ST. LUCIE UNIT 1
LICENSE AMENDMENT REQUEST
EXTENDED POWER UPRATE

ATTACHMENT 8

10 CFR 50.63 STATION BLACKOUT DC COPING

This coversheet plus 79 pages

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1.0 Introduction

LAR Attachment 8 demonstrates St. Lucie Unit 1's ability to cope with the station blackout (SBO) event relying on dc power for up to one hour of the four-hour SBO duration. The impact of the extended power uprate (EPU) on the plant's ability to cope with the SBO event is discussed in LR Section 2.3.5, Station Blackout.

Backround

St. Lucie Unit 1 is licensed as an "alternate ac" (AAC) plant for a station blackout (SBO) event. This means that an AAC power source is credited to power certain plant loads to allow plant response to the SBO event. Per the requirements of 10 CFR 50.63, Loss of all alternating current power, (hereinafter referred to as the SBO rule) no coping analysis is required if the AAC is available "…within 10 minutes of the onset of station blackout." If the 10-minute requirement cannot be met, then a coping analysis is required. For AAC plants, Regulatory Guide 1.155 recommends the AAC source be made available within an hour; thus, the assumed dc coping period is one hour.

UFSAR Section 15.2.13 describes the plant's licensing basis and demonstrates that Unit 1 can successfully withstand a four-hour SBO event. With respect to the dc coping period, which is the period of time from the onset of the event to the time the AAC source is aligned, the UFSAR credits operator action within 25 minutes to align a Unit 2 emergency diesel generator (EDG), the AAC source, to Unit 1. As part of licensed operator continuing training, plant operators are required to demonstrate the ability to align the AAC power source within 25 minutes; this is considered a "critical task" and is a pass/fail criterion for licensed operator qualifications.

The 25-minute criterion is derived taking into account 15 minutes for operators to initially respond to a plant event and to recognize a station blackout has occurred, plus 10 minutes to align the AAC source. The UFSAR reflects the Reference 1 SBO submittal, which states: "The 10 minute criterion shall start after operators perform the immediate steps in the…EOPs, confirm reactor scram, other primary system parameters, attempt to restore offsite power and attempt to start the EDGs from the control room…." This position was reiterated in FPL's Reference 2 letter that provided responses to NRC questions. FPL's interpretation of the 10-minute criterion was consistent with industry guidance endorsed by NRC (Reference 3).

NRC's Reference 3 letter acknowledged industry guidance with respect to the 10-minute requirement, which noted that operators "have numerous required actions before a decision to use AAC is even considered" and that "most, if not all, of the 10 minutes would be used up following EOPs." The guidance states:

> The 10-minute requirement was meant to cover the period between when the operators realized a station blackout had occurred and the AAC source was started from the control room. Therefore, operators would perform the immediate steps in the EOPs to verify scram, primary system parameters, etc., and attempt to restore offsite power

> and start the EDGs from the control room per the EOPs. When actions from the control room are unsuccessful in restoring offsite and onsite emergency AC power, the onset of station blackout has been verified. If you can start and be ready to load the AAC source within the next 10 minutes, taking all action from the control room, the 10-minute criteria is met.

On September 28, 2007, the NRC completed a component design basis inspection of St. Lucie Units 1 and 2. As part of the inspection, NRC reviewed the operator actions and procedures to align the AAC power source and raised questions regarding compliance with SBO rule requirements. Inspectors did not agree with FPL's position that some period of time is allowed, prior to the noted 10-minute interval, for operators to initially respond to plant conditions and subsequently recognize the onset of a station blackout event. The NRC's inspection report (Reference 4) states that FPL needs to demonstrate compliance with 10 CFR 50.63 by either: (1) verifying by test that AAC can be made available within 10 minutes, or (2) submitting the required one hour dc coping analysis to the NRC. The Reference 5 NRC Integrated Inspection Report recognized FPL had documented this issue in its Corrective Action Program and that a one-hour dc coping analysis was to be completed and provided to the NRC for review.

2.0 Evaluation

This evaluation follows the guidance provided in NRC Regulatory Guide 1.155 (Reference 7), and the NRC-endorsed guidance of NUMARC 8700, Rev 0 (Reference 9), and subsequent NRC clarification letters.

SBO involves the loss of offsite power concurrent with a turbine trip and failure of both EDG sets. For Unit 1, this results in the loss of all onsite ac power for up to one hour, except that supplied by inverters from the two safety-related and two non safety-related battery sources. The safety-related batteries provide power to the 120 V ac (safeguards) instrument power and other required loads (e.g., auxiliary feedwater actuation system) and are credited in the SBO analysis. The dc coping period is assumed to end after one hour when the Unit 1 4160 V 1AB bus and Unit 2 4160 V 2AB bus are manually connected and ac power is available to Unit 1. The acceptability of a Unit 2 EDG as an AAC source was previously reviewed and accepted by the NRC (Reference 6).

This evaluation demonstrates that St. Lucie Unit 1 is capable of coping on dc power for up to one hour, at which time the AAC power source is credited for the remaining three hours of the four-hour SBO event.

The change from a 25-minute to a one-hour dc coping period requires re-evaluation of the following SBO coping capability topics:

- Class 1E battery capacity,
- Compressed air capacity,
- Reactor coolant inventory,
- Condensate inventory,
- Effects of loss of ventilation, and

- Containment isolation.

These topics are identified in NRC Regulatory Guide 1.155, and the NRC-endorsed guidance of NUMARC 8700, Rev 0. This evaluation addresses each of these topics, with results demonstrating that Unit 1 is capable of coping on dc power for up to one hour, at which time the AAC source is assumed to be placed in service. Other SBO topics identified in Regulatory Guide 1.155 and NUMARC 8700, Rev 0 (e.g., total SBO event duration, EDG reliability, AAC source criteria, procedures and training, quality assurance program, etc.) are not affected by extending the analyzed dc coping period.

2.1 Class 1E Battery Capacity

The transition from 25-minute to one-hour dc coping does not compromise the Class 1E 125 V dc system function during the SBO event. The station batteries have sufficient capacity to power the necessary loads for one hour under SBO conditions with 100% margin.

The design features of the 125 V dc system are described in UFSAR Section 8.3.2 and include:

a) A Class 1E dc system, which is divided into redundant trains. The system includes one bus for each train and a common swing bus, 1AB, between the two. Each bus is served by one battery bank and two battery chargers, and a swing bus and charger. At each bus, both chargers work continuously, while the swing charger is in standby.

b) Each Class 1E battery is rated at 2400 amp-hours at an eight-hour discharge rate, which is sufficient for four hours of emergency operation without assistance from a battery charger. This design feature is identical to the St. Lucie Unit 2 dc system, which is capable of SBO coping on dc power for four hours.

Appendix A summarizes the calculation demonstrating the 125 V dc system's capability to power the necessary loads during the one-hour coping period.

2.2 Compressed Air Capacity

The transition from 25-minute to one-hour dc coping does not impact required compressed air capacity during the SBO event.

The design features of the compressed air system are described in UFSAR Section 9.3.1 and include:

a) An outside-of-containment instrument air system that provides compressed air for pneumatically-operated valves, instruments and controls located outside of containment;

b) An inside-of-containment instrument air system that provides compressed air for pneumatically-operated valves, instruments and controls located inside of containment; and,

c) A service air system serving normal plant operation and operation of pneumatic tools and equipment used for plant maintenance.

The compressed air system serves no safety function and it is not required or credited to achieve safe shutdown. Although the compressed air system serves no safety function, the system does supply air to some safety-related components during normal operation, e.g., the main steam isolation valves (MSIVs) are provided with check-valve-isolated safety-related air accumulators, charged with compressed air, so that loss of compressed air will not cause the MSIVs to close immediately. Air-operated, safety-related valves and their valve pressure regulators fail safe upon loss of air. The loss of compressed air to the MSIVs, the diesel generator building nonessential instruments, and the component cooling system non-essential header isolation valves will not affect the operation of any safety-related component on those systems. Thus the capacity of the compressed air system is not a factor during the one-hour dc coping period.

In addition, and independent from the compressed air system, the EDG sets are each provided with a seismic Category I air starting system. Upon receiving a start signal, the 125 V dc solenoid valves are energized to open, engaging the air start motor sets. The Unit 1 EDG system is not credited with a safety function during the entire SBO event duration.

2.3 Reactor Coolant Inventory

The transition from 25-minute to one-hour dc coping does not impact the ability to maintain adequate reactor coolant system (RCS) inventory during the SBO event.

RCS coolant inventory is potentially lost through normal RCS leakage, RCP seal leakage, and normal letdown operation. However, the letdown line is automatically isolated upon loss of power and does not contribute to a reduction in reactor coolant inventory.

The results of the analysis described in UFSAR Section 15.2.13 demonstrate that St. Lucie Unit 1 can successfully withstand the SBO event for at least four hours assuming a total leakage of 120 gpm (comprised of 25 gpm leakage per RCP seal plus a RCS leakage of 20 gpm to account for and bound allowed technical specification RCS leakage). This evaluation updates the CLB RCP seal leakage value, making use of test data specific to the St. Lucie RCP seals. The use of test data was endorsed by NRC in its letters responding to supplemental industry SBO guidance (References 3 and 10), specifically stating that “Leakage rates lower than 25 gpm for PWRs … may be used, provided a justification exists …” (page 258 of 308, Section I.6, Question 70; page 273 of 308, Section J.3, Question 2.1). The test results for St. Lucie are provided in Section 7.2.1 (page 7-4) of the NRC-approved WCAP-16175-P-A (Reference 8).

The St. Lucie RCP seal leak test was run for 100 hours without seal cooling, and the maximum seal leakage measured during this period was less than 0.3 gpm per pump. To be conservative with respect to RCS coolant inventory during an SBO event, this evaluation assumes a 60-gpm total leakage rate comprised of RCP seal leakage of

40 gpm (10 gpm per RCP) plus a conservative assumption of 20 gpm to account for and bound allowed technical specification RCS leakage). The evaluation indicates that, at the end of a four-hour SBO event, core cooling is maintained, sufficient liquid inventory remains in the vessel to ensure that the core does not uncover, and no fuel failure is imminent. To achieve this result, an operator action has been credited to ensure the start of a charging pump at one hour upon availability of the AAC power source. This action is included in the existing emergency operating procedure (EOP) for managing a station blackout, but is not credited in existing analyses.

Refer to Appendix B for details regarding the analysis of the SBO event with respect to RCS coolant inventory and core performance at 3020 MWt, which bounds the conditions at 2700 MWt. Appendix B covers the entire four-hour SBO event duration and demonstrates that the core remains covered and there are no fuel failures.

2.4 Condensate Inventory

The transition from 25-minute to one-hour dc coping does not impact the ability to maintain adequate feedwater supply to the steam generators (SGs) during the SBO event.

In accordance with NRC guidance, decay heat is based on the assumption that the reactor has operated for 100 days at 100% power. At inception of the SBO event and after receiving a steam generator (SG) low-level signal, the turbine-driven auxiliary feedwater (TDAFW) pump delivers 600 gpm to two SGs to remove reactor decay heat, taking suction from the condensate storage tank (CST). UFSAR Section 15.2.13 concludes that less than 60,000 gallons of condensate water are needed to cope with the SBO event for the entire four-hour duration based on 2700 MWt core power. The current TS Section 3.7.1.3 states that the CST shall be operable with a minimum useable volume of 116,000 gallons. Thus, the CST capacity is sufficient for the unit to cope for one hour under SBO conditions.

2.5 Loss of Ventilation

NUMARC 8700, Rev 0, states that most equipment is expected to operate in the SBO environments with no loss of function for short, i.e., four-hour durations. The NUMARC conclusion is based upon previous industry studies and plant operating experience.

Applying the requirements of 10 CFR 50.63 and guidance of Regulatory Guide 1.155, the following areas were evaluated for the effects of lost ventilation:

- reactor containment building,
- specific areas in the reactor auxiliary building, and
- auxiliary feedwater pump area.

2.5.1 Loss of Ventilation to the Reactor Containment Building

Extension of the station's dc coping period from 25 minutes to one hour does not impact the conclusions of the UFSAR Section 15.2.13 SBO analysis performed for containment temperature and pressure response.

Section 2.7.1 of NUMARC 8700, Rev 0, states the assumption that “Temperatures resulting from the loss of ventilation are enveloped by the loss of coolant accident (LOCA) and high energy line break environmental profiles.”

The analysis of the SBO event confirmed that the containment conditions due to the SBO event are bounded by LOCA and main steam line break conditions. As such, any equipment inside containment necessary to mitigate the SBO event is qualified per the station’s 10 CFR 50.49 equipment qualification (EQ) program.

The SBO containment analysis was performed with the following key assumptions:

- an initial containment temperature at the technical specification maximum limit of 120°F,
- no heat removal due to containment coolers or sprays, and
- a continuous 120-gpm RCS leak rate.

The analysis was performed using the NRC-approved CONTRANS code. The analysis showed that the peak containment temperature is less than 166°F and the peak containment pressure is less than four psig. These values are bounded by the EQ temperature and pressure profiles, where the temperature profile exceeds 225°F for the first four hours (with a peak temperature in excess of 400°F) and the pressure profile exceeds 25 psig for the first four hours (with a peak pressure of 44 psig).

2.5.2 <u>Loss of Ventilation to the Reactor Auxiliary Building</u>

Loss of ventilation to rooms and areas in the reactor auxiliary building (RAB) have been evaluated for the extension of the station’s dc coping period from 25 minutes to one hour with acceptable results.

Calculations determined the temperature response to the SBO event in the following rooms / areas required to safely shutdown the unit. The numbers in parentheses indicate the peak calculated temperature.

- control room (‹121°F),
- control room HVAC room (‹105°F),
- technical support center (‹107°F),
- charging pump room (‹108°F),
- electrical equipment areas (‹106°F),
- electrical equipment HVAC room (‹105°F),
- battery rooms (‹105°F),
- inverter rooms (‹110°F), and
- 1AB 480V and 4160V switchgear area (‹108°F).

Appendices C and E provide the technical basis for these analytical results.

Calculated temperatures for the control room remain within the station's heat stress procedural guidelines; therefore, the control room remains habitable for continuous occupancy during a blackout event.

The extension of dc coping from 25 minutes to one hour is acceptable with respect to the loss of ventilation to the RAB because a) the peak calculated temperatures are less than or essentially equal to the acceptable steady state values per NUMARC 8700, Rev 0; and b) the control room remains within the habitability guidelines of the station's heat stress procedure.

2.5.3 Loss of Ventilation to the Auxiliary Feedwater Pump Area

Loss of ventilation to the auxiliary feedwater system has been evaluated for the extension of the station's dc coping period from 25 minutes to one hour with acceptable results.

The steam-driven AFW pump and other AFW system components are located in the steam trestle area which provides natural ventilation with ambient conditions due to its location and construction. There is no forced ventilation of this area. The steam trestle area is essentially an open structure relying on natural ventilation, which minimizes temperature buildup around AFW equipment necessary to provide feedwater to the steam generators. The system and components are described in UFSAR Section 10.5.

2.6 Containment Isolation

The transition from 25-minute to one-hour dc coping does not impede the ability to maintain containment integrity during the SBO event.

The purpose of this regulatory requirement is to ensure that containment integrity can be provided during a station blackout event for the required duration. Containment integrity is necessary to preclude release of radioactive material to the environment, and containment isolation valves are designed to either fail in the safe condition or have the ability to be closed manually. The containment isolation valves requiring this capability are valves that may be in the open position or not locked closed when station blackout occurs. Containment isolation would only be necessary if core damage was imminent.

As described in Section 2.3 above, the core remains covered and no fuel failure occurs during the entire four-hour SBO event.

Containment isolation valves were analyzed using the criteria provided in NUMARC 8700, Rev 0, Section 7.2.5. Based on that evaluation, it is concluded that appropriate containment integrity is assured during the one-hour dc coping period of the SBO event. The valves identified as "valves of concern" using the NUMARC process are normally-closed motor-operated valves MV-07-2A and -2B, which are located outside containment in the common emergency core cooling system (ECCS) suction lines from the containment sump. These valves have indication in the control room, and the control room switch for each of these valves is verified weekly to be in the "closed" position. The piping system upstream of the valves is open to the containment sump, but the piping downstream of the valves is a closed, seismic Class I system. In addition, there is a solid water seal downstream between MV-07-2A and check valve V07174, and between MV-07-2B and check valve V07172. There are also solid water seals downstream of the check valves pressurized by the water column of the refueling water tank.

Further, both valves can be manually operated using a handwheel on the motor operator and have local mechanical indication that is independent from the preferred and Class 1E power supplies.

The normal plant processes followed to verify the closed-valve position, the closed seismic Class I piping system design, and the water seals provide assurance of containment integrity during the SBO event. Refer to Appendix D for additional details.

3.0 Conclusions

St. Lucie Unit 1 is an AAC plant due to its ability to receive ac power from a St. Lucie Unit 2 emergency diesel generator during an SBO event. 10 CFR 50.63 requires AAC plants to cope on dc power under SBO conditions, if the AAC source cannot be made available within 10 minutes of the onset of the SBO event. The one-hour dc coping analysis demonstrates that systems required to achieve safe shutdown and maintain containment integrity remain functional. Specifically, FPL evaluated station battery capacity, compressed air capability, reactor vessel inventory, condensate inventory, effects of loss of ventilation, and containment isolation with acceptable results.

Following the guidance provided by Standard Review Plan 8.4, Regulatory Guide 1.155, and NUMARC 8700, calculations and analyses demonstrate that St. Lucie Unit 1 complies with 10 CFR 50.63 requirements.

4.0 References

1 FPL letter to NRC, L-89-145, St. Lucie Units 1 and 2, Docket Nos. 50-335 and 50-389, Information to Resolve Station Blackout (TAC Nos. 68608 and 68609), dated April 17, 1989

2. FPL letter to NRC, L-90-058, St. Lucie Units 1 and 2, Docket Nos. 50-335 and 50-389, Information to Resolve Station Blackout, dated March 7, 1990

3. NRC letter to NUMARC, supplemental SBO guidance, dated January 3, 1990

4. NRC letter to FPL, St. Lucie Nuclear Plant - Component Design Bases Inspection - NRC Inspection Report 05000335/2007006 AND 05000389/2007006, dated November 5, 2007

5. NRC letter to FPL, St. Lucie Nuclear Plant - NRC Integrated Inspection Report 05000335/2008004, 05000389/2008004, dated October 30, 2008

6. NRC letter to FPL, Safety Evaluation on the Station Blackout (SBO) Rule for St. Lucie Units 1 and 2, dated September 12, 1991

7. NRC Regulatory Guide 1.155, Rev 0, Station Blackout, dated June 21, 1988

8. WCAP-16175-P, Revision 0, “Model for Failure of RCP Seals Given Loss of Seal Cooling in CE NSSS Plants” (Final NRC SE: ML070240429), dated February 2, 2007

9. NUMARC 87-00, Revision 0, “Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors”, dated November 1987

10. NRC letter to NUMARC, providing approval of NUMARC documents on station blackout (Generic Response Formats, Station Blackout Seminar Q&A, Appendix F, Appendix F Topical Report, and Errata), dated October 7,1988

5.0 Appendices

A. Summary of the ETAP Calculation for 125V DC Station Battery Coping Capability Upon Station Blackout

B. Summary of St. Lucie Unit 1 EPU Non-LOCA Safety Analysis Engineering Report for Station Blackout

C. Loss of Ventilation to Control Room and Reactor Auxiliary Building Areas Upon Station Blackout

D. Containment Isolation Upon Station Blackout

E. Loss of Ventilation to the Charging Pump Room Upon Station Blackout

ST. LUCIE UNIT 1
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ATTACHMENT 8
APPENDIX A

SUMMARY OF THE ETAP CACLUATION
FOR 125 VDC STATION BATTERY COPING CAPABILITY
UPON STATION BALCKOUT

Description of Summary Scope:

This summary details the existing Class 1E 125 VDC calculation, which includes an evaluation of the St. Lucie Unit 1 Station Blackout (SBO) scenario, which credits an Alternate AC (AAC) cross-tie mitigation approach to restore AC power within 1-hour. The 1-hour period in which the Class 1E battery provides power without the support of battery chargers, is also referred to as DC-Coping. This calculation addresses several aspects of the nuclear safety-related 125 VDC system including:

- the proper sizing of the battery capacities for the 125 VDC system for the Safety-Injection Actuation Signal (SIAS) scenario (duration of less than 1 minute); for the SBO scenario using the AAC power cross-tie mitigation (duration of less than 1 hour), and for the SBO scenario without AAC mitigation (categorized as 4 hours per the SBO Rule 10CFR50.63);
- the load values (load flow) of the safety-related 125 VDC batteries, panels, and cables;
- the peak magnitudes of potential short-circuit currents versus equipment SC ratings;
- the proper isolation device actuation settings (breakers & fuses) for trip coordination between bus/panel load-isolation devices and bus/panel feeder isolation devices;
- the minimum acceptable operating voltage ratings of various load equipment; and
- the corresponding minimum bus, panel and battery-terminal voltages required to ensure that adequate voltage is provided to the various required load equipment/components for SIAS, SBO 4-hour duration and SBO-AAC 1-hour duration scenarios.

