Chapter 8

ELECTRIC POWER

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Chapter 8

TABLES

FIGURES

FIGURES (Continued)

NOTE:

(a) This figure corresponds to a controlled engineering drawing that is incorporated by reference into the FSAR Update. See Table 1.6-1 for the correlation between the

FIGURES (Continued)

Chapter 8

APPENDICES

Chapter 8

ELECTRIC POWER

8.1 INTRODUCTION

The electrical auxiliary power system at the Diablo Canyon Power Plant (DCPP) is designed to provide electric power to the necessary plant electrical equipment under all foreseeable combinations of plant operation and electric power source availability. The various subsystems provide adequate protection for electrical equipment during fault conditions, while maintaining maximum system flexibility and reliability.

8.1.1 DEFINITIONS

The following definitions apply to the electrical auxiliary power system.

Offsite Power System: The system that delivers electric power from the transmission network to the onsite distribution system

Preferred Power Supply: The preferred power supply is the offsite power system. The preferred power supply is comprised of two physically independent offsite power circuits. The startup offsite power circuit (230-kV) and the auxiliary offsite power circuit (500-kV).

Normal Onsite Power Source: The normal onsite power source is the electric source which is generated by DCPP via the main generator and distributed by the 25-kV system to the 4.16-kV system.

Startup Offsite Power Circuit: The startup offsite power circuit (230-kV system) provides an immediate source of offsite power from either of the two 230-Kv transmission lines connecting to the 230-kV switchyard. Refer to Section 8.2 and Figure 8.1-2 for description of the boundary of the startup offsite power circuit.

Auxiliary Offsite Power Circuit: The auxiliary offsite power circuit (500-kV system) provides the delayed source of offsite power from any one of the three 500-kV transmission lines connecting to the 500-kV switchyard. Refer to Section 8.2 and Figure 8.1-2 for description of the boundary of the auxiliary offsite power circuit.

The main generator also feeds the auxiliary offsite power circuit during normal plant operation.

Onsite Distribution System: The Class 1E distribution system (both ac and dc voltages) permits the functioning of structures, systems, and components (SSCs) important to safety. Refer to Sections 8.3.1.1.1 through 8.3.1.1.5 and 8.3.2 for detailed descriptions of the onsite distribution systems.

There is also a non-Class 1E electrical distribution system (i.e., balance of plant). Those balance of plant portions comprising part of an offsite power circuit are subject to offsite power requirements. Those portions supplied from a Class 1E bus are subject to Class 1E isolation requirements. The remainder of the non-Class 1E balance of plant electrical distribution system is outside the scope of GDC 17, 1971 and IEEE 308-1971.

Standby Power Supply: The onsite emergency power supply. The emergency diesel generators (EDGs) are the ac standby power supply when the preferred power supply is not available. The dc standby power supply is comprised of the station batteries and the 125-Vdc system. Refer to Section 8.3.1.1.6 and 8.3.2 for detailed descriptions of the standby power supplies.

Class 1E: Refer to 3.2.2.6

Non-Class 1E: Refer to 3.2.2.6

Source: In the context of GDC 17, 1971 and IEEE 308-1971, the Class 1E ac electrical distribution system has three sources:

1) the preferred power supply

2) the standby power supply

3) the normal onsite power supply

Grid: The grid is the source of electrical power to the offsite power system. The grid is comprised of the electrical generation resources, transmission lines,

	interconnections with neighboring systems, and associated equipment, generally operated at voltages of 100-kV or higher.
Transmission Network:	The grid elements operating at a given voltage level. DCPP connects with the grid at both the 230-kV and 500-kV transmission network level.

8.1.2 GENERAL DESCRIPTION

The electrical systems generate and transmit power to the high-voltage system, distribute power to the auxiliary loads, and provide control, protection, instrumentation, and annunciation power supplies for the units. Power is generated at 25-kV. Auxiliary loads are served at 12-kV, 4.16-kV, 480-V, 120-Vac, 250-Vdc, and 125-Vdc. The engineered safety feature (ESF) auxiliary loads are served directly by the 4.16-kV, 480-V, 120-Vac, and 125-Vdc Class 1E systems.

Offsite ac power for plant auxiliaries is available from two 230-kV transmission circuits and three 500-kV transmission circuits (refer to Figures 8.1-1 and 8.1-2).

Onsite ac auxiliary power is supplied by each unit's main generator and is also available for Class 1E loads from six diesel engine-driven generators. Three diesel generators are dedicated to each unit.

Onsite dc power is supplied from six 125-Vdc station batteries in each unit. Three batteries serve 125-Vdc Class 1E loads plus some non-Class 1E loads, and three batteries serve 125-Vdc non-Class 1E loads. Two of the three batteries supplying the non-Class 1E loads are also used together (i.e., in series) to supply 250-Vdc non-Class 1E loads (refer to Figure 8.3-18).

8.1.3 POWER TRANSMISSION SYSTEM

The Pacific Gas and Electric Company (PG&E) 500-kV ac transmission system overlays an extensive 230-kV ac transmission network. The 500-kV system is further connected through the 500-kV Pacific Intertie to the Western Systems Coordinating Council network covering the eleven western states plus British Columbia. Since March 31, 1998, the California Independent System Operator (CAISO) has been responsible for operating the transmission system within California. PG&E, as well as the other transmission system operators (owners) in the state, continues to own and operate their transmission facilities.

8.1.4 SAFETY LOADS

A representative listing of each unit's systems and loads requiring electric power to perform their safety functions are listed below.

(1) Emergency core cooling system, including two each of centrifugal charging pumps (CCP1 and CCP2), residual heat removal pumps, safety injection (SI) pumps, motor-driven auxiliary feedwater pumps (AFW), and their associated valves and lube oil pumps

(2) Containment spray system, including two pumps and associated valves

(3) Containment ventilation system, including five fan cooler units

(4) Auxiliary saltwater (ASW) system, including two pumps and associated valves

(5) Component cooling water (CCW) system, including three pumps and associated motor-operated valves

(6) Diesel fuel oil (DFO) system, including two pumps and valves

(7) Auxiliary building ventilation system, including fans, dampers, and control cabinets

(8) Fuel handling building ventilation system, including fans, dampers, and control cabinets

(9) Chemical and volume control system, including boric acid transfer pumps, valves, and tank heaters

Each of these and the other safety systems are discussed in detail in the appropriate section of this FSAR Update. The safety loads, plus additional important loads that are listed in Table 8.3-5 are served from Class 1E buses at 4.16-kV or 480-V. These buses are designated buses F, G, and H; Unit 1 is shown, with its bus loads, in Figures 8.3-4 and 8.3-6 through 8.3-8. The Unit 1 Class 1E 125-Vdc and 120-Vac instrumentation systems, with their loads, are shown in Table 8.3-11 and Figures 8.3-17 and 7.6-1. The Class 1E 480-V buses are supplied through transformers fed from the Class 1E 4.16-kV buses. These, in turn, are supplied power from both the normal and the emergency power sources described in Sections 8.2 and 8.3. Unit 2 loads and configuration are similar to Unit 1.

8.1.5 DESIGN BASES, CRITERIA, SAFETY GUIDES, AND STANDARDS

The electric power system is designed to provide reliable power for all necessary equipment during startup, normal operation, shutdown, and all emergency situations. Design criteria, as well as guides, codes, and applicable standards, are discussed in this section.

8.1.5.1 Design Bases

The electrical systems are designed to ensure an adequate supply of electrical power to all essential auxiliary equipment during normal operation and under accident conditions. PG&E Design Class I loads receive power from Class 1E buses that meet the requirements for IEEE Class 1E systems as defined in IEEE 308-1971. Those electrical systems and components which are not classified Class 1E are designated non-Class 1E.

Non-Class 1E 4.16-kV auxiliary buses are provided with two power sources: offsite power and power from the main generator. Class 1E buses have an additional source: onsite diesel generators. The Class 1E electrical systems are designed so that failure of any one electrical device will not prevent operation of the minimum required ESF equipment.

The overall plant single line diagram is shown in Figure 8.1-1. The loads on the Class 1E buses and the capabilities of the diesel generators are listed in Section 8.3.

8.1.5.2 Applicable Design Basis Criteria

The documents listed in Table 8.1-1 were utilized in the design, construction, testing, and inspection of the electrical systems. Table 8.1-1 designates the electrical systems which have relevance to the indicated design basis criteria. The design basis criteria for each system are addressed in the relevant system sections of Chapter 8.

Compliance of electrical systems with the general design criteria, including seismic and environmental qualifications (EQs), is also discussed in Chapter 3.

8.1.5.3 Codes and Standards

The following codes and standards have been implemented where applicable:

IEEE Standard No. 279-1971, "Criteria for Protection Systems for Nuclear Power Generating Stations"

IEEE Standard No. 308-1971, "Criteria for Class 1E Electric Systems for Nuclear Power Stations"

IEEE Standard No. 317-1971, "Electrical Penetration Assemblies in Containment Structures for Nuclear Power Generating Stations"

IEEE Standard No. 323-1971, "IEEE Trial Use Standard: General Guide for Qualifying Class 1 Electric Equipment for Nuclear Power Generating Stations," except for formal organization of the documentation

IEEE Standard No. 334-1971, "IEEE Trial Use Guide for Type Tests of Continuous Duty Class 1 Motors Installed Inside the Containment of Nuclear Power Generating Stations"

IEEE Standard No. 336-1971, "Requirements for Instrumentation and Electric Equipment During the Construction of Nuclear Power Generating Stations-Installation, Inspection, and Testing"

IEEE Standard No. 344-1971, "Trial Use Guide for Seismic Qualification of Class I Electric Equipment for Nuclear Power Generating Stations"

(NOTE: Original Westinghouse-supplied equipment was qualified to IEEE 344-1971. Specific cases have been supplemented by seismic qualification criteria per IEEE 344-1975, "IEEE Recommended Practices for Seismic Qualification of Class I Electric Equipment for Nuclear Power Generating Stations")

IEEE Standard No. 485-1983, “Recommended Practice for Sizing Large Lead Storage Batteries for Generating Stations and Substations.”

ANSI Standard C37, 1972 Edition

ANSI Standard C57, 1971 Edition

AIEE Publication S-135-1, (1962), "Power Cable Ampacities"

IPCEA Standard S-66-524, (1971)

NEMA Standards MG-1, SG-5, SG-6, IC-1, VE-1, TR-1, (1971 Editions)

National Electric Code, 1968 Edition

8.1.6 REFERENCE DRAWINGS

Figures representing controlled engineering drawings are incorporated by reference and are identified in Table 1.6-1. The contents of the drawings are controlled by DCPP procedures.

8.2 OFFSITE POWER SYSTEM

The PG&E grid, which operates at several voltage levels, provides power to the DCPP preferred power supply as defined in Section 8.1. DCPP is interconnected to PG&E's electric grid system via two 230-kV and three 500-kV transmission lines emanating from their respective switchyards. These switchyards are physically and electrically separated and independent of each other. The 500-kV transmission lines out from the 500-kV switchyard provide for transmission of the plant's electric power output to the PG&E grid. The numbers of 230-kV and 500-kV transmission lines provide capability beyond that required to meet minimum U.S. Nuclear Regulatory Commission (NRC) regulatory requirements to ensure reliability of the offsite power systems.

The preferred power supply consists of the two independent circuits (230-kV and 500-kV) from the PG&E transmission networks. The preferred power supply consists of the offsite circuits from the switchyards' DCPP circuit breakers (including associated disconnect switches) 212 (230-kV) and 532, 542, 632 and 642 (500-kV) to the onsite distribution systems. The startup offsite power circuit consists of the 230-kV switchyard breaker (212) and lines to the standby startup transformers and the 12-kV onsite distribution which provides power to the onsite Class 1E 4.16-kV distribution system. The auxiliary offsite power circuit consists of the 500-kV switchyard breakers 532, 542, 632 and 642 and lines to the main transformers and the 25-kV onsite distribution system which also provide power to the onsite Class 1E 4.16-kV distribution system. The 12-kV system, the 25-kV system and the onsite Class 1E 4.16-kV system are addressed in Section 8.3.

The startup offsite power circuit provides startup and standby power, and is immediately available following a loss-of-coolant accident (LOCA) to assure that core cooling, containment integrity, and other vital safety functions are maintained. The auxiliary offsite power circuit provides a delayed access source of preferred power supply after the main generator is disconnected following anticipated operational occurrences. A combination of the startup offsite power circuit and the auxiliary offsite power circuit provides the preferred power supply, as required by GDC 17, 1971.

8.2.1 DESIGN BASES

8.2.1.1 General Design Criterion 4, 1967 – Sharing of Systems

The startup offsite power circuit is designed with a single line and breaker (212) which is shared with both units startup offsite circuits. The startup offsite power circuit is designed such that the shared components do not impair plant safety. The startup offsite power circuit is designed with sufficient capacity and capability to operate the ESFs for a design basis accident (or unit trip) on one unit, and those systems required for a concurrent safe shutdown of the second unit consistent with the requirements of Section 8 of IEEE 308-1971. Additionally, the startup offsite power circuit has sufficient capacity and capability to operate the ESF for a dual unit trip as a result of a seismic event or abnormal operational occurrences.

8.2.1.2 General Design Criterion 17, 1971 – Electric Power Systems

The DCPP preferred power supply is designed with two physically independent circuits. The preferred power supply has sufficient capacity and capability to assure that: (1) specified fuel design limits and design conditions of the reactor coolant pressure boundary are not exceeded as a result of anticipated operational occurrences, and (2) the core is cooled and containment integrity and other vital functions are maintained in the event of postulated accidents.

Each of the offsite power circuits are designed to be available in sufficient time following a loss of all onsite alternating current power supplies and the other offsite power circuit, to assure that specified acceptable fuel design limits and design conditions of the reactor coolant pressure boundary are not exceeded.

The startup offsite power circuit provides startup and standby power, and is immediately available following a design basis accident to assure that core cooling, containment integrity, and other vital safety functions are maintained.

The auxiliary offsite power circuit provides a delayed access source of preferred power supply after the main generator is disconnected to assure specified fuel design limits and design conditions of the reactor coolant pressure boundary are not exceeded as a result of anticipated operation occurrences. The auxiliary offsite power circuit is available in sufficient time to safely shutdown the plant following a loss of the normal onsite power source and the startup offsite power circuit.

The combination of the startup offsite power circuit and the auxiliary offsite power circuit provide physical independent sources of preferred power supply, as required by GDC 17, 1971. The preferred power supply is designed to minimize the probability of losing electric power from the transmission network coincident with the loss of onsite power generated by the main generator or the loss of onsite electric power sources (standby power supply as defined in IEEE 308-1971).

DCPP maintains protocols with the grid operator to help ensure grid reliability, to ensure that impacts on plant risk are understood, and to ensure the operability of the preferred power supply is maintained.

8.2.1.3 General Design Criterion 18, 1971 – Inspection and Testing of Electric Power Systems

The preferred power supply and its components have provisions for periodic inspection and testing. The preferred power supply components have been provided with convenient and safe features for inspecting, and testing.

8.2.1.4 Offsite Power System Safety Function Requirements

(1) Transmission Capacity

Each of the 230-kV transmission lines feeding the DCPP 230-kV switchyard is independently able to support the loads for a design basis accident on one unit and loads required for concurrent safe shutdown on the other unit.

(2) Single Failure

The preferred power supply has sufficient independence, capacity and testability to permit the operation of the ESF systems assuming a failure of a single active component.

8.2.1.5 10 CFR 50.63 – Loss of All Alternating Current Power

The preferred power supply is used for restoration of offsite power following a station blackout (SBO) event.

8.2.1.6 Safety Guide 32, August 1972 – Use of IEEE Standard 308-1971 Criteria for Class 1E Electric Systems for Nuclear Power Generating Stations

Safety Guide 32, August 1972 identifies a conflict between IEEE 308-1971 and GDC 17, 1971 specifically with respect to the time at which the delayed access offsite power circuit is required. Safety Guide 32, August 1972 supports a delayed access offsite power circuit provided that the availability of the delayed access offsite power circuit conforms to the requirements of GDC 17, 1971.

The startup offsite power circuit is the immediate source of the preferred power supply following a design basis accident or unit trip. The auxiliary offsite power circuit provides a delayed access source of preferred power supply within sufficient time as required by GDC 17, 1971.

8.2.1.7 10 CFR 50.48(c) – National Fire Protection Association Standard NFPA 805

The 230-kV system is designed to meet the nuclear safety and radioactive release performance criteria of Section 1.5 of NFPA 805, 2001 Edition.

8.2.2 DESCRIPTION

8.2.2.1 230-kV System

Offsite electrical power for startup and standby service is provided from the 230-kV system. The two incoming 230-kV transmission lines, one from the Morro Bay switchyard (about 10 miles away) and the other from the Mesa Substation, feed the 230-kV switchyard (refer to Figures 8.1-1 and 8.1-2). Shunt capacitors at DCPP and

Mesa Substations are utilized to provide voltage support when required by the 230-kV grid conditions.

Each of the two 230-kV transmission lines feeding the 230-kV switchyard is provided with relay protection consisting of a carrier distance relaying terminal, including carrier distance and directional ground relays, with backup directional ground and fault detector relays, and automatic reclosing.

A single tie-line from the 230-kV switchyard supplies the 230-kV/12-kV standby startup transformer for each unit through breaker 212. The 230-kV standby startup service power line from the 230-kV switchyard to the plant is provided with relay protection consisting of a differential pilot wire relay system with overcurrent and fault detector relays for backup.

The single line diagram of the grid and the preferred offsite power supply to Unit 1 and Unit 2 is shown on Figures 8.1-1 and 8.1-2. Figure 8.2-3 shows the general location of the 230-kV (and 500-kV) switchyards. Reference 4 shows the arrangement of the 230-kV switch, bus, and circuit breaker structures. Figure 8.2-6 shows the arrangement of the 230-kV/12-kV standby startup transformers.

The tap position on each 230-kV/12-kV standby startup transformer load tap changer (LTC) is monitored in the DCPP main control room. Malfunction of the LTC is monitored in the control room through indication and annunciator action which could include taking manual control of the LTC or removing the transformer from service. Both units are designed to be supplied from a dedicated startup transformer, with the startup bus Unit 1-Unit 2 cross-tie breaker open. However, a single 230-kV/12-kV standby startup transformer can be aligned to both units via the cross-tie breaker. Operation in this configuration is restricted by Technical Specification. The DCPP surveillance program confirms the availability of the preferred power supply by verifying the correct breaker alignments, voltage levels, capacitor bank status, and any configuration control measures.

The automatic LTCs on the 230-kV/12-kV standby startup transformers, in addition to the grid shunt capacitors, assure the voltage on the plant 12-kV and 4-kV buses is maintained within acceptable limits and has adequate VAR support (References 1 and 2).

The 230-kV switchyard dc control power is provided by a lead-acid battery and two battery chargers. Each charger is capable of supplying the normal dc load of the 230-kV switchyard and maintaining the battery in a fully charged condition. Normally, one charger is operating with the second charger available on standby. Both chargers may be operated in parallel if desired. Each charger is equipped with an ac failure alarm that operates on loss of ac to the charger. The battery and chargers feed a 125-Vdc distribution panel that is equipped with a dc undervoltage (UV) relay that initiates an alarm if the dc voltage drops below a preset value. Separate dc control circuits are provided from the dc distribution panel for each 230-kV power circuit breaker.

