & LOCA condition is:

						Time		
0	lights for closed breakers (@ 0.154 each)	0	x	0.154	=	0.000	0s-1s	R36
0	lights for closed breakers (@ 0.342 each)	0	x	0.342	=	0.000		R36
0	breaker closing coils	0	x	15.000	=	0.000		R36
0	lights for closing breakers (@ 0.231 each)	0	x	0.231	=	0.000		R36
0	lights for closing breakers (@ 0.513 each)	0	x	0.513	=	0.000		R36
2	lights for tripped breakers (@ 0.231 each)	2	x	0.231	=	0.462		R36 (Ref. 92)
2	lights for tripped breakers (@ 0.513 each)	2	x	0.513	=	1.026		R36 (Ref. 92)
10	breaker tripping coils	10	x	1.080	=	10.800		R36 (Ref. 88 & 93)
10	lights for tripping breakers (@ 0.231 each)	10	x	0.231	=	2.310		R36
	Relays energized:							
0	HEA	0	x	5.400	=	0.000		
3	HFA	3	x	0.062	=	0.186		
1	HGA	1	x	0.038	=	0.038		
2	UV Relay	2	x	0.070	=	0.140		
			TOTAL		=	14.962 Amps		R36

						Time	
0	lights for closed breakers (@ 0.154 each)	0	x	0.154	=	0.000	1s-10m15s	R36
0	lights for closed breakers (@ 0.342 each)	0	x	0.342	=	0.000		R36
0	breaker closing coils	0	x	15.000	=	0.000		R36
0	lights for closing breakers (@ 0.231 each)	0	x	0.231	=	0.000		R36
0	lights for closing breakers (@ 0.513 each)	0	x	0.513	=	0.000		R36
12	lights for tripped breakers (@ 0.231 each)	12	x	0.231	=	2.772		R36 (Ref. 92)
2	lights for tripped breakers (@ 0.513 each)	2	x	0.513	=	1.026		R36 (Ref. 92)
0	breaker tripping coils	0	x	1.080	=	0.000		R36 (Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		R36
	Relays energized:							
0	HEA	0	x	5.400	=	0.000		
3	HFA	3	x	0.062	=	0.186		
1	HGA	1	x	0.038	=	0.038		
2	UV Relay	2	x	0.070	=	0.140		
			TOTAL		=	4.162 Amps		R36

						Time	
0	lights for closed breakers (@ 0.154 each)	0	x	0.154	=	0.000	10m15s-10m17s	R36
0	lights for closed breakers (@ 0.342 each)	0	x	0.342	=	0.000		R36
1	breaker closing coils (Peak)	1	x	15.000	=	15.000		R36
0	breaker closing coils (Continuous)	0	x	5.000	=	0.000		R36
1	lights for closing breakers (@ 0.231 each)	1	x	0.231	=	0.231		R36
0	lights for closing breakers (@ 0.513 each)	0	x	0.513	=	0.000		R36
11	lights for tripped breakers (@ 0.231 each)	11	x	0.231	=	2.541		R36 (Ref. 92)
2	lights for tripped breakers (@ 0.513 each)	2	x	0.513	=	1.026		R36 (Ref. 92)
0	breaker tripping coils	0	x	1.080	=	0.000		R36 (Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		R36
	Relays energized:							
0	HEA	0	x	5.400	=	0.000		
3	HFA	3	x	0.062	=	0.186		R36
1	HGA	1	x	0.038	=	0.038		
2	UV Relay	2	x	0.070	=	0.140		R36
			TOTAL		=	19.162 Amps		R36

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LOOP & LOCA Condition

						Time		
0	lights for closed breakers (@ 0.154 each)	0 x	0.154 =	0.000		10m17s-10m30s	R36	
0	lights for closed breakers (@ 0.342 each)	0 x	0.342 =	0.000			R36	
0	breaker closing coils (Peak)	0 x	15.000 =	0.000			R36	
1	breaker closing coils (Continuous)	1 x	5.000 =	5.000			R36	
1	lights for closing breakers (@ 0.231 each)	1 x	0.231 =	0.231			R36	(Ref. 92)
0	lights for closing breakers (@ 0.513 each)	0 x	0.513 =	0.000			R36	(Ref. 92)
11	lights for tripped breakers (@ 0.231 each)	11 x	0.231 =	2.541			R36	
2	lights for tripped breakers (@ 0.513 each)	2 x	0.513 =	1.026			R36	
0	breaker tripping coils	0 x	1.080 =	0.000			R36	(Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0 x	0.231 =	0.000			R36	
	Relays energized:							
0	HEA	0 x	5.400 =	0.000				
3	HFA	3 x	0.062 =	0.186			R36	
1	HGA	1 x	0.038 =	0.038				
2	UV Relay	2 x	0.070 =	0.140			R36	
		TOTAL	=	9.162	Amps		R36	

						Time		
1	lights for closed breakers (@ 0.154 each)	1 x	0.154 =	0.154		10m30s-10m32s	R36	(Ref. 92)
0	lights for closed breakers (@ 0.342 each)	0 x	0.342 =	0.000			R36	(Ref. 92)
1	breaker closing coils (Peak)	1 x	15.000 =	15.000			R36	
0	breaker closing coils (Continuous)	0 x	5.000 =	0.000			R36	
0	lights for closing breakers (@ 0.231 each)	0 x	0.231 =	0.000			R36	
1	lights for closing breakers (@ 0.513 each)	1 x	0.513 =	0.513			R36	
11	lights for tripped breakers (@ 0.231 each)	11 x	0.231 =	2.541			R36	
1	lights for tripped breakers (@ 0.513 each)	1 x	0.513 =	0.513			R36	
0	breaker tripping coils	0 x	1.080 =	0.000			R36	(Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0 x	0.231 =	0.000			R36	
	Relays energized:							
0	HEA	0 x	5.400 =	0.000				
3	HFA	3 x	0.062 =	0.186			R36	
1	HGA	1 x	0.038 =	0.038				
2	UV Relay	2 x	0.070 =	0.140			R36	
		TOTAL	=	19.085	Amps		R36	

						Time		
							R36	
1	lights for closed breakers (@ 0.154 each)	1 x	0.154 =	0.154		10m32s-10m45s	R36	(Ref. 92)
0	lights for closed breakers (@ 0.342 each)	0 x	0.342 =	0.000			R36	(Ref. 92)
0	breaker closing coils (Peak)	0 x	15.000 =	0.000			R36	
1	breaker closing coils (Continuous)	1 x	5.000 =	5.000			R36	
0	lights for closing breakers (@ 0.231 each)	0 x	0.231 =	0.000			R36	
1	lights for closing breakers (@ 0.513 each)	1 x	0.513 =	0.513			R36	
11	lights for tripped breakers (@ 0.231 each)	11 x	0.231 =	2.541			R36	
1	lights for tripped breakers (@ 0.513 each)	1 x	0.513 =	0.513			R36	
0	breaker tripping coils	0 x	1.080 =	0.000			R36	(Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0 x	0.231 =	0.000			R36	
	Relays energized:						R36	
0	HEA	0 x	5.400 =	0.000			R36	
3	HFA	3 x	0.062 =	0.186			R36	
1	HGA	1 x	0.038 =	0.038			R36	
2	UV Relay	2 x	0.070 =	0.140			R36	
		TOTAL	=	9.085	Amps		R36	

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LOOP & LOCA Condition R36

						Time		
							R36	
1	lights for closed breakers (@ 0.154 each)	1 x 0.154	=	0.154		10m45s-end	R36	
1	lights for closed breakers (@ 0.342 each)	1 x 0.342	=	0.342			R36	
0	breaker closing coils (Peak)	0 x 15.000	=	0.000			R36	
0	breaker closing coils (Continuous)	0 x 5.000	=	0.000			R36	
0	lights for closing breakers (@ 0.231 each)	0 x 0.231	=	0.000			R36	(Ref. 92)
0	lights for closing breakers (@ 0.513 each)	0 x 0.513	=	0.000			R36	(Ref. 92)
11	lights for tripped breakers (@ 0.231 each)	11 x 0.231	=	2.541			R36	
1	lights for tripped breakers (@ 0.513 each)	1 x 0.513	=	0.513			R36	
0	breaker tripping coils	0 x 1.080	=	0.000			R36	(Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0 x 0.231	=	0.000			R36	
	Relays energized:						R36	
0	HEA	0 x 5.400	=	0.000			R36	
3	HFA	3 x 0.062	=	0.186			R36	
1	HGA	1 x 0.038	=	0.038			R36	
2	UV Relay	2 x 0.070	=	0.140			R36	
		TOTAL	=	3.914	Amps		R36	

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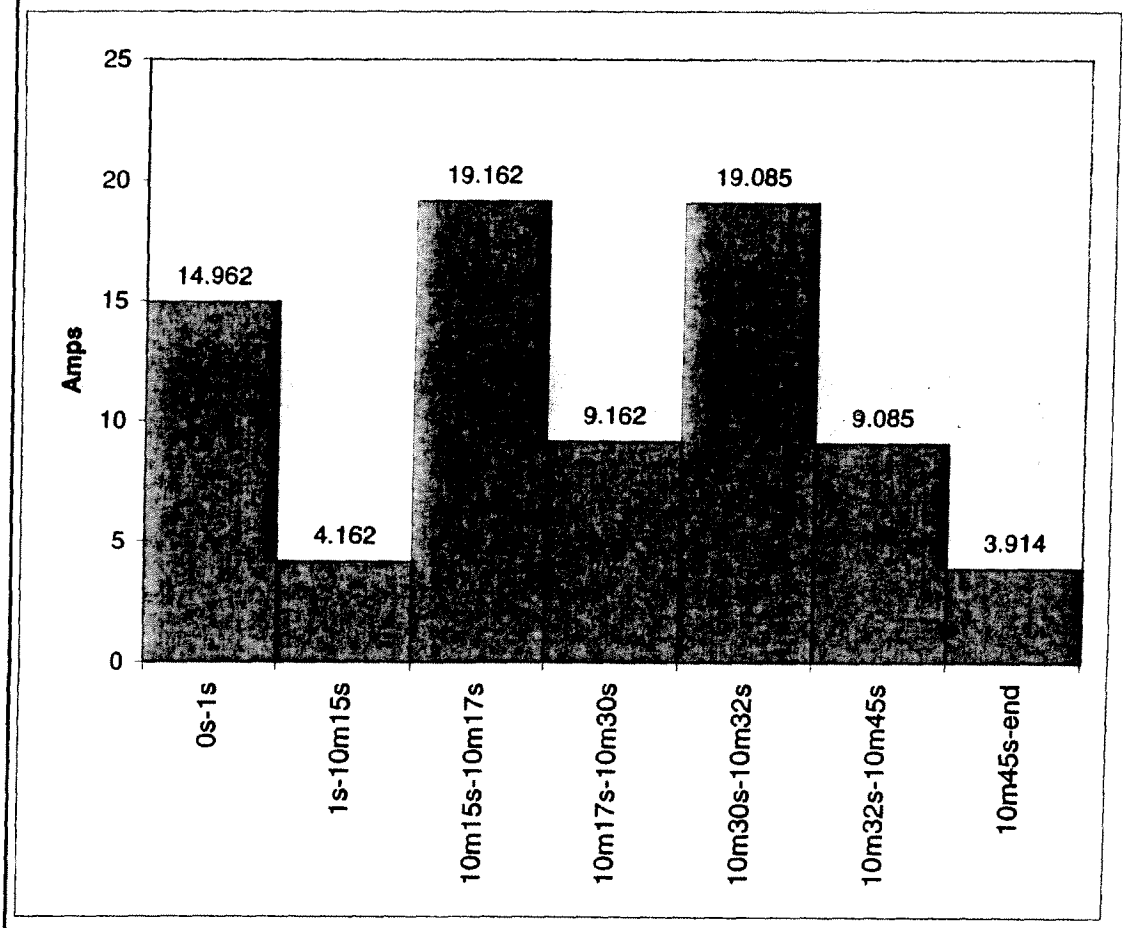
LOOP & LOCA Condition

NOTES

1.) At t=0s all closed breakers trip.4kV SWGR 23 sheds all load.
2.) At t=1s all 4kV SWGR 23 loads have been shed (i.e. all breakers have completed tripping).
3.) At t=10m15s feed breaker to 4kV SWGR 23-1 closes. R36
4.) At t=10m30s feed breaker to RHR SWP 2A or 2B closes. R36



R36

Bus Panel #2 Circuit 1
4kV Switchgear Bus 23-1 Main Feed

 R36

4kV Switchgear 23-1 AC Loads

Bkr. #	Service	AC Bkr. Status			S/D	Rev.
		On-Line	LOOP/ LOOP & LOCA (t=1)	LOOP/ LOOP & LOCA (After)		
152-2321	Div. I Cross-Tie to Bus 13-1	T	T	T/T	4E-2345	SH. 3, A
152-2322	Core Spray Pump 2A	T	T	T/C	4E-2429	SH. 1, K
152-2323	Main Feed	C	T	C/C	4E-2344	SH. 3, E
152-2324	RHR Pump 2A	T	T	T/C**	4E-2438Q	SH. 1, L
152-2325	480V Transformer 20	C	T	T/T	4E-7230	C
152-2326	RHR Pump 2B	T	T	T/C**	4E-2438Q	SH. 1, L
152-2327	480V Switchgear 28	C	C	C/C	4E-2349	SH. 1, P
152-2328	SBO DG*	T	T	T/T	--	--
152-2329	DG-1/2	T	T	C/C	4E-2345	SH. 1, AP

R36

*NOTE: The SBO breaker remains tripped when there is a LOCA on either unit. Since the scenario modeled is a LOOP on both units 1 & 2 and a LOCA on one unit, the SBO breaker is not modeled as closing.

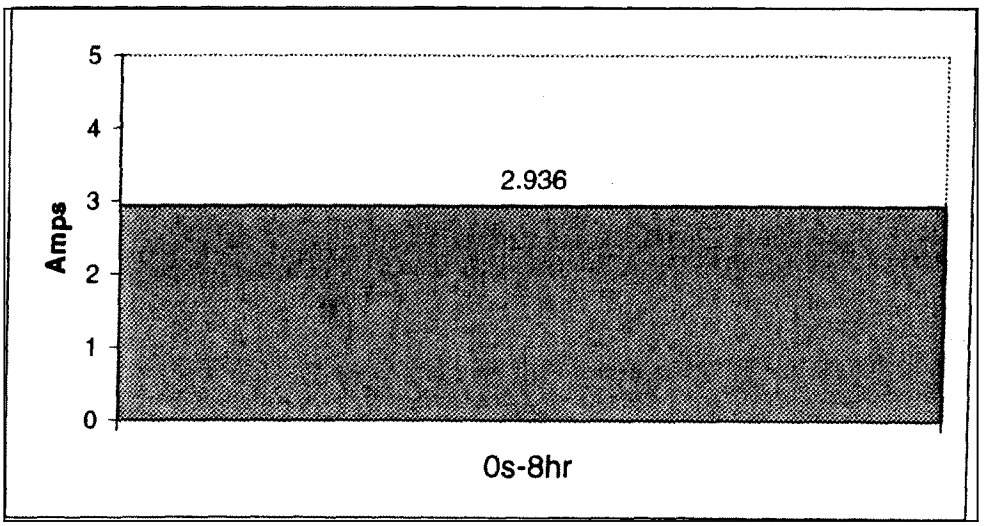
** Only 1 pump remains energized at the end of the LOOP & LOCA scenario.

4kV Switchgear 23-1 **Page 2 of 13** R36

Normal Condition

The maximum dc load on the circuit under Normal condition is:

							Time	
3	lights for closed breakers (@ 0.154 each)	3	x	0.154	=	0.462	0s-8hr	R36
0	lights for closed breakers (@ 0.342 each)	0	x	0.342	=	0.000		R36
3	lights for tripped breakers (@ 0.231 each)	3	x	0.231	=	0.693		R36 (Ref. 92)
3	lights for tripped breakers (@ 0.513 each)	3	x	0.513	=	1.539		R36 (Ref. 92)
	No switching of breakers							
	Relays energized:							
0	SA-1 Relay	0	x	0.055	=	0.000		
1	Agastat Relay	1	x	0.064	=	0.064		
0	HFA	0	x	0.062	=	0.000		
1	HGA	1	x	0.038	=	0.038		
2	UV Relay	2	x	0.070	=	0.140		
			TOTAL		=	2.936 Amps		R36



R36

4kV Switchgear 23-1 R36

LOOP Condition

The maximum dc load on the circuit under LOOP condition is:

						Time	
1	lights for closed breakers (@ 0.154 each)	1	x	0.154 =	0.154	0s-1s	R36
0	lights for closed breakers (@ 0.342 each)	0	x	0.342 =	0.000		R36
0	breaker closing coils	0	x	15.000 =	0.000		R36 (Ref. 93)
0	lights for closing breakers (@ 0.231 each)	0	x	0.231 =	0.000		R36
0	lights for closing breakers (@ 0.513 each)	0	x	0.513 =	0.000		R36
3	lights for tripped breakers (@ 0.231 each)	3	x	0.231 =	0.693		R36 (Ref. 92)
3	lights for tripped breakers (@ 0.513 each)	3	x	0.513 =	1.539		R36 (Ref. 92)
2	breaker tripping coils	2	x	1.080 =	2.160		R36 (Ref. 88 & 93)
2	lights for tripping breakers (@ 0.231 each)	2	x	0.231 =	0.462		R36
	Relays energized:						
0	SA-1 Relay	0	x	0.055 =	0.000		
4	Agastat Relay	4	x	0.064 =	0.256		R36
4	HFA	4	x	0.062 =	0.248		
2	HGA	2	x	0.038 =	0.076		R36
4	UV Relay	4	x	0.070 =	0.280		
			TOTAL	=	5.868 Amps		R36

						Time	
1	lights for closed breakers (@ 0.154 each)	1	x	0.154 =	0.154	1s-10s	R36
0	lights for closed breakers (@ 0.342 each)	0	x	0.342 =	0.000		R36
0	breaker closing coils	0	x	15.000 =	0.000		R36 (Ref. 93)
0	lights for closing breakers (@ 0.231 each)	0	x	0.231 =	0.000		R36
0	lights for closing breakers (@ 0.513 each)	0	x	0.513 =	0.000		R36
5	lights for tripped breakers (@ 0.231 each)	5	x	0.231 =	1.155		R36 (Ref. 92)
3	lights for tripped breakers (@ 0.513 each)	3	x	0.513 =	1.539		R36 (Ref. 92)
0	breaker tripping coils	0	x	1.080 =	0.000		R36 (Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231 =	0.000		R36
	Relays energized:						
0	SA-1 Relay	0	x	0.055 =	0.000		
4	Agastat Relay	4	x	0.064 =	0.256		R36
4	HFA	4	x	0.062 =	0.248		
2	HGA	2	x	0.038 =	0.076		R36
4	UV Relay	4	x	0.070 =	0.280		
			TOTAL	=	3.708 Amps		R36

						Time	
1	lights for closed breakers (@ 0.154 each)	1	x	0.154 =	0.154	10s-12s	R36
0	lights for closed breakers (@ 0.342 each)	0	x	0.342 =	0.000		R36
1	breaker closing coils (Peak)	1	x	15.000 =	15.000		R36 (Ref. 93)
0	breaker closing coils (Continuous)	0	x	5.000 =	0.000		R36
1	lights for closing breakers (@ 0.231 each)	1	x	0.231 =	0.231		R36
0	lights for closing breakers (@ 0.513 each)	0	x	0.513 =	0.000		R36
4	lights for tripped breakers (@ 0.231 each)	4	x	0.231 =	0.924		R36 (Ref. 92)
3	lights for tripped breakers (@ 0.513 each)	3	x	0.513 =	1.539		R36 (Ref. 92)
0	breaker tripping coils	0	x	1.080 =	0.000		R36 (Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231 =	0.000		R36
	Relays energized:						
1	Interposing Relay	1	x	0.235 =	0.235		
0	SA-1 Relay	0	x	0.055 =	0.000		
4	Agastat Relay	4	x	0.064 =	0.256		R36
4	HFA	4	x	0.062 =	0.248		R36
2	HGA	2	x	0.038 =	0.076		R36
4	UV Relay	4	x	0.070 =	0.280		R36
			TOTAL	=	18.943 Amps		R36

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LOOP Condition

							Time	
1	lights for closed breakers (@ 0.154 each)	1	x	0.154	=	0.154	12s-25s	R36
0	lights for closed breakers (@ 0.342 each)	0	x	0.342	=	0.000		R36
0	breaker closing coils (Peak)	0	x	15.000	=	0.000		R36 (Ref. 93)
1	breaker closing coils (Continuous)	1	x	5.000	=	5.000		R36
1	lights for closing breakers (@ 0.231 each)	1	x	0.231	=	0.231		R36
0	lights for closing breakers (@ 0.513 each)	0	x	0.513	=	0.000		R36
4	lights for tripped breakers (@ 0.231 each)	4	x	0.231	=	0.924		R36 (Ref. 92)
3	lights for tripped breakers (@ 0.513 each)	3	x	0.513	=	1.539		R36 (Ref. 92)
0	breaker tripping coils	0	x	1.080	=	0.000		R36 (Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		R36
	Relays energized:							
0	SA-1 Relay	0	x	0.055	=	0.000		
4	Agastat Relay	4	x	0.064	=	0.256		R36
4	HFA	4	x	0.062	=	0.248		R36
2	HGA	2	x	0.038	=	0.076		R36
4	UV Relay	4	x	0.070	=	0.280		R36
			TOTAL		=	8.708 Amps		R36
							Time	
2	lights for closed breakers (@ 0.154 each)	2	x	0.154	=	0.308	25s-10m	R36
0	lights for closed breakers (@ 0.342 each)	0	x	0.342	=	0.000		R36
0	breaker closing coils (Peak)	0	x	15.000	=	0.000		R36 (Ref. 93)
0	breaker closing coils (Continuous)	0	x	5.000	=	0.000		R36
0	lights for closing breakers (@ 0.231 each)	0	x	0.231	=	0.000		R36
0	lights for closing breakers (@ 0.513 each)	0	x	0.513	=	0.000		R36
4	lights for tripped breakers (@ 0.231 each)	4	x	0.231	=	0.924		R36 (Ref. 92)
3	lights for tripped breakers (@ 0.513 each)	3	x	0.513	=	1.539		R36 (Ref. 92)
0	breaker tripping coils	0	x	1.080	=	0.000		R36 (Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		R36
	Relays energized:							
0	SA-1 Relay	0	x	0.055	=	0.000		
4	Agastat Relay	4	x	0.064	=	0.256		R36
4	HFA	4	x	0.062	=	0.248		R36
2	HGA	2	x	0.038	=	0.076		R36
4	UV Relay	4	x	0.070	=	0.280		R36
			TOTAL		=	3.631 Amps		R36
							Time	
2	lights for closed breakers (@ 0.154 each)	2	x	0.154	=	0.308	10m-10m2s	R36
0	lights for closed breakers (@ 0.342 each)	0	x	0.342	=	0.000		R36
1	breaker closing coils (Peak)	1	x	15.000	=	15.000		R36 (Ref. 93)
0	breaker closing coils (Continuous)	0	x	5.000	=	0.000		R36
1	lights for closing breakers (@ 0.231 each)	1	x	0.231	=	0.231		R36 (Ref. 92)
0	lights for closing breakers (@ 0.513 each)	0	x	0.513	=	0.000		R36 (Ref. 92)
3	lights for tripped breakers (@ 0.231 each)	3	x	0.231	=	0.693		R36 (Ref. 92)
3	lights for tripped breakers (@ 0.513 each)	3	x	0.513	=	1.539		R36 (Ref. 92)
0	breaker tripping coils	0	x	1.080	=	0.000		R36 (Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		R36
	Relays energized:							
0	SA-1 Relay	0	x	0.055	=	0.000		
4	Agastat Relay	4	x	0.064	=	0.256		R36
4	HFA	4	x	0.062	=	0.248		R36
2	HGA	2	x	0.038	=	0.076		R36
4	UV Relay	4	x	0.070	=	0.280		R36
			TOTAL		=	18.631 Amps		R36

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LOOP Condition

							Time	
2	lights for closed breakers (@ 0.154 each)	2	x	0.154	=	0.308	10m2s-10m15s	R36 (Ref. 92)
0	lights for closed breakers (@ 0.342 each)	0	x	0.342	=	0.000		R36 (Ref. 92)
0	breaker closing coils (Peak)	0	x	15.000	=	0.000		R36 (Ref. 93)
1	breaker closing coils (Continuous)	1	x	5.000	=	5.000		R36
1	lights for closing breakers (@ 0.231 each)	1	x	0.231	=	0.231		R36
0	lights for closing breakers (@ 0.513 each)	0	x	0.513	=	0.000		R36
3	lights for tripped breakers (@ 0.231 each)	3	x	0.231	=	0.693		R36 (Ref. 92)
3	lights for tripped breakers (@ 0.513 each)	3	x	0.513	=	1.539		R36 (Ref. 92)
0	breaker tripping coils	0	x	1.080	=	0.000		R36 (Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		R36
	Relays energized:							
0	SA-1 Relay	0	x	0.055	=	0.000		
4	Agastat Relay	4	x	0.064	=	0.256		R36
4	HFA	4	x	0.062	=	0.248		R36
2	HGA	2	x	0.038	=	0.076		R36
4	UV Relay	4	x	0.070	=	0.280		R36
			TOTAL		=	8.631 Amps		R36

							Time	
3	lights for closed breakers (@ 0.154 each)	3	x	0.154	=	0.462	10m15s-end	R36 (Ref. 92)
0	lights for closed breakers (@ 0.342 each)	0	x	0.342	=	0.000		R36 (Ref. 92)
0	breaker closing coils (Peak)	0	x	15.000	=	0.000		R36 (Ref. 93)
0	breaker closing coils (Continuous)	0	x	5.000	=	0.000		R36
0	lights for closing breakers (@ 0.231 each)	0	x	0.231	=	0.000		R36 (Ref. 92)
0	lights for closing breakers (@ 0.513 each)	0	x	0.513	=	0.000		R36 (Ref. 92)
3	lights for tripped breakers (@ 0.231 each)	3	x	0.231	=	0.693		R36
3	lights for tripped breakers (@ 0.513 each)	3	x	0.513	=	1.539		R36
0	breaker tripping coils	0	x	1.080	=	0.000		R36 (Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		R36
	Relays energized:							
0	SA-1 Relay	0	x	0.055	=	0.000		
4	Agastat Relay	4	x	0.064	=	0.256		R36
4	HFA	4	x	0.062	=	0.248		R36
2	HGA	2	x	0.038	=	0.076		R36
4	UV Relay	4	x	0.070	=	0.280		R36
			TOTAL		=	3.554 Amps		R36

4kV Switchgear 23-1 **Page 6 of 13** R36

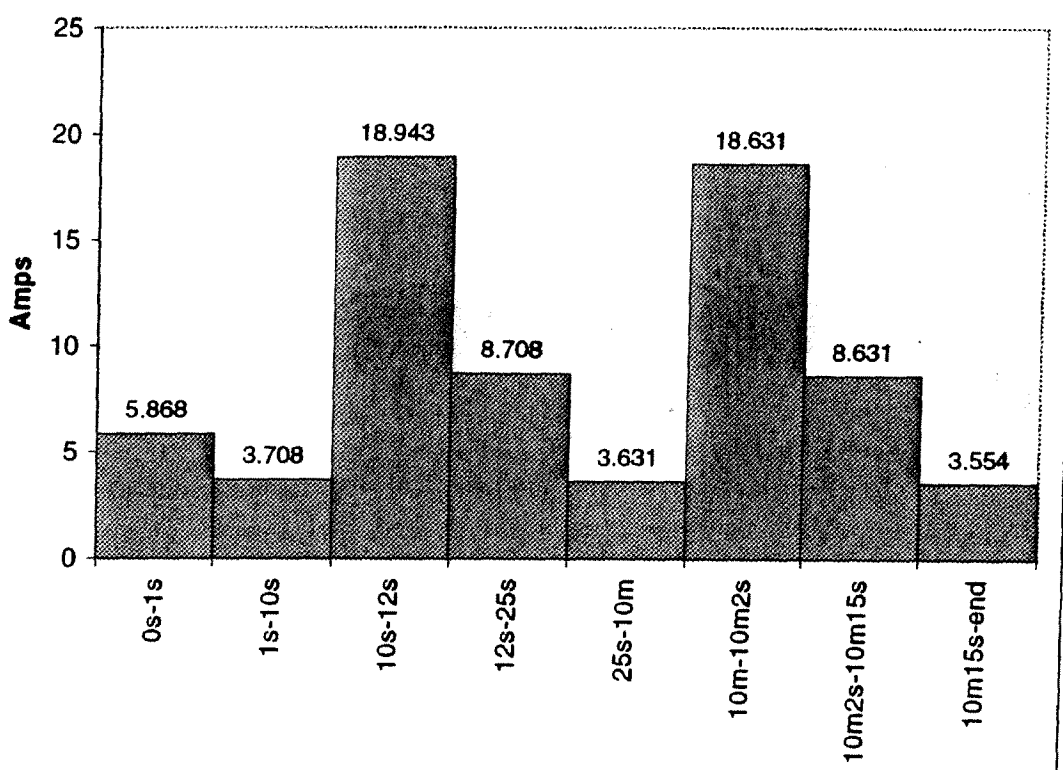
LOOP Condition

NOTES

1.) At t=0s all closed breakers trip except for 480V SWGR 28 feed. 4kV SWGR 23-1 sheds load.
2.) At t=1s all 4kV SWGR 23-1 loads have been shed except for 480V SWGR 28 (i.e. all breakers have completed tripping).
3.) At t=10s DG 1/2 breaker closes.
4.) At t=10m close Main Feed Breaker to 4kV SWGR 23. R36

