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Rev. 00**

**Joint Applications Report
for**

**DC Power Source
Allowed Outage Time Extension**

FINAL REPORT

CEOG Task 849

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**PREPARED FOR THE
COMBUSTION ENGINEERING OWNERS GROUP**

BY

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LIST OF ACRONYMS

AFW	Auxiliary Feedwater
AMG	Accident Management Guideline
ANO-2	Arkansas Nuclear One – Unit 2
AOT	Allowed Outage Time
CC-1&2	Calvert Cliffs Units 1&2
CCFP	Conditional Containment Failure Probability
CDF	Core Damage Frequency
CE	Combustion Engineering
CEOG	Combustion Engineering Owners Group
CRMP	Configuration Risk Management Program
CT	Completion Time
DC	Direct Current
DCH	Direct Containment Heating
EDG	Emergency Diesel Generator
EFW	Emergency Feedwater
ESF	Engineered Safety Feature
FCS	Fort Calhoun Station
FSAR	Final Safety Analysis Report
HPME	High Pressure Melt Ejection
ICCDP	Incremental Conditional Core Damage Probability
ICLERP	Incremental Conditional Large Early Release Probability
ISLOCA	Interfacing System Loss of Coolant Accident
ISTS	Improved Standard Technical Specifications
LCO	Limiting Condition for Operation
LER	Large Early Release
LERF	Large Early Release Frequency
LOP	Loss of Offsite Power
MP-2	Millstone Unit 2
NOED	Notice of Enforcement Discretion
NPP	Nuclear Power Plant
NRC	Nuclear Regulatory Commission
NSSS	Nuclear Steam Supply System
Pal	Palisades Nuclear Plant
PSA	Probabilistic Safety Assessment
PWR	Pressurized Water Reactor
PVNGS 1, 2 & 3	Palo Verde Nuclear Generating Station Units 1, 2, &3
RCS	Reactor Coolant System
RPS	Reactor Protection System
RPV	Reactor Pressure Vessel
SBO	Station Blackout

LIST OF ACRONYMS (Cont'd)

SG	Steam Generator
SGTR	Steam Generator Tube Rupture
SL-1	St. Lucie Plant Unit 1
SL-2	St. Lucie Plant Unit 2
SONGS 2&3	San Onofre Nuclear Generating Station Units 2 & 3
STS	Standard Technical Specifications
T-1	Thermally-Induced
TS	Technical Specification
VDC	Voltage – Direct Current
WSES-3	Waterford Steam Electric Station, Unit 3

1.0 PURPOSE

The purpose of this report is to provide justification for a risk-informed change to the Technical Specification (TS) allowed outage times (AOTs)/Completion Times (CTs) for the class 1E 125V direct current (DC) sources of the electrical power system at nuclear power plants (NPPs) with Combustion Engineering (CE) Nuclear Steam Supply System (NSSS) designs. Specifically, this report provides the methodology and technical justification for the extension of the AOT/CT addressed by Condition A of Section 3.8.4 of NUREG-1432, Revision 1 (Attachment 1) for a class 1E 125 VDC battery and its respective charger from the current 2 hours to either 8 or 24 hours. This proposed methodology applies to the batteries and respective charger(s) evaluations for all CE Pressurized Water Reactors (PWR) designs. Specific applications of this methodology are also presented in this report.

Implementation of the described AOT/CT modifications will enhance plant safety by allowing time for limited scope battery/battery charger repairs during power operation and averting unnecessary plant mode transitions. The proposed modifications will also reduce the potential for, and associated risks of, unnecessary plant shutdowns and consequently reduce the need for exigent Notice of Enforcement Discretions (NOEDs).

The described AOT/CT modifications are consistent with the objectives and intent of the Maintenance Rule [Ref. 1]. The overall risk of performing maintenance will be controlled via implementation of a configuration risk management program (CRMP) consistent with the guidance set forth in Regulatory Guide 1.177, "An Approach for Plant-Specific, Risk-Informed Decisionmaking: Technical Specifications", [Ref. 2].

2.0 SCOPE OF PROPOSED CHANGE TO TECHNICAL SPECIFICATION

The Limiting Conditions for Operation (LCO) of Section 3.8.4 of NUREG-1432, Revision 1, states that "The Train A and Train B DC electrical power subsystems shall be operable" during MODES 1, 2, 3 and 4. The required action for an inoperable DC electrical power subsystem during these modes of operation calls for restoring the DC electrical power subsystem to OPERABLE status with 2 hours. The 2 hour AOT/CT is based on a discussion provided in Regulatory Guide 1.93, "Availability of Electric Power Sources", [Ref. 3]. The intent of this effort is to use risk-informed arguments to support a change to the AOT/CT for these LCOs from the current value of 2 hours to either 8 or 24 hours, depending on the plant design.

The specific AOT/CT modifications and their relative impact are summarized in Table 2-1 for Arkansas Nuclear One Unit 2 (ANO-2), Fort Calhoun Station (FCS), San Onofre Nuclear Generating Station Units 2 & 3 (SONGS 2&3), and Waterford Steam Electric Station Unit 3 (WSES-3). The risk increments associated with implementation of the AOT/CT extension identified in the table are based on plant specific analyses. The 24 hour AOT/CT extension request reflects plant uniqueness in the DC electrical systems, which include additional redundancy in the class 1E batteries and their respective chargers. CE PWR designs in this category include SONGS 2&3 and WSES-3. Results for Palisades (not shown in Table 2-1) are provided within the body of the report to confirm the adequacy of their current 24 hour AOT for this condition. Risk data for the Palo Verde Nuclear Generating Station Units 1, 2 & 3 (PVNGS-1, 2 & 3), St. Lucie Units 1 & 2 (SL-1&2), Millstone Unit 2 (MP-2), and Calvert Cliffs Units 1 & 2 (CC 1&2) and their respective recommended AOT extension are not included in this report. Such information will be provided at the time a plant specific technical specification change request is submitted. These later submittals will utilize the general methodology contained in this report.

TABLE 2-1 Summary of Proposed AOT/CT Modifications			
CEOG Plant	Proposed AOT/CT [hours]	ICCDP Increase over Current AOT/CT	ICLERP Increase over Current AOT/CT
ANO-2	8	4.51E-7	3.21E-8
FCS	8	4.96E-7	2.68E-8
SONGS 2&3	24	6.76E-7	2.73E-8
WSES-3	24	3.43E-7	2.44E-8

The inoperability of a DC electrical power subsystem considered in this report is limited to non-common cause faults that would cause the affected electrical equipment to be taken out of service. The exclusion of common cause faults from the scope of the evaluation is based on the performance of an immediate assessment by the Combustion Engineering Owners Group (CEOG) member utility to ensure that the inoperability of the DC power subsystem was not the

result of a common cause event. The LCO of Section 3.8.4 of NUREG-1432, Revision 1, addresses the inoperability of a DC electrical power subsystem. The extension of the associated AOT/CT for an inoperable DC electrical power subsystem is the focus of this report. The simultaneous inoperability of more than one DC electrical power subsystem due to a common cause fault is governed by LCO 3.0.3, which is outside the scope of this report. Common cause faults that render the DC electrical system inoperable are risk significant and require immediate plant shutdown. Common cause faults of the DC electrical system are not candidates for on-line repair during MODES 1, 2, 3, and 4. The intent of this report is to justify extending the AOT/CT associated with the LCO for Section 3.8.4 of NUREG-1432, Revision 1, or equivalent TSs in order to perform short duration on-line repair of faulty DC electrical equipment. Such equipment would be declared inoperable and taken out of service due to a non-common cause fault.

3.0 BACKGROUND

This report provides a risk-informed technical basis for specific changes to TS AOTs/ CTs associated with inoperability of one DC electrical power subsystem. The applicable AOTs and completion times include those that correspond to the LCO and Conditions of Section 3.8.4 of NUREG 1432, Revision 1. The primary intent of the proposed changes is to provide for the potential of on-line maintenance of a battery or its respective charger that is declared INOPERABLE during operation in the applicable modes (Modes 1, 2, 3 and 4, or equivalent for customized TSs). These changes are warranted based on the low incremental risk associated with the extended AOTs. Additional time for battery/battery charger repair will also reduce the transition risk associated with shutting down the plant to Mode 5 (cold shutdown).

This application is being pursued by the CEOG as a risk-informed plant modification in accordance with NRC Regulatory Guides 1.174, [Ref. 4] and 1.177 [Ref. 2]. As required by Reference 2 all plants that adopt these changes will implement a CRMP to provide Probabilistic Safety Assessment (PSA) informed maintenance controls. CRMPs in conformance with A4 of the Maintenance Rule [Ref. 1] will be considered sufficient to satisfy this commitment.

This application provides generic information supporting the AOT extension for a battery and its respective charger, as well as the necessary plant-specific information to demonstrate the impact of these changes on an individual plant basis. The risk assessments provided in this report are based upon PSA models that reflect the plant configurations of concern during normal operation. The risk assessments provided in this document consider the significant impacts of the proposed TS modification. This includes an assessment of the Incremental Conditional Core Damage Probability (ICCDP) and the Incremental Conditional Large Early Release Probability (ICLERP) for a battery or its respective charger being out of service for the full duration of the AOT/CT. The supporting/analytical material contained herein is considered applicable to all CEOG member utilities (as appropriate) regardless of the category of their plant TSs.

In accordance with Regulatory Guide 1.177, single AOT risk is evaluated against the "very small risk" metrics of $5.0E-7$ for ICCDP and $5.0E-8$ for ICLERP. The cumulative impact of multiple simultaneous and sequential entries into the TS and the impact of external events are also considered.

4.0 SUMMARY OF APPLICABLE TECHNICAL SPECIFICATIONS

There are three distinct categories of TSs at CE designed NSSS units. Each category is described below.

The first category concerns TSs that utilized the format outlined in NUREG-0212 [Ref. 5]. Through May 1999, NUREG-0212, Revision 03, commonly referred to as "Standard Technical Specifications (STS)", has provided a model for the general structure and content of the approved technical specifications for several of the domestic CE desinged NSSS plants. The CE designed NSSS units with current, approved TSs in the STS format are: (a) MP-2, (b) SL-1, (c) SL-2, (d) ANO-2, and (e) WSES-3.

The second category concerns TSs that reference the Improved Standard Technical Specifications (ISTS) guidance provided in NUREG-1432 (Revision 0, dated September 1992 and Revision 1, dated April 1995). The CE desinged NSSS units with current, approved TSs that reference ISTS guidance are: (a) SONGS 2&3, (b) PVNGS-1, 2, and 3, and (c) CC-1&2.

The third category includes those TSs that have structures other than those that are outlined in either NUREG-0212 [Ref. 5] or NUREG-1432 [Ref. 6]. These TSs are generally referred to as "customized" TSs; and they are associated with the early CE PWR designs. The CE desinged NSSS plants that (a) have current and approved "customized" TSs and (b) do not have an on-going decommissioning plan are: Palisades Nuclear Generating Station and FCS. (Note: At the Palisades Station, there is an on-going program for conversion to TSs that reference ISTS guidance.)

Each of these categories of TSs include operating requirements for batteries and their respective chargers corresponding to the requirements addressed in NUREG-1432 LCO 3.8.4.

4.1 Standard Technical Specifications

The current STS for the various CE designed NSSS plants for DC Sources – Operating are summarized in Table 4-1. References 12 through 16 were used to summarized the information in this table. The LCO is entered whenever a battery is declared inoperable. Unavailability of a single charger may not render the associated battery inoperable due to the availability of redundant dedicated backup chargers and/or swing chargers.

In all instances, inoperability of a battery bank will result in a 2 hour AOT. The STS further requires, if OPERABLE status of the battery bank is not achieved by the end of the 2 hour interval, the plant must be in hot standby in the next 6 hours and must be in cold shutdown in 30 hours.

**Table 4-1
Summary of STS Electrical Power Systems, DC Distribution – Operating (Modes 1, 2, 3, 4)**

CEOG Plant	TS #	Limiting Condition for Operation	TS Required Action	Comment	System Configuration See Figure
MP-2	3.8.2.3	The following D.C. bus trains shall be energized and OPERABLE with at least one tie breaker between bus trains open: 1. TRAIN "A" consisting of 125-volt D.C. bus 201A, 125-volt D.C. battery bank 201A and at least 400 ampere charging capacity. 2. TRAIN "B" consisting of 125-volt D.C. bus 201B, 125-volt D.C. battery bank 201B and at least 400 ampere charging capacity.	a) With one 125-volt D.C. bus inoperable (Note 3) b) With a 125-volt D.C. battery and/or charger inoperable (Note 4)	One spare charger available	1 (Note 9)
SL-1	3.8.2.3	As a minimum the following D.C. electrical sources shall be OPERABLE: 1. 125-volt D.C. bus No. 1A, 125-volt Battery bank No. 1A and a full capacity charger. 2. 125-volt D.C. bus No. 1B, 125-volt Battery bank No. 1B and a full capacity charger.	a) With one of the required battery banks or busses inoperable (Note 1) b) With one of the required full capacity chargers inoperable (Notes 5 & 8)	Three spare chargers (to each bus and one swing)	3A (Note 9)
SL-2	3.8.2.1	As a minimum the following D.C. electrical sources shall be OPERABLE: 1. 125-volt Battery bank No. 2A and a full capacity charger. 2. 125-volt Battery bank No. 2B and a full capacity charger.	a) With one of the battery banks inoperable (Note 2) b) With one of the required full capacity chargers inoperable (Notes 6 & 8)	Three spare chargers (to each bus and one swing)	3B (Note 9)
ANO-2	3.8.2.3	As a minimum, the following D.C. electrical sources shall be OPERABLE: 1. TRAIN "A" consisting of 125-volt D.C. bus No. 1, 125-volt D.C. battery bank No. 1 and a full capacity charger. 2. TRAIN "B" consisting of 125-volt D.C. bus No. 2, 125-volt D.C. battery bank No. 2 and a full capacity charger.	c) With one of the required battery banks inoperable (Note 2) d) With one of the required full capacity chargers inoperable (Notes 7 & 8)	One spare charger available	1 (Note 9)
WSES-3	3.8.2.1	As a minimum the following D.C. electrical sources shall be OPERABLE: 1. 125-volt Battery Bank No. 3A-S and one associated full capacity charger (3A1-S or 3A2-S). 2. 125-volt Battery Bank No. 3B-S and one associated full capacity charger (3B1-S or 3B2-S). 3. 125-volt Battery Bank No. 3AB-S and one associated full capacity charger (3AB1-S or 3AB2-S).	a) With one of the required battery banks inoperable (Note 2) b) With one of the required full capacity chargers inoperable (Notes 6 & 8)	Three redundant dedicated chargers available, one dedicated to each bus	4 (Note 9)

Notes for Table 4-1

1. Restore the inoperable battery bank or bus to OPERABLE status within 2 hours or be in HOT STANDBY within 6 hours and COLD SHUTDOWN within the following 30 hours.
2. Restore the inoperable battery bank to OPERABLE status within 2 hours or be in HOT STANDBY within 6 hours and COLD SHUTDOWN within the following 30 hours.
3. Restore the inoperable bus to OPERABLE status within 2 hours or be in COLD SHUTDOWN within the next 36 hours.
4. Restore the inoperable battery and/or charger to OPERABLE status within 2 hours or be in COLD SHUTDOWN within the next 36 hours.
5. Demonstrate the OPERABILITY of its associated battery bank(s) by performing Surveillance Requirement 4.8.2.3.2.a.1 within 1 hour, and at least once per 8 hours thereafter.
6. Demonstrate the OPERABILITY of its associated battery banks by performing Surveillance Requirement 4.8.2.1a.1 within 1 hour, and at least once per 8 hours thereafter.
7. Demonstrate the OPERABILITY of its associated battery banks by performing Surveillance Requirement 4.8.2.3.a.1 within 1 hour, and at least once per 8 hours thereafter.
8. If any Category A limit in Table 4.8-2 is not met, declare the battery inoperable.
9. Figure is provided in Attachment 2.

4.2 Improved Standard Technical Specification Guidance

Section 3.8.4 of NUREG-1432, Revision 1, describes the LCO requirement for DC power sources. This includes the actions to be taken when the LCO requirements cannot be satisfied and the completion time for accomplishing the required actions. Section 2 of this report provides a description of NUREG-1432 definitions of the conditions when LCO requirements for the batteries and their respective chargers are not satisfied.

This report provides risk-informed justifications for AOT/CT extensions corresponding to the actions in response to Condition A as defined in NUREG-1432. This condition and the existing corresponding required action and completion time are provided in Attachment 1.

