DOE/HTGR--87-061

HFD-49208

CLASS 1E DC POWER
SUBSYSTEM DESIGN DESCRIPTION

4 x 350 MW(t) MODULAR HTGR PLANT

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Issued By:
Stone & Webster Engineering Corporation
Under Subcontract to Gas-Cooled Reactor Associates
For the Department of Energy
Contract DE-AC03-78SF02034

MASTER

June 1986

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LIST OF ACRONYMS

ACB	Air Circuit Breaker
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
BAT	Battery
BACH	Battery Charger
BBSW	Battery Breaker Switchgear
BSWB	Battery Switchboard
CDS	Component Design Specification
ECA	Energy Conversion Area
GBU	Backup Generator
ICD	Interface Control Document
IEEE	Institute of Electrical and Electronics Engineers
MCC	Motor Control Center
NI	Nuclear Island
NFPA	National Fire Protection Association
NSSS	Nuclear Steam Supply Systems
OPDS	Overall Plant Design Specification
PCDIS	Plant Control Data and Instrumentation System
PNLD	DC Panelboards
PPIS	Plant Protection and Instrumentation System
SDD	System Design Description
SSDD	Subsystem Design Description
XSA	Startup Auxiliary Transformer
XU	Unit Transformer
XUA	Unit Auxiliary Transformer

LIST OF DEFINITIONS

Channel	An arrangement of components as required to generate a single protective action signal. A channel loses its identity where single protective action signals are combined.
Class 1E	The safety classification of electrical systems and equipment essential in preventing significant release of radioactive material to the environment.
Coordination	Selection and setting of electrical protective devices so that the breaker/fuse closest to the electrical fault on the source side operates prior to the backup breaker/fuse and limits thermal and mechanical stresses to connected equipment below design values.
Design Basis Event (DBE)	Postulated abnormal event used in the plant design to establish the acceptable performance requirements of the structures, systems, and components.
Electrical Fault	An abnormal connection (including an arc) between two conductors, or between one conductor and ground, which results in current flow (fault current) between the two.
Feeder	The circuit conductors connecting a supply point to a feeding point or utilization equipment.
Harmonic	A sinusoidal component of a periodic wave or quantity having a frequency that is an integral multiple of the fundamental frequency (60 cycles per second).
Load Terminals	The terminals located at the electrically powered equipment.
Redundant	A system or equipment that duplicates the function of another system or equipment to the extent that either may perform the required function regardless of the state of operation or failure of the other.

LIST OF DEFINITIONS (continued)

Regulated	Maintaining a systems' electrical performance parameters (i.e., voltage and frequency) within a specified range independent of variations in electrical parameters outside the system.
Safety-Related	Necessary to meet 10CFR100 guidelines, such as retaining radionuclides in the fuel particles, controlling heat generation, removing core heat, and controlling chemical attack.
Seismic Category I Structure	Structure designed to protect Class 1E equipment against the effects of design basis events.

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PREFACE

The objective of the HTGR plant project is to produce safe, economical power. Supporting this objectives are four major goals and their associated plant states are identified as follows:

1. Maintain Safe Plant Operation
 - 1.1 Maintain Safe Energy Production
 - 1.2 Maintain Safe Plant Shutdown
 - 1.3 Maintain Safe Plant Refueling
 - 1.4 Maintain Safe Plant Startup/Shutdown
2. Maintain Plant Protection (in the event that plant operation cannot be maintained in the normal operating envelope)
 - 2.1 Protect the Capability to Maintain Safe Energy Production
 - 2.2 Protect the Capability to Maintain Safe Plant Shutdown
 - 2.3 Protect the Capability to Maintain Safe Plant Refueling
 - 2.4 Protect the Capability to Maintain Safe Plant Startup/Shutdown
3. Maintain Control of Radionuclide Release (in the low probability event of failure to maintain plant protection)
 - 3.1 Control Radiation
 - 3.2 Control Personnel Access
4. Maintain Emergency Preparedness (in the extremely low probability of failure to maintain control of release of radionuclides)

The Overall Plant Design Specification (OPDS) is the top-level technical document for the HTGR plant. The OPDS (based on owner requirements and regulatory requirements) establishes the overall performance, functional, institutional, interface, operational, safety, maintenance, inspection, and decommissioning requirements for design of the plant.

In response to the OPDS, a series of lower tier documents, System Design Descriptions (SDDs), Subsystem Design Descriptions (SSDDs), Buildings and Structures Design Descriptions (BSDDs), Component Design Specifications (CDSs) and Interface Control Documents (ICDs), describe and control the individual designs. Traceability of requirement source from plant-level requirements to equipment-level requirements shall be maintained throughout this hierarchy of design documents.

SUMMARY

The Class 1E DC Power System of the Electrical Group provides reliable and regulated 125 V dc electric power to the plant safety-related dc loads connected to the four redundant and independent 125 V dc Class 1E buses to ensure plant safe shutdown or mitigate the effects of a design basis event. These four dc buses comprise the plant four Class 1E dc control and instrument channels (A, B, C and D).

SECTION 1

SUBSYSTEM FUNCTIONS AND DESIGN REQUIREMENTS

1.1 SUBSYSTEM FUNCTIONS

The function of the Class 1E DC Power System is to provide reliable dc control and instrument power to the plant safety-related 125 V dc loads that are necessary to safely shutdown the plant and maintain a safe shutdown condition.

1.2 SUBSYSTEM DESIGN REQUIREMENTS

1.2.1 Subsystem Configuration and Essential Features Requirements

The Class 1E DC Power System configuration shall consist of four independent and redundant channels, either of which ensures plant safe shutdown by supplying dc power to the plant safety-related control and instrument dc loads.

(9208.0121.001)

The Class 1E DC Power System shall continuously supply reliable dc power to the four Class 1E 125 V dc main distribution switchboards that feed all safety-related loads indicated in Table 1-1.

(9208.0121.002)

1.2.2 Operational Requirements

The nominal voltage for the Class 1E DC Power System shall be 125 V dc, ungrounded, two-wire.

(9208.0122.001)

The Class 1E DC Power System supply voltage variation for all modes of operation at the Class 1E 125 V dc main distribution switchboards shall be between 103 V dc and 142 V dc. Class 1E dc loads shall be designed and qualified to operate between 90 V dc and 140 V dc.

(9208.0122.002)

The Class 1E DC Power System electrical equipment shall be capable of supplying the necessary power and withstanding the thermal and mechanical effects of maximum short-circuit currents indicated in Table 1-2.

(9208.0122.003)

The loss of normal ac power to the Class 1E DC Power System shall not result in system degradation for a minimum time period of 1 hour.

(9208.0122.004)

1.2.3 Structural Requirements

The Class 1E DC Power System equipment shall be located in the Seismic Category I Reactor Services Building, and be seismically supported.

(9208.0123.001)

1.2.4 Environmental Requirements

The Class 1E DC Power System electrical equipment shall be capable of operating within the normal, abnormal, and accident environmental conditions of temperature, pressure, humidity, and radiation for the design life of the equipment, as indicated in Table 1-3.

(9208.0124.001)

1.2.5 Instrumentation and Control Requirements

The Class 1E DC Power System shall be monitored and/or alarmed locally at the equipment and at the control room to provide information on the system status.

(9208.0125.001)

Computer inputs shall be provided to monitor critical parameters which shall be annunciated, and a hard copy of alarm messages for documentation of abnormal events shall also be provided.

(9208.0125.002)

1.2.6 Surveillance and In-Service Inspection Requirements

The design of the Class 1E DC Power System and its components shall incorporate, to the greatest degree practicable, those features necessary for status monitoring and implementing in-service inspection functions with the plant in operation.

(9208.0126.001)

The status of all major Class 1E DC Power System components shall be monitored, and when in-service inspection activities require removal of equipment from service, design features are included to minimize the out-of-service time.

(9208.0126.002)

1.2.7 Availability Assurance Requirements

The Class 1E DC Power System design objectives shall be such as to achieve an expected unavailability of [TBD] (outage hours per year) to support the overall plant design equivalent availability of at least 80 percent for electrical generation.

(9208.0127.001)

The Class 1E DC Power System shall be designed so that the time to repair or replace a component or the system plus all consequential effects and restart times are consistent with Regulatory Guide 1.93.

(9208.0127.002)

1.2.8 Maintenance Requirements

The Class 1E DC Power System shall be designed and arranged and components shall be located in the plant to facilitate in-place or on-line maintenance to the greatest degree practicable.

(9208.0128.001)

The Class 1E DC Power System components shall be provided with periodic maintenance consistent with the manufacturer's recommendations. In addition, adequate floor space and maintenance clearances are provided around these components to permit in-place maintenance and facilitate dismantling, removal, or replacement of equipment.

(9208.0128.002)

The Class 1E DC Power System components shall be located outside radiation zones or in very low radiation areas to control radiation exposure to plant maintenance personnel. Arrangement also considers the access path to, as well as location of, components.

(9208.0128.003)

1.2.9 Safety Requirements

The Class 1E DC Power System shall be safety related. It shall be Class 1E for component design, and Seismic Category I for component design, location, and support, except that the battery chargers are non-Class 1E for component design and Seismic Category I for location and support only.

(9208.0129.001)

The Class 1E DC Power System requirements important to safety are contained in Subsections 1.2.1 through 1.2.8 and 1.2.10 and 1.2.12.

(9208.0129.002)

1.2.10 Codes and Standards Requirements

The Class 1E DC Power System shall be designed and constructed in accordance with the Regulatory Requirements from 10CFR50, Regulatory Guidance Documents, and Industry Codes and Standards that are indicated in Tables 1-4, 1-5, and 1-6, respectively. Deviations from these requirements may be proposed by the Project Office.

(9208.01210.001)

1.2.11 Quality Assurance Requirements

All items designated Safety Related, Seismic Category I, and/or Electrical Class 1E shall come under a quality assurance program which fully complies with the requirements of Title 10, Code of Federal Regulations, Part 50 (10CFR50), Appendix B. The basic requirements and supplements of ANSI/ASME NQA-1 and the four additional supplements from NEF 2-10 regarding engineering holds, engineering drawings lists, design reviews, and management assessment shall be implemented on activities that affect the quality of such items. These items are designated as quality assurance level (QAL) I.

(9208.01211.001)

Items designated Nonsafety Related, Seismic Category non-CAT I, or Electrical Class non-1E are QAL II or QAL III. QAL II items shall come under a quality assurance program which complies with selected basic requirements and supplements of NQA-1 and the four additional supplements identified above.

(9208.01211.02)

Subsystem-level documents are assigned to QAL classification that corresponds to the highest QAL of any item in the system. Therefore, the Class 1E DC Power System SSDD is classified as QAL I.

(9208.01211.03)

1.2.12 Construction Requirements

The Class 1E DC Power System, its components and arrangement features shall be designed to facilitate the installation, removal, and reinstallation of components.

(9208.01212.001)

The Class 1E DC Power System design shall utilize shop, factory, or field fabricated, assembled, and erected components, as appropriate to minimize erection costs and maximize quality control.

(9208.01212.002)

The design of the Class 1E DC Power System and its components shall incorporate materials, processes, and parts required to meet all packaging, shipping, handling, storage, construction, and operational functions. Level B and Housekeeping Zone III shall be provided from shop, factory, or field fabrication through plant start-up.

(9208.01212.003)

1.2.13 Decommissioning Requirements

(TBD)

TABLE 1-1
LOAD REQUIREMENTS
125 V DC

<u>SSDD</u>	<u>Description</u>	<u>No. Per Reactor</u>	<u>No. Per Plant</u>	<u>Channel Load (kW)</u>			
				<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>
HFD-41012	Reserve Shutdown System Power Supplies A & B	1	4	8.00	-	8.00	-
*HFD-49205	Rectifier/Inverter Assembly, Class 1E UPS System	1	4	36.60	36.60	36.60	36.60
Total (kW/Channel)				44.60	36.60	44.60	36.60

*Only in case of loss of non-Class 1E ac power supply.