8.2.2.2 500-kV System

The 500-kV system provides for transmission of the plant's power output to the grid. The three 500-kV transmission lines, one from the Gates Substation (about 79 miles away) and two other from the Midway Substation (about 84 miles away), feed the DCPP 500-kV switchyard.

Each 500-kV transmission line is provided with relay protection terminal equipment consisting of two line relay sets (directional comparison), each operating over physically separate channels, microwave and power line carrier, and each provided with a separate dc power circuit. Single-pole tripping is not enabled for any of the lines. High-speed automatic reclosing is not enabled for the circuit breakers at the DCPP end of the lines. Backup protection (provided by a distance relaying terminal, including distance and directional ground relays) is normally cut-out, and cut-in when either primary relay set is not operable.

The 500-kV system provides power for station auxiliaries via the main transformer and the unit auxiliary transformers. Offsite electrical power is also provided from the 500-kV system. A single circuit to each unit from the 500-kV switchyard provides auxiliary offsite power through the 500-kV/25-kV main transformers and through breakers 532 and 632 (Unit 1) and breakers 542 and 642 (Unit 2). The dc motor operated main generator disconnecting switch is opened to provide auxiliary offsite power (backfeed). This telescoping disconnect switch is an integral part of the generator isolated phase bus. This switch is operated under manual control from the control room and is interlocked to prevent opening under load. Upon actuation, the motor-operated disconnect (MOD) switch takes approximately 30 seconds to isolate the main generator from the main and the unit auxiliary transformers. In the event of a loss of main generator output, the auxiliary offsite power circuit could be placed in service within 30 minutes. The position of the MOD switch is verified prior to backfeeding from the 500-kV switchyard.
Figures 8.1-1 and 8.1-2 (plant single line diagram) shows the three 500-kV transmission lines from the transmission network to the interconnections to the plant auxiliaries. Figure 8.2-3 shows the general location of the 230-kV and 500-kV switchyards. Reference 5 shows the arrangement of the 500-kV switches, buses, and circuit breaker structures.

Each 500-kV line between the 500-kV switchyard and a generator step-up transformer bank is provided with redundant current differential protection channels. Directional over-current relays are available as backup. A Special Protection Scheme (SPS) supplements the existing DCPP 500-kV switchyard/line protection (refer to Section 8.2.3.2.2).

The 500-kV switchyard dc control power is provided by a lead-acid battery and two battery chargers. Each charger is capable of supplying the normal dc load of the 500-kV switchyard and maintaining the battery in a fully charged condition. Normally, one charger is operating with the second charger available on standby. Both chargers may be operated in parallel, if desired. Each charger is equipped with an ac failure alarm that operates on loss of ac to the charger. The battery and chargers feed two 125-Vdc distribution panels, one of which is equipped with a dc UV relay that initiates an alarm if the dc voltage should drop below a preset value. Separate dc control circuits are provided for each 500-kV power circuit breaker.

8.2.3 SAFETY EVALUATION

8.2.3.1 General Design Criterion 4, 1967 – Sharing of Systems

The startup offsite power circuit is designed such that the single 230-kV line from the 230-kV switchyard, including breaker 212, is shared by both Unit 1 and Unit 2 startup offsite power circuits. The shared components have sufficient capacity to operate the ESF for a design basis accident (or unit trip) on one unit, and those systems required for a concurrent safe shutdown of the second unit consistent with the requirements of Section 8 of IEEE 308-1971. Additionally, the startup offsite power circuit has sufficient capability to operate the ESF for a dual unit trip as a result of a seismic event or abnormal operational occurrences (Reference 8). The capacity of the shared startup offsite power circuit components is evaluated to ensure that a spurious ESF actuation on the non-accident unit, concurrent with a design basis accident on the other unit, would not result in the loss of the preferred power supply.

Both units are designed to be supplied from a dedicated startup transformer, with the startup bus Unit 1-Unit 2 cross-tie breaker open. However, a single 230-kV/12-kV standby startup transformer can be aligned to both units via the cross-tie breaker. Operation in this configuration is restricted by Technical Specification.

8.2.3.2 General Design Criterion 17, 1971 – Electric Power Systems

8.2.3.2.1 Preferred Power Supply

The preferred power supply is designed to provide two physically independent offsite power circuits (from the 230-kV and the 500-kV systems) for the Class 1E buses. The startup offsite power circuit is the 230-kV power supply which includes the first inter-tie breaker (212) at the 230-kV switchyard, 230-kV/12-kV standby startup transformers and includes all equipment downstream such as transformers, switches, interrupting devices, cabling, and controls up to the Class 1E buses. The startup offsite power circuit is designed to provide the immediate access preferred power supply from the 230-kV switchyard to the Class 1E buses within a few seconds after a LOCA.

The auxiliary offsite power circuit is the 500-kV power supply which includes inter-tie breakers (generator output breakers 532 and 632 for Unit 1, breakers 542 and 642 for

Unit 2) at the 500-kV switchyard, 500-kV/25-kV main transformers and all equipment downstream such as isophase bus, breakers, transformers, switches, interrupting devices, cabling, and controls up to the Class 1E buses. The auxiliary offsite power circuit is designed to provide the delayed access source of preferred power supply from the 500-kV switchyard to the Class 1E buses after the main generator MOD switch is opened. The auxiliary offsite power circuit is available in sufficient time to safely shutdown the plant following a loss of the auxiliary onsite power source and the startup offsite power circuit (refer to Section 8.2.3.6).

The combination of the startup offsite power circuit and the auxiliary offsite power circuit provide physical independent sources of preferred power supply, as required by GDC 17, 1971. The preferred power supply is designed to minimize the probability of losing electric power from the transmission network coincident with the loss of onsite power generated by the main generator or the loss of onsite electric power sources (standby power supply as defined in IEEE-308 1971).

8.2.3.2.2 Analysis

8.2.3.2.2.1 Grid Load Flow Analysis

Load flow analyses are performed for anticipated configurations of the grid (e.g., generating units out of service, transmission line(s) out of service, or voltage control devices out of service).

For postulated design-basis events, the transmission system is assumed to be in steady state. Any external condition affecting the transmission network is assumed to occur in sufficient time prior to the transfer to the 230-kV system such that the voltage on the 230-kV/12-kV LTC has adjusted to the transient.

PG&E’s Grid Control Center controls the DCPP 230-kV switchyard voltage to meet or exceed the minimum allowed pre-trip voltage. The minimum voltage from the transmission network at the DCPP 230-kV switchyard is maintained at or above 218-kV for normal operation with all transmission lines in service. The minimum voltage from the transmission network at the DCPP 500-kV switchyard is maintained at or above 512-kV. With both DCPP units off-line, the preferred power supply is capable of providing 104-MW and 78-MVAR to DCPP for normal operation, safe shutdown and design basis accident mitigation.

Depending upon system load and available voltage support, a degraded grid voltage condition could occur and result in DCPP configuration control measures (refer to Section 8.2.3.2.2.2). PG&E operating procedures are used by the CAISO, Grid Control Center, the Diablo Canyon Control Center, and DCPP.

Configuration control measures and the voltages required to maintain operability are reviewed annually. The purpose of the review is to examine major changes in system load projections, generating capacity, and transmission grid connections. PG&E's

Energy Delivery engineering staff performs the load flow studies using the current analytical model of the entire Western Electricity Coordinating Council (WECC). The maximum permissible transmission network loading is determined for various 230 kV network operating configurations, given a complete loss of DCPP generation. The 230-kV configurations modeled include all local transmission elements in service; one line out of service; two parallel lines out of service; split buses at nearby 230-kV substations; and capacitor banks unavailable. The results of the studies are calculated system equivalents and voltages with and without DCPP loading for each configuration. The results of the system load flow studies ensure transmission voltages are adequate to support a postulated DCPP post trip load transfer.

8.2.3.2.2.2 DCPP Load Flow and Dynamic Loading Analysis

The startup offsite power circuit is the immediate source of preferred power supply following a design basis accident or unit trip. The DCPP design and licensing basis requires that the startup offsite power circuit have sufficient capacity and capability to: (1) operate the ESFs for a design-basis accident on one unit and concurrent safe shutdown on the other unit, and (2) operate the ESFs for dual unit trips as a result of a seismic event or abnormal operational occurrences.

Existing DCPP calculations demonstrate the capacity of the preferred power supply for anticipated operational occurrences and postulated post-accident conditions. The calculations demonstrate that the preferred power supply has sufficient capacity and capability to start and operate the required loads.

Depending upon system load and available voltage support, a degraded grid voltage condition can result. DCPP configuration control measures, including blocking the transfer of non-essential loads, may be necessary for certain transmission network configurations to ensure adequate voltage to the Class 1E buses and return to the startup offsite power circuit to operable status.

PG&E operating procedures identify when configuration control measures are necessary based on surrounding area load, voltage, and the availability of critical transmission elements. When notified of adverse grid conditions, DCPP operating procedures identify what configuration control measures to invoke. Continued operation of the DCPP units under these conditions is procedurally controlled to ensure the preferred power supply meets DCPP operability requirements.

Configuration control measures and the voltages required to maintain operability are reviewed annually. DCPP dynamic loading analyses are then performed, using the results of the transmission load flow studies as input. The DCPP analyses determine if the calculated voltages are adequate for starting of required plant loads and for the bus transfer to the startup offsite power circuit following a design basis accident on one unit and concurrent safe shutdown of the second unit, or a dual unit trip following a seismic event or other abnormal operational occurrences. If the voltages and existing configuration control measures are not adequate, the analysis is rerun with additional configuration control measures. Analyses are also performed to examine the effect of one 230-kV/12-kV standby startup transformer being unavailable, and for manual 230-kV/12-kV standby startup transformer LTC operation. DCPP procedures (which provide configuration control measures for the preferred power supply operability) are then modified to reflect the results of the analyses.

8.2.3.2.2.3 Grid Stability Analysis

The licensing basis requires the grid to remain stable (no complete loss of power from the preferred power source) following the loss of a generator, the loss of a large load block, or a fault on the most critical transmission line. Grid stability analyses are performed periodically whenever there is a significant change in generation, load, or transmission capability to ensure that this criterion is met. These analyses, and the load flow and dynamic loading analyses discussed above, are done to demonstrate compliance with GDC 17, 1971.

The fundamental purpose of the grid is to move electric power from the areas of generation to the areas of customer demand. The transmission network should be capable of performing this function under a wide variety of expected conditions. In addition to the more probable forced and planned outage contingencies, the planned ability to withstand less probable contingencies measure the robustness of a system.

The California transmission network (control area under CAISO) is designed and operated to comply with WECC reliability criteria (Reference 6). These criteria establish performance requirements for numerous grid contingencies, including the DCPP license basis contingencies which consist of the loss of any generator, the loss of a large load block, or a fault on the most critical transmission line.

The WECC criteria define four levels of transmission events, as follows:

Category A: No contingency, all facilities in service
Category B: Events resulting in the loss of a single grid element
Category C: Events resulting in the loss of two or more elements
Category D: Extreme events resulting in two or more (multiple elements removed or cascading out of service)

The DCPP licensing basis contingencies identified earlier in this section are consistent with the above WECC Category B events. CAISO compliance with WECC Category B ensures the availability of offsite power to DCPP because the loss of multiple elements and cascading are not involved.

The Category C and D events are beyond the licensing basis to satisfy GDC 17, 1971 criteria. CAISO compliance with WECC Category C and select Category D contingencies provides additional margin to ensure an adequate offsite power to Diablo Canyon units by protecting against dual unit trips.

Grid stability analyses are performed periodically by PG&E Electrical Operations whenever there is a significant change in generation, load, or transmission capability (based on an annual review of configuration control measures and voltages required to maintain operability) to ensure that the Category B criterion is met.

The model used in these studies represents PG&E grid and the interconnected western states in sufficient detail so that they properly address the electromechanical reaction of the combined systems to the cases studied. Scenarios modeled by PG&E include both a single-unit trip and a dual-unit trip of DCPP. Both worst case summer and winter loadings are simulated because the total area load and available generation varies with the season.

Assuming one DCPP unit already shutdown, the grid stability study concluded that the loss of the remaining generating unit at the Diablo Canyon site has little effect on the preferred power supply feeding the DCPP switchyard 230-kV buses and will not result in the complete loss of the preferred power supply. Both voltage and frequency will stabilize within several seconds. For a single-unit trip, the availability of the preferred power supply to the ESFs at Diablo Canyon will not be affected.

For a dual-unit trip (WECC Category C event), the 230-kV switchyard will remain energized (i.e., non-cascading event).

8.2.3.2.2.4 Operation During Severe Grid Disturbances Analysis

The CAISO exercises centralized control over generation and transmission facilities within California. CAISO schedules electric generation and operates the transmission network to minimize cascading during severe transmission network disturbances.

The CAISO also coordinates the scheduled outage of the electric generation and transmission facilities for preventive maintenance and repair, thereby ensuring a nearly constant level of system reliability.

It is the CAISO's responsibility to carry, at all times, operating reserve to satisfy the WECC Reliability Criteria and meet the requirements of the North American Electric Reliability Council.

To preserve the integrity of generating units during extreme grid disturbances, nuclear power plants (including DCPP) will be given the highest priority for restoration of power to their switchyards. PG&E and the CAISO have emergency restoration plans in place to utilize combustion turbine units, hydroelectric units, and the transmission grid to provide startup power to its major thermal electric generating plants. PG&E has several megawatts of its own hydro-generation within its control area that assists the grid through disturbances.

System disturbances can be initiated by trouble either within the CAISO control area or external to it. The 500-kV ac Pacific Intertie, running the length of PG&E's grid, provides an internal transmission network with ties to neighboring utilities. If the grid is subjected to a severe disturbance caused by upset conditions external to the PG&E grid, underfrequency (UF) protective relaying has been provided that will activate at the interface. This relaying automatically separates the PG&E grid from its neighbors should frequency drop below relay settings in accordance with Exhibit A of PG&E Utility Standard S1426 for Tie Lines.

The WECC has prepared a coordinated response to UF events. A coordinated response by all utilities and generation owners under WECC jurisdiction maximizes the integrity of the grid. PG&E has implemented a multi-step load shed scheme within WECC guidelines to maintain a balance between load and generation.

These guidelines include the separation of generation based on UF setpoints that have been coordinated within the WECC areas of control. All setpoints for load shedding and generation tripping have been selected to minimize equipment damage and provide long term grid reliability. To minimize the possibility of a cascading failure and the possibility of severe overloading of generating units, UF load shedding is used to automatically relieve load during an extreme emergency. This load is removed automatically in increments based on declining frequency. Should these measures fail to arrest system frequency decay, provisions have been made to automatically separate thermal power plants from the transmission network should abnormal low frequency conditions develop. DCPP has implemented setpoints and durations for conditions corresponding to those specified in Exhibit A of PG&E Utility Operations Standard S1426 for Thermal Power Plants. Additional manual load shedding may be required to stabilize the grid. Hydroelectric units connected to the transmission network have a broad capability to operate during UF conditions. The hydroelectric units' UF setpoints are lower than the thermal power plants, although most hydroelectric units do not have UF control and would remain connected and continue to provide power to the transmission system.

A SPS has been added to supplement the existing DCPP 500-kV switchyard/line protection. This SPS was designed and installed by PG&E's transmission organization. An SPS is designed to detect abnormal grid conditions and take pre-planned, corrective action (other than the isolation of faulted elements) to provide acceptable grid performance. SPS actions may include, among others, changes in demand (e.g., load shedding), generation, or system configuration to maintain grid stability, acceptable voltages, or acceptable facility loadings. The use of an SPS is an acceptable transmission practice to meet the grid performance requirements as defined under WECC Categories A, B, or C.

The Diablo Canyon switchyard SPS was installed to mitigate the potential loss of two Diablo Canyon units after the occurrence of certain 500-kV Category C events. These events, if left unmitigated, would result in the loss of both Diablo Canyon units. The SPS will prevent voltage dips that are in violation of the WECC standards. The SPS system will selectively open the generator output breakers of one generating unit (i.e., load rejection) when the pre-defined conditions exist regarding the DCPP outlet lines.

The purpose of this corrective action is to prevent intensive swings that would otherwise result in the trip of both units by either reactor coolant pump (RCP) UV or generator out-of-step protection.

The measures outlined above, together with others, provide the basis for PG&E's confidence that the offsite power sources to the Diablo Canyon site are extremely reliable. The interconnection of Diablo Canyon to the 500-kV transmission network by way of Midway and Gates switchyards, and to the 230-kV transmission network by way of Morro Bay switchyard and Mesa substation, ensures access to PG&E's electrical grid systems.

8.2.3.3 General Design Criterion 18, 1971 - Inspection and Testing of Electric Power Systems

Periodic testing and surveillance of the standby startup transformers, unit auxiliary transformers, and the main transformer are part of the normal DCPP program for oil-filled transformers.

The DCPP surveillance program confirms the availability of the preferred power supply by verifying the correct breaker alignments, voltage levels, capacitor bank status, and any configuration control measures.

8.2.3.4 Offsite Power System Safety Function Requirements

(1) <u>Transmission Capacity</u>

Each of the two 230-kV transmission lines feeding the DCPP 230-kV switchyard is independently able to support the loads for a design basis accident on one unit and loads required for concurrent safe shutdown on the other unit.

The startup preferred power supply from the transmission network including the 230-kV/12-kV standby startup offsite power circuit is designed in a manner intended to obtain a high degree of service reliability and to minimize the time and extent of outage if failures do occur. Other than the failure mechanisms identified in Section 8.2.3.4(2), the startup offsite power circuit is designed for the following normal grid conditions:

(1) Each transmission line (as described in Section 8.2.2) in service with full capacity.

(2) Voltage support devices such as the automatic LTCs and capacitor banks at DCPP and Mesa in service

(3) Operating at full load under maximum expected transmission system load

The startup offsite power circuit is capable of mitigating a design basis event without reliance on manual operator actions to restore capability. This startup offsite power circuit capability includes automatic operation of voltage support devices and transmission switching systems to re-stabilize the system following a loss of a single generator in the transmission network, transmission line, or voltage support device. For off normal conditions (e.g., following a loss of a single generator in the transmission network, transmission line, or voltage support device) such that transmission from one of the two 230-kV transmission lines is degraded, configuration control measures, that include the blocking of selective large loads (e.g., 12-kV buses D and E auto transfer, condensate/condensate booster pumps auto start), are required to maintain operability (capability to mitigate an accident in one unit and a concurrent trip of the other unit) from the other 230-kV transmission line. These configuration control measures are procedurally controlled based on grid conditions.

(2) Single Failure

The preferred power supply is designed such that both the offsite and the onsite power systems have sufficient independence, capacity and testability to permit the operation of the ESF systems assuming a failure of a single active component in each system. The combination of either two 230-kV line plus the 500-kV system provides a high degree of assurance that offsite power will be available when required.

Occurrences that could result in the loss of the startup offsite power circuit are described below. Note that these occurrences do not result in a loss of the auxiliary offsite power circuit and therefore ensure the preferred power supply is available in the event of a loss of the startup offsite power circuit.