As the subject calculation is approximately 1500 pages in length and covers several other unrelated design requirements of the Class 1E 125 VDC system (See attached calculation Table of Contents – 2 pages), this summary focuses on specific SBO-AAC sections of the calculation and will attach selected excerpts from the calculation. This summary focuses on the battery sizing, load flow, minimum analyzed equipment/component operating voltages, and the corresponding minimum required battery-terminal voltages for the SBO-AAC 1-Hour scenario. In the SBO-AAC scenario, the Unit 1 and Unit 2 Class 1E 4160 VAC busses are cross-tied within approximately 25 minutes, to utilize the opposite Unit's available emergency diesel generator (EDG) AC power, which provides 480 VAC power to the associated battery chargers, which in turn power the operating DC loads concurrent with recharging the battery. The SBO-AAC cross-tie was originally analyzed to be completed within 25 minutes to permit 15 minutes for plant operators to stabilize the affected Unit (subsequent to the Unit's trip) and to attempt to manually start the an EDG; and 10 more minutes to physically implement the AAC cross-tie to restore AC power. Therefore, a SBO DC-coping duration of 1 hour was selected to conservatively bound the actual SBO-AAC DC-coping duration.

Originally, the SBO total event duration of 4 hours was evaluated for a 4-hour DC-Coping period without the AAC crosstie, as the Class 1E 125 VDC calculations were prepared before Florida Power & Light (FPL) received the NRC approval of the SBO-AAC crosstie mitigation approach. The SBO Rule (10CFR50.63) and related guidance documents (i.e., NRC Regulatory Guide (RG) 1.155 & NUMARC 87-00 [Nuclear Management and Resource Council]) required that each nuclear site be categorized into certain risk categories, based on a number of risk factors such as geographic location and electrical system configuration. Once categorized, a specific SBO event duration could be selected from various durations, which were associated with committed reliability percentages of EDG testing/performance. Given this criteria, St. Lucie selected the 4-hour SBO event duration, as a achievable compromise between the SBO event duration and the required EDG reliability values. It should be noted that for battery loading, that the SBO 4-hour and SBO-AAC 1-hour load profiles are identical for the first hour, as the loads are the same. Both the 4-horr and 1-hour SBO calculated DC system load profiles demonstrate available margin. However, the 1-hour SBO-AAC duration provides additional voltage margin and battery capacity reserves. Therefore, the 1-hour DC-Coping duration serves as the actual design basis value, as credit is taken for the use of the AAC cross-tie, which was installed specifically to comply with SBO. It should also be noted that the 4-hour SBO load profile requires sufficient battery capacity and voltage to start its associated EDG, during the last minute of the 4-hour event. In contrast, the SBO-ACC 1-hour DC-Coping load profile is not required to start its associated EDG, as power is restored to the battery and the chargers via the AAC cross-tie to the opposite Unit.

Calculation Tools:

The St. Lucie Unit 1 125 VDC calculation was performed using the Operations Technology (OTI) Electrical Transient Analysis Program (ETAP) PowerStation software (Version 6.0.1N). ETAP PowerStation is a comprehensive electrical analysis software package that can analyze many aspects of DC system operation, including load flow, control circuit voltage drop, and battery sizing used in the SBO-AAC scenario analysis portions of this calculation. PowerStation uses a combination of Analysis Modules, Configurations, Duty Cycle Categories and Study Cases to set up the different scenarios to be analyzed.

The Battery Discharge Sizing module is used to determine the voltages at the DC busses and selected loads during the SBO-AAC loading scenario. This module is used to size the battery and quantify margin. See the attached calculation Attachment A Main One Line Diagram for the configurations of the DC busses (5 pages).

The Control System Diagrams (CSD) module is used to determine the loading for selected safety-related components (i.e., relay coils, breaker trip/close coils, breaker spring charging motors, small solenoid valves, lights), which are not specifically modeled as nodes in the load flow model (i.e., motor operated valves, motors and larger solenoid valves). The CSDs are also used to evaluate voltages for critical components, which are used in various control circuits. The individual devices in the CSDs are evaluated during the SBO-AAC loading scenario against individual pick-up and hold-in voltage criteria. These CSD voltage calculations are used along with load flow results to determine the minimum volt/cell value used to size the battery. See the attached example of a CSD diagram from the calculation Attachment AF (1 page).

Methodology:

ETAP PowerStation configurations determine the open/closed status of devices such as breakers and switches for various plant line ups. Configurations used to control the system alignments and load on/off status for each case were tabulated in the calculation text for clarity.

Duty Cycle Categories are used within PowerStation One-Line Diagrams to set the amp load value and duration for each load during different operational modes (i.e. SBO-ACC). The control device "State" is expressed as "On" or "Off" and the "Time" is expressed as a duration (in milliseconds).

The ETAP model contains the electrically operated plant equipment connected downstream of Batteries 1A and 1B. This includes common busses 1AB and 1AB-1, which can be aligned to either the 1A or 1B primary busses, as a manual swing bus. Battery data was taken from the Total Equipment Database (TEDB), manufacturer's data and drawings. Cable numbers, sizes and lengths are based on the drawings and the Cable and Raceway Schedule (CARS) program. Cable impedances were taken from another ETAP-based calculation which evaluated the Unit 1 AC System. Identification of the various loads was performed via a review of the Control Wiring Diagram (CWD) drawings associated with the DC system. The manufacturer and model number of each device was obtained first from the Bill of Material number identified on the CWD, when available, then from TEDB. The ratings for the various devices were obtained from other calculations and drawings (See the attached example Device Rating table from the calculation Attachment F – 1 page). The on/off status and actuation time for the various devices was obtained from a review of the drawings (See the attached example the device "on/off" tabulation from the calculation Attachment E – 1 page). In cases where the device ratings and operating status could not be determined, assumptions were made in order to generate a realistic, yet conservative, loading model. In these cases, notes describing the operating status were added to the load tabulation.

The calculation of the minimum required battery voltage was determined via identification of the critical loads in the DC system. Specific critical loads include the safety-related breaker close and trip circuits, inverters, motor-operated valves (MOV) and local EDG control circuits. As stated above, the voltage minimum at the EDGs is not applicable to the SBO-AAC 1-hour scenario, as this scenario does not require the start of the EDGs. Some of the critical load terminal voltages are determined directly from the Battery Discharge load flow results (i.e. inverters and MOV bus voltages). The remaining critical loads are modeled using the CSD module in ETAP. The calculated device terminal voltages are identified in the CSD voltage drop and power flow output reports. The voltages calculated during the SBO-ACC loading scenario for each critical load is then compared to the load's specific acceptance criteria. The voltage margin was then subtracted from the calculated battery terminal voltage at the specific time interval when the load is required in order to determine the minimum allowable battery voltage for each load evaluated. The most-limiting minimum required battery terminal voltage was then divided by the number of battery cells and this volt-per-cell (vpc) value was then used to size the battery in each scenario.

The inverter input minimum voltage was taken from vendor data. The required voltage at the busses upstream of the MOVs is calculated in another calculation. The minimum voltage for devices, which support switchgear breaker coil and EDG control circuit operation sequences was determined from vendor data or is documented in the assumption section of the calculation.

The SBO-AAC study case was generated to model the battery load profiles for each train. See the attached SBO-AAC battery load profiles (calculation Attachment AG - 2 pgs). These study cases were used to evaluate the voltages on the DC system and the battery margin. Voltage-drop calculations were performed for switchgear breaker closing and trip coils, the inverters and MOVs. Voltage-drop calculations were performed using the CSD module in ETAP for portions of the circuits, which contained external cables. First, the battery discharge module was run for each study case. The calculated bus voltages and CSD device terminal voltages from these battery discharge calculations were compared to the acceptance criteria of several critical loads and the battery margin was quantified. The margin was subtracted from calculated battery voltage to determine the minimum required battery voltage. The limiting maximum value was converted to a volt/cell value and the battery sizing module was run for each study case. Battery margin was calculated from results. See attached pages from calculation study cases and results for battery and voltage margins (See calculation Pgs 40, 41, 42, 52 & 53 of 54).

Acceptance Criteria:

The battery margin must remain positive. The bus voltages must not drop below the minimum required calculated voltages for the required load equipment. The DC system must be entirely supported by a single battery charger for steady-state conditions after the battery charger has been reenergized.

Detailed Assumptions:

Note that some of the following assumptions pertain to successful EDG start requirements. As the SBO-AAC event assumes that the electrical cross-tie provides power from the opposite Unit's EDG within 1-hour, there is no requirement to start the EDG associated with the discharged battery. However, as the circuits associated with the EDGs remain as a load on the DC system, the assumptions are included below for information.

1. *In general, half of the indicating lights connected on each applicable 125VDC circuit are assumed to be energized. This assumption is based on the fact that most of these status lights are installed in pairs to indicate opposing positions for equipment (e.g., open/closed, On/Off). Other indicating lights that are not used in pairs are modeled separately and their On/Off status is determined based on circuit diagrams.*

2. *The following relays were assumed to have a load rating of 8 Watts at 125VDC (0.064 Amps). This assumption is based on the fact that the specific relay types are known for the majority of relays on the DC system and their loading ranges from 3 to 8 Watts. Therefore, this assumption is considered conservative.*

   Agastat 200P series Relay

   B/M C12-3

   B/M C12-65

   B/M C12-68

   NTS/Action 812-1-6-01-OD series relay

   Relay (Note this Device Type was used generically for relays with no model # identified on CWDs or in TEDB)

3. *The following solenoid valves were assumed to have a load rating of 35.1 Watts at 125VDC (0.281 Amps): This assumption is based on the fact that other known solenoids which perform similar functions have loading ranges from 17 to 35.1 Watts. Therefore, this assumption is considered conservative.*

   Action Valve type C-5439 series SOL

   ASCO 212 series SOL

   I-SE-02-1

   I-SE-02-2

   SE-25-021A

   SE-25-021B

4. *The following Annunciator Panels were assumed to have a load rating of 50 Watts at 125VDC (0.4Amps). This assumption is based on the fact that other known Annunciator Panels which perform similar functions have loading values of 50W Watts. Note: The previous Safety Related Battery Sizing Calculation also modeled all Annunciator Panels as 50 Watts at 125VDC (0.4 Amps). Therefore, this assumption is considered conservative.*

   BETA 10 Annunciator

   BETA 1212-R Annunciator

   Hathaway BETALARM 3 Annunciator

   Annunciator (Note this Device Type was used generically for Annunciators with no model # identified on CWDs or in TEDB)

5. *The resistance of the HGA17 series relay (lowest resistance) was assumed for all HGA relay types since it results in the worst case loading. The coil resistances for the various types of HGA relays are as follows: HGA111 series 3850 ohms, HGA11 series 3650 ohms and HGA17 series 2280 ohms.*

6. *The Unit 1 loading on Turbine Lube Oil and Oil Storage area Fire Protection (FP) Local Panel and Hydrogen Seal Oil FP Local Panel are each assumed to be (0.5 amps). This loading was determined based on no fire being postulated and 8 Watts was assumed for each energized relay in the Unit 2 FP control panel, which is documented on corresponding Unit 2 drawing. The assumption is based on the similarity between the Unit 1 and Unit 2 FP control panels. Since the loading on these FP panels is relatively small, this assumption has a negligible effect of the results of this calculation.*

7. *The following devices were assumed to have a load rating equivalent to the previous sizing calculation since no nameplate or vendor data was available [For EDG starting, not required per SBO-AAC 1-hour scenario]*

   EDG Field (2.5 Amps continuous)

   Rad Monitor Cabinet (50W continuous)

8. *The following device was assumed to have a load rating as follows, since no nameplate or vendor data was available. The device has an input fuse rating of 10A. Digital Fault Recorder (5 Amps continuous)*

9. *Internal switchgear voltage drop to breaker trip coils in circuits is assumed to be 2.5V. A breaker trip circuit internal to the switchgear, consisting of two indicating lamps (0.0625A each), two HFA relays (0.0625A each) and a worst case trip coil (3.0A) through 100' of worst case #16 internal wire (4.9651Ω/1000') results in approximately a 1.6V drop. Thus, the source voltage acceptance criteria for a breaker trip coil with no external cabling is 2.5V above the coil minimum rated pickup voltage.*

10. *The required source voltage for the breaker and diesel control circuits is assumed to be 1 volt higher than calculated. This value accounts for the voltage drop due to internal panel wiring. The portions of the control circuit internal to the switchgear and EDG control panels consist of short cable lengths and the load consists of low current devices. This assumption does not apply to breaker trip coils as they are addressed separately. [For EDG starting, not required per SBO-AAC 1-hour scenario].*

11. *A maximum conductor temperature of 50°C was used for the battery discharge portions of this calculation. The cables are generally oversized and are rated for 90 °C. These cables normally carry low current when compared to their ampacities. This is due to the fact that the cables are generally sized with an ampacity equal to or greater than the maximum expected current plus some margin. Also, many of the cables service intermittent loads. With a design temperature of 40°C, a maximum temperature rise of 10°C is reasonable which results in a 50°C conductor temperature.*

12. *The SBO condition only includes a Loss of Offsite Power (LOOP). The SBO load condition assumes an undervoltage (U/V) signal is present.*

13. *Some relays are in series with a 10KΩ resistor. The current draw due to this combination is negligible and is neglected in the calculation.*

14. *The operate time for the K600 series 480V breaker spring charge motors is assumed to be 6 seconds. This value is consistent with the 6 second spring charge motor operate time for the medium voltage breakers.*

15. *Close and trip coils are assumed to operate for 0.1 seconds. Breaker spring charging motor inrush is assumed to occur for 0.1 seconds. Close and trip coils are de-energized once the breaker changes state. This is typically only a matter of cycles. The spring charge motors typically accelerate rapidly. These times are used to model the sequence of operation as part of the battery duty cycle. The battery voltage is determined in the first minute based on the 0.1 to 0.2 second timeframe as a result of the inrush on the 480V breaker spring charge motors. Increasing these durations will not change the limiting load current on the battery in the first minute.*

16. *The Train A EDG Fuel Prime Pumps are assumed to have the same loading values as the loading values determined by test from Train B. These pumps were modeled identically between trains in the previous sizing calculation.*

17. *The dropout voltage for unknown relay types is assumed to be 90V. Relays typically drop out at 50% or less of rated voltage. However, 90V is adequate for the purposes of this calculation.*

18. *It is assumed that the EDG control relays that are classified as "misc internal devices" can pick-up at 95VDC. These relays are considered internal devices because they have no cables external to the EDG control panel supplying their coils. In addition, PT, RT & K5 relays (Agastat 7000 series) will also be assumed to pick-up at 95VDC. The assumed value of 95VDC is conservative based on station test data for several of the known relay types in the EDG control panels. The station's testing determined that Agastat 7000 series will pick-up at 70VDC (published data is 80% of 125VDC or 100VDC) and GE HGA series will pick-up at 50VDC (published data is 80% of 125VDC or 100VDC). The Potter & Brumfield KRP series published data is 75% of 110VDC or 82.5VDC. The Square D X8501 series published data is 80% of 115VDC or 92VDC. Based on this information the assumed value of 95VDC is considered conservative. Note: The EDG panel voltages are above 100VDC during the entire load profile. [Not required per SBO-AAC 1-hour scenario].*

19. *The manufacturer cables feeding the EDG Turbocharger Lube Oil Pumps and the starting air solenoid pressure switches were assumed to be #12 cables. The other known cables in these circuits are #12 cables and the lengths of these manufacturer cables are very short less than 50ft.*

20. *The DC Contactors in the DG Fuel Prime Pump and Turbocharger Emergency Lube Oil Pump circuits are assumed to operate at 80% of 125VDC or 100VDC. The relays, timers, breaker close and trip coil and other devices identified in this calculation are rated to operate at 100V or less. This value for DC contactors bounds all of the other electro-mechanical switching devices within this calculation. [Not required per SBO-AAC 1-hour scenario].*

21. *The starting air solenoids are assumed to be able to pick-up at 80VDC. The Unit 2 equivalent solenoids require 80V. The manufacturer's testing determined that the 812-275 series solenoid valve will pick-up at 56VDC for worst case pressure conditions. Based on this an assumed value of 80VDC is considered conservative. [Not required per SBO-AAC 1-hour scenario].*

22. *The W 13429 relays were assumed to be the same as Westinghouse SG relays. The identical relays in other circuits are SG relays.*

23. *The DC time delay relays in the DG Fuel Prime Pump and Turbocharger Emergency Lube Oil Pump circuits are assumed to operate at 76% of 125VDC or 95VDC which is consistent with the DC time delay relays. [Not required per SBO-AAC 1-hour scenario].*

Design Inputs:

The battery parameters are provided below:

• Battery Type	C&D LCY-39
• Number of Cells	60
• Discharge Curve	*
• Number of Positive Plates	19
• Initial Voltage	1.98V/Cell
• Cell Resistance	0.0000768Ω @ 77°C
• Battery temperature	10-40°C Max
• Intercell Impedance	0 Ohms**

*See attached C&D Battery Fan (battery cell performance) Curve Data ETAP entries (calculation Attachment B - 1 page).

**per calc reference, the intercell connection impedance is accounted for in the published battery Discharge Curves.

The battery charger parameters are provided below:

• Rated output current	300A
• Current limit Setting	315A
• Float Voltage	133.5-135V
• Equalize Voltage	136-137.5V

Cable Data:

The cable number, type and size were determined from references for the various cables. The cable impedances were evaluated at a conductor temperature of 50°C to ensure a conservative analysis of voltage-drops above ambient temperatures.

Load on/off status

The load on/off status for devices fed from each breaker was determined using the CWDs. The calculation "Notes" column provides additional detail, as needed, for the on/off status for the specific load conditions modeled.

Devices per Circuit

The population of devices fed from each circuit was determined using CWDs. The "Device" lists the load as identified on the CWD.

Device Type

The "Device Type" column identifies the specific DC load type.
The device manufacturer and model numbers were taken from TEDB when Bill of Material numbers were not identified on CWDs.

Device Rating Data

The calculation summarizes the device rating information for all of the unique device types modeled. These device parameters include the rated voltage along with one of the following for each unique device type: Rated Amps, Watts, VA, or Resistance. The calculation identifies the load type (Z, P, or I) to be used by the ETAP program for modeling the load as a constant impedance (Z), power (P) or current (I) device. Finally, the calculation identifies the references/assumptions used for the device rating information listed.

Voltage Drop Circuit Paths

Cable Numbers, Cable Information, Device MFG, Device Model #, Device Ratings, and Timer Settings are determined via various references and inputs.

Cable Impedances

The resistance for each cable type used at St. Lucie Unit 1 was generated as part of the calculation, which was used to address AC System performance. This reference includes the manufacturer's resistance value of 4.44Ω/1000ft for a #16 cable with a correction factor of 1.02.

Each of the DC MOVs listed below requires 106.49VDC at Bus 1AB-1. Note that MV 08-03 is fed from 125VDC Bus 1AB, not 1AB-1. This is conservative for the purposes of this calculation. Based on references, these MOVs (except MV-08-03) actuate on an AFAS signal and stroke within 1 minute. (MV-08-03, MV-08-13, MV-08-14, MV-09-11, MV-09-12).

Square D Magnum SF Breaker Parameters [4.16 KV & 6,9 KV Switchgear]

- Close Coil: 90-140VDC, 125VDC Nominal, 3 amps
- Trip Coil: 70-140VDC, 125VDC Nominal, 3 amps
- Spring Charge Motor: 3.5 amps (24.4A inrush), 6 second duration @ 125VDC

K600 Line Breaker Parameters [480 VAC Switchgear]

- *Close Coil: 100-140VDC, 125VDC Nominal, 0.7 amps for Release coil and 0.06 amps for the anti pump relay.*
- *Trip Coil: 70-140VDC, 125VDC Nominal, 1.3 amps*
- *Spring Charge Motor: 10 amps (60-80A Inrush), 6 second duration*

NLI / Square D LGSB11 Breaker Parameters (NLI-RPL-BKR-AK25-RT-001, 002) [Reactor Trip Switchgear]

- *Close Coil: 90-140VDC, 125VDC Nominal, 200VA (Inrush), 4.5VA (Steady State)*
- *Trip Coil: 70-140VDC, 125VDC Nominal, 200VA (Inrush), 4.5VA (Steady State)*
- *Spring Charge Motor: 90-140VDC, 125VDC Nominal, 180VA*

The manufacturer and model number of the 480V, 4kV and 6.9kV breakers was identified from TEDB and relevant plant change modifications (PC/Ms).

Instrument Inverters 1A, 1B, 1C and 1D have a required input voltage range of 100-140VDC*. The operating input current is rated at 133A at 100VDC. Nominal efficiency 75% and approx 81% efficiency at 100% load. The rated output current is 83A at 120VAC.

*Note that the original inverters, which have not been completely replaced at this time, had a minimum input voltage requirement of 105 VDC. However, as the Inverters are not limiting for the SBO-ACC scenario, this has no impact on the results or available battery voltage margin.