TABLE 1-2
MAXIMUM SHORT CIRCUIT CURRENTS

<u>Description</u>	<u>RMS Symmetrical Current (A)</u>
125 V dc Switchboard Bus 1 (Channel A)	25,000 A
125 V dc Switchboard Bus 2 (Channel B)	25,000 A
125 V dc Switchboard Bus 3 (Channel C)	25,000 A
125 V dc Switchboard Bus 4 (Channel D)	25,000 A

TABLE 1-3

ENVIRONMENTAL CONDITIONS
CLASS 1E DC POWER SYSTEMA. Normal Environment

Temperature, °C (°F)	15.6-40 (60-104)
Pressure, psia	Atmospheric
Humidity, %	20-80
*Radiation, rads	(TBD)
Aging, days/year	(TBD)

B. DBE Environment

Temperature, °C (°F)	48.9 (120)
Pressure, psia	Atmospheric
Humidity, %	10-90
**Radiation, rads	(TBD)
Submergence	No
Operating time, days	(TBD)

C. Abnormal Environment

Temperature, °C (°F)	4.4-48.9 (40-120)
Humidity, %	90
Aging, days/year	(TBD)

D. Qualified life, years	40
--------------------------	----

* 40 yr total integrated dose (TID)

**40 yr TID plus accident

TABLE 1-4
REGULATORY REQUIREMENTS

Codes of Federal Register

10CFR50 Appendix B - Quality Assurance Criteria

TABLE 1-5

REGULATORY GUIDANCE DOCUMENTS

A. Regulatory Guides (RG)

1. RG 1.6 Independence Between Redundant Standby (Onsite) Power Sources and Between their Distribution Systems
2. RG 1.29 Seismic Design Classification
3. RG 1.30 Quality Assurance Requirements for the Installation, Inspection, and Testing of Instrumentation and Electric Equipment
4. RG 1.32 Criteria for Safety-Related Electric Power Systems for Nuclear Power Plants
5. RG 1.38 Quality Assurance Requirements for Packaging, Shipping, Receiving, Storage, and Handling of Items for Water Cooled Nuclear Power Plants
6. RG 1.41 Preoperational Testing of Redundant Onsite Electric Power Systems to Verify Proper Load Group Assignments
7. RG 1.47 Bypassed and Inoperable Status Indication for Nuclear Power Plant Safety Systems
8. RG 1.53 Application of the Single Failure Criterion to Nuclear Power Plant Protection Systems
9. RG 1.70 Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants
10. RG 1.75 Physical Independence of Electric Systems
11. RG 1.89 Qualification of Class 1E Equipment for Nuclear Power Plants
12. RG 1.93 Availability of Electric Power Sources
13. RG 1.100 Seismic Qualification of Electric Equipment for Nuclear Power Plants
14. RG 1.118 Periodic Testing of Electric Power and Protection Systems

TABLE 1-5 (continued)

15.	RG 1.120	Fire Protection Guidelines for Nuclear Plants
16.	RG 1.128	Installation Design and Installation of Large Lead Storage Batteries for Nuclear Power Plants.
17.	RG 1.129	Maintenance, Testing, and Replacement of Large Lead Storage Batteries for Nuclear Power Plants.
18.	RG 1.131	Qualification Tests of Electric Cables Field Splices and Connections for Light-Water-Cooled Nuclear Power Plants
B. <u>Standard Review Plans (NUREG-0800)</u>		
	Section 8	Electric Power
C. <u>NUREG Reports</u>		
	NUREG 0588	Interim Staff Position on Environmental Qualification of Safety-Related Electrical Equipment

TABLE 1-6

INDUSTRY CODES AND STANDARDS

A. American National Standards Institute (ANSI)

1. ANSI C37.20 Switchgear Assemblies Including Metal-Enclosed Bus
2. ANSI NQA-1 Quality Assurance Program Requirements for Nuclear Facilities
3. ANSI NQA-2 Quality Assurance Program Requirements for Nuclear Power Plants
4. ANSI N45.2.2 Packaging, Shipping, Receiving, Storage, and Handling of Items for Nuclear Power Plants.
5. ANSI S1-13 Methods for Measurement of Sound Pressure Levels
6. ANSI Z55.1 Gray Finishes for Industrial Apparatus and Equipment

B. Institute of Electrical and Electronic Engineers (IEEE)

1. IEEE 279 Criteria for Protection Systems for Nuclear Power Generation Stations
2. IEEE 308 Criteria for Class 1E Power Systems for Nuclear Power Generating Stations
3. IEEE 323 Qualifying Class 1E Equipment for Nuclear Power Generating Stations
4. IEEE 336 Installation, Inspection, and Testing Requirements for Power, Instrumentation and Control Equipment at Nuclear Facilities
5. IEEE 338 Criteria for the Periodic Testing of Nuclear Power Generating Station Safety Systems
6. IEEE 344 Recommended Practices for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations
7. IEEE 379 Application of the Single Failure Criterion to Nuclear Power Generating Station Class 1E Systems

TABLE 1-6 (continued)

8.	IEEE 383	Type Test of Class 1E Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations
9.	IEEE 384	Criteria for Independence of Class 1E Equipment and Circuits
10.	IEEE 450	Recommended Practice for Maintenance, Testing and Replacement of Large Lead Storage Batteries for Generating Stations and Substations.
11.	IEEE 472	Guide for Surge Withstand Capability (SWC) Tests.
12.	IEEE 484	Recommended Practice for Installation Design and Installation of Large Lead Storage Batteries for Generating Stations and Substations.
13.	IEEE 485	Recommended Practice for Sizing Large Storage Batteries for Generating Stations and Substations.
14.	IEEE 494	Methods for Identification of Documents Related to Class 1E Equipment and Systems for Nuclear Power Generating Stations
15.	IEEE 535	Qualification of Class 1E Lead Storage Batteries for Nuclear Power Generating Stations.
16.	IEEE 650	Qualification of Class 1E Static Battery Chargers and Inverters for Nuclear Power Generating Stations
C. <u>National Electrical Manufacturer's Association (NEMA)</u>		
1.	NEMA AB 1	Molded Case Circuit Breakers
2.	NEMA CC 1	Electric Power Connectors for Substations
3.	NEMA FU 1	Low Voltage Cartridge Fuses
4.	NEMA ICS	General Standards for Industrial Control and Systems
5.	NEMA ICS 6	Enclosures for Industrial Controls and Systems.
6.	NEMA PB 1	Panelboards
7.	NEMA PB 2	Dead Front Distribution Switchboards

TABLE 1-6 (continued)

D. National Fire Protection Association (NFPA)

NFPA 70

National Electric Code

E. Military Standards (MIL)

MIL-STD-461A

Electromagnetic Interface Characteristics for
Equipment.

SECTION 2

DESIGN DESCRIPTION

2.1 SUMMARY DESCRIPTION

The Class 1E DC Power System is a reliable electric system consisting of four redundant and independent channels, each with adequate capacity, capability, and reliability to supply power to all safety-related dc plant loads by maintaining electrical independence between redundant channels, and is designed to the requirements of Subsection 1.2. The Class 1E DC Power System supplies power to four redundant and independent Class 1E 125 V dc switchboard buses that supply dc control and instrument power to all four reactor modules.

Each of the Class 1E DC Power System channels is designed to normally provide regulated 125 V dc power from the normal battery charger and the dc switchboard. A backup battery charger is provided to be used in case of malfunction or during maintenance of the normal battery charger.

2.2 SUBSYSTEM CONFIGURATION

The Class 1E DC Power System is a 125 V dc two-wire, ungrounded system which consists of four batteries, four operating and four spare battery chargers, four main distribution switchboards and several distribution panelboards that comprise the four independent and redundant channels each serving redundant safety-related dc loads, as required by Subsection 1.2. Figure 2-1 shows one typical channel. Each channel has a normally operating battery charger which rectifies the three-phase 480 V ac received from a non-Class 1E motor control center to 125 V dc. A backup battery charger fed from a separate motor control center is provided so that any unit can be removed from service without degrading the systems to which dc electric power is provided by each channel.

The non-Class 1E battery chargers normally supply dc power to the 125 V dc distribution switchboard loads, maintain the Class 1E batteries in a fully charged state providing a float charge, and are capable of recharging the channel batteries within 12 hours from a discharged state. In the event of loss of all ac power, dc power is provided from the batteries for at least 1 hour. After this time, it is assumed that the ac power supply including that from the backup generators is either restored or the plant is shutdown.

The battery chargers have ample capacity to supply the largest combined demand of the steady state loads under any plant condition while recharging the batteries, which have undergone a duty-cycle discharge, to their fully charged condition within 12 hours.

The Class 1E batteries are power-station type and designed for continuous duty. Each battery consists of 60 cells connected in series. The battery cells are seismically qualified by testing. The ampere-hour capacity of each 125 V battery is suitable for supplying all connected safety-related dc loads for a minimum of 1 hour without the use of the battery chargers. The characteristics of each load, the length of time each load is required, and the basis used to establish the power required for each safety-related dc load, are utilized to

establish the combined load demand to be connected to each dc supply during the "worst" operating conditions. At the end of the 12-hour charging period, the final battery voltage will be 1.75 V per cell minimum.

The basis of selection of batteries, with regard to installation, capacity, and capability, meets the requirements of IEEE Standards 308, 484, and 485. The reliability of the dc power supplies is assured by periodic discharge of the batteries per IEEE Standard 450.

In order to ensure maximum battery life, the average yearly electrolyte temperature is maintained at 77°F. This temperature will not exceed 90°F for more than 1 percent of the year, nor exceed the range of 60°F to 120°F at any time.

Each battery is provided with a dc circuit breaker for maintenance and safety.

The Class 1E batteries are mounted on two-step Seismic Category I all steel battery racks with acid resistant insulated channels on which the battery cells rest. They are provided with earthquake bracing, side and end rails to withstand high impact, and noncombustible, moisture and acid resistant spaces between cells to keep them aligned at all times and prevent loss of function due to a seismic event. The battery racks are coated with acid-resistant enamel paint, and solidly connected to the station grounding system. They are seismically qualified by static analysis.

The Class 1E 125 V dc main distribution switchboards consist of battery breaker switchgear, battery switchboards, main buses which are supplied with 125 V dc power from the battery chargers or batteries, and branch circuit breakers which provide power to the 125 V dc loads indicated in Table 1-1. During a fault condition in any of the branch circuits, the circuit breaker will trip before the battery breaker opens.

The Class 1E dc power sources (batteries) and distribution system have sufficient independence, redundancy, and testability to perform their intended functions. The system is designed to permit periodic inspection and testing to assess continuity of the system and condition of their components. The Class 1E redundant load groups have no automatic connection to any other load group and no provisions for automatically transferring loads between these redundant loads groups.

Physical independence of the redundant Class 1E dc power system components is maintained by locating the batteries, chargers and switchboards of each channel in separate rooms, and maintaining minimum separation distance between redundant Class 1E circuits and between Class 1E and non-Class 1E circuits, in accordance with the requirements of IEEE Standard 384. In addition, there is separation by channel.

Physical identification of the redundant Class 1E DC Power System components is provided by permanently attached nameplates, color-coded for their associated channel, and engraved with the equipment number and system designation. Cables and raceways are identified at each end with permanent color-coded identification markers, and at regular intervals with the color of their associated channel.

The Class 1E DC Power System equipment is solidly grounded by copper cable to the plant grounding grid to facilitate operation of ground fault detection and provide personnel safety in the event of a ground fault. All equipment including battery racks and raceways is solidly grounded by copper cable to the plant ground grid or building steel. Long runs of cable tray are grounded at each end and at intervals not exceeding 100 ft.

All Class 1E cables are tested in accordance with IEEE Standard 383 to assure their ability to perform their intended function under expected conditions of ambient and accident temperatures during plant life. Cables are distributed by means of raceways, such as conduits and trays.

Fire detection and protection, either manually or automatically initiated, is provided in those areas required to preserve the integrity of the Class 1E circuitry. In addition, fire barriers are installed at all locations where raceways penetrate a wall or floor.