(1) Loss of Morro Bay Switchyard or loss of both circuits of the 230-kV transmission line in the sections between the Morro Bay switchyard and Diablo Canyon site. It is noted that an outage of any one of the three 230-kV circuits (Morro Bay-Diablo Canyon, Diablo Canyon-Mesa, or Morro Bay-Mesa) would not result in interruption of the transmission supply to Diablo Canyon.

(2) Loss of the 230-kV bus structure at the Diablo Canyon site. This 230-kV structure has a double bus arranged so that either bus can supply the feed to the 230-kV/12-kV standby startup transformers. A permanently faulted bus section can be isolated from the remaining unfaulted bus section by means of manual switching operations. These structures are suitably spaced from one another. Only an event of great physical extent would cause the loss of both buses.

(3) Loss of the 230-kV line from the Diablo Canyon switchyard to the 230-kV/12-kV standby startup transformers, or loss of its associated 230-kV oil circuit breaker. If the power loss is due to mechanical or electrical failure of the oil circuit breaker, the circuit breaker can be isolated and bypassed by means of manual switching operations. A

physical disruption of the short section of 230-kV line from the switchyard to the plant is considered highly unlikely.

(4) Loss of either 230-kV/12-kV standby startup transformer 11 or 21 or the associated 12-kV breakers or buses. Standby startup transformers 11 and 21 are normally separated on the 12-kV side, with transformer 11 feeding Unit 1 and transformer 21 feeding Unit 2. In case of a failure of either transformer, the faulted transformer can be manually switched out of service, its bus can then be transferred to the other transformer by closing the 12-kV bus tie vacuum circuit breaker. This circuit breaker is common to the 12-kV standby startup buses of Unit 1 and Unit 2, and is normally kept open (i.e., procedurally controlled).

(5) Failure of 12-kV/4.16-kV standby startup transformer 12 (22). By means of manual switching after a failure, the buses served from this transformer can be supplied from the 230-kV system by unit auxiliary transformer 12 (22) through unit auxiliary transformer 11 (21), fed from the 12-kV standby startup bus. This requires removal of links in the generator bus at the main transformer as well as opening of the disconnecting switch to the generator. This is an unusual configuration and is used only when better methods are not available.

8.2.3.5 10 CFR 50.63 - Loss of All Alternating Current Power

The 230-kV system or the 500-kV system is used for restoration of offsite power following a SBO. The plant procedures for SBO use several different flow paths to restore ac power and place the plant in a safe, controlled condition. Refer to Section 8.3.1.6 for additional discussion.

8.2.3.6 Safety Guide 32, August 1972 - Use of IEEE Standard 308-1971 Criteria for Class 1E Electric Systems for Nuclear Power Generating Stations

Safety Guide 32, August 1972 identifies a conflict between IEEE 308-1971 and GDC 17, 1971 specifically with respect to the time at which the delayed access circuit is required. Safety Guide 32, August 1972 allows a delayed access circuit provided that the availability of the delayed access circuit conforms to requirements of GDC 17, 1971.

The startup offsite power circuit provides standby startup power, and is immediately available following a LOCA to assure that core cooling, containment integrity, and other vital safety functions are maintained. The auxiliary offsite power circuit provides a delayed access source of preferred power supply to the plant auxiliary systems and Class 1E buses when the main generator is not in operation. The auxiliary offsite power circuit is available in sufficient time to safely shutdown the plant following anticipated operational occurrences. In the event of a loss of main generator output, the auxiliary offsite power circuit could be placed in service after about 30 minutes to ensure that specified acceptable fuel design limits and design conditions of the reactor coolant boundary are not exceeded.

The position of the MOD switch is verified prior to backfeeding from the 500-kV switchyard.

After the two 500-kV breakers are opened, operations personnel coordinate with PG&E's Grid Control Center to realign plant protective relaying; open the generator disconnect; and re-close the generator output breakers.

8.2.3.7 10 CFR 50.48(c) – National Fire Protection Association Standard NFPA 805

The 230-kV system is designed to meet the nuclear safety and radioactive release performance criteria of Section 1.5 of NFPA 805, 2001 Edition (refer to Section 9.5.1).

8.2.4 TESTS AND INSPECTIONS

Refer to Section 8.2.3.3 for inspection and testing of electric power systems.

8.2.5 INSTRUMENTATION APPLICATIONS

The tap position on each 230-kV/12-kV startup/standby transformer LTC is monitored in the DCPP main control room. Malfunctioning of the LTC is alarmed in the main control room.

8.2.6 REFERENCES

1. License Amendment Request 98-01 submitted to the NRC by PG&E Letters DCL-98-008, dated January 14, 1998; DCL-98-076, dated May 19, 1998; DCL-99-013, dated February 5, 1999; and DCL-99-018, dated February 5, 1999. Also PG&E Letter DCL-99-014, dated February 5.

2. NRC Letter to PG&E, dated April 29, 1999, granting License Amendments No. 132 to Unit 1 and No. 130 to Unit 2.

3. Deleted in Revision 21.

4. PG&E Substation and Transmission Drawing 435895, “Arrangement of 230-kV Switch, Bus, and Circuit Breaker Structures (DCPP)”

5. PG&E Substation and Transmission Drawing 57486, “Arrangement of 500-kV Switch, Bus, and Circuit Breaker Structures (DCPP)”

6. WECC “Reliability Criteria”, Part 1, “NERC/WECC Planning Standards”

7. IEEE Standard 308-1971, Criteria for Class 1E Electric Systems for Nuclear Power Generation

8. NRC Letter to PG&E, dated December 14, 2009, Safety Evaluation, Diablo Canyon Power Plant, Unit Nos. 1 and 2 - Request for Technical Specification Interpretation of 230 Kilovolt System Operability (TAC Nos. ME0711 and ME0712).

8.2.7 REFERENCE DRAWINGS

Figures representing controlled engineering drawings are incorporated by reference and are identified in Table 1.6-1. The contents of the drawings are controlled by DCPP procedures.

8.3 ONSITE POWER SYSTEMS

The onsite power systems consist of all sources of electric power and their associated distribution systems within the DCPP. Included are the main generators, EDGs, and the Class 1E and non-Class 1E station batteries.

8.3.1 AC POWER SYSTEMS

As described in the introduction (refer to Section 8.1), the onsite ac systems consist of the 25-kV, 12-kV, 4.16-kV, and 480-V power systems, the 208Y/120-Vac lighting system, and the 120-Vac instrument supply systems.

8.3.1.1 Description

Auxiliary power for normal plant operation is supplied by each unit's main generators through the unit auxiliary transformers (refer to Figure 8.1-1), except during startups and shutdowns. Auxiliary power for startups and shutdowns is supplied by offsite power sources. If offsite power is unavailable, auxiliary shutdown power is furnished by the EDGs.

8.3.1.1.1 25-kV System

As described in Section 8.2.2.2, the auxiliary offsite power circuit consists of the 500-kV switchyard breakers 532, 542, 632 and 642 and lines to the main transformers and the portion of the 25-kV onsite distribution system which provide power to the onsite Class 1E 4.16-kV distribution system.

8.3.1.1.1.1 Design Bases

8.3.1.1.1.1.1 General Design Criterion 17, 1971 – Electric Power Systems

The auxiliary offsite power circuit provides a delayed access source of preferred power supply after the main generator is disconnected to assure specified fuel design limits and design conditions of the reactor coolant pressure boundary are not exceeded as a result of anticipated operation occurrences. The auxiliary offsite power circuit is available in sufficient time to safely shut down the plant following a loss of the normal onsite power source and the startup offsite power circuit.

8.3.1.1.1.1.2 General Design Criterion 18, 1971 – Inspection and Testing of Electric Power Systems

The 25-kV system design permits appropriate periodic inspection and testing of functional and operational performance of the system as a whole and under conditions as close to design as practical.

8.3.1.1.1.1.3 Single Failure Requirements

The preferred power supply has sufficient independence, capacity and testability to permit the operation of the ESF systems assuming a failure of a single active component.

8.3.1.1.1.1.4 10 CFR 50.63 - Loss of All Alternating Current Power

The 25-kV system is used for restoration of the preferred power supply following a SBO.

8.3.1.1.1.1.5 Safety Guide 32, August 1972 – Use of IEEE Standard 308-1971, Criteria for Class 1E Electrical Systems for Nuclear Power Generating Stations

Safety Guide 32, August 1972 identifies a conflict between IEEE 308-1971 and GDC 17, 1971 with respect to the time at which the delayed access offsite power circuit is required. Safety Guide 32, August 1972 supports a delayed access offsite power circuit provided that the availability of the delayed access offsite power circuit conforms to the requirements of GDC 17, 1971.

The auxiliary offsite power circuit provides a delayed access source of preferred power supply within sufficient time as required by GDC 17, 1971, after the main generator is disconnected.

8.3.1.1.1.2 System Description

The main electrical generator output voltage is 25-kV. Approximately 96 percent of the generated power is transformed to 500-kV at the main transformers, and the remainder is transformed to 12-kV and 4.16-kV at the unit auxiliary transformers. The portion of the 25-kV system which is part of the auxiliary offsite power circuit provides access to the 500-kV preferred power supply after the main generator is disconnected by operating the isophase bus motor operated generator disconnect switch.

8.3.1.1.1.3 Safety Evaluation

8.3.1.1.1.3.1 General Design Criterion 17, 1971 – Electric Power Systems

The portion of the 25-kV system which is part of the auxiliary offsite power circuit is designed to assure specified fuel design limits and design conditions of the reactor coolant pressure boundary are not exceeded in the event of the loss of the standby power source or the startup offsite power circuit. The capability and capacity of the auxiliary offsite power circuit is adequate to power both ESF and non-ESF functions (refer to Section 8.2.3.2).

8.3.1.1.1.3.2 General Design Criterion 18, 1971 – Inspection and Testing of Electric Power Systems

Periodic testing and surveillance of the 500-kV/25-kV main transformers and the 25-kV/4.16-kV transformers are part of the normal DCPP program for oil-filled transformers.

The DCPP surveillance program confirms the availability of the auxiliary offsite power circuit by verifying the correct 25-kV isolated phase bus MOD switch alignment and voltage levels.

8.3.1.1.1.3.3 Single Failure Requirements

A failure of a single active component in the 25-kV portion of the auxiliary offsite power circuit does not result in a complete loss of the preferred power supply (refer to Section 8.2.3.4(2)).

8.3.1.1.1.3.4 10 CFR 50.63 – Loss of All Alternating Current Power

The 25-kV system is a part of the auxiliary offsite power circuit used for restoration of the preferred power supply following a SBO. Refer to Section 8.3.1.6 for further discussion of SBO.

8.3.1.1.1.3.5 Safety Guide 32, August 1972 – Use of IEEE Standard 308-1971, Criteria for Class 1E Electrical Systems for Nuclear Power Generating Stations

The portion of the 25-kV system which is part of the auxiliary offsite power circuit provides access to the auxiliary offsite power circuit after the main generator is disconnected (refer to Section 8.2.3.6).

8.3.1.1.1.4 Tests and Inspections

Refer to 8.3.1.1.1.3.2 for test and inspection details.

8.3.1.1.1.5 Instrumentation Applications

Equipment monitoring instrumentation is provided for the 25-kV isophase bus and main transformer banks.

8.3.1.1.2 12-kV System

As described in Section 8.2.2.1, the startup offsite power circuit consists of the 230-kV switchyard breaker (212) and lines to the standby startup transformers and a portion of the 12-kV onsite distribution which provides power to the onsite Class 1E 4.16-kV distribution system.

8.3.1.1.2.1 Design Bases

8.3.1.1.2.1.1 General Design Criterion 2, 1967 – Performance Standards

The portion of the 12-kV system which provides input to the reactor trip system (RTS), UV relays and UF relays, is designed to withstand the effects of, or is protected against, natural phenomena such as earthquakes, tornadoes, flooding, winds, tsunamis, and other local site effects.

8.3.1.1.2.1.2 General Design Criterion 4, 1967 – Sharing of Systems

The 12-kV system and components are not shared by the DCPP units unless it is shown safety is not impaired by the sharing.

8.3.1.1.2.1.3 General Design Criterion 11, 1967 – Control Room

The 12-kV system is designed to or contains instrumentation and controls that support actions to maintain the safe operational status of the plant from the control room.

8.3.1.1.2.1.4 General Design Criterion 12, 1967 – Instrumentation and Control System

Instrumentation and controls are provided as required to monitor and maintain 12-kV system variables within prescribed operating ranges.

8.3.1.1.2.1.5 General Design Criterion 15, 1967 – Engineered Safety Features Protection Systems

The 12-kV system design provides input to the solid state protection system (SSPS) through bus monitoring UV and UF relays for the RCPs. The UV and UF relays monitor the 12-kV bus for accident situations through potential transformer (PT) sensing circuits.

8.3.1.1.2.1.6 General Design Criterion 17, 1971 – Electric Power Systems

The startup offsite power circuit is designed to provide an immediate access source of preferred power supply from the 230-kV switchyard to the ESF buses within a few seconds after a LOCA. A portion of the 12-kV system (from the standby startup transformer 11[21] through the standby startup transformer 12[22] to the 4.16-kV Class 1E buses) is designed with sufficient capacity and capability, and is immediately available to operate the ESFs following a design basis accident to assure that core cooling, containment integrity, and other vital safety functions are maintained.

8.3.1.1.2.1.7 General Design Criterion 18, 1971 – Inspection and Testing of Electric Power Systems

The 12-kV system design permits appropriate periodic inspection and testing of functional and operational performance of the system as a whole and under conditions as close to design as practical.

8.3.1.1.2.1.8 General Design Criterion 49, 1967 – Containment Design Basis

The 12-kV system circuits routed through containment electrical penetrations are designed to support the containment design basis such that the containment structure can accommodate, without exceeding the design leakage rate, pressure and temperatures following a LOCA.

8.3.1.1.2.1.9 Single Failure Requirements

The preferred power supply has sufficient independence, capacity and testability to permit the operation of the ESF systems assuming a failure of a single active component in the 12-kV system.

8.3.1.1.2.1.10 10 CFR 50.63 – Loss of All Alternating Current Power

The 12-kV system is a part of the auxiliary offsite power circuit used for restoration of the preferred power supply following a SBO.

8.3.1.1.2.1.11 Safety Guide 32, August 1972 – Use of IEEE Standard 308-1971 Criteria for Class 1E Electric Systems for Nuclear Power Generating Stations

Safety Guide 32, August 1972 identifies a conflict between IEEE 308-1971 and GDC 17, 1971 specifically with respect to the time at which the delayed access offsite power circuit is required. Safety Guide 32, August 1972 supports a delayed access offsite power circuit provided that the availability of the delayed access offsite power circuit conforms to the requirements of GDC 17, 1971.

The startup offsite power circuit is the immediate source of the preferred power supply following a design basis accident or unit trip.

8.3.1.1.2.1.12 Regulatory Guide 1.63, Revision 1, May 1977 – Electrical Penetration Assemblies in Containment Structures for Light-Water-Cooled Nuclear Plants

The 12-kV circuits routed through containment electrical penetrations are designed to the requirements of Regulatory Guide 1.63, Revision 1, regarding installation of redundant or backup fault current protection devices to limit fault current to less than that which the penetration can withstand, assuming a single random failure of the circuit overload protective device.

8.3.1.1.2.2 System Description

The 12-kV system for each unit is a three-phase, three-wire, high-resistance-grounded non-Class 1E system that serves two circulating water pumps and the four RCPs. The loads are divided into two groups, each served by a separate bus having two sources: one from the main generator through the unit auxiliary transformer 11(21) and one from the 230-kV transmission system through standby startup transformer 11(21), as shown in Figures 8.1-1, 8.3-1, 8.3-2, and 8.3-5.

Auxiliary buildings and other loads not associated with power generation are normally fed from two 12-kV circuit breakers on the startup bus of each unit.

The 12-kV system is provided with metalclad switchgear located indoors. Refer to Figures 8.1-1, 8.3-2, and 8.3-5 for detailed component ratings and vendor information. Each bus section is separated from the other by an aisle space, and each circuit breaker cubicle is separated from adjacent units by metal barriers. The 230-kV/12-kV standby startup transformer 11(21) LTCs are described in Section 8.2.2. A grounding transformer is provided on each 12-kV source. No ESF loads are served at 12-kV; however, the startup bus is part of the startup offsite power circuit between the 230-kV switchyard and the 4.16-kV Class 1E buses for each respective unit (refer to Figure 8.1-1).

8.3.1.1.2.3 Safety Evaluation

8.3.1.1.2.3.1 General Design Criterion 2, 1967 – Performance Standards

The 12-kV UV and UF circuits are contained within the PG&E Design Class II turbine building. This building or applicable portions have been designed not to impact PG&E Design Class I components and associated safety functions. Refer to Sections 3.2.1, 3.3.2.5.2.8, 3.4.2.1.1, 3.5.1.2, and 3.7.2.2.2.1 for additional information. Analyses have been performed to assure that the lack of seismic qualification and seismic installation of these inputs will not degrade the function of the RTS from these monitoring channels. Refer to Section 7.2.3.1 for additional discussion.

8.3.1.1.2.3.2 General Design Criterion 4, 1967 – Sharing of Systems

The 12-kV system is designed with cross-tie capability to align a single 230-kV/12-kV standby startup transformer (11 or 21) to provide power to both units via the cross-tie breaker. Operation in this configuration is restricted by Technical Specification. The shared portion of the 12-kV system is designed with sufficient capacity and capability to operate the ESFs for a design basis accident (or unit trip) on one unit, and those systems required for a concurrent safe shutdown of the second unit consistent with the requirements of IEEE 308-1971, Section 8 (Reference 3).

8.3.1.1.2.3.3 General Design Criterion 11, 1967 – Control Room

Each 12-kV bus feeder (i.e., unit auxiliary transformer and standby startup transformer) is provided with a voltmeter and ammeter mounted on the control room main control board for remote indication to facilitate actions that maintain the safe operational status of the plant.

8.3.1.1.2.3.4 General Design Criterion 12, 1967 – Instrumentation and Control Systems

The startup switchgear has internally mounted PTs and current transformers for maintaining and operating the 12-kV system within prescribed operating ranges through use of the 230-kV/12-kV standby startup transformer 11(21) LTC. Refer to Section 8.2.2.1 for additional discussion.

8.3.1.1.2.3.5 General Design Criterion 15, 1967 – Engineered Safety Features Protection Systems

The 12-kV system provides input to the SSPS for reactor protection through UV and UF sensors. Refer to Section 7.2.3.1 for additional discussion.

8.3.1.1.2.3.6 General Design Criterion 17, 1971 – Electric Power System

The DCPP offsite power system is designed to supply offsite electrical power by two physically independent circuits. The portion of the 12-kV system from the 230-kV/12-kV standby startup transformer 11(21) through the 12-kV/4.16-kV standby startup transformer 12(22) to the 4.16-kV Class 1E buses provide startup and standby power, and is immediately available following a design basis accident to assure that core cooling, containment integrity, and other vital safety functions are maintained. The portion of the 12-kV system which is part of the immediately available offsite power circuit is designed with sufficient capacity and capability to operate the ESFs following a design basis accident. The startup bus portion of the 12-kV system is included in the startup offsite power circuit and provides input to the startup transformer 11(21) LTC controller for voltage control. The capability of the 12-kV startup bus is adequate to power both ESF and non-ESF functions. Refer to Section 8.2.3.2.1 for additional discussion of capacity and capability of the startup offsite power circuit.