NOTE:

The SBO breaker remains tripped when there is a LOCA on either unit. Since the scenario modeled is a LOOP on both units 1 & 2 and a LOCA on one unit, the SBO breaker is not modeled as closing. R36



R36

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LOOP & LOCA Condition

The maximum dc load on the circuit under LOOP & LOCA condition is:

							Time	
1	lights for closed breakers (@ 0.154 each)	1	x	0.154	=	0.154	0s-1s	R36
0	lights for closed breakers (@ 0.342 each)	0	x	0.342	=	0.000		R36
0	breaker closing coils	0	x	15.000	=	0.000		R36 (Ref. 93)
0	lights for closing breakers (@ 0.231 each)	0	x	0.231	=	0.000		R36
0	lights for closing breakers (@ 0.513 each)	0	x	0.513	=	0.000		R36
3	lights for tripped breakers (@ 0.231 each)	3	x	0.231	=	0.693		R36 (Ref. 92)
3	lights for tripped breakers (@ 0.513 each)	3	x	0.513	=	1.539		R36 (Ref. 92)
2	breaker tripping coils	2	x	1.080	=	2.160		R36 (Ref. 88 & 93)
2	lights for tripping breakers (@ 0.231 each)	2	x	0.231	=	0.462		R36
	Relays energized:							
0	SA-1 Relay	0	x	0.055	=	0.000		
4	Agastat Relay	4	x	0.064	=	0.256		R36
4	HFA	4	x	0.062	=	0.248		
2	HGA	2	x	0.038	=	0.076		R36
4	UV Relay	4	x	0.070	=	0.280		
			TOTAL		=	5.868 Amps		R36

							Time	
1	lights for closed breakers (@ 0.154 each)	1	x	0.154	=	0.154	1s-10s	R36
0	lights for closed breakers (@ 0.342 each)	0	x	0.342	=	0.000		R36
0	breaker closing coils	0	x	15.000	=	0.000		R36 (Ref. 93)
0	lights for closing breakers (@ 0.231 each)	0	x	0.231	=	0.000		R36
0	lights for closing breakers (@ 0.513 each)	0	x	0.513	=	0.000		R36
5	lights for tripped breakers (@ 0.231 each)	5	x	0.231	=	1.155		R36 (Ref. 92)
3	lights for tripped breakers (@ 0.513 each)	3	x	0.513	=	1.539		R36 (Ref. 92)
0	breaker tripping coils	0	x	1.080	=	0.000		R36 (Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		R36
	Relays energized:							
0	SA-1 Relay	0	x	0.055	=	0.000		
4	Agastat Relay	4	x	0.064	=	0.256		R36
4	HFA	4	x	0.062	=	0.248		
2	HGA	2	x	0.038	=	0.076		R36
4	UV Relay	4	x	0.070	=	0.280		
			TOTAL		=	3.708 Amps		R36

							Time	
1	lights for closed breakers (@ 0.154 each)	1	x	0.154	=	0.154	10s-12s	R36
0	lights for closed breakers (@ 0.342 each)	0	x	0.342	=	0.000		R36
1	breaker closing coils (Peak)	1	x	15.000	=	15.000		R36 (Ref. 90)
0	breaker closing coils (Continuous)	0	x	5.000	=	0.000		R36
1	lights for closing breakers (@ 0.231 each)	1	x	0.231	=	0.231		R36
0	lights for closing breakers (@ 0.513 each)	0	x	0.513	=	0.000		R36
4	lights for tripped breakers (@ 0.231 each)	4	x	0.231	=	0.924		R36 (Ref. 92)
3	lights for tripped breakers (@ 0.513 each)	3	x	0.513	=	1.539		R36 (Ref. 92)
0	breaker tripping coils	0	x	1.080	=	0.000		R36 (Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		R36
	Relays energized:							
1	Interposing Relay	1	x	0.235	=	0.235		
0	SA-1 Relay	0	x	0.055	=	0.000		
4	Agastat Relay	4	x	0.064	=	0.256		R36
4	HFA	4	x	0.062	=	0.248		R36
2	HGA	2	x	0.038	=	0.076		R36
4	UV Relay	4	x	0.070	=	0.280		R36
			TOTAL		=	18.943 Amps		R36

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LOOP & LOCA Condition

								Time	
1	lights for closed breakers (@ 0.154 each)	1	x	0.154	=	0.154		12s-13s	R36
0	lights for closed breakers (@ 0.342 each)	0	x	0.342	=	0.000			R36
0	breaker closing coils (Peak)	0	x	15.000	=	0.000			R36 (Ref. 90)
1	breaker closing coils (Continuous)	1	x	5.000	=	5.000			R36
1	lights for closing breakers (@ 0.231 each)	1	x	0.231	=	0.231			R36
0	lights for closing breakers (@ 0.513 each)	0	x	0.513	=	0.000			R36
4	lights for tripped breakers (@ 0.231 each)	4	x	0.231	=	0.924			R36 (Ref. 92)
3	lights for tripped breakers (@ 0.513 each)	3	x	0.513	=	1.539			R36 (Ref. 92)
0	breaker tripping coils	0	x	1.080	=	0.000			R36 (Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000			R36
	Relays energized:								
0	SA-1 Relay	0	x	0.055	=	0.000			
4	Agastat Relay	4	x	0.064	=	0.256			R36
4	HFA	4	x	0.062	=	0.248			R36
2	HGA	2	x	0.038	=	0.076			R36
4	UV Relay	4	x	0.070	=	0.280			R36
			TOTAL		=	8.708	Amps		R36

								Time	
1	lights for closed breakers (@ 0.154 each)	1	x	0.154	=	0.154		13s-15s	R36
0	lights for closed breakers (@ 0.342 each)	0	x	0.342	=	0.000			R36
1	breaker closing coils (Peak)	1	x	15.000	=	15.000			R36 (Ref. 90)
1	breaker closing coils (Continuous)	1	x	5.000	=	5.000			R36
1	lights for closing breakers (@ 0.231 each)	1	x	0.231	=	0.231			R36 (Ref. 92)
1	lights for closing breakers (@ 0.513 each)	1	x	0.513	=	0.513			R36 (Ref. 92)
4	lights for tripped breakers (@ 0.231 each)	4	x	0.231	=	0.924			R36 (Ref. 92)
2	lights for tripped breakers (@ 0.513 each)	2	x	0.513	=	1.026			R36 (Ref. 92)
0	breaker tripping coils	0	x	1.080	=	0.000			R36 (Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000			R36
	Relays energized:								
0	SA-1 Relay	0	x	0.055	=	0.000			
4	Agastat Relay	4	x	0.064	=	0.256			R36
4	HFA	4	x	0.062	=	0.248			R36
2	HGA	2	x	0.038	=	0.076			R36
4	UV Relay	4	x	0.070	=	0.280			R36
			TOTAL		=	23.708	Amps		R36

								Time	
1	lights for closed breakers (@ 0.154 each)	1	x	0.154	=	0.154		15s-18s	R36 (Ref. 92)
0	lights for closed breakers (@ 0.342 each)	0	x	0.342	=	0.000			R36 (Ref. 92)
0	breaker closing coils (Peak)	0	x	15.000	=	0.000			R36 (Ref. 90)
2	breaker closing coils (Continuous)	2	x	5.000	=	10.000			R36
1	lights for closing breakers (@ 0.231 each)	1	x	0.231	=	0.231			R36
1	lights for closing breakers (@ 0.513 each)	1	x	0.513	=	0.513			R36
4	lights for tripped breakers (@ 0.231 each)	4	x	0.231	=	0.924			R36 (Ref. 92)
2	lights for tripped breakers (@ 0.513 each)	2	x	0.513	=	1.026			R36 (Ref. 92)
0	breaker tripping coils	0	x	1.080	=	0.000			R36 (Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000			R36
	Relays energized:								
0	SA-1 Relay	0	x	0.055	=	0.000			
4	Agastat Relay	4	x	0.064	=	0.256			R36
4	HFA	4	x	0.062	=	0.248			R36
2	HGA	2	x	0.038	=	0.076			R36
4	UV Relay	4	x	0.070	=	0.280			R36
			TOTAL		=	13.708	Amps		R36

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LOOP & LOCA Condition

							Time 18s-20s	
1	lights for closed breakers (@ 0.154 each)	1	x	0.154	=	0.154		R36 (Ref. 92)
0	lights for closed breakers (@ 0.342 each)	0	x	0.342	=	0.000		R36 (Ref. 92)
1	breaker closing coils (Peak)	1	x	15.000	=	15.000		R36 (Ref. 90)
2	breaker closing coils (Continuous)	2	x	5.000	=	10.000		R36
1	lights for closing breakers (@ 0.231 each)	1	x	0.231	=	0.231		R36 (Ref. 92)
2	lights for closing breakers (@ 0.513 each)	2	x	0.513	=	1.026		R36 (Ref. 92)
4	lights for tripped breakers (@ 0.231 each)	4	x	0.231	=	0.924		R36
1	lights for tripped breakers (@ 0.513 each)	1	x	0.513	=	0.513		R36
0	breaker tripping coils	0	x	1.080	=	0.000		R36 (Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		R36
	Relays energized:							
0	SA-1 Relay	0	x	0.055	=	0.000		
4	Agastat Relay	4	x	0.064	=	0.256		R36
4	HFA	4	x	0.062	=	0.248		R36
2	HGA	2	x	0.038	=	0.076		R36
4	UV Relay	4	x	0.070	=	0.280		R36
			TOTAL		=	28.708 Amps		R36
							Time 20s-23s	
1	lights for closed breakers (@ 0.154 each)	1	x	0.154	=	0.154		R36 (Ref. 92)
0	lights for closed breakers (@ 0.342 each)	0	x	0.342	=	0.000		R36 (Ref. 92)
0	breaker closing coils (Peak)	0	x	15.000	=	0.000		R36 (Ref. 90)
3	breaker closing coils (Continuous)	3	x	5.000	=	15.000		R36
1	lights for closing breakers (@ 0.231 each)	1	x	0.231	=	0.231		R36
2	lights for closing breakers (@ 0.513 each)	2	x	0.513	=	1.026		R36
4	lights for tripped breakers (@ 0.231 each)	4	x	0.231	=	0.924		R36
1	lights for tripped breakers (@ 0.513 each)	1	x	0.513	=	0.513		R36
0	breaker tripping coils	0	x	1.080	=	0.000		R36 (Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		R36
	Relays energized:							
0	SA-1 Relay	0	x	0.055	=	0.000		
4	Agastat Relay	4	x	0.064	=	0.256		R36
4	HFA	4	x	0.062	=	0.248		R36
2	HGA	2	x	0.038	=	0.076		R36
4	UV Relay	4	x	0.070	=	0.280		R36
			TOTAL		=	18.708 Amps		R36
							Time 23s-25s	R36
1	lights for closed breakers (@ 0.154 each)	1	x	0.154	=	0.154		R36 (Ref. 92)
0	lights for closed breakers (@ 0.342 each)	0	x	0.342	=	0.000		R36 (Ref. 92)
1	breaker closing coils (Peak)	1	x	15.000	=	15.000		R36 (Ref. 90)
3	breaker closing coils (Continuous)	3	x	5.000	=	15.000		R36
1	lights for closing breakers (@ 0.231 each)	1	x	0.231	=	0.231		R36
3	lights for closing breakers (@ 0.513 each)	3	x	0.513	=	1.539		R36
4	lights for tripped breakers (@ 0.231 each)	4	x	0.231	=	0.924		R36
0	lights for tripped breakers (@ 0.513 each)	0	x	0.513	=	0.000		R36
0	breaker tripping coils	0	x	1.080	=	0.000		R36 (Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		R36
	Relays energized:							R36
0	SA-1 Relay	0	x	0.055	=	0.000		R36
4	Agastat Relay	4	x	0.064	=	0.256		R36
4	HFA	4	x	0.062	=	0.248		R36
2	HGA	2	x	0.038	=	0.076		R36
4	UV Relay	4	x	0.070	=	0.280		R36
			TOTAL		=	33.708 Amps		R36

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LOOP & LOCA Condition

								Time	
2	lights for closed breakers (@ 0.154 each)	2	x	0.154	=	0.308		25s-28s	R36 (Ref. 92)
0	lights for closed breakers (@ 0.342 each)	0	x	0.342	=	0.000			R36 (Ref. 92)
0	breaker closing coils (Peak)	0	x	15.000	=	0.000			R36 (Ref. 90)
3	breaker closing coils (Continuous)	3	x	5.000	=	15.000			R36
0	lights for closing breakers (@ 0.231 each)	0	x	0.231	=	0.000			R36
3	lights for closing breakers (@ 0.513 each)	3	x	0.513	=	1.539			R36
4	lights for tripped breakers (@ 0.231 each)	4	x	0.231	=	0.924			R36
0	lights for tripped breakers (@ 0.513 each)	0	x	0.513	=	0.000			R36
0	breaker tripping coils	0	x	1.080	=	0.000			R36 (Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000			R36
	Relays energized:								
0	SA-1 Relay	0	x	0.055	=	0.000			
4	Agastat Relay	4	x	0.064	=	0.256			R36
4	HFA	4	x	0.062	=	0.248			R36
2	HGA	2	x	0.038	=	0.076			R36
4	UV Relay	4	x	0.070	=	0.280			R36
			TOTAL		=	18.631	Amps		R36
								Time	
2	lights for closed breakers (@ 0.154 each)	2	x	0.154	=	0.308		28s-33s	R36 (Ref. 92)
1	lights for closed breakers (@ 0.342 each)	1	x	0.342	=	0.342			R36 (Ref. 92)
0	breaker closing coils (Peak)	0	x	15.000	=	0.000			R36 (Ref. 90)
2	breaker closing coils (Continuous)	2	x	5.000	=	10.000			R36
0	lights for closing breakers (@ 0.231 each)	0	x	0.231	=	0.000			R36
2	lights for closing breakers (@ 0.513 each)	2	x	0.513	=	1.026			R36
4	lights for tripped breakers (@ 0.231 each)	4	x	0.231	=	0.924			R36
0	lights for tripped breakers (@ 0.513 each)	0	x	0.513	=	0.000			R36
0	breaker tripping coils	0	x	1.080	=	0.000			R36 (Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000			R36
	Relays energized:								
0	SA-1 Relay	0	x	0.055	=	0.000			
4	Agastat Relay	4	x	0.064	=	0.256			R36
4	HFA	4	x	0.062	=	0.248			R36
2	HGA	2	x	0.038	=	0.076			R36
4	UV Relay	4	x	0.070	=	0.280			R36
			TOTAL		=	13.460	Amps		R36
								Time	R36
2	lights for closed breakers (@ 0.154 each)	2	x	0.154	=	0.308		33s-38s	R36 (Ref. 92)
2	lights for closed breakers (@ 0.342 each)	2	x	0.342	=	0.684			R36 (Ref. 92)
0	breaker closing coils (Peak)	0	x	15.000	=	0.000			R36 (Ref. 90)
1	breaker closing coils (Continuous)	1	x	5.000	=	5.000			R36
0	lights for closing breakers (@ 0.231 each)	0	x	0.231	=	0.000			R36
1	lights for closing breakers (@ 0.513 each)	1	x	0.513	=	0.513			R36
4	lights for tripped breakers (@ 0.231 each)	4	x	0.231	=	0.924			R36
0	lights for tripped breakers (@ 0.513 each)	0	x	0.513	=	0.000			R36
0	breaker tripping coils	0	x	1.080	=	0.000			R36 (Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000			R36
	Relays energized:								R36
0	SA-1 Relay	0	x	0.055	=	0.000			R36
4	Agastat Relay	4	x	0.064	=	0.256			R36
4	HFA	4	x	0.062	=	0.248			R36
2	HGA	2	x	0.038	=	0.076			R36
4	UV Relay	4	x	0.070	=	0.280			R36
			TOTAL		=	8.289	Amps		R36

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LOOP & LOCA Condition

						Time	R36	
2	lights for closed breakers (@ 0.154 each)	2	x	0.154	= 0.308	38s-10m	R36	(Ref. 92)
3	lights for closed breakers (@ 0.342 each)	3	x	0.342	= 1.026		R36	(Ref. 92)
0	breaker closing coils (Peak)	0	x	15.000	= 0.000		R36	(Ref. 90)
0	breaker closing coils (Continuous)	0	x	5.000	= 0.000		R36	
0	lights for closing breakers (@ 0.231 each)	0	x	0.231	= 0.000		R36	
0	lights for closing breakers (@ 0.513 each)	0	x	0.513	= 0.000		R36	
4	lights for tripped breakers (@ 0.231 each)	4	x	0.231	= 0.924		R36	
0	lights for tripped breakers (@ 0.513 each)	0	x	0.513	= 0.000		R36	
0	breaker tripping coils	0	x	1.080	= 0.000		R36	(Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	= 0.000		R36	
	Relays energized:						R36	
0	SA-1 Relay	0	x	0.055	= 0.000		R36	
4	Agastat Relay	4	x	0.064	= 0.256		R36	
4	HFA	4	x	0.062	= 0.248		R36	
2	HGA	2	x	0.038	= 0.076		R36	
4	UV Relay	4	x	0.070	= 0.280		R36	
			TOTAL		= 3.118 Amps		R36	
						Time	R36	
2	lights for closed breakers (@ 0.154 each)	2	x	0.154	= 0.308	10m-10m1s	R36	(Ref. 92)
2	lights for closed breakers (@ 0.342 each)	2	x	0.342	= 0.684		R36	(Ref. 92)
0	breaker closing coils (Peak)	0	x	15.000	= 0.000		R36	(Ref. 90)
0	breaker closing coils (Continuous)	0	x	5.000	= 0.000		R36	
0	lights for closing breakers (@ 0.231 each)	0	x	0.231	= 0.000		R36	
0	lights for closing breakers (@ 0.513 each)	0	x	0.513	= 0.000		R36	
4	lights for tripped breakers (@ 0.231 each)	4	x	0.231	= 0.924		R36	
0	lights for tripped breakers (@ 0.513 each)	0	x	0.513	= 0.000		R36	
1	breaker tripping coils	1	x	1.080	= 1.080		R36	(Ref. 88 & 93)
1	lights for tripping breakers (@ 0.231 each)	1	x	0.231	= 0.231		R36	
	Relays energized:						R36	
0	SA-1 Relay	0	x	0.055	= 0.000		R36	
4	Agastat Relay	4	x	0.064	= 0.256		R36	
4	HFA	4	x	0.062	= 0.248		R36	
2	HGA	2	x	0.038	= 0.076		R36	
4	UV Relay	4	x	0.070	= 0.280		R36	
			TOTAL		= 4.087 Amps		R36	
						Time	R36	
2	lights for closed breakers (@ 0.154 each)	2	x	0.154	= 0.308	10m1s-10m15s	R36	(Ref. 92)
2	lights for closed breakers (@ 0.342 each)	2	x	0.342	= 0.684		R36	(Ref. 92)
0	breaker closing coils (Peak)	0	x	15.000	= 0.000		R36	(Ref. 90)
0	breaker closing coils (Continuous)	0	x	5.000	= 0.000		R36	
0	lights for closing breakers (@ 0.231 each)	0	x	0.231	= 0.000		R36	
0	lights for closing breakers (@ 0.513 each)	0	x	0.513	= 0.000		R36	
4	lights for tripped breakers (@ 0.231 each)	4	x	0.231	= 0.924		R36	
1	lights for tripped breakers (@ 0.513 each)	1	x	0.513	= 0.513		R36	
0	breaker tripping coils	0	x	1.080	= 0.000		R36	(Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	= 0.000		R36	
	Relays energized:						R36	
0	SA-1 Relay	0	x	0.055	= 0.000		R36	
4	Agastat Relay	4	x	0.064	= 0.256		R36	
4	HFA	4	x	0.062	= 0.248		R36	
2	HGA	2	x	0.038	= 0.076		R36	
4	UV Relay	4	x	0.070	= 0.280		R36	
			TOTAL		= 3.289 Amps		R36	

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LOOP & LOCA Condition | R36

						Time	R36	
2	lights for closed breakers (@ 0.154 each)	2	x	0.154	=	0.308	10m15s-10m17s	R36 (Ref. 92)
2	lights for closed breakers (@ 0.342 each)	2	x	0.342	=	0.684		R36 (Ref. 92)
1	breaker closing coils (Peak)	1	x	15.000	=	15.000		R36 (Ref. 90)
0	breaker closing coils (Continuous)	0	x	5.000	=	0.000		R36
1	lights for closing breakers (@ 0.231 each)	1	x	0.231	=	0.231		R36
0	lights for closing breakers (@ 0.513 each)	0	x	0.513	=	0.000		R36
3	lights for tripped breakers (@ 0.231 each)	3	x	0.231	=	0.693		R36
1	lights for tripped breakers (@ 0.513 each)	1	x	0.513	=	0.513		R36
0	breaker tripping coils	0	x	1.080	=	0.000		R36 (Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		R36
	Relays energized:							R36
0	SA-1 Relay	0	x	0.055	=	0.000		R36
4	Agastat Relay	4	x	0.064	=	0.256		R36
4	HFA	4	x	0.062	=	0.248		R36
2	HGA	2	x	0.038	=	0.076		R36
4	UV Relay	4	x	0.070	=	0.280		R36
			TOTAL		=	18.289 Amps		R36
							Time	R36
2	lights for closed breakers (@ 0.154 each)	2	x	0.154	=	0.308	10m17s-10m30s	R36 (Ref. 92)
2	lights for closed breakers (@ 0.342 each)	2	x	0.342	=	0.684		R36 (Ref. 92)
0	breaker closing coils (Peak)	0	x	15.000	=	0.000		R36 (Ref. 90)
1	breaker closing coils (Continuous)	1	x	5.000	=	5.000		R36
1	lights for closing breakers (@ 0.231 each)	1	x	0.231	=	0.231		R36
0	lights for closing breakers (@ 0.513 each)	0	x	0.513	=	0.000		R36
3	lights for tripped breakers (@ 0.231 each)	3	x	0.231	=	0.693		R36
1	lights for tripped breakers (@ 0.513 each)	1	x	0.513	=	0.513		R36
0	breaker tripping coils	0	x	1.080	=	0.000		R36 (Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		R36
	Relays energized:							R36
0	SA-1 Relay	0	x	0.055	=	0.000		R36
4	Agastat Relay	4	x	0.064	=	0.256		R36
4	HFA	4	x	0.062	=	0.248		R36
2	HGA	2	x	0.038	=	0.076		R36
4	UV Relay	4	x	0.070	=	0.280		R36
			TOTAL		=	8.289 Amps		R36
							Time	R36
3	lights for closed breakers (@ 0.154 each)	3	x	0.154	=	0.462	10m30s-end	R36 (Ref. 92)
2	lights for closed breakers (@ 0.342 each)	2	x	0.342	=	0.684		R36 (Ref. 92)
0	breaker closing coils (Peak)	0	x	15.000	=	0.000		R36 (Ref. 90)
0	breaker closing coils (Continuous)	0	x	5.000	=	0.000		R36
0	lights for closing breakers (@ 0.231 each)	0	x	0.231	=	0.000		R36
0	lights for closing breakers (@ 0.513 each)	0	x	0.513	=	0.000		R36
3	lights for tripped breakers (@ 0.231 each)	3	x	0.231	=	0.693		R36
1	lights for tripped breakers (@ 0.513 each)	1	x	0.513	=	0.513		R36
0	breaker tripping coils	0	x	1.080	=	0.000		R36 (Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		R36
	Relays energized:							R36
0	SA-1 Relay	0	x	0.055	=	0.000		R36
4	Agastat Relay	4	x	0.064	=	0.256		R36
4	HFA	4	x	0.062	=	0.248		R36
2	HGA	2	x	0.038	=	0.076		R36
4	UV Relay	4	x	0.070	=	0.280		R36
			TOTAL		=	3.212 Amps		R36

4kV Switchgear 23-1 **Page 13 of 13** R36

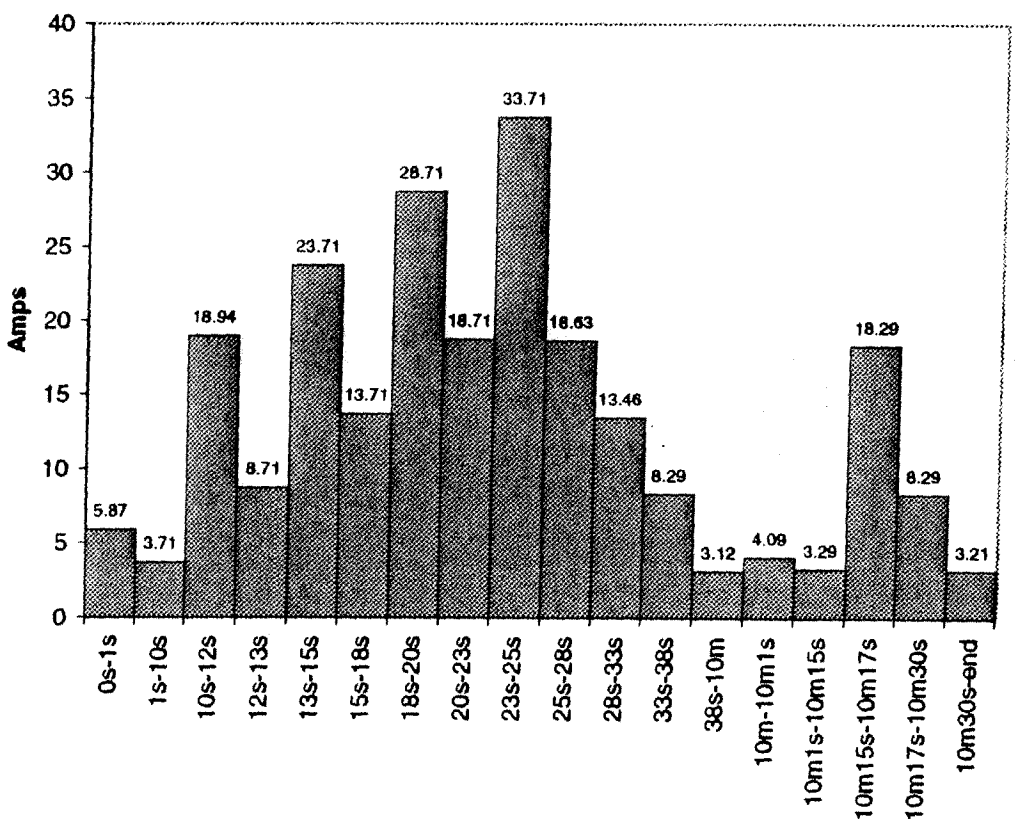
LOOP & LOCA Condition

NOTES

1.) At t=0s all closed breakers trip except for 480V SWGR 28 feed. 4kV SWGR 23-1 sheds load.
2.) At t=1s all 4kV SWGR 23-1 loads have been shed except for 480V SWGR 28 (i.e. all breakers have completed tripping).
3.) At t=10s DG 1/2 breaker closes. R36
4.) At t=13s close breaker for RHR Pump 2A. R36
5.) At t=18s close breaker for RHR Pump 2B. R36
6.) At t=23s close breaker for Core Spray Pump 2A. R36
7.) At t=10m trip RHR Pump 2A or 2B. R36
8.) At t=10m15s close Main Feed Breaker to 4kV SWGR 23. R36

NOTE:

The SBO breaker remains tripped when there is a LOCA on either unit. Since the scenario modeled is a LOOP on both units 1 & 2 and a LOCA on one unit, the SBO breaker is not modeled as closing. R36



R36

Bus 2B-1 Circuit 6
4kV Switchgear Bus 24 Main Feed

 R36

4kV Switchgear 24 AC Loads

Bkr. #	Service	AC Bkr. Status			S/D	Rev.
		On-Line	LOOP/ LOOP & LOCA (t=1)	LOOP/ LOOP & LOCA (After)		
152-2401	480V Switchgear 26	C	T	T/T	4E-2348	E
152-2402	RHR SWP 2C	T	T	C*/C*	4E-2438P	SH. 2, J
152-2403	Main Feed	C	T	T/T	4E-2343	T
152-2404	Circ. Water Pump 2C	C	T	T/T	4E-2368	J
152-2405	Cond. & Booster Pump 2C	C	T	T/T	4E-2370	J
152-2406	RHR SWP 2D	T	T	C*/C*	4E-2438P	SH. 2, J
152-2407	Service Water Pump 2B	C	T	C/T	4E-2391	C
152-2408	Cond. & Booster Pump 2D	C	T	T/T	4E-2370	J
152-2409	Service Water Pump 1/2	C	T	T/T	4E-2391	C
152-2410	Reserve Feed	T	T	T/T	4E-2343	T
152-2411	480V Switchgear 27	C	T	T/T	4E-2348	E
152-2412	CRD Pump 2B	C	T	C/T	4E-2416	J
152-2413	Bus 24-1 Feed	C	T	C/C	4E-2344	SH. 2, B
152-2414	Well Water Pump #5	C	T	T/T	4E-2387D	B
152-2415	Spare Breaker	$	$	$	---	---
---	Spare Cubicle	❍	❍	❍	---	---

R36

$ - This is a spare breaker with the control power fuses pulled. No dc load is assumed.
❍ - This is a spare cubicle with the control power fuses pulled. No dc load is assumed.
* Only 1 pump is energized. R36

4kV Switchgear 24 **Page 2 of 12**

Normal Condition

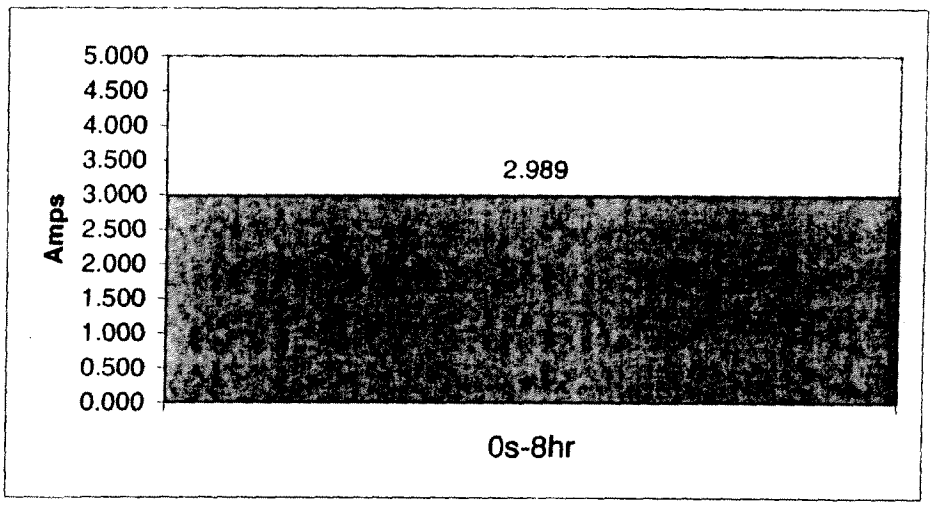
The maximum dc load on the circuit under Normal condition is:

							Time	
11	lights for closed breakers (@ 0.154 each)	11	x	0.154	=	1.694	0s-8hr	
0	lights for closed breakers (@ 0.342 each)	0	x	0.342	=	0.000		
1	lights for tripped breakers (@ 0.231 each)	1	x	0.231	=	0.231		(Ref. 92)
2	lights for tripped breakers (@ 0.513 each)	2	x	0.513	=	1.026		(Ref. 92)
	No switching of breakers							
	Relays energized:							
0	HEA	0	x	5.400	=	0.000		
0	HFA	0	x	0.062	=	0.000		
1	HGA	1	x	0.038	=	0.038		
0	UV Relay	0	x	0.070	=	0.000		
			TOTAL		=	2.989 Amps		

NOTE

1.) The UV relay circuit would have one HGA relay energized.