2.3 SUBSYSTEM PERFORMANCE CHARACTERISTICS

2.3.1 Subsystem Operating Modes

The Class 1E DC Power System operating modes during various plant conditions can be summarized as follows:

During plant startup, the Class 1E DC Power System is energized by being fed from the normal battery chargers connected to the motor control centers. Power to the motor control centers is provided through the startup auxiliary transformers which are connected to the utility grid.

During plant shutdown, the Class 1E DC Power System is energized by being fed the same way as during startup, except that power to the motor control centers feeding the normal battery chargers is provided through the unit auxiliary transformers, the startup auxiliary transformers, or the backup generators.

During plant base-load normal operation, the Class 1E DC Power System remains energized by being fed the same way as during startup, except that power to the motor control centers feeding the normal battery chargers is provided from the unit auxiliary transformers.

During plant abnormal operation, the Class 1E DC Power System remains energized by being fed from the backup battery chargers or the batteries if ac power is not available. Power to the motor control centers feeding the backup battery chargers is provided from the startup auxiliary transformers or the backup generators. In case ac power is not available, the batteries are capable of supplying the safety-related dc loads for 1 hour. If after 1 hour ac power has not been restored, the plant is shutdown.

The relationship between system operating modes and plant conditions is shown in Table 2-1.

2.3.2 Subsystem Steady-State Performance

(TBD)

2.3.3 Subsystem Response to Plant Transients

The Class 1E DC Power System is normally connected to the unit generators via the unit auxiliary transformers supplying non-Class 1E ac power to the motor control centers providing normal and backup power input to the system. Should the plant undergo a transient which would result in system normal and backup power input parameters being outside the range for proper system operation, power to the safety-related dc loads will be directly provided from the system Class 1E batteries.

2.3.4 Subsystem Failure Modes and Effects

The system failure mode is its inability to meet the normal operational requirements outlined in Section 1.2.2. The effect of a failure would be the inability of the system to supply the safety-related loads connected to the four redundant and independent Class 1E dc buses (channels). Since all safety-related loads are redundant and fed from separate channels, loss of one load group will not affect safe shutdown.

2.4 SUBSYSTEM ARRANGEMENT

The Class 1E DC Power System redundant electrical equipment is located in separate rooms within the Seismic Category I and tornado-missile protected Reactor Services Building. Each room has ventilation and/or air-conditioning units which prevent single events from disabling redundant features of the system. The exhaust fan provided for each battery room is powered from the respective battery. The air in each room is changed a minimum of eight times per hour. Door separating redundant portions of the Class 1E DC Power Systems assure that fire in any one room will not propagate to the other redundant equipment rooms. The equipment associated with the locations indicated in Appendix E, Table E-1, will be specified to meet the environmental requirements shown in Table 1-3.

2.5 INSTRUMENTATION AND CONTROL

The Class 1E DC Power System, consisting of four separate channels, is automatic. The instrumentation and control provided for each channel component consists of local ammeters, voltmeters, relays, as well as alarms sensing various abnormal conditions. The PPIS is provided data to determine the status of the Class 1E DC Power System.

Each battery charger is equipped with a dc voltmeter, output ammeter, under- and over-voltage relays, and an ac undervoltage relay. A battery charger open breaker and a malfunction of a battery charger activates an alarm in the control room. Indicating lights over appropriate nameplates indicate the nature of the trouble to the battery charger.

Each battery is equipped with a float charge ammeter, an output ammeter and a bus voltmeter. Voltage level is continuously monitored and displayed in the control room. Two undervoltage relays, one low voltage to alarm at 2.08 V per

cell and one low-low voltage to alarm between 1.75 to 2.03 V per cell, are provided for battery monitoring in the control room and computer. In addition, low charging current and bus overvoltage is alarmed in the control room.

The battery breaker is equipped with long-time and short-time adjustable pickup with adjustable time. A battery breaker open condition is alarmed in the control room. A shunt with an ammeter is also provided, together with ground detection voltmeters and alarm relay. All branch circuit breakers have over-current protection on both wires.

TABLE 2-1

PLANT/SUBSYSTEM OPERATING RELATIONSHIPS

<u>Plant Conditions</u>	<u>Initial Steady-State Mode</u>	<u>Final Steady-State Mode</u>	<u>Remarks</u>
(1) Startup	Standby	Operating	
(2) Shutdown	Operating	Operating	System can be maintained after the plant is shut down
(3) Normal Operation	Operating	Operating	
(4) Abnormal Operation	Operating	Operating	

NOTE: For all other duty cycle transient listed in Appendix H to OPDS, there is no change in operating mode for this system.

NOTE: SYSTEM SHOWN IS
TYPICAL FOR 4
CHANNELS

TYP - TYPICAL
* - NON-CLASS 1E

Figure 2-1
CLASS 1E DC POWER SYSTEM

SECTION 3

COMPONENT FUNCTIONS AND DESIGN REQUIREMENTS

3.1 COMPONENT FUNCTIONS

3.1.1 Battery Component Functions

The function of the Class 1E batteries is to provide dc power to the four Class 1E 125 V dc switchboard buses in case of battery charger failure.

3.1.2 Battery Charger Component Functions

The function of the non-Class 1E battery chargers is to provide dc power supply to the safety-related 125 V dc switchboard bus loads, keep the batteries fully charged, and recharge the batteries from a discharged state.

3.1.3 Battery Breaker Switchgear Component Functions

The function of the Class 1E battery breaker switchgear is to provide disconnecting means between the battery and the battery switchboards for maintenance and safety.

3.1.4 Battery Switchboard Component Functions

The function of the Class 1E battery distribution switchboards is to supply 125 V dc power to the safety-related loads and 125 V dc panelboards connected to the switchboard buses from either the battery chargers or directly from the batteries.

3.1.5 DC Panelboards Component Functions

The function of the Class 1E 125 V dc distribution panelboards is to supply dc power to the 125 V dc safety-related loads from either the battery chargers or directly from the battery through the battery distribution switchboards.

3.2 COMPONENT DESIGN REQUIREMENTS

3.2.1 Battery Component Design Requirements

3.2.1.1 Component Configuration and Essential Features Requirements

The battery nominal output voltage shall be 125 V, ungrounded, positive, and negative pole, two-wire, direct current.

(9208.3211.001)

Batteries shall be lead-acid type, designed for continuous duty. Each battery shall consist of 60 cells connected in series. Each battery cell shall be of the sealed type with a clear or translucent polycarbonate container, and covers bonded in place to form a leak-proof seal. Electrolyte high and low level marks shall be provided on all four sides of containers.

(9208.3211.002)

The ampere-hour capacity of each battery shall be suitable for supplying all connected loads for a minimum of one hour without the use of the battery chargers. At the end of the one hour period, the final battery terminal voltage shall be 105 V or greater.

(9208.3211.003)

The basis for selection of batteries with regard to capacity and reliability shall meet the requirements of IEEE 309. The reliability of the dc power supplies shall be assured by periodic discharge of the batteries in accordance with IEEE 450.

(9208.3211.004)

All necessary connectors between cells, between groups of cells, and between rows of cells, but not between racks, shall be furnished complete with hardware. The cell terminal posts and all connectors shall have adequate capacities to prevent excessive losses and to prevent overheating on short-time high-current loads.

(9208.3211.005)

Each battery shall be provided with a battery circuit breaker for maintenance and safety located at the 125 V dc battery breaker switchgear.

(9208.3211.006)

The cells of the batteries shall be seismically qualified by test after the cells have been subjected to accelerated aging in accordance with IEEE 323.

(9208.3211.007)

The batteries, when shipped, shall be fully charged, filled with electrolyte, and capable of delivering full rated capacity at any design discharge rate.

(8208.3211.008)

The batteries shall be mounted on Seismic Category I steel racks provided with acid resistant insulated channels on which the battery cells rest, earthquake bracing, side and end rails with high impact, noncombustible moisture and acid resistant spacers between cells to keep them aligned at all times and prevent loss of function.

(9208.3211.009)

The Seismic Category I racks on which the batteries are mounted shall be designed for earthquake protection and qualified by static analysis. Restricting members shall be arranged to prevent motion of cells relative to each other, or to the rack, and with extended leg construction and provision for anchoring to prevent overturning.

(9208.3211.010)

The battery racks shall be coated with acid resistant enamel paint and solidly connected to the plant grounding system.

(9208.3211.011)

A two-step rack shall be selected to provide seismic suitability, minimum temperature differential between battery cells, and cell accessibility for ease of maintenance.

(9208.3211.012)

The battery racks shall be mounted on and fillet welded to sill channels embedded in the concrete floor.

(9208.3211.013)

Battery racks that are shipped knocked down shall have all parts easily identifiable to facilitate field assembly.

(9208.3211.014)

3.2.1.2 Operation Requirements

Each battery shall be connected to a battery charger and switchboard bus. During normal operation, the batteries shall be maintained in fully charged condition at a regulated voltage. Upon loss of power from the battery charger, the batteries shall supply all the 125 V dc safety-related loads for a period of one hour, reducing the battery terminal voltage to no less than 105 V dc at the end of this period.

(9208.3212.001)

The batteries shall be capable of supplying the necessary power and withstanding the thermal and mechanical effects of maximum short-circuit currents indicated in Table 1-2.

(9208.3212.002)

3.2.1.3 Structural Requirements

The batteries and battery racks shall be located in the Seismic Category I Reactor Services Building, and be seismically supported.

(9208.3213.01)

3.2.1.4 Environmental Requirements

The batteries shall be capable of operating within the normal, abnormal, and accident environmental conditions of temperature, pressure, humidity, and radiation for the design life of the equipment as indicated in Table 3-1. Equipment location is shown in Appendix E, Table E-1.

(9208.3214.001)

3.2.1.5 Instrumentation and Control Requirements

The requirements for instrumentation and control for the batteries are provided by other components of the Class 1E 125 V dc power system.

(9208.3215.001)

3.2.1.6 Surveillance and In-service Inspection Requirements

The batteries shall incorporate, to the greatest degree practicable, those features necessary for status monitoring and implementing in-service inspection functions with the plant in operation.

(9208.3216.001)

In-service inspections for the batteries shall include visual inspections for leaks and corrosion and a check of all batteries for voltage, specific gravity, and level of electrolyte. If the cells are low in voltage, an equalizing charge shall be applied to bring all cells up to an equal voltage. If a cell reveals weakness or weakening trends, necessary replacements shall be made. When in-service inspection activities require removal of battery components from service, design features shall be included to minimize out-of-service time.

(9208.3216.002)

3.2.1.7 Availability Assurance Requirements

The battery design objectives shall be to achieve an expected unavailability of (TBD) (outage hour per year) to support the Class 1E DC Power System design goal of (TBD) (outage hours per year).

(9208.3217.001)

3.2.1.8 Maintenance Requirements

The batteries shall be designed to facilitate in-place, on-line preventive maintenance to the greatest degree practicable for systematic service, or replacement of parts, plus inspection to assess and correct deterioration. Also, periodic off-line testing to verify functional adequacy shall be provided.

(9208.3218.001)

The batteries shall be provided with periodic maintenance consistent with the manufacturer's recommendations.

(9208.3218.002)

Adequate floor space and clearances shall be provided around the battery to permit corrective maintenance requiring dismantling and removal/replacement of a component in order to restore it to a satisfactory condition.

(9208.3218.003)

The battery shall be located outside radiation zones or in very low radiation areas to control radiation exposure to plant maintenance personnel. Arrangement shall also consider the access path to as well as location, of the battery.

(9208.3218.004)

3.2.1.9 Safety Requirements

The batteries shall be safety related. They shall be Class 1E for equipment design, and Seismic Category I for equipment design, location, and support.

(9208.3219.001)

The battery requirements important to safety are contained in Subsections 3.2.1.1 through 3.2.1.9 and 3.2.1.10 and 3.2.1.12.