8.3.1.1.2.3.7 General Design Criterion 18, 1971 – Inspection and Testing of Electric Power Systems

Periodic testing and surveillance of the standby startup transformers and the 12-kV/4.16-kV transformers are part of the normal DCPP program for oil-filled transformers.

The DCPP surveillance program confirms the availability of the startup offsite power circuit by verifying the correct breaker alignments, voltage levels, and compensatory measures.

8.3.1.1.2.3.8 General Design Criterion 49, 1967 – Containment Design Basis

The 12-kV circuits routed through containment electrical penetrations are each provided with electrical protection devices. This arrangement is such that with the failure of one device, the penetration remains protected from high current temperature by the other in-series device to ensure the containment penetration remains functional (refer to Sections 3.8.2.1.1.3 and 8.3.1.4.8 for additional details).

8.3.1.1.2.3.9 Single Failure Requirements

A failure of a single active component in the 12-kV portion of the startup offsite power circuit does not result in a complete loss of the preferred power supply. Refer to Section 8.2.3.4(2).

8.3.1.1.2.3.10 10 CFR 50.63 – Loss of All Alternating Current Power

A portion of the 12-kV system is used as an attendant distribution system of the 230-kV offsite power circuits used for restoration of offsite power following a SBO event. The plant procedures for SBO and loss of offsite power (LOOP) use several different flow paths to restore ac power and place the plant in a safe, controlled cooldown. Refer to Section 8.3.1.6 for further discussion of SBO.

8.3.1.1.2.3.11 Safety Guide 32, August 1972 – Use of IEEE Standard 308-1971 Criteria for Class 1E Electric Systems for Nuclear Power Generating Stations

The portion of the 12-kV system from the standby startup transformer 11(21) through the standby startup transformer 12(22) to the 4.16-kV Class 1E buses provides startup and standby power, and is immediately available following a design basis accident or unit trip to assure that core cooling, containment integrity, and other vital safety functions are maintained. The immediately available 12-kV startup bus is continuously energized to support the immediate availability of the startup offsite power circuit (refer to Section 8.2.3.6.

8.3.1.1.2.3.12 Regulatory Guide 1.63, Revision 1, May 1977 – Electrical Penetration Assemblies in Containment Structures for Light-Water-Cooled Nuclear Plants

12-kV circuits routed through containment electrical penetrations are designed with redundant overcurrent protection. Refer to Section 8.3.1.4.8 for additional details.

8.3.1.1.2.4 Tests and Inspections

Refer to Section 8.3.1.1.2.3.7 for test and inspection details.

8.3.1.1.2.5 Instrumentation Applications

Refer to Section 8.3.1.1.2.3.4 for instrumentation applications.

8.3.1.1.3 4.16-kV System

8.3.1.1.3.1 Design Bases

8.3.1.1.3.1.1 General Design Criterion 2, 1967 – Performance Standards

The Class 1E portion of the 4.16-kV system is designed to withstand the effects of, or is protected against, natural phenomena such as earthquakes, tornadoes, flooding, winds, tsunamis, and other local site effects.

8.3.1.1.3.1.2 General Design Criterion 3, 1971 – Fire Protection

The Class 1E portion of the 4.16-kV system is designed and located to minimize, consistent with other safety requirements, the probability and effect of fires and explosions.

8.3.1.1.3.1.3 General Design Criterion 11, 1967 – Control Room

The Class 1E portion of the 4.16-kV system is designed to or contains instrumentation and controls that support actions to maintain the safe operational status of the plant from the control room or from an alternate location if control room access is lost due to fire or other causes.

8.3.1.1.3.1.4 General Design Criterion 12, 1967 – Instrumentation and Control Systems

Instrumentation and controls are provided as required to monitor and maintain 4.16-kV system variables within prescribed operating ranges.

8.3.1.1.3.1.5 General Design Criterion 17, 1971 – Electric Power Systems

The Class 1E portion of the 4.16-kV system is designed with sufficient capacity, capability, independence, redundancy, and testability to perform its safety function assuming a single failure.

8.3.1.1.3.1.6 General Design Criterion 18, 1971 – Inspection and Testing of Electric Power Systems

The Class 1E portion of the 4.16-kV system design permits appropriate periodic inspection and testing of functional and operational performance of the system as a whole and under conditions as close to design as practical.

8.3.1.1.3.1.7 General Design Criterion 21, 1967 – Single Failure Definition

The Class 1E portion of the 4.16-kV system is designed to remain operable after sustaining a single failure. Multiple failures resulting from a single event shall be treated as a single failure.

8.3.1.1.3.1.8 General Design Criterion 40, 1967 – Missile Protection

The portions of the Class 1E 4.16-kV system, that support ESF loads, are designed to be protected against dynamic effects and missiles that might result from plant equipment failures.

8.3.1.1.3.1.9 4.16-kV System Safety Function Requirements

(1) Protection from Missiles

The Class 1E portion of the 4.16-kV system is designed and located to be protected against the effects of missiles which may result from plant equipment failure and from events and conditions outside the plant.

(2) Protection Against High Energy Pipe Rupture Effects

The Class 1E portion of the 4.16-kV system is designed and located to accommodate the dynamic effects of a postulated high-energy pipe failure to the extent necessary to assure that a safe shutdown condition of the reactor can be accomplished and maintained.

(3) Protection from Moderate Energy Pipe Rupture Effects – Outside Containment

The outside containment Class 1E portion of the 4.16-kV system required to bring the plant to cold shutdown is designed to be protected against the effects of moderate energy pipe failure.

(4) Protection from Jet Impingement – Inside Containment

The inside containment Class 1E portion of the 4.16-kV system is designed to be protected against the effects of jet impingement which may result from high energy pipe rupture.

(5) Protection from Flooding Effects – Outside Containment

The outside containment Class 1E portion of the 4.16-kV system required to bring the plant to cold shutdown is to be protected from the effects of internal flooding.

8.3.1.1.3.1.10 10 CFR 50.49 – Environmental Qualification of Electrical Equipment Important to Safety for Nuclear Power Plants

The Class 1E 4.16-kV system electrical components that require EQ are qualified to the requirements of 10 CFR 50.49.

8.3.1.1.3.1.11 10 CFR 50.63 – Loss of All Alternating Current Power

The Class 1E 4.16-kV system provides power to the loads required to support systems that assure core cooling and containment integrity is maintained following a SBO event.

8.3.1.1.3.1.12 10 CFR 50.48(c) – National Fire Protection Association Standard NFPA 805

The Class 1E portion of the 4.16 kV System is designed to meet the nuclear safety and radioactive release performance criteria of Section 1.5 of NFPA 805, 2001 Edition.

8.3.1.1.3.1.13 Safety Guide 6, March 1971 – Independence Between Redundant Standby (Onsite) Power Sources and Between their Distribution Systems

The Class 1E portion of the 4.16-kV system is designed so that electrically powered loads are separated into redundant load groups such that loss of any one group will not prevent the minimum safety functions from being performed.

8.3.1.1.3.1.14 Regulatory Guide 1.97, Revision 3, May 1983 – Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant and Environs Conditions During and Following an Accident

The 4.16-kV system provides instrumentation in the control room to monitor 4.16-kV system electrical status for post-accident instrumentation.

8.3.1.1.3.2 System Description

The 4.16-kV system is a three-phase, three-wire, high-resistance-grounded neutral system that serves motors from 200 to 3000 hp, and transformers for the smaller loads at the lower voltages. The Class 1E 4.16-kV distribution system provides power to ESF loads to safely shut down the unit. The 4.16-kV loads are divided into five groups; two of these groups are not vital to the ESFs and are connected to non-Class 1E 4.16-kV Buses D and E. Each of the non-Class 1E buses has two sources of preferred power supply: one from the main generator (or the 500-kV system through the main transformer) through the 25-kV/4.16-kV unit auxiliary transformer 12(22), and one from the 230-kV transmission system through the 230-kV/12-kV standby startup transformers 11(21) and 12-kV/4.16-kV standby startup transformers 12(22) (refer to Figures 8.1-1, 8.3-3, and 8.3-5). Utility power for the 230-kV and 500-kV switchyards is provided from the Unit 1, non-Class 1E, 4.16-kV switchgear Buses D and E, respectively. Refer to Sections 8.2.2.1 (230-kV system) and 8.2.2.2 (500-kV system) for further discussion.

The other three load groups are important to safety and are connected to 4.16-kV Class 1E Buses F, G, and H. Each of these buses has three sources: two being the immediate and delayed preferred power supply, and the standby power supply from the diesel-driven generators (refer to Figures 8.3-3 and 8.3-4).

As noted in Section 8.2.3.2, compensatory action will be taken as necessary to ensure that the ESF motor terminal voltages are within their acceptable voltage tolerance (typically $\pm$10 percent) when fed from the preferred power supply. Once started, the motors will operate with applied voltages as low as 70 percent of rated voltage without breakdown, but the time is limited because of motor heating.

The 4.16-kV system is provided with metal clad switchgear and breakers rated at 350-MVA interrupting capacity, and 78,000 amperes of closing and latching capability. The circuit breakers are in individual cubicles, each separated from the adjacent circuit breakers by metal barriers. All 4.16-kV switchgear is located in the turbine building. The non-Class 1E 4.16-kV switchgear is located in the same room as the 12-kV switchgear and have the two bus sections separated by a common aisle. The Class 1E 4.16-kV switchgear is located in rooms separated from each other and from non-Class 1E equipment (refer to Figures 1.2-14 through 1.2-16 and 1.2-18 through 1.2-20).

The unit auxiliary and standby startup transformers are equipped with an automatic water spray deluge system that can be manually actuated locally at the system valves or remotely from the control room (refer to Section 9.5.1.2.4).

8.3.1.1.3.3 Safety Evaluation

8.3.1.1.3.3.1 General Design Criterion 2, 1967 – Performance Standards

The Class 1E 4.16-kV switchgear and associated 4.16-kV/120-Vac PTs and safeguard relay boards are located in the PG&E Design Class II turbine building. This building, or applicable portions thereof, has been designed not to impact PG&E Design Class I components and associated safety functions (refer to Section 3.7.2.2.2). The turbine building is designed to withstand the effects of winds and tornadoes (refer to Section 3.3.1.2 and 3.3.2.5.2.8), floods and tsunamis (refer to Section 3.4), external missiles (refer to Section 3.5), and earthquakes (refer to Section 3.7.2.2.2) to protect the Class 1E 4.16-kV switchgear and associated 4.16-kV/120-Vac PTs and safeguard relay boards, ensuring their design function will be performed.

The 4.16-kV switchgear and associated 4.16-kV/120-Vac PTs and safeguard relay boards are seismically designed to perform their safety functions under the effects of earthquakes (refer to Section 3.10.3.7).

8.3.1.1.3.3.2 General Design Criterion 3, 1971 – Fire Protection

The Class 1E 4.16-kV switchgear and cable spreading room are designed to meet the requirements of 10 CFR 50.48(a) and (c) (refer to Section 9.5.1).
Refer to Section 8.3.1.4.9 for further discussion on fire barriers and separation.

8.3.1.1.3.3.3 General Design Criterion 11, 1967 – Control Room

The Class 1E 4.16-kV supply and load breakers are controlled remotely from the main control room and locally at their respective switchgear cubicles. The supply breaker for each Class 1E load center transformer is equipped with an isolation switch, located at the switchgear that disconnects breaker control from the control room in the event that the main control room is rendered uninhabitable. The HSP, which is the alternate control location in the event that the main control room is rendered uninhabitable, is provided with a mode switch, control switch and status indication for each of the pumps required to bring the plant to a safe shutdown condition. It is also provided with a voltage indication of each Class 1E 4.16-kV bus. Transfer switches are located in the Class 1E 4.16-kV switchgear cubicles to isolate 4.16-kV circuit breaker control cables between the main control room and the switchgear and transfer control of the breaker locally to the HSP or the switchgear. Alarms are provided in the control room to monitor the status of the 4.16-kV system and alert the plant when an abnormal condition is detected. Refer to Section 8.3.1.1.3.3.4 for additional instrumentation and control information.

8.3.1.1.3.3.4 General Design Criterion 12, 1967 – Instrumentation and Control Systems

Control switches, status indication and ammeters are provided in the main control room and at the respective switchgear cubicle for all the motor load and load center transformer feeder breakers. Additionally, watt and var meters are provided for each load center transformer feeder in the main control room as well as voltage indication for each 4.16-kV bus.

The unit auxiliary and standby startup transformers feeding the 4.16-kV buses are provided with an ammeter, voltmeter, wattmeter, varmeter, watt-hour meter and an indicating light in the main control room.

8.3.1.1.3.3.5 General Design Criterion 17, 1971 – Electric Power Systems

Each unit's Class 1E 4.16-kV distribution system is comprised of three electrically independent and redundant load groups. Each Class 1E switchgear, including its associated relay board, is located in separate rooms and meets the single failure criteria. If a single failure occurs in any of the three load groups, the remaining load groups have sufficient capability and capacity to provide power to ESF loads required to safely shut the unit down.

Each load group is normally supplied power from the main generator via the unit auxiliary transformer. In the event of a unit trip or accident condition, the power source to each Class 1E, 4.16-kV switchgear is automatically transferred to the immediate preferred power source via the standby startup transformers 11 and 12 (21 and 22) in series. If the transfer to the standby startup transformer is unsuccessful or if there is a loss of voltage or degraded voltage from the standby startup transformer, UV protection for each Class 1E 4.16-kV bus is provided by the first level UV relays (FLUR) and second level UV relays (SLUR). These sets of relays and associated timers start the EDG, perform a load shed on its respective bus and transfer loading to the EDG in the event the preferred power supply is unavailable or in a degraded condition (refer to Figure 8.3-16).

8.3.1.1.3.3.5.1 Class 1E Bus Undervoltage Protection Design Criteria

The emergency electric power system including each Class 1E bus and its control, protection, and instrumentation is designed in accordance with IEEE 308-1971 (Reference 3), IEEE 279-1971 (Reference 4), and the following supplemental NRC positions regarding the susceptibility to sustained degraded voltage conditions and the interaction of the preferred power supply and standby power supply (Reference 26).

(1) Second Level UV Protection with Time Delay:

A second level of voltage protection for the onsite power system is provided (i.e., in addition to loss of voltage protection). The preferred power supply is the common source that normally supplies power to the redundant Class 1E buses. Any transient or sustained degradation of this common source will be reflected onto the onsite Class 1E electrical distribution system. A sustained degradation of the preferred power supply voltage could result in the loss of capability of the redundant safety loads, their control circuitry, and the associated electrical components required for performing safety functions. The following requirements ensure adequate protection from this common mode failure mechanism:

(a) The selection of voltage and time set points are based on an analysis of the voltage requirements of the safety related loads at all onsite system distribution levels;

(b) The voltage protection includes coincidence logic to preclude spurious trips of the preferred power supply;

(c) The time delay selection is based on the following conditions:

i) The allowable time delay, including margin, does not exceed the maximum time delay that is assumed in the accident analyses;

ii) The time delay minimizes the effect of short duration disturbances from reducing the availability of the preferred power supply;

iii) The allowable time duration of a degraded voltage condition at all distribution system levels does not result in failure of safety systems or components;

(d) The voltage sensors automatically initiate the disconnection of the preferred power supply whenever the voltage set point and time delay limits have been exceeded; and

(e) The voltage sensors are designed to satisfy the applicable requirements of IEEE 279-1971 (Reference 4).

(2) Interaction of Onsite Power Supplies with Load Shed Feature:

The second level UV logic (i.e., degraded grid) input to the load shed feature for each Class 1E 4.16-kV bus is inhibited when the EDG output breaker is closed and the auxiliary preferred power supply feeder breaker is open (i.e., bus is solely energized by the standby power supply). The second level UV logic input to the load shed feature is also inhibited when EDG is paralleled to the startup preferred power supply. The second level UV logic input to the load shed feature is automatically reinstated when the EDG output breaker opens.

8.3.1.1.3.3.5.2 Operation of 4.16-kV Distribution System

The ESF loads and their onsite sources are grouped so the functions required during a major accident are provided regardless of any single failure in the electrical system. Any two of the three diesel generators and their buses are adequate to serve at least the minimum required ESF loads of a unit after a major accident.

During normal operation, the main generator supplies the auxiliary load for each unit. The circuit breakers on 4.16-kV Class 1E Buses F, G, and H, which feed the ESFs, are aligned as follows:

(1) 4.16-kV circuit breakers that are open:

(a) Diesel-driven generators

(b) Standby startup Transformer 12 (22)

(c) SI pumps

(d) Containment spray pumps

(e) AFW pumps

(f) Residual heat removal pumps

(2) 4.16-kV circuit breakers that are closed:

(a) Unit auxiliary transformer 12 (22)

(b) 4.16-kV/480-V Class 1E load centers that provide power for pumps, fans, valves, and other low-voltage devices

(3) 4.16-kV circuit breakers that may be either open or closed, depending on the operating conditions of the following pumps:

(a) Charging pumps

(b) ASW pumps

(c) CCW pumps

To achieve the objective of an adequate source of electrical power for the Class 1E 4.16-kV Buses F, G, and H, the electrical systems are designed to operate as follows:

In the event of a loss of satisfactory electrical power from the main generating unit, due to a unit trip, a safeguard signal, or a loss of voltage on the bus, the Class 1E 4.16-kV buses are automatically disconnected immediately from the main unit as a source.

If power is available from the startup offsite power circuit, the Class 1E 4.16-kV buses are transferred to this source automatically after a short delay to allow for voltage decay on the motors that were running.

The delayed method of transfer is used to protect the ESF motors from overvoltage transients. The advantage of motor protection is greater than any disadvantage of reduced operating capacity during the short delay period, especially in view of the fact that when there is also a loss of startup offsite power circuit, the delay in transferring to emergency power is on the order of 10 seconds (the time for the diesel generators to reach minimum bus voltage) plus load sequencing. Schematic diagrams of the automatic transfer circuits for the ESF buses are presented in Figures 8.3-9 through 8.3-11; logic diagrams are shown in Figure 8.3-16.

Because the individual loads are not tripped under these circumstances, they remain in the same operating state as before the transfer, except for the low-voltage loads operated by magnetic controllers having no maintained contact control circuits, such as the containment fan coolers. Without an SIS signal, individual timers start the containment fan coolers and the ASW pump. The containment fan coolers would operate at the low speed after the transfer of the Class 1E power supply. With an SIS signal, the Class 1E loads are started in sequence in the same manner as with the diesel generators. As noted in Table 8.3-4, an SIS signal only allows the containment fan coolers to start on low speed.

Also, if bus voltage is not restored, the associated diesel generator is started automatically and brought to a condition suitable for loading.

Each of the following initiates the starting of the diesel generators:

(1) A SI actuation signal from either Train A or B of the ESF actuation system.

(2) UV on the startup offsite power circuit to each of the Class 1E 4.16-kV buses start its respective diesel.

(3) Sustained UV or loss of voltage on any of the Class 1E 4.16-kV buses starts its respective diesel.