4.3 “Customized” Technical Specifications

The “customized” TSs for DC power sources differ from those in the two versions of STSs. These differences include the duration of the allowed outage time and the descriptions of the surveillance requirements. The CEOG plants that currently employ the “customized” TS format are the Fort Calhoun Station and Palisades units. The current TS and allowed outage times for DC power sources of these units are as shown in Table 4-2. References 17 and 18 were used to summarize the information in this table.

**Table 4-2
Summary of Customized TS DC Electrical Power Sources (Modes 1, 2, 3, 4)**

CEOG Plant	TS #	Limiting Conditions for Operation	TS Required Action	Comments	Allowed Outage Time (AOT)	
					Class 1E Battery	Class 1E Battery Charger
FCS	2.7	The reactor shall not be heated up or maintained at temperatures above 300 °F unless the following electrical systems are operable: k. Station batteries No. 1 and 2 (EE-8A and EE-8B) including one charger on each 125 V d-c bus No. 1 and 2 (EE-8F and EE-8G)	a) If the minimum station battery requirements cannot be satisfied (Note 1) b) Modification of battery charger minimum requirements (Note 2)	One spare battery charger is available (See Figure 1 of Attachment 2)	None	8 hours (Note 2)
PAL	3.7.4	The following DC electrical power sources shall be OPERABLE: a. Station Battery ED-01 and Charger ED-15, and b. Station Battery ED-02 and Charger ED-16	a) With one required charge inoperable (Note 3) b) With one battery inoperable: (Note 4)	Two spare battery chargers are available (See Figure 2 of Attachment 2)	24 hours	7 days

Notes for Table 4-2

1. The unit shall be placed in at least HOT SHUTDOWN within 6 hours, ..., and in at least COLD SHUTDOWN within the following 30 hours.
2. Two battery chargers may be inoperable for up to 8 hours provided battery charger No. 1 (EE-8C) or No. 2 (EE-8D) is operable. If this modification to the minimum requirement is violated, the reactor shall be placed in hot shutdown condition within the following 12 hours. If the violation is not corrected within an additional 12 hours, the reactor shall be placed in a cold shutdown condition within an additional 24 hours.
3. Place the cross-connected charger for the affected battery in service immediately, and restore the required charger to OPERABLE status within 7 days or the reactor shall be placed in HOT SHUTDOWN within 12 hours and the reactor shall be placed in COLD SHUTDOWN within 48 hours.
4. Place both chargers in service for the affected battery immediately, and restore the required charger to OPERABLE status within 7 days or the reactor shall be placed in HOT SHUTDOWN within 12 hours and the reactor shall be placed in COLD SHUTDOWN within 48 hours.

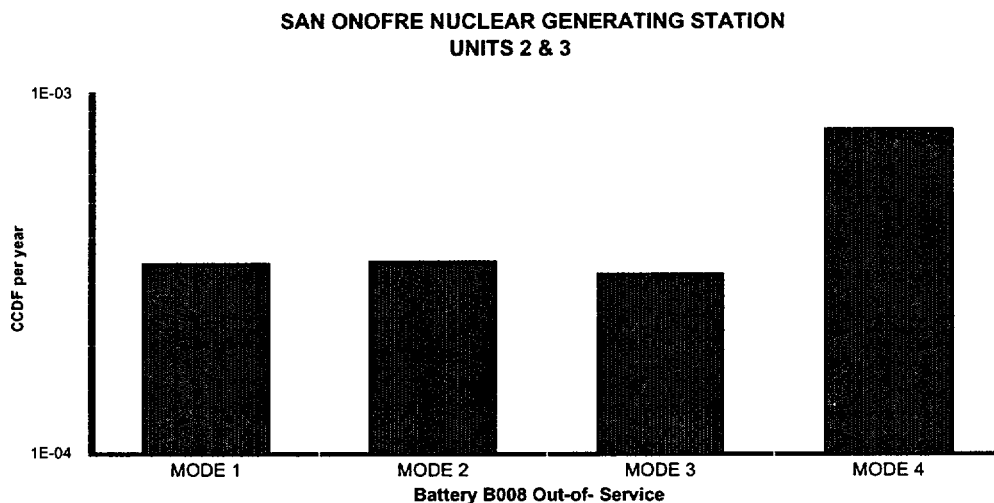
4.4 IEEE Draft Reference to TS 3.8

Results of this analysis may also be used to support generic CEOG based AOTs/CTs for the proposed revision to the Improved Standard Technical Specification (ISTS) being developed by IEEE.

4.5 Comments on DC Systems Shutdown TS

For most technical specifications, leaving the modes of applicability improves the plant restraints on the associated component. However, unavailability of the DC system has risk impact on all operating and non-operating plant modes. For the class 1E DC electrical systems, Mode 4/5 (cold shutdown) risk strongly relies on the availability of offsite power. The EDGs rely on the batteries to start and turbine-driven AFW pump relies on the battery for controlling steam generator level. Mode 4 and 5 operations are also sensitive to battery availability. Thus, assured entry into cold shutdown may actually increase plant risk by exposing the plant to transition risks and potentially increased mode specific risks. The mode risks associated with unavailability of the most limiting single battery for the San Onofre units is provided in Figure 4-1.

Figure 4-1



The respective risk increases in the hot and cold shutdown states are caused by postulated increases in the loss of offsite power initiating event due to potential grid instability, increased potential of switchyard maintenance/activities and unavailability (and/or increased unreliability) of the turbine-driven auxiliary feedwater pump. The absolute values of this impact will vary among the CEOG member utilities; however, the expectation of equivalent or higher risk during shutdown cooling entry should be consistent among the units.

5.0 SYSTEM DESCRIPTION AND OPERATING EXPERIENCE

5.1 System Description

The station DC electrical power system provides both motive and control power to selected safety related equipment. It also provides preferred AC power to the 120 VAC vital buses (via inverters). For all of the CE NSSS designs (except CC-1&2, PVNGS 1, 2 & 3, SONGS 2&3, and WSES-3), the class 1E 125 VDC electrical power system consists of two independent and redundant safety related subsystems. For CC-1&2, PVNGS 1, 2 & 3, and SONGS 2&3, the class 1E 125 VDC electrical power system consists of four independent and redundant safety related subsystems. At WSES-3, there are three class 1E 125 VDC safety related subsystems. Each subsystem consists of one battery, the associated battery charger(s) for each battery, and all the associated control equipment and interconnecting cabling. The class 1E 125 VDC electrical power system at certain CE designed PWRs is also equipped with a swing charger, which can be aligned to either of its DC subsystems. For these units, the transfer mechanism is interlocked to prevent the respective DC subsystems from being simultaneously connected to the swing charger.

During normal operation, the 125 VDC loads are powered from the battery chargers with the batteries floating on the system. In the case of loss of normal power to the battery chargers, the 125 VDC loads are automatically powered from the batteries. Each battery charger has ample power output capacity for the steady state operation of connected loads required during normal operation, while at the same time maintaining its battery fully charged. Each battery charger also has sufficient capacity to restore its associated battery from the design minimum charge to its fully charged state while supplying normal steady state loads.

Seven configurations of class 1E DC power were identified for the CE PWRs. A brief description, which identifies the major electrical equipment for each configuration, is provided below and summarized in Table 5-1. A schematic for each configuration is provided in Attachment 2.

- (1) Two batteries with a dedicated battery charger per battery and one swing battery charger. This is representative of *ANO-2, FCS, and MP-2*.
- (2) Two batteries with two dedicated battery chargers per battery. This is representative of *Palisades*.
- (3) Two batteries with two dedicated battery chargers per battery and a swing battery charger. This is representative of *SL-1&2*.
- (4) Three batteries with two dedicated battery chargers per battery. This is representative of *WSES-3*.
- (5) Four batteries with a dedicated battery charger per battery. This is representative of *SONGS 2&3*.

- (6) Four batteries with a dedicated battery charger per battery and two swing battery chargers. This is representative of *PVNGS 1, 2, & 3*.
- (7) Four batteries with two dedicated battery chargers per battery. This is representative of *CC-1&2*.

Table 5-1

Comparison of Class 1E 125 VDC Power System Configurations at CE Designed PWRs

DC Power Equipment	CEOG Plants									
	ANO-2	CC 1&2	FCS	MP-2	PAL	PVNGS 1, 2 & 3	SONGS 2&3	SL-1	SL-2	WSES-3
No. of Class 1E 125 VDC Buses	2 (Note 1)	4 (Note 5)	2 (Note 1)	2 (Note 1)	2 (Note 1)	4 (Note 5)	4 (Note 5)	3 (Note 9)	5 (Note 10)	3 (Note 1)
No. of Class 1E 125 VDC Batteries	2 (Note 2)	4 (Note 7)	2 (Note 2)	2 (Note 2)	2 (Note 2)	4 (Note 7)	4 (Note 7)	2 (Note 2)	2 (Note 2)	3 (Note 13)
No. of Dedicated Battery Chargers	2 (Note 3)	8 (Note 12)	2 (Note 3)	2 (Note 3)	4 (Note 6)	4 (Note 6)	4 (Note 6)	5 (Note 11)	5 (Note 14)	6 (Note 12)
No. of Swing Battery Chargers	1 (Note 4)	0	1 (Note 4)	1 (Note 4)	0	2 (Note 8)	0	1 (Note 4)	1 (Note 4)	0

Notes for Table 5-1

1. The Class 1E 125 VDC power system is equipped with one bus per train
2. The Class 1E 125 VDC power system is equipped with one battery per train.
3. The Class 1E 125 VDC power system includes one dedicated battery charger per train
4. The swing battery charger can be aligned to either Train A or Train B, but not both trains at the same time.
5. The Class 1E 125 VDC power system is equipped with two buses per train.
6. The Class 1E 125 VDC power system is equipped with two dedicated battery chargers per train.
7. The Class 1E 125 VDC power system is equipped with two batteries per train. One battery is connected to its associated bus.
8. A swing battery charger can be aligned to either of the two associated buses within the train.
9. The Class 1E 125 VDC power system is equipped with one bus per train and one swing bus, which can be aligned to either train.
10. The Class 1E 125 VDC power system is equipped with two buses per train and one swing bus, which can be aligned to either train.
11. Each bus is connected to two dedicated battery chargers, except the swing bus which is connected to a single dedicated battery charger.
12. Each bus is connected to two dedicated battery chargers.
13. Each bus is connected to a dedicated Class 1E 125 VDC battery.
14. Each bus is connected to one dedicated battery charger.

In the remainder of this subsection, typical loading for the class 1E DC electrical systems at the CEOG member utilities is provided. Generic representation of the loads is provided for the various battery configurations identified above. Because the safety-related Auxiliary (or Emergency) Feedwater systems play a very important role in mitigating transient events, especially loss of offsite power and station blackout events, the DC power sources for the motor-driven and turbine-driven pumps are also identified for the various CE designed PWRs. The intent is to identify key safeguards equipment that will become inoperable when a DC power source is out of service concurrent with a loss of offsite power or station blackout event.

Two Battery Configuration

For all of the two battery configurations (i.e., ANO-2, FCS, MP-2, Palisades and SL-1&2), the loads powered by the class 1E DC electrical systems are divided into two safety-related divisions.

Typical loads for Division A (left channel at Palisades) include the following:

- Control power for emergency diesel generator A (or No. 1)
- 4.16 KV (2.40 KV at Palisades) breaker control power for Train A (left channel at Palisades) engineered safety feature equipment
- 480 V breaker control power for Train A (left channel at Palisades) engineered safety feature equipment
- Control power for reactor trip switchgear associated with RPS channels A and C
- Vital 120 VAC inverter A (inverter 1 at Palisades)
- Vital 120 VAC inverter C (inverter 3 at Palisades)

Typical loads for Division B (right channel at Palisades) include the following:

- Control power for emergency diesel generator B (or No. 2)
- 4.16 KV (2.40 KV at Palisades) breaker control power for Train B (right channel at Palisades) engineered safety feature equipment
- 480 V breaker control power for Train B (right channel at Palisades) engineered safety feature equipment
- Control power for reactor trip switchgear associated with RPS channels B and D
- Vital 120 VAC inverter B (inverter 2 at Palisades)
- Vital 120 VAC inverter D (inverter 4 at Palisades)

The safety-related Auxiliary (or Emergency) Feedwater system at ANO-2 and FCS is equipped with one motor-driven pump and one turbine-driven pump. Control power for the turbine-driven pumps at both of these units is obtained from the Division B load group, while control power for the motor-driven pumps is obtained from the Division A load group. The Auxiliary Feedwater (AFW) system at the remaining units (i.e., MP-2, Palisades, and SL-1&2) with two battery configuration is equipped with two motor-driven pumps and one turbine-driven pump. Control power for each of the motor-driven pumps is obtained from a separate load group division. For these units with the exception of Palisades, either load group division can provide control power for the turbine-driven pump. At the Palisades unit, turbine-driven steam supply control circuit power is from the left channel only.

Three Battery Configuration

For WSES-3, which is the only CE designed PWR with a three battery configuration, the loads powered by the class 1E DC electrical systems are divided into three safety-related divisions. As shown in Figure 4 of Attachment 2, battery 3A-S is one of the power sources for the loads associated with Division A. Typical loads for Division A include the following:

-
- Control power for emergency diesel generator 3A-S
 - Emergency diesel generator 3A-S fuel oil booster pump
 - 6.9 KV breaker control power for Train A equipment
 - 4.16 KV breaker control power for Train A engineered safety feature equipment
 - 480 V breaker control power for Train A engineered safety feature equipment
 - Control power for reactor trip switchgear associated with RPS channels A and C
 - 120 VAC inverter 3A-S
 - 120 VAC inverter 3MA-S
 - 120 VAC inverter 3MC-S

Battery 3B-S is one of the power sources for the loads associated with Division B. Typical loads for Division B include the following:

- Control power for emergency diesel generator 3B-S
- Emergency diesel generator 3B-S fuel oil booster pump
- 6.9 KV breaker control power for Train B equipment
- 4.16 KV breaker control power for Train B engineered safety feature equipment
- 480 V breaker control power for Train B engineered safety feature equipment
- Control power for reactor trip switchgear associated with RPS channels B and D
- 120 VAC inverter 3B-S
- 120 VAC inverter 3MB-S
- 120 VAC inverter 3MD-S

The Emergency Feedwater (EFW) System at WSES-3 is equipped with two motor-driven pumps and one turbine-driven pump. Control power for each of the EFW motor-driven pumps is obtained from one of the above load group divisions. The third safety-related division, which is designated as AB, provides control power for the EFW turbine-driven pump. Battery 3AB-S is one of the power sources for this load group division. In addition to supplying control power for the EFW turbine-driven pump, typical loads for Division AB include the following:

- EFW turbine-driven pump steam supply valves
- 4.16 KV breaker control power for switchgear 3AB3-S
- 480 V breaker control power for switchgear 3AB31-S

Four Battery Configuration

For all of the four battery configurations (i.e., PVNGS 1, 2 & 3 and SONGS 2&3), the loads powered by the class 1E DC electrical systems are divided into four safety-related subsystems. Two of these subsystems, A and C, provide power to safeguard equipment in Division A load group. The other two subsystems, B and D, provide power to safeguard equipment in Division B load group. As shown in Figures 5 and 6 of Attachment 2, each of the subsystems is powered by a single dedicated DC battery during emergency conditions. During normal operating conditions, a single dedicated battery charger is used to power each of the subsystems at SONGS 2&3 (i.e., DC bus D1, D2, D3, or D4). In addition to the dedicated battery charger for each subsystem at

PVNGS 1, 2 & 3 (see Figure 6 of Attachment 2), a backup battery charger is also provided for each division. The backup battery charger for Division A can be manually aligned to either subsystem A or C (i.e., DC bus PKA-M41 or PKC-M43). The transfer mechanism is mechanically interlocked to prevent both subsystems from being simultaneously connected to the backup battery charger. A similar backup battery charger is provided for Division B. This charger can be manually connected to either subsystem B or C (i.e., DC bus PKB-M42 or PKD-M44).