(9208.3219.002)

3.2.1.10 Codes and Standards Requirements

The batteries shall be designed and constructed in accordance with the Regulatory Requirements from 10CFR50, and the applicable Regulatory Guidance Documents and Industry Codes and Standards that are indicated in Table 1-4, 1-5 and 1-6, respectively. Deviations from these requirements may be proposed by the Project Office.

(9208.32110.001)

3.2.1.11 Quality Assurance Requirements

All items designated Safety Related, Seismic Category I, and/or Electrical Class 1E shall come under a quality assurance program which fully complies with the requirements of Title 10 Code of Federal Regulations Part 50 (10CFR50), Appendix B. The basic requirements and supplements of ANSI/ASME NQA-1 and the four additional supplements from NEF2-10, regarding engineering holds, engineering drawing list, design reviews, and management assessment shall be implemented on activities that affect the quality of such items. These items are designated as quality assurance level (QAL) I.

(9208.32111.001)

Items designated non-safety Related, Seismic Category non-CAT I, or Electrical Class non-1E are QAL II or QAL III. QAL II items shall come under a quality assurance program which complies with selected basic requirements and supplements of NQA-1 and the four additional supplements identified above.

(9208.32111.002)

The battery and battery rack documents are assigned the QAL classification that corresponds to the highest QAL of any item in the assembly. Therefore, the batteries and battery racks of this SSDD are classified as QAL I.

(9208.32111.003)

3.2.1.12 Construction Requirements

The batteries and battery racks shall utilize factory or field fabricated, assembled and erected components, as appropriate, to minimize erection costs and maintain quality control.

(9208.32112.001)

The batteries and battery rack and their components shall incorporate materials and processes, as required, to meet all packaging, shipping, receiving, storage, handling, construction and operational functions. Level B and Housekeeping Zone III shall be provided from shop fabrication through plant startup.

(9208.32112.002)

3.2.1.13 Decommissioning Requirements

(TBD)

3.2.2 Battery Charger Component Design Requirements

3.2.2.1 Component Configuration and Electrical Features Requirements

The battery chargers shall be used as the normal power supply sources for the 125 V dc switchboard buses and to maintain the batteries in fully charged condition.

(9208.3221.001)

The battery chargers input voltage shall be 460 V ± 10 percent, three-phase, 3-wire, with an input frequency of 60 Hz ± 3.0 Hz.

(9208.3221.002)

The battery charger nominal output voltage shall be 130 V dc. The 60-cell battery minimum float voltage range is 2.00-2.30 V per cell, and the minimum equalizing voltage range 2.25-2.40 V per cell.

(9208.3221.003)

The battery chargers shall have ac and dc transient and surge voltage protection, and the load circuit shall be electrically insulated from the source circuit.

(9208.3221.004)

Filters shall be provided to limit output ripple voltage to 30 millivolts rms, with chargers supplying full load current and not connected to batteries.

(9208.3221.005)

The battery chargers shall be equipped with a capacitor discharge network which will discharge the capacitors to less than 25 V in 1 min. A warning sign shall be prominently affixed to the equipment to warn personnel of the possible existence of lethal voltages after the unit is de-energized.

(9208.3221.006)

The battery chargers shall have two readily accessible individual manual controls for adjusting the set points of output voltage in the float and equalizing charge ranges and shall each have a resolution of one volt. The adjusting devices shall have slotted shafts for screwdriver adjustment and shall have locking devices to maintain settings.

(9208.3221.007)

An alternating current motor-driven timer shall be provided to control the duration of equalizing charge cycles. It shall be adjustable over a range of 24 hr. At completion of set interval, it shall automatically return the charger output voltage to the float level. The timer shall have manual control to initiate an equalizing charge. After an interruption of timer power supply during an equalizing charge cycle, restoration of power supply shall cause timer to complete the preset equalizing charge cycle.

(9208.3221.008)

Pilot lights shall be furnished to indicate that input voltage is available. Indicating lights shall be Westinghouse rectangular Minalite, rated at 24 V, with resistors suitable for operation over the entire range of control potential. The lights shall be connected to the rectifier side of the input circuit breaker.

(9208.3221.009)

A circuit breaker shall be provided in the output circuit for protection of the battery and the charger against internal charger faults, and for use as a manual disconnecting device. The battery is capable of delivering a bolted fault current of 20,000 amp.

(9208.3221.010)

A circuit breaker shall be provided to open all conductors of input circuit for protection against internal charger faults and for use as a manual disconnecting device.

(9208.3221.011)

The short circuit current available from the ac input system is 22,000 amp. Auxiliary contacts shall be provided to allow remote monitoring of circuit breaker trip or closed condition. One contact shall be normally open and one normally closed. Both contacts shall be electrically isolated from the power supply circuits, case, ground, and each other. Both sides of each contact shall be wired to terminal blocks for connection to the Purchaser's alarm system.

(9208.3221.012)

The power rectifier units shall be of the silicon diode type. Peak inverse voltage (PIV) rating shall be at least 2.5 times the PIV which exists in operation with worst case conditions of power input, load, and temperature. Protective devices shall be provided in the rectifier circuits to limit the PIV to not more than 70 percent of rated PIV of the devices used. If multiple rectifier units are connected in parallel as components of the charger, the division of load at any total load not exceeding the charger rating shall be substantially proportional to the ampere output ratings of the rectifiers. A separate direct current ammeter shall be provided for each such parallel connected rectifier or group of rectifiers.

(9208.3221.013)

Silicon rectifier units shall be accessible without disassembling charger.

(9208.3221.014)

3.2.2.2 Operation Requirements

The battery chargers shall be capable of supplying the necessary power and withstanding the thermal and mechanical effects of maximum short-circuit currents indicated in Table 1-2.

(9208.3222.001)

3.2.2.3 Structural Requirements

The battery chargers shall be located in the Seismic Category I Reactor Services Building, and be seismically supported.

(9208.3223.001)

3.2.2.4 Environmental Requirements

The battery chargers shall be capable of operating within the normal, abnormal, and accident environmental conditions of temperature, pressure, humidity, and

radiation for the design life of the equipment as indicated in Table 3-2. Equipment location is shown in Appendix E, Table E-1.

(9208.3224.001)

3.2.2.5 Instrumentation and Control Requirements

The charger output circuit shall have one voltmeter and one ammeter. They shall have scales not less than 3-1/2 in. long.

(9208.3225.001)

The ammeter shall cover a range from zero to at least 150 percent of rated current and shall be accurate within 2 percent of full scale. The voltmeter shall be of the expanded scale type with scale covering the range of 0-150 V dc. It shall be accurate within 1 percent of full scale.

(9208.3225.002)

The voltmeter shall sense the voltage output on the rectifier side of the output circuit breaker and shall also be wired to terminal blocks for connection to the Purchaser's system.

(9208.3225.003)

Instrument cases shall be of a type permitting removal of the instrument from the case for adjustment or repair or for scale marking or replacement. Readily accessible means for pointer adjustment shall be provided external to the case.

(9208.3225.004)

Suitable relays having adjustable set points and normally open dry alarm contacts for 125 V service shall be provided to alarm on low power supply voltage. Alarm contacts shall be rated for at least one ampere resistive.

(9208.3225.005)

The low power supply input ac voltage detection circuit shall sense all three phases of the available ac voltage on the rectifier side of the input circuit breaker and shall cause an alarm if the input voltage drops to less than minus 10 percent of nominal for a period of time greater than 83 milliseconds (5 cycles).

(9208.3225.006)

All alarm contacts shall be electrically isolated from the power supply circuits, case, and ground. Both sides of each alarm contact shall be wired to terminal blocks for connection to the Purchaser's alarm system.

(9208.3225.007)

3.2.2.6 Surveillance and In-service Requirements

The battery chargers shall incorporate, to the greatest degree practicable, those features necessary for implementing in-service inspection functions with the plant in operation.

(9208.3226.001)

When in-service inspection activities require removal of a battery charger component from service, design features shall be included to minimize out-of-service time.

(9208.3226.002)

3.2.2.7 Availability Assurance Requirements

The battery charger design objectives shall be to achieve an expected unavailability of (TBD) (outage hours per year) to support the Class 1E dc power system design goal of (TBD) (outage hours per year).

(9208.3227.001)

3.2.2.8 Maintenance Requirements

The battery chargers shall be designed to facilitate in-place, on-line preventive maintenance for systematic servicing, or replacement of parts, plus inspection to assess and correct deterioration. This includes periodic off-line testing to verify functional adequacy.

(9208.3228.001)

The battery chargers shall be provided with periodic maintenance consistent with the manufacturer's recommendations.

(9208.3228.002)

Adequate floor space and clearances shall be provided around the battery chargers to permit corrective maintenance requiring dismantling and/or removal/replacement of a component in order to restore it to satisfactory condition.

(9208.3228.003)

The battery chargers shall be located outside radiation zones, or in very low radiation areas to control radiation exposure to plant maintenance personnel. Arrangement shall also consider the access path to as well as location of the chargers.

(9208.3228.004)

3.2.2.9 Safety Requirements

The battery chargers shall be non-safety related. They shall be non-Class 1E for equipment design, and Seismic Category I for equipment location, and support.

(9208.3229.001)

3.2.2.10 Code and Standards Requirements

The battery chargers shall be designed and constructed in accordance with the applicable Industry Codes and Standards that are indicated in Table 1-6.

(9208.32210.001)

3.2.2.11 Quality Assurance Requirements

Items designated non-Safety Related, Seismic Category non-CAT I, or Electrical Class non-1E are QAL II or QAL III. QAL II items shall come under a quality assurance program which complies with selected basic requirements and supplements of NQA-1 and the four additional supplements identified above.

(9208.32211.001)

The battery charger documents are assigned the QAL classification that corresponds to the highest QAL of any item in the chargers. Therefore, the battery chargers of this SSDD are classified as QAL II.

(9208.32211.002)

3.2.2.12 Construction Requirements

The battery chargers shall utilize factory or field fabricated, assembled and erected components, as appropriate, to minimize erection costs and maintain quality control.

(9208.32212.001)

The battery chargers shall incorporate materials and processes, as required, to meet all packaging, shipping, receiving, storage, handling, construction, and operational functions. Level B and Housekeeping Zone III shall be provided from shop fabrication through plant startup.

(9208.32212.002)

3.2.2.13 Decommissioning Requirements

(TBD)

3.2.3 Battery Breaker Switchgear Component Design Requirements

3.2.3.1 Component Configuration and Electrical Features Requirements

The battery breaker switchgear in-coming line service shall be from a nominal 125 V ungrounded battery. During battery equalize charging, bus voltage may rise to 140 V dc.

(9208.3231.001)

The battery breaker switchgear shall provide a nominal 125 V dc two-wire ungrounded system for feeders and motors.

(9208.3231.002)

Each battery breaker switchgear shall be a free-standing metal-enclosed assembly with provisions for two electrically-operated drawout type air circuit breakers rated at 600 amp, an instrument panel, and a blank panel.

(9208.3231.003)

Housing shall be comprised of a rigid, self-supporting, steel assembly completely enclosed. Enclosure shall be suitable for indoor use and bolted and gasketed cover plates shall be provided for all openings or cutouts in the top of the switchgear. Removable panels shall be provided on the rear of each cubicle for access to cable connections.

(9208.3231.004)

Means shall be provided for leveling and bolting or welding the housing to sills set in the concrete floor. Sills or anchors will be furnished by the Purchaser.

(9208.3231.005)

All structural bolts, nuts, and washers shall be hot-dipped galvanized steel or cadmium plated.

(9208.3231.006)

The ground bus required by ANSI C37.20, Section 6.1.2, shall accommodate a two hole NEMA drilled compression type lug size 4/0 copper grounding cable which will enter from below. The ground bus shall be copper, 1/4 in. by 1 in. minimum size, and shall extend the length of the switchgear housing.

(9208.3231.007)

The main power bus shall be manufacturer's standard design which conforms to ANSI C37.20, Sections 6.1.1 and 7. All buses shall be copper. All bolted bus joints and contact areas shall be silver plated. A minimum of two bolts shall

be used in all such joints. All bolting shall be performed under controlled torque. All main bus connections and control bus taps shall use cadmium-plated hardware.