In each case, an independent set of signals or relays is applied to start the diesel for its bus. The first level UV relay (initiating load shedding signal) for the startup offsite power circuit of each Class 1E 4.16-kV bus has inverse time characteristics and a slight delay upon complete voltage failure. The first level UV relay has three select voltages and time delay settings, with the lowest being set at approximately 818-V.

The second level of UV protection for each Class 1E 4.16-kV bus is set at approximately 3800-V. The protection consists of two relays for each bus having a two-out-of-two logic arrangement. Start of the respective diesel is delayed by 10 seconds. Bus loads are shed in 20 seconds, and bus transfer to the diesel generator takes place in 22 seconds. These timing features will prevent needless diesel starts during transient voltage dips, and provide adequate time delay for the startup offsite power circuit voltage to recover before transferring the bus to the diesel generator.

Should there be a loss of the startup offsite power circuit concurrent with the loss of onsite power (i.e., the main generating unit), the following events occur automatically, initiated by the first level of UV protection:

(1) The 4.16-kV circuit breaker feeding the Class 1E 4.16-kV Buses F, G, and H from the main generating unit is opened immediately.

(2) All three diesel generators for the unit are started and accelerated to minimum required frequency and bus voltage in a period of less than 10 seconds.

(3) Should the startup offsite power circuit be restored before the diesel auto-transfer interlock relay actuates, the circuit breakers feeding the Class 1E

4.16-kV Buses F, G, and H from the startup offsite power circuit are closed to restore power to the loads. First-level UV relays have already shed loads. Loads, including certain ESF loads that may not have been operating, are started in the same manner and sequence as when fed from the diesel generator. The preferred power supply may be restored by reclosing the circuit breakers for the 230-kV transmission lines automatically and/or manually at Morro Bay switchyard under the control of the CAISO (refer to Section 8.2.3.2).

Should the startup offsite power circuit still be unavailable when the diesel generators have reached breaker close-in voltage, all circuit breakers from the standby power supply and startup offsite power circuit to these Class 1E 4.16-kV buses are given a trip signal independently to make sure they are open (the expected condition at this point). The startup offsite power circuit is automatically blocked from reclosing. The circuit breakers for all loads, except the 4.16-kV/480-V load center transformers, have already been opened by the first level UV relays. Each of the Class 1E 4.16-kV buses has a separate pair of these relays. The relays have a two-out-of-two logic arrangement for each bus to prevent inadvertent tripping of operating loads during a loss of voltage either from a single failure in the potential circuits or from human error. Also, one of the relays has an inverse time characteristic and a slight delay of about 4 seconds at no voltage to prevent loss of operating loads during transient voltage dips, and to permit the startup offsite power circuit to pick up the load.

The Class 1E buses are then isolated from the rest of the plant, and from each other, and therefore operate independently. Any required or desired bus interconnecting is done manually by the operator.

The 4.16-kV circuit breaker for each diesel generator then closes automatically to restore power to the Class 1E 4.16-kV bus, and, consequently, the 480-V and 120-Vac buses also. All 4.16-kV circuit breakers have stored-energy closing mechanisms and close in less than 0.1 seconds.

The loads that remain connected to the 480-V buses become energized at the same time as the buses (refer to Section 8.3.1.1.4). These loads are within the initial load pickup capability of the diesel generators and are composed of the Class 1E lighting, the battery chargers, etc.

Other 480-V and 120-Vac equipment that can also operate immediately are those that are under automatic process control, and those under control of the protection system for the ESFs.

When the bus voltage is restored by the diesel generators, the UV relays that previously had tripped the loads will reset automatically. The individual loads are put into operation in a staggered sequence to reduce the effects of momentary loads and motor starting on the diesel generators (refer to Technical Specifications [Reference 5]). The timing sequences have been given a nominal 4-second interval between steps during an SI signal, and a nominal 2 to 6 seconds between steps without an SI signal. The overall time to complete starting of all Class 1E loads is limited to less than 1 minute. The remaining loads can then be put into operation as desired.

The timing sequence for each Class 1E bus is initiated only when voltage is restored to the bus. When the startup offsite power circuit is available, power to the buses is restored in a few seconds when the residual voltage on the motors drops to 25 percent of normal. Otherwise, the delay is the time required for the diesel generators to transfer to the bus (shed loads and reach the minimum bus voltage, approximately 10 seconds or less).

To improve independence of control and to provide flexibility in setting the delays, individual adjustable timing relays are used for each motor. In addition, separate sets of these timing relays are used, depending on the presence or absence of the SI signal, so that response can be optimized for each condition. Should there be a second-level degraded grid condition, where the voltage of the Class 1E 4.16-kV buses remains at approximately 3,800-V or below, but above the setpoints of the first-level UV relays, the following events occur automatically within the time periods stated in the Technical Specifications:

(1) After the specified time delay, the respective diesel generators will be started.

(2) After the next specified time delay, if the UV condition persists, the circuit breakers for all loads to the respective Class 1E 4.16-kV buses, except the 4.16-kV/480-V load center transformer, are opened.

(3) Then the 4.16-kV circuit breakers from the normal onsite power source is given a trip signal to open the breaker feeding the bus and the standby power source breaker is already open, and then the circuit breaker for each respective diesel generator is closed.

(4) Restoration of normal voltage to the Class 1E 4.16-kV buses, supplied by the individual diesel generators, actuates timers that put loads back into operation in a staggered sequence.

Each Class 1E 4.16-kV bus has its own set of second level UV relays and associated timers causing the above sequences. Again, the Class 1E buses are now isolated from each other and from the rest of the plant and operate independently. Any required or desired bus interconnection has to be done manually by the operator. The transfer and subsequent operation of the Class 1E buses, because of degraded grid UV protection, is the same as described above for loss of the startup offsite power circuit concurrent with a loss of onsite power. However, no attempt will be made to transfer to the startup offsite power circuit. Switching directly to the diesel generators ensures fast restoration of reliable power to the Class 1E 4.16-kV buses.

The logic used in starting and loading the EDGs is shown in Figure 8.3-16. Schematic diagrams of these functions are shown in Figures 8.3-12 through 8.3-14. A schematic diagram of the potential and synchronizing circuitry for the Class 1E buses is shown in Figure 8.3-20.

The starting inrush and momentary loads that occur during the initial phases of each interval will be handled by the short-time overload capability of the diesel generators. The diesel generators can maintain the electric power frequency and voltage at satisfactory levels during the cumulative loading of the successive steps.

The engine has an adequate short-time overload capability along with a fast response governor to hold the frequency. The generator has a low subtransient reactance and a voltage regulator with a fast response and a high excitation ceiling that will hold the voltage to a minimum of 75 percent of nominal during motor starting.

The Class 1E 4.16-kV/480-V load centers are left connected to their buses and are, therefore, energized first. Their initial load will consist of the momentary loads of the equipment that was left on, in addition to those initiated during the interruption. The net initial load on the load center consists of those loads that operate for a short time, such as motor operated valves, auxiliary lube oil pumps, etc., and the normal steady-state values for the remainder.

The starting loads of the larger motors that are started subsequently have also been included in the capabilities of the diesel generators.

8.3.1.1.3.3.5.3 4.16-kV Emergency Loads

In the event of an emergency shutdown of the main generating unit in the absence of the preferred power supply, the loads supplied by the diesel generator are applied in the following manner:

(1) In the absence of a SI signal, the first set of timing relays will operate and start the loads listed:

 (a) The timing sequence and intervals are listed in Table 8.3-2. Notes for Table 8.3-2 and others in Section 8.3 are listed in Table 8.3-1.

 (b) The loading on the Class 1E 4.16-kV buses, immediately following a unit shutdown without a LOCA, is as listed in Table 8.3-3.

(2) In the presence of a SI signal, the second set of timing relays operate and start the loads for the injection phase as listed in Table 8.3-4.

(3) The loading on the Class 1E 4.16-kV buses immediately following a unit shutdown, concurrent with a LOCA, is as listed in Table 8.3-5.

(4) The loading of the Class 1E 4.16-kV/480-V load centers, following a unit shutdown, with or without a LOCA, is as detailed on Figures 8.3-6 through 8.3-8.

8.3.1.1.3.3.6 General Design Criterion 18, 1971 – Inspection and Testing of Electric Power Systems

Surveillance tests and inspections are performed periodically to demonstrate the 4.16-kV system's design basis requirements are met. The controls for the 4.16-kV system are designed to be capable of periodic testing to assure operational and functional performance of the Class 1E components and operability of the system as a whole.

8.3.1.1.3.3.7 General Design Criterion 21, 1967 – Single Failure Definition

Each unit's Class 1E 4.16-kV distribution system is comprised of three electrically independent and redundant (refer to Section 8.3.1.4) Class 1E buses enclosed in separate rooms. If a single failure occurs in any of the three buses, the remaining buses have sufficient capability to provide power to ESF loads required to safely shut down the unit.

8.3.1.1.3.3.8 General Design Criterion 40, 1967 – Missile Protection

The portions of the Class 1E 4.16-kV system that support ESF loads and are located in zones where provision against dynamic effects must be made, are protected from missiles, pipe whip, or jet impingement from the rupture of any nearby high-energy line (refer to Sections 3.5, 3.6, 8.3.1.4.10.2, and 8.3.1.4.10.3).

8.3.1.1.3.3.9 4.16-kV System Safety Function Requirements

(1) <u>Protection from Missiles</u>

The provisions taken to protect the Class 1E portion of the 4.16-kV system from missiles resulting from plant equipment failures and from events and conditions outside the plant are discussed in Sections 3.5 and 8.3.1.4.10.2.

(2) <u>Protection Against High Energy Pipe Rupture Effects</u>

The provisions taken to protect the Class 1E portion of the 4.16-kV system from damage that might result from dynamic effects associated with a postulated rupture of high-energy piping are discussed in Sections 3.6 and 8.3.1.4.10.3.

(3) Protection from Moderate Energy Pipe Rupture Effects – Outside Containment

The provisions taken to provide protection of the Class 1E portion of the 4.16-kV system located outside containment from the effects of moderate energy pipe failure are discussed in Section 3.6.

(4) Protection from Jet Impingement – Inside Containment

The provisions taken to provide protection of the Class 1E portion of the 4.16-kV system located inside containment from the effects of jet impingement which may result from high energy pipe rupture are discussed in Section 3.6 and 8.3.1.4.10.3.

(5) Protection from Flooding Effects – Outside Containment

The provisions taken to provide protection of the Class 1E portion of the 4.16-kV system located outside containment from flooding that might result from the effects associated with a postulated rupture of piping are discussed in Section 3.6.

8.3.1.1.3.3.10 10 CFR 50.49 – Environmental Qualification of Electrical Equipment Important to Safety for Nuclear Power Plants

The Class 1E 4.16-kV system SSCs required to function in harsh environments under accident conditions are qualified to the applicable environmental conditions to ensure that they will continue to perform their safety functions. Section 3.11 describes the DCPP EQ program and the requirements for the environmental design of the electrical and related mechanical equipment. The affected components are listed in the EQ Master List.

8.3.1.1.3.3.11 10 CFR 50.63 – Loss of All Alternating Current Power

The Class 1E portion of the 4.16-kV system serves to distribute power to loads required to bring the plant to a safe shutdown condition (Mode 3) following a SBO. Refer to Section 8.3.1.6 for further discussion on SBO.

8.3.1.1.3.3.12 10 CFR 50.48(c) – National Fire Protection Association Standard NFPA 805

The Class 1E 4.16-kV system is designed to meet the nuclear safety and radioactive release performance criteria of Section 1.5 of NFPA 805, 2001 Edition (refer to Section 9.5.1).
Refer to Section 8.3.1.4.10.1 for additional discussion.

8.3.1.1.3.3.13 Safety Guide 6, March 1971 – Independence Between Redundant Standby (Onsite) Power Sources and Between their Distribution Systems

The three Class 1E 4.16-kV buses are physically enclosed in separate rooms and are electrically independent from each other when powered from their respective EDGs. Refer to Section 8.3.1.4 for further discussion on independence of redundant systems.

8.3.1.1.3.3.14 Regulatory Guide 1.97, Revision 3, May 1983 – Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant and Environs Conditions During and Following an Accident

Class 1E, Category 2 indication for each of the Class 1E 4.16-kV bus voltage and load center transformer primary amperage is provided in the control room for Regulatory Guide 1.97, Revision 3, monitoring (refer to Table 7.5-6).

8.3.1.1.3.4 Tests and Inspections

Refer to Section 8.3.1.1.3.3.6 for test and inspections details.

8.3.1.1.3.5 Instrumentation Applications

Refer to Section 8.3.1.1.3.3.4 for instrumentation details.

8.3.1.1.4 480-V System

8.3.1.1.4.1 Design Bases

8.3.1.1.4.1.1 General Design Criterion 2, 1967 – Performance Standards

The Class 1E portion of the 480-V system is designed to withstand the effects of, or is protected against, natural phenomena such as earthquakes, tornadoes, flooding, winds, tsunamis, and other local site effects.

8.3.1.1.4.1.2 General Design Criterion 3, 1971 – Fire Protection

The Class 1E portion of the 480-V system is designed and located to minimize, consistent with other safety requirements, the probability and effect of fires and explosions.

8.3.1.1.4.1.3 General Design Criterion 4, 1967 – Sharing of Systems

The 480-V system or components are not shared by the DCPP units unless it is shown safety is not impaired by the sharing.

8.3.1.1.4.1.4 General Design Criterion 11, 1967 – Control Room

The Class 1E portion of the 480-V system is designed to or contains instrumentation and controls that support actions to maintain the safe operational status of the plant from the control room or from an alternate location if control room access is lost due to fire or other causes.

8.3.1.1.4.1.5 General Design Criterion 12, 1967 – Instrumentation and Control Systems

Instrumentation and controls are provided as required to monitor and maintain 480-V system variables within prescribed operating ranges.

8.3.1.1.4.1.6 General Design Criterion 17, 1971 – Electric Power Systems

The Class 1E portion of the 480-V system is designed to have sufficient capacity, capability, independence, redundancy, and testability to perform its safety function assuming a single failure.

8.3.1.1.4.1.7 General Design Criterion 18, 1971 – Inspection and Testing of Electric Power Systems

The Class 1E portion of the 480-V system design permits appropriate periodic inspection and testing of functional and operational performance of the system as a whole and under conditions as close to design as practical.

8.3.1.1.4.1.8 General Design Criterion 21, 1967 – Single Failure Definition

The Class 1E portion of the 480-V system is designed to remain operable after sustaining a single failure. Multiple failures resulting from a single event shall be treated as a single failure.

8.3.1.1.4.1.9 General Design Criterion 40, 1967 – Missile Protection

The portions of the Class 1E 480-V system that support ESF loads are designed to be protected against dynamic effects and missiles that might result from plant equipment failures.

8.3.1.1.4.1.10 General Design Criterion 49, 1967 – Containment Design Basis

The Class 1E and non-Class1E 480-V circuits routed through containment electrical penetrations are designed to support the containment design basis such that the containment structure can accommodate, without exceeding the design leakage rate, pressures and temperatures following a LOCA.

8.3.1.1.4.1.11 480-V System Safety Function Requirements

(1) Protection from Missiles

The Class 1E portion of the 480-V system is designed and located to be protected against the effects of missiles which may result from plant equipment failure and from events and conditions outside the plant.

(2) Protection Against High Energy Pipe Rupture Effects

The Class 1E portion of the 480-V system is designed and located to accommodate the dynamic effects of a postulated high-energy pipe failure to the extent necessary to assure that a safe shutdown condition of the reactor can be accomplished and maintained.

(3) Protection from Moderate Energy Pipe Rupture Effects – Outside Containment

The outside containment Class 1E portion of the 480-V system required to bring the plant to cold shutdown is designed to be protected against the effects of moderate energy pipe failure.

(4) Protection from Jet Impingement – Inside Containment

The inside containment Class 1E portion of the 480-V system is designed to be protected against the effects of jet impingement which may result from high energy pipe rupture.

(5) Protection from Flooding Effects – Outside Containment

The outside containment Class 1E portion of the 480-V system required to bring the plant to cold shutdown is to be protected from the effects of internal flooding.

8.3.1.1.4.1.12 10 CFR 50.49 – Environmental Qualification of Electrical Equipment

The 480-V system electrical components that require EQ are qualified to the requirements of 10 CFR 50.49.

8.3.1.1.4.1.13 10 CFR 50.63 – Loss of All Alternating Current Power

The Class 1E 480-V system provides power to the loads required to support systems that ensure core cooling and containment integrity is maintained following a SBO event.

8.3.1.1.4.1.14 10 CFR 50.48(c) – National Fire Protection Association Standard NFPA 805

The Class 1E portion of the 480-V system is designed to meet the nuclear safety and radioactive release performance criteria of Section 1.5 of NFPA 805, 2001 Edition.

8.3.1.1.4.1.15 Safety Guide 6, March 1971 – Independence Between Redundant Standby (Onsite) Power Sources and Between their Distribution Systems

The Class 1E portion of the 480-V system is designed such that electrically powered loads are separated into redundant load groups such that loss of any one group will not prevent the minimum safety functions from being performed.

8.3.1.1.4.1.16 Regulatory Guide 1.63, Revision 1, May 1977 – Electric Penetration Assemblies in Containment Structures for Light-Water-Cooled Nuclear Plants

The Class 1E and non-Class1E 480-V circuits routed through containment electrical penetrations are designed to meet the requirements of Regulatory Guide 1.63, Revision 1, for the installation of redundant or backup fault current protection devices. The protection devices are designed to limit fault current to less than which the penetration can withstand assuming a single random failure of the circuit overload protective device.

8.3.1.1.4.1.17 Regulatory Guide 1.97, Revision 3, May 1983 – Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant and Environs Conditions During and Following an Accident

The 480-V system provides instrumentation in the control room to monitor 480-V system electrical status for post-accident instrumentation.

8.3.1.1.4.1.18 NUREG-0737 (Items II.E.3.1 (1) and II.G.I (2)), November 1980 – Clarification of TMI Action Plan Requirements

Item II.E.3.1 (1) – Emergency Power for Pressurizer Heaters: The non-Class 1E pressurizer heater power supply design provides the capability to supply, from either the preferred offsite power source or the standby power source (when offsite power is not available), to a predetermined number of pressurizer heaters and associated controls necessary to establish and maintain natural circulation at hot standby conditions. The required heaters and their controls are connected to the Class 1E emergency buses in a manner that will provide redundant power supply capability.

Item II.G.1 (2) – Emergency Power for Pressurizer Equipment: Motive and control components associated with the power operated relief valve (PORV) block valves are capable of being supplied from either the preferred offsite power source or the standby power source when the offsite power is not available.

8.3.1.1.4.2 System Description

The 480-V system is a three-phase, three-wire, ungrounded system that provides power to motors not greater than 350 hp, lighting and electric heating systems, battery chargers, and instrument and control systems.

The 480-V loads are served from the 4.16-kV buses through 4.16-kV/480-V transformers closely coupled to either metal-enclosed low voltage switchgear or to motor control centers (MCCs). Five transformers in a duplex arrangement are provided for the non-Class 1E 480-V loads; two in the turbine building, two in the auxiliary building, and one at the intake structure. Three additional transformers, connected radially, are provided for the Class 1E 480-V loads, and the units are isolated from each other to maintain separation for the redundant Class 1E loads (refer to Figures 1.2-6, 1.2-8, 1.2-14, 1.2-16, 1.2-18, 1.2-20, and 8.3-6 through 8.3-8).