Battery A (B007 for SONGS 2&3 or PKA-F11 for PVNGS 1, 2 & 3) is one of the power sources for the loads associated with subsystem A of Division A. Typical loads for this subsystem at PVNGS 1, 2 & 3 include the following, with similar loads at SONGS 2&3:

- Vital 120 VAC inverter A
- Reactor trip switchgear associated with RPS channel A
- 4.16 KV breaker control power for Train A engineered safety feature equipment
- 480 V breaker control power for Train A engineered safety feature equipment
- AFW turbine-driven pump steam supply valves and turbine governor control and feedwater valves
- Control power for Diesel generator A
- Channel A vital instrument distribution panel
- Turbine-driven AFW pump discharge valve and AFW discharge valve A (for SONGS 2 & 3)

Battery B (B008 for SONGS 2&3 or PKB-F12 for PVNGS 1, 2 & 3) is one of the power sources for the loads associated with subsystem B of Division B. Typical loads for this subsystem at PVNGS 1, 2 & 3 include the following, with similar loads at SONGS 2&3:

- Vital 120 VAC inverter B
- Reactor trip switchgear associated with RPS channel B
- 4.16 KV breaker control power for Train B engineered safety feature equipment
- 480 V breaker control power for Train B engineered safety feature equipment
- Turbine-driven AFW pump discharge valve and AFW discharge valve B (for SONGS 2&3)
- Control power for Diesel generator B
- Channel B vital instrument distribution panel

Battery C (B009 for SONGS 2&3 or PKC-F13 for PVNGS 1, 2 & 3) is one of the power sources for the loads associated with subsystem C of Division A. Typical loads for this subsystem at PVNGS 1, 2 & 3 include the following, with similar loads at SONGS 2&3:

- Vital 120 VAC inverter C
- Reactor trip switchgear associated with RPS channel C
- Shutdown cooling isolation valve UV-653 (for PVNGS 1, 2 & 3)
- Channel C vital instrument distribution panel

- Train A AFW pump feedwater valves (for PVNGS 1, 2 & 3)
- Turbine-driven AFW pump panel A for AFW pump steam inlet valve and governor (for SONGS 2&3)

Battery D (B010 for SONGS 2&3 or PKD-F14 for PVNGS 1, 2 & 3) is one of the power sources for the loads associated with subsystem D of Division B. Typical loads for this subsystem at PVNGS 1, 2 & 3 include the following, with similar loads at SONGS 2&3:

- Vital 120 VAC inverter D
- Reactor trip switchgear associated with RPS channel D
- Shutdown cooling isolation valve UV-654 (for PVNGS 1, 2 & 3)
- Channel D vital instrument distribution panel

The AFW system at PVNGS 1, 2 & 3 is equipped with one turbine-driven pump and one motor-driven pump. Subsystem A (i.e., DC bus PKA-M41), as show above, provides power for governor controller of the turbine-driven pump and the associated steam supply valves for the turbine. Control power for the circuit breaker of the motor-driven pump at PVNGS 1, 2 & 3 is obtained from subsystem B (i.e., DC bus PKB-M42).

The AFW system at SONGS 2&3 consists of two motor-driven pumps and one turbine-driven pump. Control power for the motor-driven pump associated with Train A of safeguard equipment is obtained from subsystem A (i.e., DC bus D1). Likewise, control power for the motor-driven pump associated with Train B of safeguard equipment is obtained from subsystem B (i.e., DC bus D2). The steam supply isolation valves, the stop valve, and the controls to the turbine governor are supplied with DC power from subsystem C (i.e., DC bus D3).

5.2 Operating Experience

In light of the current 2 hour AOT, on-line scheduled preventive maintenance of a DC power source is rare. A limited amount of on-line maintenance activities is performed. In general, maintenance activities associated with the DC power sources include:

- Fuse replacement
- Restoration of battery parameters within the allowable limits
- Replacement/changing of a bad battery cell
- Jumpering a bad battery cell
- Aligning a battery for parallel operation
- Repairing/replacing fault connectors

The majority of the above maintenance activities require more time to perform than is currently allowed by the TS. The correction of inter-cell or cable high resistance readings can be performed within 6 to 8 hours. Limited battery cell replacement has been performed at certain CEOG utilities within 2 hours. Such activities allow no margin for unexpected equipment faults or problems that could occur during the replacement. Unexpected equipment problems during the 2 hour period would have forced a plant shutdown and increased the risk associated with

shutting down the plant. Such maintenance activities would be performed under highly stressful conditions, which increase the potential for technician error and personal injury. More realistically, battery cell replacement can be accomplished in 8 to 16 hours with proper planning and under routine conditions. Bolt replacements can be accomplished within 4 to 6 hours. While at power, bolt replacements for seismic restraints would cause the affected battery to be declared inoperable and subject the maintenance to a 2 hour AOT. This activity is currently performed during plant outages.

Periodic surveillance is performed to verify the battery terminal voltage and the battery charging (float) current. The verification of battery charger output voltage while on float charge helps to ensure the effectiveness of the charging system and the ability of the battery charger to perform its intended function. On float charge, the battery will receive adequate current to maintain it in a fully charged state. The verification of the battery charging current while on float charge helps to ensure the ability of the battery to perform its intended function. The float charge is a condition that allows the battery charger to supply the continuous charge needed to overcome the internal losses of a battery and maintain the battery in its fully charged state.

Visual inspection of the battery is also performed on a periodic basis. This helps to detect corrosion of the battery cells and connections. The measurement of the resistance of each inter-cell, inter-rack and terminal connection provides an indication of physical damage or abnormal deterioration that could degrade battery performance.

As discussed in Section 4.5, while at power the DC electrical system serves a valuable safety function. Its value at shutdown is of equal, if not of increased, importance. This is particularly true as the plant undergoes mode transition and if concurrent switchyard maintenance activities are underway. Hence, the current practice of diverting corrective maintenance activities of battery/battery charger to shutdown mode may not necessarily reduce plant risk.

6.0 TECHNICAL JUSTIFICATION FOR CLASS 1E 125 VDC BATTERY AOT EXTENSION

This section presents an integrated assessment of the proposed AOT extension. The assessment includes discussion of: (a) motivation and need for technical specification change, (b) the impact of the change on the plant design basis and (c) probabilistic risk assessment of the proposed change.

Section 6.1 presents a summary statement of the need for the AOT extension (the supporting information for this section has been previously presented in Section 5). Section 6.2 provides an assessment of the deterministic factors, particularly those associated with the plant design basis. The probabilistic risk assessment of this AOT extension is contained in Section 6.3. These sections generally follow the Nuclear Regulatory Commission (NRC) guidance set forth in Reference 2 for risk informed changes to TSs.

6.1 Statement of Need

The OPERABILITY of the DC electrical power subsystems requires all batteries and respective chargers to be operating and connected to the associated DC bus(es). The DC electrical power subsystems provide normal and emergency DC power for the Engineered Safety Features (ESF) systems including the emergency diesel generators and emergency auxiliary equipment. The batteries and their respective battery chargers are the power sources for the DC electrical power subsystems. The OPERABILITY of the batteries and their respective chargers is consistent with the initial assumptions of the accident analyses presented in Chapters 6, 14, and 15 of the Final Safety Analysis Reports (FSARs), as appropriate for the selected plant. The OPERABILITY of these DC power sources is based on meeting the design basis of the unit. This includes maintaining the DC power sources operable during accident conditions in the event of:

- a. An assumed loss of all offsite AC power or all onsite AC power; and
- b. A worst case single failure.

The Regulatory position (RG 1.193) associated with availability of power sources is that if the available onsite DC supplies are one less than that required by the LCO, power operation should be limited to two hours. If the unit cannot restore the affected DC supply in that time frame the unit should be brought promptly to a controlled shutdown and to a cold shutdown state in 36 hours. It was further noted that use of the above AOT was explicitly intended for corrective maintenance only.

The current AOT/CT for a class 1E station battery at all of the CEOG plants is 2 hours, with the exception of FCS, CC-1&2 and Palisades. With a class 1E battery out of service at FCS, the LCO ACTION STATEMENT requires that *"the unit shall be placed in at least HOT SHUTDOWN within 6 hours, in at least subcritical and < 300 °F within the next 6 hours, and in*

at least COLD SHUTDOWN within the following 30 hours ..." This requirement allows no time for restoring the battery to operability without shutting down the plant. Both CC-1&2 and Palisades LCO ACTION STATEMENTS allow more than 2 hours for restoring a class 1E battery to operability prior to the initiation of a plant shutdown. At CC-1&2, a CT of 4 hours is allowed for replacing the inoperable battery with the reserve battery. Otherwise, (if the reserve battery is not available) the inoperable battery should be restored to operability within 2 hours. With one battery inoperable at the Palisades unit, both chargers for the affected battery must be placed in service immediately and the affected battery must be restored to operable status within 24 hours. Otherwise, a plant shutdown is initiated if the battery cannot be restored within the AOT.

Certain CEOG plants also have AOTs for the restoring an inoperable class 1E battery charger to operability. The AOTs for the DC power sources at the CEOG plants are shown in Table 6-1. The corresponding number for the LCO ACTION STATEMENT is also shown in this table.

Table 6-1

Current DC Power Source AOT for CEOG Plants

DC Power Equipment	CEOG Plants									
	ANO-2	CC-1&2	FCS	MP-2	PAL	PVNGS 1, 2 &3	SONGS 2&3	SL-1	SL-2	WSES-3
Class 1E 125 VDC Battery	2 hrs	4 hrs (Note 2)	(Note 3)	2 hrs	24 hrs	2 hrs	2 hrs	2 hrs	2 hrs	2 hrs
Class 1E Battery Charger	(Note 1)	2 hrs	8 hrs (Note 4)	2 hrs	7 days	24 hrs	(Note 1)	(Note 1)	(Note 1)	(Note 1)
LCO Action	3.8.2.3	3.8.4	2.7	3.8.2.3	3.7.4	3.8.4	3.8.4	3.8.2.3	3.8.2.1	3.8.2.1

Notes for Table 6-1

1. If one of the required battery chargers is inoperable, the operability of the associated battery shall be demonstrated by verifying that the battery parameters meet the specified limits within 1 hour, and at least once per 8 hours thereafter. If any of the battery parameters is outside the limit, then the associated battery must be declared inoperable immediately.
2. The inoperable battery is replaced with the reserved battery within 4 hours. Otherwise, restore the DC channel within 2 hours.
3. If any of the station batteries is inoperable, the reactor shall be placed in a HOT SHUTDOWN condition within 6 hours.
4. Two battery chargers may be inoperable for up to 8 hours.

There have been no reported instances of maintenance on the station battery or battery charger having resulted in a forced plant shutdown. However, experience does indicate that the current 2 hour AOT is inadequate for most related maintenance tasks (see Section 2). Based on a review of the maintenance requirements on the DC power sources for CE designed PWRs, it was determined that extending the AOT/CT, from the current 2 hours (or less) to 8 hours, would provide sufficient margin to effect most of the anticipated and (on-line) maintenance activities. These activities would be performed to repair or restore faulty DC electrical equipment, which have been declared inoperable due to a non-common cause failure. Based on plant specific risk evaluations, it is further recommended that the AOT/CT be extended from 2 hours to 24 hours for SOnGS 2&3, and WSES-3. These units have additional redundancy associated with their DC

electrical systems. Such extensions may be justified from a risk perspective based on regulatory approaches contained in RG 1.177. Technical support for this request is presented in Sections 6.2 and 6.3.

6.2 Assessment of Deterministic Factors

The deterministic impact of a loss of a battery or charger varies among the CE designed NSSS units. This variation is due to differences in component redundancy and battery loading alignments. Thus, the impact of component (battery/charger) unavailability is greater for plants with lesser levels of component redundancy. This is also observed in review of PSA results (see Section 6.3). The following provides a deterministic assessment of unavailability of a battery/charger when the available DC electrical power sources are one less than the LCO. Such a system would be considered fully functional, however, a subsequent single failure could render the entire DC electrical power system ineffective on a turbine generator trip. [Note that PVNGS 1, 2 & 3, SOGS 2&3 and WSES-3 have additional battery/charger redundancies that make them more robust to a Loss of Offsite Power (LOP) event.] The deterministic assessment discusses the impact of the unavailability of a battery/charger following both an internal and external initiating event.

Internal Event Considerations

Unavailability of DC power sources decreases the capability of the plant to respond to reactor trips, LOP events and Station Blackout (SBO) events. Early CE designed units are typically designed such that the ESF buses are powered as part of the plant hotel loads. Following normal reactor trips the batteries provide control power to allow a fast transfer from the on-site alignment to the switchyard alignment, for those plants with fast transfer capability. Plants capable of fast transfer are ANO-2, FCS, SL-1&2, WSES-3, and MP-2. For the other CE plant designs, the ESF busses are powered from switchyard (offsite loads) during normal power operation and hence are not impacted during a normal reactor trip.

Following a LOP event the DC power is used for starting the Emergency Diesel Generators (EDGs). Unavailability of a battery renders its respective EDG inoperable, which in turn causes an entire train of ESF equipment to become INOPERABLE. Thus, should a loss of offsite power occur the plant relies entirely on the remaining train of AFW for heat removal. Failure of the respective AFW pump, without timely recovery of offsite power would result in core damage.

If the remaining battery fails upon LOP and no alternate AC (AAC) is provided, a condition will develop which results in total loss of power to the plant (no EDGs and no battery backup). The Turbine-driven pump at the plant may be available and would function, so long as the steam generators are not overfilled. However, all AFW control is performed "blind", that is without available instrumentation (only after both batteries fail will all instrumentation be lost). This potential is mitigated in some CE designed PWRs by either increased redundancy in DC systems or additional plant features that make them more robust to a LOP event. For example, SL-1&2 can cross-tie their units to power a bus from an EDG of the other unit. PVNGS 1, 2 & 3 has on

site AAC capability as does MP-2, CC-1&2, and ANO-2. FCS uses a diesel-driven auxiliary feedwater pump that is independent of station DC power.

While the DC electrical system is important during power operations, it is no less important during shutdown conditions (particularly when the plant is on shutdown cooling, see Section 4.5). Shutdown cooling operation is strongly dependent on DC power to ensure RCS heat removal. However, during shutdown cooling conditions LOP probability is greater due to both increased maintenance and the potential for lower grid stability. Hence, a LOP with a DC power source out of service would also expose the plant to potential core damage events. One particular vulnerability that may exist for some PWRs is an SBO with a DC power source out of service followed by the inability of a DC-dependent LTOP relief valve to open. This would ultimately result in an over-pressurization of the shutdown cooling piping, thus creating an intersystem LOCA leading to both core damage and a potential large early release.

External Event Considerations

External initiating events include seismic and weather related events including external flooding. As a result of the short exposure time associated with these events, random occurrences will produce low plant risk. For example, a seismic occurrence sufficient to create LOP at the San Onofre units is approximately $6.9E-3$ per year [Ref. 10]. Hence for an exposure time of 8 hours, the seismic challenge probability during the exposure time that a battery is out of service is approximately $6.3E-6$. Assuming that a seismic-induced LOP and failure of the remaining EDG (with a probability of $3.0E-2$) and a loss of the turbine-driven AFW pump (with a failure probability of approximately 0.02) lead to core damage, the conditional probability for this sequence can be estimated using the following expression:

$$CCDP = [\text{LOP} \times \text{Failure Probability of EDG} \times \text{Failure Probability of Turbine-driven AFW pump}] \text{AOT (hrs)}/8760$$

Using the above specified values, the core damage probability during the exposure time of 8 hours is approximately $3.9E-9$. For an exposure time of 24 hours, the core damage probability would be $1.1E-8$. These values are much less than the acceptable at-power maintenance risk level. The risk involving seismic-induced failures is significantly less than the risk involving a seismic event and random failures. For example, the occurrence of a seismic-induced LOP and seismic-induced failure of the EDGs at SONGS 2&3 is $7.6E-8$ per year [Ref. 10]. The corresponding core damage probability during the exposure time of 8 hours is $6.9E-11$, which is significantly less than the example involving random failure of the EDG. No credit is taken for restoring LOP following battery depletion and prior to the onset of core damage. For other CE designed PWRs, the seismic risk is low due to low seismic occurrence frequency.

In the event that an external event has a high likelihood of occurrence (such as pending hurricane or expectant ice storms) the Maintenance Rule related CRMP guidance will establish appropriate plant operating states based on plant configuration. This is particularly true when implementing this AOT because of its short proposed duration. For example, if a storm is expected to occur within the next day and battery maintenance and repair can be accomplished within an 8 hours

time frame if the plant is at power, but repair would be delayed if a plant shutdown is initiated, the expeditious course of action would be to repair the battery at power and avert the risk of transitioning the plant to shutdown and exposing the plant to a high potential external event risk with an inoperable DC power source. In other instances, depending on the plant configuration and the confidence in completing the repair the prudent course of action may suggest plant shutdown.

SONGS 2&3 results presented in Section 6.3 specifically include effects of the dominant external event contributors to risk. As a consequence of the short duration AOT, impact of external events is considered negligible because either the probability of the initiating event occurring in the time frame is low or adequate compensatory actions may be taken within the CRMP to control risk. CRMP actions would include, as necessary, (1) assessment of the functional capability of the DC system, (2) ensuring availability of the redundant DC system, (3) increasing operation awareness to the increased plant risk during the battery outage, and (4) restricting activities that could challenge the plant's electrical systems or result in a plant trip.