(9208.3231.008)

The buses shall be supported on nonhydroscopic, flame retardant, track-resistant insulating material and shall have a minimum short circuit bracing equal to (or greater than) that of the main breaker. The continuous ampere bus rating shall be equal to (or greater than) that of the largest electrically operated air circuit breaker in the switchgear assembly.

(9208.3231.009)

Cable terminal lugs for power cables shall be long barrel compression type, Burndy Hylug Type YA, with NEMA standard bold holes. Each input and output cable terminal pad shall have provision for connection of two two-hole lugs.

(9208.3231.010)

Ample room shall be furnished in the cable wireways and compartments to route the cable and make up cable terminations.

(9208.3231.011)

Bolted and gasketed removable plates shall be provided for drilling holes for all conduit entrances through the housing. All power cables will enter from the top or bottom.

(9208.3231.012)

The battery breaker switchgear air circuit breakers shall be two-pole, single-throw, electrically-operated, drawout type for service on a nominal 125 V dc system. Breaker mechanism shall be electrically and mechanically trip-free under all conditions and at any point in the stroke, and the control circuit shall be nonpumping. Breakers shall have visual indication of open and closed position. The stored energy devices on electrically operated breakers shall be charged by motors. The stored energy spring shall be suitable for manual charging and trip, and close pushbuttons shall be furnished for manual operation of the breaker. A charging handle shall be furnished with each switchgear for manually charging the springs.

(9208.3231.013)

The interrupting ratings of the 600 amp air circuit breakers shall be in accordance with ANSI C37.16, Table 8, and rated at 25,000 amp maximum short circuit current.

(9208.3231.014)

The breaker operating mechanism shall be of the stored energy type for use with 125 V dc control and have an operating voltage range as called for in ANSI C37.16, Table 23.

(9208.3231.015)

Each electrically-operated circuit breaker shall be provided with both mechanical and electrical close and trip devices mounted on the breaker. The electrical close and trip devices shall be operable in the test position only. Control of breaker in operating position shall be from remote switch or automatic circuit. All normal control circuits shall be disconnected in the test position.

(9208.3231.016)

Electro-mechanical overcurrent trip devices monitoring each pole shall be provided. These devices shall have provision from long-time adjustable pickup with adjustable time and short-time adjustable pickup with adjustable time or instantaneous adjustable pickup in accordance with ANSI C37.17. Trip ratings will be specified at a later date.

(9208.3231.017)

All breakers shall be draw out type and means shall be provided for placing breakers in either the operating, test, or fully disconnected position. Design and location of equipment shall be such that it will be possible to close the compartment door with the breaker in any position. Visual indication of breaker position shall be provided, showing whether the breaker is in the operate, test, or fully disengaged position, with a second indicator showing the breaker open or closed.

(9208.3231.018)

Necessary breaker position switches shall be furnished to provide for automatic changes in the control circuits, then the breaker is moved from one position to another. When the breaker is in the test position, the remote control switch and the remote and local indicating lights shall not be operative. Only the test control switch shall be operative.

(9208.3231.019)

All disconnecting devices shall be accurately located and securely mounted to maintain alignment. The main contacts and their supports shall be guaranteed not to distort or fail under mechanical stresses and heating due to maximum short circuit currents permitted by feeder breaker ratings.

(9208.3231.020)

Each breaker shall be equipped with eight field adjustable auxiliary switches and shall have a bell alarm device with one normally closed and one normally open switch to indicate automatic trip. In addition, each electrically operated breaker compartment shall be equipped with a compartment-mounted cell

(breaker position) switch which operates when the breaker moves between the operating and test positions. This switch shall have a minimum of four field adjustable contacts.

(9208.3231.021)

Each battery breaker switchgear shall have a compartment for a future breaker which shall be wired and equipped similar to other electrically operated breaker compartments being furnished, except for the breaker removable elements, and shall be furnished with blank doors.

(9208.3231.022)

The switchgear shall be wired with UL listed, flame-retardant, VW-1, type SIS switchboard wire. Secondary wiring shall consist of tinned copper conductors not smaller than No. 14 AWG, with Class B stranding. For equipment located on the hinged door only, wiring shall be flexible 41-strand.

(9208.3231.023)

Wiring shall be neatly arranged and clamped securely to panels to prevent movement and breaking. Wiring clamps and supports at hinge transition points shall be properly sized to prevent chafing of insulation when the cubicle door is opened and closed. No metal bands shall be used for bundle wiring. Tie wraps shall be cut so no sharp edges are left after cutting. Clamps shall be nonmetallic, similar to Burndy Nyloclip Type HP-N. Clamps with sharp edges will not be acceptable. Wiring shall be arranged so as to be accessible for inspection and maintenance. In no case shall wiring arrangement impede access to the mounted instruments or spaces for future equipment or with incoming cable. Large single bundles of wiring shall be avoided across hinged panels which may make it difficult to close doors.

(9208.3231.024)

All wires shall be terminated with indent compression type ring-tongue lugs, Burndy Corporation Hylug Type YAV.

(9208.3231.025)

Control wiring shall be brought out to terminal blocks for extension to a remote control switch or pushbutton and indicating lights. All auxiliary switch spare contacts, transducer leads, and auxiliary relay and alarm contacts shall be wired out to terminal blocks. All terminal blocks shall be accessible without exposure to bus work.

(9208.3231.026)

Terminal blocks shall have removable line connectors, brass screws, and marking strip, suitable for ring-tongue terminal lugs.

(9208.3231.027)

Each terminal shall be marked in a clear easy-to-read manner with labels which refer to the designations used on wiring diagrams. Parallel rows of terminal blocks shall be spaced a minimum of 6 in. Provisions shall be made for space for future terminal blocks. There shall be no terminal blocks located on the top side of the cubicles.

(9208.3231.028)

The control circuit of each breaker shall be protected by a 2-pole, 125 V dc molded case air circuit breaker, 100 amp frame, 5,000 amp interrupting capacity with magnetic trip. The circuit breaker shall be mounted in the instrument compartment and connected to the battery leads, and shall have screw-type terminals for ring-tongue terminal lugs.

(9208.3231.029)

3.2.3.2 Operation Requirements

The battery breaker switchgear shall be capable of withstanding the thermal and mechanical effects of maximum short circuit currents indicated in Table 1-2.

(9208.3232.001)

3.2.3.3 Structural Requirements

The battery breaker switchgear shall be located in the Seismic Category I Reactor Services Building, and be seismically supported.

(9208.3233.001)

3.2.3.4 Environmental Requirements

The battery breaker switchgear shall be capable of operating within the normal, abnormal, and accident environmental conditions of temperature, pressure, humidity, and radiation for the design life of the equipment, as indicated in Table 3-3. Equipment location is shown in Appendix E, Table E-1.

(9208.3234.001)

3.2.3.5 Instrument and Control Requirements

Each battery breaker switchgear shall be provided with the following:

- (a) Battery ammeter with shunt
- (b) Battery bus voltmeter
- (c) Ground detector voltmeter with resistor
- (d) Battery monitor undervoltage relay
- (e) Isolation transducers
- (f) Red and green indicating lights.

(9208.3235.001)

All instruments, relays, resistors, ground detectors, etc, shall be mounted on the hinged instrument panel. The arrangement of equipment on the instrument panel shall be subject to approval of the Purchaser.

(9208.3235.002)

Instruments shall be 4 in. size, taut band, suspension type, 250 deg scale, ANSI C39.1, 1 percent accuracy class of full scale with white faces and black letters.

(9208.3235.003)

The battery ammeters shall be connected to 300 A, 150 MV shunts, and have 150-0-300 A scales.

(9208.3235.004)

The bus voltmeters and the ground detector voltmeters shall be connected to resistors and have 0-150 V and 150-0-150 V scales, respectively. Additional resistors shall be provided for the remote ground detector voltmeters located in the control room.

(9208.3235.005)

The battery voltage undervoltage relays and their auxiliary contacts shall be suitable for continuous duty at 70 to 140 V dc and have a 90 to 160 V dc input range.

(9208.3235.006)

Red and green indicating lamps of the tipless type rated at 24 V, with resistors suitable for operation over the entire range of control potential shall be furnished, mounted on the instrument panels to show closed and open positions of the breakers. Red lamps shall be connected so as to monitor trip coils. Wiring shall permit connection of Purchaser's remote indicating lamps in parallel with those on the switchgear.

(9208.3235.007)

All dc isolation transducers for connection to remote voltmeter and the computer shall have an input of 0 to 140 V dc, output 0 to 1 ma into a load of 0 to 10,000 ohms with a transfer accuracy of ± 0.5 percent and power input of 120 V dc, 60 Hz. The power inputs and signal outputs shall be wired to terminal blocks.

(9208.3235.008)

3.2.3.6 Surveillance and In-service Inspection Requirements

The battery breaker switchgear shall incorporate, to the greatest degree practicable, those features necessary for implementing in-service inspection functions with the plant in operation.

(9208.3236.001)

Where in-service inspection activities require removal of a battery breaker switchgear component from service, design features shall be included to minimize out-of-service time.

(9208.3236.002)

3.2.3.7 Availability Assurance Requirements

The battery breaker switchgear design objectives shall be to achieve an expected unavailability of (TBD) (outage hours per year) to support the Class 1E DC Power System design goal of (TBD) (outage hours per year).

(9208.3237.001)

3.2.3.8 Maintenance Requirements

The battery breaker switchgear shall be designed to facilitate in-place on-line preventive maintenance for systematic servicing, or replacement of parts, plus inspection to assess and correct deterioration. This includes periodic off-line testing to verify functional adequacy.

(9208.3238.001)

The battery breaker switchgear shall be provided with periodic maintenance consistent with the manufacturer's recommendations.

(9208.3238.002)

Adequate clearance shall be provided around the battery breaker switchgear enclosure to permit corrective maintenance requiring dismantling and/or removal/replacement of a component in order to restore it to satisfactory condition.

(9208.3238.003)

The battery breaker switchgear shall be located outside radiation zones, or in very low radiation areas, to control radiation exposure to plant maintenance personnel. Arrangement shall also consider the access as well as location of the static switches.

(9208.3238.004)

3.2.3.9 Safety Requirements

The battery breaker switchgear shall be safety related. It shall be Class 1E for equipment design, and Seismic Category I for equipment design, location, and support.

(9208.3239.001)

3.2.3.10 Codes and Standards Requirements

The battery breaker switchgear shall be designed and constructed in accordance with the Regulatory Requirements from 10CFR50, and the applicable Regulatory

Guidance Documents and Industry Codes and Standards that are indicated in Tables 1-4, 1-5, and 1-6, respectively. Deviations from these requirements may be proposed by the Project Office.

(9208.32310.001)

3.2.3.11 Quality Assurance Requirements

All items designated Safety-Related, Seismic Category I, and/or Electrical Class 1E shall come under a quality assurance program which fully complies with the requirements of Title 10 Code of Federal Regulations Part 50 (10CFR50), Appendix B. The basic requirements and supplements of ANSI/ASME NQA-1 and four additional supplements from NEF 2-10 regarding engineering holds, engineering drawing lists, design reviews, and management assessment shall be implemented on activities that affect the quality of such items. These items are designated as quality assurance level (QAL) I.

(9208.32311.001)

Items designated Non-Safety Related, Seismic Category non-CAT I, or Electrical Class non-1E are QAL II or QAL III. QAL II items shall come under a quality assurance program which complies with selected basic requirements and supplements of NQA-1 and the four additional supplements identified above.

(9208.32311.002)

Battery breaker switchgear documents are assigned the QAL classification that corresponds to the highest QAL of any item in the switches. Therefore, the battery breaker switchgear of this SSDD is classified as QAL I.

(9208.32311.003)

3.2.3.12 Construction Requirements

The battery breaker switchgear shall utilize factory or field fabricated, assembled, and erected components, as appropriate, to minimize erection costs and maintain quality control.