The AC output current for the inverters is as follows. The values in ETAP include a contingency of 8.9% for Inverters 1A and 1B and 11.6% for Inverters 1C and 1D:

Desc	Calc Ref. value	Value in ETAP
Inverter 1A	28.18A	30.69A
Inverter 1B	28.18A	30.69A
Inverter 1C	51.18A	57.14A
Inverter 1D	51.18A	57.14A

The battery chargers are sequenced onto the safety-related 480 VAC motor control centers (MCC) at 30 seconds of completion of SBO-AAC crosstie energizes the associated MCCs.

The load currents for various motors are shown below.

Pump	Inrush Amps	Steady State Amps
MV-08-03	19A	3.8A
MV-08-13, 14	40A	8A
MV-08-11, 12	22.5A	3.8A
Square D SF6 Spring Charge Motor	24.4A	3.5A
Fuel Prime Pump 1B1	9.75A	2.25A
Fuel Prime Pump 1B2	10.25A	2.25A
TurboChgr Emerg Oil Pump 1A1	8.6A	3.4A
TurboChgr Emerg Oil Pump 1A2	10.0A	3.2A
TurboChgr Emerg Oil Pump 1B1	6.0A	4.5A
TurboChgr Emerg Oil Pump 1B2	8.4A	4.1A

The minimum pickup voltage for various devices is shown below:

Device	Pickup (V)
HGA Relay	80% of 125V
SG Relay	80% of 125V
Agastat E7000 Relay	80% of 125V
700-RT Relay	120V -20%
Square D 8501 Relay	115V -20%
Potter & Brumfield KRP Relay	75% of 110V
Graham White 812-215 Solenoid	80V
EDG Fuel Prime Pump	92V
EDG Turbochgr Emerg Oil Pmp	90V
EDG Motor Contactors	80% of 125V
Timers in DG Motor Circuits	80% of 125V
"A" relay in DG Motor Circuits	80% of 125V

The manufacturer cables feeding the EDG Turbocharger (soakback) Lube Oil Pumps, Fuel Prime pumps and the starting air solenoid relay pressure switches are listed on a cable walkdown sheet.

The EDG Fuel Prime Pumps are able to start and run at 92V. [Not required per SBO-AAC 1-hour scenario].

The EDG Turbocharger Emergency Lube Oil Pumps are able to start and run at 90V. [Not required per SBO-AAC 1-hour scenario]

It should be noted, that there are some pending calculation revision changes, which remain open against the calculation at this time. These pending changes were reviewed under this response. With the exception of the Instrument Inverters, which were concluded not to be the most limiting equipment for the minimum voltage requirement (as discussed in the Design Input paragraph 15 above), the pending changes either increased voltage margin via replacement of equipment with lower minimum voltage requirements or via the reduction of DC system loading. In limited cases, the DC load was increased loading by a negligible amount, which did not impact results.

Calculation Results:

See attached pages from calculation study cases and results for battery and voltage margins (Calculation Pgs 40, 41, 42, 52 & 53 of 54). Results are as follows:

A-Train 125 VDC Results for SBO-AAC 1-hour DC Coping

DC Load Profile:	0 - 1 minutes	-	514A
	1 - 30 minutes	-	232A
	30 – 60 minutes	-	226A
Battery 1A Capacity Remaining @ 60 minutes		-	63.7%
Minimum 1A Battery Voltage Required		-	109.2VDC
Minimum Available Bus 1AB-1 Voltage Margin		-	7.08 VDC

B-Train 125 VDC Results for SBO-AAC 1-hour DC Coping

DC Load Profile:	0 - 1 minutes	-	521A
	1 - 30 minutes	-	245A
	30 – 60 minutes	-	239A
Battery 1B Capacity Remaining @ 60 minutes		-	58.0%
Minimum 1B Battery Voltage Required		-	110.4VDC
Minimum Available Bus 1AB-1 Voltage Margin		-	6.02 VDC

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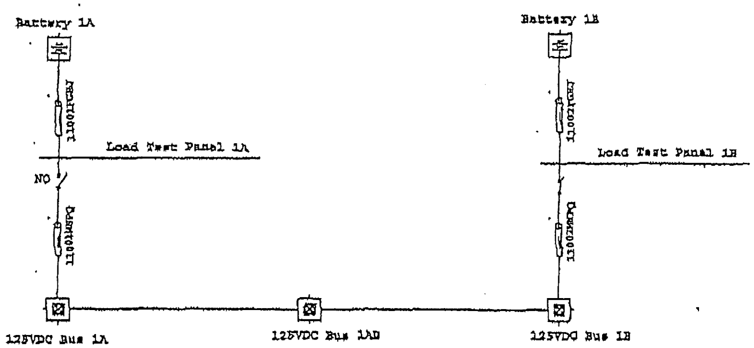
One-Line Diagram - Main One Line (Battery Discharge and Sizing)



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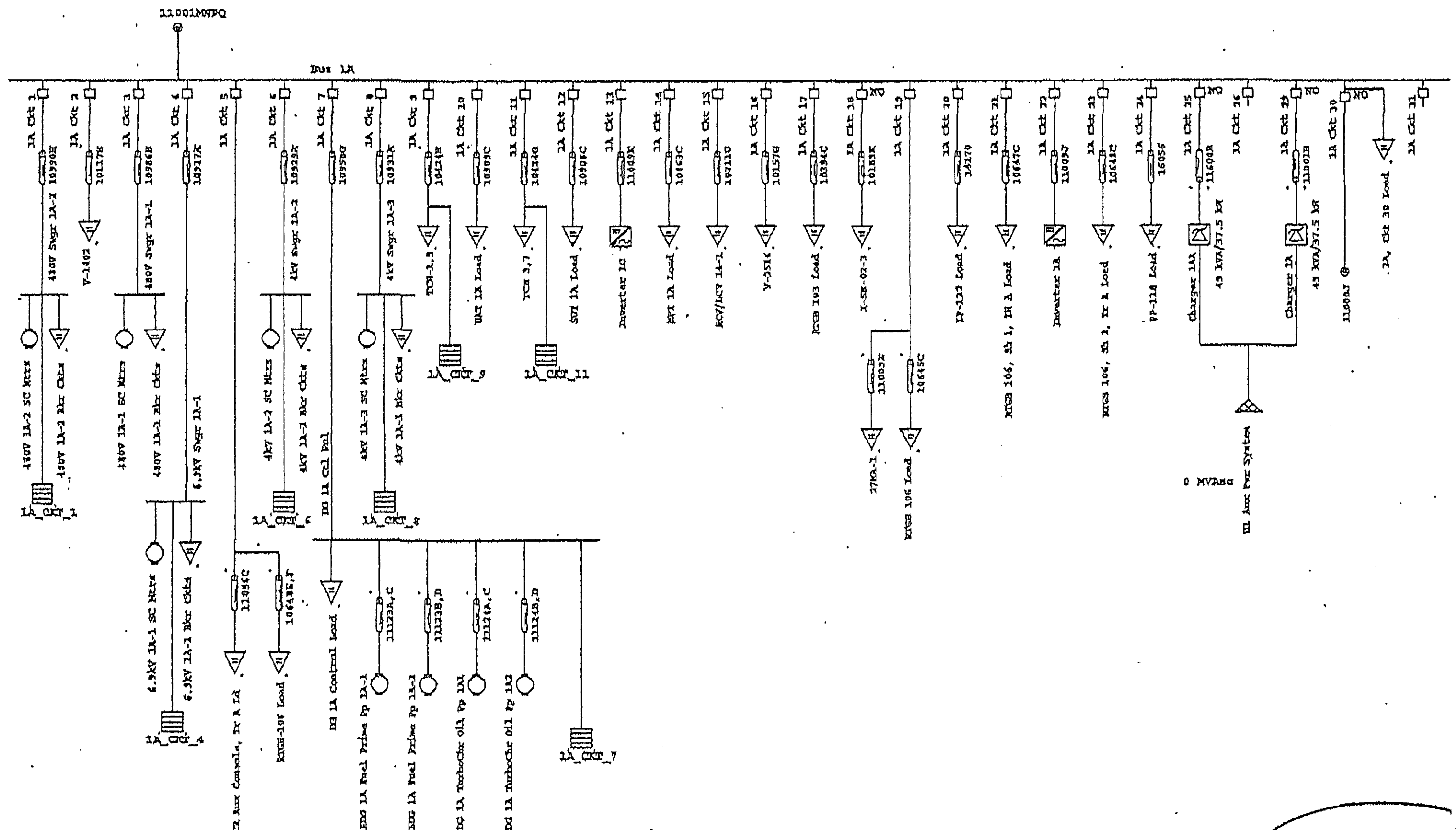
One-Line Diagram - Main One Line=>125VDC Bus 1A (Battery Discharge and Sizing)



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Attachment A
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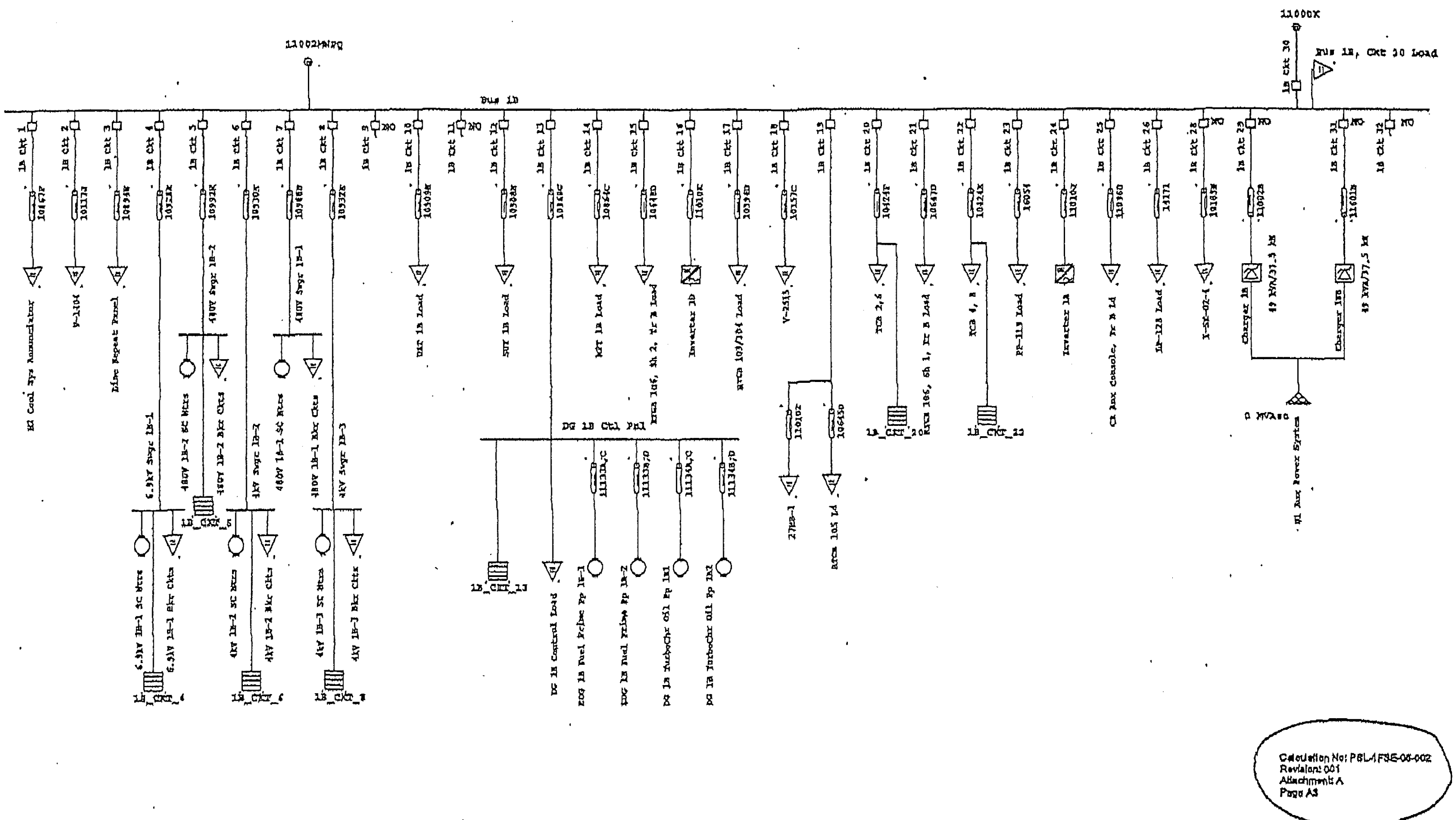
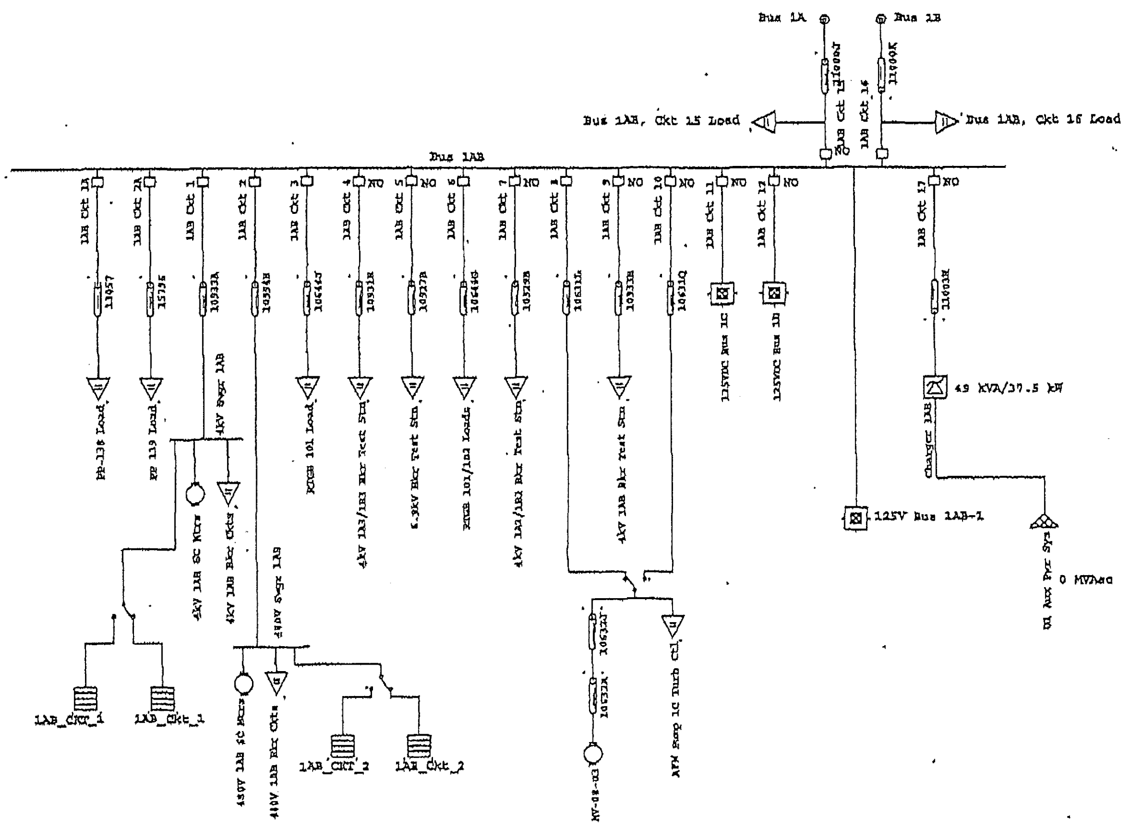
One-Line Diagram - Main One Line=>125VDC Bus 1B (Battery Discharge and Sizing)



One-Line Diagram - Main One Line=>125VDC Bus 1AB (Battery Discharge and Sizing)



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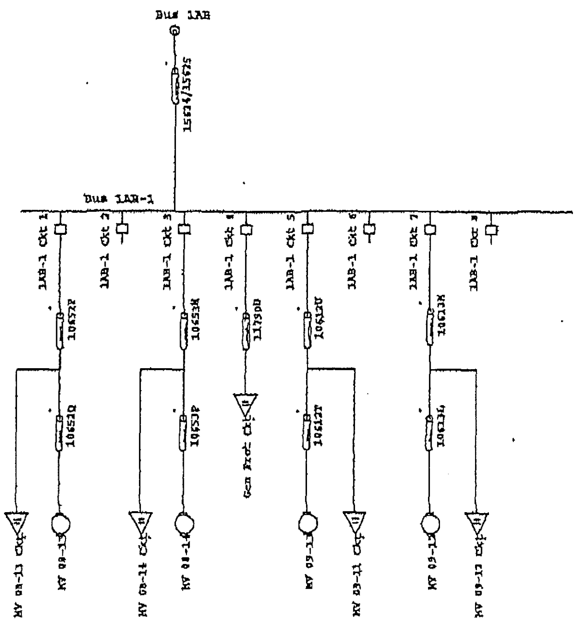
One-Line Diagram - Main One Line=>...=>125V Bus 1AB-1 (Battery Discharge and Sizing)



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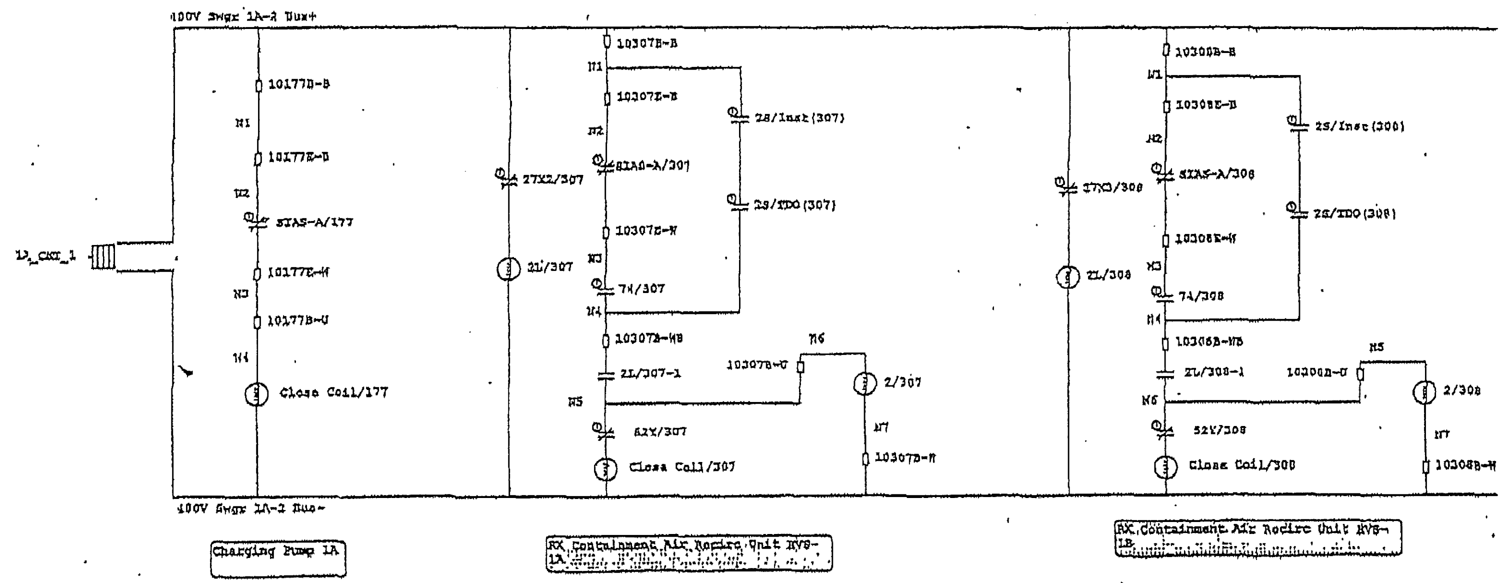
Control System Diagram - 1A CKT 1 (Edit Mode)



EXAMPLE CSD DIAGRAM FROM CALCULATION

Calculation No: PSL-1FSE-05-002
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Attachment: AF
Total Pages in Attachment: 27