6.3 Assessment of "At Power" Risk

This section provides an assessment of the increased risk associated with continued plant operation with a DC power source out of service. In accordance with Regulatory Guide 1.177, the risk is reported in terms of the associated ICCDP and the ICLERP due to the AOT extension. The increased risk was assessed for conditions involving a 125 VDC battery out of service, or its respective battery charger out of service. The evaluation of the "at power" risk was assessed to determine the impact on plant risk due to the proposed AOT extension of a DC power source. The evaluation was performed on a plant specific basis using the current PSA model for the individual plant. All the models used are upgrades of those used in the IPE and reflect the current plant configurations at the time the evaluation was performed, with the exception of the Palisades unit. Palisades used the IPE model for PSA applications. A statement regarding the status of the PSA and a statement confirming the applicability of the plant specific risk values contained in this report will be provided at the time of submittal for the AOT extension for each participating CEOG member utility.

The general assumptions that were made and the input used in estimating the plant risk are outlined in Section 6.3.1. The general approach used to estimate the plant risk due to the AOT extension is outlined in Section 6.3.2. The results obtained by applying the approach on a plant-specific basis are summarized in Section 6.3.3. A large early release sensitivity study of thermally-induced Steam Generator Tube Rupture (SGTR) probability is provided in Section 6.3.4. Since the DC electrical power system configuration varies among the CEOG member utilities, entry into the LCO also varies from plant to plant and is based on the type and number of equipment declared inoperable. The results provided in this section reflect the DC power configuration, for each of the participating CEOG member utilities, that leads to entry into the LCO and the largest conditional core damage frequency. Hence, the results for each plant presented in Section 6.3.3 are bounding for the various DC power configurations that may lead to LCO entry.

6.3.1 Assumptions/Input

The following assumptions/input were made or used in estimating the plant risk due to the proposed extension of DC power source allowed outage time. The assumptions were divided into generic and specific assumptions. The generic assumptions are applicable to both ICCDP and ICLERP. The specific assumptions are applicable to either ICCDP or ICLERP, but not both. The results and conclusions are based on the assumptions and inputs specified in this subsection.

Generic Assumptions

1. The risk measures used in estimating the incremental conditional core damage probabilities and incremental conditional large early release probabilities, as described in Section 6.3.2, were provided as input by the participating CEOG member utilities. The risk measures are based on the PSAs as they exist at the time this evaluation was performed.
2. The inoperability of more than one DC power source is not considered in this evaluation because such a condition is governed by the "3.0.3" LCO (or equivalent for plants with customized TSs. It is assumed that prior to on-line maintenance an assessment is performed to assure that the inoperability of the affected DC power source is not the result of a common cause failure. Appropriate assurances to that effect will be provided on a plant specific basis at the time of the individual submittal.

ICCDP Assumptions

1. The full allowed outage time for an inoperable DC power source is assumed to increase from its current duration of 2 hours in the majority of cases to a minimum duration of 8 hours. A duration of 24 hours is also considered and is recommended for the AOT/CT extension when supported by the plant specific evaluation.
2. The proposed full allowed outage time is assumed to be adequate for performing the majority of on-line maintenance for the DC power sources.
3. If a class 1E DC battery is taken out of service, it is assumed that the associated battery charger(s) are capable of handling the loading requirements following an uncomplicated transient such as a regular reactor trip. For complicated transients that require load shedding following a reactor trip or the actuation of safeguard equipment (i.e., the emergency diesel generators), it is assumed that the battery chargers are incapable of handling the transient loading requirements. Consequently, with a battery out of service the affected battery chargers will trip off line following a reactor trip, causing a consequential loss of the affected DC bus. This assumption is not applicable to ANO-2, Palisades and WSES-3. (See discussion on *Battery Charger Capacity* in Section 6.3.3.1.1.)

ICLERP Assumptions

1. The probability of containment isolation failure used in the PSAs for the CEOG member utilities varies from 1.0E-4 to approximately 3.0E-3. The upper limit was selected and used as a bounding value in this report.
2. It is assumed that all incremental core damage events lead to a core condition at high RCS pressure. Therefore, the potential for these events becoming a large early release is dependent upon the ability of the RCS to maintain the steam generator tubes intact and for the secondary side to isolate.
3. It is assumed that when exposed to high pressure plant core damage states the probability of a steam generator tube failing prior to failure of the reactor system component is 0.5. It is also assumed that a thermally-induced steam generator tube rupture is classified as a large early release.
4. A conditional containment failure probability (CCFP) of 0.01 due to high pressure melt ejection (HPME) is selected and used as a bounding value for the combined effects of RCS piping failure and HPME induced containment failure for all of the CEOG plants. This is based on a recent assessment performed by Sandia National Laboratories [Ref. 7].

6.3.2 General Approach

Plant specific evaluations were performed by each participating CEOG member utility to determine the impact on plant risk resulting from a DC power source being out of service. Results of these evaluations were then compared using the following risk measures:

Core Damage Probability (CDP): This risk measure represents the probability of core damage occurring. The core damage probability is approximated by multiplying the estimated core damage frequency by a time period.

Conditional Core Damage Frequency (CCDF): This risk measure represents the core damage frequency conditional on some event, such as equipment being out of service. CCDF is calculated by re-quantifying the PSA model after adjusting the basic event probabilities associated with the out of service equipment.

Increase in Core Damage Frequency (ΔCDF): This risk measure represents the difference between the CCDF evaluated for a DC power source *out of service* minus the CCDF evaluated for a DC power source *not out of service*. Using the battery for example, the following expression can be used to estimate the increase in CDF:

$$\Delta CDF = CCDF_{OOS} - CDF_B \quad (6-1)$$

where,

$$\Delta CDF = \text{Increase in core damage frequency (per year)}$$

- CCDF_{OOS} = Conditional core damage frequency given that a class 1E battery is out of service (per year)
- CDF_B = Conditional core damage frequency given that a class 1E battery is not out of service (per year)

Incremental Conditional Core Damage Probability (ICCDP): This measure is the incremental increase in risk associated with a DC source out of service for a period of time. This time period may be over the full duration of the AOT/CT, or over the actual maintenance duration. ICCDP measures the increase in probability of core damage occurring during the AOT/CT, or the outage time, from the baseline value. The value is obtained by multiplying the increase in CDF by the AOT, which can be expressed as:

$$ICCDP = [CCDF_{OOS} - CDF_B] \times \left[\frac{AOT}{8760} \right] \quad (6-2)$$

where,

- ICCDP = Incremental conditional core damage probability for the full allowed outage time
- CCDF_{OOS} = Conditional core damage frequency given that a class 1E battery is out of service (per year)
- CDF_B = Conditional core damage frequency given that a class 1E battery is not out of service (per year)
- AOT = Allowed outage time (in hours)

The methodology used to calculate the above risk measures is presented below. For plants with PSAs that were quantified using RISKMAN methodology, equivalent steps were taken to meet the intent of the methodology presented below.

Each CEOG member utility used its current PSA to assess CCDFs given that a DC power source is out of service. Each member utility verified that the appropriate basic events are contained in the core damage cutsets (for internal events) used to determine the AOT risk contributions. This verification was performed as the first task in calculating the CCDFs. Using the core damage cutsets, the following or equivalent steps were performed to calculate the CCDF resulting from a DC power source out of service.

- (1) Identify the independent basic event with the highest failure probability that is associated with the DC power source that is out of service and set it to true (i.e., failure probability of 1.0).
- (2) Set all other independent basic event probabilities for the DC power source identified in item (1) to false (i.e., failure probability of 0.0). This includes the basic event(s) that represent unavailability due to test/maintenance.
- (3) Set the basic event(s) that represent the unavailability of the remaining DC power source(s) due to test/maintenance to false.

- (4) Set common cause basic event probability for the DC power sources to false because the remaining DC power source(s) are verified to be operable and not affected by common cause failure prior to entry into the LCO ACTION STATEMENT.
- (5) After making the appropriate changes to the basic event probabilities, re-quantify the core damage cutsets. The resulting value represents the CCDF given that the specified DC power source is out of service.

The CCDF given that a DC power source is not out of service was obtained by setting the basic event that represents unavailability due to test/maintenance to false. No adjustment was made to the common cause basic event probability or to the other independent basic event probabilities for this case. The core damage cutsets were then re-quantified.

Large Early Release Frequency (LERF): This risk measure is defined as the frequency of those accidents leading to significant, unmitigated release of radioactivity from containment in a time frame prior to effective evacuation of the close-in population such that there is a potential for early health effects. This includes events which lead to early containment failure at or shortly after vessel breach, containment bypass events, and loss of containment isolation. The definition used by the CEOG member utilities varies in detail, however in practice the utility definitions are consistent with that of the NRC. LERF is evaluated by summing all severe accident events leading to: (a) containment bypass events, (b) core damage events occurring in conjunction with loss of containment isolation, and (c) early energetic failures of the reactor vessel that cause containment failure. Basemat melt-through events and gradual over-pressurization events were not classified as early containment failures. These failures were considered to result in a sufficiently gradual challenge that evacuation of the close-in population surrounding the plant may be accomplished prior to containment failure.

CEOG plants with automated LERF models have provided LERF estimates conditional on a DC power source out of service, as well as a DC power source not out of service. A simplified LERF model was applied to establish bounding estimates for incremental conditional large early release probability (see below) for the remaining CEOG plants.

Incremental Conditional Large Early Release Probability (ICLERP): This measure is the incremental risk associated with a DC power source out of service for a period of time. This time period may be over the full duration of the AOT/CT, or over the actual maintenance duration. ICLERP measures the increase in probability of large early release occurring during the AOT/CT, or the outage time, from the baseline value.

For the CEOG plants with automated LERF models, ICLERP can be obtained by multiplying the increase in LERF by the AOT, which can be expressed as:

$$ICLERP = [CLERF_{OOS} - CLERF_b] \times \left[\frac{AOT}{8760} \right] \quad (6-3)$$

where,

- ICLERP = Incremental conditional large early release probability for the full allowed outage time
- CLERF_{OOS} = Conditional large early release frequency given that a class 1E battery is out of service (per year)
- CLERF_B = Conditional large early release frequency given that a class 1E battery is not out of service (per year)
- AOT = Allowed outage time (in hours)

For the CEOG plants without automated LERF models, bounding ICLERP estimates were developed by using a simplified large early release event tree. In general, the large early release (LER) event tree sums the incremental contributions from (a) containment bypass events (including ISLOCAs and induced Steam Generator Ruptures), (b) loss of containment isolation events, and (c) energetic containment failures.

LERF assessments are provided for at power operation only. The simplified LER event tree (see Figure 6-1) focuses on causes for, and interrelationships of, the containment large early release contributors following an event which is adversely impacted by unavailability of a class 1E battery or its associated charger. The input into the LER event tree is the ICCDP. The fraction of ICCDP that propagates into a large early release event is established based on responses to the following events:

- Containment isolation
- Secondary side depressurization of the steam generator(s)
- Occurrence of thermally-induced SGTR
- Containment failure due to RPV lower head failure

In evaluating the LERF increases, it was conservatively assumed that all incremental core damage events lead to high pressure RCS core damage states. It was also assumed that no operator actions were performed to depressurize the RCS prior to failure of the reactor vessel lower head. The top events in the LER tree are described and modeled as follows:

Containment Isolated

This top event defines the state of containment integrity prior to the event. Large early fission product releases could occur when a severe accident occurs in conjunction with an initially unisolated containment. Typically, these events are very small contributors to the total containment failure probability. The probability of containment isolation failure used in the PSAs for the CEOG member utilities varies from 1.0E-4 to approximately 3.0E-3. The upper limit was selected as a bounding value.

Steam Generator Depressurized

It is conservatively assumed that all incremental core damage events lead to a core melt condition at high RCS pressure. Therefore, the potential for these events becoming a large early release is

dependent upon the ability to maintain the steam generator tubes intact and the secondary side isolated. Both of these factors are reflected in the response to this query. Steam generator depressurization is assumed to occur either via prior operator action or failure of a Main Steam Safety Valve (MSSV) to close. Since the Accident Management Guideline (AMG) suggests that operators not depressurize the steam generator without the ability to cool the steam generator tubes, the potential for operator failure is limited. The probability of the MSSV failing open is taken as 0.1.

Thermally-Induced SGTR Occurs

Given a steam generator depressurization, it is conservatively assumed that the probability that a steam generator tube will fail prior to failure of another reactor coolant system component is 0.5. (This factor is a conservative representation of the failure probability and will be dependent on the steam generator design, age, operating history, and time in cycle.) The probability of steam generator tube failure reduces significantly if the steam generators remain pressurized. For this condition, the probability of thermally-induced steam generator tube rupture is conservatively assumed to be 0.01.

Additional conservatism taken in the thermally-induced SGTR assessment includes neglect of the potential for the challenged PSV/PORV to stick open and the neglect of any operator actions to depressurize the RCS. Both of these factors can result in significant reduction to the LERP. For example, NRC assessments of PSV/PORV challenges during station blackout scenarios indicate a large number (~35 water/two phase) challenges of the PSVs prior to core uncover. Such challenges have a high (~14%) probability of failing the PSV, resulting in a potentially open valve [Ref. 11].

RPV Lower Head Failure Result in Containment Failure

Failure of the Reactor Pressure Vessel (RPV) lower head releases an energetic discharge of molten core materials into the containment. Recent assessment of direct containment heating (DCH) induced containment threats performed by Sandia National Laboratories [Ref. 7] concluded that the conditional containment failure probability (CCFP) is less than 0.01 for FCS, PVNGS 1, 2 & 3, SL-1&2, and WSES-3. The calculations for these plants were based on an assessment of DCH induced pressure loading and the plant specific fragility curves. ANO-2, MP-2, Palisades, and SONGS 2&3 were assessed to have CCFPs between 0.01 and 0.1. One utility (CC-1&2) failed the screening criterion established by the methodology described in Reference 7. (CC-1&2 have a CCFP of 0.149 and also failed the success criterion of the methodology.) The CEOP plants that did not satisfy the screening or success criterion required additional analyses to resolve the DCH issue. After considering the High pressure melt ejection (HPME) probabilities given core damage for these plants, the Sandia assessment concluded that the CCFPs for all CE designed PWRs would be approximately 0.01 or less when considering thermal induced failure of RCS piping in advance of reactor vessel lower head failure. Therefore, a CCFP of 0.01 due to HPME is selected and used as a bounding value for the combined effects of RCS piping failure and HPME induced containment failure for all of the CEOP plants.

Figure 6-1
Simplified Large Early Release Event Tree

PAS	CI	SGD	SGTR	DCH	LERP	Name
PLANT ACCIDENT SEQUENCE WITH HIGH PRIMARY AND SECONDARY PRESSURE	CONTAINMENT ISOLATED	SG DEPRESSURIZED MANUALLY OR VIA STUCK OPEN SECONDARY VALVE	THERMAL INDUCED SGTR OCCURS	HPME EVENT FAILS CONTAINMENT (i.e., DIRECT CONTAINMENT HEATING - DCH)		
					4.99E-02	LERP-1
			5.00E-01		4.99E-04	LERP-2
		1.00E-01		1.00E-02	4.94E-02	OK
			5.00E-01	9.90E-01	8.97E-03	LERP-3
	9.97E-01				8.88E-03	LERP-4
		9.00E-01	1.00E-02		8.79E-01	OK
			9.90E-01	1.00E-02	3.00E-03	LERP-5
				9.90E-01		
1.00E+00						
	3.00E-03					
DC POWER OUT OF SERVICE CET			C:\CAFTA-WOPPD\DC_CET.TRE		9/22/99	Page 1

6.3.3 Summary of Results for "At Power" Risk

6.3.3.1 ICCDP Assessment

The appropriate CCDFs supplied by the CEOG member utilities were substituted into Equation (6-1) to obtain the risk resulting from an increase in core damage due to a DC power source out of service. The CCDFs shown in Table 6-2 are bounding values for the various CE designed PWRs. Since the class 1E DC electrical power system configuration varies from plant to plant, the configuration that produced the bounding CCDF also varies among the CEOG member utilities. The loading of the DC electrical power subsystems varies from plant to plant. This also is an important contributor to the CCDF. The bounding configuration for each plant is shown in the figure identified in Table 6-2. The figure provides a pictorial representation of the DC component (i.e., battery or associated charger) that is assumed to be out of service, thus causing the LCO to be entered. The out of service equipment is shown with an "X" drawn through it. Potential AOT durations were selected and substituted along with the CCDFs into Equation (6-2) to obtain the risk resulting from incremental core damage probability due to a DC power source out of service. The resulting ICCDPs for the CEOG member utilities are summarized in Table 6-2.