8.3.1.1.4.2.1 Maximum Demand

The loading on the Class 1E 480-V load centers immediately following a unit shutdown is as detailed on Figures 8.3-6 through 8.3-8. About 40 minutes after a major accident, the manual change-over of certain Class 1E bus loads to support the recirculation phase would be completed.

8.3.1.1.4.2.2 Pressurizer Equipment Power Supplies

Pressurizer equipment power supplies are designed to meet the requirements of GDC 17, 1971 and NUREG-0737 (Reference 2) in the event of LOOP. For further discussion of pressurizer equipment, refer to Section 5.5.9.

8.3.1.1.4.2.2.1 Pressurizer Heaters

The four pressurizer heater groups are normally connected to non-Class 1E 480-V power sources. All of the four pressurizer heater groups can be supplied with power from the offsite power sources when they are available.

When offsite power is not available, power can be provided to two out of four heater groups from the emergency power system (refer to Section 8.3.1.1.6) through Class 1E Buses G and H (refer to Figure 8.3-19). Sufficient power (150 kW) is available from the Class 1E buses to energize enough heaters to maintain natural circulation at hot standby conditions. Redundancy is provided by supplying the two groups of heaters from the different Class 1E buses. The ability to supply emergency power to the heaters minimizes a potential loss of subcooling in the reactor coolant system after a LOOP.

Transfer of pressurizer heater power supplies can be performed manually (in accordance with operating procedures) in less than 60 minutes using manual transfer switches located at the 100-foot elevation in the auxiliary building. Since the pressurizer heaters are non-Class 1E loads, they are automatically tripped off of the Class 1E buses upon occurrence of a SI actuation signal. Breaker and switchgear equipment interfacing the pressurizer heaters with the Class 1E buses is Class 1E and seismically qualified.

8.3.1.1.4.2.3 Lighting

Normal lighting is operated at 208Y/120-Vac, three-phase, on a four-wire solidly grounded system supplied from the 480-V system through dry-type, delta-wye connected, 3-phase transformers.

The ac emergency lighting is supplied from two of the three Class 1E 480-V buses. Emergency lighting is located throughout the plant to provide minimum general lighting during a failure of normal lighting. Direct current emergency lighting is operated at 125-Vdc from the non-Class 1E station batteries.

ESF equipment areas and various access routes thereto are provided with individual BOLs capable of providing 8 hours of illumination when ac power to the BOL is lost. The batteries are continuously charged with a built-in charger. Rack area uninterruptible power supply (UPS) lighting is provided for the same purpose.

Refer to Section 9.5.3 for requirements for battery operated lights.

8.3.1.1.4.3 Safety Evaluation

8.3.1.1.4.3.1 General Design Criterion 2, 1967 – Performance Standards

The Class 1E 480-V load center transformers and switchgear are located at 100 foot elevation of the auxiliary building, a PG&E Design Class I structure (refer to Figure 1.2-6). The auxiliary building is designed to withstand the effects of winds and tornadoes (refer to Section 3.3), floods and tsunamis (refer to Section 3.4), external missiles (refer to Section 3.5), and earthquakes (refer to Section 3.7). This design protects the Class 1E 480-V load center transformers and switchgear, ensuring their design function will be performed.

The Class 1E 480-V load center transformers and switchgear are seismically designed to perform their safety functions under the effects of earthquakes (refer to Section 3.10.3.7.4).

8.3.1.1.4.3.2 General Design Criterion 3, 1971 – Fire Protection

The Class 1E 480-V switchgear and cable spreading room are designed to meet the requirements of 10 CFR 50.48(a) and (c) (refer to Section 9.5.1).

Refer to Section 8.3.1.4.9 for further discussion on fire barriers and separation.

8.3.1.1.4.3.3 General Design Criterion 4, 1967 – Sharing of Systems

Portions of the control room ventilation system (CRVS) and control room pressurization system equipment required to maintain control room habitability are shared between Unit 1 and Unit 2, 480-V, Class 1E switchgear buses via mechanically interlocked transfer switches.

Power to the technical support center, which is normally fed by a Unit 2, non-Class 1E, 480-V MCC, may be manually transferred via a transfer switch to a Unit 2, Class 1E 480-V switchgear. If this power supply is not available, power can be transferred to the Unit 1 Class 1E 480-V switchgear via another transfer switch.

The DFO transfer pumps are powered from either Unit 1 or Unit 2 Class 1E 480-V bus via a manual transfer switch.

The Unit 1 and Unit 2 communication room power distribution panels are normally fed from their corresponding Class 1E 480-V bus. Each is provided with a manual transfer switch, which allows transfer of power source to the other unit's Class 1E 480-V bus.

Operation of these transfer switches is administratively controlled to ensure that a fault in one unit is isolated from the other units power source.

8.3.1.1.4.3.4 General Design Criterion 11, 1967 – Control Room

The Class 1E 480-V switchgear and MCCs fed by a load transformer have a single phase voltmeter and an indicating potential light to monitor bus availability within the control room.

The HSP, which is the alternate control location in the event that the control room is rendered uninhabitable, is provided with transfer switches, control switches and status indication for the 480-V components that are controllable at the HSP. Additionally, a cut-in/cut-out switch and relay located at the 480-V MCC is provided to isolate the HSP from the switchgear control circuits in the event of fire at the HSP.

8.3.1.1.4.3.5 General Design Criterion 12, 1967 – Instrumentation and Control Systems

The Class 1E and non-Class 1E 480-V switchgear and MCCs that are directly fed from a load transformer are equipped with a ground detection circuit and ground indicating lights that provide annunciation in the main control room. The 480-V switchgears and MCCs are also provided with local bus monitoring devices. The load center transformers are equipped with winding temperature sensors with alarm contacts and provide automatic and manual control of the cooling fans.

8.3.1.1.4.3.6 General Design Criterion 17, 1971 – Electric Power Systems

The Class 1E 480-V distribution system is comprised of three (3) electrically independent and redundant load groups (refer to Section 8.3.1.4). Each of the Class 1E MCCs are located in separate rooms for independence to meet the single failure criterion. If a single failure occurs in any of the three MCC groups, the remaining two MCC groups have sufficient capacity and capability (refer to Section 8.3.1.1.4.3.8) to provide power to ESF loads required to safely shut down the unit.

8.3.1.1.4.3.7 General Design Criterion 18, 1971 – Inspection and Testing of Electric Power Systems

The Class 1E 480-V system is designed to be capable of periodic testing to assure operational and functional performance of the Class 1E components and operability of the system. Refer to Section 8.3.1.4.3.2 for further discussion on test and inspection for electrical cables.

Each MCC is independently supplied power (refer to Section 8.3.1.4) from a load center transformer that derives power from a 4.16-kV switchgear and allows for testability of the 480-V distribution system.

8.3.1.1.4.3.8 General Design Criterion 21, 1967 – Single Failure Definition

The Class 1E 480-V distribution system is comprised of three (3) electrically independent and physically separated redundant (refer to Section 8.3.1.4) Class 1E buses enclosed in separate rooms. If a single failure occurs in any of the Class 1E buses, the remaining two buses have sufficient capacity and capability to provide power to ESF loads required to safely shut down the unit.

8.3.1.1.4.3.9 General Design Criterion 40, 1967 – Missile Protection

The portions of the Class 1E 480-V system that support ESF loads and are located in zones where provision against dynamic effects must be made, are protected from missiles, pipe whip, or jet impingement from the rupture of any nearby high-energy line (refer to Sections 3.5, 3.6, and 8.3.1.4.10.2).

8.3.1.1.4.3.10 General Design Criterion 49, 1967 – Containment Design Basis

The Class 1E and non-Class1E 480-V circuits routed through containment electrical penetrations are each provided with electrical protection devices. This arrangement is such that with the failure of one device, the penetration remains protected from high current temperature by the other in-series device to ensure the containment penetration remains functional. Refer to Sections 3.8.2.1.1.3.1 and 8.3.1.4.8 for additional details.

8.3.1.1.4.3.11 480-V System Safety Function Requirements

(1) Protection from Missiles

The provisions taken to protect the Class 1E portion of the 480-V system from missiles resulting from plant equipment failures and from events and conditions outside the plant are discussed in Sections 3.5 and 8.3.1.4.10.2.

(2) Protection Against High Energy Pipe Rupture Effects

The provisions taken to protect the Class 1E portion of the 480-V system from damage that might result from dynamic effects associated with a postulated rupture of high-energy piping are discussed in Sections 3.6 and 8.3.1.4.10.3.

(3) Protection from Moderate Energy Pipe Rupture Effects – Outside Containment

The provisions taken to provide protection of the Class 1E portion of the 480-V system located outside containment from the effects of moderate energy pipe failure are discussed in Section 3.6.

(4) Protection from Jet Impingement – Inside Containment

The provisions taken to provide protection of the Class 1E portion of the 480-V system located inside containment from the effects of jet impingement which may result from high energy pipe rupture are discussed in Section 3.6 and 8.3.1.4.10.3.

(5) Protection from Flooding Effects – Outside Containment

The provisions taken to provide protection of the Class 1E portion of the 480-V system located outside containment from flooding that might result from the effects associated with a postulated rupture of piping are discussed in Section 3.6.

8.3.1.1.4.3.12 10 CFR 50.49 – Environmental Qualification of Electrical Equipment

The Class 1E 480-V system SSCs required to function in harsh environments under accident conditions are qualified to the applicable environmental conditions to ensure that they will continue to perform their safety functions. Section 3.11 describes the DCPP EQ program and the requirements for the environmental design of the electrical and related mechanical equipment. The affected components are listed on the EQ Master List (refer to Section 3.11.2).

8.3.1.1.4.3.13 10 CFR 50.63 – Loss of All Alternating Current Power

The Class 1E portion of the 480-V system serves to distribute power to loads required to bring the plant to a safe shutdown condition (Mode 3) following a SBO. Refer to Section 8.3.1.6 for further discussion on SBO.

8.3.1.1.4.3.14 10 CFR 50.48(c) – National Fire Protection Association Standard NFPA 805

The Class 1E 480-V system is designed to meet the nuclear safety and radioactive release performance criteria of Section 1.5 of NFPA 805, 2001 Edition (refer to Section 9.5.1).

8.3.1.1.4.3.15 Safety Guide 6, March 1971 – Independence Between Redundant Standby (Onsite) Power Sources and Between their Distribution Systems

The three Class 1E 480-V buses are physically enclosed in separate rooms and are electrically independent from each other when powered from their respective EDGs. Refer to Section 8.3.1.4 for further discussion on independence of redundant systems.

8.3.1.1.4.3.16 Regulatory Guide 1.63, Revision 1, May 1977 – Electric Penetration Assemblies in Containment Structures for Light-Water-Cooled Nuclear Plants

Class 1E and non-Class 1E 480-V circuits routed through containment electrical penetrations are designed with redundant overcurrent protection. Refer to Section 8.3.1.4.8 for further discussion.

8.3.1.1.4.3.17 Regulatory Guide 1.97, Revision 3, May 1983 – Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant and Environs Conditions During and Following an Accident

Class 1E, Category 2 indications for each Class 1E 480-V bus voltage is provided in the control room for Regulatory Guide 1.97, Revision 3, monitoring (refer to Table 7.5-6).

8.3.1.1.4.3.18 NUREG-0737 (Items II.E.3.1 (1) and II.G.1 (2)), November 1980 – Clarification of TMI Action Plan Requirements

II.E.3.1 (1) – Emergency Power Supply for Pressurizer Heaters: Section 8.3.1.1.4.2.2.1 provides a discussion of the power supply design configuration for the pressurizer heaters in conformance with NUREG-0737, II.E.3.1 (1).

II.G.1 (2) – Emergency Power for Pressurizer Equipment: The three Class 1E 480-V motor operated PORV block valves are each powered independently from the Class 1E 480-V ESF buses which are capable of being supplied from either the offsite source or the emergency power source when the offsite power source is not available. This conforms to the requirement of NUREG-0737, II.G.1 (2).

8.3.1.1.4.4 Tests and Inspections

Refer to Section 8.3.1.1.4.3.7 for tests and inspections.

8.3.1.1.4.5 Instrumentation Applications

Refer to Section 8.3.1.1.4.3.5 for instrumentation applications.

8.3.1.1.5 120-Vac Instrument Supply Systems

8.3.1.1.5.1 Design Bases

8.3.1.1.5.1.1 General Design Criterion 2, 1967 – Performance Standards

The Class 1E 120-Vac system is designed to withstand the effects of, or is protected against, natural phenomena such as earthquakes, tornadoes, flooding, winds, tsunamis, and other local site effects.

8.3.1.1.5.1.2 General Design Criterion 3, 1971 – Fire Protection

The Class 1E 120-Vac system is designed and located to minimize, consistent with other safety requirements, the probability and effect of fires and explosions.

8.3.1.1.5.1.3 General Design Criterion 4, 1967 – Sharing of Systems

The 120-Vac system or components are not shared by the DCPP units unless it is shown safety is not impaired by the sharing.

8.3.1.1.5.1.4 General Design Criterion 11, 1967 – Control Room

The Class 1E portion of the 120-Vac system is designed to or contains instrumentation and controls that support actions to maintain the safe operational status of the plant from the control room or from an alternate location if control room access is lost due to fire or other causes.

8.3.1.1.5.1.5 General Design Criterion 12, 1967 – Instrumentation and Control Systems

Instrumentation and controls are provided as required to monitor and maintain the 120-Vac system variables within prescribed operating ranges.

8.3.1.1.5.1.6 General Design Criterion 17, 1971 – Electric Power Systems

The Class 1E 120-Vac system is required to have sufficient capacity, capability, independence, redundancy, and testability to perform its safety function assuming a single failure.

8.3.1.1.5.1.7 General Design Criterion 18, 1971 – Inspection and Testing of Electric Power Systems

The Class 1E portion of the 120-Vac system design permits appropriate periodic inspection and testing of functional and operational performance of the system as a whole and under conditions as close to design as practical.

8.3.1.1.5.1.8 General Design Criterion 21, 1967 – Single Failure Definition

The Class 1E portion of the 120-Vac system is designed to remain operable after sustaining a single failure. Multiple failures resulting from a single event shall be treated as a single failure.

8.3.1.1.5.1.9 General Design Criterion 24, 1967 – Emergency Power for Protection Systems

The Class 1E portion of the 120-Vac system is designed to remain operable after a loss of all offsite power.

8.3.1.1.5.1.10 General Design Criterion 40, 1967 – Missile Protection

The portions of the Class 1E 120-Vac system that support ESF loads are designed to be protected against dynamic effects and missiles that might result from plant equipment failures.

8.3.1.1.5.1.11 General Design Criterion 49, 1967 – Containment Design Basis

The Class 1E and non-Class 1E 120-Vac circuits routed through containment electrical penetrations are designed to support the containment design basis such that the containment structure can accommodate, without exceeding the design leakage rate, the pressures and temperatures following a LOCA.

8.3.1.1.5.1.12 120-Vac System Safety Function Requirements

(1) <u>Protection from Missiles</u>

The Class 1E 120-Vac system is designed and located to be protected against the effects of missiles which may result from plant equipment failure and from events and conditions outside the plant.

(2) Protection Against High Energy Pipe Rupture Effects

The Class 1E 120-Vac system is designed and located to accommodate the dynamic effects of a postulated high-energy pipe failure to the extent necessary to assure that a safe shutdown condition of the reactor can be accomplished and maintained.

(3) Protection from Moderate Energy Pipe Rupture Effects – Outside Containment

The outside containment portion of the Class 1E 120-Vac system required to bring the plant to cold shutdown is designed to be protected against the effects of moderate energy pipe failure.

(4) Protection from Jet Impingement – Inside Containment

The inside containment portion of the Class 1E 120-Vac system is designed to be protected against the effects of jet impingement which may result from high energy pipe rupture.

(5) Protection from Flooding Effects – Outside Containment

The outside containment portion of the Class 1E 120-Vac system required to bring the plant to cold shutdown is to be protected from the effects of internal flooding.

8.3.1.1.5.1.13 10 CFR 50.49 – Environmental Qualification of Electrical Equipment Important to Safety for Nuclear Power Plants

The Class 1E 120-Vac system electrical components that require EQ are qualified to the requirements of 10 CFR 50.49.

8.3.1.1.5.1.14 10 CFR 50.62 – Requirements for Reduction of Risk from Anticipated Transients without Scram Events for Light-Water-Cooled Nuclear Power Plants

The non-Class 1E 120-Vac power source meets the electrical power requirements to provide a source to the anticipated transients without scram (ATWS) mitigation actuation circuitry (AMSAC) that is independent from the protection system power supplies.

8.3.1.1.5.1.15 10 CFR 50.63 – Loss of All Alternating Current Power

The Class 1E 120-Vac system provides power to the loads required to support systems that assure core cooling and containment integrity is maintained following a SBO event.

8.3.1.1.5.1.16 10 CFR 50.48(c) – National Fire Protection Association Standard NFPA 805

The Class 1E portion of the 120-Vac system is designed to meet the nuclear safety and radioactive release performance criteria of Section 1.5 of NFPA 805, 2001 Edition.

8.3.1.1.5.1.17 Safety Guide 6, March 1971 – Independence Between Redundant Standby (Onsite) Power Sources and Between their Distribution Systems

The Class 1E portion of the 120-Vac system is designed such that electrically powered loads are separated into redundant load groups such that loss of any one group will not prevent the minimum safety functions from being performed.

8.3.1.1.5.1.18 Regulatory Guide 1.63, Revision 1, May 1977 – Electric Penetration Assemblies in Containment Structures for Light-Water-Cooled Nuclear Power Plants

The Class 1E and non-Class 1E 120-Vac circuits routed through containment electrical penetrations are designed to meet the requirements of Regulatory Guide 1.63, Revision 1, regarding installation of redundant or backup fault current protection devices to limit fault current to less than the penetration can withstand assuming a single random failure of the circuit overload protective device.

8.3.1.1.5.1.19 NUREG-0737 (Item II.G.1 (4)), November 1980 – Clarification of TMI Action Plan Requirements

Item II.G.1 (4) – Emergency Power for Pressurizer Equipment (Pressurizer Level Indication): The pressurizer level indication instrument channels shall be powered from the Class 1E instrument buses. The buses shall have the capability of being supplied from either the preferred power supply or the standby power supply when the preferred power supply is not available.

8.3.1.1.5.2 System Description

8.3.1.1.5.2.1 Class 1E 120-Vac Instrument Power Supply System

The 120-Vac Class 1E instrument bus system shown in Figure 7.6-1 supplies electric power for instrumentation, control, protection, and annunciation for the nuclear steam supply system and other Class 1E loads. The nuclear steam supply system loads are divided into four redundant groups each with its own distribution panel(s) for each unit. The six panels are served by four dedicated UPSs supplied either from their associated Class 1E 480-V bus or from their associated Class 1E batteries. The UPSs are sized to continuously carry the maximum connected load without exceeding their nameplate rating. In addition, each UPS has a backup regulating transformer with manual transfer switch that can be fed from either of two 480-V Class 1E buses. This backup power is provided through the UPS static transfer switch or the UPS manual bypass switch, and supplies backup 120-Vac power to the instrument bus when its UPS is out of service. This four UPS design provides redundant, uninterrupted 120-Vac, 60-Hz, single-phase power to the Class 1E instrument buses.