DEVICE RATINGS TABULATION

Device Description	Load Type (Z, P, I)	Device Ratings: Voltage (DC)	Device Ratings: Amps	Device Ratings: Watts	Device Ratings: VA	Device Ratings: R (ohms)	Continuous Amps at Rated V (FLA)	Equivalent Amps at 125V (FLA)	Inrush Amps (LRA)	Reference/Assumption	
(AK-25-2) Close Coil/SCM	Z	125	44				44.000	44.000		Reference 6.6.15	
(AK-25-2) Trip Coil	Z	125	1.9				1.900	1.900		Reference 6.6.15	
(K600/1600 Line) Close Coil	Z	125	0.76				0.760	0.760		Reference 6.6.9	R1
(K600/1600 Line) Trip Coil/SCM	Z	125	1.3/10				1.3/10	1.3/10	80.0	Reference 6.6.9 (see note 1)	R1
(K3000 Line) Close Coil	Z	125	2.06				2.060	2.060		Reference 6.6.9	R1
(K3000 Line) Trip Coil/SCM	Z	125	2/10				2/10	2/10	80.0	Reference 6.6.9 (see note 1)	R1
(SQ-D) 4.16 Close Coil/SCM	Z	125	3/3.5				3/3.5	3/3.5	24.4	Reference 6.6.10 (see note 1)	R1
(SQ-D) 4.16 Trip Coil	Z	125	3				3.000	3.000		Reference 6.6.10	
(SQ-D) 6.9 Close Coil/SCM	Z	125	3/3.5				3/3.5	3/3.5	24.4	Reference 6.6.10 (see note 1)	R1
(SQ-D) 6.9 Trip Coil	Z	125	3				3.000	3.000		Reference 6.6.10	R1
(LGSB11) SCM	Z	125			180		1.440	1.440	1.44	Reference 6.44, 6.45	R1
(LGSB11) Close Coil	Z	125			4.5		0.036	0.036	1.6	Reference 6.44, 6.45	R1
(LGSB11) Trip Coil	Z	125			4.5		0.036	0.036	1.6	Reference 6.44, 6.45	R1
1000VA	Z	125			1000		8.000	8.000		8770-B-400 sh. 128	
1800W	Z	125		1800			14.400	14.400		8770-B-400 sh. 127	
500ohm resistor	Z	125				500	0.250	0.250		8770-B-327 sh. 952 and 2998-B-327 sh. 952	
Abbott AW50S/24-A-ER Power Supply	Z	125	0.6144				0.614	0.614		Reference 6.6.17 & Assumption 4.2	
Action Valve type C-5439 series SOL	Z	125		35.1			0.281	0.281		Reference 6.6.21 & Assumption 4.3	
Agastat 200P series Relay	Z	125		8			0.064	0.064		Assumption 4.2	
Agastat 7000 series Relay	Z	125		8			0.064	0.064		Reference 6.6.1	
Agastat EGP series Relay	Z	125		6			0.048	0.048		Reference 6.6.2	
Allen Bradley 700-RT Relay	Z	115			17		0.148	0.161		Reference 6.6.4	
Ametek AN-3100D Annunciator	Z	125	0.17				0.170	0.170		Reference 6.6.16	R1
AN-1195 Annun Reflash Module	Z	125	0.5				0.500	0.500		Reference 6.6.19	
Annunciator	Z	125	0.4				0.400	0.400		Reference 6.6.18 & Assumption 4.4	
ASCO 206, 208 210 series SOL	Z	125		35.1			0.281	0.281		Reference 6.6.21	
ASCO 212 series SOL	Z	125		35.1			0.281	0.281		Reference 6.6.21 & Assumption 4.3	
ASCO NS/NP8300, 8342 series SOL	Z	125		35.1			0.281	0.281		Reference 6.6.21	
\SCO NS/NP8314,16,20,21 & 44 series SOL	Z	125		17.4			0.139	0.139		Reference 6.6.21	
Automatic Valve type U02 series SOL	Z	125				948	0.132	0.132		Reference 6.6.22	
B/M C11-19	Z	125				220000	0.001	0.001		Reference 6.6.14	
B/M C11-5	Z	125				2000	0.063	0.063		Reference 6.6.14	
B/M C12-107	Z	125				2000	0.063	0.063		Reference 6.6.23	
B/M C12-21	Z	125				2000	0.063	0.063		Reference 6.6.23	
B/M C12-26	Z	125		4			0.032	0.032		Reference 6.6.24	
B/M C12-3	Z	125		8			0.064	0.064		Assumption 4.2	
B/M C12-35	Z	125		8			0.064	0.064		Reference 6.6.1	
B/M C12-36	Z	125		8			0.064	0.064		Reference 6.6.1	
B/M C12-37	Z	125		8			0.064	0.064		Reference 6.6.1	
B/M C12-38	Z	110		4			0.036	0.041		Reference 6.6.3	
B/M C12-41	Z	125				2000	0.063	0.063		Reference 6.6.23	
B/M C12-61	Z	125		6			0.048	0.048		Reference 6.6.2	
B/M C12-65	Z	125		8			0.064	0.064		Assumption 4.2	
B/M C12-66	Z	125	0.05				0.050	0.050		Reference 6.6.25 & 8770-B-325 sh. C12-64	
B/M C12-67	Z	125	0.05				0.050	0.050		Reference 6.6.25 & 8770-B-325 sh. C12-64	
B/M C12-68	Z	125		8			0.064	0.064		Assumption 4.2	
B/M C12-7	Z	125				2280	0.055	0.055		Reference 6.6.26 & Assumption 4.5	
B/M C12-72	Z	125		8			0.064	0.064		Reference 6.6.1 & 8770-B-325 sh. C12-72	
B/M C12-73	Z	125		8			0.064	0.064		Reference 6.6.1 & 8770-B-325 sh. C12-72	
B/M C12-76	Z	125		8			0.064	0.064		Reference 6.6.1 & 8770-B-325 sh. C12-72	
B/M C12-79	Z	125		8			0.064	0.064		Reference 6.6.1 & 8770-B-325 sh. C12-78	
B/M C12-80	Z	125		8			0.064	0.064		Reference 6.6.1 & 8770-B-325 sh. C12-78	
B/M C12-81	Z	125		8			0.064	0.064		Reference 6.6.1 & 8770-B-325 sh. C12-78	

EXAMPLE OF LOADS ON/OFF TABLES

Bus	Ckt	CWD	Device	Device Type	Quantity	Int/SS	SIAS Load Condition On (Y/N)	SIAS Load Condition Steady State Lookup Amps	SIAS Load Condition Steady State (On entire duty cycle) Ckt totals	SBO Load Condition On (Y/N)	SBO Load Condition Steady State Lookup Amps	SBO Load Condition Steady State (On entire duty cycle) Ckt totals	Load Type	MFG (TEDB)	Model Number (TEDB)	
1A	1	990	74	GE HGA Relay	1	SS	Y	0.055		Y	0.055		Z	GE	12HGA11J52	
1A	1	990	27-1	B/M C12-66	1	SS	Y	0.050		Y	0.050		Z	ITE	211T4175	
1A	1	990	27-4	B/M C12-66	1	SS	Y	0.050		Y	0.050		Z	ITE	211T4175	
1A	1	990	27X1	B/M C12-107	1	SS	Y	0.063		Y	0.063		Z	GE	12HFA151A2H	
1A	1	990	27X2	B/M C12-107	1	SS	Y	0.063		Y	0.063		Z	GE	12HFA151A2H	
1A	1	990	27X3	B/M C12-107	1	SS	Y	0.063		Y	0.063		Z	GE	12HFA151A2H	
1A	1	990	27X4	B/M C12-7	1	SS	Y	0.055		Y	0.055		Z	GE	12HGA111J2	
1A	1	177	Lights	Indicating Light	6	SS	M	0.188		M	0.188					
1A	1	177	CC	(K600/1600 Line) Close Coil	1	Int								ABB	C1525-773-132-41 W/O UV	R1
1A	1	177	TC	(K600/1600 Line) Trip Coil/SCM	1	Int								ABB	C1525-773-132-41 W/O UV	R1
1A	1	177	3X1/177	GE HGA Relay	1	SS	Y	0.055		N	0.000		Z	GE	12HGA11J52	
1A	1	177	74/TDDO	B/M C12-87	1	SS	N	0.000		Y	0.064		Z	AGA	E7022PB003	
1A	1	177	62/TDPU	B/M C12-76	1	SS	N	0.000		N	0.000			AGA	E7012PC003	
1A	1	307	Lights	Indicating Light	4	SS	M	0.125		M	0.125					
1A	1	307	CC	(K600/1600 Line) Close Coil	1	Int								ABB	C1525-773-132-41 W/O UV	R1
1A	1	307	TC	(K600/1600 Line) Trip Coil/SCM	1	Int								ABB	C1525-773-132-41 W/O UV	R1
1A	1	307	2/TDDO	B/M C12-79	1	Int	Y			N			Z	AGA	E7022PC003	R1
1A	1	307	74/TDDO	B/M C12-87	1	SS	N	0.000		Y	0.064		Z	AGA	E7022PB003	
1A	1	307	62/TDPU	B/M C12-83	1	SS	Y	0.064		Y	0.064		Z	AGA	E7012PD003	
1A	1	307	2S/TDDO	B/M C12-89	1	SS	Y	0.064		Y	0.064		Z	AGA	E7022PDT	
1A	1	307	2L/TDPU	Allen Bradley 700-RT Relay	1	Int	Y			N			Z	ALB	700-RT11B200Z1	R1
1A	1	308	Lights	Indicating Light	4	SS	M	0.125		M	0.125					
1A	1	308	CC	(K600/1600 Line) Close Coil	1	Int								ABB	C1525-773-132-41 W/O UV	R1
1A	1	308	TC	(K600/1600 Line) Trip Coil/SCM	1	Int								ABB	C1525-773-132-41 W/O UV	R1
1A	1	308	2L/TDPU	Allen Bradley 700-RT Relay	1	SS	N	0.000		N	0.000			ALB	700-RT11B200Z1	
1A	1	308	2/TDDO	B/M C12-79	1	SS	N	0.000		N	0.000			AGA	E7022PC003	
1A	1	308	74/TDDO	B/M C12-87	1	SS	N	0.000		Y	0.064		Z	AGA	E7022PB003	
1A	1	308	62/TDPU	B/M C12-83	1	SS	Y	0.064		Y	0.064		Z	AGA	E7012PD003	
1A	1	308	2S/TDDO	B/M C12-89	1	SS	Y	0.064		Y	0.064		Z	AGA	E7022PDT	
1A	1	401	Lights	Indicating Light	2	SS	M	0.063		M	0.063					
1A	1	401	CC	(K600/1600 Line) Close Coil	1	Int								ABB	C1525-773-132-41 W/O UV	R1
1A	1	401	TC	(K600/1600 Line) Trip Coil/SCM	1	Int								ABB	C1525-773-132-41 W/O UV	R1
1A	1	501	Lights	Indicating Light	4	SS	M	0.125		M	0.125					
1A	1	501	CC	(K600/1600 Line) Close Coil	1	Int								ABB	C1525-773-132-41 W/O UV	R1
1A	1	501	TC	(K600/1600 Line) Trip Coil/SCM	1	Int								ABB	C1525-773-132-41 W/O UV	R1
1A	1	501	4Y/TDPU	Agastat 7000 series Relay	1	SS	Y	0.064		Y	0.064		Z	AGA	7012P	
1A	1	501	3	GE HGA Relay	1	SS	N	0.000		Y	0.055		Z	GE	12HGA111J2	
1A	1	501	20/SE	SE-25-021A	1	SS	Y	0.281		Y	0.281		Z	N/A	N/A	
1A	1	852	Lights	Indicating Light	2	SS	M	0.063		M	0.063					
1A	1	852	CC	(K600/1600 Line) Close Coil	1	Int								ITE	K-600	R1
1A	1	852	TC	(K600/1600 Line) Trip Coil/SCM	1	Int								ITE	K-600	R1
1A	1	852	2RC/TDPU	Allen Bradley 700-RT Relay	1	SS	N	0.000		Y	0.161		Z	ALB	700-RTA11E200Z1	
1A	1	852	68X	GE HGA Relay	1	SS	Y	0.055		Y	0.055		Z	GE	12HGA11J52	
1A	1	974	Space													
1A	1	977	Lights	Indicating Light	4	SS	M	0.125		M	0.125					
1A	1	977	CC	(K3000 Line) Close Coil	1	Int								ITE	K-3000S	R1
1A	1	977	TC	(K3000 Line) Trip Coil/SCM	1	Int								ITE	K-3000S	R1
1A	1	507	Lights	Indicating Light	4	SS	M	0.125		M	0.125					
1A	1	507	CC	(K600/1600 Line) Close Coil	1	Int								ABB	C1525-773-132-41 W/O UV	R1
[illegible]	1	507	TC	(K600/1600 Line) Trip Coil/SCM	1	Int								ABB	C1525-773-132-41 W/O UV	R1
		507	62/TDPU	Agastat 200P series Relay	1	SS	Y	0.064		Y	0.064		Z	AGA	D200P	
		507	2/TDPU	Agastat 7000 series Relay	1	SS	Y	0.064		Y	0.064		Z	AGA	7012P	
		978	Lights	Indicating Light	4	SS	M	0.125		M	0.125					
		978	CC	(K600/1600 Line) Close Coil	1	Int								ITE	K-1600S	R1
		978	TC	(K600/1600 Line) Trip Coil/SCM	1	Int								ITE	K-1600S	R1

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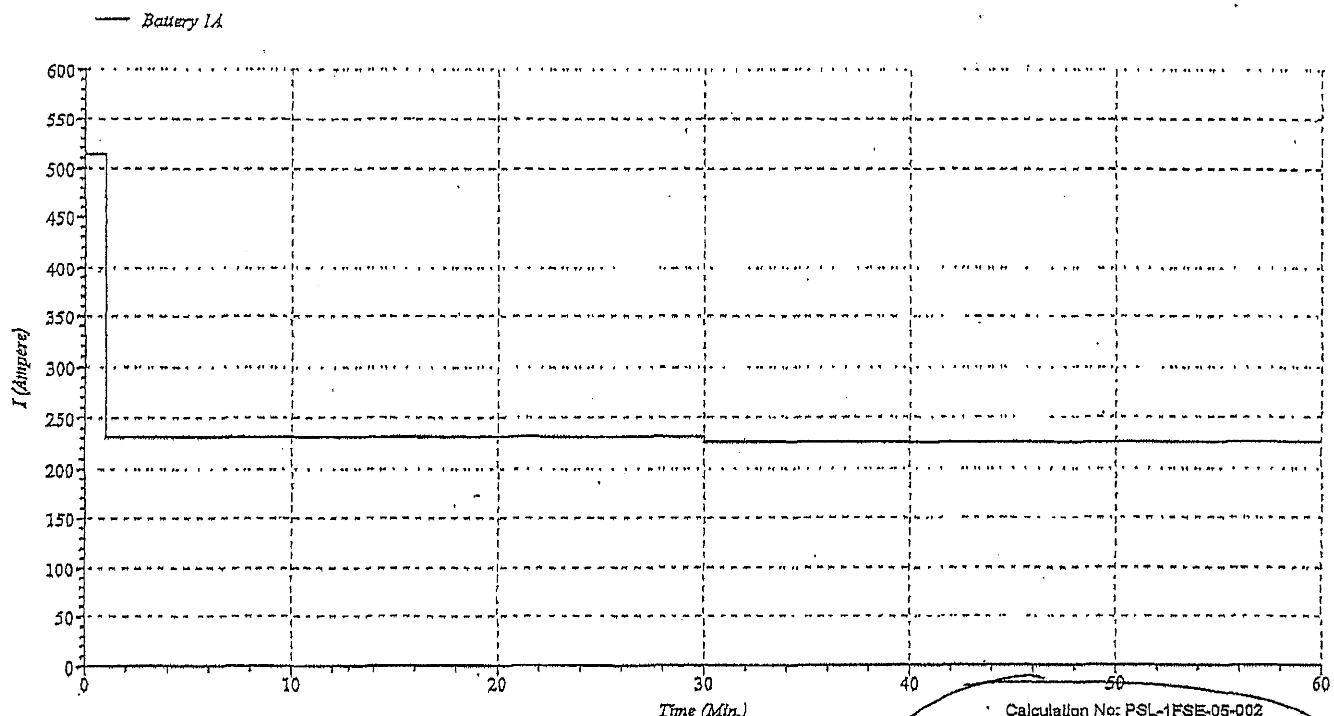
Location:				SN:	WASHINGRPN
Contract:				Revision:	Base
Engineer:		Study Case: SBO Alt AC A		Config.:	Train A

SBO profile, 1Hr Alternate AC Strategy, Train A

Project File: St_Lucie_U1
Output Report: SBO_Alt_AC_A

Battery DutyCycle (Combined Load)



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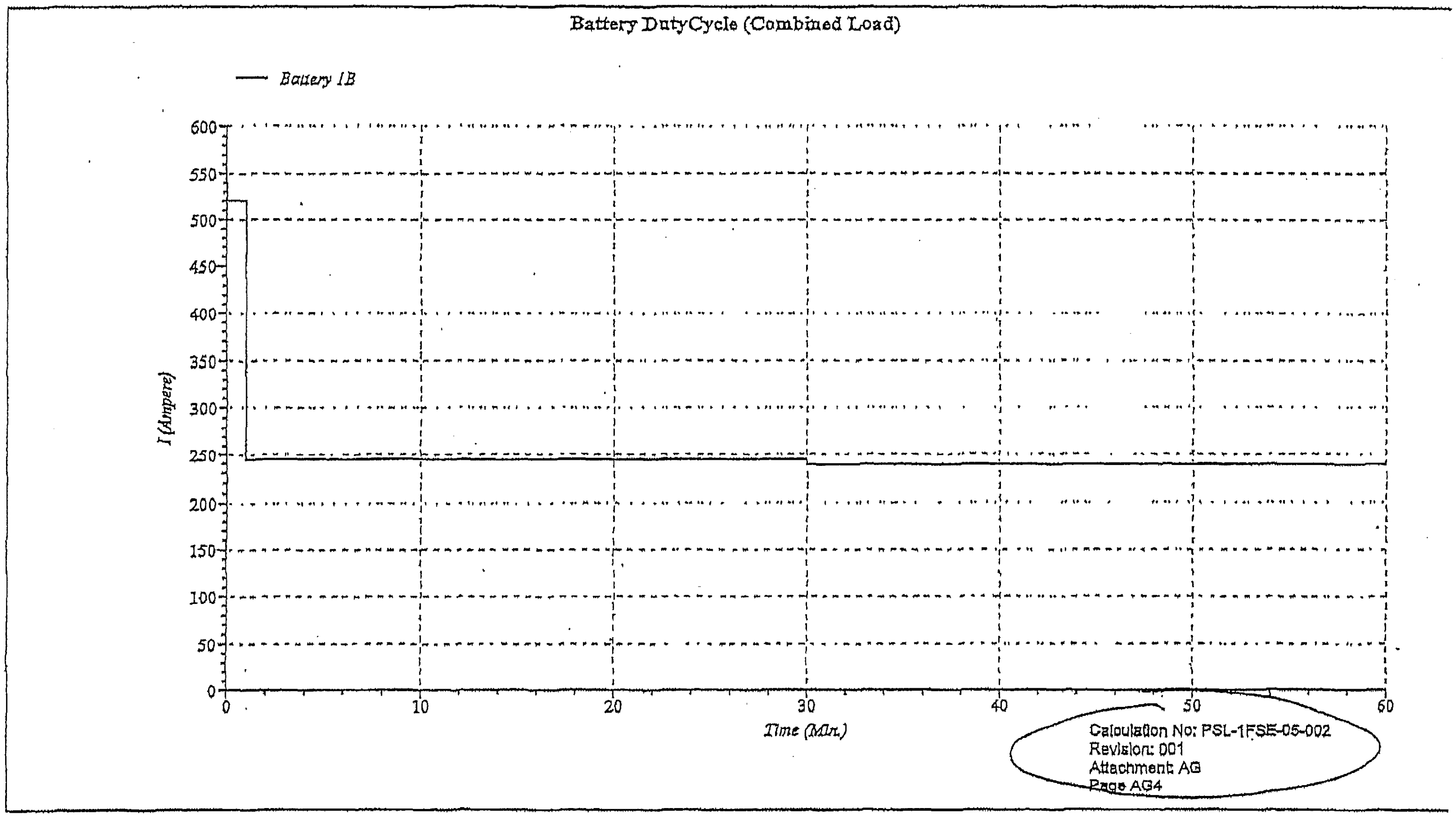
Project:	St. Lucie Unit 1 125VDC System	ETAP 6.0.1N	Date:	11-04-2008
Location:			SN:	WASHINGRPN
Contract:			Revision:	Base
Engineer:		Study Case: SBO Alt AC B	Config.:	Train B

SBO profile, 1Hr Alternate AC Strategy, Train B

Project File: St_Lucie_U1
Output Report: SBO_Alt_AC_B



4 HR SBO SCENARIO

For Train A, the most limiting battery terminal voltage requirement is 110.47V in order to support operation of the control circuits for the TC Lube Oil Pumps in the 1st minute of the duty cycle. The battery was sized to 111.0V or 1.85V/Cell. This value was added in the sizing page of the study case and the Battery Sizing module was run. This resulted in 9.978 positive plates required with a total correction factor of 1.488. The resultant number of required positive plates is 14.842. The battery margin is calculated by dividing the number of positive plates by the required number of positive plates resulting in 21.9% battery capacity remaining.

For Train B, the limiting required battery terminal voltage is 110.64V in order to support operation of the control circuits for the TC Lube Oil Pumps in the 1st minute of the duty cycle. The battery was sized to 111.0V or 1.85V/Cell. This value was added in the sizing page of the study case and the Battery Sizing module was run. This resulted in 10.521 positive plates required with a total correction factor of 1.488. The resultant number of required positive plates is 15.650. The battery margin is calculated by dividing the number of positive plates by the required number of positive plates resulting in 17.6% battery capacity remaining.

Output reports are included in Attachment BB through BG for all runs performed as part of these SBO Coping study cases. R1

7.3.2. SBO AAC Study Cases

These study cases evaluate the SBO Alternate AC strategy for meeting the Station Blackout rule. Two study cases named SBO Alt AC A and SBO Alt AC B were created.