Table 6-2

ICCDP Estimates due to Unavailability of a Battery/Battery Charger

CEOG Plant	Configuration Analyzed	CDF_B [Per Year]	$CCDF_{Oos}$ [Per Year]	Full AOT [hours]	ICCDP	ICCDP Increase Over Current AOT
ANO-2	Battery 2D11 out of service (See Figure 1 of Attachment 3)	2.08E-5	6.79E-4	24	1.80E-6	1.65E-6
				8	6.01E-7	4.51E-7
				2	1.50E-7	0
CC-1&2	[Note 1]	[Note 1]	[Note 1]	24	-	-
				8	-	-
				2	-	-
FCS	Batt. Charger #2 out of service (See Figure 2 of Attachment 3) [Note 4]	1.85E-5	7.42E-4	24	1.98E-6	1.82E-6
				8	6.61E-7	4.96E-7
				2	1.65E-7	0
MP-2	[Note 1]	[Note 1]	[Note 1]	24	-	-
				8	-	-
				2	-	-
PAL	Battery #2 out of service (See Figure 3 of Attachment 3)	5.15E-5	2.05E-4	24	4.21E-7	[Note 2]
				8	1.40E-7	
				2	3.50E-8	
PVNGS 1, 2 & 3	[Note 1]	[Note 1]	[Note 1]	24	-	-
				8	-	-
				2	-	-
SONGS 2 & 3	Battery B008 out of service (See Figure 6 of Attachment 3)	6.99E-5	3.39E-4	24	7.37E-7	6.76E-7
				8	2.46E-7	1.85E-7
				2	6.14E-8	0

Table 6-2 (Cont'd)

ICCDP Estimates due to Unavailability of a Battery/Battery Charger

CEOG Plant	Configuration Analyzed	CDF _B [Per Year]	CCDF _{Oos} [Per Year]	Full AOT [hours]	ICCDP	ICCDP Increase Over Current AOT
SL-1	[Note 1]	[Note 1]	[Note 1]	24	-	-
				8	-	-
				2	-	-
SL-2	[Note 1]	[Note 1]	[Note 1]	24	-	-
				8	-	-
				2	-	-
WSES-3	Battery 3AB-S out of service (See Figure 5 of Attachment 3)	1.54E-5	1.52E-4	24	3.74E-7	3.43E-7
				8	1.25E-7	9.38E-8
				2	3.12E-8	0

Notes for Table 6-2

1. Relevant data from this plant will be provided at the time of submittal.
2. Palisades TS includes a 24 hour AOT for DC subsystem INOPERABLE.
3. ICCDP increase over current AOT is defined as the difference between the ICCDP for the proposed AOT and the ICCDP for the current AOT.
4. The limiting DC power configuration analyzed for FCS involves battery charger #2 being out of service. At FCS, the current Tech Spec allows an 8 hour outage time for a battery charger and none for the battery. The ICCDPs for FCS shown above confirms the appropriateness of the AOT for the chargers. These values are used as bounding values for ICCDP due to a battery out of service.

The ICCDP results summarized in Table 6-2 are based on the full outage duration of 2 hours, 8 hours or 24 hours. The results for CEOG member utilities that provided information show that the plant risk is below or marginally above the acceptance guideline value of 5.0E-07 for a proposed AOT of 8 hours.

The class 1E DC electrical power systems at SONGS 2&3 and WSES-3 have added redundancy associated with the battery and battery charger. This feature results in a plant risk due to ICCDP, which is well below the acceptance guideline value for a proposed AOT of 8 hours. The risk for these units is still within the bounds of the acceptance guideline even for a proposed AOT of 24 hours. Hence, the plant risk for a proposed AOT of 8 or 24 hours is well within the acceptance guideline value. It should be noted that the Palisades plant already includes a 24 hour AOT for DC battery inoperability. The results for the Palisades evaluation confirm the appropriateness of the existing TS.

In the majority of cases, loss of offsite power initiator dominates the plant risk when a battery is out of service. With the battery out of service concurrent with a loss of offsite power event, the associated emergency diesel generator will fail to start. This condition results in the inoperability of one train of safeguard equipment. A combined failure of the remaining EFW or AFW pump(s) will result in the loss of secondary side heat removal capability. Core damage will occur following the consequential failure of once through cooling, for those plant equipped with Feed and Bleed capability. For the plants without Feed and Bleed capability, core damage will also occur following loss of the alternate secondary heat removal capability.

6.3.3.1.1 Other Considerations

The ICCDP assessment described above is based on the current PSA models for the CEOG member utilities. The remainder of this subsection addresses concerns which are unique to the PSA joint application for extending the allowed outage time for the DC power source. These concerns involve the battery charger capacity for handling transient loading requirements and the potential increase in loss of DC bus frequency, given that a class 1E 125 VDC battery is out of service. The inoperability of a battery due to non-functional seismic restraint is also a concern. These concerns may not be addressed fully in the current PSA models for all of the CEOG member utilities. Assessments of these concerns are therefore provided in the remainder of this subsection in order to assess the significance of their risk impact.

(a) Battery Charger Capacity and Ability to Handle Post-Trip Transient Loading with One DC Battery Out of Service

The ICCDP for extending the allowed outage time for a class 1E 125 VDC battery was determined based on the core damage frequency conditional on a battery being out of service for the full duration of the AOT. With the battery removed from service the respective battery charger(s) are relied on as the source of power for the affected class 1E 125 VDC bus. A concern has been raised regarding the adequacy of the charger(s) to handle the transient loading requirements. The chargers are designed to trip off line when the loading demand exceeds its capacity. This may be problematic for the configuration with a battery out of service. A plant trip and consequential generation of a safeguard signal (i.e., SIAS) would require the actuation of the emergency diesel generators and other safeguard equipment. Battery chargers are often sized to meet the plant steady state load requirements. With a battery out of service, the capacity of the associated battery charger(s) may not be adequate for handling the transient loading requirement of affected safeguard equipment. The transient loading demand on the battery charger(s) following reactor trip would cause the battery charger(s) to trip off line, thus causing a loss of the affected class 1E 125 VDC bus. Loss of DC power would prevent the affected safeguard equipment from starting.

To address the above concern, the descriptions of the class 1E 125 VDC system provided in the updated FSARs were reviewed and plants were surveyed to determine the capacity of each battery charger. The capacity of a charger for those units that provided such information was typically 300 Amp to 400 Amp. These capacities are not generally sufficient to meet the demands of the full spectrum of accidents. One exception was ANO-2, which selected the capacity of the battery charger(s) to be adequate to meet the transient loading requirements if the associated battery is out of service. The class 1E 125 VDC FSAR system description for ANO-2 states that "*the chargers may be used as battery eliminators so that they can supply 125 volt DC power if the associated battery has to be taken out of service for testing or becomes unavailable for any reason*". Investigation also indicated that the capacity of the battery chargers at Palisades and WSES-3 is capable of handling the transient loading requirements. Therefore, the battery

chargers at ANO-2, Palisades, and WSES-3 are considered as backups for the associated battery.

The battery chargers at the other units for the CEOG member utilities may not be capable of satisfying the transient loading requirements for all initiating events considered in the PRAs. With a battery out of service, the associated battery chargers would trip off line in attempting to satisfy a transient loading demand. This would result in a consequential loss of the affected class 1E 125 VDC bus. The class 1E 125 VDC FSAR system descriptions for PVNGS 1, 2 & 3, SONGS 2&3, SL 1&2, and CC-1&2 indicate that the capacity of the charger is based on the normal steady-state loads and the charging requirement for the associated battery. Certain plants modeled operability of the DC bus as requiring both the battery and the respective chargers. For example, CC-1&2 and SONGS 2&3 indicates that successful operation of a 125 VDC subsystem, as modeled in the PRA for these units, is dependent on both the battery charger and battery being operable. This implies that a 125 VDC bus would eventually lose its ability to power the associated loads if either the battery or battery charger becomes unavailable due to hardware failure or removal from service.

The remaining CEOG utilities with battery chargers that may not be capable of handling transient loading demand requirements for all initiating events if the associated battery is out of service include FCS, MP-2, PVNGS 1, 2 & 3, and SL 1&2. Of these units, the FCS, MP-2, and SL 1&2 have fast transfer capability while the PVNGS 1, 2 & 3 do not. For the units without fast transfer capability, realignment of offsite power to the safeguard buses is not performed following a reactor trip because these buses are already connected to the switchyard. For the units with fast transfer capability, a relatively small number of breakers is involved in the realignment of the AC power sources following a reactor trip. The capacity of the battery chargers is adequate to handle the transient loading requirements caused by the realignment of AC power sources following a reactor trip caused by an uncomplicated transient. Hence, the battery chargers would not trip off line, given that the associated battery is out of service. However, for complicated transient events and events that involve safeguards actuation, the capacity of the battery chargers alone would not be adequate for handling the transient loading demand requirements following a reactor trip. Such events include loss of offsite power and the various categories of LOCAs. For these initiating events the battery chargers would trip off line following a reactor trip, thus causing a consequential loss of the affected class 1E 125 VDC bus. The inability of the battery chargers to handle complicated transient events and events involving safeguards actuation is applicable to all of the above units, those with and without fast transfer capability.

For FCS, MP-2, PVNGS 1, 2 & 3, and SL 1&2, the capacity of the battery chargers alone is inadequate for handling the transient loading requirements resulting from initiating events that require the starting of the EDGs. An assessment was therefore performed to estimate the conditional core damage frequency, given that a class 1E 125 VDC battery is out of service and the capacity of the associated battery chargers cannot handle the transient loading demand requirements. The assessment assumes that the affected battery

chargers will trip off line following a reactor trip caused by events that require starting of the EDGs. Tripping of the battery chargers results in a consequential loss of the associated class 1E 125 VDC bus. The assessment was performed for a representative unit for the CEOG member utilities.

Results obtained for assessing the risk impact due to inadequate battery charger capacity show that the dominant contributors to the conditional core damage frequency involve core damage scenarios initiated by a loss of offsite power. A plant configuration with a class 1E 125 VDC battery out of service that experiences a loss of offsite power causes the associated battery charger to lose its source of power. Consequently, the affected DC bus becomes unavailable regardless of the charger capacity. For this condition, the affected EDG will not start and one train of safeguard equipment will become inoperable because of the DC power dependency. A comparison of the results from this assessment with results for the case with adequate battery capacity shows that the dominant contributors to core damage frequency are the same. In either case, with or without adequate battery charger capacity, loss of offsite power is the dominant contributor to risk. Consequently, the results presented in Table 6-2 are applicable to battery chargers with and without adequate capacity to handle transient loading demand requirements.

(b) Impact of DC Battery Unavailability on the Potential for an Increase in Loss of DC Bus Frequency

With a class 1E 125 VDC battery out of service, the associated battery chargers are the only source of power for the affected DC bus. During this plant configuration for the proposed AOT, failure of the battery chargers would cause an increase in the loss of DC bus frequency. A bounding assessment was performed for the CEOG member utilities to determine the risk impact due to the potential increase in loss of DC bus frequency with a battery out of service. The assessment may or may not reflect current operating practices of the DC subsystems allowed by the current 2 hour AOT at all of the CEOG member utilities. The intent of the assessment is to determine the impact on loss of DC bus frequency with the battery charger(s) as the sole source of power for the affected DC bus during the proposed extension to the AOT.

With a class 1E 125 battery out of service, the dominant contributor to loss of the associated DC bus is failure of the battery chargers. The class 1E DC power configuration schematics provided in Attachment 2 show that a DC bus for all CE designed units with the exception of SONGS 2&3 can be powered by two battery chargers and the associated battery. For SONGS 2&3, a single battery charger and the associated battery provide power to each of the DC buses. The ICCDP given the potential for increasing the loss of a DC bus frequency with a battery out of service can be determined by the following expression:

$$ICCDP_{BATT} = \lambda_c AOT CCDP_{LODC} \quad (6-3)$$

where,

ICCDP _{BATT}	= Incremental conditional core damage probability given the potential increase in loss of a DC bus frequency
λ_c	= The overall failure rate of the battery chargers (per hour)
AOT	= Allowed outage time (hours)
CCDP _{LODC}	= Conditional core damage probability given a loss of DC bus

The assessment used generic failure data for the battery chargers, and an assumed bounding value for CCDP given the loss of a DC bus based on the current PRAs for the CE designed plants. A generic failure rate of 2.39E-05 per hour [Ref. 8] and a beta factor of 1.26E-02 [Ref. 9] were used to estimate the overall failure rate of 3.01E-07 per hour for two battery chargers. A CCDP_{LODC} value of 2.0E-02 was assumed based on a review of current PRA information for the CE designed plants. In the majority of cases, the CCDP_{LODC} is approximately an order of magnitude smaller than 2.0E-02. Therefore, a CCDP_{LODC} of 2.0E-02 is considered to be bounding for all of the CE designed PWRs.

Substituting the above values and an AOT of 2 hours into Equation 6-3 yields a value of 1.2E-08 for ICCDP_{BATT}. Similar substitutions for an AOT of 8 or 24 hours yield a CCDP_{BATT} value of 4.8E-08 and 1.4E-7, respectively. These values are not included in the results presented in Table 6-2 and would contribute less than 10% to the ICCDP increase over the current AOT. Based on the above assessment, the ICCDP due to the potential for increasing loss of DC bus frequency with the associated battery out of service is small and can be neglected.

It should be noted that the overall failure rate used for the battery chargers is not applicable to SONGS 2&3 because each of the DC subsystems at this utility includes a single battery charger. However, SONGS 2&3 procedure does not allow the battery charger to be the sole source of power to the associated DC bus. At SONGS 2&3, the removal of a class 1E battery from service requires the associated vital bus inverter to be transferred to its alternate power supply, then the battery charger is also removed from service. Therefore, the battery and associated battery charger are always operated in tandem. Consequently, the potential increase in loss of a DC bus frequency with a battery out of service is negligible at SONGS 2&3.

(c) Battery Inoperability Due to Non-functional Seismic Restraint

The battery seismic restraint may be removed to accomplish the necessary maintenance on the battery. Even though the function of the battery is restored after maintenance it would still be regarded as inoperable without the seismic restraint. The risk for an 8 hour exposure associated with the non-functional seismic restraint is bounded by the conditional core damage probability of 3.9E-9, as discussed under the "External Event Considerations" in Section 6.2. Similarly, the risk for a 24 hour exposure is bounded by the conditional core damage probability of 1.1E-8, which is also discussed under the "External Event Considerations".

6.3.3.2 ICLERP Assessment

The appropriate LERFs supplied by those CEOG member utilities with automated LERF models were substituted into Equation (6-3) to obtain the risk resulting from an increase in large early releases due to a DC power source out of service. Estimates for ICLERPs were developed for the remaining CEOG plants based on the conservative approach described in Section 6.3.1. This approach sums the incremental LER contributors identified in the simplified LER event tree shown in Figure 6-1. Accordingly, the ICLERP is estimated by multiplying the incremental contributors to large early release with the associated ICCDP for the proposed AOT. The incremental contributors to large early release are identified in Figure 6-1 as event tree scenarios LERP-1 through LERP-5. A summary description for each of these scenarios is as follows:

LERP-1: This incremental contributor to large early release involves incremental core damage probability followed by an isolated containment, a depressurized steam generator due to stuck open MSSV, and thermal-induced steam generator tube rupture.

LERP-2: This incremental contributor to large early release involves incremental core damage probability followed by an isolated containment, a depressurized steam generator due to stuck open MSSV, steam generator tubes intact, and HPME failure of the containment.

LERP-3: This incremental contributor to large early release involves incremental core damage probability followed by an isolated containment, pressurized steam generators, and thermal-induced steam generator tube rupture.

LERP-4: This incremental contributor to large early release involves incremental core damage probability followed by an isolated containment, pressurized steam generators with tubes intact, and HPME failure of the containment.

LERP-5: This incremental contributor to large early release involves incremental core damage probability followed by failure to isolate the containment.

The simplified LER event tree was quantified for all of the CE designed PWRs for a normalized ICCDP. The results of the quantification are shown in Table 6-4. The conditional probability for each of the scenarios that contribute to large early release is provided along with the sum of the contributions for the plants.