(9208.32312.001)

The battery breaker switchgear shall incorporate materials and processes as required to meet all packaging, shipping, receiving, storage, handling, construction, and operational functions. Level B and Housekeeping Zone III shall be provided from shop fabrication through plant start-up.

(9208.32312.002)

3.2.3.13 Decommissioning Requirements

(TBD)

3.2.4 Battery Switchboard Component Design Requirements

3.2.4.1 Component Configuration and Electrical Features Requirements

The 125 V battery switchboard cabinets shall be constructed from code gage sheet steel with no knockouts provided. Switchboard panel sections shall be freestanding, self-supporting, solid front type with front and rear doors. Both the front and rear doors shall be equipped with a three-point latching lever handle arranged to fasten door at top, center, and bottom.

(9208.3241.001)

The panel section shall have one cable opening in the top section, with windlace around edges to protect cable insulation.

(9208.3241.002)

Front door panels shall be pre-punched for the maximum number of breakers (ten), and cover plates provided for breaker positions designated as future.

(9208.3241.003)

Each panel breaker assembly chassis shall be rigidly supported and designed so that any breaker can be removed or added without disturbing adjacent breakers and without removing main or branch circuit connectors. Main buses and back pans shall be of such design that branch circuit protective devices may be changed without additional machining, drilling, or tapping. Circuit number markings shall be provided near the load side terminals of each breaker so that the circuits can be identified from both the front and rear of the switchboard.

(9208.3241.004)

Bus bars for the mains shall be copper rated at 600A and based on a current density of not more than 1,000 amp per square inch. Bus bar bracing for short circuit stresses shall be 25,000 amp.

(9208.3241.005)

Drilling shall be provided at the top of the main bus for all incoming feeds. All main bus connections shall have four bolt drilling in accordance with NEMA Standards. A stud to flat bar bronze connector shall be provided to connect each line side circuit breaker stud to the branch circuit bus bar. Belleville washers shall be provided on all bolted connections of copper bus bar to stud connectors.

(9208.3241.006)

All electrical connections within the switchboard shall be copper-to-copper with no current carried through screws alone, and with bolted connections made so that circuit breakers are readily removable and replaceable with minimum

disturbance to adjacent circuit breakers or the bus bars. All hardware (except stainless steel Belleville washers) touching copper bus shall be Everdur or silicon bronze.

(9208.3241.007)

Two ground buses shall be provided, one on either side of the breaker mounting area. Each ground bus shall be copper, 1 in. by 1/4 in. by the height of the breaker mounting area. The ground bus, as required by ANSI C37.20, Section 6.1.2, shall accommodate a NEMA drilled two hole, long barrel, compression Burndy Hylug Type YA lug for the Purchaser's size 4/0 ground cable which will enter from below.

(9208.3241.008)

All buses shall be securely fastened to insulating buses and shall not be dependent upon the circuit breaker terminals for support. The breaker rear connecting studs shall be suitably insulated if passing through metallic mounting panels with no decrease in the dielectric strength of the insulation system.

(9208.3241.009)

Circuit breakers shall be molded case type, with two poles per breaker and rated interrupting capacity of 20,000 A at 125 V dc. Circuit breakers shall have rear connecting studs of suitable length on both line and load sides. All circuit breakers are to be installed so that the line terminals always connect to the main bus.

(9208.3241.010)

Circuit breakers shall be quick make, quick break with toggle-type handle switching mechanism that is trip free from the handle so that contacts cannot be held closed against short circuits and abnormal currents. Tripping due to overloads or short circuits shall be clearly indicated by the handle assuming a marked position. All poles of multipole circuit breakers shall open or close simultaneously.

(9208.3241.011)

All terminal blocks shall be with removable line connector, brass screws, and marking strip. A four point terminal block shall be mounted in the accessible position near the top of the panel(s) for the termination of the circuit breaker alarm switch wiring.

(9208.3241.012)

The battery switchboard shall be wired with UL listed, flame retardant, VW-1, type SIS switchboard wire. Wiring shall consist of tinned copper conductors not smaller than No. 14 AWG, with Class B stranding.

(9208.3241.013)

All wiring shall be terminated with Burndy Hylug Type YAV ring-tongue terminals.

(9208.3241.014)

3.2.4.2 Operation Requirements

The 125 V battery switchboards shall be capable of withstanding the thermal and mechanical effects of maximum short circuit currents indicated in Table 1-2.

(9208.3242.001)

3.2.4.3 Structural Requirements

The 125 V battery switchboards shall be located in the Seismic Category I Reactor Services Building, and be seismically supported.

(9208.3243.001)

3.2.4.4 Environmental Requirements

The 125 V dc battery switchboards shall be capable of operating within the normal, abnormal, and accident environmental conditions of temperature, pressure, humidity, and radiation for the design life of the equipment, as indicated in Table 3-4. Equipment location is shown in Appendix E, Table E-1.

(9208.3244.001)

3.2.4.5 Instrumentation and Control Requirements

Circuit breakers shall be furnished with thermal magnetic, interchangeable trip units with type, quantity, and trip settings to be specified later. Circuit breakers shall be calibrated for 40 C.

(9208.3245.001)

3.2.4.6 Surveillance and In-service Inspection Requirements

The 125 V dc battery switchboards shall incorporate, to the greater degree practicable, those features necessary for implementing in-service inspection functions with the plant in operation.

(9208.3246.001)

When in-service inspection activities require removal of a battery switchboard component from service, design features shall be included to minimize out-of-service time.

(9208.3246.002)

3.2.4.7 Availability Assurance Requirements

The 125 V dc battery switchboard design objectives shall be to achieve an expected unavailability of (TBD) (outage hours per year) to support the Class 1E DC Power System design goal of (TBD) (outage hours per year).

(9208.3247.001)

3.2.4.8 Maintenance Requirements

The 125 V dc battery switchboards shall be designed to facilitate in-place, on-line preventive maintenance for systematic servicing or replacement of parts, plus inspection to assess and correct deterioration. This includes periodic off-line testing to verify functional adequacy.

(9208.3248.001)

The 125 V dc battery switchboards shall be provided with periodic maintenance consistent with the manufacturer's recommendations.

(9208.3248.002)

Adequate clearances shall be provided around the battery switchboard enclosures to permit corrective maintenance requiring dismantling and/or removal/replacement of a component in order to restore it to satisfactory conditions.

(9208.3248.003)

The 125 V dc battery switchboards shall be located outside radiation zones, or in very low radiation areas to control radiation exposure to plant maintenance personnel. Arrangement shall also consider the access path as well as location of the battery switchboards.

(9208.3248.004)

3.2.4.9 Safety Requirements

The 125 V dc battery switchboards shall be safety related. They shall be Class 1E for equipment design, and Seismic Category I for equipment design, location, and support.

(9208.3249.001)

3.2.4.10 Codes and Standards Requirements

The 125 V dc battery switchboards shall be designed and constructed in accordance with the Regulatory Requirements from 10CFR50, and the applicable Regulatory Guidance Documents and Industry Codes and Standards that are indicated in Tables 1-4, 1-5, and 1-6, respectively. Deviations from these requirements may be proposed by the Project Office.

(9208.32410.001)

3.2.4.11 Quality Assurance Requirements

All items designated Safety Related, Seismic Category I, and/or Electrical Class 1E shall come under a quality assurance program which fully complies with the requirements of Title 10 Code of Federal Regulations Part 50 (10CFR50), Appendix B. The basic requirements and supplements of ANSI/ASME NQA-1 and the four additional supplements from NEF 2-10 regarding engineering holds, engineering drawing lists, design review, and management assessment shall be implemented on activities that affect the quality of such items. These items are designated as quality assurance level (QAL) I.

(9208.32411.001)

Items designated Non-Safety Related, Seismic Category non-CAT I, or Electrical Class non-1E are QAL II or QAL III. QAL II items shall come under a quality assurance program which complies with selected basic requirements and supplements of NQA-1 and the four additional supplements identified above.

(9208.32411.002)

The 125 V dc battery switchboard documents are assigned the QAL classification that corresponds to the highest QAL of any item in the switches. Therefore, the battery switchboards of this SSDD are classified as QAL I.

(9208.32411.003)

3.2.4.12 Construction Requirements

The 125 V dc battery switchboards shall utilize factory or field fabricated, assembled, and erected components, as appropriate, to minimize erection costs and maintain quality control.

(9208.32412.001)

The 125 V dc battery switchboards shall incorporate materials and processes, as required, to meet all packaging, shipping, receiving, storage, handling, construction, and operational functions. Level B and Housekeeping Zone III shall be provided from shop fabrication through plant start-up.

(9208.32412.002)

3.2.4.13 Decommissioning Requirements

(TBD)

3.2.5 DC Panelboards Component Design Requirements

3.2.5.1 Component Configuration and Electrical Features Requirements

The 125 V dc panelboards shall supply reliable dc power to the safety-related 125 V dc loads as indicated in Table 1-1.

(9208.3251.001)

The 125 V dc panelboards shall be freestanding, self-supporting, solid front circuit breaker type, with front and rear doors, arranged for 125 V dc, 2-wire service.

(9208.3251.002)

Circuit breakers for 125 V dc, 2-wire service shall be magnetic type 2-pole units for feeder breakers, and 2-pole units 100 amp, non-automatic for main breakers, with a minimum interrupting capacity of 5,000 amp.

(9208.3251.003)

The panel interiors shall be so designed that any circuit breaker can be removed and replaced without removing main bus, or branch circuit connectors, and main buses and back panels may be changed without additional machining, drilling, or tapping.

(9208.3251.004)

All buses shall be securely fastened to insulated bases, and not dependent upon main or branch breakers for support. The main buses shall be copper rated at 600 A and braced for 25,000 amp symmetrical maximum short-circuit current.

(9208.3251.005)

Two ground buses shall be provided, one on either side of the breaker mounting area. Each ground bus shall be copper and mounted at the opposite end from the main lugs or main breakers. A NEMA drilled 2-hole, long barrel, compression grounding lug shall also be provided at the top and bottom of each ground bus for connecting the 4/0 copper grounding cable.

(9208.3251.006)

3.2.5.2 Operation Requirements

The 125 V dc panelboards shall be capable of withstanding the thermal and mechanical effects of maximum short-circuit currents indicated in Table 1-2.

(9208.3252.001)

3.2.5.3 Structural Requirements

The 125 V dc panelboards shall be located in the Seismic Category I Reactor Services Building, and be seismically supported.

(9208.3253.001)

3.2.5.4 Environmental Requirements

The 125 V dc panelboards shall be capable of operating within the normal, abnormal, and accident environmental conditions of temperature, pressure,

humidity, and radiation for the design life of the equipment, as indicated in Table 3-5. Equipment location is shown in Appendix E, Table E-1.

(9208.3254.001)

3.2.5.5 Instrumentation and Control Requirements

The 125 V dc panelboards have no special instrumentation and control requirements.

(9208.3255.001)

3.2.5.6 Surveillance and In-service Inspection Requirements

The 125 V dc panelboards shall incorporate, to the greatest degree practicable, those features necessary for implementing in-service inspection functions with the plant in operation.

(9208.3256.001)

When in-service inspection activities require removal of battery panelboard components from service, design features shall be included to minimize out-of-service time.

(9208.3256.002)

3.2.5.7 Availability Assurance Requirements

The 125 V dc panelboard design objectives shall be to achieve an expected unavailability of (TBD) (outage hours per year) to support the Class 1E DC Power System design goal of (TBD) (outage hours per year).

(9208.3257.001)

3.2.5.8 Maintenance Requirements

The 125 V dc panelboards shall be designed to facilitate in-place, on-line preventive maintenance for systematic servicing or replacement of parts, plus inspection to assess the correct deterioration. This includes periodic off-line testing to verify functional adequacy.

(9208.3258.001)

The 125 V dc panelboards shall be provided with periodic maintenance consistent with the manufacturer's recommendations.

(9208.3258.002)

Adequate clearances shall be provided around the 125 V dc panelboard enclosures to permit corrective maintenance requiring dismantling and/or removal/replacement of a component in order to restore it to satisfactory conditions.