The Train A and Train B configurations were used with the SBO Alt AC A and B study cases respectively. The battery discharge module was run. Output reports are included in Attachments BH through BM. R1

Voltage criteria for this scenario require evaluation in the 1st minute of the duty cycle. The first minute of the coping and alternate AC SBO duty cycles are the same. Thus, the voltage criteria for the 1st minute is identical to the SBO Coping study cases, only the EDG loads are not evaluated since the EDGs are not ever credited with starting in this scenario.

The ETAP Scenario, Output Report name, Configuration, Study Type etc. is identified in the Scenario Matrix included in Attachment BA.

All of the parameters in these study cases are the same as the SBO Coping study cases except the load duration was set to 1 hr. This removes the last 3 hrs of the coping profile including the diesel generator starting load added to the 239th minute of the profile. However, the AAC SBO strategy relies on a start of a Unit 2 EDG, not a Unit 1 EDG, to end the event. Thus, elimination of the last minute EDG starting load is consistent with the AAC strategy. R1

The "Voltage Drop and Power Flow Report" output reports document the CSD device terminal voltages (Attachments BH and BK).

The voltage acceptance criterion is evaluated below similar to the coping study cases. The acceptance criteria is the same as the SBO Coping study cases except no acceptance criteria is applicable to the EDG controls since the EDG is not credited with starting. In addition, the criteria related to the EDG breaker closure in the 240th minute are not applicable. The minimum calculated inverter voltage was also re-evaluated since it may have occurred past 60 minutes in the coping study. The results for the applicable criteria are reiterated below. R1

c. Train A SBO Alternate AC

Bus	Service	DC Circuit	Time Voltage Required Min/Sec, (as noted)	Calculated Bus/Ckt Voltage (V) Note 1	CSD Device Terminal Voltage (V) Note 2	Req'd Load Volts (V)	Margin (V)	Req'd Battery Volts (V)
4kV Swgr 1A-3	Tripping	1A CKT 8	0.000 to 0.100 sec	114.428	N/A	72.5 **	41.93	74.10
480V Swgr 1A2	Tripping	1A CKT 1	0.000 to 0.100 sec	114.155	N/A	72.5 **	41.66	74.37
4kV Swgr 1AB	Tripping	1AB CKT 1	0.000 to 0.100 sec	111.813	N/A	72.5 **	39.31	76.72
480V Swgr 1AB	Tripping	1AB CKT 2	0.000 to 0.100 sec	114.125	N/A	72.5 **	41.63	74.40
4kV Swgr 1A-2	Trip Coil/914, Trip Coil/934 & Tripping	1A CKT 6	0.000 to 0.100 sec	110.712	109.15	72.5 **	36.65	79.38
6.9KV Swgr 1A-1	Trip Coil/912 & Tripping	1A CKT 4	0.000 to 0.100 sec	112.860	111.18	72.5 **	38.68	77.35
Reactor Trip Swgr Cub 001 (TCB 1,5)	Trip Coil/411, Trip Coil/412	1A CKT 9	0.000 to 0.100 sec	N/A	117.42	72.5 **	44.92	71.11
Reactor Trip Swgr Cub 004 (TCB 3,7)	Trip Coil/415, Trip Coil/416	1A CKT 11	0.000 to 0.100 sec	N/A	117.40	72.5 **	44.90	71.13
Inverter 1A	Inverter 1A	N/A	0 - 60 sec	113.251	N/A	100.0	13.25	102.78
		N/A	1 - 60 min	115.816	N/A	100.0	15.82	101.86
Inverter 1C	Inverter 1C	N/A	0 - 60 sec	112.243	N/A	100.0	12.24	103.79
		N/A	1 - 60 min	114.831	N/A	100.0	14.83	102.84
125V Bus 1AB	MV-08-03	N/A	0 - 60 sec	113.980	N/A	106.49	7.49	108.54
125V Bus 1AB-1	MV-08-13/14 MV-09-11/12	N/A	0 - 60 sec	113.571	N/A	106.49	7.08	108.95
Battery 1A			0 - 60 sec	116.028	N/A			
			1 - 60 min	117.872	N/A			

R1

* 1V added per Section 4.10
** 2.5V added per Section 4.9

Notes:
1. Bus/Ckt voltage used for loads not modeled in a CSD
2. Device terminal voltage for loads modeled in CSD

R1

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Train B SBO Alternate AC

Bus	Service	DC Circuit	Time Voltage Required Min/Sec, (as noted)	Calculated Bus/Ckt Voltage (V) Note 1	CSD Device Terminal Voltage (V) Note 2	Req'd Load Volts (V)	Margin (V)	Req'd Battery Volts (V)
4kV Swgr 1B-3	Tripping	1B CKT 8	0.000 to 0.100 sec	112.405	N/A	72.5 **	39.91	76.07
480V Swgr 1B2	Tripping	1B CKT 5	0.000 to 0.100 sec	113.110	N/A	72.5 **	40.61	75.37
4kV Swgr 1AB	Tripping	1AB CKT 1	0.000 to 0.100 sec	110.931	N/A	72.5 **	38.43	77.55
480V Swgr 1AB	Tripping	1AB CKT 2	0.000 to 0.100 sec	113.225	N/A	72.5 **	40.73	75.25
4kV Swgr 1B-2	Trip Coil/915, Trip Coil/935 & Tripping	1B CKT 6	0.000 to 0.100 sec	108.414	107.97	72.5 **	35.47	80.51
6.9KV Swgr 1B-1	Trip Coil/913 & Tripping	1B CKT 4	0.000 to 0.100 sec	111.076	110.97	72.5 **	38.47	77.51
Reactor Trip Swgr Cub 002 (TCB 2,6)	Trip Coil/413, Trip Coil/414	1B CKT 20	0.000 to 0.100 sec	N/A	116.73	72.5 **	44.23	71.75
Reactor Trip Swgr Cub 005 (TCB 4,8)	Trip Coil/417, Trip Coil/418	1B CKT 22	0.000 to 0.100 sec	N/A	116.75	72.5 **	44.25	71.73
Inverter 1B	Inverter 1B	N/A	0 - 60 sec	112.669	N/A	100.0	12.67	103.31
		N/A	1 - 60 min	115.547	N/A	100.0	15.55	102.01
Inverter 1D	Inverter 1D	N/A	0 - 60 sec	112.345	N/A	100.0	12.35	103.63
		N/A	1 - 60 min	115.230	N/A	100.0	15.23	102.33
125V Bus 1AB	MV-08-03	N/A	0 - 60 sec	112.918	N/A	106.49	6.43	109.55
125V Bus 1AB-1	MV-08-13/14 MV-09-11/12	N/A	0 - 60 sec	112.513	N/A	106.49	6.02	109.96
Battery 1B			0 - 60 sec	115.978	N/A			
			1 - 60 min	117.555	N/A			

R1

* 1V added per Section 4.10
** 2.5V added per Section 4.9

Notes:
1. Bus/Ckt voltage used for loads not modeled in a CSD
2. Device terminal voltage for loads modeled in CSD

For Train A, the limiting required battery terminal voltage is 108.95V. The battery was sized to 109.2V or 1.82V/Cell. This value was added in the sizing page of the study case and the Battery Sizing module was run. This resulted in 4.637 positive plates required with a total correction factor of 1.488. The resultant number of required positive plates is 6.897. The battery margin is calculated by dividing the number of positive plates by the required number of positive plates resulting in 63.7% battery capacity remaining. R1

R1

8. **Conclusions:**

The sizing and voltage drop results are valid for an aging factor of 125% and a minimum battery temperature of 10°C. R1

8.1. SBO Coping

8.1.1. Voltage Drop

All loads within the scope of this calculation have adequate voltage.

8.1.2. Battery Sizing

Each battery has positive margin as shown below. The voltage used to size the battery is shown in parenthesis.

- Battery 1A 21.9% battery capacity remaining. (111.0V or 1.85V/Cell)
- Battery 1B 17.6% battery capacity remaining. (111.0V or 1.85V/Cell) R1

The load profile associated with each Train is shown below. The load current is rounded up to the nearest amp. These load currents are corrected based on battery terminal voltage using load flow. Battery Duty Cycle graphs are included in Attachment AG. R1

Train A	
0-1 Minutes	514A
1-30 Minutes	232A
30-239 Minutes	226A
239-240 Minutes	259A

R1

Train B	
0-1 Minutes	521A
1-30 Minutes	245A
30-239 Minutes	239A
239-240 Minutes	271A

R1

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8.2. SBO AAC

8.2.1. Voltage Drop

All loads within the scope of this calculation have adequate voltage.

8.2.2. Battery Sizing

Each battery has positive margin as shown below. The voltage used to size the battery is shown in parenthesis.

- Battery 1A 63.7% battery capacity remaining. (109.2V or 1.82V/Cell)
- Battery 1B 58.0% battery capacity remaining. (110.4V or 1.84V/Cell) R1

The load profile associated with each Train is shown below. The load current is rounded up to the nearest amp. These load currents are corrected based on battery terminal voltage using load flow. Battery Duty Cycle graphs are included in Attachment AG. R1

Train A	
0-1 Minutes	614A
1-30 Minutes	232A
30-60 Minutes	226A

R1

Train B
0-1 Minutes 521A
1-30 Minutes 245A
30-60 Minutes 239A

SIAS SCENARIO R1

8.3. SIAS

8.3.1. Voltage Drop

All loads within the scope of this calculation have adequate voltage

8.3.2. Battery Sizing

Each battery has positive margin as shown below. The voltage used to size the battery is shown in parenthesis.

- Battery 1A 47.4% battery capacity remaining. (112.2V or 1.87V/Cell)
- Battery 1B 51.2% battery capacity remaining. (111.6V or 1.86V/Cell) R1

The load profile associated with each Train is shown below. The load current is rounded up to the nearest amp. These load currents are corrected based on battery terminal voltage using load flow. Battery Duty Cycle graphs are included in Attachment AG. R1

Train A
0-1 Minutes 511A
1-2 Minutes 216A (DC load will be on the charger) R1

Train B
0-1 Minutes 518A
1-2 Minutes 227A (DC load will be on the charger) R1

The DC current after 1 minute is within the rating of a single charger.

8.4. Short Circuit

The calculated short circuit currents are listed below. The calculated fault currents do not exceed the ratings of any of the breakers modeled in this calculation. In addition, the fault currents are within the 20000A rating of Buses 1A, 1B, 1AB & 1AB-1.

Bus	SC Current
Load Test Panel 1A	19982 A
Bus 1A	17220 A
Bus 1AB	13087 A
Bus 1AB-1	9678 A
LP-127	4706 A
PP-118	2217 A
PP-138	286 A
PP-139	230 A

R1

SHORT CIRCUIT RUNS

Bus	SC Current
Load Test Panel 1B	17024 A
Bus 1B	14860 A
Bus 1AB	10439 A
Bus 1AB-1	8171 A
LP-128	4018 A
PP-119	1597 A
PP-138	287 A
PP-139	231 A

R1

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Location:		Date:	11-04-2008
Contract:		SN:	WASHTNGRPN
Engineer:	Study Case: SBO Coping A	Revision:	Base
Filename: St_Lucie_U1		Config.:	Train A

SBO profile, 4Hr Coping Strategy, Train A

Battery Characteristics

MFR: C&D Tech
Model: LCY-39
Type: Time vs amp

V/Cell: 1.980
Rp: 0.001459 Resistance/Positive Plate
Temp: 25 °C

No of Plates: 39
Capacity: 2400 AH
1 Min. A Rate: 3040

Battery sizes given in the library are used

Ampere per Positive Plate as a Function of Time (minutes) and Voltage (volts)

Time	1.75	1.80	1.85*	1.90	1.95
1.00	160.50	124.50	90.00	55.00	25.00
5.00	149.50	118.30	87.50	54.50	24.99
10.00	133.50	109.50	83.70	53.90	24.97
15.00	120.50	101.00	79.50	52.70	24.90
20.00	110.00	93.50	75.50	51.50	24.80
30.00	94.50	82.00	68.20	49.00	24.40
45.00	78.50	69.50	59.50	45.00	23.85
60.00	68.20	61.00	53.00	41.80	23.20
90.00	53.70	48.50	43.50	36.00	21.40
120.00	44.50	41.00	37.00	31.10	19.85
180.00	33.00	31.00	29.00	24.50	17.00
240.00	26.70	25.10	23.60	20.30	15.00
300.00	22.10	21.40	20.20	17.60	13.40
360.00	20.00	18.87	17.90	15.30	12.10
480.00	16.20	15.50	14.50	12.00	9.90

* indicates the curve used in battery string.

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Attachment B
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ST. LUCIE UNIT 1
LICENSE AMENDMENT REQUEST
EXTENDED POWER UPRATE

ATTACHMENT 8
APPENDIX B

SUMMARY OF ST. LUCIE UNIT 1 EPU NON-LOCA SAFETY ANALYSIS ENGINEERING REPORT FOR STATION BLACKOUT

3.33 ***Station Blackout (UFSAR 15.2.13)***

3.33.1 Identification of Causes and Accident Description

The SBO event is defined as a complete loss of alternating current electric power to the essential and nonessential switchgear buses. SBO involves the loss of offsite power concurrent with turbine trip and failure of both Emergency Diesel Generator sets. For Unit 1, this results in the loss of all onsite AC power except that supplied by inverters from the two safety related battery sources. This provides power to the 120 V AC (safeguards) instrument power and other required loads (e.g., Auxiliary Feedwater system). When the Unit 1 4160 volt 1 A/B bus and Unit 2 4160 volt 2A/B bus are manually connected, limited AC power is available to Unit 1, based on excess Unit 2 EDG capacity (Reference 11 and 12). At the time of the SBO, power supply is lost to the following systems: MFW pumps, reactor scram mechanism (holdout coils), RCPs, pressurizer heaters, steam dump bypass system and SI system. In addition, RCP seal leakage is conservatively assumed.

This event is essentially a natural circulation cooldown with the secondary side heat sink limited to the initial SG shell side liquid inventory and Auxiliary Feedwater flow provided by the steam turbine-driven AFW pump.

3.33.2 Description of Analyses and Evaluations

While the Reference 1 methodology does not specifically address the SBO event, the progression of the transient is very similar to the Loss of AC Power and also the Steam Generator Tube Rupture events for which S-RELAP5 is approved. Due to the similarities of the SBO to these events, the Reference 1 methodology was judged to be applicable to analysis of this event.

10 CFR 50.63, "Loss of all alternating current power," requires that a plant be able to withstand a specified duration and recover from a SBO. The specific St. Lucie Unit 1 requirements are provided by NRC Safety Evaluation of Station Blackout (SBO) Rule (References 11 and 12); this analysis addresses section 2.3.6 "Reactor Coolant Inventory" with the following assumptions:

- Best estimate full power conditions
- No independent equipment failures (other than those associated with the event) occur during the course of the transient.

The current licensing analysis was based on the RETRAN computer code whereas the analysis supporting the EPU was performed using S-RELAP5. Changes from the current licensing basis presented in References 11, 12, and 13 included:

- Higher rated initial core power of 3,020 MWt vs. 2,700 MWt (reflecting the EPU)
- Lower RCS leakage flow rate of 60 gpm vs. 120 gpm
- Credit for flow from one charging pump beginning at one hour
- Decay heat based on 100% of the 1973 ANS Standard vs.105% of the 1979 version
- Incorporation of blowdown (cleanup) flow from the Steam Generators as part of the initial condition.

The total initial RCS leakage flow rate was modeled as 60 gpm. This represents 10 gpm leakage from each RCP seal plus 20 gpm as a combination of identified and unidentified leakage allowed by Technical Specifications. A value of 10 gpm for each RCP seal is a conservatively high allowance for the N9000 RCP seals used at St. Lucie Unit 1. RCP leakage was modeled to decrease with decreasing RCS pressure.

3.33.3 Input Parameters and Assumptions

The input parameters and biasing for the analysis of this event is shown in Table 3.33. As an exception to the usual biasing presented in the Reference 1 methodology, the input parameters reflect more of a best estimate approach in accordance with the plant specific current licensing basis.

3.33.4 Acceptance Criteria

The analysis must show that the plant can successfully withstand a SBO event for at least 4 hours. The prime directive in Reference 14 is ensuring that the core remains covered. Avoiding core uncovery is interpreted as maintaining a collapsed liquid level in the reactor vessel above the top of the fuel or active core. With an active core height of 136.7 inches, this corresponds to a minimum level of approximately 11.4 feet above the bottom of the active core. As a more restrictive criterion, in order to avoid "breaking suction" in the RCS loops, the water level in the reactor vessel should not drop below the top of the hot leg nozzles. The top of the hot leg is approximately 18.7 feet above the bottom of the core. Avoiding core uncovery ensures that no fuel failures occur.

Sufficient inventory must be available in the Condensate Storage Tank for decay heat removal. In order for the Steam Generator to remain effective in removing heat from the RCS, it is necessary to avoid dryout of the secondary side.

3.33.5 Results

The results of this analysis are summarized in Table 2.6. The transient sequence of events is shown in Table 3.34, and the transient results are shown in Figure 3.198 to Figure 3.209.

RCS leakage follows the same general trend as pressurizer pressure. Opening and closing of the MSSVs provide limited cooling of the RCS for the first hour. Opening the ADV at one hour produces a sharper drop in RCS temperature and pressure. RCS leakage decreases to a minimum of approximately 30 gpm at a minimum RCS pressure of approximately 1,000 psia at about 80 minutes. This is less than the charging flow rate of 40 gpm. The minimum reactor vessel level occurs between 80 and 90 minutes where the level drops slightly below the Support Plate at the top of the Upper Guide Structure (separating the upper head from the upper plenum). With a minimum water level of approximately 29 feet, there is substantial margin the top of the hot leg nozzles at 18.7 feet.

There is no significant change in RCS temperature, pressure or power prior to reactor scram, so this event does not challenge the DNBR or FCM SAFDLs. Significant steam generator liquid mass inventories were retained in both steam generators, so there was adequate mass in the steam generators supplied by AFW to make up for the steam mass lost through the MSSVs and ADVs. Likewise, the total amount of AFW delivered is well within the initial inventory of the Condensate Storage Tank. Thus, all acceptance criteria are satisfied for this event.

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Table 3.33 Station Blackout: Initial Conditions and Biasing

Parameter	Value
Core Power	3,020 MWt
Core Inlet Temperature	551°F
RCS Flow Rate	375,000 gpm
Pressurizer Pressure	2,250 psia
Pressurizer Level	65.6%
Scram Reactivity	8,125 pcm
Pressurizer PORV	Disabled
Pressurizer Spray	Disabled
Pressurizer Heaters	Disabled
Pressurizer Safety Valves	Available
SBCS	Disabled
ADV	Available with operator action after 1 hr.
Charging Pump	40 gpm with operator action after 1 hr.
MSSV	Available
Low SG Level ESF Trip (AFW)	Credited
AFW (Steam-driven pump)	600 gpm as full flow, throttled to approximately half flow after 10 min. with operator action
MSSV Setpoints	Bank 1: 4/SG @ 1,000 psia Bank 2: 4/SG @ 1,040 psia
Steam Generator Blowdown Flow	50 gpm per SG terminated at 30 min.
Condensate Storage Tank water volume	116,000 gal.[a]
Duration/coping time	4 hr.
Total initial RCP leakage	60 gpm

[a] This analysis would bound any increase in the CST water volume to a value greater than 116,000 gal.