Table 6-3

**Normalized Bounding CLERP Estimates due to Unavailability of a Battery/Battery Charger
Using Simplified LERF Model**

CEOG Plant	T-I SGTR Probability	LERP-1	LERP-2	LERP-3	LERP-4	LERP-5	Total LERP
ANO-2, PAL, WSES-3 (Note 1)	0.5	4.99E-2	4.99E-4	8.97E-3	8.88E-3	3.00E-3	7.12E-2

Notes for Table 6-3

1. A bounding value of 0.01 is used for CCFP due to HPME in the calculations.

The normalized total LERP shown in Table 6-3 is used to estimate the ICLERP for those CEOG member utilities that do not have an automated LERF model. This is accomplished by multiplying the normalized total LERP with the ICCDP for the plant of concern. The resulting plant risks are summarized in Table 6-4.

The ICLERP results presented in Table 6-4 show that the plant risk for the CEOG member utilities that provided information is below the acceptance guideline value of 5.0E-8 for a proposed AOT of 8 hours. Plant specific evaluations show that the risk due to ICLERP is also below the acceptance guideline value for a proposed AOT of 24 hours at selected units among the CEOG utilities. Generally, these units include CE designed PWRs that have increased redundancies in class 1E DC power systems (i.e., SONGS 2&3 and WSES-3) or additional plant design features that minimizes LOP events at the site (i.e., the Palisades unit).

Table 6-4

ICLERP Estimates due to Unavailability of a Battery/Battery Charger

CEOG Plant	LERF Model	CLERF _B [Per Year]	CLERF _{Oos} [Per Year]	Full AOT [hours]	ICCDP [From Table 6-2]	ICLERP
ANO-2	Simplified LER event tree	[Note 1]	[Note 1]	24	1.80E-6	1.28E-7
				8	6.01E-7	4.28E-8
				2	1.50E-7	1.07E-8
CC-1&2	[Note 2]	[Note 2]	[Note 2]	24	-	-
				8	-	-
				2	-	-
FCS	Automated LERF model	2.56E-6	4.16E-5	24	1.98E-6	1.07E-7
				8	6.61E-7	3.57E-8
				2	1.65E-7	8.91E-9
MP-2	[Note 2]	[Note 2]	[Note 2]	24	-	-
				8	-	-
				2	-	-
PAL	Simplified LER event tree	[Note 1]	[Note 1]	24	4.21E-7	3.00E-8
				8	1.40E-7	9.97E-9
				2	3.50E-8	2.49E-9

Table 6-4 (Cont'd)

ICLERP Estimates due to Unavailability of a Battery/Battery Charger

CEOG Plant	LERF Model	CLERF _B [Per Year]	CLERF _{OOS} [Per Year]	Full AOT [hours]	ICCDP [From Table 6-2]	ICLERP
PVNGS 1, 2 & 3	[Note 2]	[Note 2]	[Note 2]	24	-	-
				8	-	-
				2	-	-
SONGS 2&3	Automated LERF model	1.32E-6	1.22E-5	24	7.37E-7	2.98E-8
				8	2.46E-7	9.94E-9
				2	6.14E-8	2.48E-9
SL-1	[Note 2]	[Note 2]	[Note 2]	24	-	-
				8	-	-
				2	-	-
SL-2	[Note 2]	[Note 2]	[Note 2]	24	-	-
				8	-	-
				2	-	-
WSES-3	Simplified LER event tree	[Note 1]	[Note 1]	24	3.74E-7	2.66E-8
				8	1.25E-7	8.90E-9
				2	3.12E-8	2.22E-9

Notes for Table 6-4

1. Not required for the simplified LERF model
2. Relevant data from this plant will be provided at the time of submittal

6.3.4 LERP Sensitivity Studies

(a) Thermally-Induced SGTR

Thermally-induced SGTR depends on the steam generator design, age, operating history, and the time in cycle. Each factor or combination of factors may influence the likelihood of large early releases. In this evaluation, a conservative probability of 0.5 was assumed for failure of the steam generator tube prior to failure of the reactor vessel lower head. A sensitivity evaluation was performed to determine the impact of the likelihood of thermally-induced SGTR on large early releases. This involved varying the probability of thermally-induced SGTR from 0.6 to 0.1 and then requantifying the simplified LER event tree to estimate the normalized LERPs for each CEOG plant group. Variations in the probability for thermally-induced SGTR affect the probabilities of large early scenarios LERP-1 and LERP-2 (see Figure 6-1) for all of the CEOG plant groups. All of the other probabilities within the plant group for the remaining large early scenarios are unaffected. The results of this sensitivity evaluation are summarized in Table 6-5.

Table 6-5

Sensitivity Results for Thermally-Induced SGTR

CEOG Plant Group	T-I SGTR Probability	LERP-1	LERP-2	LERP-3	LERP-4	LERP-5	Total LERP
ANO-2, PAL, WSES-3 (Note 1)	0.6	5.98E-2	3.99E-4	8.97E-3	8.88E-3	3.00E-3	8.10E-2
	0.5	4.99E-2	4.99E-4	8.97E-3	8.88E-3	3.00E-3	7.12E-2
	0.4	3.99E-2	5.98E-4	8.97E-3	8.88E-3	3.00E-3	6.13E-2
	0.3	2.99E-2	6.98E-4	8.97E-3	8.88E-3	3.00E-3	5.14E-2
	0.2	1.99E-2	7.98E-4	8.97E-3	8.88E-3	3.00E-3	4.15E-2
	0.1	9.97E-3	8.97E-4	8.97E-3	8.88E-3	3.00E-3	3.17E-2

Notes for Table 6-5

1. A bounding value of 0.01 is used in the calculations for CCFP due to HPME.

Using the thermally-induced SGTR probability of 0.5 as the base case, the results in Table 6-5 indicate that the normalized LERP increases as the thermal-induced SGTR probability increases. As the thermally-induced SGTR probability decreases, the normalized LERP also decreases. The results of the sensitivity evaluation conclude that thermally-induced SGTR probability impacts the normalized LERP and consequently the plant risk associated with ICLERP for all of the CEOG plants.

(b) MSSV Failure Probability

The potential for core damage events at high RCS pressure becoming a large early release is dependent upon the ability to maintain the steam generator tubes intact and the secondary side isolated. In this evaluation a conservative probability of 0.1 was assumed for the MSSV failing open. A sensitivity evaluation was also performed to determine the impact of the likelihood of the MSSV failing open on large early releases. This involves varying the probability of MSSV failing open from 0.05 to 0.2 and then requantifying the simplified LER event tree to estimate the normalized LERP for each CEOG plant group. Variations of the probability for MSSV failing open affect the probabilities of large early scenarios LERP-1 through LERP-4 (see Figure 6-1) for all of the CEOG plant groups. The probability of large early scenario LERP-5 is not affected. The results of this sensitivity evaluation are summarized in Table 6-6.

Table 6-6

Sensitivity Results for MSSV Failing Open

CEOG Plant Group	MSSV Probability	LERP-1	LERP-2	LERP-3	LERP-4	LERP-5	Total LERP
ANO-2, PAL, WSES-3 (Note: A bounding value of 0.01 is used in the calculations for CCFP due to HPME)	0.050	2.49E-2	2.49E-4	9.47E-3	9.38E-3	3.00E-3	4.70E-2
	0.075	3.74E-2	3.74E-4	9.22E-3	9.13E-3	3.00E-3	5.90E-2
	0.100	4.99E-2	4.99E-4	8.97E-3	8.88E-3	3.00E-3	7.12E-2
	0.125	6.23E-2	6.23E-4	8.72E-3	8.64E-3	3.00E-3	8.33E-2
	0.150	7.48E-2	7.48E-4	8.47E-3	8.39E-3	3.00E-3	9.54E-2
	0.175	8.72E-2	8.72E-4	8.23E-3	8.14E-3	3.00E-3	1.07E-1
	0.200	9.97E-2	9.97E-4	7.98E-3	7.90E-3	3.00E-3	1.20E-1

Using the MSSV failure probability of 0.1 as the base case, the results in Table 6-6 indicate that the normalized LERP increases as the MSSV failure probability increases. Likewise, as the MSSV failure probability decreases the normalized LERP also decreases. The results of this sensitivity evaluation conclude that the normalized LERP and consequently the plant risk associated with ICLERP are sensitive to MSSV failure probability.

7.0 CONFIGURATION RISK MANAGEMENT PROGRAM

Risks associated with the use of this AOT will be subsumed within the plant's CRMP. Appropriate CRMP commitments relating to the implementation of this AOT will be included in the plant specific submittal.

8.0 SUMMARY AND CONCLUSIONS

This report provides the results of an evaluation for extending the AOT/CT for the class 1E DC electrical power source from the current 2 hours to a minimum of 8 hours for the participating CEOG member utilities. For selected units, including SONGS 2&3 and WSES-3, plant specific evaluations demonstrate support for an AOT/CT extension of 24 hours. The increased AOT/CT reflects the additional redundancy in the class 1E DC electrical power sources at these units. The AOT/CT extension is sought to provide flexibility in the performance of surveillance testing, preventive and corrective maintenance of the DC electrical power sources (i.e., battery and its associated charger) during power operation. This will allow allocation of time for on-line maintenance, repair and testing of the DC electrical power sources. Justification of this AOT/CT modification was based on an integral review and assessment of plant operations, deterministic/design basis factors, and plant risk.

The plant risk associated with ICCDP was estimated as the product of the incremental core damage frequency and the proposed increase in AOT. The proposed increase in AOT/CT for a DC electrical power source was analyzed for a plant configuration that maximizes the conditional core damage frequency given that a DC power source is out of service. The plant-specific PSA models were used to perform the analysis. The ICCDP results show that the plant risks for the participating CEOG member utilities are below the acceptance guideline value of $5.0E-7$ for a proposed AOT of 8 hours. The ICCDP results for SONGS 2&3, WSES-3 and Palisades also show that the plant risks for these units are below or marginally above the acceptance guideline value for a proposed AOT of 24 hours.

Since all of the CEOG member utilities do not have a LERF model in place, the plant risk associated with ICLERP was estimated using either an automated LERF model or a simplified LER event tree. The plant risk associated with ICLERP for the units with automated LERF models was estimated as the product of the incremental large early release frequency and the proposed AOT. The plant risk associated with ICLERP for the units without automated LERF models was estimated using a simplified LER event tree. This event tree focused on the causes for, and the interrelationships of, the containment large early release contributors following a class 1E DC power source being out of service. The ICCDP is propagated through the simplified LER event tree to determine what fraction contributes to large early release events based on the response to containment isolation, secondary side depressurization of the steam generator(s), occurrence of thermally-induced SGTR, and containment failures due to reactor vessel lower head failure. The insights obtained from the ICLERP results are similar to the insights for ICCDP. The ICLERP results show that the plant risks for the CEOG member utilities that provided data are below the acceptance guideline value of $5.0E-8$ for a proposed AOT of 8 hours. The ICLERP results for the SONGS 2&3, WSES-3 and Palisades units also show that the plant risks for these units are below the acceptance guideline value for a proposed AOT of 24 hours.

The plant risks associated with ICCDP and ICLERP cover the inoperability of a class 1E DC electrical power source for the proposed AOT due to non-common cause faults. Common cause faults are not evaluated in this report because such a condition is governed by the "3.0.3" LCO

(or equivalent for plants with customized TSs). Implementation of the CRMP will provide guidance for assuring that confirmation or verification of the remaining DC electrical power subsystem(s) is (are) operable.

The proposed extension of the AOT/CT was evaluated from the perspective of the various risks associated with plant operation. Incorporation of the proposed extension of the AOT/CT into the TSs may result in a negligible to small increase in the "at power" risk. The instantaneous plant risk associated with entry into the proposed LCO Action Statement will be controlled via the plant's CRMP and will be strongly dependent on the extent of DC power functionality. It is expected that the primary usage of the proposed extended AOT/CT will involve activities with negligible plant risk. The results of this evaluation demonstrate that the proposed AOT/CT extension provides plant operational flexibility while simultaneously allowing plant operation with an acceptable level of risk. The results also demonstrate that the risk level associated with the proposed AOT/CT is below the regulatory guidelines set forth in Regulatory Guide 1.177.

9.0 REFERENCES

1. 10 CFR 50.65, Appendix A, "The Maintenance Rule".
2. NRC Regulatory Guide, "An Approach for Plant-Specific, Risk-Informed Decisionmaking: Technical Specifications", RG 1.177, August 1998.
3. NRC Regulatory Guide, "Availability of Electric Power Sources", RG 1.93, December 1974.
4. NRC Regulatory Guide, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions On Plant-Specific Changes to the Licensing Basis", RG 1.174, July 1998.
5. NRC, "Standard Technical Specifications for Combustion Engineering Pressurized Water Reactors", NUREG-0212, July 9, 1982.
6. NRC, "Standard Technical Specifications: Combustion Engineering Plants", NUREG-1432, Rev. 1, April 1995.
7. Pilch, M. M., et al, "Resolution of the Direct Containment Heating Issue for Combustion Engineering Plants and Babcock & Wilcox Plants", NUREG/CR-6475, November 1998.
8. Gilbert, B. G., et al, "Nuclear Computerized Library for Assessing Reactor Reliability (NUCLARR), Data Manual – Part 3: Hardware Component Failure Data", NUREG/CR-4639, December 1990.
9. Marshall, F. M., et al, "Common-Cause Failure Parameter Estimations", NUREG/CR-5497, October 1998.
10. Letter, "Docket Nos. 50-361 and 50-362, Response to Generic Letter 88-20, Supplement 4, Individual Plant Examination of External Events (IPEEE), San Onofre Nuclear Generating Units 2 and 3", from W.C. Marsh (Southern California Edison Company) to US Nuclear Regulatory Commission, dated December 15, 1995.
11. USNRC, "Risk Assessment of Severe Accident Induced Steam Generator Tube Rupture", NUREG-1570, March 1998.
12. Millstone Nuclear Power Station Unit 2, Technical Specifications, Appendix "A" to License No. DPR-65, Section 3.8.2.3, Amendment No. 180.
13. St. Lucie Plant Unit 1, Technical Specifications, Appendix "A" to License No. NPF-67, Section 3.8.2.3, Amendment No. 94.

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14. St. Lucie Plant Unit 2, Technical Specifications, Appendix "A" to License No. NPF-16, Section 3.8.2.1.
 15. Arkansas Nuclear One Unit 2, Technical Specifications, Appendix "A" to License No. NPF-6, Section 3.8.2.3, Amendment No. 94.
 16. Waterford Steam Electric Station Unit 3, Appendix A (Technical Specifications) to License No. NPF-38, Section 3.8.2.1.
 17. Fort Calhoun Station Unit 1, Operating License No. DPR-40 Appendix A (Technical Specifications), Section 2.7, Amendment Nos. 162 & 180.
 18. Palisades Plant Facility Operating License DPR-20, Appendix A, Technical Specifications, Section 3.7.4, Amendment No. 180.

Attachment 1

NUREG-1432 Revision 1, Section 3.8.4

(Pages 3.8.4-1 through 3.8.4-3)

DC Sources - Operating
3.8.4

3.8 ELECTRICAL POWER SYSTEMS

3.8.4 DC Sources - Operating

LCO 3.8.4 The Train A and Train B DC electrical power subsystems shall be OPERABLE.