R39



4kV Switchgear 24 **Page 3 of 12**

LOOP Condition

The maximum dc load on the circuit under LOOP condition is:

						Time		
0	lights for closed breakers (@ 0.154 each)	0 x	0.154	=	0.000	0s-1s		
0	lights for closed breakers (@ 0.342 each)	0 x	0.342	=	0.000			
0	breaker closing coils	0 x	15.000	=	0.000			
0	lights for closing breakers (@ 0.231 each)	0 x	0.231	=	0.000			
0	lights for closing breakers (@ 0.513 each)	0 x	0.513	=	0.000			
1	lights for tripped breakers (@ 0.231 each)	1 x	0.231	=	0.231			(Ref. 92)
2	lights for tripped breakers (@ 0.513 each)	2 x	0.513	=	1.026			(Ref. 92)
11	breaker tripping coils	11 x	1.080	=	11.880			(Ref. 88 & 93)
11	lights for tripping breakers (@ 0.231 each)	11 x	0.231	=	2.541			
	Relays energized:							
1	Misc. Relay	1 x	0.080	=	0.080			
5	HFA	5 x	0.062	=	0.310		R39	
1	HGA	1 x	0.038	=	0.038			
4	UV Relay	4 x	0.070	=	0.280			
		TOTAL		=	16.386 Amps		R39	

						Time		
0	lights for closed breakers (@ 0.154 each)	0 x	0.154	=	0.000	1s-10m		
0	lights for closed breakers (@ 0.342 each)	0 x	0.342	=	0.000			
0	breaker closing coils	0 x	15.000	=	0.000			
0	lights for closing breakers (@ 0.231 each)	0 x	0.231	=	0.000			
0	lights for closing breakers (@ 0.513 each)	0 x	0.513	=	0.000			
12	lights for tripped breakers (@ 0.231 each)	12 x	0.231	=	2.772			(Ref. 92)
2	lights for tripped breakers (@ 0.513 each)	2 x	0.513	=	1.026			(Ref. 92)
0	breaker tripping coils	0 x	1.080	=	0.000			(Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0 x	0.231	=	0.000			
	Relays energized:							
1	Misc. Relay	1 x	0.080	=	0.080			
5	HFA	5 x	0.062	=	0.310		R39	
1	HGA	1 x	0.038	=	0.038			
4	UV Relay	4 x	0.070	=	0.280			
		TOTAL		=	4.506 Amps		R39	

						Time		
0	lights for closed breakers (@ 0.154 each)	0 x	0.154	=	0.000	10m-10m2s		
0	lights for closed breakers (@ 0.342 each)	0 x	0.342	=	0.000			
1	breaker closing coils (Peak)	1 x	15.000	=	15.000			
0	breaker closing coils (Continuous)	0 x	5.000	=	0.000			
1	lights for closing breakers (@ 0.231 each)	1 x	0.231	=	0.231			
0	lights for closing breakers (@ 0.513 each)	0 x	0.513	=	0.000			
11	lights for tripped breakers (@ 0.231 each)	11 x	0.231	=	2.541			(Ref. 92)
2	lights for tripped breakers (@ 0.513 each)	2 x	0.513	=	1.026			(Ref. 92)
0	breaker tripping coils	0 x	1.080	=	0.000			(Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0 x	0.231	=	0.000			
	Relays energized:							
1	Misc. Relay	1 x	0.080	=	0.080			
5	HFA	5 x	0.062	=	0.310		R39	
1	HGA	1 x	0.038	=	0.038			
4	UV Relay	4 x	0.070	=	0.280			
		TOTAL		=	19.506 Amps		R39	

4kV Switchgear 24

LOOP Condition

						Time	
0	lights for closed breakers (@ 0.154 each)	0 x	0.154	=	0.000	10m2s-10m15s	
0	lights for closed breakers (@ 0.342 each)	0 x	0.342	=	0.000		
0	breaker closing coils (Peak)	0 x	15.000	=	0.000		
1	breaker closing coils (Continuous)	1 x	5.000	=	5.000		
1	lights for closing breakers (@ 0.231 each)	1 x	0.231	=	0.231		(Ref. 92)
0	lights for closing breakers (@ 0.513 each)	0 x	0.513	=	0.000		(Ref. 92)
11	lights for tripped breakers (@ 0.231 each)	11 x	0.231	=	2.541		
2	lights for tripped breakers (@ 0.513 each)	2 x	0.513	=	1.026		
0	breaker tripping coils	0 x	1.080	=	0.000		(Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0 x	0.231	=	0.000		
	Relays energized:						
1	Misc. Relay	1 x	0.080	=	0.080		
5	HFA	5 x	0.062	=	0.310		R39
1	HGA	1 x	0.038	=	0.038		
4	UV Relay	4 x	0.070	=	0.280		
		TOTAL		=	9.506 Amps		R39

						Time	
1	lights for closed breakers (@ 0.154 each)	1 x	0.154	=	0.154	10m15s-10m17s	(Ref. 92)
0	lights for closed breakers (@ 0.342 each)	0 x	0.342	=	0.000		(Ref. 92)
1	breaker closing coils (Peak)	1 x	15.000	=	15.000		
0	breaker closing coils (Continuous)	0 x	5.000	=	0.000		
0	lights for closing breakers (@ 0.231 each)	0 x	0.231	=	0.000		
1	lights for closing breakers (@ 0.513 each)	1 x	0.513	=	0.513		
11	lights for tripped breakers (@ 0.231 each)	11 x	0.231	=	2.541		(Ref. 92)
1	lights for tripped breakers (@ 0.513 each)	1 x	0.513	=	0.513		(Ref. 92)
0	breaker tripping coils	0 x	1.080	=	0.000		(Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0 x	0.231	=	0.000		
	Relays energized:						
1	Misc. Relay	1 x	0.080	=	0.080		
5	HFA	5 x	0.062	=	0.310		R39
1	HGA	1 x	0.038	=	0.038		
4	UV Relay	4 x	0.070	=	0.280		
		TOTAL		=	19.429 Amps		R39

						Time	
1	lights for closed breakers (@ 0.154 each)	1 x	0.154	=	0.154	10m17s-10m30s	(Ref. 92)
0	lights for closed breakers (@ 0.342 each)	0 x	0.342	=	0.000		(Ref. 92)
0	breaker closing coils (Peak)	0 x	15.000	=	0.000		
1	breaker closing coils (Continuous)	1 x	5.000	=	5.000		
0	lights for closing breakers (@ 0.231 each)	0 x	0.231	=	0.000		
1	lights for closing breakers (@ 0.513 each)	1 x	0.513	=	0.513		
11	lights for tripped breakers (@ 0.231 each)	11 x	0.231	=	2.541		(Ref. 92)
1	lights for tripped breakers (@ 0.513 each)	1 x	0.513	=	0.513		(Ref. 92)
0	breaker tripping coils	0 x	1.080	=	0.000		(Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0 x	0.231	=	0.000		
	Relays energized:						
1	Misc. Relay	1 x	0.080	=	0.080		
5	HFA	5 x	0.062	=	0.310		R39
1	HGA	1 x	0.038	=	0.038		
4	UV Relay	4 x	0.070	=	0.280		
		TOTAL		=	9.429 Amps		R39

4kV Switchgear 24

LOOP Condition

						Time	
1	lights for closed breakers (@ 0.154 each)	1 x	0.154	=	0.154	10m30s-10m45s	
1	lights for closed breakers (@ 0.342 each)	1 x	0.342	=	0.342		
0	breaker closing coils (Peak)	0 x	15.000	=	0.000		
0	breaker closing coils (Continuous)	0 x	5.000	=	0.000		
0	lights for closing breakers (@ 0.231 each)	0 x	0.231	=	0.000		(Ref. 92)
0	lights for closing breakers (@ 0.513 each)	0 x	0.513	=	0.000		(Ref. 92)
11	lights for tripped breakers (@ 0.231 each)	11 x	0.231	=	2.541		
1	lights for tripped breakers (@ 0.513 each)	1 x	0.513	=	0.513		
0	breaker tripping coils	0 x	1.080	=	0.000		(Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0 x	0.231	=	0.000		
	Relays energized:						
1	Misc. Relay	1 x	0.080	=	0.080		
5	HFA	5 x	0.062	=	0.310		R39
1	HGA	1 x	0.038	=	0.038		
4	UV Relay	4 x	0.070	=	0.280		
		TOTAL		=	4.258 Amps		R39

						Time	
1	lights for closed breakers (@ 0.154 each)	1 x	0.154	=	0.154	10m45s-10m47s	(Ref. 92)
1	lights for closed breakers (@ 0.342 each)	1 x	0.342	=	0.342		(Ref. 92)
1	breaker closing coils (Peak)	1 x	15.000	=	15.000		
0	breaker closing coils (Continuous)	0 x	5.000	=	0.000		
1	lights for closing breakers (@ 0.231 each)	1 x	0.231	=	0.231		
0	lights for closing breakers (@ 0.513 each)	0 x	0.513	=	0.000		
10	lights for tripped breakers (@ 0.231 each)	10 x	0.231	=	2.310		(Ref. 92)
1	lights for tripped breakers (@ 0.513 each)	1 x	0.513	=	0.513		(Ref. 92)
0	breaker tripping coils	0 x	1.080	=	0.000		(Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0 x	0.231	=	0.000		
	Relays energized:						
1	Misc. Relay	1 x	0.080	=	0.080		
5	HFA	5 x	0.062	=	0.310		R39
1	HGA	1 x	0.038	=	0.038		
4	UV Relay	4 x	0.070	=	0.280		
		TOTAL		=	19.258 Amps		R39

						Time	
1	lights for closed breakers (@ 0.154 each)	1 x	0.154	=	0.154	10m47s-11m	(Ref. 92)
1	lights for closed breakers (@ 0.342 each)	1 x	0.342	=	0.342		(Ref. 92)
0	breaker closing coils (Peak)	0 x	15.000	=	0.000		
1	breaker closing coils (Continuous)	1 x	5.000	=	5.000		
1	lights for closing breakers (@ 0.231 each)	1 x	0.231	=	0.231		
0	lights for closing breakers (@ 0.513 each)	0 x	0.513	=	0.000		
10	lights for tripped breakers (@ 0.231 each)	10 x	0.231	=	2.310		(Ref. 92)
1	lights for tripped breakers (@ 0.513 each)	1 x	0.513	=	0.513		(Ref. 92)
0	breaker tripping coils	0 x	1.080	=	0.000		(Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0 x	0.231	=	0.000		
	Relays energized:						
1	Misc. Relay	1 x	0.080	=	0.080		
5	HFA	5 x	0.062	=	0.310		R39
1	HGA	1 x	0.038	=	0.038		
4	UV Relay	4 x	0.070	=	0.280		
		TOTAL		=	9.258 Amps		R39

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LOOP Condition

						Time	
2	lights for closed breakers (@ 0.154 each)	2 x	0.154	=	0.308	11m-11m15s	
1	lights for closed breakers (@ 0.342 each)	1 x	0.342	=	0.342		
0	breaker closing coils (Peak)	0 x	15.000	=	0.000		
0	breaker closing coils (Continuous)	0 x	5.000	=	0.000		
0	lights for closing breakers (@ 0.231 each)	0 x	0.231	=	0.000		(Ref. 92)
0	lights for closing breakers (@ 0.513 each)	0 x	0.513	=	0.000		(Ref. 92)
10	lights for tripped breakers (@ 0.231 each)	10 x	0.231	=	2.310		
1	lights for tripped breakers (@ 0.513 each)	1 x	0.513	=	0.513		
0	breaker tripping coils	0 x	1.080	=	0.000		(Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0 x	0.231	=	0.000		
	Relays energized:						
1	Misc. Relay	1 x	0.080	=	0.080		
5	HFA	5 x	0.062	=	0.310		R39
1	HGA	1 x	0.038	=	0.038		
4	UV Relay	4 x	0.070	=	0.280		
		TOTAL		=	4.181 Amps		R39

						Time	
2	lights for closed breakers (@ 0.154 each)	2 x	0.154	=	0.308	11m15s-11m17s	(Ref. 92)
1	lights for closed breakers (@ 0.342 each)	1 x	0.342	=	0.342		(Ref. 92)
1	breaker closing coils (Peak)	1 x	15.000	=	15.000		
0	breaker closing coils (Continuous)	0 x	5.000	=	0.000		
1	lights for closing breakers (@ 0.231 each)	1 x	0.231	=	0.231		
0	lights for closing breakers (@ 0.513 each)	0 x	0.513	=	0.000		
9	lights for tripped breakers (@ 0.231 each)	9 x	0.231	=	2.079		(Ref. 92)
1	lights for tripped breakers (@ 0.513 each)	1 x	0.513	=	0.513		(Ref. 92)
0	breaker tripping coils	0 x	1.080	=	0.000		(Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0 x	0.231	=	0.000		
	Relays energized:						
1	Misc. Relay	1 x	0.080	=	0.080		
5	HFA	5 x	0.062	=	0.310		R39
1	HGA	1 x	0.038	=	0.038		
4	UV Relay	4 x	0.070	=	0.280		
		TOTAL		=	19.181 Amps		R39

						Time	
2	lights for closed breakers (@ 0.154 each)	2 x	0.154	=	0.308	11m17s-11m30s	(Ref. 92)
1	lights for closed breakers (@ 0.342 each)	1 x	0.342	=	0.342		(Ref. 92)
0	breaker closing coils (Peak)	0 x	15.000	=	0.000		
1	breaker closing coils (Continuous)	1 x	5.000	=	5.000		
1	lights for closing breakers (@ 0.231 each)	1 x	0.231	=	0.231		
0	lights for closing breakers (@ 0.513 each)	0 x	0.513	=	0.000		
9	lights for tripped breakers (@ 0.231 each)	9 x	0.231	=	2.079		(Ref. 92)
1	lights for tripped breakers (@ 0.513 each)	1 x	0.513	=	0.513		(Ref. 92)
0	breaker tripping coils	0 x	1.080	=	0.000		(Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0 x	0.231	=	0.000		
	Relays energized:						
1	Misc. Relay	1 x	0.080	=	0.080		
5	HFA	5 x	0.062	=	0.310		R39
1	HGA	1 x	0.038	=	0.038		
4	UV Relay	4 x	0.070	=	0.280		
		TOTAL		=	9.181 Amps		R39

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LOOP Condition

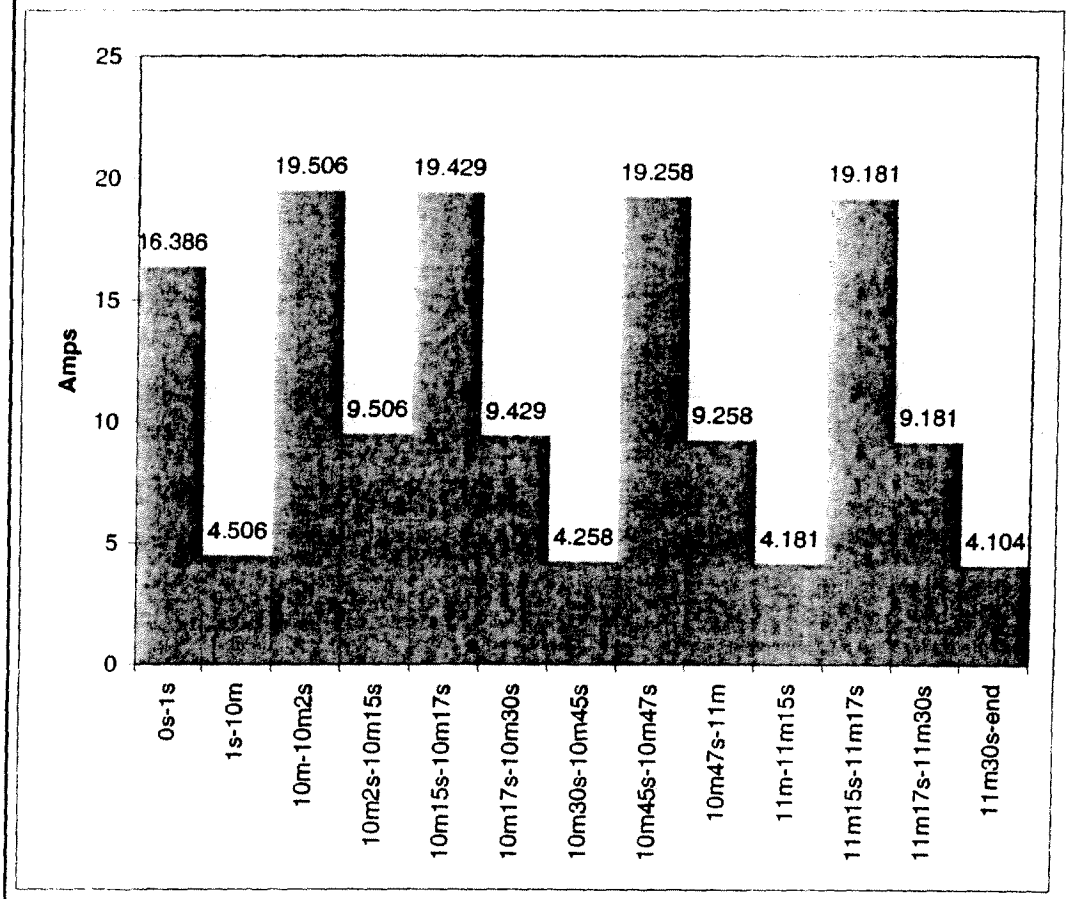
							Time	
3	lights for closed breakers (@ 0.154 each)	3	x	0.154	=	0.462	11m30s-end	
1	lights for closed breakers (@ 0.342 each)	1	x	0.342	=	0.342		
0	breaker closing coils (Peak)	0	x	15.000	=	0.000		
0	breaker closing coils (Continuous)	0	x	5.000	=	0.000		
0	lights for closing breakers (@ 0.231 each)	0	x	0.231	=	0.000		(Ref. 92)
0	lights for closing breakers (@ 0.513 each)	0	x	0.513	=	0.000		(Ref. 92)
9	lights for tripped breakers (@ 0.231 each)	9	x	0.231	=	2.079		
1	lights for tripped breakers (@ 0.513 each)	1	x	0.513	=	0.513		
0	breaker tripping coils	0	x	1.080	=	0.000		(Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		
	Relays energized:							
1	Misc. Relay	1	x	0.080	=	0.080		
5	HFA	5	x	0.062	=	0.310		R39
1	HGA	1	x	0.038	=	0.038		
4	UV Relay	4	x	0.070	=	0.280		
			TOTAL		=	4.104 Amps		R39

4kV Switchgear 24 **Page 8 of 12**

LOOP Condition

NOTES

1.) At t=0s all closed breakers trip. 4kV SWGR 24 sheds all load.
2.) At t=1s all 4kV SWGR 24 loads have been shed (i.e. all breakers have completed tripping).
3.) At t=10m feed breaker to 4kV SWGR 24-1 closes.
4.) At t=10m15s feed breaker to RHR SWP 2C or 2D closes.
5.) At t=10m45s feed breaker to SW Pump 2C closes.
6.) At t=11m15s feed breaker to CRD Feed Pump 2C closes.



R39

4kV Switchgear 24 **Page 9 of 12**

LOOP & LOCA Condition

The maximum dc load on the circuit under LOOP & LOCA condition is:

						Time	
0	lights for closed breakers (@ 0.154 each)	0 x	0.154 =	0.000		0s-1s	
0	lights for closed breakers (@ 0.342 each)	0 x	0.342 =	0.000			
0	breaker closing coils	0 x	15.000 =	0.000			
0	lights for closing breakers (@ 0.231 each)	0 x	0.231 =	0.000			
0	lights for closing breakers (@ 0.513 each)	0 x	0.513 =	0.000			
1	lights for tripped breakers (@ 0.231 each)	1 x	0.231 =	0.231			(Ref. 92)
2	lights for tripped breakers (@ 0.513 each)	2 x	0.513 =	1.026			(Ref. 92)
11	breaker tripping coils	11 x	1.080 =	11.880			(Ref. 88 & 93)
11	lights for tripping breakers (@ 0.231 each)	11 x	0.231 =	2.541			
	Relays energized:						
1	Misc. Relay	1 x	0.080 =	0.080			
5	HFA	5 x	0.062 =	0.310			R39
1	HGA	1 x	0.038 =	0.038			
4	UV Relay	4 x	0.070 =	0.280			
		TOTAL	=	16.386	Amps		R39

						Time	
0	lights for closed breakers (@ 0.154 each)	0 x	0.154 =	0.000		1s-10m15s	
0	lights for closed breakers (@ 0.342 each)	0 x	0.342 =	0.000			
0	breaker closing coils	0 x	15.000 =	0.000			
0	lights for closing breakers (@ 0.231 each)	0 x	0.231 =	0.000			
0	lights for closing breakers (@ 0.513 each)	0 x	0.513 =	0.000			
12	lights for tripped breakers (@ 0.231 each)	12 x	0.231 =	2.772			(Ref. 92)
2	lights for tripped breakers (@ 0.513 each)	2 x	0.513 =	1.026			(Ref. 92)
0	breaker tripping coils	0 x	1.080 =	0.000			(Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0 x	0.231 =	0.000			
	Relays energized:						
1	Misc. Relay	1 x	0.080 =	0.080			
5	HFA	5 x	0.062 =	0.310			R39
1	HGA	1 x	0.038 =	0.038			
4	UV Relay	4 x	0.070 =	0.280			
		TOTAL	=	4.506	Amps		R39

						Time	
0	lights for closed breakers (@ 0.154 each)	0 x	0.154 =	0.000		10m15s-10m17s	
0	lights for closed breakers (@ 0.342 each)	0 x	0.342 =	0.000			
1	breaker closing coils (Peak)	1 x	15.000 =	15.000			
0	breaker closing coils (Continuous)	0 x	5.000 =	0.000			
1	lights for closing breakers (@ 0.231 each)	1 x	0.231 =	0.231			
0	lights for closing breakers (@ 0.513 each)	0 x	0.513 =	0.000			
11	lights for tripped breakers (@ 0.231 each)	11 x	0.231 =	2.541			(Ref. 92)
2	lights for tripped breakers (@ 0.513 each)	2 x	0.513 =	1.026			(Ref. 92)
0	breaker tripping coils	0 x	1.080 =	0.000			(Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0 x	0.231 =	0.000			
	Relays energized:						
1	Misc. Relay	1 x	0.080 =	0.080			
5	HFA	5 x	0.062 =	0.310			R39
1	HGA	1 x	0.038 =	0.038			
4	UV Relay	4 x	0.070 =	0.280			
		TOTAL	=	19.506	Amps		R39

4kV Switchgear 24

LOOP & LOCA Condition

						Time	
0	lights for closed breakers (@ 0.154 each)	0 x	0.154	=	0.000	10m17s-10m30s	
0	lights for closed breakers (@ 0.342 each)	0 x	0.342	=	0.000		
0	breaker closing coils (Peak)	0 x	15.000	=	0.000		
1	breaker closing coils (Continuous)	1 x	5.000	=	5.000		
1	lights for closing breakers (@ 0.231 each)	1 x	0.231	=	0.231		(Ref. 92)
0	lights for closing breakers (@ 0.513 each)	0 x	0.513	=	0.000		(Ref. 92)
11	lights for tripped breakers (@ 0.231 each)	11 x	0.231	=	2.541		
2	lights for tripped breakers (@ 0.513 each)	2 x	0.513	=	1.026		
0	breaker tripping coils	0 x	1.080	=	0.000		(Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0 x	0.231	=	0.000		
	Relays energized:						
1	Misc. Relay	1 x	0.080	=	0.080		
5	HFA	5 x	0.062	=	0.310		R39
1	HGA	1 x	0.038	=	0.038		
4	UV Relay	4 x	0.070	=	0.280		
		TOTAL		=	9.506 Amps		R39

						Time	
1	lights for closed breakers (@ 0.154 each)	1 x	0.154	=	0.154	10m30s-10m32s	(Ref. 92)
0	lights for closed breakers (@ 0.342 each)	0 x	0.342	=	0.000		(Ref. 92)
1	breaker closing coils (Peak)	1 x	15.000	=	15.000		
0	breaker closing coils (Continuous)	0 x	5.000	=	0.000		
0	lights for closing breakers (@ 0.231 each)	0 x	0.231	=	0.000		
1	lights for closing breakers (@ 0.513 each)	1 x	0.513	=	0.513		
11	lights for tripped breakers (@ 0.231 each)	11 x	0.231	=	2.541		
1	lights for tripped breakers (@ 0.513 each)	1 x	0.513	=	0.513		
0	breaker tripping coils	0 x	1.080	=	0.000		(Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0 x	0.231	=	0.000		
	Relays energized:						
1	Misc. Relay	1 x	0.080	=	0.080		
5	HFA	5 x	0.062	=	0.310		R39
1	HGA	1 x	0.038	=	0.038		
4	UV Relay	4 x	0.070	=	0.280		
		TOTAL		=	19.429 Amps		R39

						Time	
1	lights for closed breakers (@ 0.154 each)	1 x	0.154	=	0.154	10m32s-10m45s	(Ref. 92)
0	lights for closed breakers (@ 0.342 each)	0 x	0.342	=	0.000		(Ref. 92)
0	breaker closing coils (Peak)	0 x	15.000	=	0.000		
1	breaker closing coils (Continuous)	1 x	5.000	=	5.000		
0	lights for closing breakers (@ 0.231 each)	0 x	0.231	=	0.000		
1	lights for closing breakers (@ 0.513 each)	1 x	0.513	=	0.513		
11	lights for tripped breakers (@ 0.231 each)	11 x	0.231	=	2.541		
1	lights for tripped breakers (@ 0.513 each)	1 x	0.513	=	0.513		
0	breaker tripping coils	0 x	1.080	=	0.000		(Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0 x	0.231	=	0.000		
	Relays energized:						
1	Misc. Relay	1 x	0.080	=	0.080		
5	HFA	5 x	0.062	=	0.310		R39
1	HGA	1 x	0.038	=	0.038		
4	UV Relay	4 x	0.070	=	0.280		
		TOTAL		=	9.429 Amps		R39

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LOOP & LOCA Condition

							Time	
1	lights for closed breakers (@ 0.154 each)	1	x	0.154	=	0.154	10m45s-end	
1	lights for closed breakers (@ 0.342 each)	1	x	0.342	=	0.342		
0	breaker closing coils (Peak)	0	x	15.000	=	0.000		
0	breaker closing coils (Continuous)	0	x	5.000	=	0.000		
0	lights for closing breakers (@ 0.231 each)	0	x	0.231	=	0.000		(Ref. 92)
0	lights for closing breakers (@ 0.513 each)	0	x	0.513	=	0.000		(Ref. 92)
11	lights for tripped breakers (@ 0.231 each)	11	x	0.231	=	2.541		
1	lights for tripped breakers (@ 0.513 each)	1	x	0.513	=	0.513		
0	breaker tripping coils	0	x	1.080	=	0.000		(Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0	x	0.231	=	0.000		
	Relays energized:							
1	Misc. Relay	1	x	0.080	=	0.080		
5	HFA	5	x	0.062	=	0.310		R39
1	HGA	1	x	0.038	=	0.038		
4	UV Relay	4	x	0.070	=	0.280		
			TOTAL		=	4.258 Amps		R39

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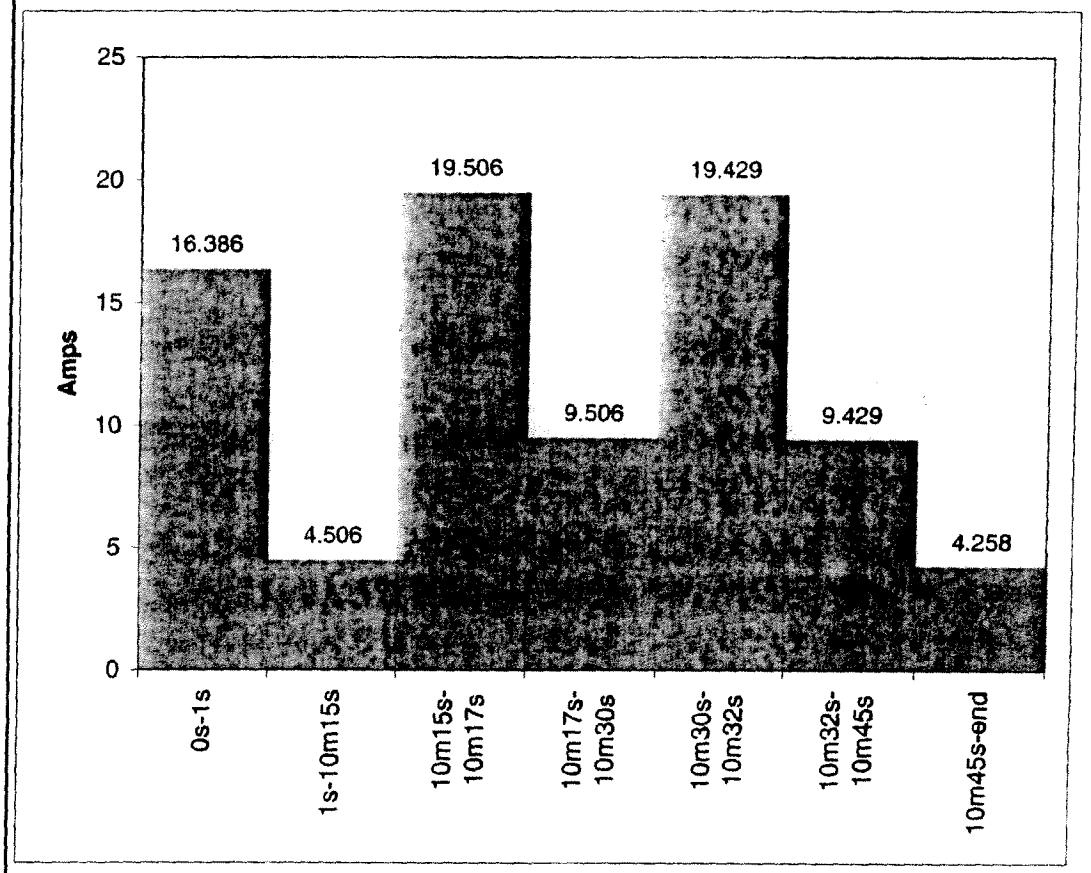
LOOP & LOCA Condition

NOTES

1.) At t=0s all closed breakers trip.4kV SWGR 24 sheds all load.
2.) At t=1s all 4kV SWGR 24 loads have been shed (i.e. all breakers have completed tripping).
3.) At t=10m15s feed breaker to 4kV SWGR 24-1 closes.
4.) At t=10m30s feed breaker to RHR SWP 2C or 2D closes.