Table 3.34 Station Blackout: Sequence of Events

	Time	
	seconds	minutes
Loss of all AC power: scram turbine trip begin Main Feedwater coastdown begin RCP coastdown begin RCP leak	1	
CEA insertion begins	1.5	
CEAs fully inserted	4.4	
SG low level setpoint reached	6.6	
Bank 1 MSSVs in both loops open (begin cycling)	7	
Beginning of AFW delivery to SGs	336.6	
AFW flow throttled to about half of initial	600	10
SG blowdown flow secured		30
Operators open ADVs (for the first time) Operators supply power and start one charging pump	3,600	60
PZR level off scale low		65
Upper Head subcooling lost		~72
Operator closes ADVs (for the first time) Minimum level in the reactor vessel		~80
ADVs open (for 2nd time)		~89
ADVs close (for 2nd time) Minimum RCS pressure		~96
PZR level recovers (and remains above zero % span)		~118
AFW flow is (temporarily) stopped (for the first time)		~165
AFW flow resumes		~183
End (power is restored)	14,400	240

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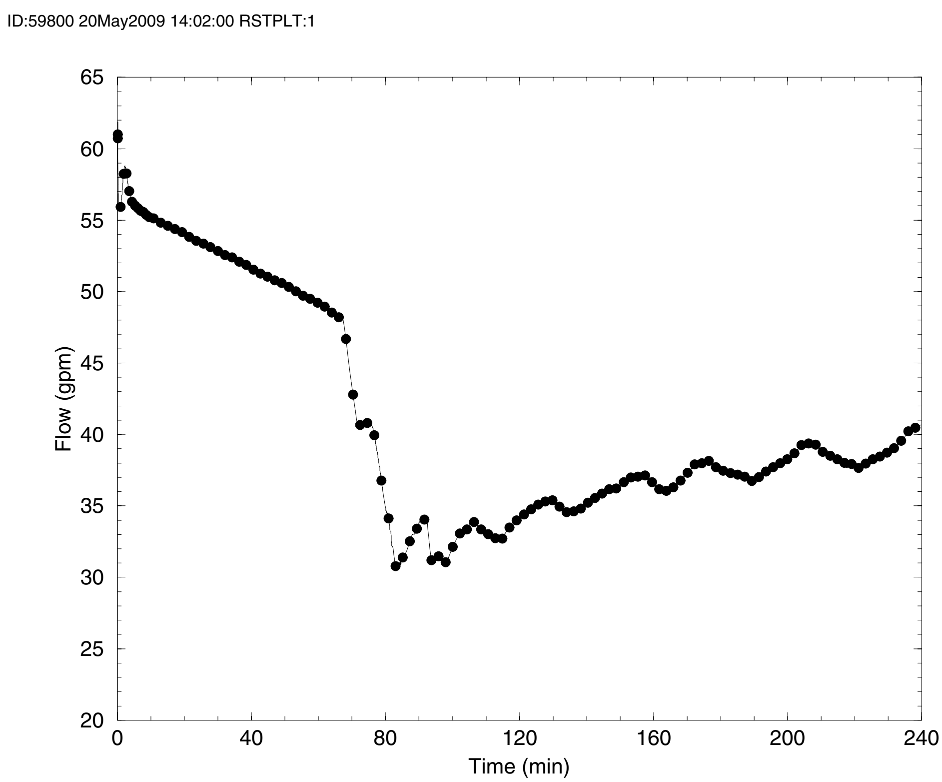

Figure 3.198 Station Blackout: Total RCS Leakage

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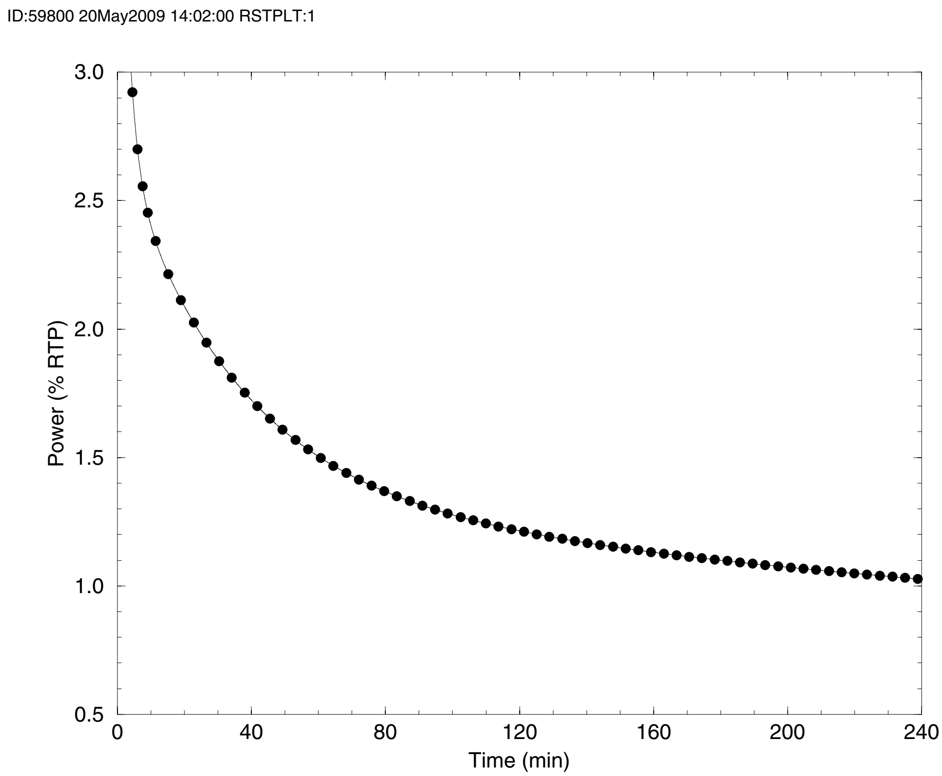

Figure 3.199 Station Blackout: Reactor Power (Decay Heat)

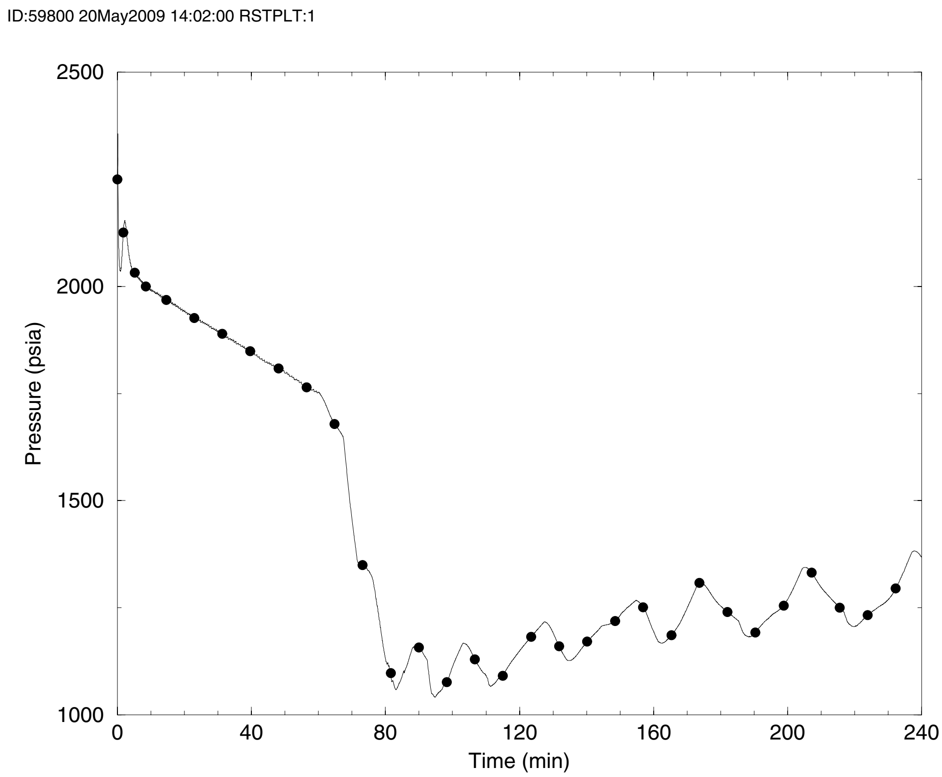

Figure 3.200 Station Blackout: Pressurizer Pressure

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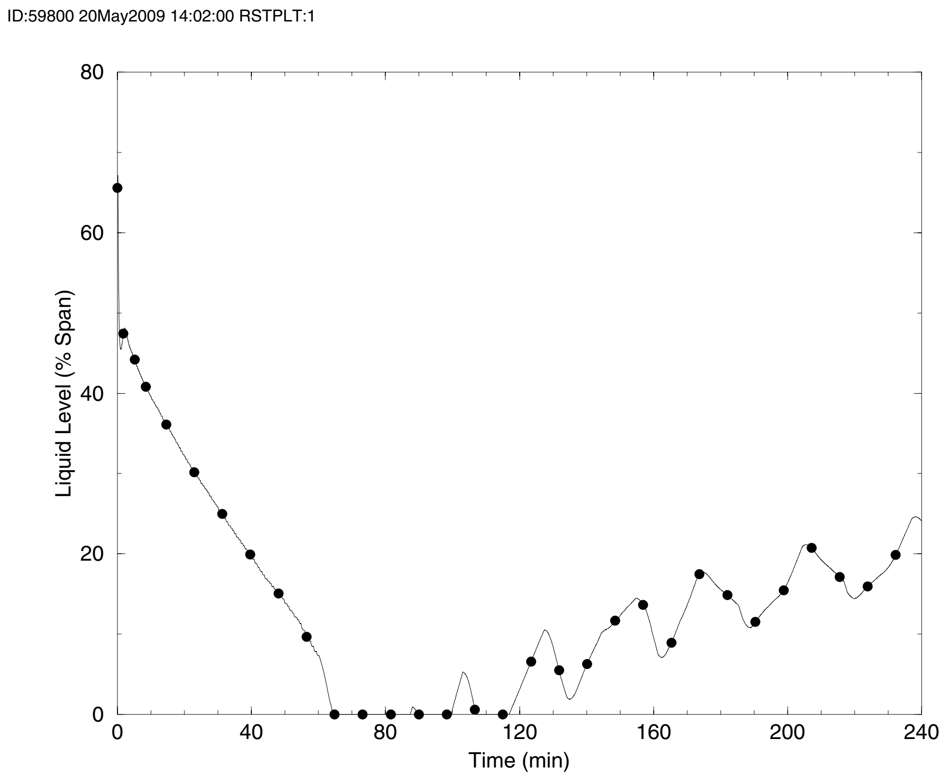

Figure 3.201 Station Blackout: Pressurizer Liquid Level

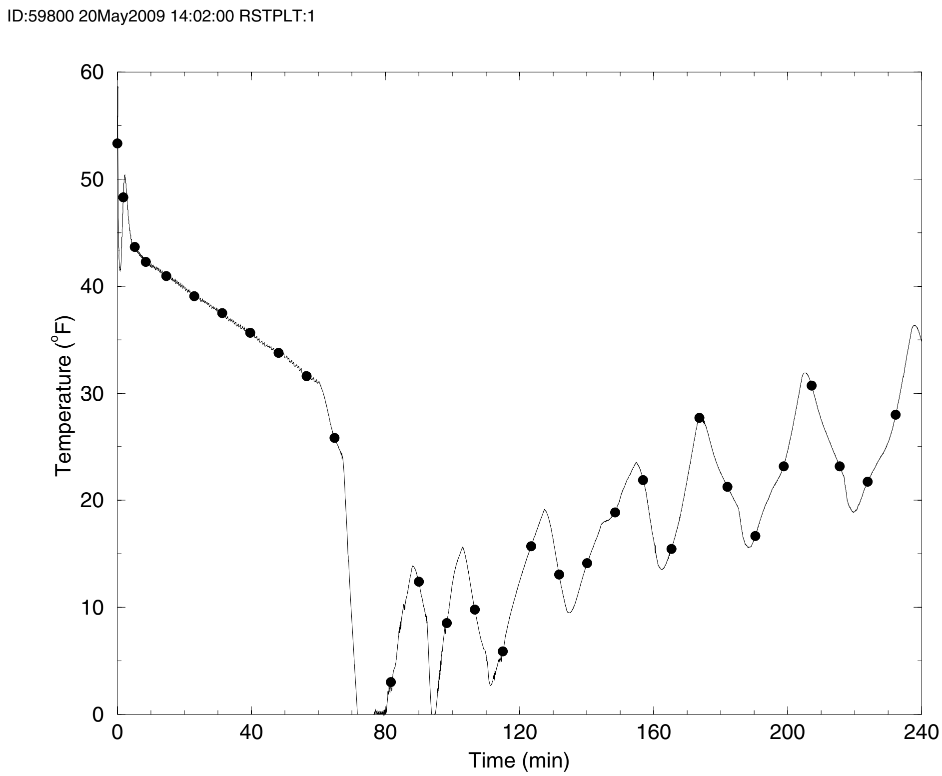

Figure 3.202 Station Blackout: RCS Reactor Vessel Upper Head Subcooling

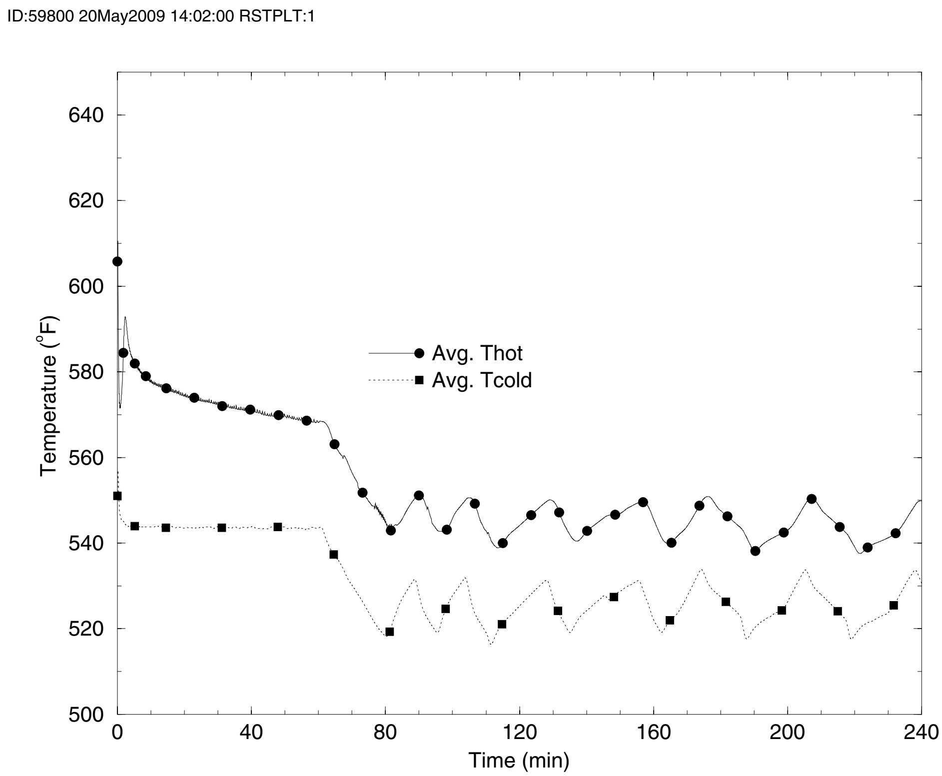

Figure 3.203 Station Blackout: RCS Average Temperatures

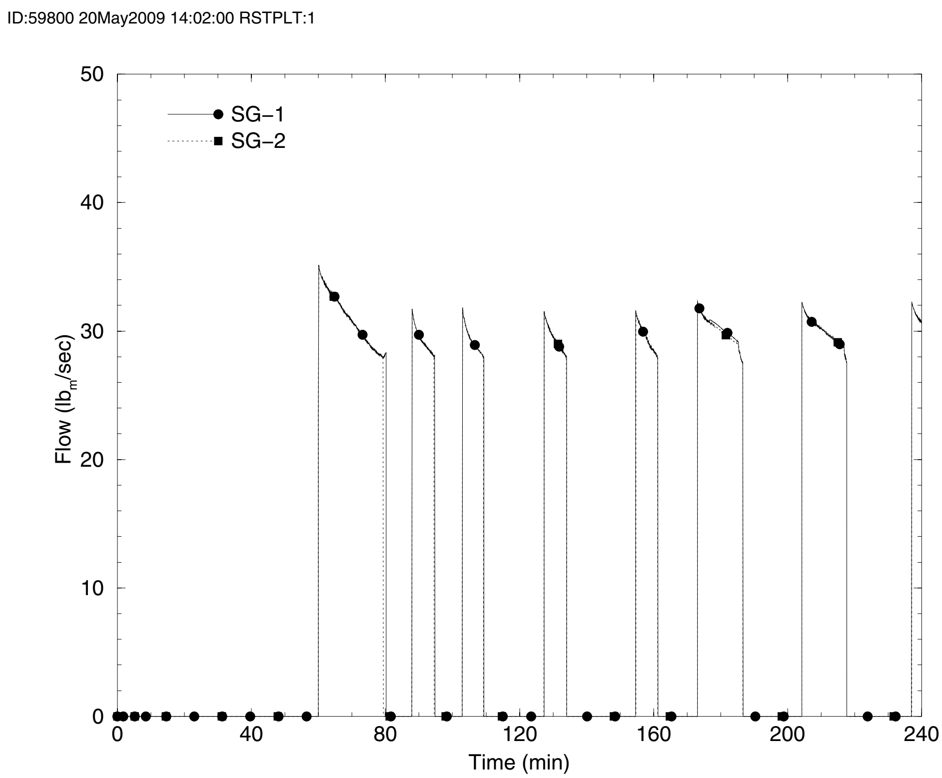

Figure 3.204 Station Blackout: ADV Flow Rates

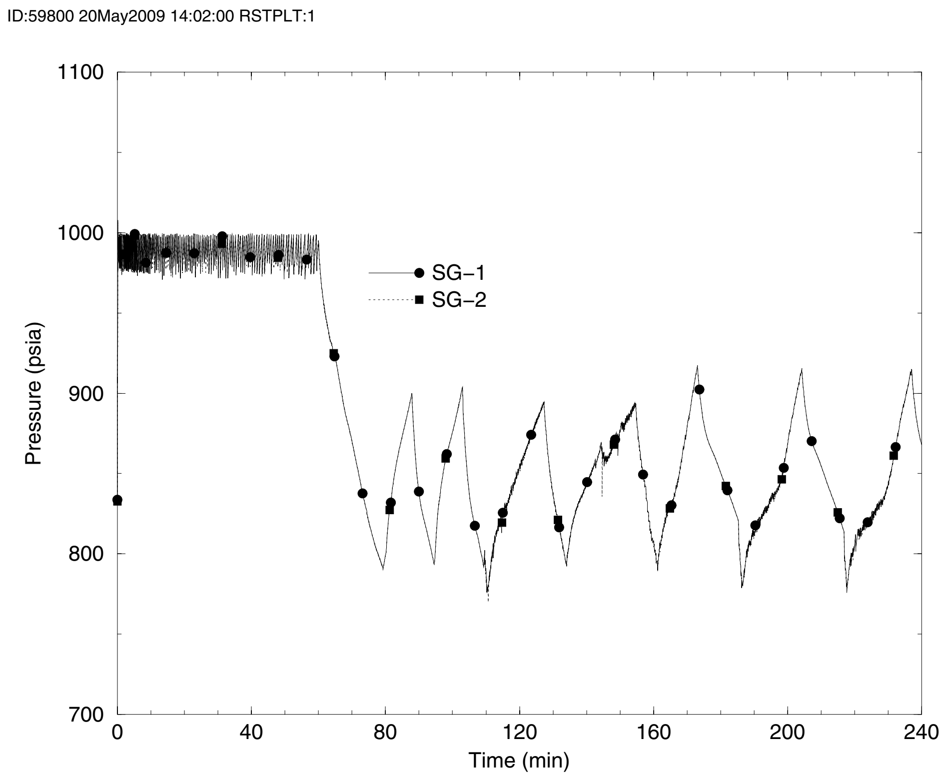

Figure 3.205 Station Blackout: Steam Generator Pressure

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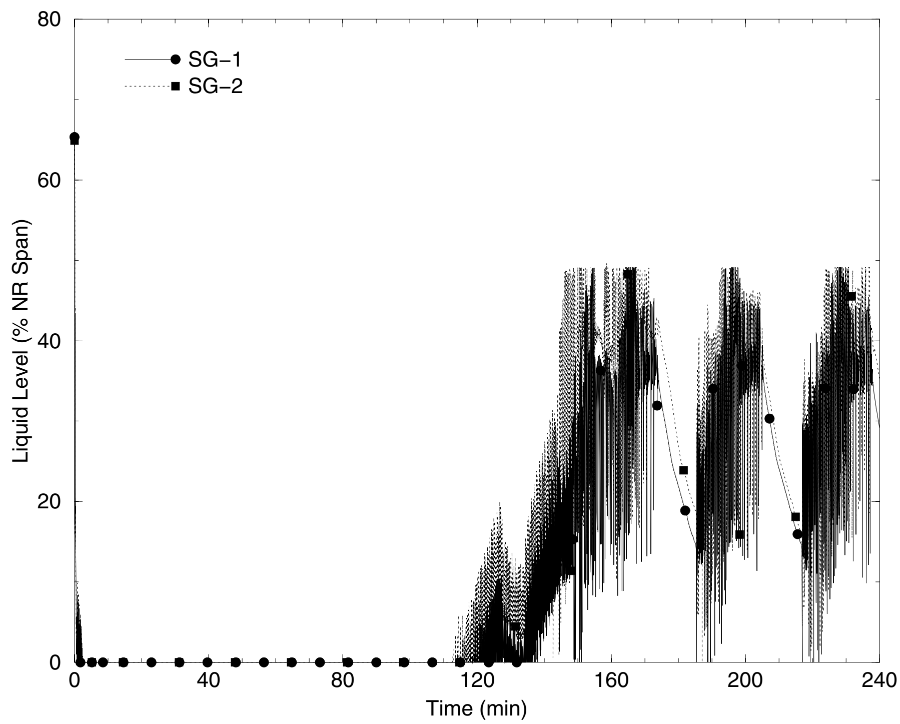