(9208.3258.003)

The 125 V dc panelboards shall be located outside radiation zones, or in very low radiation areas to control radiation exposure to plant maintenance personnel. Arrangement shall also consider the access path as well as location of the vital bus panels.

(9208.3258.004)

3.2.5.9 Safety Requirements

The 125 V dc panelboards shall be safety related. They shall be Class 1E for equipment design, and Seismic Category I for equipment design, location, and support.

(9208.3259.001)

3.2.5.10 Codes and Standards Requirements

The 125 V dc panelboards shall be designed and constructed in accordance with the Regulatory Requirements from 10CFR50, and the applicable Regulatory Guidance Documents and Industry Codes and Standards that are indicated in Tables 1-4, 1-5, and 1-6, respectively. Deviations from these requirements may be proposed by the Project Office.

(9208.32510.001)

3.2.5.11 Quality Assurance Requirements

All items designated Safety Related, Seismic Category I, and/or Electrical Class 1E shall come under a quality assurance program which fully complies with the requirements of Title 10 Code of Federal Regulations Part 50 (10CFR50), Appendix B. The basic requirements and supplements of ANSI/ASME NQA-1 and the four additional supplements from NEF 210, regarding engineering holds, engineering drawing lists, design review, and management assessment shall be implemented on activities that affect the quality of such items. These items are designated as quality assurance level (QAL) I.

(9208.32511.001)

Items designated Non-Safety Related, Seismic Category non-CAT I, or Electrical Class non-1E are QAL II or QAL III. QAL II items shall come under a quality assurance program which complies with selected basic requirements and supplements of NQA-1 and the four additional supplements identified above.

(9208.32511.002)

The 125 V dc panelboard documents are assigned the QAL classification that corresponds to the highest QAL of any item in the switches. Therefore, the battery panelboards of this SSDD are classified as QAL I.

(9208.32511.003)

3.2.5.12 Construction Requirements

The 125 V dc panelboards shall utilize factory or field-fabricated and erected components, as appropriate, to minimize erection costs and maintain quality control.

(9208.32512.001)

The 125 V dc panelboards shall incorporate materials and processes, as required, to meet all packaging, shipping, receiving, storage, handling, construction and operational functions. Level B and Housekeeping Zone III shall be provided from shop fabrication through plant start-up.

(9208.32512.002)

3.2.5.13 Decommissioning Requirements

(TBD)

TABLE 3-1
ENVIRONMENTAL CONDITIONS
BATTERIES

Environment	Specified	Qualified	Method	Remarks
A. <u>Normal</u>				
Temperature, °C (°F)	15.6-40 (60-104)	(TBD)	(TBD)	(TBD)
Pressure, psia	Atmospheric			
Humidity, %	20-80			
*Radiation, rads	(TBD)			
Aging, days/year	(TBD)			
Operating cycles	(TBD)			
Heat rise, °F	N/A			
Activation energy, ev	N/A			
B. <u>DBE</u>				
Temperature, °C (°F)	48.9 (120)			
Pressure, psia	Atmospheric			
Humidity, %	10-90			
**Radiation, rads	(TBD)			
Submergence	No			
Operating time, days	(TBD)			
Test duration	N/A			
C. <u>Abnormal</u>				
Temperature, °C (°F)	4.4-48.9 (40-120)			
Humidity, %	90			
Aging, days/year	(TBD)			
D. <u>Qualified life, years</u>				
	40			
*40 yrs total integrated dose (TID)				
**40 yr TID plus accident				

TABLE 3-2

ENVIRONMENTAL CONDITIONS
BATTERY CHARGERS

Environment	Specified	Qualified	Method	Remarks
A. <u>Normal Environment</u>				
Temperature, °C (°F)	15.6-40 (60-104)	(TBD)	(TBD)	(TBD)
Pressure, psia	Atmospheric			
Humidity, %	20-80			
*Radiation, rads	(TBD)			
Aging, days/year	(TBD)			
Operating cycles	(TBD)			
Heat rise, °F	N/A			
Activation energy, ev	N/A			
B. <u>DBE Environment</u>				
Temperature, °C (°F)	N/A	N/A	N/A	Non-Class 1E Equipment
Pressure, psia	N/A	N/A	N/A	
Humidity, %	N/A	N/A	N/A	
**Radiation, rads	N/A	N/A	N/A	
Submergence	N/A	N/A	N/A	
Operating time, days	N/A	N/A	N/A	
Seismic test duration	N/A	N/A	N/A	
C. <u>Abnormal Environment</u>				
Temperature, °C (°F)	4.4-48.9 (40-120)			
Humidity, %	90			
Aging, days/year	(TBD)			
D. <u>Qualified life, years</u>				
	40			
*40 yrs total integrated dose (TID)				
**40 yr TID plus accident				

TABLE 3-3

ENVIRONMENTAL CONDITIONS
BATTERY BREAKER SWITCHGEAR

Environment	Specified	Qualified	Method	Remarks
A. <u>Normal</u>				
Temperature, °C (°F)	15.6-40 (60-104)	(TBD)	(TBD)	(TBD)
Pressure, psia	Atmospheric			
Humidity, %	20-80			
*Radiation, rads	(TBD)			
Aging, days/year	(TBD)			
Operating cycles	(TBD)			
Heat rise, °F	N/A			
Activation energy, ev	N/A			
B. <u>DBE</u>				
Temperature, °C (°F)	48.9 (120)			
Pressure, psia	Atmospheric			
Humidity, %	10-90			
**Radiation, rads	(TBD)			
Submergence	No			
Operating time, days	(TBD)			
Test duration	N/A			
C. <u>Abnormal</u>				
Temperature, °C (°F)	4.4-48.9 (40-120)			
Humidity, %	90			
Aging, days/year	(TBD)			
D. <u>Qualified life</u>, years				
	40			
*40 yrs total integrated dose (TID)				
**40 yr TID plus accident				

TABLE 3-4

ENVIRONMENTAL CONDITIONS
BATTERY SWITCHBOARDS

Environment	Specified	Qualified	Method	Remarks
A. <u>Normal</u>				
Temperature, °C(°F)	15.6-40 (60-104)	(TBD)	(TBD)	(TBD)
Pressure, psia	Atmospheric			
Humidity, %	20-80			
*Radiation, rads	(TBD)			
Aging, days, year	(TBD)			
Operating cycles	(TBD)			
Heat rise, °F	NA			
Activation energy, ev	NA			
B. <u>DBE</u>				
Temperature, °C(°F)	48.9 (120)			
Pressure, psia	Atmospheric			
Humidity, %	10-90			
**Radiation, rads	(TBD)			
Submergence	No			
Operating time, days	(TBD)			
Test duration	NA			
C. <u>Abnormal</u>				
Temperature, °C(°F)	4.4-48.9 (40-120)			
Humidity, %	90			
Aging, days/year	(TBD)			
D. <u>Qualified life, years</u>				
	40			
*40 yrs total integrated dose (TID)				
**40 yr TID plus accident				

TABLE 3-5
ENVIRONMENTAL CONDITIONS
DC PANELBOARDS

Environment	Specified	Qualified	Method	Remarks
A. <u>Normal</u>				
Temperature, °C (°F)	15.6-40 (60-104)	(TBD)	(TBD)	(TBD)
Pressure, psia	Atmospheric			
Humidity, %	20-80			
*Radiation, rads	(TBD)			
Aging, days/year	(TBD)			
Operating cycles	(TBD)			
Heat rise, °F	N/A			
Activation energy, ev	N/A			
B. <u>DBE</u>				
Temperature, °C (°F)	48.9 (120)			
Pressure, psia	Atmospheric			
Humidity, %	10-90			
**Radiation, rads	(TBD)			
Submergence	No			
Operating time, days	(TBD)			
Test duration	N/A			
C. <u>Abnormal</u>				
Temperature, °C (°F)	4.4-48.9 (40-120)			
Humidity, % RH	90			
Aging, days/year	(TBD)			
D. Qualified life, years				
	40			
*40 yrs total integrated dose (TID)				
**40 yr TID plus accident				

SECTION 4

SUBSYSTEM AND COMPONENT INTERFACES

4.1 SUBSYSTEM INTERFACE REQUIREMENTS

4.1.1 Interface Requirements Imposed on Other Systems

Interface requirements, at the system level, are presented in Table 4-1 showing the interfacing systems with subsystem identification on which the requirements are imposed, the nature of the interface, the interfacing components and the interfacing requirements.

4.1.2 Interface Requirements Imposed on Subsystems Within the System

Interface requirements, at the subsystem level, are presented in Table 4-2 showing the interfacing subsystems within the system on which the requirements are imposed, the nature of the interface, the interfacing components and the interfacing requirements.

4.2 COMPONENT BOUNDARY DEFINITION

(TBD)

TABLE 4-1

INTERFACE REQUIREMENTS IMPOSED ON OTHER SYSTEMS

Interfacing Systems (With Subsystem/Identification)	Nature of Interface	Interfacing Component	Interface Requirements
1. <u>Reactor System</u> (10) (Neutron Control)	Requires Class 1E dc power	Reserve Shutdown Power System Power Supplies A&B	No interface requirements are imposed on this subsystem. However, the subsystem imposes interface requirements of 90-142 V dc, 8 kW/ch on two channels
2. <u>Vessel System</u> (11)	No Interface	N/A	N/A
3. <u>Reactor Services Group</u> (20)	No Interface	N/A	N/A
4. <u>Heat Transport System</u> (21)	No Interface	N/A	N/A
5. <u>Miscellaneous Control and Instrumentation Group</u> (30)	No Interface	N/A	N/A
6. <u>Plant Protection and Instrumentation System</u> (32)	No Interface	N/A	N/A
7. <u>Fuel Handling, Storage and Shipping System</u> (34)	No Interface	N/A	N/A
8. <u>Plant Control, Data and Instrumentation System</u> (37)	No Interface	N/A	N/A
9. <u>Power Conversion Group</u> (50)	No Interface	N/A	N/A

TABLE 4-1 (continued)

Interfacing Systems (With Subsystem/Identification)	Nature of Interface	Interfacing Component	Interface Requirements
10. <u>Heat Rejection Group</u> (52)	No Interface	N/A	N/A
11. <u>Reactor Cavity Cooling System</u> (56)	No Interface	N/A	N/A
12. <u>Shutdown Cooling System</u> (57)	No Interface	N/A	N/A
13. <u>Buildings Structures, and Building Services Group</u> (70) (Reactor Services Building)	Provides space for the Class 1E dc power system equipment	Four battery rooms and four battery equipment rooms, e.g., two rooms per channel equipment	Separate rooms for each channel equipment in Seismic Category I structure (9205.0411.001)
14. <u>Mechanical Services Group</u> (90) (HVAC)	Provides heat removal to maintain environment	No direct component interface	Maintain environmental conditions per Table 1-3 on Class 1E dc battery and battery equipment rooms (9208.0411.002)
15. <u>Electrical Group</u> (92)	See Table 4-2 for interface requirements imposed on subsystems within the Electrical Group.		

TABLE 4-2

INTERFACE REQUIREMENTS IMPOSED ON OTHER SUBSYSTEMS
WITHIN THE SYSTEM

Interfacing Systems (With Subsystem/Identification)	Nature of Interface	Interfacing Component	Interface Requirements
<u>Electrical Group (92)</u>			
(Offsite and Main Generator Transmission)	No Interface	N/A	N/A
(Non-Class 1E AC Distribution)	Provides non-Class 1E ac power input to battery chargers.	Eight non-Class 1E 480 V ac MCC buses.	460 V $\pm 10\%$, 60 Hz $\pm 5\%$, 3-phase, 80 amp ac input on the four MCC buses and 100 amp ac input on the other four MCC buses. (9208.0412.001)
(Non-Class 1E UPS)	No Interface	N/A	N/A
(Class 1E UPS)	Requires Class 1E dc power in case of loss of non-Class 1E ac power supply.	Four rectifier/inverter assemblies of Class 1E UPS system.	90-140 V dc; 36.6 kW/ch on two channels, and 44.6 kW/ch on the other two channels. (9208.0412.002)
(Non-Class 1E DC Power)	Provides non-Class 1E dc power.	Four battery room exhaust fans.	90-140 V dc, for four 0.33 hp battery room exhaust fans, with two fans on each of the two non-Class 1E dc buses. (9208.0412.003)

TABLE 4-2 (continued)

Interface Systems (With Subsystem/Identification)	Nature of Interface	Interfacing Component	Interface Requirements
(Class 1E DC Power)	No Interface	N/A	N/A
(Communication)	No Interface	N/A	N/A
(Lighting and Service Power)	No Interface	N/A	N/A
(Plant Security)	No Interface	N/A	N/A
(Grounding, Lightning, Heat Tracing, and Cathodic Protection)	Provides grounding to equipment components.	Equipment component enclosures.	See individual systems.