R39

Bus 2B-1 Circuit 4
4kV Switchgear Bus 24-1 Main Feed

 R36

4kV Switchgear 24-1 AC Loads

Bkr. #	Service	AC Bkr. Status			S/D	Rev.
		On-Line	LOOP/ LOOP & LOCA (t=1)	LOOP/ LOOP & LOCA (After)		
152-2421	DG-2	T	T	C/C	4E-2346	SH. 1, AG
152-2422	SBO DG*	T	T	T/T	--	--
152-2423	Main Feed from SWGR 24	C	T	C/C	4E-2344	SH. 4, D
152-2424	RHR Pump 2C	T	T	T/C**	4E-2438Q	SH. 2, L
152-2425	Reserve Feed to SWGR 31	T	T	C/C	4E-2346A	A
152-2426	RHR Pump 2D	T	T	T/C**	4E-2438Q	SH. 2, L
152-2427	480V Switchgear 29	C	C	C/C	4E-2349	SH. 1, P
152-2428	Corespray Pump 2B	T	T	T/C	4E-2429	SH. 2, J
152-2429	Div. II Cross-Tie to Bus 14-1	T	T	T/T	4E-2346	SH. 1, AG

R36

*NOTE: The SBO breaker remains tripped when there is a LOCA on either unit. Since the scenario modeled is a LOOP on both units 1 & 2 and a LOCA on one unit, the SBO breaker is not modeled as closing.

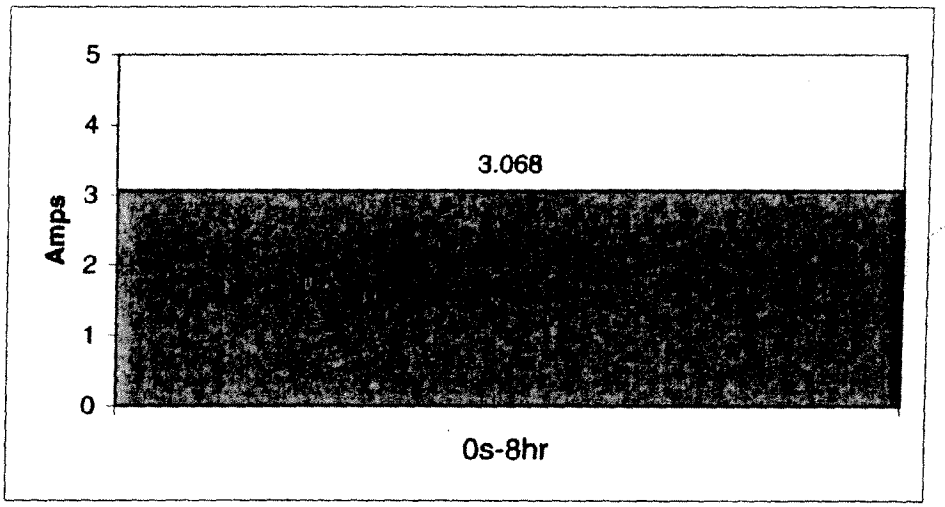
** Only 1 pump remains energized at the end of the LOOP & LOCA scenario.

4kV Switchgear 24-1 **Page 2 of 14** R36

Normal Condition

The maximum dc load on the circuit under Normal condition is:

					Time		
2 lights for closed breakers (@ 0.154 each)	2 x 0.154 =	0.308		0s-8hr	R36	
0 lights for closed breakers (@ 0.342 each)	0 x 0.342 =	0.000			R36	
4 lights for tripped breakers (@ 0.231 each)	4 x 0.231 =	0.924			R36	(Ref. 92)
3 lights for tripped breakers (@ 0.513 each)	3 x 0.513 =	1.539			R36	(Ref. 92)
No switching of breakers						
Relays energized:						
0 IAC Relay	0 x 0.200 =	0.000				
1 SA-1 Relay	1 x 0.055 =	0.055				
1 Agastat Relay	1 x 0.064 =	0.064				
0 HFA	0 x 0.062 =	0.000				
1 HGA	1 x 0.038 =	0.038				
2 UV Relay	2 x 0.070 =	0.140				
	TOTAL =	3.068	Amps		R36	



4kV Switchgear 24-1 **Page 3 of 14** R36

LOOP Condition

The maximum dc load on the circuit under LOOP condition is:

					Time		
1	lights for closed breakers (@ 0.154 each)	1 x 0.154 =	0.154		0s-1s	R36	
0	lights for closed breakers (@ 0.342 each)	0 x 0.342 =	0.000			R36	
0	breaker closing coils	0 x 15.000 =	0.000			R36	(Ref. 93)
0	lights for closing breakers (@ 0.231 each)	0 x 0.231 =	0.000			R36	
0	lights for closing breakers (@ 0.513 each)	0 x 0.513 =	0.000			R36	
4	lights for tripped breakers (@ 0.231 each)	4 x 0.231 =	0.924			R36	(Ref. 92)
3	lights for tripped breakers (@ 0.513 each)	3 x 0.513 =	1.539			R36	(Ref. 92)
1	breaker tripping coils	1 x 1.080 =	1.080			R36	(Ref. 88 & 93)
1	lights for tripping breakers (@ 0.231 each)	1 x 0.231 =	0.231			R36	
	Relays energized:						
2	IAC Relay	2 x 0.200 =	0.400			R36	
1	SA-1 Relay	1 x 0.055 =	0.055				
5	Agastat Relay	5 x 0.064 =	0.320			R36	
5	HFA	5 x 0.062 =	0.310			R36	
1	HGA	1 x 0.038 =	0.038				
4	UV Relay	4 x 0.070 =	0.280				
		TOTAL =	5.331	Amps		R36	

					Time		
1	lights for closed breakers (@ 0.154 each)	1 x 0.154 =	0.154		1s-10s	R36	
0	lights for closed breakers (@ 0.342 each)	0 x 0.342 =	0.000			R36	
0	breaker closing coils	0 x 15.000 =	0.000			R36	(Ref. 93)
0	lights for closing breakers (@ 0.231 each)	0 x 0.231 =	0.000			R36	
0	lights for closing breakers (@ 0.513 each)	0 x 0.513 =	0.000			R36	
5	lights for tripped breakers (@ 0.231 each)	5 x 0.231 =	1.155			R36	(Ref. 92)
3	lights for tripped breakers (@ 0.513 each)	3 x 0.513 =	1.539			R36	(Ref. 92)
0	breaker tripping coils	0 x 1.080 =	0.000			R36	(Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0 x 0.231 =	0.000			R36	
	Relays energized:						
2	IAC Relay	2 x 0.200 =	0.400			R36	
1	SA-1 Relay	1 x 0.055 =	0.055				
5	Agastat Relay	5 x 0.064 =	0.320			R36	
5	HFA	5 x 0.062 =	0.310			R36	
1	HGA	1 x 0.038 =	0.038				
4	UV Relay	4 x 0.070 =	0.280				
		TOTAL =	4.251	Amps		R36	

					Time		
1	lights for closed breakers (@ 0.154 each)	1 x 0.154 =	0.154		10s-12s	R36	
0	lights for closed breakers (@ 0.342 each)	0 x 0.342 =	0.000			R36	
1	breaker closing coils (Peak)	1 x 15.000 =	15.000			R36	(Ref. 93)
0	breaker closing coils (Continuous)	0 x 5.000 =	0.000			R36	
1	lights for closing breakers (@ 0.231 each)	1 x 0.231 =	0.231			R36	
0	lights for closing breakers (@ 0.513 each)	0 x 0.513 =	0.000			R36	
4	lights for tripped breakers (@ 0.231 each)	4 x 0.231 =	0.924			R36	(Ref. 92)
3	lights for tripped breakers (@ 0.513 each)	3 x 0.513 =	1.539			R36	(Ref. 92)
0	breaker tripping coils	0 x 1.080 =	0.000			R36	(Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0 x 0.231 =	0.000			R36	
	Relays energized:						
2	IAC Relay	2 x 0.200 =	0.400				
1	SA-1 Relay	1 x 0.055 =	0.055				
5	Agastat Relay	5 x 0.064 =	0.320			R36	
5	HFA	5 x 0.062 =	0.310			R36	
1	HGA	1 x 0.038 =	0.038				
4	UV Relay	4 x 0.070 =	0.280			R36	
		TOTAL =	19.251	Amps		R36	

4kV Switchgear 24-1 | Page 4 of 14 | R36

LOOP Condition

						Time		
1	lights for closed breakers (@ 0.154 each)	1 x	0.154	=	0.154	12s-25s	R36	
0	lights for closed breakers (@ 0.342 each)	0 x	0.342	=	0.000		R36	
0	breaker closing coils (Peak)	0 x	15.000	=	0.000		R36	(Ref. 93)
1	breaker closing coils (Continuous)	1 x	5.000	=	5.000		R36	
1	lights for closing breakers (@ 0.231 each)	1 x	0.231	=	0.231		R36	
0	lights for closing breakers (@ 0.513 each)	0 x	0.513	=	0.000		R36	
4	lights for tripped breakers (@ 0.231 each)	4 x	0.231	=	0.924		R36	(Ref. 92)
3	lights for tripped breakers (@ 0.513 each)	3 x	0.513	=	1.539		R36	(Ref. 92)
0	breaker tripping coils	0 x	1.080	=	0.000		R36	(Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0 x	0.231	=	0.000		R36	
	Relays energized:							
2	IAC Relay	2 x	0.200	=	0.400			
1	SA-1 Relay	1 x	0.055	=	0.055			
5	Agastat Relay	5 x	0.064	=	0.320		R36	
5	HFA	5 x	0.062	=	0.310		R36	
1	HGA	1 x	0.038	=	0.038			
4	UV Relay	4 x	0.070	=	0.280		R36	
		TOTAL		=	9.251 Amps		R36	

						Time		
2	lights for closed breakers (@ 0.154 each)	2 x	0.154	=	0.308	25s-10m	R36	
0	lights for closed breakers (@ 0.342 each)	0 x	0.342	=	0.000		R36	
0	breaker closing coils (Peak)	0 x	15.000	=	0.000		R36	(Ref. 93)
0	breaker closing coils (Continuous)	0 x	5.000	=	0.000		R36	
0	lights for closing breakers (@ 0.231 each)	0 x	0.231	=	0.000		R36	
0	lights for closing breakers (@ 0.513 each)	0 x	0.513	=	0.000		R36	
4	lights for tripped breakers (@ 0.231 each)	4 x	0.231	=	0.924		R36	(Ref. 92)
3	lights for tripped breakers (@ 0.513 each)	3 x	0.513	=	1.539		R36	(Ref. 92)
0	breaker tripping coils	0 x	1.080	=	0.000		R36	(Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0 x	0.231	=	0.000		R36	
	Relays energized:							
2	IAC Relay	2 x	0.200	=	0.400			
1	SA-1 Relay	1 x	0.055	=	0.055			
5	Agastat Relay	5 x	0.064	=	0.320		R36	
5	HFA	5 x	0.062	=	0.310		R36	
1	HGA	1 x	0.038	=	0.038			
4	UV Relay	4 x	0.070	=	0.280		R36	
		TOTAL		=	4.174 Amps		R36	

						Time		
2	lights for closed breakers (@ 0.154 each)	2 x	0.154	=	0.308	10m-10m2s	R36	
0	lights for closed breakers (@ 0.342 each)	0 x	0.342	=	0.000		R36	
1	breaker closing coils (Peak)	1 x	15.000	=	15.000		R36	(Ref. 93)
0	breaker closing coils (Continuous)	0 x	5.000	=	0.000		R36	
1	lights for closing breakers (@ 0.231 each)	1 x	0.231	=	0.231		R36	(Ref. 92)
0	lights for closing breakers (@ 0.513 each)	0 x	0.513	=	0.000		R36	(Ref. 92)
3	lights for tripped breakers (@ 0.231 each)	3 x	0.231	=	0.693		R36	(Ref. 92)
3	lights for tripped breakers (@ 0.513 each)	3 x	0.513	=	1.539		R36	(Ref. 92)
0	breaker tripping coils	0 x	1.080	=	0.000		R36	(Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0 x	0.231	=	0.000		R36	
	Relays energized:							
2	IAC Relay	2 x	0.200	=	0.400			
1	SA-1 Relay	1 x	0.055	=	0.055			
5	Agastat Relay	5 x	0.064	=	0.320		R36	
5	HFA	5 x	0.062	=	0.310		R36	
1	HGA	1 x	0.038	=	0.038			
4	UV Relay	4 x	0.070	=	0.280		R36	
		TOTAL		=	19.174 Amps		R36	

4kV Switchgear 24-1 | Page 5 of 14 | R36

LOOP Condition

					Time		
2 lights for closed breakers (@ 0.154 each)	2 x 0.154 =	0.308	10m2s-10m15s	R36	(Ref. 92)
0 lights for closed breakers (@ 0.342 each)	0 x 0.342 =	0.000		R36	(Ref. 92)
0 breaker closing coils (Peak)	0 x 15.000 =	0.000		R36	(Ref. 93)
1 breaker closing coils (Continuous)	1 x 5.000 =	5.000		R36	
1 lights for closing breakers (@ 0.231 each)	1 x 0.231 =	0.231		R36	
0 lights for closing breakers (@ 0.513 each)	0 x 0.513 =	0.000		R36	
3 lights for tripped breakers (@ 0.231 each)	3 x 0.231 =	0.693		R36	(Ref. 92)
3 lights for tripped breakers (@ 0.513 each)	3 x 0.513 =	1.539		R36	(Ref. 92)
0 breaker tripping coils	0 x 1.080 =	0.000		R36	(Ref. 88 & 93)
0 lights for tripping breakers (@ 0.231 each)	0 x 0.231 =	0.000		R36	
Relays energized:					
2 IAC Relay	2 x 0.200 =	0.400			
1 SA-1 Relay	1 x 0.055 =	0.055			
5 Agastat Relay	5 x 0.064 =	0.320		R36	
5 HFA	5 x 0.062 =	0.310		R36	
1 HGA	1 x 0.038 =	0.038			
4 UV Relay	4 x 0.070 =	0.280		R36	
	TOTAL =	9.174 Amps		R36	

					Time		
3 lights for closed breakers (@ 0.154 each)	3 x 0.154 =	0.462	10m15s-11m30s	R36	(Ref. 92)
0 lights for closed breakers (@ 0.342 each)	0 x 0.342 =	0.000		R36	(Ref. 92)
0 breaker closing coils (Peak)	0 x 15.000 =	0.000		R36	(Ref. 93)
0 breaker closing coils (Continuous)	0 x 5.000 =	0.000		R36	
0 lights for closing breakers (@ 0.231 each)	0 x 0.231 =	0.000		R36	(Ref. 92)
0 lights for closing breakers (@ 0.513 each)	0 x 0.513 =	0.000		R36	(Ref. 92)
3 lights for tripped breakers (@ 0.231 each)	3 x 0.231 =	0.693		R36	
3 lights for tripped breakers (@ 0.513 each)	3 x 0.513 =	1.539		R36	
0 breaker tripping coils	0 x 1.080 =	0.000		R36	(Ref. 88 & 93)
0 lights for tripping breakers (@ 0.231 each)	0 x 0.231 =	0.000		R36	
Relays energized:					
2 IAC Relay	2 x 0.200 =	0.400			
1 SA-1 Relay	1 x 0.055 =	0.055			
5 Agastat Relay	5 x 0.064 =	0.320		R36	
5 HFA	5 x 0.062 =	0.310		R36	
1 HGA	1 x 0.038 =	0.038			
4 UV Relay	4 x 0.070 =	0.280		R36	
	TOTAL =	4.097 Amps		R36	

					Time		
3 lights for closed breakers (@ 0.154 each)	3 x 0.154 =	0.462	11m30s-11m32s	R36	(Ref. 92)
0 lights for closed breakers (@ 0.342 each)	0 x 0.342 =	0.000		R36	(Ref. 92)
1 breaker closing coils (Peak)	1 x 15.000 =	15.000		R36	(Ref. 93)
0 breaker closing coils (Continuous)	0 x 5.000 =	0.000		R36	
1 lights for closing breakers (@ 0.231 each)	1 x 0.231 =	0.231		R36	
0 lights for closing breakers (@ 0.513 each)	0 x 0.513 =	0.000		R36	
2 lights for tripped breakers (@ 0.231 each)	2 x 0.231 =	0.462		R36	
3 lights for tripped breakers (@ 0.513 each)	3 x 0.513 =	1.539		R36	
0 breaker tripping coils	0 x 1.080 =	0.000		R36	(Ref. 88 & 93)
0 lights for tripping breakers (@ 0.231 each)	0 x 0.231 =	0.000		R36	
Relays energized:					
2 IAC Relay	2 x 0.200 =	0.400			
1 SA-1 Relay	1 x 0.055 =	0.055			
5 Agastat Relay	5 x 0.064 =	0.320		R36	
5 HFA	5 x 0.062 =	0.310		R36	
1 HGA	1 x 0.038 =	0.038			
4 UV Relay	4 x 0.070 =	0.280		R36	
	TOTAL =	19.097 Amps		R36	

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LOOP Condition

					Time		
3 lights for closed breakers (@ 0.154 each)	3 x 0.154 =	0.462	11m32s-11m45s	R36	(Ref. 92)
0 lights for closed breakers (@ 0.342 each)	0 x 0.342 =	0.000		R36	(Ref. 92)
0 breaker closing coils (Peak)	0 x 15.000 =	0.000		R36	(Ref. 93)
1 breaker closing coils (Continuous)	1 x 5.000 =	5.000		R36	
1 lights for closing breakers (@ 0.231 each)	1 x 0.231 =	0.231		R36	
0 lights for closing breakers (@ 0.513 each)	0 x 0.513 =	0.000		R36	
2 lights for tripped breakers (@ 0.231 each)	2 x 0.231 =	0.462		R36	
3 lights for tripped breakers (@ 0.513 each)	3 x 0.513 =	1.539		R36	
0 breaker tripping coils	0 x 1.080 =	0.000		R36	(Ref. 88 & 93)
0 lights for tripping breakers (@ 0.231 each)	0 x 0.231 =	0.000		R36	
Relays energized:					
2 IAC Relay	2 x 0.200 =	0.400			
1 SA-1 Relay	1 x 0.055 =	0.055			
5 Agastat Relay	5 x 0.064 =	0.320		R36	
5 HFA	5 x 0.062 =	0.310		R36	
1 HGA	1 x 0.038 =	0.038			
4 UV Relay	4 x 0.070 =	0.280		R36	
	TOTAL =	9.097 Amps		R36	

					Time		
4 lights for closed breakers (@ 0.154 each)	4 x 0.154 =	0.616	11m45s-end	R36	(Ref. 92)
0 lights for closed breakers (@ 0.342 each)	0 x 0.342 =	0.000		R36	(Ref. 92)
0 breaker closing coils (Peak)	0 x 15.000 =	0.000		R36	(Ref. 93)
0 breaker closing coils (Continuous)	0 x 5.000 =	0.000		R36	
0 lights for closing breakers (@ 0.231 each)	0 x 0.231 =	0.000		R36	
0 lights for closing breakers (@ 0.513 each)	0 x 0.513 =	0.000		R36	
2 lights for tripped breakers (@ 0.231 each)	2 x 0.231 =	0.462		R36	
3 lights for tripped breakers (@ 0.513 each)	3 x 0.513 =	1.539		R36	
0 breaker tripping coils	0 x 1.080 =	0.000		R36	(Ref. 88 & 93)
0 lights for tripping breakers (@ 0.231 each)	0 x 0.231 =	0.000		R36	
Relays energized:					
2 IAC Relay	2 x 0.200 =	0.400			
1 SA-1 Relay	1 x 0.055 =	0.055			
5 Agastat Relay	5 x 0.064 =	0.320		R36	
5 HFA	5 x 0.062 =	0.310		R36	
1 HGA	1 x 0.038 =	0.038			
4 UV Relay	4 x 0.070 =	0.280		R36	
	TOTAL =	4.020 Amps		R36	

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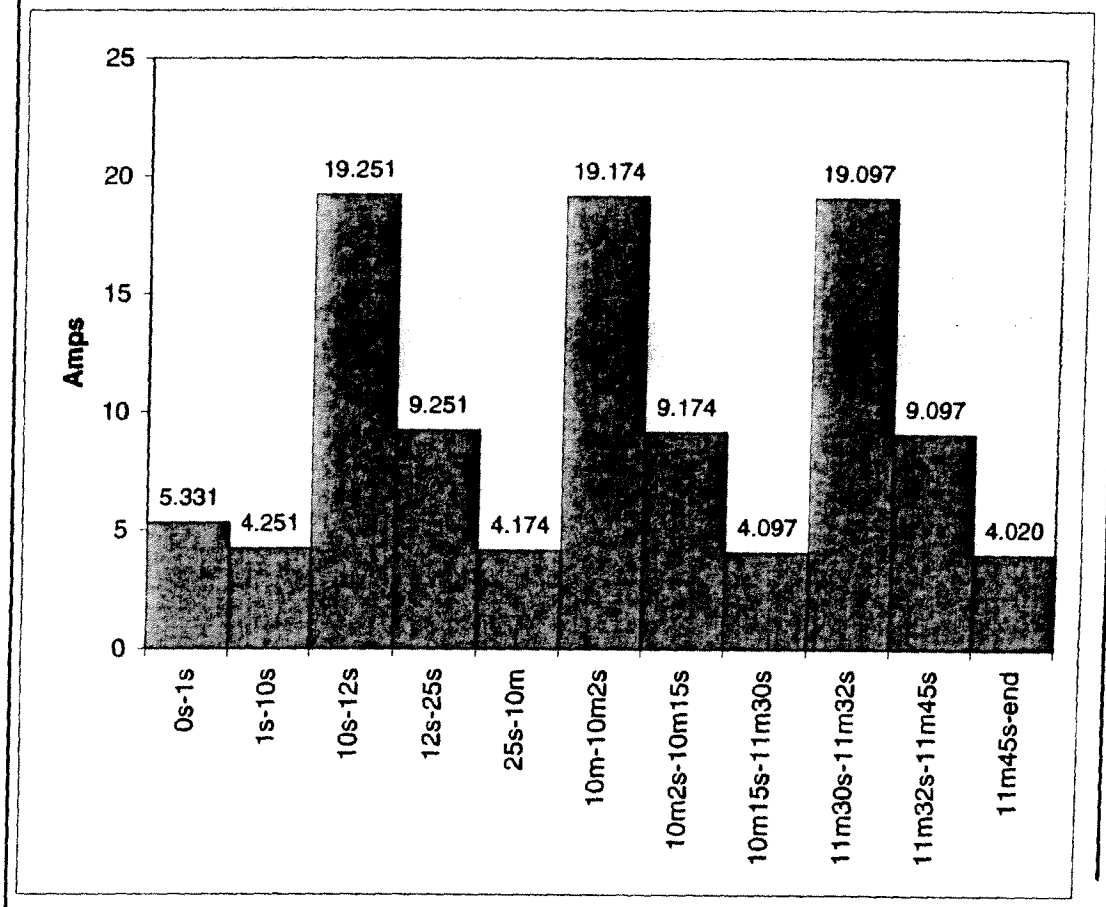
LOOP Condition

NOTES

1.) At t=0s all closed breakers trip except for 480V SWGR 29 feed. 4kV SWGR 24-1 sheds load.
2.) At t=1s all 4kV SWGR 24-1 loads have been shed except for 480V SWGR 29 (i.e. all breakers have completed tripping).
3.) At t=10s DG 2 breaker closes.
4.) At t=10m close Main Feed Breaker to 4kV SWGR 24. R36
5.) At t=11m30s close breaker for 4kV SWGR 31 (Safe Shutdown System). R36

NOTE:

The SBO breaker remains tripped when there is a LOCA on either unit. Since the scenario modeled is a LOOP on both units 1 & 2 and a LOCA on one unit, the SBO breaker is not modeled as closing. R36



R36

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LOOP & LOCA Condition

The maximum dc load on the circuit under LOOP & LOCA condition is:

					Time		
1	lights for closed breakers (@ 0.154 each)	1 x 0.154 =	0.154		0s-1s	R36	
0	lights for closed breakers (@ 0.342 each)	0 x 0.342 =	0.000			R36	
0	breaker closing coils	0 x 15.000 =	0.000			R36	(Ref. 93)
0	lights for closing breakers (@ 0.231 each)	0 x 0.231 =	0.000			R36	
0	lights for closing breakers (@ 0.513 each)	0 x 0.513 =	0.000			R36	
4	lights for tripped breakers (@ 0.231 each)	4 x 0.231 =	0.924			R36	(Ref. 92)
3	lights for tripped breakers (@ 0.513 each)	3 x 0.513 =	1.539			R36	(Ref. 92)
1	breaker tripping coils	1 x 1.080 =	1.080			R36	(Ref. 88 & 93)
1	lights for tripping breakers (@ 0.231 each)	1 x 0.231 =	0.231			R36	
	Relays energized:						
2	IAC Relay	2 x 0.200 =	0.400			R36	
1	SA-1 Relay	1 x 0.055 =	0.055				
5	Agastat Relay	5 x 0.064 =	0.320			R36	
5	HFA	5 x 0.062 =	0.310			R36	
1	HGA	1 x 0.038 =	0.038				
4	UV Relay	4 x 0.070 =	0.280				
		TOTAL =	5.331	Amps		R36	

					Time		
1	lights for closed breakers (@ 0.154 each)	1 x 0.154 =	0.154		1s-10s	R36	
0	lights for closed breakers (@ 0.342 each)	0 x 0.342 =	0.000			R36	
0	breaker closing coils	0 x 15.000 =	0.000			R36	(Ref. 93)
0	lights for closing breakers (@ 0.231 each)	0 x 0.231 =	0.000			R36	
0	lights for closing breakers (@ 0.513 each)	0 x 0.513 =	0.000			R36	
5	lights for tripped breakers (@ 0.231 each)	5 x 0.231 =	1.155			R36	(Ref. 92)
3	lights for tripped breakers (@ 0.513 each)	3 x 0.513 =	1.539			R36	(Ref. 92)
0	breaker tripping coils	0 x 1.080 =	0.000			R36	(Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0 x 0.231 =	0.000			R36	
	Relays energized:						
2	IAC Relay	2 x 0.200 =	0.400			R36	
1	SA-1 Relay	1 x 0.055 =	0.055				
5	Agastat Relay	5 x 0.064 =	0.320			R36	
5	HFA	5 x 0.062 =	0.310			R36	
1	HGA	1 x 0.038 =	0.038				
4	UV Relay	4 x 0.070 =	0.280				
		TOTAL =	4.251	Amps		R36	