The dc power flow control of the inverter unit ensures that while the ac power input to the rectifier is available, the power to the distribution panels will be supplied through the rectifier and the inverter. When the ac power input to the rectifier is not available, the power to the distribution panel(s) will be supplied from the dc bus through the inverter

8.3.1.1.5.2.2 Non-Class 1E 120-Vac Instrument Power Supply System

Other UPSs and inverters are supplied from the 480-V or 208Y/120-Vac systems and backed up by either station batteries or a dedicated UPS battery. UPSs and inverters are used to supply the plant's digital computers and other non-Class 1E plant instrumentation and control systems needing uninterrupted ac power.

8.3.1.1.5.3 Safety Evaluation

8.3.1.1.5.3.1 General Design Criterion 2, 1967 – Performance Standards

The Class 1E 120-Vac UPSs, inverter, voltage regulating transformer and distribution panel equipment are located in the auxiliary building, which is a PG&E Design Class I structure, contained within the Class 1E 125-Vdc switchgear rooms (refer to Figure 1.2-5). The Class 1E 125-Vdc switchgear rooms are adjacent to the Class 1E 125-Vdc battery rooms. The auxiliary building is designed to withstand the effects of winds and tornadoes (refer to Section 3.3), floods and tsunamis (refer to Section 3.4), external missiles (refer to Section 3.5), and earthquakes (refer to Section 3.7) to protect the Class 1E 120-Vac UPSs, inverters, voltage regulating transformers and distribution panel equipment, ensuring their design function will be performed. Loss of dc switchgear/inverter room ventilation and Class 1E raceways located outdoors, associated with 120-Vac system that are exposed to effects of tornadoes, have been evaluated and they do not compromise the capability of shutting down the plant safely (refer to Section 3.3.2.3).

The Class 1E 120-Vac UPSs, inverters, and voltage regulating transformers are seismically designed to perform their safety functions under the effects of earthquakes (refer to Section 3.10.3.1.4).

8.3.1.1.5.3.2 General Design Criterion 3, 1971 – Fire Protection

The Class 1E inverters are located in the Class 1E 125-Vdc switchgear rooms. The 125-Vdc switchgear rooms are designed to meet the requirements of 10 CFR 50.48(a) and (c) (refer to Section 9.5.1).
Refer to Section 8.3.1.4.9 for further discussion on fire barriers and separation.

8.3.1.1.5.3.3 General Design Criterion 4, 1967 – Sharing of Systems

The Class 1E 120-Vac system is shared between the CRVS for both units through the use of manually operated mechanical transfer switches.

Power to Unit 1 CRVS panels, which is normally fed from a Unit 1, Class 1E 120-Vac instrument supply system, may be manually transferred to a Unit 2 Class 1E 120-Vac instrument supply system, in the event the Unit 1 supply is not available, through the mechanical transfer switch. Similar operation can be accomplished for the Unit 2 CRVS panels.

Safety is not impaired by the sharing since the transfer of power supply between the units is not done automatically but through the use of manually operated mechanical transfer switches. These transfer switches ensure that a fault in one unit is isolated from the other unit's power source. In addition, operation of these transfer switches is administratively controlled.

8.3.1.1.5.3.4 General Design Criterion 11, 1967 – Control Room

The dc power flow is monitored internally in the UPS, and dc input power to the inverter is supplied from the rectifier or from the dc bus as appropriate.

The loss of ac power to the distribution panels is alarmed in the control room. There are no UPS breaker controls on the control board, as transfers between Class 1E ac and dc sources will occur automatically without interruption due to loss of the 480-V power source.

8.3.1.1.5.3.5 General Design Criterion 12, 1967 – Instrumentation and Control Systems

The loss of ac power to the distribution panels is alarmed in the control room.

The Class 1E UPSs have locally mounted meters for dc input, bypass input, and ac output indications. They also have power available indication lights for ac input, dc input and bypass input power sources. An alarm mimic panel mounted on the face of the UPS panel is provided with alarm indication lights to indicate normal and abnormal conditions.

8.3.1.1.5.3.6 General Design Criterion 17, 1971 – Electric Power Systems

The Class 1E UPSs are sized to continuously carry the maximum connected loads without exceeding their nameplate rating.

The inverters are designed to maintain their outputs within the limits of 60 Hz ± 0.5 percent and 120-Vac ± 2 percent from zero to full load.

There are three independent Class 1E 480-V power sources, Buses F, G, and H, in each unit. Bus F serves UPS 11, Bus G serves UPS 12, and Bus H serves UPSs 13 and 14. Three Class 1E 125-Vdc sources serve the four UPSs: UPS 11 is supplied power from battery 11, UPSs 12 and 14 are supplied power from battery 12, and UPS 13 is supplied power from battery 13. The UPSs operate normally on both the ac and dc systems. If either system is interrupted, the UPS will be supplied from the remaining source without interruption (refer to Figure 7.6-1).

Each of the four UPSs is independently connected to its respective channel instrument distribution panels so that the loss of a UPS cannot affect more than one channel of the system.

8.3.1.1.5.3.7 General Design Criterion 18, 1971 – Inspection and Testing of Electric Power Systems

The Class 1E UPS inverters are routinely checked on a weekly basis and are inspected and tested on a refueling outage frequency. Periodic component replacements per manufacturer's specifications are performed to maintain the Class 1E qualification.

Additional discussion on inspection and testing is found in Section 8.3.1.4.3.2

8.3.1.1.5.3.8 General Design Criterion 21, 1967 – Single Failure Definition

The onsite Class 1E electrical power distribution system is designed with three independent 4.16-kV and 480-V Class 1E buses (F, G, and H) and three 125-Vdc Class 1E buses in each unit (refer to Section 8.3.1.1.5.3.6 and Figure 7.6-1).

Each of the four UPSs is independently connected to its respective channel instrument distribution panels so that the loss of a UPS cannot affect more than one channel of the system.

In addition, each of the four UPSs may be automatically transferred to a regulated 120-Vac backup power source by its static transfer switch. Each distribution panel can also receive power from the regulated 120-Vac backup source by its manual bypass switch. Each regulating transformer has its normal and alternate power source through a manual transfer switch. Each UPS has its rectifier connected to the inverter and the dc power source through a blocking diode that prevents the rectifier from backfeeding the dc system.

The UPSs operate normally on both the ac and dc systems. If the ac system is interrupted, the inverter will be supplied from the Class 1E dc source without interruption (refer to Figure 7.6-1).

The plant protection system is designed with four input channels (I, II, III, and IV) powered from four 120-Vac Class 1E buses (1, 2, 3, and 4). The four channels provide input to the SSPS Trains A and B. Class 1E 120-Vac Bus 1 and 4 provide power to the

SSPS train A and train B output relays, respectively. The SSPS input relays are fail safe (with the exception of the input circuits that initiate containment spray, the radiation monitoring channels that initiate containment ventilation isolation, and the RCP UF low flow trip channels [refer to Sections 7.2.3.12 and 7.3.4.1.1]), whereas the SSPS output relays require power to actuate.

Each SSPS train actuates ESF equipment in the three Class 1E ac and dc buses and certain Non-Class 1E equipment in the Non-Class 1E ac and dc buses. As allowed per IEEE 308-1971, Class 1E dc Bus 12 feeds Class 1E 120-Vac Buses 12 and 14 in Unit 1 and Class 1E dc Bus 22 feeds Class 1E 120-Vac Buses 22 and 24 in Unit 2. For design basis accident scenarios concurrent with a LOOP, a single failure of the Unit 1 Class 1E dc Bus 12 will cause the loss of Class 1E 120-Vac Buses 12 and 14 in Unit 1. Similarly a single failure of the Unit 2 Class 1E dc Bus 22 will cause the loss of Class 1E 120-Vac Buses 22 and 24 in Unit 2. This is acceptable because the loss of Class 1E dc Bus 12 in Unit 1 or Class 1E dc Bus 22 in Unit 2 does not prevent the minimum safety functions from being performed. Loss of both IY/PY 12(22) and IY/PY 14(24) is acceptable because the remaining two 120-Vac inverters and buses can supply at least one full ESF train.

Therefore, a single failure in the instrumentation and control power supply system or its associated power supplies does not prevent the minimum safety functions from being performed.

8.3.1.1.5.3.9 General Design Criterion 24, 1967 – Emergency Power for Protection Systems

In the event of a loss of all offsite power, the Class 1E 120-Vac system is automatically powered from the Class 1E 125-Vdc system and will automatically be re-powered from the Class 1E 4.16-kV/480-V bus when the EDG loads onto its Class 1E 4.16-kV bus.

8.3.1.1.5.3.10 General Design Criterion 40, 1967 – Missile Protection

Class 1E 120-Vac instrument supply system equipment and cables that support ESF loads are protected from internally generated missiles, pipe-whip and jet impingement. Detailed discussions of these protections are delineated in Sections 8.3.1.4.10.2 and 8.3.1.4.10.3 respectively.

8.3.1.1.5.3.11 General Design Criterion 49, 1967 – Containment Design Basis

Class 1E and non-Class 1E 120-Vac circuits routed through containment are analyzed for redundant overcurrent protection and available fault energy. Circuits without direct in-line redundant protection have been analyzed to determine the available fault current is not of sufficient magnitude to damage the penetration conductor, penetration, or containment integrity.

Refer to Sections 3.8.2.1.1.3, 8.3.1.1.5.3.15, and 8.3.1.4.8 for additional details.

8.3.1.1.5.3.12 120-Vac System Safety Function Requirements

(1) Protection from Missiles

The provisions taken to protect the Class 1E 120-Vac system from missiles resulting from plant equipment failures and from events and conditions outside the plant are discussed in Sections 3.5 and 8.3.1.4.10.2.

(2) Protection Against High Energy Pipe Rupture Effects

The provisions taken to protect the Class 1E 120-Vac system from damage that might result from dynamic effects associated with a postulated rupture of high-energy piping are discussed in Sections 3.6 and 8.3.1.4.10.3.

(3) Protection from Moderate Energy Pipe Rupture Effects – Outside Containment

The provisions taken to provide protection of the Class 1E portion of the 120-Vac system located outside containment from the effects of moderate energy pipe failure are discussed in Section 3.6.

(4) Protection from Jet Impingement – Inside Containment

The provisions taken to provide protection of the Class 1E portion of the 120-Vac system located inside containment from the effects of jet impingement which may result from high energy pipe rupture are discussed in Section 3.6 and 8.3.1.4.10.3.

(5) Protection from Flooding Effects – Outside Containment

The provisions taken to provide protection of the Class 1E portion of the 120-Vac system located outside containment from flooding that might result from the effects associated with a postulated rupture of piping are discussed in Section 3.6.

8.3.1.1.5.3.13 10 CFR 50.49 – Environmental Qualification of Electrical Equipment Important to Safety for Nuclear Power Plants

The Class 1E 120-Vac system SSCs required to function in harsh environments under accidents conditions are qualified to the applicable environmental conditions to ensure that they will continue to perform their safety functions. Section 3.11 describes the DCPP EQ program and the requirements for the environmental design of the electrical and related mechanical equipment. The affected components are listed on the EQ Master List.

8.3.1.1.5.3.14 10 CFR 50.62 – Requirements for Reduction of Risk from Anticipated Transients without Scram Events for Light-Water-Cooled Nuclear Power Plants

The AMSAC in both units is powered from the Non-Class 1E chemistry lab and counting room inverter. This inverter is powered from non-reactor protection system (RPS) power supplies in either Unit 1 or Unit 2.

8.3.1.1.5.3.15 10 CFR 50.63 – Loss of All Alternating Current Power

The Class 1E UPSs are sized to continuously carry the maximum connected loads without exceeding their nameplate rating during a SBO event.

To prevent receiving an spurious SI signal during a SBO condition, operator action is taken within 2 hours to provide at least two input channels of instrumentation to monitor system functions and actuate one train of safeguards equipment.

The Class 1E portion of the 120-Vac system serves to distribute power to loads required to bring the plant to a safe shutdown condition (Mode 3) following a SBO event. Refer to Section 8.3.1.6 for further discussion on SBO.

8.3.1.1.5.3.16 10 CFR 50.48(c) – National Fire Protection Association Standard NFPA 805

The Class 1E 120-Vac system is designed to meet the nuclear safety and radioactive release performance criteria of Section 1.5 of NFPA 805, 2001 Edition (refer to Section 9.5.1).

8.3.1.1.5.3.17 Safety Guide 6, March 1971 – Independence Between Redundant Standby (Onsite) Power Sources and Between their Distribution Systems

Each of the redundant onsite Class 1E 120-Vac power sources and its distribution system is independent from each other. The electrically powered loads are separated into redundant load groups such that loss of any one group will not prevent the minimum safety functions from being performed.

For discussion related to independence of redundant systems, separation criteria for Class 1E systems and Class 1E separation and protection criteria (refer to Sections 8.3.1.4, 8.3.1.4.1, and 8.3.1.4.10, respectively).

Further discussions on separation and isolations are found in Sections 8.3.1.4.2, 8.3.1.4.4, and 8.3.1.4.6.

8.3.1.1.5.3.18 Regulatory Guide 1.63, Revision 1, May 1977 – Electric Penetration Assemblies in Containment Structures for Light-Water-Cooled Nuclear Power Plants

Class 1E and non-Class 1E 120-Vac circuits routed through containment electrical penetrations are designed with redundant overcurrent protection. Circuits without direct in-line redundant protection have been analyzed to determine the available fault current is not of sufficient magnitude to damage the penetration conductor or penetration.

Refer to Sections 8.3.1.1.5.3.11 and 8.3.1.4.8 for additional details.

8.3.1.1.5.3.19 NUREG-0737 (Item II.G.1 (4)), November 1980 – Clarification of TMI Action Plan Requirements

Item II.G.1 (4) – Emergency Power for Pressurizer Equipment (Pressurizer Level Indication): The pressurizer level indication circuits are Class 1E and qualified for post-accident. The Class 1E instrument channels are supplied from inverters which are supplied from the ESF buses with automatic backup from the Class 1E emergency batteries.

8.3.1.1.5.4 Tests and Inspections

Refer to Section 8.3.1.1.5.3.7 for tests and inspections details.

8.3.1.1.5.5 Instrumentation Applications

Refer to Section 8.3.1.1.5.3.5 for instrumentation applications.

8.3.1.1.6 Diesel Generator Units

The physical arrangement of the engine generator units is shown in Figures 9.5-10 and 9.5-11 for Unit 1; the arrangement is similar for Unit 2. Figure 9.5-12 shows the outline of the Unit 1 engine generators. The arrangement is similar for the Unit 2 generators with the exception of EDG 2-3, which is slightly different.

The six diesel generators for Unit 1 and Unit 2 are essentially identical, self-contained units housed in individual compartments at elevation 85 feet in the turbine building. Three are located in the northwest or Unit 1 portion, and three are located in the southwest or Unit 2 portion of the structure. The compartments separate each diesel generator and its accessories from the adjacent units and conform to PG&E Design Class I requirements.

8.3.1.1.6.1 Design Bases

8.3.1.1.6.1.1 General Design Criterion 2, 1967 – Performance Standards

The EDG system is designed to withstand the effects of, or is protected against natural phenomena such as earthquakes, tornadoes, flooding, winds, tsunamis, and other local site effects.

8.3.1.1.6.1.2 General Design Criterion 3, 1971 – Fire Protection

The EDG system is designed and located to minimize, consistent with other safety requirements, the probability and effect of fires and explosions.

8.3.1.1.6.1.3 General Design Criterion 4, 1967 – Sharing of Systems

The EDG system or components are not shared by the DCPP units unless it is shown safety is not impaired by the sharing.

8.3.1.1.6.1.4 General Design Criterion 11, 1967 – Control Room

The EDG system is designed to or contains instrumentation and controls that support actions to maintain the safe operational status of the plant from the control room or from an alternate location if control room access is lost due to fire or other causes.

8.3.1.1.6.1.5 General Design Criterion 12, 1967 – Instrumentation and Control Systems

Instrumentation and controls are provided as required to monitor and maintain EDG system variables within prescribed operating ranges.

8.3.1.1.6.1.6 General Design Criterion 17, 1971 – Electric Power Systems

The EDG system is designed to have sufficient capacity, capability, independence, redundancy, and testability to perform its safety function assuming a single failure.

8.3.1.1.6.1.7 General Design Criterion 18, 1971 – Inspection and Testing of Electric Power Systems

The EDG system design permits appropriate periodic inspection and testing of functional and operational performance of the system as a whole and under conditions as close to design as practical.

8.3.1.1.6.1.8 General Design Criterion 21, 1967 – Single Failure Definition

The EDG system is designed to remain operable after sustaining a single failure. Multiple failures resulting from a single event shall be treated as a single failure.

8.3.1.1.6.1.9 Emergency Diesel Generator System Safety Function Requirements

(1) Protection from Missiles

The EDG system is designed and located to be protected against the effects of missiles which may result from plant equipment failure and from events and conditions outside the plant to the extent necessary to assure that a safe shutdown condition of the reactor can be accomplished and maintained.

(2) Protection Against High Energy Pipe Rupture Effects

The EDG system is designed and located to accommodate the dynamic effects of a postulated high-energy pipe failure to the extent necessary to assure that a safe shutdown condition of the reactor can be accomplished and maintained to the extent necessary to assure that a safe shutdown condition of the reactor can be accomplished and maintained.

(3) Protection from Moderate Energy Pipe Rupture Effects – Outside Containment

The EDG system is designed to be protected against the effects of moderate energy pipe failure to the extent necessary to assure that a safe shutdown condition of the reactor can be accomplished and maintained.

(4) Protection from Flooding Effects – Outside Containment

The EDG system is to be protected from the effects of internal flooding to the extent necessary to assure that a safe shutdown condition of the reactor can be accomplished and maintained.

8.3.1.1.6.1.10 10 CFR 50.55a(g) – Inservice Inspection Requirements

Applicable EDG system components are inspected to the requirements of 10 CFR 50.55a(g)(4) and 10 CFR 50.55a(g)(5) to the extent practical.

8.3.1.1.6.1.11 10 CFR 50.63 – Loss of All Alternating Current Power

The EDG system meets the criterion of providing an alternate ac (AAC) source within ten minutes of SBO.

8.3.1.1.6.1.12 10 CFR 50.48(c) – National Fire Protection Association Standard NFPA 805

The EDG system is designed to meet the nuclear safety and radioactive release performance criteria of Section 1.5 of NFPA 805, 2001 Edition.

8.3.1.1.6.1.13 Safety Guide 9, March 1971 – Selection of Diesel Generator Set Capacity for Standby Power Supplies

The EDG system meets the applicable requirements of Safety Guide 9, March 1971 for steady state loading capability with one regulatory approved exception for DCPP:

(1) Exception to loading sequence frequency requirements of Safety Guide 9, March 1971, Position C.4 for motor-driven AFW pump loading on EDGs 1-1, 1-3, 2-2, and 2-3 (Reference 30).

8.3.1.1.6.1.14 Regulatory Guide 1.97, Revision 3, May 1983 – Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant and Environs Conditions During and Following an Accident

The EDG instrumentation systems provide instrumentation in the control room to monitor EDG electrical status for post-accident instrumentation.