SECTION 6

SUBSYSTEM OPERATION

6.1 SUBSYSTEM LIMITATIONS, SET POINTS, AND PRECAUTIONS

6.1.1 Subsystem Limitations and Set Points

The Class 1E DC Power System components can be loaded only within their nameplate ratings. Excess loads cause reduced life expectancy and may cause automatic disconnection of the loaded circuit. Electrical equipment is sized, and load groupings are assigned, such that the maximum coincidental load falls within the rating of each of these power system components.

6.1.2 Precautions

(TBD)

6.2 PREOPERATIONAL CHECKOUT

(TBD)

6.3 STARTUP/SHUTDOWN

6.3.1 Startup to 25 Percent Steam Flow

There is no such condition applicable to the Class 1E DC Power System.

6.3.2 Shutdown from 25 Percent Steam Flow

There is no such condition applicable to the Class 1E DC Power System.

6.4 NORMAL OPERATION

During normal Class 1E DC Power System operation, all components function automatically by monitoring system conditions, and provide regulated and uninterruptible dc control and instrument power, as required, to safety-related dc loads to ensure safe plant operation.

6.5 REFUELING

There is no such condition applicable to the Class 1E DC Power System components.

6.6 SHUTDOWN

Shutdown of the Class 1E DC Power System components is addressed in the manufacturer's operations manual.

6.7 ABNORMAL OPERATION

Abnormal operation of the Class 1E DC Power System components is addressed in the manufacturer's operations manuals.

6.8 CASUALTY EVENTS AND RECOVERY PROCEDURES

6.8.1 Casualty Events

The possible casualty events that could affect the Class 1E DC Power System are identified as follows:

1. Loss of non-Class 1E AC power
2. Electrical Faults
3. Natural phenomena, such as earthquake and tornado missiles
4. Postulated phenomena, such as accident environment, fire, flood, loss of offsite power, and component failure.

6.8.2 Design Features to Mitigate Effects of Casualty Events

For loss of non-Class 1E ac power to both the normal and backup battery chargers, Class 1E dc power is automatically provided to the safety-related dc loads from the channel Class 1E batteries. These batteries are capable of supplying power for one hour.

Circuit breakers provide isolation of electrical faults; also, they provide isolation for maintenance.

All components of the Class 1E DC Power System are located in the Seismic Category I Reactor Services Building which provides protection against the natural phenomena, such as earthquake and tornado missiles, in Subsection 6.8.1, Item 3.

Protection against the postulated events in Subsection 6.8.1, Item 4, is provided by qualifying safety-related components to IEEE Standard 323, use of barriers, physical separation, fire detection and suppression, location at a proper elevation, use of backup generators, alternate power sources, and redundant components.

6.8.3 Recovery Procedures

(TBD)

SECTION 9

REFERENCES

1. Gas Cooled Reactor Associates (GCRA). Utility/User Design Requirements for Modular High Temperature Gas-Cooled Reactor Plant, GCRA 86-002, Rev. 1, GCRA, San Diego, CA, March 1986.
2. GA Technologies, Inc. (GA) et al. Overall Plant Design Specification Modular High Temperature Gas-Cooled Reactor, HTGR-86-004, Rev. 1, GA, San Diego, CA, February 1986.
3. GA Technologies, Inc. (GA). NSSS/BOP Interface Requirements for the Modular HTGR Plant, HTGR-86-007, GA, San Diego, CA, April 1986.
4. Stone & Webster Engineering Corporation (SWEC). Class 1E UPS System, HFD-49205, Rev. 0, SWEC, Boston, MA, June 1986.
5. Quality Assurance Requirements, HCP-20801, Rev. 1, September 1984.

APPENDIX E
EQUIPMENT LIST

1. INTRODUCTION

Appendix E lists the major equipment for the Class 1E DC Power System in Table E-1. Table E-1 shows the equipment name, equipment number, equipment classification, channel, rating, power supply, and location.

TABLE E-1
EQUIPMENT LIST
CLASS 1E DC POWER SYSTEM

Equipment Name	Equipment Number	Class	Channel	Rating Amps or kVA or AH	Power Supply	Location
Battery	BAT-9208-001-P-A	1E	A	(TBD)	(TBD)	Reactor Services Building
Battery	BAT-9208-002-P-B	1E	B			Reactor Services Building
Battery	BAT-9208-003-P-C	1E	C			Reactor Services Building
Battery	BAT-9208-004-P-D	1E	D			Reactor Services Building
Battery Charger (Normal)	BACH-9208-005-P-A	Non-1E	A			Reactor Services Building
Battery Charger (Normal)	BACH-9208-006-P-B	Non-1E	B			Reactor Services Building
Battery Charger (Normal)	BACH-9208-007-P-C	Non-1E	C			Reactor Services Building
Battery Charger (Normal)	BACH-9208-008-P-D	Non-1E	D			Reactor Services Building
Battery Charger (Backup)	BACH-9208-009-P-E	Non-1E	A			Reactor Services Building
Battery Charger (Backup)	BACH-9208-010-P-F	Non-1E	B			Reactor Services Building
Battery Charger (Backup)	BACH-9208-011-P-G	Non-1E	C			Reactor Services Building
Battery Charger (Backup)	BACH-9208-012-P-H	Non-1E	D			Reactor Services Building
Battery Breaker Switchgear	BBSW-9208-013-P-A	1E	A			Reactor Services Building
Battery Breaker Switchgear	BBSW-9208-014-P-B	1E	B			Reactor Services Building
Battery Breaker Switchgear	BBSW-9208-015-P-C	1E	C			Reactor Services Building
Battery Breaker Switchgear	BBSW-9208-016-P-D	1E	D			Reactor Services Building
Battery Switchboards	BSWB-9208-017-P-A	1E	A			Reactor Services Building
Battery Switchboards	BSWB-9208-018-P-B	1E	B			Reactor Services Building
Battery Switchboards	BSWB-9208-019-P-C	1E	C			Reactor Services Building
Battery Switchboards	BSWB-9208-020-P-D	1E	D			Reactor Services Building
DC Panelboards	PNLD-9208-021-P-A	1E	A			Reactor Services Building
DC Panelboards	PNLD-9208-022-P-B	1E	B			Reactor Services Building
DC Panelboards	PNLD-9208-023-P-C	1E	C			Reactor Services Building
DC Panelboards	PNLD-9208-024-P-D	1E	D			Reactor Services Building

APPENDIX F
PARAMETER LISTS

1. INTRODUCTION

Appendix F lists the major parameters of the Class 1E DC Power System major components, as indicated in the following Tables:

Table F-1 -	Batteries
Table F-2 -	Battery Chargers
Table F-3 -	Battery Breaker Switchgear
Table F-4 -	Battery Switchgear
Table F-5 -	DC Panelboards

TABLE F-1
COMPONENT PARAMETERS
BATTERIES

Description	Parameters
• Safety Classification	Class 1E
• Number of Batteries	4
• Battery Make	(TBD)
• Battery Type	Lead-acid
• Battery capacity to supply all loads for one hour without charge, AH.	(TBD)
• Number of cells	60
• Nominal output voltage, volts	125 V dc
• Output voltage range, volts	105 V to 142 V dc
• Average float voltage, volts/cell	2.25 v/c
• Average equalize voltage, volts/cell	2.33 v/c
• Final voltage after charging, volts/cell	1.75 v/c
• Max fault current at 2.33 v/c and 90°F, amp	(TBD)
• Average yearly electrolyte temperature, °F	77°F
• Average yearly electrolyte temperature range, °F	60°F to 120°F
• Battery weight complete with electrolyte, lb	(TBD)
• Battery racks:	
- Type	Two-step
- Material	Steel
- Paint	Acid resistant
- Weight, lb	(TBD)
• Qualified life, per IEEE 535, yr.	(TBD)
• Max storage temperature, °C	40°C
• Min storage temperature, °C	0°C
• Special Tools	None

TABLE F-2
COMPONENT PARAMETERS
BATTERY CHARGERS

Description	Parameters
• Safety Classification	non-Class 1E
• Charger Make	(TBD)
• Charger Type	Silicon
• Charger capacity, dc output, amps	(TBD)
• Time to recharge battery, hours	12 hours
• Charger input voltage, volts	460 V $\pm$ 10%
• Nominal output voltage, volts	130 V dc
• Float voltage range, volts/cell	2.00 to 2.30 v/c
• Equalize voltage range, volts/cell	2.25 to 2.40 v/c
• Charger efficiency, %	up to 90%
• Output voltage regulation from 0 to 100% load, %	$\pm$ 0.5%
• Current limiting at % of rated output	110%
• DC instrument accuracy, %	$\pm$ 2%
• Direct current backfeed protection	Blocking diode
• Charger Mounting	Floor
• Cooling Method	Convection
• Heat release, watts/hour	(TBD)
• Charger weight, lb	(TBD)
• Charger expected life, yrs	(TBD)
• Max storage temperature, °C	40°C
• Min storage temperature, °C	0°C
• Special tools	None

TABLE F-3

COMPONENT PARAMETERS
BATTERY BREAKER SWITCHGEAR

Description	Parameters
• Safety Classification	Class 1E
• Number of Switchgear	4
• Switchgear Make	(TBD)
• Switchgear Type	Metal-enclosed
• Switchgear main bus material	Copper
• Switchgear main bus ampacity	(TBD)
• Main bus bracing for fault current of, amp	(TBD)
• Breaker type	ACB Drawout
• Breaker operation	Electrical
• Breaker continuous frame rating, amp	(TBD)
• Breaker operating mechanism type	Spring charging
• Breaker auxiliary contacts	4 min.
• Battery breaker auxiliary contacts	4 min.
• Instrument accuracy, %	± 1%
• Switchgear weight, lb	(TBD)
• Heat release, complete assembly, watts/hour	(TBD)
• Max storage temperature, °C	40°C
• Min storage temperature, °C	0°C
• Special tools	None

TABLE F-4

COMPONENT PARAMETERS
BATTERY SWITCHBOARD

Description	Parameters
• Safety Classification	Class 1E
• Switchboard Make	(TBD)
• Switchboard Type	Metal-enclosed
• Enclosure Type	NEMA 1
• Switchboard main bus material	Copper
• Switchboard main bus ampacity, amps	(TBD)
• Branch circuit breaker type	Molded-case
• Breaker frame size	(TBD)
• Breaker interrupting rating at 125 V dc, amp	20,000 A
• Max storage temperature, °C	40°C
• Min storage temperature, °C	0°C
• Special Tools	None

TABLE F-5
COMPONENT PARAMETERS
DC PANELBOARDS

Description	Parameters
• Safety Classification	Class 1E
• Panelboard Make	(TBD) .
• Panelboard Type	Metal-enclosed
• Enclosure type	NEMA 1
• Service voltage rating, volts	125 V dc
• Panelboard main bus material	Copper
• Panelboard main bus ampacity, amps	(TBD)
• Panelboard breaker type	Molded-case
• Breaker frame size, amp	(TBD)
• Breaker interrupting rating at 125 V dc, amp	(TBD)
• Max storage temperature, °C	40°C
• Min storage temperature, °C	0°C
• Special Tools	None

APPENDIX G

1. INTRODUCTION

There are no proprietary claims for the Class 1E DC Power SSDD.