					Time		
1	lights for closed breakers (@ 0.154 each)	1 x 0.154 =	0.154		10s-12s	R36	
0	lights for closed breakers (@ 0.342 each)	0 x 0.342 =	0.000			R36	
1	breaker closing coils (Peak)	1 x 15.000 =	15.000			R36	(Ref. 90)
0	breaker closing coils (Continuous)	0 x 5.000 =	0.000			R36	
1	lights for closing breakers (@ 0.231 each)	1 x 0.231 =	0.231			R36	
0	lights for closing breakers (@ 0.513 each)	0 x 0.513 =	0.000			R36	
4	lights for tripped breakers (@ 0.231 each)	4 x 0.231 =	0.924			R36	(Ref. 92)
3	lights for tripped breakers (@ 0.513 each)	3 x 0.513 =	1.539			R36	(Ref. 92)
0	breaker tripping coils	0 x 1.080 =	0.000			R36	(Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0 x 0.231 =	0.000			R36	
	Relays energized:						
2	IAC Relay	2 x 0.200 =	0.400				
1	SA-1 Relay	1 x 0.055 =	0.055				
5	Agastat Relay	5 x 0.064 =	0.320			R36	
5	HFA	5 x 0.062 =	0.310			R36	
1	HGA	1 x 0.038 =	0.038				
4	UV Relay	4 x 0.070 =	0.280			R36	
		TOTAL =	19.251	Amps		R36	

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LOOP & LOCA Condition

					Time		
1	lights for closed breakers (@ 0.154 each)	1 x 0.154 =	0.154		12s-13s	R36	
0	lights for closed breakers (@ 0.342 each)	0 x 0.342 =	0.000			R36	
0	breaker closing coils (Peak)	0 x 15.000 =	0.000			R36	(Ref. 90)
1	breaker closing coils (Continuous)	1 x 5.000 =	5.000			R36	
1	lights for closing breakers (@ 0.231 each)	1 x 0.231 =	0.231			R36	
0	lights for closing breakers (@ 0.513 each)	0 x 0.513 =	0.000			R36	
4	lights for tripped breakers (@ 0.231 each)	4 x 0.231 =	0.924			R36	(Ref. 92)
3	lights for tripped breakers (@ 0.513 each)	3 x 0.513 =	1.539			R36	(Ref. 92)
0	breaker tripping coils	0 x 1.080 =	0.000			R36	(Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0 x 0.231 =	0.000			R36	
	Relays energized:						
2	IAC Relay	2 x 0.200 =	0.400				
1	SA-1 Relay	1 x 0.055 =	0.055				
5	Agastat Relay	5 x 0.064 =	0.320			R36	
5	HFA	5 x 0.062 =	0.310			R36	
1	HGA	1 x 0.038 =	0.038				
4	UV Relay	4 x 0.070 =	0.280			R36	
		TOTAL =	9.251 Amps			R36	
					Time		
1	lights for closed breakers (@ 0.154 each)	1 x 0.154 =	0.154		13s-15s	R36	
0	lights for closed breakers (@ 0.342 each)	0 x 0.342 =	0.000			R36	
1	breaker closing coils (Peak)	1 x 15.000 =	15.000			R36	(Ref. 90)
1	breaker closing coils (Continuous)	1 x 5.000 =	5.000			R36	
1	lights for closing breakers (@ 0.231 each)	1 x 0.231 =	0.231			R36	(Ref. 92)
1	lights for closing breakers (@ 0.513 each)	1 x 0.513 =	0.513			R36	(Ref. 92)
4	lights for tripped breakers (@ 0.231 each)	4 x 0.231 =	0.924			R36	(Ref. 92)
2	lights for tripped breakers (@ 0.513 each)	2 x 0.513 =	1.026			R36	(Ref. 92)
0	breaker tripping coils	0 x 1.080 =	0.000			R36	(Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0 x 0.231 =	0.000			R36	
	Relays energized:						
2	IAC Relay	2 x 0.200 =	0.400				
1	SA-1 Relay	1 x 0.055 =	0.055				
5	Agastat Relay	5 x 0.064 =	0.320			R36	
5	HFA	5 x 0.062 =	0.310			R36	
1	HGA	1 x 0.038 =	0.038				
4	UV Relay	4 x 0.070 =	0.280			R36	
		TOTAL =	24.251 Amps			R36	
					Time		
1	lights for closed breakers (@ 0.154 each)	1 x 0.154 =	0.154		15s-18s	R36	(Ref. 92)
0	lights for closed breakers (@ 0.342 each)	0 x 0.342 =	0.000			R36	(Ref. 92)
0	breaker closing coils (Peak)	0 x 15.000 =	0.000			R36	(Ref. 90)
2	breaker closing coils (Continuous)	2 x 5.000 =	10.000			R36	
1	lights for closing breakers (@ 0.231 each)	1 x 0.231 =	0.231			R36	
1	lights for closing breakers (@ 0.513 each)	1 x 0.513 =	0.513			R36	
4	lights for tripped breakers (@ 0.231 each)	4 x 0.231 =	0.924			R36	(Ref. 92)
2	lights for tripped breakers (@ 0.513 each)	2 x 0.513 =	1.026			R36	(Ref. 92)
0	breaker tripping coils	0 x 1.080 =	0.000			R36	(Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0 x 0.231 =	0.000			R36	
	Relays energized:						
2	IAC Relay	2 x 0.200 =	0.400				
1	SA-1 Relay	1 x 0.055 =	0.055				
5	Agastat Relay	5 x 0.064 =	0.320			R36	
5	HFA	5 x 0.062 =	0.310			R36	
1	HGA	1 x 0.038 =	0.038				
4	UV Relay	4 x 0.070 =	0.280			R36	
		TOTAL =	14.251 Amps			R36	

LOOP & LOCA Condition

						Time		
1	lights for closed breakers (@ 0.154 each)	1 x	0.154	=	0.154	18s-20s	R36	(Ref. 92)
0	lights for closed breakers (@ 0.342 each)	0 x	0.342	=	0.000		R36	(Ref. 92)
1	breaker closing coils (Peak)	1 x	15.000	=	15.000		R36	(Ref. 90)
2	breaker closing coils (Continuous)	2 x	5.000	=	10.000		R36	
1	lights for closing breakers (@ 0.231 each)	1 x	0.231	=	0.231		R36	(Ref. 92)
2	lights for closing breakers (@ 0.513 each)	2 x	0.513	=	1.026		R36	(Ref. 92)
4	lights for tripped breakers (@ 0.231 each)	4 x	0.231	=	0.924		R36	
1	lights for tripped breakers (@ 0.513 each)	1 x	0.513	=	0.513		R36	
0	breaker tripping coils	0 x	1.080	=	0.000		R36	(Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0 x	0.231	=	0.000		R36	
	Relays energized:							
2	IAC Relay	2 x	0.200	=	0.400			
1	SA-1 Relay	1 x	0.055	=	0.055			
5	Agastat Relay	5 x	0.064	=	0.320		R36	
5	HFA	5 x	0.062	=	0.310		R36	
1	HGA	1 x	0.038	=	0.038			
4	UV Relay	4 x	0.070	=	0.280		R36	
		TOTAL		=	29.251 Amps		R36	
						Time		
1	lights for closed breakers (@ 0.154 each)	1 x	0.154	=	0.154	20s-23s	R36	(Ref. 92)
0	lights for closed breakers (@ 0.342 each)	0 x	0.342	=	0.000		R36	(Ref. 92)
0	breaker closing coils (Peak)	0 x	15.000	=	0.000		R36	(Ref. 90)
3	breaker closing coils (Continuous)	3 x	5.000	=	15.000		R36	
1	lights for closing breakers (@ 0.231 each)	1 x	0.231	=	0.231		R36	
2	lights for closing breakers (@ 0.513 each)	2 x	0.513	=	1.026		R36	
4	lights for tripped breakers (@ 0.231 each)	4 x	0.231	=	0.924		R36	
1	lights for tripped breakers (@ 0.513 each)	1 x	0.513	=	0.513		R36	
0	breaker tripping coils	0 x	1.080	=	0.000		R36	(Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0 x	0.231	=	0.000		R36	
	Relays energized:							
2	IAC Relay	2 x	0.200	=	0.400			
1	SA-1 Relay	1 x	0.055	=	0.055			
5	Agastat Relay	5 x	0.064	=	0.320		R36	
5	HFA	5 x	0.062	=	0.310		R36	
1	HGA	1 x	0.038	=	0.038			
4	UV Relay	4 x	0.070	=	0.280		R36	
		TOTAL		=	19.251 Amps		R36	
						Time	R36	
1	lights for closed breakers (@ 0.154 each)	1 x	0.154	=	0.154	23-25s	R36	(Ref. 92)
0	lights for closed breakers (@ 0.342 each)	0 x	0.342	=	0.000		R36	(Ref. 92)
1	breaker closing coils (Peak)	1 x	15.000	=	15.000		R36	(Ref. 90)
3	breaker closing coils (Continuous)	3 x	5.000	=	15.000		R36	
1	lights for closing breakers (@ 0.231 each)	1 x	0.231	=	0.231		R36	
3	lights for closing breakers (@ 0.513 each)	3 x	0.513	=	1.539		R36	
4	lights for tripped breakers (@ 0.231 each)	4 x	0.231	=	0.924		R36	
0	lights for tripped breakers (@ 0.513 each)	0 x	0.513	=	0.000		R36	
0	breaker tripping coils	0 x	1.080	=	0.000		R36	(Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0 x	0.231	=	0.000		R36	
	Relays energized:						R36	
2	IAC Relay	2 x	0.200	=	0.400		R36	
1	SA-1 Relay	1 x	0.055	=	0.055		R36	
5	Agastat Relay	5 x	0.064	=	0.320		R36	
5	HFA	5 x	0.062	=	0.310		R36	
1	HGA	1 x	0.038	=	0.038		R36	
4	UV Relay	4 x	0.070	=	0.280		R36	
		TOTAL		=	34.251 Amps		R36	

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LOOP & LOCA Condition

					Time		
2	lights for closed breakers (@ 0.154 each)	2 x 0.154 =	0.308		25s-28s	R36	(Ref. 92)
0	lights for closed breakers (@ 0.342 each)	0 x 0.342 =	0.000			R36	(Ref. 92)
0	breaker closing coils (Peak)	0 x 15.000 =	0.000			R36	(Ref. 90)
3	breaker closing coils (Continuous)	3 x 5.000 =	15.000			R36	
0	lights for closing breakers (@ 0.231 each)	0 x 0.231 =	0.000			R36	
3	lights for closing breakers (@ 0.513 each)	3 x 0.513 =	1.539			R36	
4	lights for tripped breakers (@ 0.231 each)	4 x 0.231 =	0.924			R36	
0	lights for tripped breakers (@ 0.513 each)	0 x 0.513 =	0.000			R36	
0	breaker tripping coils	0 x 1.080 =	0.000			R36	(Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0 x 0.231 =	0.000			R36	
	Relays energized:						
2	IAC Relay	2 x 0.200 =	0.400				
1	SA-1 Relay	1 x 0.055 =	0.055				
5	Agastat Relay	5 x 0.064 =	0.320			R36	
5	HFA	5 x 0.062 =	0.310			R36	
1	HGA	1 x 0.038 =	0.038				
4	UV Relay	4 x 0.070 =	0.280			R36	
		TOTAL =	19.174	Amps		R36	
					Time		
2	lights for closed breakers (@ 0.154 each)	2 x 0.154 =	0.308		28s-33s	R36	(Ref. 92)
1	lights for closed breakers (@ 0.342 each)	1 x 0.342 =	0.342			R36	(Ref. 92)
0	breaker closing coils (Peak)	0 x 15.000 =	0.000			R36	(Ref. 90)
2	breaker closing coils (Continuous)	2 x 5.000 =	10.000			R36	
0	lights for closing breakers (@ 0.231 each)	0 x 0.231 =	0.000			R36	
2	lights for closing breakers (@ 0.513 each)	2 x 0.513 =	1.026			R36	
4	lights for tripped breakers (@ 0.231 each)	4 x 0.231 =	0.924			R36	
0	lights for tripped breakers (@ 0.513 each)	0 x 0.513 =	0.000			R36	
0	breaker tripping coils	0 x 1.080 =	0.000			R36	(Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0 x 0.231 =	0.000			R36	
	Relays energized:						
2	IAC Relay	2 x 0.200 =	0.400				
1	SA-1 Relay	1 x 0.055 =	0.055				
5	Agastat Relay	5 x 0.064 =	0.320			R36	
5	HFA	5 x 0.062 =	0.310			R36	
1	HGA	1 x 0.038 =	0.038				
4	UV Relay	4 x 0.070 =	0.280			R36	
		TOTAL =	14.003	Amps		R36	
					Time	R36	
2	lights for closed breakers (@ 0.154 each)	2 x 0.154 =	0.308		33s-38s	R36	(Ref. 92)
2	lights for closed breakers (@ 0.342 each)	2 x 0.342 =	0.684			R36	(Ref. 92)
0	breaker closing coils (Peak)	0 x 15.000 =	0.000			R36	(Ref. 90)
1	breaker closing coils (Continuous)	1 x 5.000 =	5.000			R36	
0	lights for closing breakers (@ 0.231 each)	0 x 0.231 =	0.000			R36	
1	lights for closing breakers (@ 0.513 each)	1 x 0.513 =	0.513			R36	
4	lights for tripped breakers (@ 0.231 each)	4 x 0.231 =	0.924			R36	
0	lights for tripped breakers (@ 0.513 each)	0 x 0.513 =	0.000			R36	
0	breaker tripping coils	0 x 1.080 =	0.000			R36	(Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0 x 0.231 =	0.000			R36	
	Relays energized:					R36	
2	IAC Relay	2 x 0.200 =	0.400			R36	
1	SA-1 Relay	1 x 0.055 =	0.055			R36	
5	Agastat Relay	5 x 0.064 =	0.320			R36	
5	HFA	5 x 0.062 =	0.310			R36	
1	HGA	1 x 0.038 =	0.038			R36	
4	UV Relay	4 x 0.070 =	0.280			R36	
		TOTAL =	8.832	Amps		R36	

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LOOP & LOCA Condition R36

					Time	R36	
2	lights for closed breakers (@ 0.154 each)	2 x 0.154 =	0.308		38s-10m	R36	(Ref. 92)
3	lights for closed breakers (@ 0.342 each)	3 x 0.342 =	1.026			R36	(Ref. 92)
0	breaker closing coils (Peak)	0 x 15.000 =	0.000			R36	(Ref. 90)
0	breaker closing coils (Continuous)	0 x 5.000 =	0.000			R36	
0	lights for closing breakers (@ 0.231 each)	0 x 0.231 =	0.000			R36	
0	lights for closing breakers (@ 0.513 each)	0 x 0.513 =	0.000			R36	
4	lights for tripped breakers (@ 0.231 each)	4 x 0.231 =	0.924			R36	
0	lights for tripped breakers (@ 0.513 each)	0 x 0.513 =	0.000			R36	
0	breaker tripping coils	0 x 1.080 =	0.000			R36	(Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0 x 0.231 =	0.000			R36	
	Relays energized:					R36	
2	IAC Relay	2 x 0.200 =	0.400			R36	
1	SA-1 Relay	1 x 0.055 =	0.055			R36	
5	Agastat Relay	5 x 0.064 =	0.320			R36	
5	HFA	5 x 0.062 =	0.310			R36	
1	HGA	1 x 0.038 =	0.038			R36	
4	UV Relay	4 x 0.070 =	0.280			R36	
		TOTAL =	3.661	Amps		R36	
					Time	R36	
2	lights for closed breakers (@ 0.154 each)	2 x 0.154 =	0.308		10m-10m1s	R36	(Ref. 92)
2	lights for closed breakers (@ 0.342 each)	2 x 0.342 =	0.684			R36	(Ref. 92)
0	breaker closing coils (Peak)	0 x 15.000 =	0.000			R36	(Ref. 90)
0	breaker closing coils (Continuous)	0 x 5.000 =	0.000			R36	
0	lights for closing breakers (@ 0.231 each)	0 x 0.231 =	0.000			R36	
0	lights for closing breakers (@ 0.513 each)	0 x 0.513 =	0.000			R36	
4	lights for tripped breakers (@ 0.231 each)	4 x 0.231 =	0.924			R36	
0	lights for tripped breakers (@ 0.513 each)	0 x 0.513 =	0.000			R36	
1	breaker tripping coils	1 x 1.080 =	1.080			R36	(Ref. 88 & 93)
1	lights for tripping breakers (@ 0.231 each)	1 x 0.231 =	0.231			R36	
	Relays energized:					R36	
2	IAC Relay	2 x 0.200 =	0.400			R36	
1	SA-1 Relay	1 x 0.055 =	0.055			R36	
5	Agastat Relay	5 x 0.064 =	0.320			R36	
5	HFA	5 x 0.062 =	0.310			R36	
1	HGA	1 x 0.038 =	0.038			R36	
4	UV Relay	4 x 0.070 =	0.280			R36	
		TOTAL =	4.630	Amps		R36	
					Time	R36	
2	lights for closed breakers (@ 0.154 each)	2 x 0.154 =	0.308		10m1s-10m15s	R36	(Ref. 92)
2	lights for closed breakers (@ 0.342 each)	2 x 0.342 =	0.684			R36	(Ref. 92)
0	breaker closing coils (Peak)	0 x 15.000 =	0.000			R36	(Ref. 90)
0	breaker closing coils (Continuous)	0 x 5.000 =	0.000			R36	
0	lights for closing breakers (@ 0.231 each)	0 x 0.231 =	0.000			R36	
0	lights for closing breakers (@ 0.513 each)	0 x 0.513 =	0.000			R36	
4	lights for tripped breakers (@ 0.231 each)	4 x 0.231 =	0.924			R36	
1	lights for tripped breakers (@ 0.513 each)	1 x 0.513 =	0.513			R36	
0	breaker tripping coils	0 x 1.080 =	0.000			R36	(Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0 x 0.231 =	0.000			R36	
	Relays energized:					R36	
2	IAC Relay	2 x 0.200 =	0.400			R36	
1	SA-1 Relay	1 x 0.055 =	0.055			R36	
5	Agastat Relay	5 x 0.064 =	0.320			R36	
5	HFA	5 x 0.062 =	0.310			R36	
1	HGA	1 x 0.038 =	0.038			R36	
4	UV Relay	4 x 0.070 =	0.280			R36	
		TOTAL =	3.832	Amps		R36	

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LOOP & LOCA Condition R36

					Time	R36	
2	lights for closed breakers (@ 0.154 each)	2 x 0.154 =	0.308		10m15s-10m17s	R36	(Ref. 92)
2	lights for closed breakers (@ 0.342 each)	2 x 0.342 =	0.684			R36	(Ref. 92)
1	breaker closing coils (Peak)	1 x 15.000 =	15.000			R36	(Ref. 90)
0	breaker closing coils (Continuous)	0 x 5.000 =	0.000			R36	
1	lights for closing breakers (@ 0.231 each)	1 x 0.231 =	0.231			R36	
0	lights for closing breakers (@ 0.513 each)	0 x 0.513 =	0.000			R36	
3	lights for tripped breakers (@ 0.231 each)	3 x 0.231 =	0.693			R36	
1	lights for tripped breakers (@ 0.513 each)	1 x 0.513 =	0.513			R36	
0	breaker tripping coils	0 x 1.080 =	0.000			R36	(Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0 x 0.231 =	0.000			R36	
	Relays energized:					R36	
2	IAC Relay	2 x 0.200 =	0.400			R36	
1	SA-1 Relay	1 x 0.055 =	0.055			R36	
5	Agastat Relay	5 x 0.064 =	0.320			R36	
5	HFA	5 x 0.062 =	0.310			R36	
1	HGA	1 x 0.038 =	0.038			R36	
4	UV Relay	4 x 0.070 =	0.280			R36	
		TOTAL =	18.832 Amps			R36	
					Time	R36	
2	lights for closed breakers (@ 0.154 each)	2 x 0.154 =	0.308		10m17s-10m30s	R36	(Ref. 92)
2	lights for closed breakers (@ 0.342 each)	2 x 0.342 =	0.684			R36	(Ref. 92)
0	breaker closing coils (Peak)	0 x 15.000 =	0.000			R36	(Ref. 90)
1	breaker closing coils (Continuous)	1 x 5.000 =	5.000			R36	
1	lights for closing breakers (@ 0.231 each)	1 x 0.231 =	0.231			R36	
0	lights for closing breakers (@ 0.513 each)	0 x 0.513 =	0.000			R36	
3	lights for tripped breakers (@ 0.231 each)	3 x 0.231 =	0.693			R36	
1	lights for tripped breakers (@ 0.513 each)	1 x 0.513 =	0.513			R36	
0	breaker tripping coils	0 x 1.080 =	0.000			R36	(Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0 x 0.231 =	0.000			R36	
	Relays energized:					R36	
2	IAC Relay	2 x 0.200 =	0.400			R36	
1	SA-1 Relay	1 x 0.055 =	0.055			R36	
5	Agastat Relay	5 x 0.064 =	0.320			R36	
5	HFA	5 x 0.062 =	0.310			R36	
1	HGA	1 x 0.038 =	0.038			R36	
4	UV Relay	4 x 0.070 =	0.280			R36	
		TOTAL =	8.832 Amps			R36	
					Time	R36	
3	lights for closed breakers (@ 0.154 each)	3 x 0.154 =	0.462		10m30s-end	R36	(Ref. 92)
2	lights for closed breakers (@ 0.342 each)	2 x 0.342 =	0.684			R36	(Ref. 92)
0	breaker closing coils (Peak)	0 x 15.000 =	0.000			R36	(Ref. 90)
0	breaker closing coils (Continuous)	0 x 5.000 =	0.000			R36	
0	lights for closing breakers (@ 0.231 each)	0 x 0.231 =	0.000			R36	
0	lights for closing breakers (@ 0.513 each)	0 x 0.513 =	0.000			R36	
3	lights for tripped breakers (@ 0.231 each)	3 x 0.231 =	0.693			R36	
1	lights for tripped breakers (@ 0.513 each)	1 x 0.513 =	0.513			R36	
0	breaker tripping coils	0 x 1.080 =	0.000			R36	(Ref. 88 & 93)
0	lights for tripping breakers (@ 0.231 each)	0 x 0.231 =	0.000			R36	
	Relays energized:					R36	
2	IAC Relay	2 x 0.200 =	0.400			R36	
1	SA-1 Relay	1 x 0.055 =	0.055			R36	
5	Agastat Relay	5 x 0.064 =	0.320			R36	
5	HFA	5 x 0.062 =	0.310			R36	
1	HGA	1 x 0.038 =	0.038			R36	
4	UV Relay	4 x 0.070 =	0.280			R36	
		TOTAL =	3.755 Amps			R36	

4kV Switchgear 24-1 **Page 14 of 14** R36

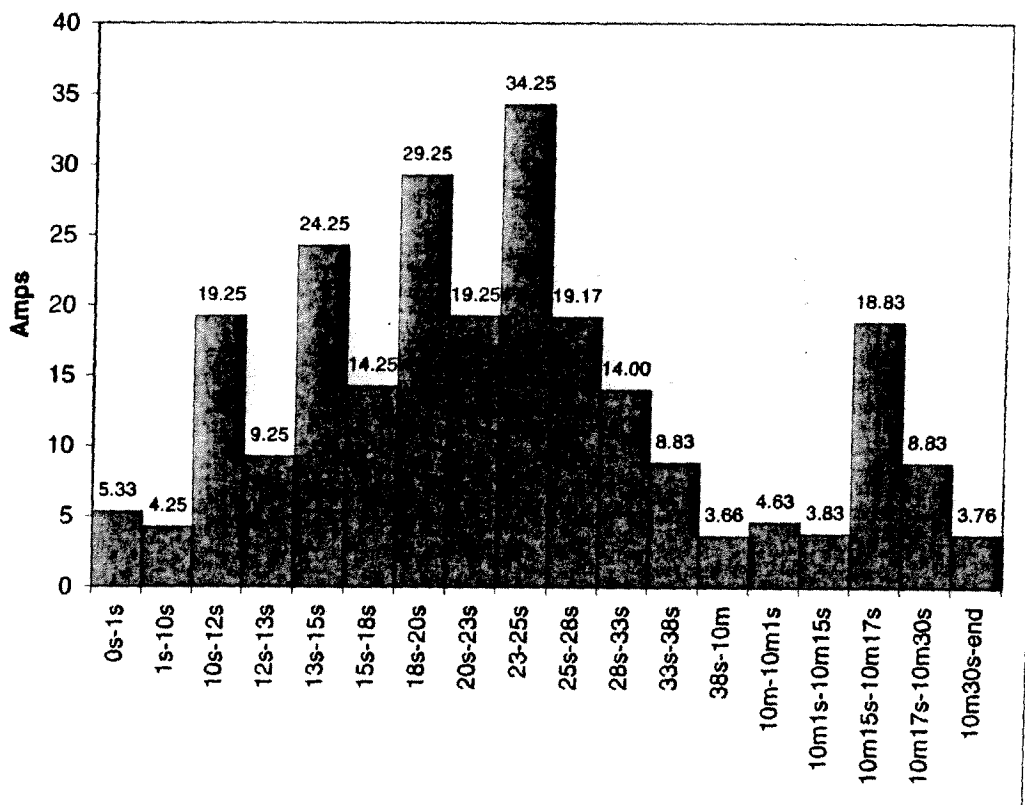
LOOP & LOCA Condition

NOTES

1.) At t=0s all closed breakers trip except for 480V SWGR 29 feed. 4kV SWGR 24-1 sheds load.
2.) At t=1s all 4kV SWGR 24-1 loads have been shed except for 480V SWGR 29 (i.e. all breakers have completed tripping).
3.) At t=10s DG 2 breaker closes. R36
4.) At t=13s close breaker for RHR Pump 2C. R36
5.) At t=18s close breaker for RHR Pump 2D. R36
6.) At t=23s close breaker for Core Spray Pump 2B. R36
7.) At t=10m trip RHR Pump 2C or 2D. R36
8.) At t=10m15s close Main Feed Breaker to 4kV SWGR 24. R36

NOTE:

The SBO breaker remains tripped when there is a LOCA on either unit. Since the scenario modeled is a LOOP on both units 1 & 2 and a LOCA on one unit, the SBO breaker is not modeled as closing. R36



R36

SARGENT & LUNDY ENGINEERS	Calcs. For		Calc. No. 7318-32-1
			Rev. 30 Date
	Safety-Related	Non-Safety-Related	Page 156 of

Client		Prepared by	Date
Project		Reviewed by	Date
Proj. No. 9398-07	Equip. No.	Approved by	Date

Bus Reactor Building Dist. Panel #1
Ckt 12
Source CAM/ACAD Panel 901-55

Ref. Dwg. 4E-1318, SH.1; 4E-6559

Analysis

1 Misc. relay that could energize under LOOP/LOCA condition. Thus .08A will be used as the load on this circuit. This is conservative.

1 Misc. Relay 1 x .08 = .08A

Form GQ-3.08.1 Rev. 2

SARGENT & LUNDY ENGINEERS	Calcs. For		Calc. No. 7318-32-19
			Rev. 30 Date
	Safety-Related	Non-Safety-Related	Page 157 of

Client		Prepared by	Date
Project		Reviewed by	Date
Proj. No. 9398-07	Equip. No.	Approved by	Date

Bus Turbine Building Reserve Bus 2B-1
Ckt 8
Source CAM/ACAD Panel 902-56

Ref. Dwg 4E-2318, SH. 1; 4E - 7560

Analysis

1 Misc. relay that could energize under LOOP/LOCA condition. Thus .08A will be used as the load on this circuit. This is conservative.

1 Misc. Relay 1 x .08 = .08A

Form GQ-3.08.1 Rev. 2

SARGENT & LUNDY ENGINEERS	Calcs. For		Calc. No. 7318-32-
			Rev. 30 Date
	Safety-Related	Non-Safety-Related	Page 158 of

Client		Prepared by	Date
Project		Reviewed by	Date
Proj. No. 9398-07	Equip. No.	Approved by	Date

Bus Reactor Building Dist. Panel #2
Ckt 15
Source CAM/ACAD Panel 902-55

Ref. Dwg 4E-2318, SH.1;

Analysis

1 Misc. relay that could energize under LOOP/LOCA condition. Thus .08A will be used as the load on this circuit. This is conservative.

1 Misc. Relay 1 x .08 = .08A

Form GQ-3.08.1 Rev. 2

SARGENT & LUNDY ENGINEERS	Calcs. For		Calc. No. 7318-32-19
			Rev. 30 Date
	Safety-Related	Non-Safety-Related	Page 159 of

Client		Prepared by	Date
Project		Reviewed by	Date
Proj. No. 9398-07	Equip. No.	Approved by	Date

Bus Turbine Building Reserve Bus 1B-1
Ckt 8
Source CAM/CAD Panel 901-56

Ref. Dwg. 4E-1318, SH. 1; 4E-6560

Analysis:

1 misc relay that could energize under LOOP/LOCA condition. Thus .08A will be used as the load on this circuit. This is conservative.