Figure 3.206 Station Blackout: Steam Generator Liquid Level

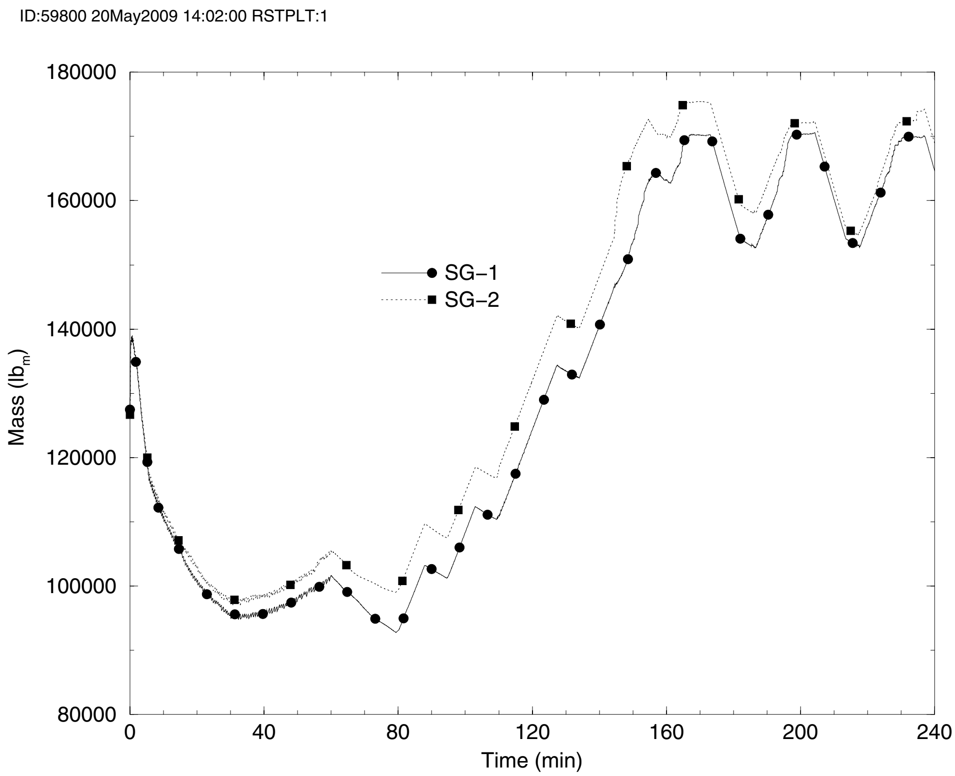

Figure 3.207 Station Blackout: Steam Generator Total Mass

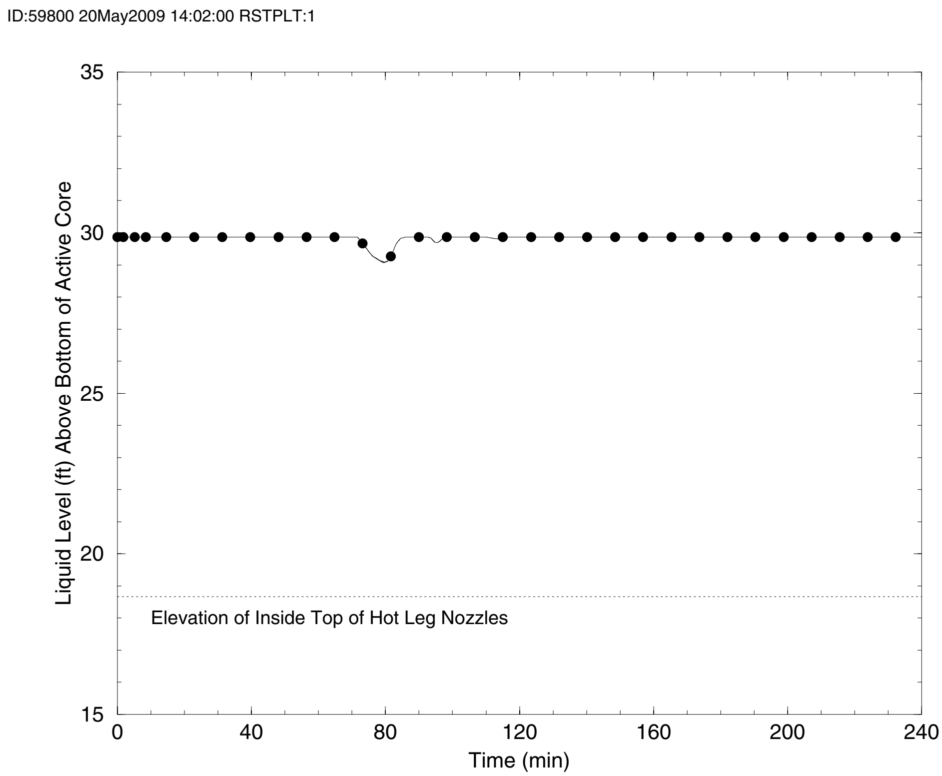

Figure 3.208 Station Blackout: Reactor Vessel Liquid Level (Above Bottom of Active Core)

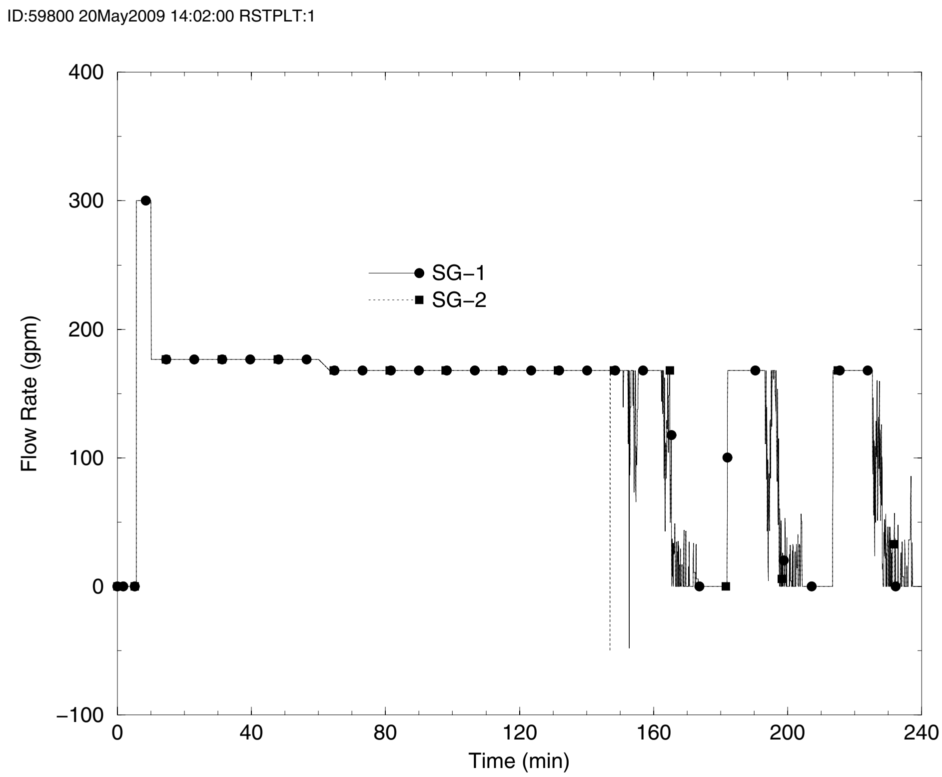

Figure 3.209 Station Blackout: Total Auxiliary Feedwater Flow

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5.0 References

1. EMF-2310(P)(A) Revision 1, *SRP Chapter 15 Non-LOCA Methodology for Pressurized Water Reactors*, Framatome ANP, Inc., May 2004.

2. XN-NF-82-21(P)(A) Revision 1, *Application of Exxon Nuclear Company PWR Thermal Margin Methodology to Mixed Core Configurations*, Exxon Nuclear Company, September 1983.

3. EMF-1961(P)(A) Revision 0, *Statistical/Transient Methodology for Combustion Engineering Type Reactors*, Siemens Power Corporation, July 2000.

4. EMF-92-153(P)(A) Revision 1, *HTP: Departure From Nucleate Boiling Correlation for High Thermal Performance Fuel*, Siemens Power Corporation, January 2005.

5. XN-NF-78-44(NP)(A), *A Generic Analysis of the Control Rod Ejection Transient for Pressurized Water Reactors,* Exxon Nuclear Company, October 1983.

6. XN-NF-81-58(P)(A) Revision 2 and Supplements 1 and 2, *RODEX2 Fuel Thermal-Mechanical Response Evaluation Model*, Exxon Nuclear Company, March 1984.

7. ANF-81-58(P)(A) Revision 2 Supplements 3 and 4, *RODEX2 Fuel Thermal-Mechanical Response Evaluation Model*, Advanced Nuclear Fuels, June 1990.

8. XN-NF-75-21(P)(A) Revision 2, *XCOBRA-IIIC: A Computer Code to Determine the Distribution of Coolant During Steady State and Transient Core Operation,* Exxon Nuclear Company, January 1986.

9. IN-1412, TID-4500, *A Correlation of Rod Bundle Critical Heat Flux for Water in the Pressure Range 150 to 725 psia.* Idaho Nuclear Corporation, July 1970.

10. RS-001 (Revision 0), *Review Standard for Extended Power Uprates*, Office of Nuclear Reactor Regulation, USNRC, December 2003.

11. Letter, J.A. Norris to J. H. Goldberg, "St. Lucie, Units 1 and 2 - 10 CFR 50.63 – Station Blackout (TAC Nos. 68608 and 68609)", September 12, 1991, Docket Nos. 50-335 and 50-389.

12. Letter, J. A. Norris to J. H. Goldberg, "St. Lucie Plant, Units 1 and 2 - Response to 10 CFR 50.63 - Station Blackout", dated June 11, 1992.

13. FPL Letter L-89-236 to the NRC, "Turkey Point Units 3 & 4 Dockets Nos. 50-240 and 40-251 - St. Lucie Units 1 and 2 Docket Nos. 50-335 and 50-389, Report NTH-TR-01, RETRAN MODEL QUALIFICATION", October 12, 1989.

14. NUMARC 87-00, Rev. 1, Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors.

15. EMF-96-029(P)(A), Volumes 1 and 2, Reactor Analysis Systems for PWR, Volume 1 – Methodology, Volume 2 – Benchmarking Results, Siemens Power Corporation, January 1997.

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ATTACHMENT 8
APPENDIX C

LOSS OF VENTILATION TO CONTROL ROOM AND REACTOR AUXILIARY BUILDING AREAS UPON STATION BLACKOUT

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1.0 Purpose

This report documents the St. Lucie Unit 1 Station Blackout (SBO) 1-Hour DC Coping Assessment for temperatures in the Control Room (CR), Technical Support Center (TSC), Electrical Equipment Rooms (EER), Battery Rooms (BR), Inverter Room (INV), and Control Element Assembly Motor Generator (CEA MG) Area with regard to loss of ventilation.

2.0 Licensing Requirements

The SBO rule [10 CFR 50.63(c)(2)] (Reference 7.2) requires alternate AC (AAC) plants to perform a coping analysis to address how the plant would cope without AC power for one hour if AAC power could not be restored in 10 minutes. For the one-hour coping analysis, the crosstie to the Unit 2 EDG is assumed to be unavailable for one hour, and the station copes on DC power during that time.

3.0 Criteria

3.1 NUMARC 87-00

NUMARC 87-00 Section 2.7 (Reference 7.3) criteria includes assumptions concerning the potential for thermal-induced equipment failure for the dominant areas of concern that are separated into three distinct conditions based on bulk air temperatures:

Equipment located in Condition 1 rooms is considered to be of low concern. This condition is defined by a steady-state temperature of 120 °F.

Equipment located in Condition 2 rooms generally requires no forced cooling in order to assure operability. If additional cooling is needed, operator actions such as opening doors or removing ceiling tiles may be sufficient to support equipment operation to mitigate a station blackout event. This condition is defined by a steady-state temperature of 150 °F.

Equipment located in Condition 3 rooms require plant-specific treatment of the potential for thermal-induced failure. Such treatment may include (1) further plant-specific analysis, (2) providing forced cooling, and (3) replacement by equipment designed or qualified to the environment.

All of the rooms/areas evaluated in this report are Condition 1 rooms.

3.2 Control Room Area Habitability

Reference 7.3, Section 2.7.2(3) includes discussion concerning control room habitability in higher temperature environments. The St. Lucie personnel heat stress requirements that establish action time criteria for habitability for working in elevated-temperature areas are utilized in this report. Those requirements indicate that for workers performing light work at 110 °F, the action time is slightly longer than 30 minutes; and for workers performing light work at 120 °F, the action time is slightly longer than 20 minutes.

4.0 Analyses

SBO room heatup analyses were performed for the Control Room (CR), Technical Support Center (TSC), Electrical Equipment Rooms (EER), Battery Rooms (BR), Inverter Room (INV), and Control Element Assembly Motor Generator (CEA MG) Area. The analyses considered a loss of ventilation for one hour. There is no process equipment (i.e., piping, pumps or heat exchangers) located in the areas under consideration. Electrical equipment, lighting, personnel and stored energy from steel masses were the primary heat loads considered.

4.1 Electrical and Lighting Heat Loads

The following electrical and lighting heat loads were developed in plant calculations and considered in the analysis:

Table 4-1 Electrical/Lighting Heat Loads for Station Blackout

Room	Heat released in BTU/HR (SBO-DC)
Electrical Equipment Room 1A	275
Electrical Equipment Room 1B	49,379
Electrical Equipment Room 1C	22,002
Inverter Room	9,481
Control Room	328,111
Technical Support Center	22,515
CEA MG Area	112

4.2 Personnel Heat Loads

Heat loads were modeled based on eight people working in the control room and thirty-one people in the TSC. The numbers of personnel exceed the minimum shift complement in the control room and represent full staff in the TSC. For a worker, standing or walking and performing light work, the total heat load per worker was 550 Btu/hr. Conservatively, the entire heat load is modeled as sensible heat.

4.3 Steel Thermal Mass for Heat Loads

The heated steel mass in each room was derived in plant calculations from field walkdowns and vendor drawings. The values used in the analysis were as follows.

Table 4-2 Heated Steel Mass

Description	Steel Mass (lbm)
CR Cabinets	20054
TSC Cabinets	2557
EERA Cabinets	10602
EERB Cabinets	17364
EERC Cabinets	18279
Batt Rm 1A Cab	2039
Batt Rm 1B Cab	2161
Inv Rm Cabinets	3712
M-G Sets	*

* Heat addition from the M-G sets was based on equipment surface temperature and surface area data. For analysis purposes, the initial M-G set temperature is maintained for the entire 1-hour period, which conservatively models the heat load.

4.4 Radiation Heat Gain

The radiation heat gain through exterior surfaces due to solar sources was developed in plant calculations using the 2009 ASHRAE Sol-Air Method and considered in the analysis.

4.5 Room Free Volumes

The following room free volumes were developed in plant calculation and used in the analyses for determining the temperatures:

Table 4-3 Room Free Volumes

Room	Free Volume (cubic feet)
Battery Room 1A	5,862
Battery Room 1B	6,951
Electrical Equipment Room 1A	22,165

Room	Free Volume (cubic feet)
Electrical Equipment Room 1B	68,674
Electrical Equipment Room 1C	50,356
Inverter Room	2,679
Control Room – Below dropped ceiling	26,482
Control Room , TSC and associated areas above dropped ceiling	46,352
Technical Support Center	9,494
CEA MG Area	36,470

4.6 Walls, Floors and Ceilings

Concrete and concrete block walls, floors and ceilings were considered for each room as both heat sinks and as conductors between spaces. Structural steel heat sinks, such as the unistrut framework above the drop ceiling, are conservatively not credited. The surface areas of the concrete and concrete block walls determined from plant drawings and included in the analysis are as follows:

Table 4-4 Conductor Surface Areas

Area Description	Conductor Surface area
Elevation 62', including the Control Room and TSC	31942 sq feet
Elevation 43', including the Battery rooms. Inverter room and Electronic Equuipment Rooms	24333 sq feet
CEA MG Set Room	7211 sq feet

The thicknesses of the concrete and concrete block vary from 4 inches to 36 inches.

In addition to the concrete and concrete block, the acoustic tile drop ceiling, metal stud walls, fire barrier walls and acoustic wall covering were considered as conductors between spaces. Each of these materials has some heat capacity in the model, although it is minimal as compared to the concrete.

5.0 Results

The following table presents the resulting temperatures for the areas evaluated. No credit is taken for operator actions.

Table 5-1 Station Blackout Room Temperatures

Time (min)	Control Room	TSC	EER 1A	EER 1B	EER 1C	Battery Room 1A	Battery Room 1B	Inverter Room	CEA MG Area
0	76	76	104	104	89	104	104	104	104
5	82	86	103	103	91	104	104	103	106
10	86	90	103	103	92	104	103	103	106
15	89	92	103	103	92	104	103	104	107
20	94	94	103	103	92	104	103	105	107
25	98	96	103	104	92	104	103	105	107
30	103	97	103	104	93	104	103	106	107
35	106	99	103	104	93	104	103	107	107
40	109	100	103	104	93	104	103	107	107
45	112	102	103	105	93	104	103	108	107
50	115	103	103	105	94	104	103	108	107
55	118	105	103	105	94	104	103	109	106
60	120	106	103	105	94	104	103	109	106

Table Note: The elevation 62 ft H&V Room, containing the control room and electrical equipment rooms HVAC equipment, experienced a temperature rise of less than 1 °F during the one-hour transient. No heat load inputs, from either electrical equipment or residual heat sources, were applied to any of the cells representing the room.

The graphs on the following pages present the detailed transient temperature profiles for the areas.