APPLICABILITY: MODES 1, 2, 3, and 4.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One DC electrical power subsystem inoperable.	A.1 Restore DC electrical power subsystem to OPERABLE status.	2 hours
B. Required Action and associated Completion Time not met.	B.1 Be in MODE 3.	6 hours
	<u>AND</u>	
	B.2 Be in MODE 5.	36 hours

SURVEILLANCE REQUIREMENTS

SURVEILLANCE	FREQUENCY
SR 3.8.4.1 Verify battery terminal voltage is \geq [129/258] V on float charge.	7 days
SR 3.8.4.2 Verify no visible corrosion at battery terminals and connectors. <u>OR</u> Verify battery connection resistance [is \leq [1E-5 ohm] for inter-cell connections, \leq [1E-5 ohm] for inter-rack connections, \leq [1E-5 ohm] for inter-tier connections, and \leq [1E-5 ohm] for terminal connections].	92 days

DC Sources - Operating
3.8.4

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
SR 3.8.4.3	Verify battery cells, cell plates, and racks show no visual indication of physical damage or abnormal deterioration that could degrade battery performance.	[12] months
SR 3.8.4.4	Remove visible terminal corrosion and verify battery cell to cell and terminal connections are [clean and tight, and are] coated with anti-corrosion material.	[12] months
SR 3.8.4.5	Verify battery connection resistance [is \leq [1E-5 ohm] for inter-cell connections, \leq [1E-5 ohm] for inter-rack connections, \leq [1E-5 ohm] for inter-tier connections, and \leq [1E-5 ohm] for terminal connections].	[12] months
SR 3.8.4.6	<p align="center">- NOTE -</p> <p>This Surveillance shall not be performed in MODE 1, 2, 3, or 4.</p> <hr/> <p>Verify each battery charger supplies \geq [400] amps at \geq [125/250] V for \geq [8] hours.</p>	[18 months]
SR 3.8.4.7	<p align="center">- NOTES -</p> <ol style="list-style-type: none"> The modified performance discharge test in SR 3.8.4.8 may be performed in lieu of the service test in SR 3.8.4.7 once per 60 months. This Surveillance shall not be performed in MODE 1, 2, 3, or 4. <hr/> <p>Verify battery capacity is adequate to supply, and maintain in OPERABLE status, the required emergency loads for the design duty cycle when subjected to a battery service test.</p>	[18 months]

DC Sources - Operating
3.8.4

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE	FREQUENCY
<p>SR 3.8.4.8</p> <hr/> <p align="center">- NOTE -</p> <p>This Surveillance shall not be performed in MODE 1, 2, 3, or 4.</p> <hr/> <p>Verify battery capacity is \geq [80]% of the manufacturer's rating when subjected to a performance discharge test or a modified performance discharge test.</p>	<p>60 months</p> <p>AND</p> <p>12 months when battery shows degradation or has reached [85]% of the expected life with capacity < 100% of manufacturer's rating</p> <p>AND</p> <p>24 months when battery has reached [85]% of the expected life with capacity \geq 100% of manufacturer's rating</p>

Attachment 2

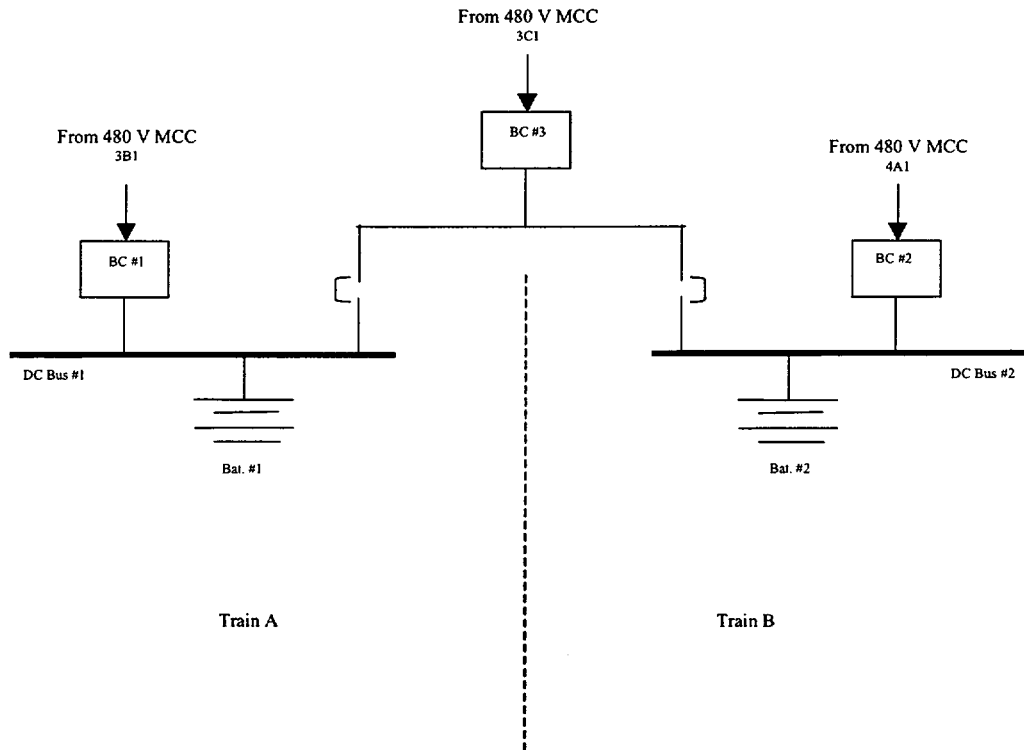
DC Electrical Power System Configurations at CE Designed PWRs

This attachment provides the configurations for the safety related DC electrical power system utilized by the CE PWRs. The configurations are presented as representative figures in this attachment. The following table identifies the configuration that is representative of the CE NSSS design.

Description of Configuration	Figure No.	CEOG Plant
1. Two batteries with a dedicated battery charger per battery and one swing battery charger	1	Arkansas Nuclear One – Unit 2 Fort Calhoun Station Millstone Unit 2
2. Two batteries with two dedicated battery chargers per battery	2	Palisades Nuclear Plant
3. Two batteries with two dedicated battery charger per battery and a swing battery charger	3A 3B	St. Lucie Unit 1 St. Lucie Unit 2
4. Three batteries with two dedicated battery chargers per battery	4	Waterford Unit 3
5. Four batteries with a dedicated battery charger per battery [Note 1]	5	San Onofre Unit 2 San Onofre Unit 3
6. Four batteries with a dedicated battery charger per battery and two swing battery chargers	6	Palo Verde Unit 1 Palo Verde Unit 2 Palo Verde Unit 3
7. Four batteries with two dedicated battery chargers per battery [Note 2]	7	Calvert Cliffs Unit 1 Calvert Cliffs Unit 2

Notes:

1. A spare battery charge is available for on-line replacement of any of the four normal battery chargers.
2. A reserve 125 VDC electrical system is also available. This system consists of one battery, one battery charger, and associated DC switching equipment. Only the battery may be transferred for replacement of any of the other four batteries.



Note: The Fort Calhoun (FCS) naming convention is used in this schematic

Figure 1

Schematic of Class 1E DC Power Configuration for ANO-2, FCS, and MP2

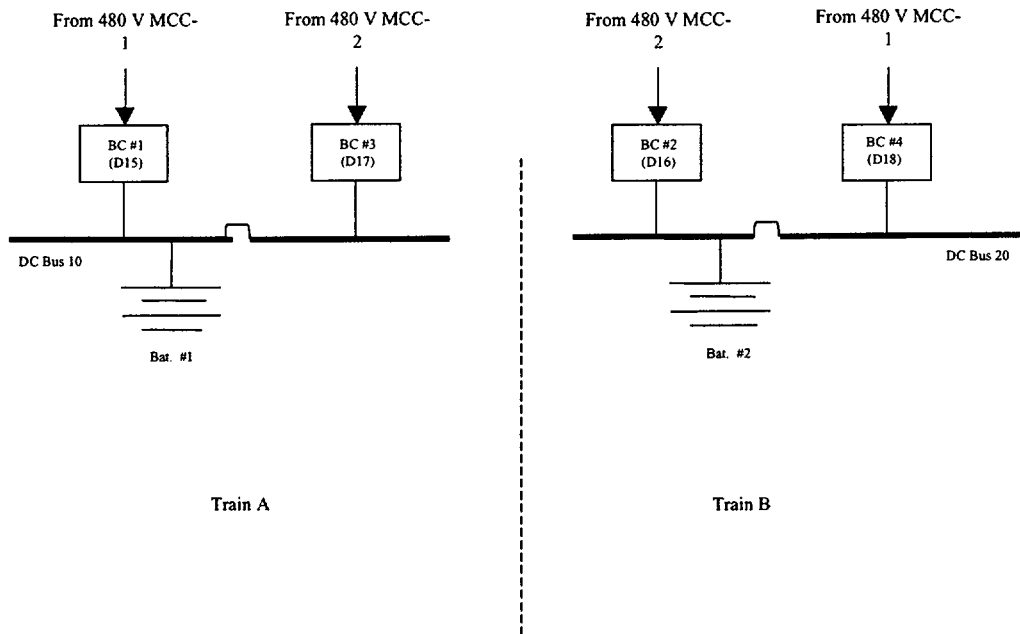


Figure 2

Schematic of Class 1E DC Power Configuration for the Palisades Nuclear Plant

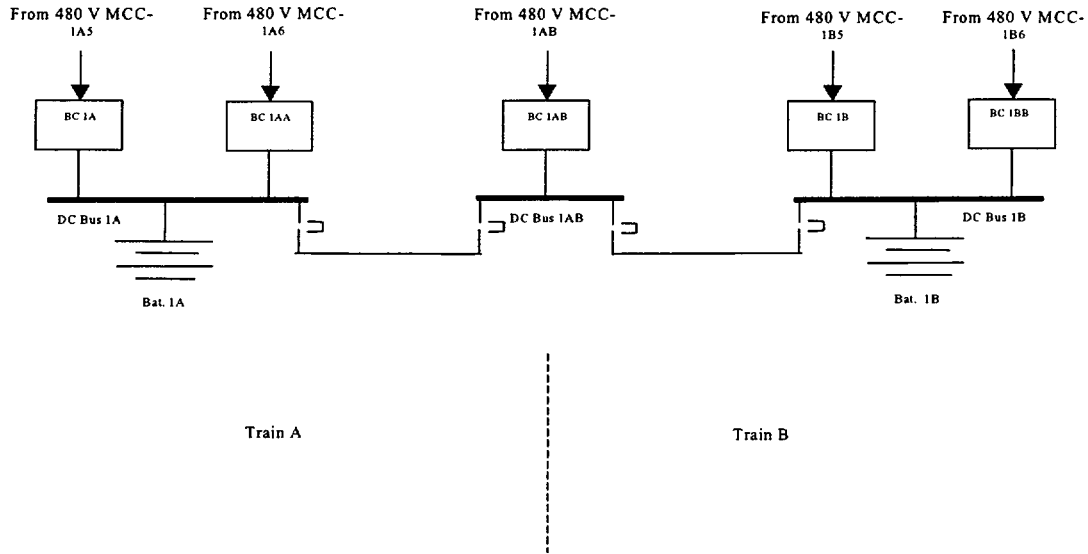


Figure 3A

Schematic of Class 1E DC Power Configuration for SL1

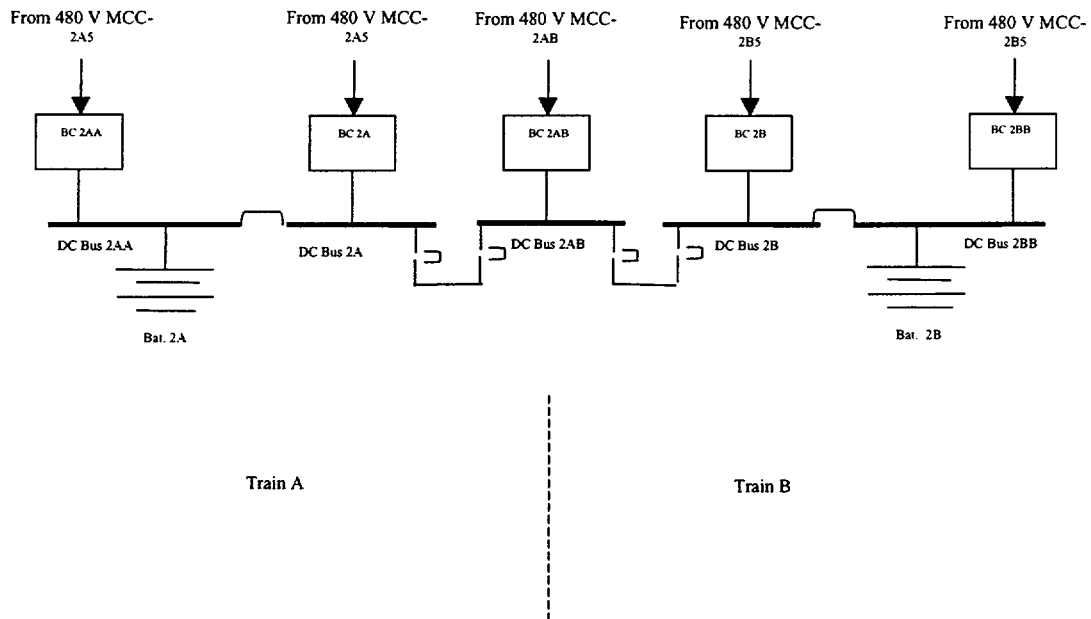


Figure 3B

Schematic of Class 1E DC Power Configuration for SL2

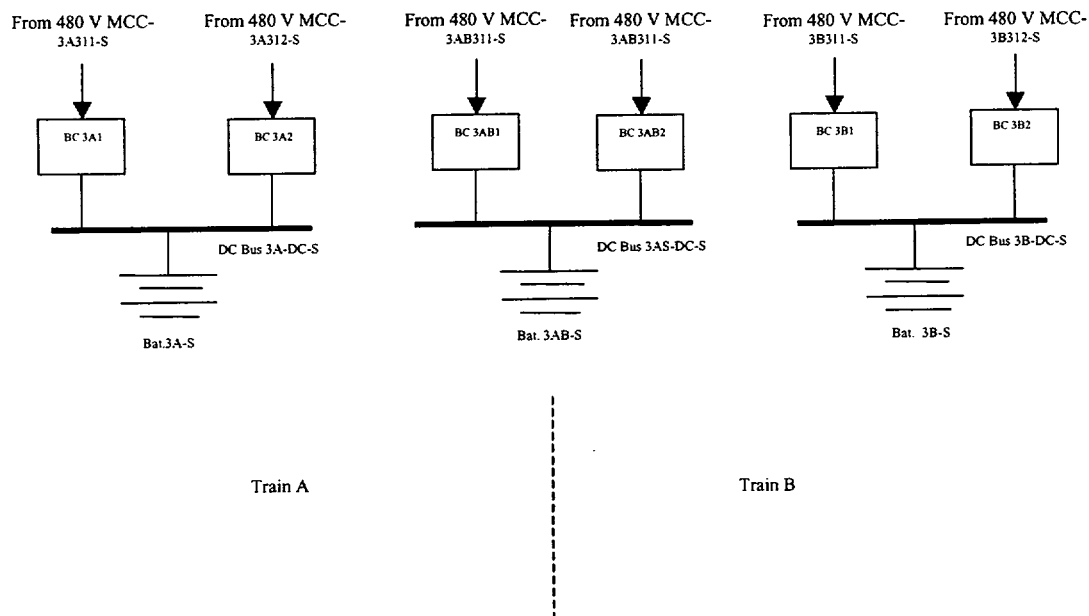
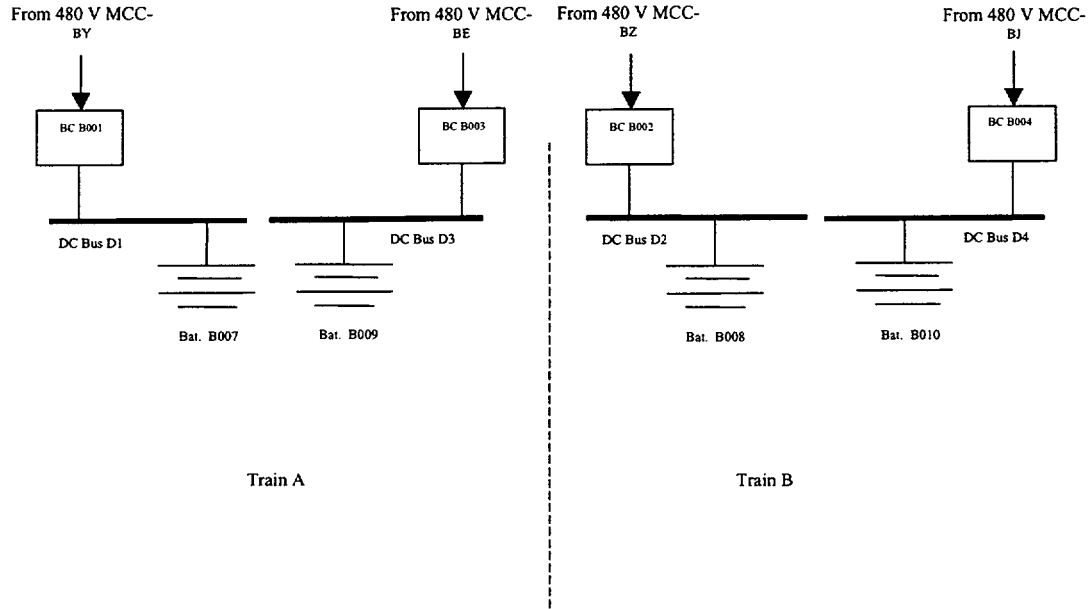


Figure 4

Schematic of Class 1E DC Power Configuration for WSES



Note: A reserve battery charger (not shown) is available for on-line replacement of any of the four battery chargers shown above.