1 Misc. Relay 1 x .08 = .08A

Form GO-3.08.1 Rev. 2

R33

SARGENT & LUNDY ENGINEERS

Calcs. For			Calc. No. 7318-32-19
			Rev. 33 Date
Safety-Related		Non-Safety-Related	Page 160 of

Client		Prepared by	Date
Project		Reviewed by	Date
Proj. No. 9398-07	Equip. No.	Approved by	Date

Bus Turbine Building Reserve Bus 1B-1
Ckt 38
Source Supervisory Matter Station Panel 912-8

Ref. Dwg. 4E-1318, SH. 2; 4E-465B

Analysis

The loading of .400A will be used for the loading on this circuit. This value was the value used before Modification M04-1-87-051C was installed. Modification M04-1-87-051C removed some load from this circuit, and the remaining load is not trackable on the drawings. Thus, .400A will be used. This is conservative.

Form GQ-3.08.1 Rev. 2

Unit 1 Modified File

Q1D5YLS.M67

INPUT DATA REPORT - LOAD DATA

Load record number.....	1 Load is ON	2 Load is ON	3 Load is ON	4 Load is ON
Load name.....	4KV BUS 13 MN 1OF4	4KV BUS 13 MN 2OF4	4KV BUS 13 MN 3OF4	4KV BUS 13 MN 4OF4
Status.....(E, N, or M)	E	E	E	E
Transient current...(Amps)	14.167	18.367	18.290	.000
Transient duration...(Sec)	1	2	2	0
Continuous current (Amps)	3.367	8.367	8.290	3.213
Time load Starts.(MIN.SEC)	.00	10.15	10.30	10.45
Load duration....(MIN.SEC)	10.15	.15	.15	229.15
Source bus or panel.....	1A-1 CKT 1	1A-1 CKT 1	1A-1 CKT 1	1A-1 CKT 1
System code.....				
Source of equipment data..	7318-32-19-1 REV. 36	7318-32-19-1 REV. 36	7318-32-19-1 REV. 36	7318-32-19-1 REV. 36
Ref. document (dwgs,etc)..				
Document revision.....				
Modification number.....	M04-1-91-033A	M04-1-91-033A	M04-1-91-033A	M04-1-91-033A
Cable number.....				
Load on charger.....(Amps)	.000	.000	.000	.000

Load record number.....	5 Load is ON	6 Load is ON	7 Load is ON	8 Load is ON
Load name.....	4KV BUS 14 RES	AUTO BLO 901-32 1OF2	AUTO BLO 901-32 2OF2	RHR PNL 901-32
Status.....(E, N, or M)	E	E	E	E
Transient current...(Amps)	.000	.000	.000	2.640
Transient duration...(Sec)	0	0	0	10
Continuous current (Amps)	.000	.768	.384	2.640
Time load Starts.(MIN.SEC)	.00	.00	60.00	.00
Load duration....(MIN.SEC)	.00	60.00	180.00	240.00
Source bus or panel.....	1A-1 CKT 2	1A-1 CKT 3	1A-1 CKT 3	1A-1 CKT 5
System code.....				
Source of equipment data..	CALC 705600 19-1	PI 83 S040-QH-0507	PI 83 S040-QH-0507	DCR 990315
Ref. document (dwgs,etc)..	4E-1654F	4E-1461, 4E-1462	4E-1461, 4E-1462	4E-1438G
Document revision.....				
Modification number.....				
Cable number.....				
Load on charger.....(Amps)	.000	.000	.000	.000

Load record number.....	9 Load is ON	10 Load is ON	11 Load is ON	12 Load is ON
Load name.....	HPCI SYS PNL 901-39	HPCI FIC FAILURE RLY	CORE SPRAY VLV 1OF3	CORE SPRAY VLV 2OF3
Status.....(E, N, or M)	E	E	E	E
Transient current...(Amps)	.000	.073	.100	.100
Transient duration...(Sec)	0	1	10	10
Continuous current (Amps)	2.771	.073	.180	.180
Time load Starts.(MIN.SEC)	.00	.00	.00	.50
Load duration....(MIN.SEC)	240.00	240.00	.50	14.10
Source bus or panel.....	1A-1 CKT 6	1A-1 CKT 6	1A-1 CKT 7	1A-1 CKT 7
System code.....				
Source of equipment data..	PI-83 S040-QH-0382	ECN 04-00853E	CALC 705600 19-1	CALC 705600 19-1
Ref. document (dwgs,etc)..	4E-1527	4E-1527A	4E-1428	4E-1428
Document revision.....		E		
Modification number.....	DCP 9900238	P04-1-92-051		
Cable number.....		18434		
Load on charger.....(Amps)	.000	.000	.000	.000

INPUT DATA REPORT - LOAD DATA

Load record number.....	13 Load is ON	14 Load is ON	15 Load is ON	16 Load is ON
Load name.....	CORE SPRAY VLV 3OF3	CHNL A PNL 901-15	PCI SYS 901-40 1OF3	PCI SYS 901-40 2OF3
Status.....(E, N, or M)	E	E	E	E
Transient current...(Amps)	.000	.000	2.960	.000
Transient duration...(Sec)	0	0	10	0
Continuous current (Amps)	.100	.420	2.120	2.960
Time load Starts.(MIN.SEC)	15.00	.00	.00	1.00
Load duration....(MIN.SEC)	225.00	240.00	1.00	14.00
Source bus or panel.....	1A-1 CKT 7	1A-1 CKT 8	1A-1 CKT 11	1A-1 CKT 11
System code.....				
Source of equipment data..	DCR 990315	CALC 705600 19-1	CALC 705600 19-1	CALC 705600 19-1
Ref. document (dwgs,etc)..	4E-1428	4E-1467	4E-1502A	4E-1502A
Document revision.....				
Modification number.....				
Cable number.....				
Load on charger.....(Amps)	.000	.000	.000	.000

Load record number.....	17 Load is ON	18 Load is ON	19 Load is ON	20 Load is ON
Load name.....	PCI SYS 901-40 3OF3	SOL#1,MSIV 203-1ABCD	ATWS PNL 1-2201-70A	ATS PNL 1-2201-73AA
Status.....(E, N, or M)	E	E	M	M
Transient current...(Amps)	.000	.000	.000	.000
Transient duration...(Sec)	0	0	0	0
Continuous current (Amps)	.920	.285	6.032	.725
Time load Starts.(MIN.SEC)	15.00	.00	.00	.00
Load duration....(MIN.SEC)	225.00	240.00	240.00	240.00
Source bus or panel.....	1A-1 CKT 11	1A-1 CKT 11	1A-1 CKT 16	1A-1 CKT 18
System code.....				
Source of equipment data..	CALC 705600 19-1	PI-83 S040-QH-0314	7318-32-19-1, Rev.40	7318-32-19-1, Rev.40
Ref. document (dwgs,etc)..	4E-1502A	4E-1505A		
Document revision.....				
Modification number.....			EC 24569	EC 24569
Cable number.....				
Load on charger.....(Amps)	.000	.000	.000	.000

Load record number.....	21 Load is ON	22 Load is ON	23 Load is ON	24 Load is ON
Load name.....	4KV BUS 11 MN	4KV BUS 12 RES	480V BUS 15 MN	480V BUS 16 RES
Status.....(E, N, or M)	E	E	E	E
Transient current...(Amps)	19.240	.000	3.310	.000
Transient duration...(Sec)	1	0	10	0
Continuous current (Amps)	1.240	.000	1.410	.000
Time load Starts.(MIN.SEC)	.00	.00	.00	.00
Load duration....(MIN.SEC)	240.00	.00	240.00	.00
Source bus or panel.....	1A-2 CKT 1	1A-2 CKT 2	1A-2 CKT 3	1A-2 CKT 4
System code.....				
Source of equipment data..	CALC 705600 19-1	CALC 705600 19-1	CALC 705600 19-1	CALC 705600 19-1
Ref. document (dwgs,etc)..	4E-1318A	4E-1318A	4E-1657E	4E-1658E
Document revision.....				
Modification number.....	EC 331380			
Cable number.....				
Load on charger.....(Amps)	.000	.000	.000	.000

INPUT DATA REPORT - LOAD DATA

Load record number.....	25 Load is ON	26 Load is ON	27 Load is ON	28 Load is ON
Load name.....	480V BUS 17 RES	REG CABINET 2251-6	J4K	ANN CAB 901-34 MN FD
Status.....(E, N, or M)	E	E	E	E
Transient current...(Amps)	.000	12.868	.000	.000
Transient duration...(Sec)	0	5	0	0
Continuous current (Amps)	.000	.868	.064	54.000
Time load Starts.(MIN.SEC)	.00	.00	.00	.00
Load duration....(MIN.SEC)	.00	30.00	30.00	240.00
Source bus or panel.....	1A-2 CKT 5	1A-2 CKT 6	1A-2 CKT 6	1A-2 CKT 7
System code.....				
Source of equipment data..	CALC 705600 19-1	CALC 705600 19-1		IMPELL PAR E101-149
Ref. document (dwgs,etc)..	4E-1659E	4E-1353		4E-1579
Document revision.....				
Modification number.....			M04-1-84-031	M04-1-87-051A
Cable number.....			14194	69485
Load on charger.....(Amps)	.000	.000	.000	.000

Load record number.....	29 Load is ON	30 Load is ON	31 Load is ON	32 Load is ON
Load name.....	GEN&XFMR CAB 901-29	GEN BKUP CAB 901-29	ESC LTG ELC 20	RCIC DRN VLV 901-4
Status.....(E, N, or M)	E	E	M	E
Transient current...(Amps)	9.223	8.210	.000	.000
Transient duration...(Sec)	5	5	0	0
Continuous current (Amps)	7.147	6.960	29.600	1.580
Time load Starts.(MIN.SEC)	.00	.00	.00	.00
Load duration....(MIN.SEC)	30.00	30.00	30.00	240.00
Source bus or panel.....	1A-2 CKT 8	1A-2 CKT 10	1A-2 CKT 14	1A-2 CKT 15
System code.....				
Source of equipment data..	7318-32-19-1,Rev 38I		EC 364141	DCR 990315
Ref. document (dwgs,etc)..	4E-1338,4E-1339	4E-1338A	4E-1685E	4E-1484C
Document revision.....				
Modification number.....	EC 351280	EC 361260		
Cable number.....				
Load on charger.....(Amps)	.000	.000	.000	.000

Load record number.....	33 Load is ON	34 Load is ON	35 Load is ON	36 Load is ON
Load name.....	CONT RM LTG CAB 10	RWB ESC LTG PNL 30	902-29 PRIM RES FEED	902-29 BKUP RES FEED
Status.....(E, N, or M)	E	E	E	E
Transient current...(Amps)	.000	.000	.000	.000
Transient duration...(Sec)	0	0	0	0
Continuous current (Amps)	21.600	12.800	.000	.000
Time load Starts.(MIN.SEC)	.00	.00	.00	.00
Load duration....(MIN.SEC)	30.00	30.00	.00	.00
Source bus or panel.....	1A-2 CKT 16	1A-2 CKT 17	1A-2 CKT 18	1A-2 CKT 19
System code.....				
Source of equipment data..	CALC 705600 19-1	CALC 705600 19-1	PI-83 S040-QH-0388	PI-83 S040-QH-0388
Ref. document (dwgs,etc)..	4E-1318A	4E-1318A	4E-2338, 4E-2339	4E-2338A
Document revision.....				
Modification number.....			DCP 9800034	DCP 9800034
Cable number.....				
Load on charger.....(Amps)	.000	.000	.000	.000

INPUT DATA REPORT - LOAD DATA

Load record number.....	37 Load is ON	38 Load is ON	39 Load is ON	40 Load is ON
Load name.....	RCIC PNL 901-48	RCIC FIC FAILURE RLY	ANN & 2212-41A&B	H2 STR CLG 2251-7 MN
Status.....(E, N, or M)	E	E	E	E
Transient current...(Amps)	.000	.073	.000	.000
Transient duration...(Sec)	0	1	0	0
Continuous current (Amps)	.950	.073	.650	.800
Time load Starts.(MIN.SEC)	.00	.00	.00	.00
Load duration....(MIN.SEC)	240.00	240.00	30.00	30.00
Source bus or panel.....	1A-2 CKT 20	1A-2 CKT 20	1A-2 CKT 21	1A-2 CKT 22
System code.....				
Source of equipment data..	DCR 990315	DCR 990315	CALC 705600 19-1	CALC 705600 19-1
Ref. document (dwgs,etc)..	4E-1484C	4E-1484C	4E-1392A	4E-1367
Document revision.....		AJ		
Modification number.....				EC 333261
Cable number.....		10475		
Load on charger.....(Amps)	.000	.000	.000	.000

Load record number.....	41 Load is ON	42 Load is ON	43 Load is ON	44 Load is ON
Load name.....	901-53,54,55,56	4KV BUS 13-1 MN1OF11	4KV BUS 13-1 MN2OF11	4KV BUS 13-1 MN3OF11
Status.....(E, N, or M)	E	E	E	E
Transient current...(Amps)	.000	6.383	18.378	23.143
Transient duration...(Sec)	0	1	2	2
Continuous current (Amps)	5.000	3.143	8.143	13.143
Time load Starts.(MIN.SEC)	.00	.00	.10	.13
Load duration....(MIN.SEC)	30.00	.10	.03	.05
Source bus or panel.....	1A-2 CKT 23	RB PNL 1 CKT 1	RB PNL 1 CKT 1	RB PNL 1 CKT 1
System code.....				
Source of equipment data..	IMPELL PAR E101-155	7318-32-19-1 REV. 36	7318-32-19-1 REV. 36	7318-32-19-1 REV. 36
Ref. document (dwgs,etc)..	4E-1685E	4E-1655A	4E-1655A	4E-1655A
Document revision.....				
Modification number.....	M04-1-87-051C	EC 336499	EC 336499	EC 336499
Cable number.....	69486			
Load on charger.....(Amps)	.000	.000	.000	.000

Load record number.....	45 Load is ON	46 Load is ON	47 Load is ON	48 Load is ON
Load name.....	4KV BUS 13-1 MN4OF11	4KV BUS 13-1 MN5OF11	4KV BUS 13-1 MN6OF11	4KV BUS 13-1 MN7OF11
Status.....(E, N, or M)	E	E	E	E
Transient current...(Amps)	28.143	33.143	.000	.000
Transient duration...(Sec)	2	2	0	0
Continuous current (Amps)	18.143	18.066	12.989	7.912
Time load Starts.(MIN.SEC)	.18	.23	.28	.33
Load duration....(MIN.SEC)	.05	.05	.05	.05
Source bus or panel.....	RB PNL 1 CKT 1	RB PNL 1 CKT 1	RB PNL 1 CKT 1	RB PNL 1 CKT 1
System code.....				
Source of equipment data..	7318-32-19-1 REV. 36	7318-32-19-1 REV. 36	7318-32-19-1 REV. 36	7318-32-19-1 REV. 36
Ref. document (dwgs,etc)..	4E-1655A	4E-1655A	4E-1655A	4E-1655A
Document revision.....				
Modification number.....	EC 336499	EC 336499	EC 336499	EC 336499
Cable number.....				
Load on charger.....(Amps)	.000	.000	.000	.000

INPUT DATA REPORT - LOAD DATA

Load record number.....	49 Load is ON	50 Load is ON	51 Load is ON	52 Load is ON
Load name.....	4KV BUS 13-1 MN8OF11	4KV BUS 13-1 MN9OF11	4KVBUS 13-1 MN10OF11	4KVBUS 13-1 MN11OF11
Status.....(E, N, or M)	E	E	E	E
Transient current...(Amps)	.000	3.992	17.912	.000
Transient duration...(Sec)	0	1	2	0
Continuous current (Amps)	2.835	2.912	7.912	2.835
Time load Starts.(MIN.SEC)	.38	10.00	10.15	10.30
Load duration....(MIN.SEC)	9.22	.15	.15	229.30
Source bus or panel.....	RB PNL 1 CKT 1	RB PNL 1 CKT 1	RB PNL 1 CKT 1	RB PNL 1 CKT 1
System code.....				
Source of equipment data..	7318-32-19-1 REV. 36	7318-32-19-1 REV. 36	7318-32-19-1 REV. 36	7318-32-19-1 REV. 36
Ref. document (dwgs,etc)..	4E-1655A	4E-1655A	4E-1655A	4E-1655A
Document revision.....				
Modification number.....	EC 336499	EC 336499	EC 336499	EC 336499
Cable number.....				
Load on charger.....(Amps)	.000	.000	.000	.000

Load record number.....	53 Load is ON	54 Load is ON	55 Load is ON	56 Load is ON
Load name.....	4KV BUS 14-1 RES	480V BUS 18 MN 1OF4	480V BUS 18 MN 2OF4	480V BUS 18 MN 3OF4
Status.....(E, N, or M)	E	E	E	E
Transient current...(Amps)	.000	57.140	5.240	.000
Transient duration...(Sec)	0	5	40	0
Continuous current (Amps)	.000	3.260	3.340	5.260
Time load Starts.(MIN.SEC)	.00	.00	.10	1.00
Load duration....(MIN.SEC)	.00	.10	.50	14.00
Source bus or panel.....	RB PNL 1 CKT 2	RB PNL 1 CKT 3	RB PNL 1 CKT 3	RB PNL 1 CKT 3
System code.....				
Source of equipment data..	CALC 705600 19-1	PI 83 S040-QH-0507	CALC 705600 19-1	CALC 705600 19-1
Ref. document (dwgs,etc)..	4E-1656G	4E-1660E	4E-1660E	4E-1660E
Document revision.....				
Modification number.....				
Cable number.....				
Load on charger.....(Amps)	.000	.000	.000	.000

Load record number.....	57 Load is ON	58 Load is ON	59 Load is ON	60 Load is ON
Load name.....	480V BUS 18 MN 4OF4	480V BUS 19 RES	ESC LTG ELC 29	FR PROT HPCI
Status.....(E, N, or M)	E	E	M	E
Transient current...(Amps)	.000	.000	.000	.000
Transient duration...(Sec)	0	0	0	0
Continuous current (Amps)	3.340	.000	36.800	.120
Time load Starts.(MIN.SEC)	15.00	.00	.00	.00
Load duration....(MIN.SEC)	225.00	.00	240.00	30.00
Source bus or panel.....	RB PNL 1 CKT 3	RB PNL 1 CKT 4	RB PNL 1 CKT 5	RB PNL 1 CKT 6
System code.....				
Source of equipment data..	CALC 705600 19-1	CALC 705600 19-1	EC 364141	7318-32-19-1
Ref. document (dwgs,etc)..	4E-1660E	4E-1661E	4E-1686	4E-1597
Document revision.....				
Modification number.....				
Cable number.....				
Load on charger.....(Amps)	.000	.000	.000	.000

INPUT DATA REPORT - LOAD DATA

Load record number.....	61 Load is ON	62 Load is ON	63 Load is ON	64 Load is ON
Load name.....	DISTR PNL HTR	HPCI PNL 2251-47	AUTO BLO2201-32 1OF4	AUTO BLO2201-32 2OF4
Status.....(E, N, or M)	E	E	E	E
Transient current...(Amps)	.000	.000	.000	.000
Transient duration...(Sec)	0	0	0	0
Continuous current (Amps)	1.600	.640	1.610	96.660
Time load Starts.(MIN.SEC)	.00	.00	.00	2.00
Load duration....(MIN.SEC)	240.00	30.00	2.00	2.30
Source bus or panel.....	RB PNL 1 CKT 7	RB PNL 1 CKT 8	RB PNL 1 CKT 10	RB PNL 1 CKT 10
System code.....				
Source of equipment data..	CALC 705600 19-1	7318-32-19-1	7318-32-19-1 REV 36	7318-32-19-1 REV 36
Ref. document (dwgs,etc)..	4E-1318 SH. 1	4E-1597	4E-1461, 4E-1462	4E-1461, 4E-1462
Document revision.....				
Modification number.....	DCR EC 357099			
Cable number.....				
Load on charger.....(Amps)	.000	.000	.000	.000

Load record number.....	65 Load is ON	66 Load is ON	67 Load is ON	68 Load is ON
Load name.....	AUTO BLO2201-32 3OF4	AUTO BLO2201-32 4OF4	PNL 901-55 ANNUN SYS	DG1/2 2212-46 (P1)
Status.....(E, N, or M)	E	E	E	E
Transient current...(Amps)	.000	.000	.000	65.112
Transient duration...(Sec)	0	0	0	5
Continuous current (Amps)	1.610	.803	.080	29.123
Time load Starts.(MIN.SEC)	4.30	60.00	.00	.00
Load duration....(MIN.SEC)	55.30	180.00	240.00	.10
Source bus or panel.....	RB PNL 1 CKT 10	RB PNL 1 CKT 10	RB PNL 1 CKT 12	RB PNL 1 CKT 13
System code.....				
Source of equipment data..	7318-32-19-1 REV 36	7318-32-19-1 REV 36	IMPELL PAR E101-155	PI 83 S040-QH-0507
Ref. document (dwgs,etc)..	4E-1461, 4E-1462	4E-1461, 4E-1462		4E-1337
Document revision.....				
Modification number.....			M04-1-87-051C	DCR 4-93-319
Cable number.....				
Load on charger.....(Amps)	.000	.000	.000	.000

Load record number.....	69 Load is ON	70 Load is ON	71 Load is ON	72 Load is ON
Load name.....	DG1/2 2212-46 (P2)	DG1/2 2212-46 (P3)	DG1/2 CKT AGAS. RLY	DG 12 AUX XFER INTLK
Status.....(E, N, or M)	E	E	E	E
Transient current...(Amps)	20.517	1.500	.000	.000
Transient duration...(Sec)	40	30	0	0
Continuous current (Amps)	2.517	.240	.064	.160
Time load Starts.(MIN.SEC)	.10	.00	1.00	.00
Load duration....(MIN.SEC)	.50	240.00	239.00	240.00
Source bus or panel.....	RB PNL 1 CKT 13	RB PNL 1 CKT 13	RB PNL 1 CKT 13	RB PNL 1 CKT 13
System code.....				
Source of equipment data..	PI 83 S040-QH-0507	DCP 9900056	PI 83 S040-QH-0507	
Ref. document (dwgs,etc)..	4E-1337		4E-1351A, SH.2	
Document revision.....				
Modification number.....	DCR 4-93-319	M4-1,2,1/2-83-009	DCP # 9600390	M04-2-92-006H
Cable number.....				
Load on charger.....(Amps)	.000	.000	.000	.000

INPUT DATA REPORT - LOAD DATA

Load record number.....	73 Load is ON	74 Load is ON	75 Load is ON	76 Load is ON
Load name.....	DR INT'LK105,147,148	DR INT'LK154,157,239	480V BUS 29 MN 1OF4	480V BUS 29 MN 2OF4
Status.....(E, N, or M)	E	E	E	E
Transient current...(Amps)	.000	.000	64.956	4.600
Transient duration...(Sec)	0	0	5	40
Continuous current (Amps)	.500	.500	2.920	2.980
Time load Starts.(MIN.SEC)	.00	.00	.00	.10
Load duration....(MIN.SEC)	240.00	240.00	.10	.50
Source bus or panel.....	RB PNL 1 CKT 17	RB PNL 1 CKT 18	2B-1 CKT 1	2B-1 CKT 1
System code.....				
Source of equipment data..	CALC 705600 19-1	CALC 705600 19-1	PI 83 S040-QH-0507	CALC 705600 19-1
Ref. document (dwgs,etc)..	4E-1318 SH. 1	4E-1318 SH.1	4E-2661E	4E-2661E
Document revision.....				
Modification number.....	DCR EC 357099	DCR EC 357099		
Cable number.....				
Load on charger.....(Amps)	.000	.000	.000	.000

Load record number.....	77 Load is ON	78 Load is ON	79 Load is ON	80 Load is ON
Load name.....	480V BUS 29 MN 3OF4	480V BUS 29 MN 4OF4	UV RELAY 7824-27NA	OV RELAY 7824-59N
Status.....(E, N, or M)	E	E	E	E
Transient current...(Amps)	.000	.000	.000	.000
Transient duration...(Sec)	0	0	0	0
Continuous current (Amps)	4.820	3.100	.050	.050
Time load Starts.(MIN.SEC)	1.00	15.00	.00	.00
Load duration....(MIN.SEC)	14.00	225.00	240.00	240.00
Source bus or panel.....	2B-1 CKT 1	2B-1 CKT 1	2B-1 CKT 1	2B-1 CKT 1
System code.....				
Source of equipment data..	CALC 705600 19-1	CALC 705600 19-1	ASEA B.B. INSTR BOOK	ASEA B.B. INSTR BOOK
Ref. document (dwgs,etc)..	4E-2661E	4E-2661E		
Document revision.....				
Modification number.....			M4-2-89-165	M4-2-89-165
Cable number.....			78155	78155
Load on charger.....(Amps)	.000	.000	.000	.000

Load record number.....	81 Load is ON	82 Load is ON	83 Load is ON	84 Load is ON
Load name.....	UF/OF RELAY 7824-81	TD RELAY 7824-CR29A	AUX RELAY 7824-CR29B	480V BUS 28 RES
Status.....(E, N, or M)	E	E	E	E
Transient current...(Amps)	.000	.000	.000	.000
Transient duration...(Sec)	0	0	0	0
Continuous current (Amps)	.070	.070	.070	.000
Time load Starts.(MIN.SEC)	.00	.00	.00	.00
Load duration....(MIN.SEC)	240.00	240.00	240.00	.00
Source bus or panel.....	2B-1 CKT 1	2B-1 CKT 1	2B-1 CKT 1	2B-1 CKT 2
System code.....				
Source of equipment data..	ASEA B.B. INSTR BOOK	7000 SERIES AGASTAT	GE CAT # GEH-2024A	CALC 705600 19-1
Ref. document (dwgs,etc)..				4E-2660E
Document revision.....				
Modification number.....	M4-2-89-165	M4-2-89-165	M4-2-89-165	
Cable number.....	78155	78155	78155	
Load on charger.....(Amps)	.000	.000	.000	.000

INPUT DATA REPORT - LOAD DATA

Load record number.....	85 Load is ON	86 Load is ON	87 Load is ON	88 Load is ON
Load name.....	4KV BUS 23-1 RES	4KV BUS 24-1 MN 1OF7	4KV BUS 24-1 MN 2OF7	4KV BUS 24-1 MN 3OF7
Status.....(E, N, or M)	E	E	E	E
Transient current...(Amps)	.000	5.331	19.251	.000
Transient duration...(Sec)	0	1	2	0
Continuous current (Amps)	.000	4.251	9.251	4.174
Time load Starts.(MIN.SEC)	.00	.00	.10	.25
Load duration....(MIN.SEC)	.00	.10	.15	9.35
Source bus or panel.....	2B-1 CKT 3	2B-1 CKT 4	2B-1 CKT 4	2B-1 CKT 4
System code.....				
Source of equipment data..	CALC 705600 19-1	7318-32-19-1 REV. 36	7318-32-19-1 REV. 36	7318-32-19-1 REV. 36
Ref. document (dwgs,etc)..	4E-2655K			
Document revision.....				
Modification number.....		DCP 9600335	DCP 9600335	DCP 9600335
Cable number.....				
Load on charger.....(Amps)	.000	.000	.000	.000

Load record number.....	89 Load is ON	90 Load is ON	91 Load is ON	92 Load is ON
Load name.....	4KV BUS 24-1 MN 4OF7	4KV BUS 24-1 MN 5OF7	4KV BUS 24-1 MN 6OF7	4KV BUS 24-1 MN 7OF7
Status.....(E, N, or M)	E	E	E	E
Transient current...(Amps)	19.174	.000	19.097	.000
Transient duration...(Sec)	2	0	2	0
Continuous current (Amps)	9.174	4.097	9.097	4.020
Time load Starts.(MIN.SEC)	10.00	10.15	11.30	11.45
Load duration....(MIN.SEC)	.15	1.15	.15	228.15
Source bus or panel.....	2B-1 CKT 4	2B-1 CKT 4	2B-1 CKT 4	2B-1 CKT 4
System code.....				
Source of equipment data..	7318-32-19-1 REV. 36	7318-32-19-1 REV. 36	7318-32-19-1 REV. 36	7318-32-19-1 REV. 36
Ref. document (dwgs,etc)..				
Document revision.....				
Modification number.....	DCP 9600335	DCP 9600335	DCP 9600335	DCP 9600335
Cable number.....				
Load on charger.....(Amps)	.000	.000	.000	.000

Load record number.....	93 Load is ON	94 Load is ON	95 Load is ON	96 Load is ON
Load name.....	4KV BUS 23 RES	4KV BUS 24 MN 1OF8	4KV BUS 24 MN 2OF8	4KV BUS 24 MN 3OF8
Status.....(E, N, or M)	E	E	E	E
Transient current...(Amps)	.000	16.386	19.506	19.429
Transient duration...(Sec)	0	1	2	2
Continuous current (Amps)	.000	4.506	9.506	9.429
Time load Starts.(MIN.SEC)	.00	.00	10.00	10.15
Load duration....(MIN.SEC)	.00	10.00	.15	.15
Source bus or panel.....	2B-1 CKT 5	2B-1 CKT 6	2B-1 CKT 6	2B-1 CKT 6
System code.....				
Source of equipment data..	CALC 705600 19-1			
Ref. document (dwgs,etc)..	4E-2653G			
Document revision.....				
Modification number.....		EC 358697	EC 358697	EC 358697
Cable number.....				
Load on charger.....(Amps)	.000	.000	.000	.000