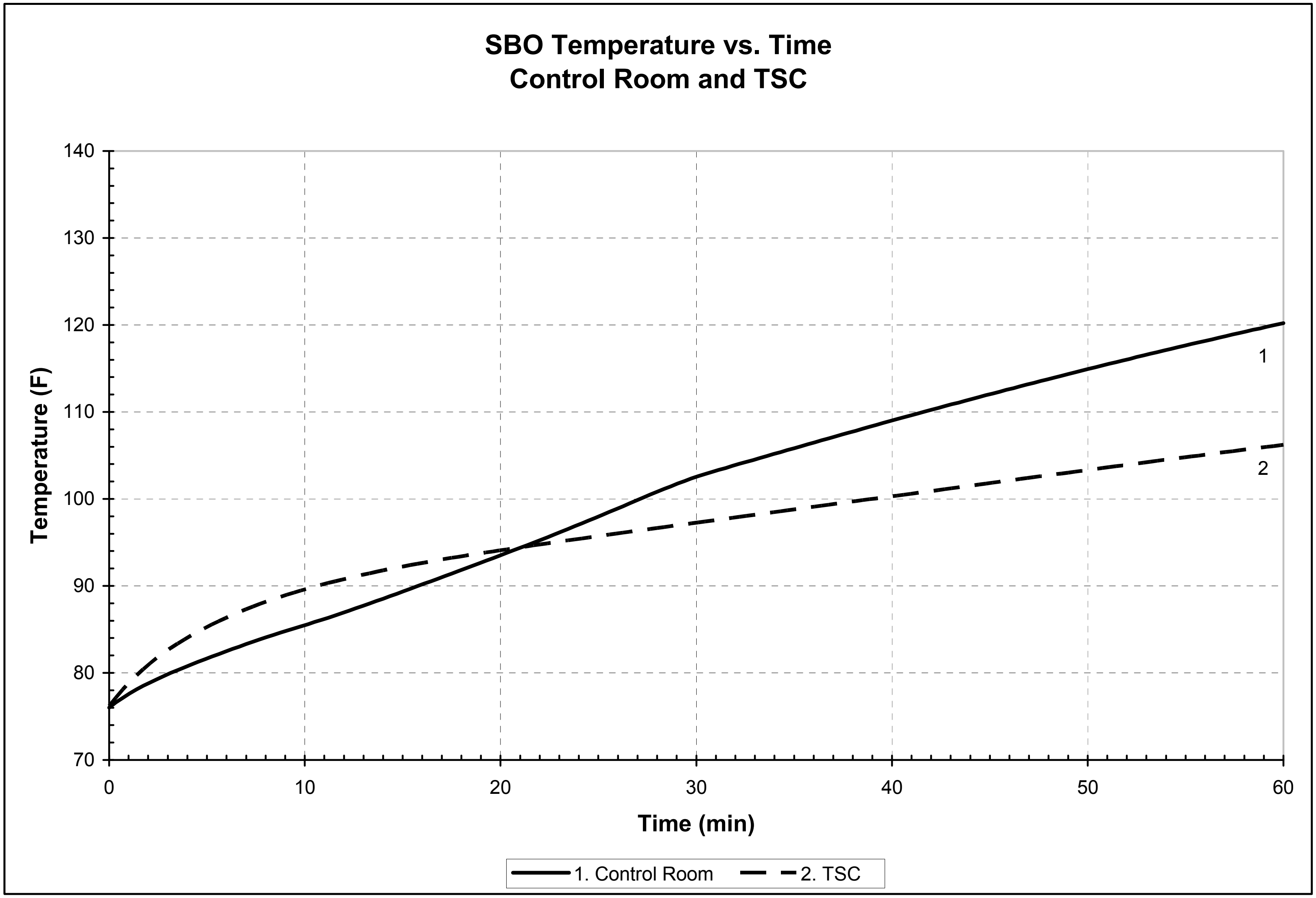

Figure 1 Control Room and TSC Temperatures

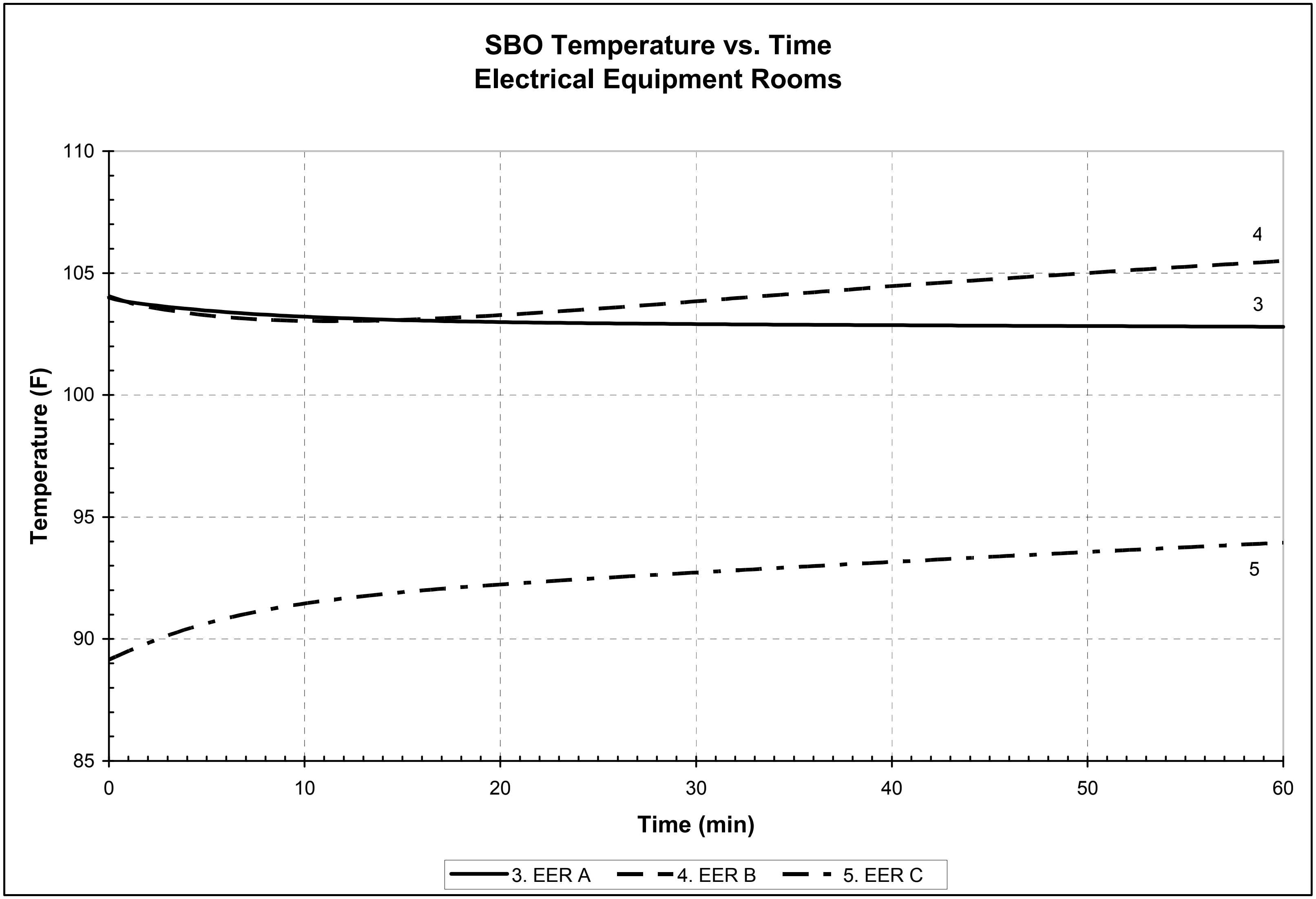

Figure 2 Electrical Equipment Room Temperatures

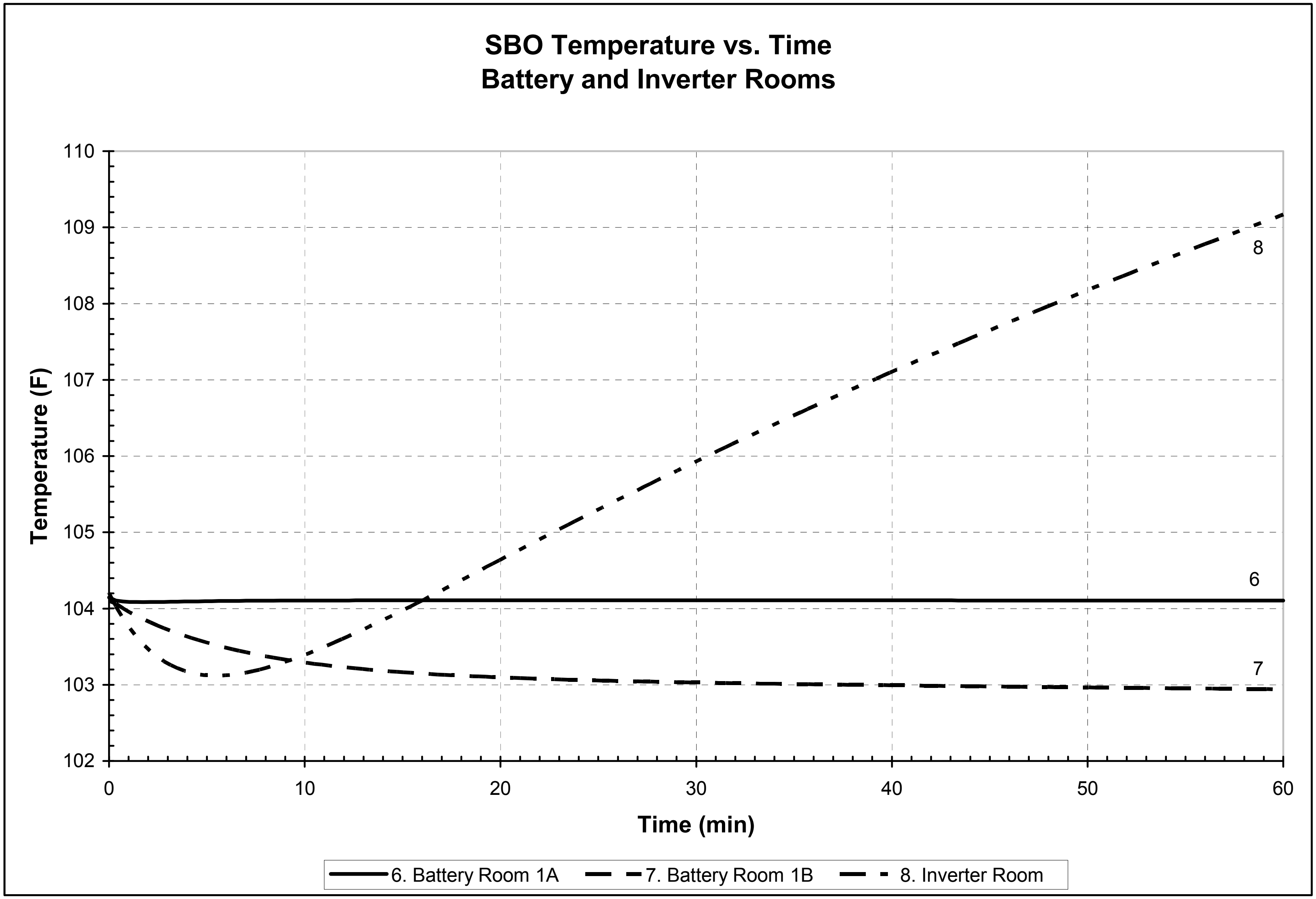

Figure 3 Battery and Inverter Room Temperatures

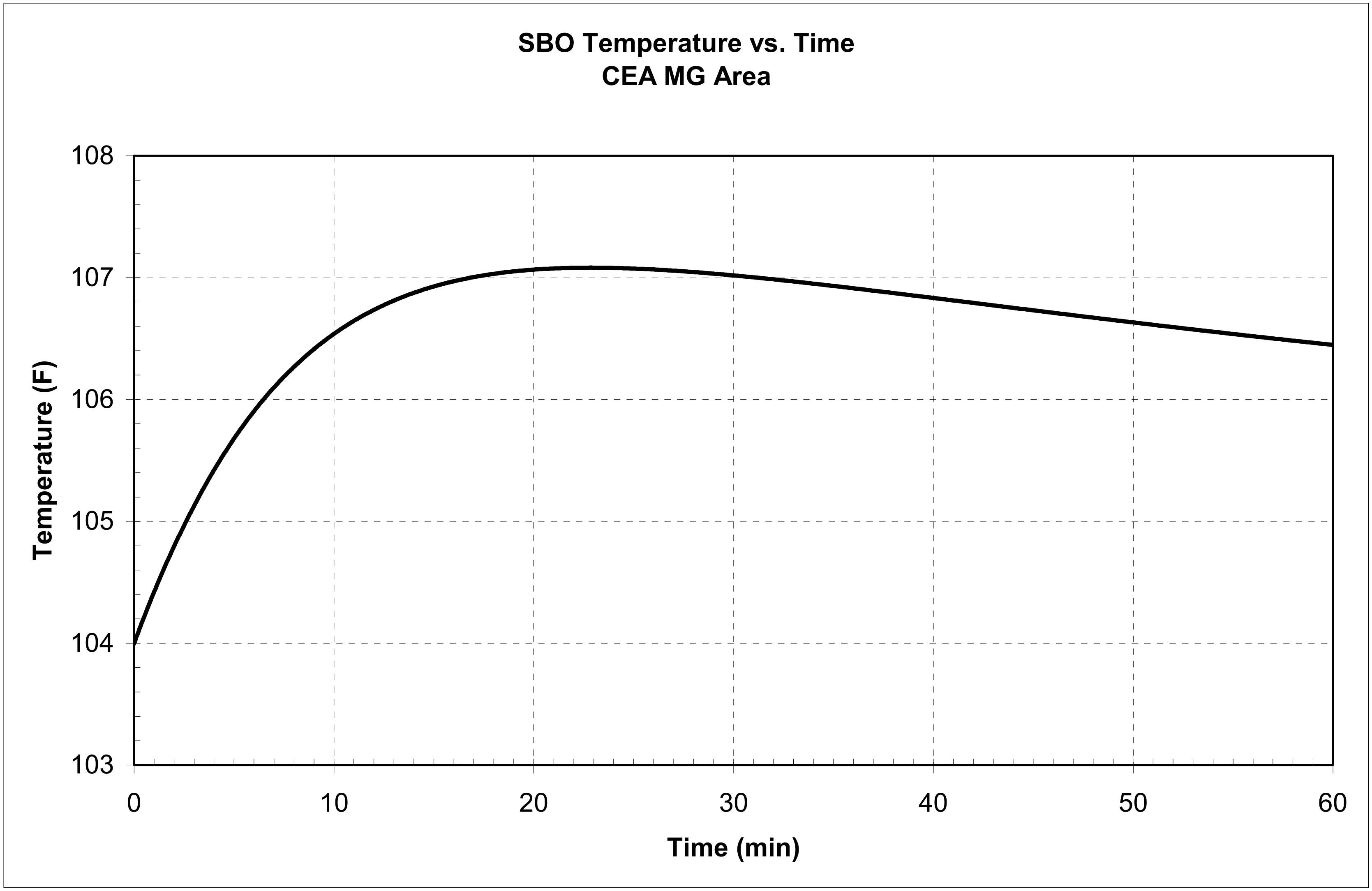

Figure 4 CEA MG Area Temperature

6.0 Conclusions

SBO equipment operation and habitability requirements are met with respect to temperatures in the areas considered.

7.0 References

7.1 UFSAR Unit 1, Amendment 209.

7.2 10 CFR 50.63, "Loss of all Alternating Current Power."

7.3 NUMARC 87-00, Revision 0, "Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors," dated November 1987.

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APPENDIX D

CONTAINMENT ISOLATION UPON STATION BLACKOUT

St. Lucie Unit 1
SBO Coping Assessment – Containment Isolation

Discussion

NUMARC 87-00 (Reference 1) provides a methodology for ensuring appropriate containment integrity can be provided during a station blackout event for the required duration. NUMARC 87-00 defines "appropriate containment integrity" as providing the capability for valve position indication and closure of certain containment isolation valves independent of the preferred or Class 1E power supplies. Acceptable means of closure include manual operation, air operation (including air-operated valves that are mechanically closed on loss of air, DC-powered operation, and Alternate AC-powered operation. Acceptable means of position indication include local mechanical indication, DC-powered indication (including AC-powered indicators powered by inverters), and Alternate AC-powered indication.

Evaluation Methodology

Based on NUMARC 87-00, Section 7.2.5, the following methodology is used to ensure appropriate containment integrity can be provided during an SBO event for the required duration (i.e., 4 hours for St. Lucie Unit 1):

Step 1: Valve Identification

Review the list of containment isolation valves (CIVs) and exclude the following from consideration:

(1) Valves normally locked closed during operation
(2) Valves that fail closed on loss of AC power or air
(3) Check valves
(4) Valves in non-radioactive closed-loop systems not expected to be breached in a station blackout (with exception of lines that communicate directly with the containment atmosphere)
(5) All valves less than 3-inch nominal diameter

The remaining valves are the containment isolation valves of concern.

Step 2: Containment Isolation Valves Requiring Manual Operation

List valves from Step 1 that are of concern and which need to be operated to cope with an SBO for the required duration. Ensure that these valves can be operated independent of the preferred and Class 1E power supplies and have position indication that is independent of the preferred and Class 1E power supplies.

Step 3: Containment Isolation Valves Requiring Closure Capability

List valves from Step 1 not identified in Step 2. Ensure that these valves can be closed independent of the preferred and Class 1E power supplies and have position indication that is independent of the preferred and Class 1E power supplies.

The following supplemental guidance contained in References 1.a and 1.b is applicable to this evaluation:

- Reference 1.a, Question 100 states: "Can we assume that if our procedures call for valves to be closed can they be considered locked closed per Section 7.2.5, Step 1?" Answer to Question 7.1 states: "No. Locked closed means a mechanical device of some sort has been applied to the valve. Procedures calling for valve closure or administrative tagouts do not qualify as providing locked closed status."

- Reference 1.b, Question 7.1 states: "When ensuring containment integrity, can normally closed valves be excluded from consideration similar to valves normally locked during operation per NUMARC 87-00, Section 7.2.5, Step 1 (1)?" Answer to Question 7.1 states: "No. A normally closed valve may not be considered to be a normally locked closed valve unless some action is taken to prevent valve operation. Such actions would include removing control power fuses or racking out breakers supplying power to motor operators"

- Reference 1.a, Question 101 states: "Do you have to show that you can close both the inboard and outboard containment isolation valves?" Answer to Question 101 states: "No. Since you do not have to assume a single failure in addition to the failures resulting in a station blackout, providing the capability to close one valve would establish containment integrity."

Evaluation

Step 1 Evaluation

Table 6.2-16 of the UFSAR (Reference 2) was used to identify all containment isolation valves. Each CIV was evaluated against the exclusion criteria for Step 1. Since Table 6.2-16 gives the pipe sizes of the containment penetrations, applicable P&IDs were used to obtain CIV size, as required. The evaluation results are documented in Table 1 of this report. As shown in the table, the following valves are identified as "containment isolation valves of concern":

- MV-07-2A, MV-07-2B - Containment Sump Isolation Valves

Step 2 Evaluation

Regarding status of systems during an SBO event, UFSAR Section 15.2.13.3 (Reference 3) states the following: The active containment heat removal systems have been assumed to be unavailable.

Based on the above, the CIVs of concern identified in Step 1 are not required to be operated to cope with an SBO event.

Step 3 Evaluation

Per NUMARC 87-00 criteria, CIVs MV-07-2A and -2B have been identified in Step 1 as valves of concern and thus require further evaluation to demonstrate containment integrity during the SBO event.

These motor-operated valves, located outside containment in the containment spray system lines from the containment sump, are normally closed. These valves have indication in the Control Room; the Control Room switch for each of these valves is verified weekly by procedure to be in the "closed" position. The piping system upstream of the valves is open to the containment sump, but the piping system downstream of the valves is a closed, seismic Class I system (Reference 4). In addition, there is a solid water seal downstream between MV-07-2A and check valve V07174, and between MV-07-2B and check valve V07172. There are also solid water seals downstream of the check valves pressurized by the water column of the refueling water tank.

The normal plant processes followed to verify the closed-valve position, the closed seismic Class I piping system design, and the water seals provide assurance of containment integrity during the SBO event.

Further, both valves can be manually operated using a handwheel on the motor operator and have local mechanical indication.

Conclusion

Based on the above evaluation, appropriate containment integrity is provided during a station blackout event for the SBO coping duration. The valves identified as "valves of concern" have been evaluated further and shown to provide containment integrity during the SBO event. These valves are also capable of manual operation with position indication that is independent of the preferred and Class 1E power supplies. Modifications to these valves are not required.

References

1. NUMARC 87-00, Rev. 0, "Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors," as supplemented by the following letters (refer to Reference 5):

    a. NRC to NUMARC letter dated October 7, 1988, providing approval of NUMARC documents on station blackout (Generic Response Formats, Station Blackout Seminar Q&A, Appendix F, Appendix F Topical Report, and Errata

    b. NRC to NUMARC letter dated January 3, 1990, providing approval of NUMARC 87-00 supplemental guidance documents (Supplemental Q&A and Major Assumptions)

2. UFSAR Table 6.2-16, "Containment Penetration and Isolation Valve Information," Amendment No. 22

3. UFSAR Section 15.2.13.3, "Station Blackout Analysis, Analysis Assumptions and System Operation," Amendment No. 22

4. UFSAR Section 6.2.4.4, Containment Isolation System, Testing and Inspection, Amendment No. 20

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ATTACHMENT 8
APPENDIX E

LOSS OF VENTILATION TO CHARGING PUMP ROOM UPON STATION BLACKOUT

1.0 PURPOSE AND SCOPE

The purpose of the Charging Pump Room Temperature During SBO calculation is to determine the maximum room air temperature in the charging pump room for the first hour following a Station Blackout (SBO) event.

2.0 METHODOLOGY

- All lights off
- No ventilation to the room
- Heat sources in the room are the fluid in the process piping and the residual energy in the idled pump and motor

The following equations are used to calculate the room temperature after 1 hour (T_1):

$T_1 = T_0 + (q/V\rho c_p)$, where equation 1

T_0 = initial room temperature, °F

q = sensible heat (BTU)

V = Room volume, ft^3

ρ = density of air, 0.075 lb/ft^3

c_p = specific heat of air, 0.24 BTU/lb-°F

The heat added to the room by the process piping (q_p) is calculated using the following formula:

$q_p = ((T_f - T_0)/(r_s(\ln(r_s/r_p)) KD\pi L$, where equation 2

q_p = heat added to room by pipe, BTU/hr

T_f = temperature of process fluid, °F

T_0 = Starting ambient temperature, 104 °F

r_s = radius from the enter of the pipe to the outside of the insulation, in

r_p = radius from the enter of the pipe to the surface of the pipe, in

K = thermal conductivity of insulation, 0.38 BTU-in/hr-ft^2-°F

L = length of pipe, ft

D = outside diameter of the insulation, ft

The heat added to the room by the pump motor (q_m) is calculated using the following formula:

$q_m = UA_m\Delta T$, where equation 3

q_m = heat transferred by the motor to the room, BTU/hr

U = surface conductance of the motor, BTU/hr-ft^2-°F

A = surface area of motor ft^2

ΔT = temperature difference between average motor temperature and room initial ambient temperature, °F

The surface area of the motor is determined by considering it to be a cylinder and determining the area of the cylinder walls and ends separately.

The heat removed from the charging pump room (q_w) by conduction into the concrete walls is:

$q_w = A_w (T_{air}-T_{wall})^{(4/3)}$, where equation 4

q_w = heat transmitted through the walls, watt

A_w = area of walls, M^2

T_{air} = ambient room temperature, °C

T_{wall} = temperature of wall, °C

The maximum air temperature occurs when the heat transferred out of the room through the walls is equal to the heat added to the room by the pump and motor. This occurs when the following equation is satisfied:

$A_w (T_{air}-T_{wall})^{(4/3)} = q_m + q_p$ equation 5

The equilibrium room temperature is determined by assuming a room temperature and performing a series of iterations to make the equation true.

The effects of air infiltration and the reduction in heat load due to changes in the fluid and motor temperature as they cool are not included.

4.0 ASSUMPTIONS/BASES

The pump motor temperature at time T= 0 is based on field data.

Process fluid piping temperature is 120 °F. Vent, drain and bypass piping is at ambient temperature.

During the first hour of the event a constant room temperature of 104 °F is conservatively assumed when calculating the heat added to the room.

The motor is assumed to be all steel, with a specific heat of 0.10 BTU/lb-°F.

Rooms adjacent to the charging pump room will remain at a constant air temperature of 104 °F for the duration of the event.

The room volume is heated evenly.

5.0 CALCULATION

By iterating equation 5 the room temperature at the end of the first hour is 106.7 °F

6.0 RESULTS

The maximum ambient temperature in the charging pump room at the end of the first hour of the SBO event, with no ventilation or equipment operating is 106.7 °F.