Figure 5

Schematic of Class 1E DC Power Configuration for SONGS

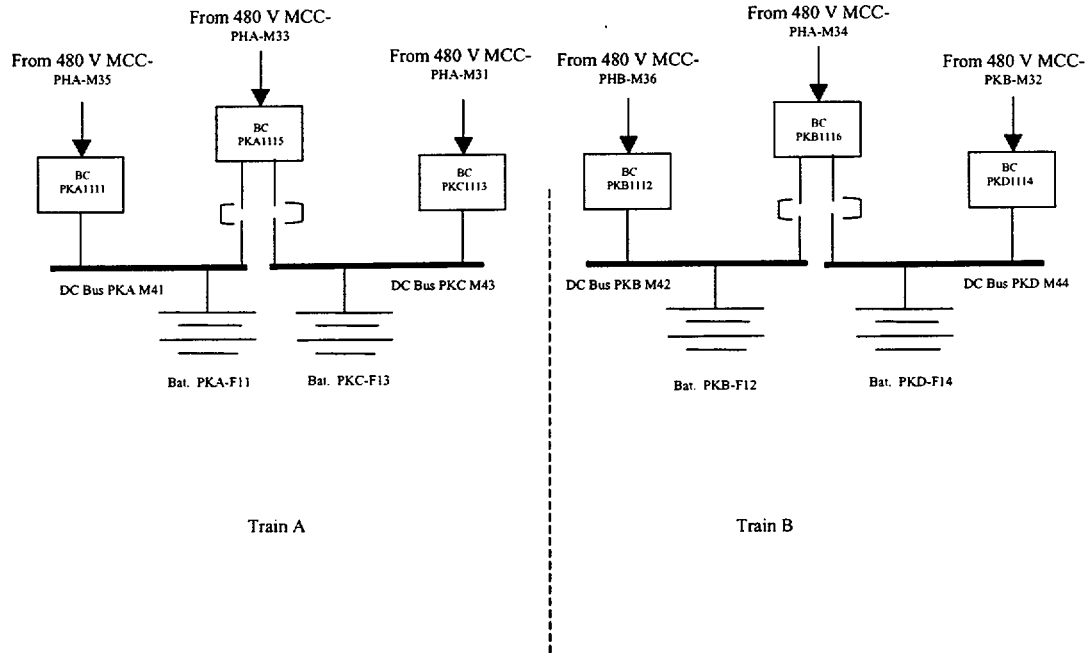
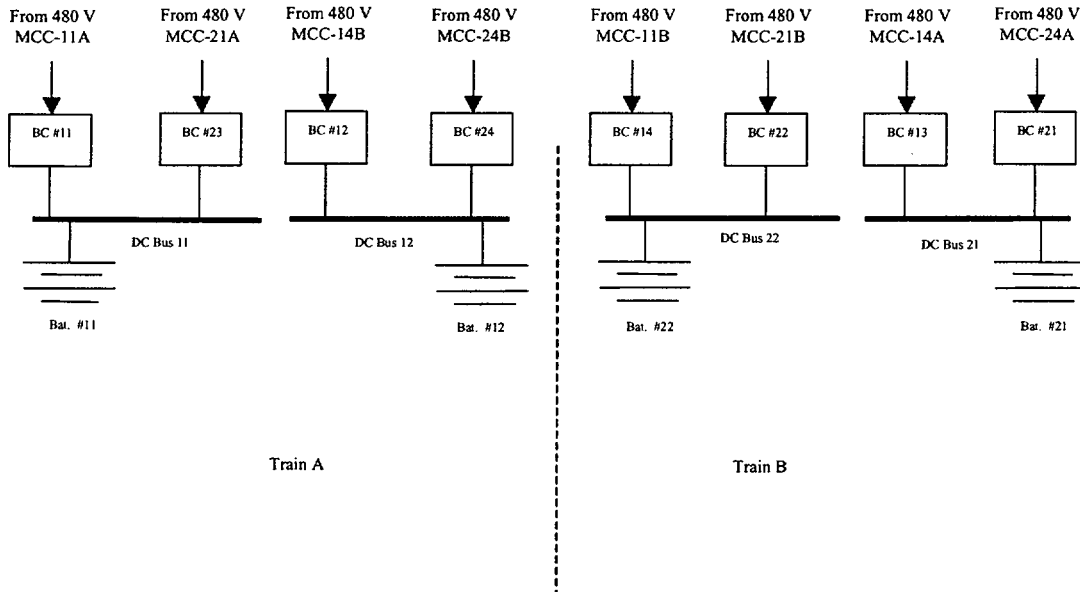


Figure 6

Schematic of Class 1E DC Power Configuration for PVNGS



Note: A reserve 125 DC battery (not shown) is also available for on-line replacement of any of the four batteries shown above.

Figure 7
Schematic of Class 1E DC Power Configuration for CCNP

Attachment 3

**DC Electrical Power System Configurations Analyzed
for the CE Designed PWRs**

Note: For this attachment, the out of service equipment is shown with an "X" drawn through it.

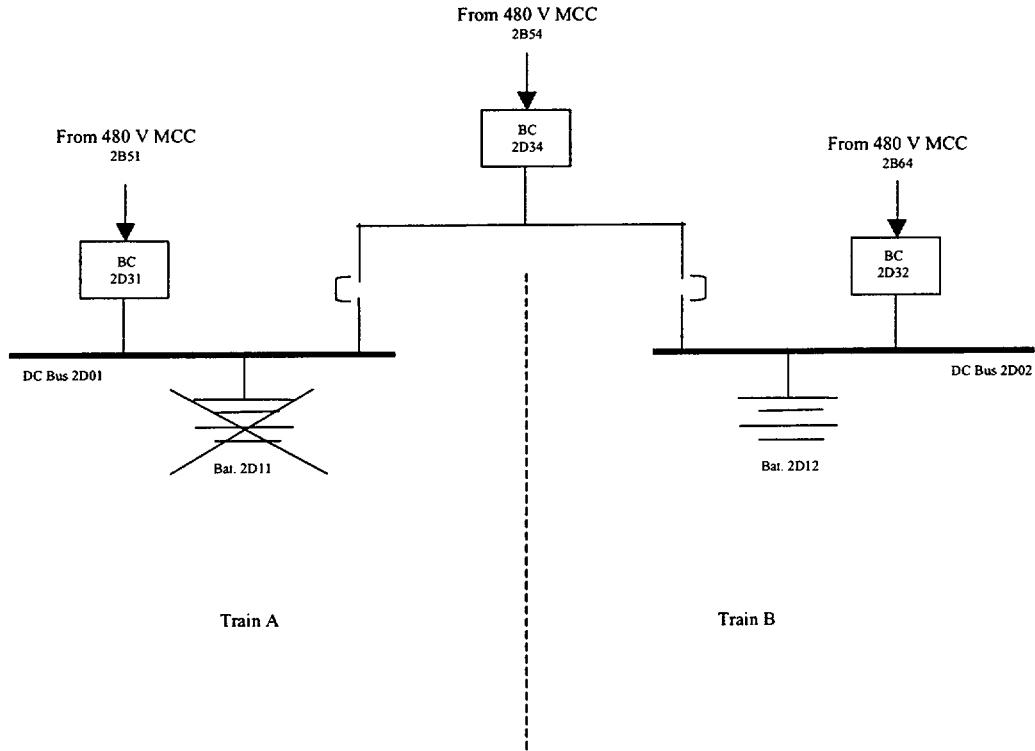


Figure 1

Schematic of Class 1E DC Power System Bounding Configuration
Analyzed for Arkansas One Unit 2

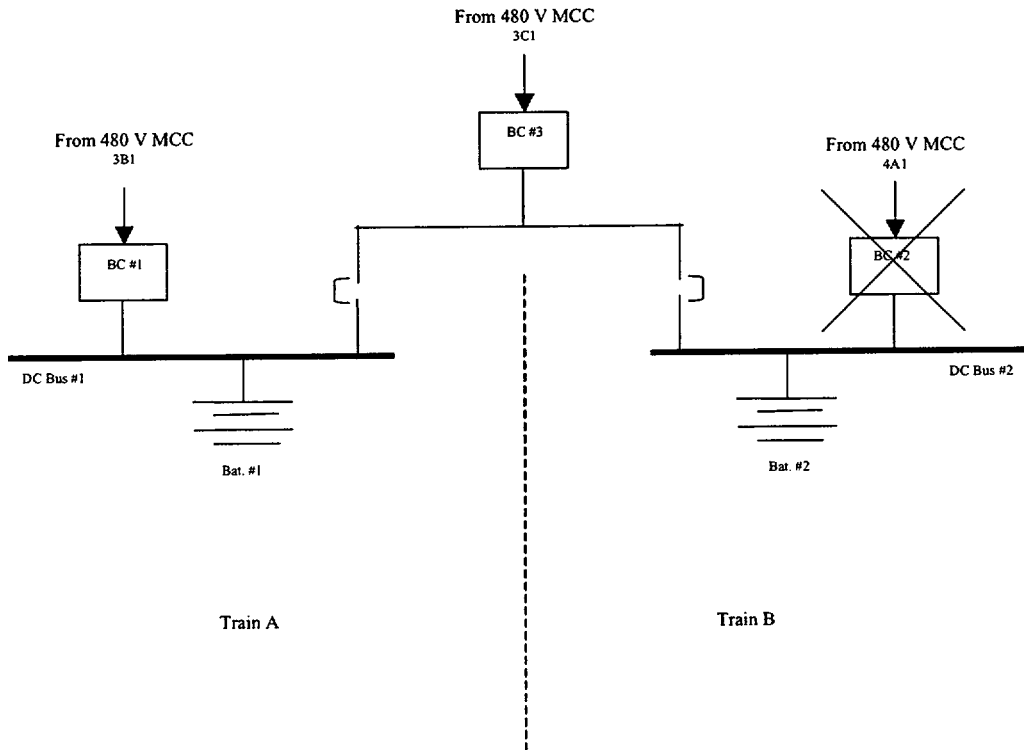


Figure 2

Schematic of Class 1E DC Power System Bounding Configuration
Analyzed for Fort Calhoun Station

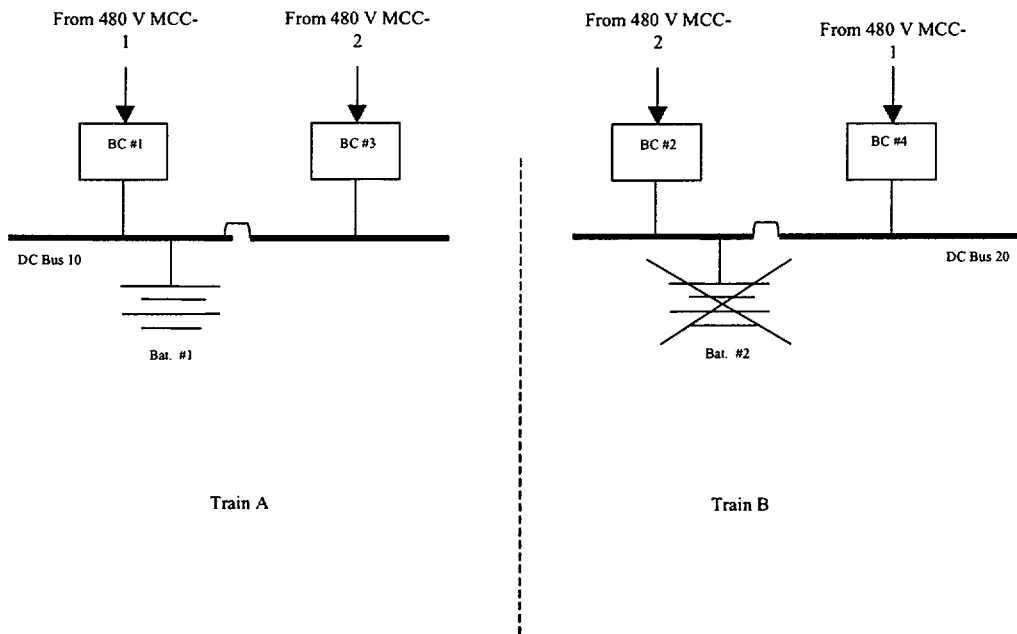


Figure 3

Schematic of Class 1E DC Power System Bounding Configuration
Analyzed for Palisades Nuclear Plant

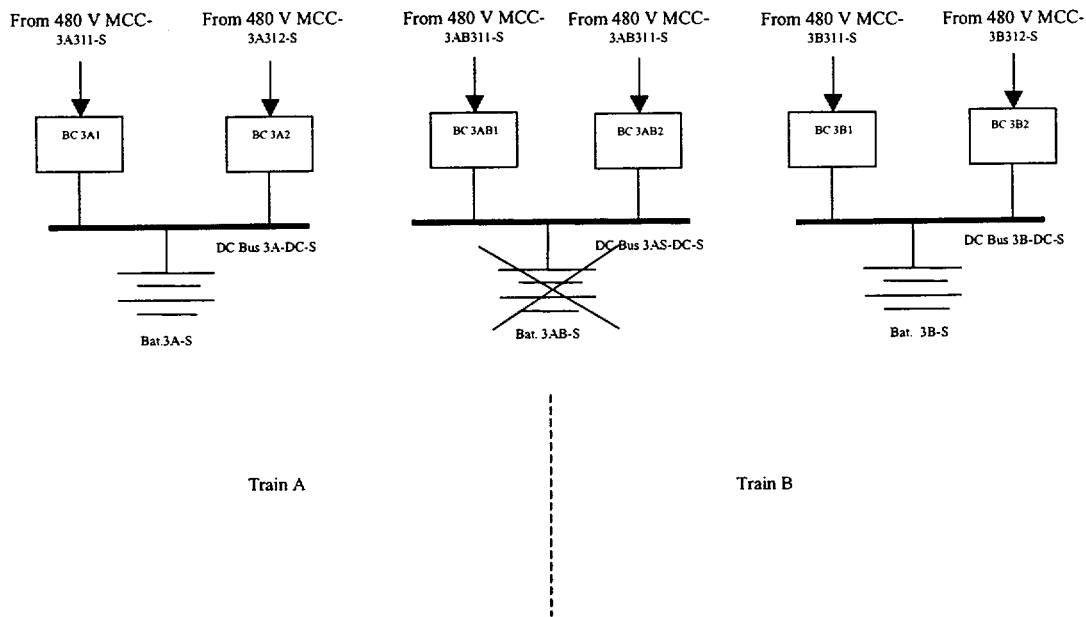


Figure 4

Schematic of Class 1E DC Power System Bounding Configuration
Analyzed for Waterford Unit 3

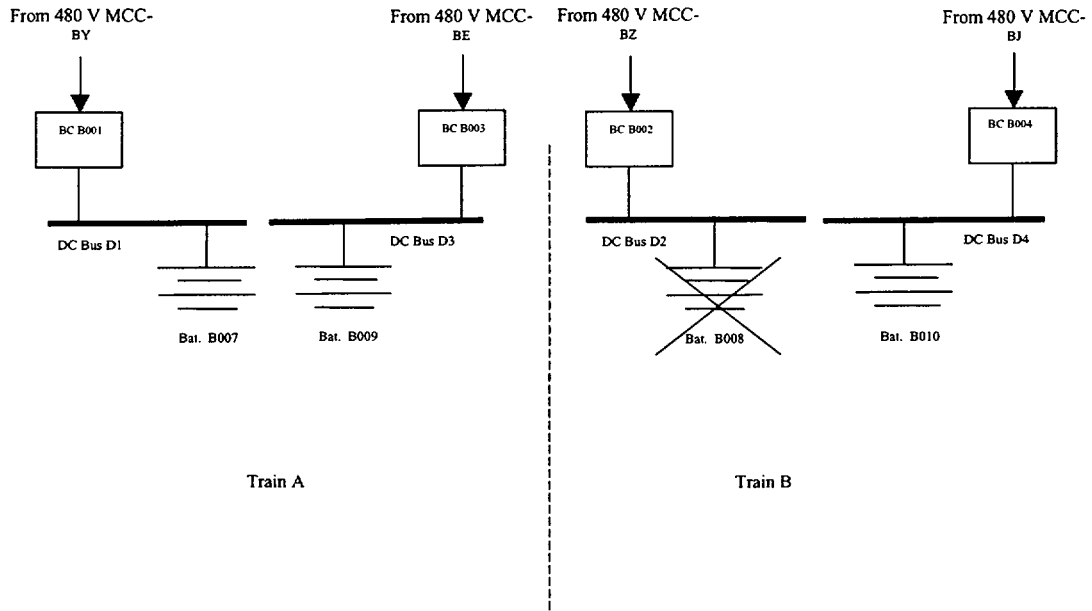


Figure 5

Schematic of Class 1E DC Power System Bounding Configuration
Analyzed for San Onofre Units 2 and 3