INPUT DATA REPORT - LOAD DATA

Load record number.....	97 Load is ON	98 Load is ON	99 Load is ON	100 Load is ON
Load name.....	4KV BUS 24 MN 4OF8	4KV BUS 24 MN 5OF8	4KV BUS 24 MN 6OF8	4KV BUS 24 MN 7OF8
Status.....(E, N, or M)	E	E	E	E
Transient current...(Amps)	.000	19.258	.000	19.181
Transient duration...(Sec)	0	2	0	2
Continuous current (Amps)	4.258	9.258	4.181	9.181
Time load Starts.(MIN.SEC)	10.30	10.45	11.00	11.15
Load duration....(MIN.SEC)	.15	.15	.15	.15
Source bus or panel.....	2B-1 CKT 6	2B-1 CKT 6	2B-1 CKT 6	2B-1 CKT 6
System code.....				
Source of equipment data..				
Ref. document (dwgs,etc)..				
Document revision.....				
Modification number.....	EC 358697	EC 358697	EC 358697	EC 358697
Cable number.....				
Load on charger.....(Amps)	.000	.000	.000	.000

Load record number.....	101 Load is ON	102 Load is ON	103 Load is ON	104 Load is ON
Load name.....	4KV BUS 24 MN 8OF8	4KV BUS 31 RES FD	CAM-ACAD PNL 902-56	CORE SPRAY VLV 1OF3
Status.....(E, N, or M)	E	E	E	E
Transient current...(Amps)	.000	.000	.000	.100
Transient duration...(Sec)	0	0	0	10
Continuous current (Amps)	4.104	.000	.080	.180
Time load Starts.(MIN.SEC)	11.30	.00	.00	.00
Load duration....(MIN.SEC)	228.30	.00	240.00	.50
Source bus or panel.....	2B-1 CKT 6	2B-1 CKT 7	2B-1 CKT 8	2B-1 CKT 9
System code.....				
Source of equipment data..		CALC 705600 19-1	IMPELL PAR E101-156	CALC 705600 19-1
Ref. document (dwgs,etc)..		4E-1346A	4E-7560	4E-2428
Document revision.....				
Modification number.....	EC 358697		M04-2-87-051C	
Cable number.....				
Load on charger.....(Amps)	.000	.000	.000	.000

Load record number.....	105 Load is ON	106 Load is ON	107 Load is ON	108 Load is ON
Load name.....	CORE SPRAY VLV 2OF3	CORE SPRAY VLV 3OF3	PLT SIRENS PNL 1OF2	PLT SIRENS PNL 2OF2
Status.....(E, N, or M)	E	E	E	E
Transient current...(Amps)	.100	.000	.000	.000
Transient duration...(Sec)	10	0	0	0
Continuous current (Amps)	.180	.100	2.160	.100
Time load Starts.(MIN.SEC)	.50	15.00	.00	15.00
Load duration....(MIN.SEC)	14.10	225.00	15.00	15.00
Source bus or panel.....	2B-1 CKT 9	2B-1 CKT 9	2B-1 CKT 10	2B-1 CKT 10
System code.....				
Source of equipment data..	CALC 705600 19-1	DCR 990315	CALC 705600 19-1	CALC 705600 19-1
Ref. document (dwgs,etc)..	4E-2428	4E-2428	4E-1844G	4E-1844G
Document revision.....				
Modification number.....				
Cable number.....				
Load on charger.....(Amps)	.000	.000	.000	.000

INPUT DATA REPORT - LOAD DATA

Load record number.....	109 Load is ON	110 Load is ON	111 Load is ON	112 Load is ON
Load name.....	CHNL B PNL 902-17	DG2 PNL 2252-12 (P1)	DG2 PNL 2252-12 (P2)	DG2 PNL 2252-12 (P3)
Status.....(E, N, or M)	E	E	E	E
Transient current...(Amps)	.000	66.757	21.700	.000
Transient duration...(Sec)	0	5	20	0
Continuous current (Amps)	.380	30.770	20.400	2.464
Time load Starts.(MIN.SEC)	.00	.00	.10	.50
Load duration....(MIN.SEC)	240.00	.10	.40	239.10
Source bus or panel.....	2B-1 CKT 12	2B-1 CKT 13	2B-1 CKT 13	2B-1 CKT 13
System code.....				
Source of equipment data..	CALC 705600 19-1	PI-83 S040-QH-0507	PI-83 S040-QH-0507	PI-83 S040-QH-0507
Ref. document (dwgs,etc)..	4E-2467	4E-2336	4E-2336	4E-2336
Document revision.....				
Modification number.....		EC 24423		
Cable number.....				
Load on charger.....(Amps)	.000	.000	.000	.000

Load record number.....	113 Load is ON	114 Load is ON	115 Load is ON	116 Load is ON
Load name.....	DG2 CKT AGAS. RLY	RFP INT'LK PNL902-6	RB VENT PNL 2252-24	RHR PNL 902-32&902-4
Status.....(E, N, or M)	E	E	E	E
Transient current...(Amps)	.000	.000	.000	1.300
Transient duration...(Sec)	0	0	0	10
Continuous current (Amps)	.064	.900	1.950	2.600
Time load Starts.(MIN.SEC)	.00	.00	.00	.00
Load duration....(MIN.SEC)	240.00	30.00	30.00	240.00
Source bus or panel.....	2B-1 CKT 13	2B-1 CKT 14	2B-1 CKT 16	2B-1 CKT 18
System code.....				
Source of equipment data..	PI-83 S040-QH-0354	CALC 705600 19-1	CALC 705600 19-1	CALC 705600 19-1
Ref. document (dwgs,etc)..	4E-2350, SH.2	4E-2370,2394	4E-2387C	4E-2438G,2430,2462
Document revision.....				
Modification number.....	DCP # 9600392			
Cable number.....				
Load on charger.....(Amps)	.000	.000	.000	.000

Load record number.....	117 Load is ON	118 Load is ON	119 Load is ON	120 Load is ON
Load name.....	AUTO BLO RES	AUTO BLO 902-33 (P1)	AUTO BLO 902-33 (P2)	PCI VLVPNL902-4 1OF2
Status.....(E, N, or M)	E	E	E	E
Transient current...(Amps)	.000	.000	.000	2.960
Transient duration...(Sec)	0	0	0	10
Continuous current (Amps)	.000	.232	.116	2.120
Time load Starts.(MIN.SEC)	.00	.00	60.00	.00
Load duration....(MIN.SEC)	.00	60.00	180.00	15.00
Source bus or panel.....	2B-1 CKT 19	2B-1 CKT 20	2B-1 CKT 20	2B-1 CKT 21
System code.....				
Source of equipment data..	EIC-99-001	PI 83 S040-QH-0507	PI-83 S040-QH-0507	CALC 705600 19-1
Ref. document (dwgs,etc)..	4E-2461, 4E-2462	4E-2462 SH. 2	4E-2462 SH. 2	4E-2510
Document revision.....				
Modification number.....				
Cable number.....				
Load on charger.....(Amps)	.000	.000	.000	.000

INPUT DATA REPORT - LOAD DATA

Load record number.....	121 Load is ON	122 Load is ON	123 Load is ON	124 Load is ON
Load name.....	PCI VLVPNL902-4 2OF2	PCISYSPNL902-41 1OF2	PCISYSPNL902-41 2OF2	HPCI PNL 902-39 1OF2
Status.....(E, N, or M)	E	E	E	E
Transient current...(Amps)	.000	2.960	.000	.000
Transient duration...(Sec)	0	10	0	0
Continuous current (Amps)	1.300	2.120	1.300	2.869
Time load Starts.(MIN.SEC)	15.00	.00	15.00	.00
Load duration....(MIN.SEC)	225.00	15.00	225.00	1.00
Source bus or panel.....	2B-1 CKT 21	2B-1 CKT 22	2B-1 CKT 22	2B-1 CKT 23
System code.....				
Source of equipment data..	CALC 705600 19-1	CALC 705600 19-1	CALC 705600 19-1	PI-83 S040-QH-0448
Ref. document (dwgs,etc)..	4E-2510	4E-2502	4E-2502	4E-2527A
Document revision.....				
Modification number.....				DCP 9900239
Cable number.....				
Load on charger.....(Amps)	.000	.000	.000	.000

Load record number.....	125 Load is ON	126 Load is ON	127 Load is ON	128 Load is ON
Load name.....	HPCI PNL 902-39 2OF2	HPCI MGU ANNUN RELAY	JB2TB53&JB2TB54 1OF2	JB2TB53&JB2TB54 2OF2
Status.....(E, N, or M)	E	E	E	E
Transient current...(Amps)	.000	.000	.000	.000
Transient duration...(Sec)	0	0	0	0
Continuous current (Amps)	2.909	.048	.680	.340
Time load Starts.(MIN.SEC)	1.00	.00	.00	15.00
Load duration....(MIN.SEC)	239.00	240.00	15.00	15.00
Source bus or panel.....	2B-1 CKT 23	2B-1 CKT 23	2B-1 CKT 27	2B-1 CKT 27
System code.....				
Source of equipment data..	PI-83 S040-QH-0448		CALC 705600 19-1	CALC 705600 19-1
Ref. document (dwgs,etc)..	4E-2527A		4E-2597	4E-2597
Document revision.....				
Modification number.....	DCP 9900239	M4-1-85-05		
Cable number.....		16248		
Load on charger.....(Amps)	.000	.000	.000	.000

Load record number.....	129 Load is ON	130 Load is ON	131 Load is ON	132 Load is ON
Load name.....	FR PROT PNL 2212-47	ATS PNL 2-2202-73BB	ATWS 2-2202-70B INV	H2 SEAL OIL 2252-34
Status.....(E, N, or M)	E	M	M	E
Transient current...(Amps)	.000	.000	.000	.000
Transient duration...(Sec)	0	0	0	0
Continuous current (Amps)	4.770	1.456	6.560	2.274
Time load Starts.(MIN.SEC)	.00	.00	.00	.00
Load duration....(MIN.SEC)	30.00	240.00	240.00	30.00
Source bus or panel.....	2B-1 CKT 28	2B-1 CKT 31	2B-1 CKT 32	2B-1 CKT 33
System code.....				
Source of equipment data..	CALC 705600 19-1	7318-32-19-1, Rev.40	7318-32-19-1, Rev.40	7318-32-19-1
Ref. document (dwgs,etc)..	4E-1595	4E-7850G	4E-7573C	4E-2596
Document revision.....				
Modification number.....			EC 24513	
Cable number.....		79592	79594	
Load on charger.....(Amps)	.000	.000	.000	.000

INPUT DATA REPORT - LOAD DATA

Load record number.....	133 Load is ON	134 Load is ON	135 Load is ON	136 Load is ON
Load name.....	4KV BUS 21 RES	4KV BUS 22 MN	480V BUS 26&27 MN	BUS 26&27 SPR CH MOT
Status.....(E, N, or M)	E	E	E	E
Transient current...(Amps)	.000	19.240	12.900	60.000
Transient duration...(Sec)	0	1	10	5
Continuous current (Amps)	.000	1.240	5.670	4.000
Time load Starts.(MIN.SEC)	.00	.00	.00	.00
Load duration....(MIN.SEC)	.00	240.00	30.00	.05
Source bus or panel.....	2B-2 CKT 1	2B-2 CKT 2	2B-2 CKT 5	2B-2 CKT 5
System code.....				
Source of equipment data..	CALC 705600 19-1	CALC 705600 19-1	CALC 705600 19-1	7318-32-91-1 REV 38B
Ref. document (dwgs,etc)..	4E-2318 SH. 2	4E-2318 SH. 2	4E-2658E,2659E	4E-2658E,2659E
Document revision.....				
Modification number.....		EC 331380		
Cable number.....				
Load on charger.....(Amps)	.000	.000	.000	.000

Load record number.....	137 Load is ON	138 Load is ON	139 Load is ON	140 Load is ON
Load name.....	480V BUS 25 RES	ANN RLY CAB902-34RES	VOT REG 2252-6 RES	H2 STR CLG2252-7 RES
Status.....(E, N, or M)	E	E	E	E
Transient current...(Amps)	.000	.000	.000	.000
Transient duration...(Sec)	0	0	0	0
Continuous current (Amps)	.000	.000	.000	.000
Time load Starts.(MIN.SEC)	.00	.00	.00	.00
Load duration....(MIN.SEC)	.00	.00	.00	.00
Source bus or panel.....	2B-2 CKT 6	2B-2 CKT 8	2B-2 CKT 14	2B-2 CKT 16
System code.....				
Source of equipment data..	CALC 705600 19-1	CALC 705600 19-1	CALC 705600 19-1	CALC 705600 19-1
Ref. document (dwgs,etc)..	4E-2657E	4E-2579	4E-2353	4E-2367,2340,7226
Document revision.....				
Modification number.....				
Cable number.....				
Load on charger.....(Amps)	.000	.000	.000	.000

SARGENT & LUNDY, ENGINEERS CHICAGO, ILLINOIS ELMS-DC VERSION 2.00 PROJECT NUMBER: 08646 PAGE:
UTILITY: Commonwealth Edison Company STATION: QUAD CITIES UNIT: 1 USER: DW
DATA FILE: c:\elmsdc\qld5yls.m67 DATE: 6-5-08
7318-32-19-1, Rev. 40 - ATWS Inverter Loading

BATTERY SIZING CALCULATION

Lowest Expected Electrolyte Temp: 65.00 Cell Mfg: GNB (IEEE-450,1987)
Minimum Battery Voltage.....: 105.00 Cell Type: NCX (MODELS NCX-17, NCX-21, AND NCX-27)
Minimum Cell Voltage.....: 1.810 No. Cells: 58 No. Pos. Plates: 10

Section	(1) Period	(2) Load (amperes)	(3) Change in Load (amperes)	(4) Duration of Period (minutes)	(5) Time to End of Section (minutes)	(6) Capacity at T min. rate Amps/Pos (RT)	(7) Req'd Section Size (3) / (6) Positive Plates
1	1	A1 = 662.137	A1 -0 = 662.137	M1 = 1	T = M1 = 1	105.434	6.280
							Total = 6.280
2	1	A1 = 662.137	A1 -0 = 662.137	M1 = 1	T = M1 +..+M2 = 2	104.362	6.345
	2	A2 = 270.039	A2 -A1 = -392.098	M2 = 1	T = M2 = 1	105.434	-3.719
							Total = 2.626
3	1	A1 = 662.137	A1 -0 = 662.137	M1 = 1	T = M1 +..+M3 = 5	101.146	6.546
	2	A2 = 270.039	A2 -A1 = -392.098	M2 = 1	T = M2 +..+M3 = 4	102.218	-3.836
	3	A3 = 365.089	A3 -A2 = 95.050	M3 = 3	T = M3 = 3	103.290	.920
							Total = 3.631
4	1	A1 = 662.137	A1 -0 = 662.137	M1 = 1	T = M1 +..+M4 = 10	95.786	6.913
	2	A2 = 270.039	A2 -A1 = -392.098	M2 = 1	T = M2 +..+M4 = 9	96.858	-4.048
	3	A3 = 365.089	A3 -A2 = 95.050	M3 = 3	T = M3 +..+M4 = 8	97.930	.971
	4	A4 = 270.039	A4 -A3 = -95.050	M4 = 5	T = M4 = 5	101.146	-.940
							Total = 2.895
5	1	A1 = 662.137	A1 -0 = 662.137	M1 = 1	T = M1 +..+M5 = 11	94.713	6.991
	2	A2 = 270.039	A2 -A1 = -392.098	M2 = 1	T = M2 +..+M5 = 10	95.786	-4.094
	3	A3 = 365.089	A3 -A2 = 95.050	M3 = 3	T = M3 +..+M5 = 9	96.858	.981
	4	A4 = 270.039	A4 -A3 = -95.050	M4 = 5	T = M4 +..+M5 = 6	100.074	-.950
	5	A5 = 314.962	A5 -A4 = 44.923	M5 = 1	T = M5 = 1	105.434	.426
							Total = 3.355
6	1	A1 = 662.137	A1 -0 = 662.137	M1 = 1	T = M1 +..+M6 = 12	93.641	7.071
	2	A2 = 270.039	A2 -A1 = -392.098	M2 = 1	T = M2 +..+M6 = 11	94.713	-4.140
	3	A3 = 365.089	A3 -A2 = 95.050	M3 = 3	T = M3 +..+M6 = 10	95.786	.992
	4	A4 = 270.039	A4 -A3 = -95.050	M4 = 5	T = M4 +..+M6 = 7	99.002	-.960
	5	A5 = 314.962	A5 -A4 = 44.923	M5 = 1	T = M5 +..+M6 = 2	104.362	.430
	6	A6 = 284.483	A6 -A5 = -30.479	M6 = 1	T = M6 = 1	105.434	-.289
							Total = 3.105

BATTERY SIZING CALCULATION

Lowest Expected Electrolyte Temp: 65.00 Cell Mfg: GNB (IEEE-450,1987)
Minimum Battery Voltage.....: 105.00 Cell Type: NCX (MODELS NCX-17, NCX-21, AND NCX-27)
Minimum Cell Voltage.....: 1.810 No. Cells: 58 No. Pos. Plates: 10

Section	(1) Period	(2) Load (amperes)	(3) Change in Load (amperes)	(4) Duration of Period (minutes)	(5) Time to End of Section (minutes)	(6) Capacity at T min. rate Amps/Pos (RT)	(7) Req'd Section Size (3) / (6) Positive Plates
7	1	A1 = 662.137	A1 -0 = 662.137	M1 = 1	T = M1 +..+M7 = 15	90.425	7.322
	2	A2 = 270.039	A2 -A1 = -392.098	M2 = 1	T = M2 +..+M7 = 14	91.497	-4.285
	3	A3 = 365.089	A3 -A2 = 95.050	M3 = 3	T = M3 +..+M7 = 13	92.569	1.027
	4	A4 = 270.039	A4 -A3 = -95.050	M4 = 5	T = M4 +..+M7 = 10	95.786	-.992
	5	A5 = 314.962	A5 -A4 = 44.923	M5 = 1	T = M5 +..+M7 = 5	101.146	.444
	6	A6 = 284.483	A6 -A5 = -30.479	M6 = 1	T = M6 +..+M7 = 4	102.218	-.298
	7	A7 = 269.329	A7 -A6 = -15.154	M7 = 3	T = M7 = 3	103.290	-.147
							Total = 3.071
8	1	A1 = 662.137	A1 -0 = 662.137	M1 = 1	T = M1 +..+M8 = 30	80.841	8.191
	2	A2 = 270.039	A2 -A1 = -392.098	M2 = 1	T = M2 +..+M8 = 29	81.480	-4.812
	3	A3 = 365.089	A3 -A2 = 95.050	M3 = 3	T = M3 +..+M8 = 28	82.119	1.157
	4	A4 = 270.039	A4 -A3 = -95.050	M4 = 5	T = M4 +..+M8 = 25	84.036	-1.131
	5	A5 = 314.962	A5 -A4 = 44.923	M5 = 1	T = M5 +..+M8 = 20	87.230	.515
	6	A6 = 284.483	A6 -A5 = -30.479	M6 = 1	T = M6 +..+M8 = 19	87.869	-.347
	7	A7 = 269.329	A7 -A6 = -15.154	M7 = 3	T = M7 +..+M8 = 18	88.508	-.171
	8	A8 = 259.449	A8 -A7 = -9.880	M8 = 15	T = M8 = 15	90.425	-.109
							Total = 3.292
9	1	A1 = 662.137	A1 -0 = 662.137	M1 = 1	T = M1 +..+M9 = 60	63.664	10.401
	2	A2 = 270.039	A2 -A1 = -392.098	M2 = 1	T = M2 +..+M9 = 59	64.236	-6.104
	3	A3 = 365.089	A3 -A2 = 95.050	M3 = 3	T = M3 +..+M9 = 58	64.809	1.467
	4	A4 = 270.039	A4 -A3 = -95.050	M4 = 5	T = M4 +..+M9 = 55	66.527	-1.429
	5	A5 = 314.962	A5 -A4 = 44.923	M5 = 1	T = M5 +..+M9 = 50	69.389	.647
	6	A6 = 284.483	A6 -A5 = -30.479	M6 = 1	T = M6 +..+M9 = 49	69.962	-.436
	7	A7 = 269.329	A7 -A6 = -15.154	M7 = 3	T = M7 +..+M9 = 48	70.535	-.215
	8	A8 = 259.449	A8 -A7 = -9.880	M8 = 15	T = M8 +..+M9 = 45	72.252	-.137
	9	A9 = 157.196	A9 -A8 = -102.253	M9 = 30	T = M9 = 30	80.841	-1.265
							Total = 2.930

SARGENT & LUNDY, ENGINEERS CHICAGO, ILLINOIS ELMS-DC VERSION 2.00 PROJECT NUMBER: 08646 PAGE:
UTILITY: Commonwealth Edison Company STATION: QUAD CITIES UNIT: 1 USER: DW
DATA FILE: c:\elmsdc\q1d5y1s.m67 DATE: 6-5-08
7318-32-19-1, Rev. 40 - ATWS Inverter Loading

BATTERY SIZING CALCULATION

Lowest Expected Electrolyte Temp: 65.00 Cell Mfg: GNB (IEEE-450,1987)
Minimum Battery Voltage.....: 105.00 Cell Type: NCX (MODELS NCX-17, NCX-21, AND NCX-27)
Minimum Cell Voltage.....: 1.810 No. Cells: 58 No. Pos. Plates: 10

Section	(1) Period	(2) Load (amperes)	(3) Change in Load (amperes)	(4) Duration of Period (minutes)	(5) Time to End of Section (minutes)	(6) Capacity at T min. rate Amps/Pos (RT)	(7) Req'd Section Size (3) / (6) Positive Plates
10	1	A1 = 662.137	A1 -0 = 662.137	M1 = 1	T = M1 +..+M10 = 240	29.424	22.503
	2	A2 = 270.039	A2 -A1 = -392.098	M2 = 1	T = M2 +..+M10 = 239	29.526	-13.280
	3	A3 = 365.089	A3 -A2 = 95.050	M3 = 3	T = M3 +..+M10 = 238	29.629	3.208
	4	A4 = 270.039	A4 -A3 = -95.050	M4 = 5	T = M4 +..+M10 = 235	29.936	-3.175
	5	A5 = 314.962	A5 -A4 = 44.923	M5 = 1	T = M5 +..+M10 = 230	30.448	1.475
	6	A6 = 284.483	A6 -A5 = -30.479	M6 = 1	T = M6 +..+M10 = 229	30.551	-.998
	7	A7 = 269.329	A7 -A6 = -15.154	M7 = 3	T = M7 +..+M10 = 228	30.653	-.494
	8	A8 = 259.449	A8 -A7 = -9.880	M8 = 15	T = M8 +..+M10 = 225	30.961	-.319
	9	A9 = 157.196	A9 -A8 = -102.253	M9 = 30	T = M9 +..+M10 = 210	32.498	-3.146
	10	A10= 155.889	A10-A9 = -1.307	M10 = 180	T = M10 = 180	35.571	-.037
							Total = 5.738

Maximum section size = Uncorrected size (US) = 6.280 from period 1

US	X TEMP. CORR.	X DESIGN MARGIN	X AGING FACTOR	= MINIMUM REQUIRED SIZE
6.280	1.08	1.00	1.25	8.478

Selected battery pos plates = 10 | Battery capacity remaining = 15.2%
WARNING: Fewer plates may not be adequate! Confirm by calculation.

BATTERY SIZING CALCULATION

RT curve points used to size battery:

TIME (MIN)	AMPS PER POS PLATE
0	105.91
1	105.43
15	90.43
30	80.84
60	63.66
90	51.84
120	46.31
180	35.57
240	29.42
300	25.36
480	17.57

ATTACHMENT 3
Engineering Change 365045, Revision 002

Engineering Change

Print Date: 11/11/2008

Exelon

EC Number : 0000365045 002
Status/Date : CLOSED 12/27/2007
Facility : QDC
Type/Sub-type: EVAL ELEC

EC Title: EVALUATE THE MAXIMUM ALLOWABLE INTER-CELL RESISTANCE ACCEPTANCE CRITERIA FOR THE SAFETY RELATED 125/250 VDC BATTERIES AT QUAD CITIES

Mod Nbr : KW1: SR KW2: KW3: KW4: KW5:

Master EC :	N	Work Group :		Temporary :	N
Outage :	N	Alert Group:	DEE	Aprd Reqd Date:	12/31/2007
WO Required :		Image Addr :		Exp Insvc Date:	
Adv Wk Appvd:	N	Alt Ref. :		Expires On :	
Auto-Advance:	Y	Priority :		Auto-Asbuild :	N
Caveat Outst:	N	Department :	08452	Discipline :	ED
Resp Engr :	DAVID	W WOLF			
Location :					

Milestone	Date	PassPort	Name		Req By
110-PREPARE EC	12/11/2007	QDCEI	WOLF	DAVID	APPROVED
120-REVIEW EC	12/12/2007	QCTAH	HESSENKEMPER	AARON	APPROVED
240-ITPR-OTHER	12/11/2007	QDCEI	WOLF	DAVID	APPROVED
300-APPROVE EC	12/13/2007	QACJT	TAFT	JOSEPH	APPROVED
800-ATTR CLOSED	12/27/2007	QADD6	BECKETT	VICKI	CLOSED

ATTACHMENT 1
Technical Evaluation

DOCUMENT NUMBER: EC 365045, Revision 002

Title: Evaluate the Maximum Allowable Inter-Cell Resistance Acceptance Criteria for the Safety Related 125/250 VDC Batteries at Quad Cities Station.

Reason For Evaluation / Scope:

Revision 002:

This revision was necessary to re-evaluate the design inputs to this evaluation by 12/14/07 to verify that the 70 micro-ohm value is still valid. A new service test of the Unit 2 125 VDC Battery was conducted on 9/7/07 (ref. 12). The lowest recorded voltage was 108.4 VDC. This is 3.4 VDC above the 105 VDC minimum and is above the 2.2 VDC value used previously in this EC which is conservative and bounding. The maximum loading of the battery of 704 amps has not changed from revision 001 of this EC (ref. 2). Since no large load increases are expected before the end of 2008, this evaluation will remain valid until 12/12/08 at which time the design inputs will be re-evaluated. This will be tracked by AT item 540524-02.

Revision 001:

This revision was necessary to re-evaluate the design inputs to this evaluation by 6/29/07 to verify that the 70 micro-ohm acceptance criteria is still valid. During the interim period, the worst case loading on the Unit 2 125 VDC battery increased from 700 amps to 704 amps. This small increase, however, does not change the 70 micro-ohm acceptance criteria. Since no large load increases are expected before the end of 2007, this evaluation will remain valid until 12/14/07 at which time the design inputs will be re-evaluated. This will be tracked by AT item 540524-02.

Revision 000:

The purpose of this evaluation is to determine the maximum allowable inter-cell connector resistances for the 125 and 250 VDC batteries. The existing Tech Spec section 3.8.4 value of 150 micro-ohms was deemed by the NRC to be non-conservative. This EC-EVAL will supercede EC 362983 in its entirety. EC 362983 used an incorrect assumption regarding the micro-ohm values obtained during the periodic surveillance testing. EC 365045 will utilize the excessive conservatism used in EC 362983 to show that the original 70 micro-ohm acceptance criteria is still valid.

This EC as well as EC 362983 were performed as an interim measure to provide a more conservative value in lieu of the 150 micro-ohm value listed in the Tech Specs. A formal calculation evaluating and documenting the maximum allowable inter-cell connection resistance will be performed per AT item 540524-07. This calculation will be performed under the guidance of corporate EC 363948 which was prepared generically for all the sites in the

DOCUMENT NUMBER: EC 365045, Revision 002

Title: Evaluate the Maximum Allowable Inter-Cell Resistance Acceptance Criteria for the Safety Related 125/250 VDC Batteries at Quad Cities Station.

Exelon fleet as well as the relevant IEEE guidance on inter-cell connections. If Quad Cities Station is unable to maintain the connection resistances within the allowable values as described in EC 363948, then a site specific calculation will be performed to determine the revised values of resistance and its impact on the DC system.

Detailed Evaluation:

125 VDC Batteries

This evaluation is applicable to all safety related batteries installed at Quad Cities Station. To simplify the analysis, the most limiting battery will be evaluated to determine the maximum allowable inter-cell resistance. This maximum value will then be used as the acceptance criteria for all the batteries. A review of the latest service tests, ELMS-DC load profiles, and battery replacement work orders revealed that the Unit 2 125 VDC Battery is the most limiting. The 250 VDC as well as the alternate batteries are newer and will perform better than the older 125 VDC batteries. The Unit 2 125 VDC battery has a higher loading than the Unit 1 125 VDC battery.

Per UFSAR section 8.3.2, the battery terminal voltages are not allowed to drop below 105 VDC. During the latest service test for the Unit 2 125 VDC Battery, the lowest voltage recorded was 107.2 volts (Ref. 7). This leaves a voltage margin of 2.2 VDC.

The inter-cell measurements are taken per procedure QCEPM 0100-01, page 7 (Ref. 9). The inter-cell connectors are shown in figure 1 of this procedure (on page 7) for the 125 VDC safety related battery. From figure 1 of this procedure, it can be seen that each cell has four terminal posts (two positive and two negative). The inter-cell connectors connect posts A and B from one battery to C and D of the next. From the procedure, readings are taken between A and C or B and D. These readings represent the equivalent resistance of a complex resistive network involving the terminal posts, the inter-cell connectors as shown below in figure 2:

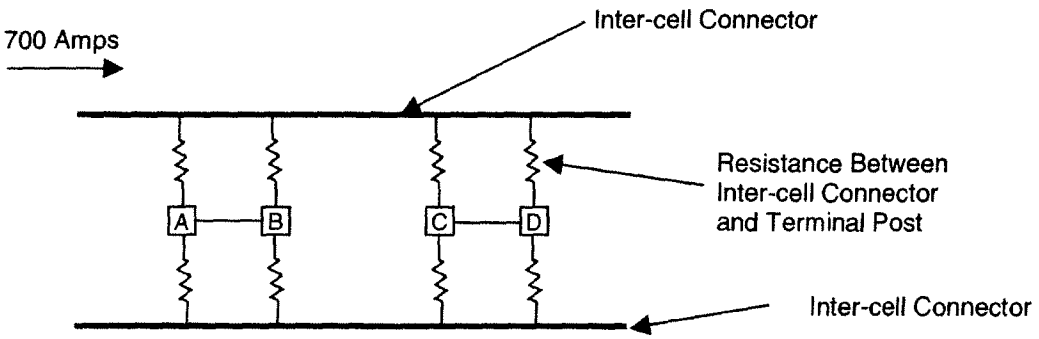


Figure 2

DOCUMENT NUMBER: EC 365045, Revision 002

Title: Evaluate the Maximum Allowable Inter-Cell Resistance Acceptance Criteria for the Safety Related 125/250 VDC Batteries at Quad Cities Station.

Figure 2 is a representation of the inter-cell connection between two cells in the 125 VDC battery. The resistors shown in Figure 2 represent the resistance between the inter-cell connection plate and the battery terminal posts. It should be noted that although there is some resistance between posts A and B and between posts C and D, this resistance is so small that it can be considered to be a short circuit. The resistance measurements taken between posts A and C and between B and D are therefore the same measurement. This measurement is the actual inter-cell resistance for that connection.

The maximum allowable inter-cell connection resistance is the sum of the following two components:

1. The inter-cell resistance that exists when the battery string is at the 105 VDC minimum allowable voltage described in the UFSAR.

2. The extra inter-cell resistance that can be used as margin due to the voltage difference that exists between the minimum voltage measured during the battery service test and the 105 VDC minimum.

These two values are added together to produce the maximum allowable inter-cell connection resistance.

Inter-cell Resistance (Part 1)

The manufacturer's published characteristics for the batteries assume a 20 millivolt drop across each inter-cell connection based on the 1-hour discharge rate to 1.75 volts/cell (Ref. 10). The NCN-21 cells used at Quad Cities have a 1-hour rate of 750 amps (Ref. 6). From Ohm's Law:

$$V = I \times R \quad \text{or} \quad R = 0.020 / 750 = 26.67 \text{ micro-ohms}$$

When the battery is at 105 VDC, a minimum of **26.67 micro-ohms** will exist at each inter-cell connection.

Inter-cell Resistance (Part 2)

To account for the battery's interconnecting cables and cable to lug resistances, inter-tier cables, test equipment inaccuracies, as well as other parameters which may affect the inter-

DOCUMENT NUMBER: EC 365045, Revision 002

Title: Evaluate the Maximum Allowable Inter-Cell Resistance Acceptance Criteria for the Safety Related 125/250 VDC Batteries at Quad Cities Station.

cell resistance values, a design margin of 120% will be incorporated into the calculated minimum inter-cell resistance value. The use of this 120% design margin is acceptable based on the conservatism that is built into ELMS-DC. Specifically, the first minute of the duty cycle represents the highest loading on the batteries (approx 704 amps). Even though the in-rush currents for the larger loads may occur at different times during the first minute, for conservatism, they are all combined into one large loading value which is carried out for the entire 60 seconds. In reality, these in-rush current spikes are non-coincident and produce a much smaller first-minute loading value. The 704 amp value that is used for this evaluation is therefore, conservative and justifies the use of the 120% design margin for the inter-cell connector resistance analysis. The 150% design margin that was originally used in EC 362983 was found to be over-conservative due to the conservatism that currently exists in ELMS-DC. AT item 540524-02 has been created to verify that the battery margin has been maintained (12/12/08). This is sufficient since the formal Tech Spec calculation will be completed by that time.

This design margin also will account for future increases in load on the batteries as well as slight degradation of battery connections.

Since the 125 VDC batteries contain 58 cells, there are 57 inter-cell connections involved with 2 cable lug connections. The 2 additional cable lug connections are accounted for by adding 2 more inter-cell connections for a total of 59. Applying the 120% design margin produces, (59)(1.20) = 71 inter-cell connections. Therefore, the 125 VDC battery will be assumed to have 71 inter-cell connectors rather than 59.

From the latest service test (Ref. 7), the battery exhibited 2.2 volts of margin above the UFSAR required 105 VDC. (Although the 2.2 volts of margin may drop over time due to battery aging and load additions, it is not expected to drop significantly over the course of the this year (December 2008) at which time a formal calculation will be performed to support the Tech Spec change (Ref. AT 540524-07). All the 125 VDC batteries have been performing well in regards to capacity tests (Ref. 5) and there is very little capacity left to allow any significant load additions. Per the system engineer, the batteries are nearing the end of their design life. However, they are not expected to drop below 100% before the formal calculation is completed. Furthermore, the 120% design margin added to this evaluation will ensure that the 2.2 volt margin remains valid. When this margin is divided by the number of inter-cell connectors, the total allowable drop across each connector can be calculated as follows:

$$V_{drop} = \frac{\text{Battery Voltage Margin}}{\text{Number of Connectors}} = \frac{2.2}{71} = 0.031 \text{ volts}$$

The maximum allowable inter-cell connector resistance can be determined by Ohm's Law as follows:

ATTACHMENT 1
Technical Evaluation

DOCUMENT NUMBER: EC 365045, Revision 002

Title: Evaluate the Maximum Allowable Inter-Cell Resistance Acceptance Criteria for the Safety Related 125/250 VDC Batteries at Quad Cities Station.

$V_{drop} = IR_{Total}$ where,

V_{drop} = Total voltage drop across the inter-cell connector
I = Maximum load current seen by the connections (704 amps per ref. 2)
R_{Total} = Maximum allowable resistance of the inter-cell connector

Solving for R_{Total},

$$R_{Total} = \frac{V_{drop}}{I} = \frac{0.031}{704} = 0.000044 \text{ ohms} \quad \text{or} \quad \textbf{44 micro-ohms}$$

The total allowable inter-cell resistance is;

$R_{Allowable}$ = 26 micro-ohms + 44 micro-ohm = **<u>70 micro-ohms</u>**

DCR, EC 365104 has been created to ensure that this evaluation will be reviewed prior to performing any load changes. This will ensure that the assumptions associated with the 2.2 volts of margin remains valid (December 2008). The use of the 70 micro-ohm value will not affect battery capacity or the ELMS-DC analysis that supports it.

<u>250 VDC Batteries</u>

A similar evaluation can be performed for the 250 VDC batteries as follows. The 250 VDC batteries consist of 120 cells (NCN-21) with 121 inter-cell connectors. From the latest service test for the Unit 2 batteries on 1/22/06, the minimum voltage recorded was 226.7 volts with a maximum load current of 830 amps (Ref. 5). As stated earlier, the 226.7 volt value is not expected to change in the next year and will remain valid until the formal calculation for the Tech Spec change is approved (Ref. AT 540524-07). Since the minimum design voltage of the 250 VDC battery is 210 VDC (UFSAR 8.3.2 requirement), a total of 226.7 – 210 = 16.7 volts of margin exists. Applying the same methodology as previously described, the maximum inter-cell resistance for each connector on the 250 VDC battery is as follows. Note that 150% design margin will be used for this analysis due to the higher voltage margin that currently exists.

ATTACHMENT 1
Technical Evaluation

DOCUMENT NUMBER: EC 365045, Revision 002

Title: Evaluate the Maximum Allowable Inter-Cell Resistance Acceptance Criteria for the Safety Related 125/250 VDC Batteries at Quad Cities Station.

$$V_{drop} = \frac{\text{Battery Voltage Margin}}{\text{Number of Connectors}} = \frac{16.7}{121(1.5)} = 0.09 \text{ volts}$$

$$R_{Total} = \frac{V_{drop}}{I} = \frac{0.09}{830} = 0.000108 \text{ ohms} \quad \text{or} \quad \textbf{108 micro-ohms}$$

$$R_{Allowable} = 26 \text{ micro-ohms} + 108 \text{ micro-ohm} = \underline{\textbf{134 micro-ohms}}$$

This value is well above the 70 micro-ohm value that was previously determined for the 125 VDC batteries.

Conclusions / Findings:

The maximum allowable inter-cell resistance for the 125 VDC and 250 VDC batteries is 70 micro-ohms and 134 micro-ohms respectively. The 70 micro-ohm value will be used for both the 125 and 250 VDC battery surveillances since it is limiting. The 70 micro-ohm acceptance criteria is based on the conservative assumption that all the inter-cell connectors have reached this value. Should the 70 micro-ohm value be exceeded on any or all of the connections, an IR should be generated so the operations department can make an operability determination and initiate further evaluation activities as required. This evaluation is valid until 12/12/08. This review will be tracked by AT 540524-02. The 70 micro-ohm inter-cell connection resistance value is, therefore, the bounding value because it is the most restrictive and it can be applied to both the 125 VDC and 250 VDC batteries.

This EC as well as EC 362983 were performed as an interim measure to provide a more conservative value in lieu of the 150 micro-ohm value listed in the Tech Specs. A formal calculation documenting the maximum allowable inter-cell connection resistance will be performed per AT item 540524-07. This calculation will be performed under the guidance of corporate EC 363948 which was prepared generically for all the sites in the Exelon fleet as well as the relevant IEEE guidance on inter-cell connections. If Quad Cities Station is unable to maintain the connection resistances within the allowable values as described in EC 363948, then a site specific calculation will be performed to determine the revised values of resistance and its impact on the DC system (December 2008). Document Change Request (DCR) EC 365104 has been created to ensure that this evaluation will be reviewed prior to performing any load changes. This will ensure that the assumptions associated with the 2.2 volts of margin remains valid.

ATTACHMENT 1
Technical Evaluation

DOCUMENT NUMBER: EC 365045, Revision 002

Title: Evaluate the Maximum Allowable Inter-Cell Resistance Acceptance Criteria for the Safety Related 125/250 VDC Batteries at Quad Cities Station.

References:

1. ELMS-DC File Q1D5YLS.M64 (Latest Unit 1 125 VDC Battery File)
2. ELMS-DC File Q2D5YLS.M67 (Latest Unit 2 125 VDC Battery File)
3. ELMS-DC File Q1D6250V.M23 (Latest Unit 1 250 VDC Battery File)
4. ELMS-DC File Q2D6250V.M20 (Latest Unit 2 250 VDC Battery File)
5. Telephone conversation with John Bailey, DC System Engineer, 10/13/06
6. Calculation 7318-32-19-1, Rev. 39
7. WO 572075-02, Unit 2 125 VDC Battery Service Test
8. UFSAR Section 8.3.2, DC Power Systems
9. QCEPM 0100-01, Revision 22
10. C&D Memorandum to Brian Ledger, dated 11/19/96
11. DCR EC 365104, ELMS-DC Battery Sizing
12. WO 847853-01, Unit 2 125 VDC Battery Service Test

Prepare: David Wolf 12/11/07

Review –Independent Aaron Hessenkemper 12/12/07

Approver – Joe Taft 12/12/07

ATTACHMENT 4
Markup of Revised Proposed Technical Specifications Pages

TS 3.8.4-4
TS 3.8.4-5

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.8.4.1	Verify battery terminal voltage on float charge is: a. ≥ 260.4 VDC for each 250 VDC subsystem; and b. ≥ 125.9 VDC for each 125 VDC subsystem.	7 days
SR 3.8.4.2	Verify no visible corrosion at battery terminals and connectors. OR ~~Verify battery connection resistance is ≤ 1.5E-4 ohm for inter-cell connections and ≤ 1.5E-4 ohm for terminal connections.~~ Verify total battery connection resistance is less than limits specified in TS Bases to ensure performance of design function.	92 days
SR 3.8.4.3	Verify battery cells, cell plates, and racks show no visual indication of physical damage or abnormal deterioration that could degrade battery performance.	24 months
SR 3.8.4.4	Remove visible corrosion and verify battery cell to cell and terminal connections are coated with anti-corrosion material.	24 months
SR 3.8.4.5	~~Verify battery connection resistance is ≤ 1.5E-4 ohm for inter-cell connections and ≤ 1.5E-4 ohm for terminal connections.~~ Verify total battery connection resistance is less than limits specified in TS Bases to ensure performance of design function.	24 months

(continued)

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.8.4.6	Verify each required battery charger supplies: a. ≥ 250 amps at ≥ 250 VDC for ≥ 4 hours for the 250 VDC subsystems; and b. ≥ 200 amps at ≥ 125 VDC for ≥ 4 hours for the 125 VDC subsystems.	24 months
SR 3.8.4.7	----------NOTE---------- The modified performance discharge test in SR 3.8.4.8 may be performed in lieu of the service test in SR 3.8.4.7 provided the modified performance discharge test completely envelopes the service test. ---------- Verify battery capacity is adequate to supply, and maintain in OPERABLE status, the required emergency loads for the design duty cycle when subjected to a battery service test.	24 months

(continued)

ATTACHMENT 5
Markup of Revised Proposed Technical Specifications Bases Pages

TS B 3.8.4-10
TS B 3.8.4-11
TS B 3.8.4-12
TS B 3.8.4-15

BASES

ACTIONS (continued)

F.1 and F.2

If the DC electrical power subsystem cannot be restored to OPERABLE status within the required Completion Time, the unit must be brought to a MODE in which the LCO does not apply. To achieve this status, the unit must be brought to at least MODE 3 within 12 hours and to MODE 4 within 36 hours. The allowed Completion Times are reasonable, based on operating experience, to reach the required plant conditions from full power conditions in an orderly manner and without challenging plant systems. The Completion Time to bring the unit to MODE 4 is consistent with the time required in Regulatory Guide 1.93 (Ref. 6).

SURVEILLANCE REQUIREMENTS

SR 3.8.4.1

Verifying battery terminal voltage while on float charge for the batteries helps to ensure the effectiveness of the charging system and the ability of the batteries to perform their intended function. Float charge is the condition in which the charger is supplying the continuous charge required to overcome the internal losses of a battery and maintain the battery in a fully charged state. The voltage requirements are based on the nominal design voltage of the battery and are consistent with the initial voltages assumed in the battery sizing calculations. The 7 day Frequency is conservative when compared with manufacturers recommendations and IEEE-450 (Ref. 7).

SR 3.8.4.2

Visual inspection to detect corrosion of the battery cells and connections, or measurement of the resistance of ~~each intercell and terminal connection~~ the sum of connections, provides an indication of physical damage or abnormal deterioration that could potentially degrade battery performance.

See Bases Insert

~~The connection resistance limits established for this SR are within the values established by industry practice. The connection resistance limits of this SR are related to the resistance of individual bolted connections and do not include the resistance of conductive components (e.g., cables or conductors located between cells, racks, or tiers).~~

(continued)

BASES

SURVEILLANCE REQUIREMENTS

SR 3.8.4.2 (continued)

The Frequency for these inspections, which can detect conditions that can cause power losses due to resistance heating, is 92 days. This Frequency is considered acceptable based on operating experience related to detecting corrosion trends.

SR 3.8.4.3

Visual inspection of the battery cells, cell plates, and battery racks provides an indication of physical damage or abnormal deterioration that could potentially degrade battery performance. The presence of physical damage or deterioration does not necessarily represent a failure of this SR, provided an evaluation determines that the physical damage or deterioration does not affect the OPERABILITY of the battery (its ability to perform its design function).

The 24 month Frequency for the Surveillance is based on engineering judgement. Operating experience has shown that these components usually pass the SR when performed at the 24 month Frequency. Therefore, the Frequency was concluded to be acceptable from a reliability standpoint.

SR 3.8.4.4 and SR 3.8.4.5

the sum of

Visual inspection and resistance measurements of ~~intercell and terminal~~ connections provides an indication of physical damage or abnormal deterioration that could indicate degraded battery condition. The anti-corrosion material is used to help ensure good electrical connections and to reduce terminal deterioration. The visual inspection for corrosion is not intended to require removal of and inspection under each terminal connection.

The removal of visible corrosion is a preventive maintenance SR. The presence of visible corrosion does not necessarily represent a failure of this SR, provided visible corrosion is removed during performance of this Surveillance.

(continued)

BASES

SURVEILLANCE REQUIREMENTS

SR 3.8.4.4 and SR 3.8.4.5 (continued)

See Bases Insert

~~The connection resistance limits established for this SR are within the values established by industry practice. The connection resistance limits of this SR are related to the resistance of individual bolted connections and do not include the resistance of conductive components (e.g., cables or conductors located between cells, racks, or tiers).~~

The 24 month Frequency for the Surveillance is based on engineering judgement. Operating experience has shown that these components usually pass the SR when performed at the 24 month Frequency. Therefore, the Frequency was concluded to be acceptable from a reliability standpoint.

SR 3.8.4.6

Battery charger capability requirements are based on the design capacity of the chargers (Ref. 1). According to Regulatory Guide 1.32 (Ref. 8), the battery charger supply is required to be based on the largest combined demands of the various steady state loads and the charging capacity to restore the battery from the design minimum charge state to the fully charged state, irrespective of the status of the unit during these demand occurrences. The minimum required amperes and duration ensures that these requirements can be satisfied.

The Frequency is acceptable given the administrative controls existing to ensure adequate charger performance during these 24 month intervals. In addition, this Frequency is intended to be consistent with expected fuel cycle lengths.

SR 3.8.4.7

A battery service test is a special test of the battery's capability, as found, to satisfy the design requirements (battery duty cycle) of the DC electrical power system. The test can be performed using simulated or actual loads. The discharge rate and test length corresponds to the design duty cycle requirements as specified in Reference 1.

(continued)

BASES

SURVEILLANCE REQUIREMENTS

SR 3.8.4.8 (continued)

≥ 10% below the manufacturer's rating. The 12 month and 60 month Frequencies are consistent with the recommendations in IEEE-450 (Ref. 7). The 24 month Frequency is derived from the recommendations of IEEE-450 (Ref. 7).

REFERENCES

1. UFSAR, Section 8.3.2.
2. Safety Guide 6, March 10, 1971.
3. IEEE Standard 308, 1978.
4. UFSAR, Chapter 6.
5. UFSAR, Chapter 15.
6. Regulatory Guide 1.93, Revision 0, December 1974.
7. IEEE Standard 450, 1987.
8. Regulatory Guide 1.32, Revision 2, February 1977.
9. IEEE Standard 485, 1978.
10. Calculation QDC-8300-E-1587, Revision 001

ATTACHMENT 5
Markup of Revised Proposed Technical Specifications Bases Pages

Bases Insert

To ensure aggregate inter-cell and terminal connection resistances do not, as a whole, impede the batteries' capability to perform their design function, total battery resistance will be verified. The total battery resistances are based upon calculated total allowable resistances with added conservatism (Reference 10). The table below is a summary of the acceptance criteria associated with this SR for total battery resistance.

Battery	$R_{Accept-Criteria}$
U1 125 VDC (Normal)	2900 μΩ
U1 125 VDC (Alternate)	2900 μΩ
U1 250 VDC	7000 μΩ
U2 125 VDC (Normal)	2800 μΩ
U2 125 VDC (Alternate)	2800 μΩ
U2 250 VDC	7000 μΩ

ATTACHMENT 6
Proposed License Condition

License Condition Insert for DPR-29 and DPR-30

The values that represent limits for total battery connection resistance will be located in the Technical Specifications (TS) Bases and controlled by TS Section 5.5.10, "Technical Specification (TS) Bases Control Program." These values will be included as acceptance criteria in applicable surveillance procedures and will be controlled in accordance with EGC's design control program.

ATTACHMENT 7
Updated No Significant Hazards Consideration Evaluation

No Significant Hazards Consideration

Exelon Generation Company, LLC (EGC) requests an amendment to Facility Operating License Nos. DPR-29 and DPR-30 for Quad Cities Nuclear Power Station (QCNPS), Units 1 and 2. The proposed change revises Technical Specifications (TS) Surveillance Requirement (SR) 3.8.4.2 and SR 3.8.4.5 to add an acceptance criterion to verify that total battery connector resistances for the 125 volts Direct Current (VDC) and 250 VDC batteries are within pre-established limits that ensure the batteries can perform their design function. The proposed incorporation of the acceptance criterion in SR 3.8.4.2 and SR 3.8.4.5 is conservative, as it adds a restriction on total battery connector resistance which will ensure design functions are achievable. SR 3.8.4.2 and SR 3.8.4.5 will continue to be performed as previously completed and will not change in the manner and frequency of execution.

According to 10 CFR 50.92, "Issuance of amendment," paragraph (c), a proposed amendment to an operating license involves no significant hazards consideration if operation of the facility in accordance with the proposed amendment would not:

(1) Involve a significant increase in the probability or consequence of an accident previously evaluated; or

(2) Create the possibility of a new or different kind of accident from any accident previously evaluated; or

(3) Involve a significant reduction in a margin of safety.

EGC has evaluated the proposed change to the TS for QCNPS, Units 1 and 2, using the criteria in 10 CFR 50.92, and has determined that the proposed change does not involve a significant hazards consideration. The following information is provided to support a finding of no significant hazards consideration.

1. Does the proposed change involve a significant increase in the probability or consequences of an accident previously evaluated?

Response: No

The revisions of SR 3.8.4.2 and SR 3.8.4.5 to add a battery connector resistance acceptance criterion will not challenge the ability of the safety-related batteries to perform their safety function. Appropriate monitoring and maintenance will continue to be performed on the safety-related batteries. In addition, the safety-related batteries are within the scope of 10 CFR 50.65, "Requirements for monitoring the effectiveness of maintenance at nuclear power plants," which will ensure the control of maintenance activities associated with this equipment.

Current TS requirements will continue to require that the equipment be regularly monitored and tested. Since the proposed change does not alter the manner in which the batteries are operated, there is no significant impact on reactor operation.

The proposed change does not involve a physical change to the batteries, nor does it change the safety function of the batteries. The proposed TS revision involves no significant changes to the operation of any systems or components in normal or accident operating conditions and no changes to existing structures, systems, or components.

Therefore, these changes will not increase the probability or consequences of an accident previously evaluated.

2. Does the proposed change create the possibility of a new or different kind of accident from any accident previously evaluated?

   Response: No

   The proposed changes revising SR 3.8.4.2 and SR 3.8.4.5 to add an additional acceptance criterion for battery connector resistance is an increase in conservatism, without a change in system testing methods, operation, or control. Safety-related batteries installed in the plant will be required to meet criteria more restrictive and conservative than current acceptance criteria and standards. The proposed change does not affect the manner in which the batteries are tested and maintained; therefore, there are no new failure mechanisms for the system.

   Therefore, the proposed change does not create the possibility of a new or different kind of accident from any previously evaluated.

3. Does the proposed change involve a significant reduction in a margin of safety?

   Response: No

   The margin of safety is established through the design of the plant structures, systems, and components, the parameters within which the plant is operated, and the setpoints for the actuation of equipment relied upon to respond to an event. The proposed change does not modify the safety limits or setpoints at which protective actions are initiated. The change is conservative and further ensures the availability and operability of the safety-related batteries. As such, sufficient DC capacity to support operation of mitigation equipment is enhanced, which results in an increase in the margin of safety.

   Therefore, the proposed change does not involve a significant reduction in the margin of safety.

Based upon the above, EGC concludes that the proposed amendment presents no significant hazards consideration under the standards set forth in 10 CFR 50.92(c), and, accordingly, a finding of no significant hazards consideration is justified.

ATTACHMENT 8
Excerpt from Calculation 9149-20-19-1, Revision 010

ATTACHMENT 1
Design Analysis Major Revision Cover Sheet
Page 1

Design Analysis (Major Revision)		**Last Page No.** [6] R42	
Analysis No.: [1]	9149-20-19-1	**Revision:** [2]	010
Title: [3]	125 Vdc Bus Voltage Calculations for Quad Cities Station		
EC/ECR No.: [4]	371992	**Revision:** [5]	000

Station(s): [7]	Quad Cities	**Component(s):** [14]	
Unit No.: [8]	01, 02	1-8300 (B04)	
Discipline: [9]	E	2-8300 (B04)	
Descrip. Code/Keyword: [10]	E13		
Safety/QA Class: [11]	SR		
System Code: [12]	DC		
Structure: [13]	N/A		

CONTROLLED DOCUMENT REFERENCES [15]

Document No.:	From/To	Document No.:	From/To
7318-32-19-1	From		
QDC-0203-E-0943	To		

Is this Design Analysis Safeguards Information? [16] **Yes** ☐ **No** ☒ If yes, see SY-AA-101-106

Does this Design Analysis contain Unverified Assumptions? [17] **Yes** ☐ **No** ☒ If yes, ATI/AR#:

This Design Analysis SUPERCEDES: [18] **N/A** **in its entirety.**

Description of Revision (list affected pages for partials): [19]

This major revision incorporates minor revision 009A and the changes made to calculation 7318-32-19-1, revision 040.

Preparer: [20] DAVID WOLF (Print Name) [signature] (Sign Name) 9/19/08 (Date)

Method of Review: [21] **Detailed Review** ☒ **Alternate Calculations (attached)** ☐ **Testing** ☐

Reviewer: [22] TODD LELONEK (Print Name) [signature] (Sign Name) 9/19/08 (Date)

Review Notes: [23] Independent review ☒ Peer review ☐

N/A

(For External Analyses Only)

External Approver: [24] N/A (Print Name) N/A (Sign Name) N/A (Date)

Exelon Reviewer: [25] N/A (Print Name) N/A (Sign Name) N/A (Date)

Independent 3rd Party Review Reqd? [26] **Yes** ☐ **No** ☒

Exelon Approver: [27] Randy C. Buttke (Print Name) [signature] (Sign Name) 9/19/08 (Date)

PURPOSE/ OBJECTIVE

The purpose of this voltage drop calculation is to determine the 125 Vdc bus voltages at the 4.16 kV and 480V safety-related switchgear and upstream 125 Vdc buses for Unit 1 and Unit 2 during the Load Shedding Conditions. In addition, this calculation shall determine the adequacy of the available voltage at the terminals of select 4 kV and 480 V switchgear tripping and closing relays. These circuits were selected based on a review that identified them to be bounding of the 4 kV & 480 V breaker circuits. The Load Shedding Condition simulates a dual unit Loss of Offsite Power (LOOP) concurrent with a Loss of Coolant Accident (LOCA) in one unit where predetermined loads are shed at 30 minutes into the scenario based on an approved operating procedure.

For these calculations the normal bus alignment is used, and no credit is taken for non-safety-related battery charger operation.

R6

The purpose of this voltage drop calculation is also to determine the 125 Vdc bus voltages at the 4.16 kV and 480V safety-related switchgear and upstream 125 Vdc buses for Unit 1 during the Station Blackout Condition. In addition, this calculation shall determine if the Load Shed scenario voltages bound the Station Blackout voltages. Circuit paths for tripping or closing relays shall be reviewed independently in order to determine the resistance of the relay circuit paths.

The Unit 1 (Unit 2) equipment included in the scope of this calculation are as follows:

- 125 Vdc Battery #1 (#2)
- 125 Vdc Battery Bus #1 (#2)
- Turbine Building (TB) 125-Vdc Main Bus lA (2A)
- TB 125 Vdc Main Bus lA-1 (2A-l)
- TB 125 Vdc Reserve Bus 2B (lB)
- TB 125 Vdc Reserve Bus 2B-1 (lB-1)
- TB 125 Vdc Reserve Bus 2B-2 (lB-2)
- 4160 V Switchgear (SWGR) 24 (14)
- 4160 V Switchgear 24-1 (14-1)
- TB Main Bus 1A-2 (2A-2)
- Reactor Building 125 Vdc Distribution Panel #1 (#2)
- 4160 V Switchgear 13-1 (23-1)
- 4160 V Switchgear 13 (23)
- 480 V Switchgear 18 and 29 (19 and 28)
- Select 125 Vdc Tripping and Closing Relays

METHODOLOGY AND ACCEPTANCE CRITERIA

METHODOLOGY

General

- All cable and bus resistances are 90° C.
- Normal 125 Vdc Alignment is used.

Calculation Specific

- Load profiles for Load Shed Condition are from Calculation 7318-32-19-1 (Reference 7).
- Load profiles for One-Hour SBO Condition are from calculation 7318-32-19-1, Revision 37 (Reference 7) R

  Note: As indicated in DC-ELMS Calculation 7318-32-19-1, revision 37, the Load Shed scenario envelopes the SBO condition. The conclusion's section of 7318-32-19-1 states that the SBO profile was a one-time analysis and no future revisions to the profile are necessary. Since DC-ELMS provides the load profiles for this calculation, 125 Vdc Bus Voltage, the SBO scenario will not be updated beyond rev. 7 of this calculation.

- This calculation will determine the 125 Vdc bus voltages for the selected buses during both the Load Shed condition and the One-Hour SBO Condition. Revision No. 5 of this calculation only updates the analysis of the Load Shed Condition. Revision No. 6 of this calculation only updated the analysis of the Unit 1 SBO Condition.
- This calculation will determine the available voltage at the terminals of selected switchgear tripping and closing relay coils based on bounding circuit paths.

  Note: Switchgear load profiles in DC-ELMS model all ancillary switchgear relays as energized. These profiles are input into Table A of Attachments A7.1 and C7.1. As defined in DC-ELMS, this adds conservatism without being excessive. Therefore, each switchgear breaker's trip or close coil voltage development provided on pages 22 through 34 incorporate the total relay load into the switchgear's lump load as defined in the "4kV Switchgear analysis" section of reference 7.

ACCEPTANCE CRITIERA

The minimum calculated voltages at the terminals of the various closing and tripping relays equipment shall be sufficient for their operation. The minimum requirement for the switchgear closing relays is 90 Vdc (Ref. 34) and for the switchgear tripping relays is 70 Vdc (Ref. 34). This calculation will also verify that the battery's terminal voltage does not drop below the minimum required voltage of 105 Vdc (Reference 45). R10