8.3.1.1.6.1.15 Regulatory Guide 1.108, Revision 1, August 1977 – Periodic Testing of Diesel Generator Units Used as Onsite Electric Power Systems at Nuclear Power Plants

As required by Regulatory Guide 1.108, Revision 1 (Reference 25), EDG testing simulates, where practical, the parameters of operation that would be expected if actual demand were to be placed on the system, as delineated in Technical Specification Bases 3.8.1.

There are four regulatory approved exceptions to Regulatory Guide 1.108, Revision 1 for DCPP:

(1) Exception to testing frequency guidelines of Regulatory Position C.2.a based on compliance with the TS 5.5.18 Surveillance Frequency Control Program (Reference 27).

(2) Exception to EDG hot restart testing guidelines of Regulatory Position C.2.a (5) based on use of a modified hot restart test (Reference 28).

(3) Exceptions to Regulatory Positions C.2.a (9), C.2.d, C.2.e and C.3 based on compliance with NUMARC 93-01, Revision 2, “Industry Guidelines for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants” (Reference 29).

(4) Exception to Regulatory Position C.2.a(3) to demonstrate full-load-carrying capability for an interval of 2 hours at a load equivalent to the 2-hour rating of the diesel generator (Reference 33).

8.3.1.1.6.2 System Description

8.3.1.1.6.2.1 Diesel Generator Unit Description

Each diesel generator unit consists of a self-contained diesel engine directly connected to an alternating current generator, and the separate accessories needed for proper operation, all mounted on a common structural steel skid-type base. Mechanical power is provided by an 18 cylinder, vee configuration, four-cycle, 9-inch bore x 10-1/2 inch stroke, 12,024 cubic inch displacement, 3630 horsepower at 900 rpm, turbocharged and aftercooled, heavy-duty, stationary-type diesel engine.

The generator is rated at 3250 kVA, 0.8 PF, 4.16kV, 60 Hz, three-phase, Y-connected, ungrounded, 80°C temperature rise, Class B insulation, with a drip-proof enclosure. The transient reactance is 14.1 percent, and the subtransient reactance is 8.1 percent. The exciter is a static series, boost-type exciter controlled by a static solid-state voltage regulator.

Five diesel engine generator units have been supplied by the ALCO Engine Division of White Industrial Power, Inc. The sixth diesel engine generator, EDG 2-3, was manufactured by G. E. Locomotives, the current owner and manufacturer of ALCO engines and locomotives at the time. In most respects, this EDG is similar to the other five EDGs; the differences and commercial grade dedication are documented in RPE M-6602. ALCO has supplied engine generator units to serve as emergency onsite standby power at several nuclear power plants. Among these are two ALCO units for the Palisades Nuclear Plant, which have the same engine as the first five DCPP engine generator units and a slightly smaller generator (2500kW continuous rating), and the two ALCO units for the Pilgrim I Nuclear Station, which has engines and generators that are identical to the first 5 at DCPP. Both of these nuclear power plants are in operation. In addition, the Salem 1 and 2 nuclear power plant has engine generator units with the same engines and generators as the first five DCPP engine generator units.

The EDG auxiliary systems; starting air system, ventilation system, cooling water system, lubrication system, fuel oil storage and transfer system, and compartment ventilation system are described in Sections 9.4.7 and 9.5.4 through 9.5.7.

8.3.1.1.6.2.2 Combustion Air Intake System

The combustion air is taken into the engine through woven, dry-type, particulate filter media, encased in a cylindrical steel retaining structure. This air intake filter structure is supported from the ceiling in the radiator fan portion of the engine generator compartment. After passing through the filter, the combustion air is drawn into the engine through a 22-inch carbon steel pipe. The physical arrangement of the air intake filter and piping for Unit 1 is shown in Figures 9.5-10 and 9.5.11, and is similar for Unit 2. The diagram of the combustion air intake system is shown in Figure 3.2-21 (Sheets 7, 8, 8A, and 8B).

As shown in Figures 9.5-10 and 9.5-11 for Unit 1, the combustion air for the diesel engines is taken from the west side of the building, and the exhaust from the engines is directed upward through the roof on the north side of the turbine building for Unit 1. Unit 2 diesels are similar, except the exhaust is through the south wall of the turbine building. The exhaust is at a higher elevation than the combustion air intake. This arrangement ensures that the engine exhaust will be dispersed without the possibility of diluting the combustion air. There is no equipment or structure on the west side of the turbine building within the proximity of the combustion air intake that would create the potential for noncombustible or explosive gases being drawn into the engine.

Approximately 30 percent of the outside air drawn by the radiator fan is routed through ductwork providing ventilation for the diesel generator compartment. Refer to Section 9.4.7 for a complete description of the ventilation system.

8.3.1.1.6.3 Safety Evaluation

8.3.1.1.6.3.1 General Design Criterion 2, 1967 – Performance Standards

The EDGs are located at elevation 85 foot of the turbine building, which is a PG&E Design Class II structure (refer to Figures 1.2-16 and 1.2-20). This building or applicable portions have been designed not to impact PG&E Design Class I components and associated safety functions (refer to Section 3.7.2.2.2.1). The turbine building is designed to withstand the effects of winds and tornadoes (refer to Sections 3.3.1.2 and 3.3.2.5.2.8), floods and tsunamis (refer to Section 3.4), external missiles (refer to Section 3.5), and earthquakes (refer to Section 3.7.2.2.2.1) to protect the EDGs.

The diesel generator excitation cubicle and control cabinet are seismically qualified to perform their safety functions under the effects of the Design Earthquake (DE), Double Design Earthquake (DDE), and Hosgri Earthquake (HE) (refer to Section 3.10.3.6).

The engine generator units and their associated auxiliary systems, as shown for Unit 1 in Figures 9.5-8 through 9.5-10, and similarly for Unit 2, are installed in separate compartments that are protected from fires, flooding, and external missiles.

Any postulated external missile would not penetrate into more than one compartment. Section 3.3.2 provides more discussion on hypothetical external missiles generated by a postulated tornado. No common failure mode exists where one single event would disable more than one diesel generator.

It is not credible for the HE to restrict the flow of exhaust gases from the diesel engine and thereby create excessive back pressure on the engine. The design of the exhaust system, shown schematically in Figure 3.2-21 (Sheet 7), precludes any major failures, such as a major failure of the silencer and/or the connecting piping, which would have to develop to produce any significant flow restriction. The internal baffles and chambers of the silencer are designed so that even if an internal baffle breaks completely loose, it will not block exhaust flow. The silencer supports, as well as the connecting piping supports, are designed in accordance with the same criteria as for PG&E Design Class I equipment supports; i.e., to withstand the HE with no loss of function. Exhaust and combustion air inlet piping is qualified for the HE.

The exhaust silencers and piping are located in separate compartments with no other piping or equipment that could adversely affect the silencers or piping during a HE. The exhaust lines of the Unit 1 diesels pass through the turbine building roof, and the exhaust lines of the Unit 2 diesels pass through the south wall of the turbine building, but are not considered a risk in the seismically induced system interaction (SISI) program. The compartments are located immediately above the engine generators in the turbine building. An engineering review of the turbine building has shown that during a seismic event the building will not collapse. This analysis is discussed in Section 3.7.2.

Other equipment associated with the diesel generators that is seismically qualified includes:

(1) Fuel oil day tanks

(2) Closed cooling water system, including fan and radiator

(3) Fuel oil storage tanks and fuel oil piping

(4) Lube oil system

(5) Ventilation system

8.3.1.1.6.3.2 General Design Criterion 3, 1971 – Fire Protection

The EDG areas are designed to meet the requirements of 10 CFR 50.48(a) and (c) (refer to Section 9.5.1).

Refer to Section 8.3.1.4.9 for further discussion on fire barriers and separation. The portion of each compartment that houses the diesel generator is provided with a thermally actuated total flooding CO_2 gas system, in accordance with NFPA Standard No. 12, 1973 (Reference 6). Temperature-actuated, automatic closing, roll-down fire-rated doors close ventilation air openings to prevent CO_2 leakage. The CO_2 flooding is restricted to the engine generator compartment by closing fire doors that isolate and seal the compartment. Refer to Section 9.5.1 for a complete description of the CO_2 system. Additionally, two hose stations are provided adjacent to the compartment locations in each unit. The diesel generator installation is in accordance with NFPA 37-1970 (Reference 7).

Each engine generator compartment is provided with a CO_2 flooding system for fire suppression. CO_2 flooding will extinguish a fire in one compartment while the other engine generator units continue normal operation. In addition, 3-hour fire walls are provided between the individual compartments. A normally closed, 3-hour fire door separates the corridor connecting the diesel generator rooms from the main condenser area. This door is also designed to prevent a postulated condenser leak from flooding the diesel generator rooms (refer to Section 10.4.5). Section 9.5.1 provides more information on the fire protection system.

There is no combustible gas line or storage facility within or near the engine generator compartments. The only flammable liquids contained within the engine generator compartments are those necessary for the operation of the engines, i.e.; engine lube oil and DFO.

The startup transformers, located immediately north of the Unit 1 and south of the Unit 2 engine generator compartments, contain insulating oil, which is a potential fire hazard. However, the transformers are equipped with fire detection and fire suppression systems to quench potential fires. The engine generator compartment nearest the startup transformer is separated from the transformer by a 3-hour fire wall. The engine generator combustion air intakes are not affected by a transformer fire since combustion air is drawn from the west side of the building.

The main turbine seal oil systems are the closest source of flammable liquids within the turbine building. The seal oil units are located about 65 feet from the common corridor for each unit's diesel generators. Each seal oil unit is supplied with a fire detection and fire suppression system.

A failure of the number 10 turbine bearing (between the exciter and generator) is the next closest potential fire hazard, since an open bay connects the turbine deck elevation (140 feet) with the diesel generator elevation (85 feet). The bay opening is located about 35 feet horizontally from the diesel generator common corridor. The Number 10 bearing is equipped with a fire detection and fire suppression system. The turbine building fire suppression systems would contain any turbine lube oil fire and prevent any hazard to the diesel engine generators. Refer to Section 9.5.1 for additional fire protection system information.

8.3.1.1.6.3.3 General Design Criterion 4, 1967 – Sharing of Systems

The fuel oil storage and transfer subsystem of the EDG system are shared between Unit 1 and Unit 2 (refer to Section 9.5.4.3.3).

8.3.1.1.6.3.4 General Design Criterion 11, 1967 – Control Room

Controls for engine generator functions are both local at the engine generator compartment and remote in the main control room. Each of the units may be manually started or stopped from either location to facilitate periodic testing. The generators may be synchronized from the control room so that they can be paralleled with the other power systems for testing. In addition, there is an emergency manual stop for each unit located outside each engine generator compartment. Automatic starting of the units occurs in the event of the conditions listed in Section 8.3.1.1.3.3.5.1. Each of the six units is provided with two starting control circuits.

Engine generator units are normally controlled from the control room. A two-position local-remote switch located at each engine generator unit allows control of each unit to be switched from the control room (remote) to the engine generator compartment (local). Whenever control of any of the units is switched to the compartment (local), the operator is informed by a control room annunciator alarm. The alarm identifies the engine generator unit on local control.

8.3.1.1.6.3.5 General Design Criterion 12, 1967 – Instrumentation and Control Systems

The units are fully instrumented to monitor important parameters and alarm abnormal conditions, both locally at the engine generator compartment and remotely in the main control room.

Each diesel generator is designed with two starting control circuits, one field flashing circuit, and one sensing circuit. These circuits receive Class 1E dc control power through a manual transfer switch. Class 1E dc power is from the same train as the diesel generator. In the event of failure of dc power to these control circuits, an alarm appears on the main annunciator. The manual transfer switch, located near the control panel at the diesel generator can be used to transfer to backup Class 1E dc power.

Loading of the diesel generators during the recirculation phase is under the control of the operator. To aid in loading these units, instruments are provided to indicate their load at all times.

For additional information on instrumentation application, refer to Section 8.3.1.1.6.5

8.3.1.1.6.3.6 General Design Criterion 17, 1971 – Electric Power System

The EDG system is required to have sufficient capacity, capability, independence, redundancy, and testability to perform its safety function assuming a single failure.

The emergency power system includes onsite, independent, automatic starting diesel generators that supply power to essential auxiliaries if normal power sources are not available.

Three dedicated 4.16-kV, three-phase, 60-Hz, 2600-kW, 0.8 PF continuous rating diesel generators are provided for each unit as shown in Figure 8.1-1. The individual diesel generator units are physically isolated from each other and from other equipment. Each diesel generator supplies power to its associated 4.16-kV Class 1E bus (refer to Figures 8.3-4, 1.2-16, and 1.2-20).

The ESF loads and their onsite sources are grouped so the functions required during a major accident are provided regardless of any single failure in the electrical system. Any two of the three diesel generators and their buses are adequate to serve at least the minimum required ESF loads of a unit after a major accident.

Refer to Section 8.3.1.1.3.3.5.2 for additional discussion of ESF load grouping.

Section 8.3.1.1.6.3.13 discusses EDG capacity and Section 8.3.1.1.6.4 demonstrates EDG system testability.

8.3.1.1.6.3.7 General Design Criterion 18, 1971 – Inspection and Testing of Electric Power Systems

Descriptions of the inspections and tests are provided in Section 8.3.1.1.6.4.

8.3.1.1.6.3.8 General Design Criterion 21, 1967 – Single Failure Definition

The ESF loads and their onsite standby sources (EDGs) are grouped so the functions required during a major accident or transient coincident with a complete loss of the preferred power source are provided regardless of a single failure of an EDG. Any two of the three diesel generators and their buses are adequate to serve the required ESF loads of a unit after a major accident or transient.

The single failure criterion applies to the DFO system. Refer to Section 9.5.4.3.7 for discussion related to the DFO system.

8.3.1.1.6.3.9 Emergency Diesel Generator Systems Safety Function Requirements

(1) Protection from Missiles

The engine generator units and their associated auxiliary systems, as shown for Unit 1 in Figures 9.5-8 through 9.5-10, and similarly for Unit 2, are installed in separate compartments that provide protection from internal missiles.

Because the engine generator units are separated from each other by the concrete walls of the compartments, the units are protected from postulated internal missiles. Any missile created by an explosion within a compartment would remain in that compartment.

The provisions taken to protect the EDG system from missiles resulting from plant equipment failures and from events and conditions outside the plant are discussed in Sections 3.5 and 8.3.1.4.10.2.

(2) Protection Against High Energy Pipe Rupture Effects

The provisions taken to protect the EDG system from damage that might result from dynamic effects associated with a postulated rupture of high-energy piping are discussed in Sections 3.6 and 8.3.1.4.10.3.

(3) Protection from Moderate Energy Pipe Rupture Effects – Outside Containment

The provisions taken to provide protection of the EDG system portion located outside containment from the effects of moderate energy pipe failure are discussed in Section 3.6.

(4) Protection from Flooding Effects – Outside Containment

The provisions taken to provide protection of the EDG system portion located outside containment from flooding that might result from the effects associated with a postulated rupture of piping are discussed in Section 3.6.

The possibility of flooding in the turbine building is discussed in Sections 9.2.1, 9.2.2, 9.2.7, 10.4.5, and 10.4.7 under the service cooling water, CCW, ASW, circulating water and condensate and feedwater systems, respectively. Flooding in these areas of the turbine building were assessed for impact on the diesel generator compartments.

High-energy line breaks outside the containment that could affect the turbine building are discussed in Section 3.6. There is no significant source of water within any of the engine generator compartments, and the design of the engine generator compartments (refer to Figures 1.2-16 and 1.2-20) prevents flooding within the generator compartments because the cross-sectional area for water to enter the compartments is less than the cross-sectional area for water to exit the compartments.

8.3.1.1.6.3.10 10 CFR 50.55a(g) – Inservice Inspection Requirements

Only the EDG jacket water cooling system components are included in the DCPP Inservice Inspection Program per 10 CFR 50.55a(g)(4) and 10 CFR 50.55a(g)(5).

8.3.1.1.6.3.11 10 CFR 50.63 – Loss of All Alternating Current Power

The SBO analysis demonstrates that the plant can be safely shutdown following a SBO event utilizing Bus F and its normally connected EDG (AAC source). The AAC source is a Class 1E EDG and meets the criteria for an AAC stated in NUMARC-8700 (Reference 23). The AAC source will be available within 10 minutes of the onset of SBO with a target reliability of 0.95. The SBO Analysis demonstrates that the AAC source has sufficient capacity and capability to operate systems necessary for coping with a SBO for the required duration of 4 hours to maintain the unit in a safe shutdown condition (Mode 3). Refer to Section 8.3.1.6 for a complete discussion of SBO.

8.3.1.1.6.3.12 10 CFR 50.48(c) – National Fire Protection Association Standard NFPA 805

The EDG system is designed to meet the nuclear safety and radioactive release performance criteria of Section 1.5 of NFPA 805, 2001 Edition (refer to Section 9.5.1).

8.3.1.1.6.3.13 Safety Guide 9, March 1971 – Selection of Diesel Generator Set Capacity for Standby Power Supplies

The diesel generators have a net continuous electrical output rating of 2600 kW at 0.8 PF, and 2750 kW at 0.8 PF, for 2000 hours per year. Short-term ratings of the diesel generators are 2860 kW at 0.8 PF for 2 hours per 24-hour period, and 3056 kW at 0.8 PF for 30 minutes per 24-hour period. During the starting sequence for the safeguard loads, these machines can also carry short-time overloads. EDG loading meets the applicable criteria of Safety Guide 9, March 1971 (Reference 8).

Momentary loads consisting principally of transient inrush currents, relay and solenoid short-time currents, starting currents to motors, and starting and operating currents for motor-operated valves are within the short-time capability of the electric power systems and the engine generators.

During a design basis-loading scenario with nominal timer interval, these machines maintain the electric power frequency within 5 percent, hold voltages to a minimum of 75 percent, and recover successfully by complying with Safety Guide 9, March 1971 (Reference 8) with the exception of Regulatory Position C.4. Safety Guide 9, March 1971, Regulatory Position C.4 specifies that during the EDG loading sequence the frequency should be restored to within 2 percent of nominal in less than 40 percent of each load sequence time interval. For AFW pump loading for EDGs 1-1, 1-3, 2-2, and 2-3, the frequency is restored to within 2 percent of nominal in less than 60 percent of the load sequence time interval. Based on test data, EDGs 1-1, 1-3, 2-2, and 2-3 have adequate margin to prevent overlapping of loads and meet the objectives of Safety Guide 9, March 1971, Regulatory Position C.4. This exception to Safety Guide 9, March 1971, was approved in License Amendments 211/213 dated March 29, 2012.

Refer to Section 8.3.1.1.3.3.5.2 for additional discussion of EDG ESF loading and functions.

8.3.1.1.6.3.14 Regulatory Guide 1.97, Revision 3, May 1983 – Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant and Environs Conditions During and Following an Accident

Class 1E, Category 2 indications for each EDG wattage and amperage is provided in the control room for Regulatory Guide 1.97, Revision 3, monitoring (refer to Table 7.5-6).

8.3.1.1.6.3.15 Regulatory Guide 1.108, Revision 1, August 1977 – Periodic Testing of Diesel Generator Units Used as Onsite Electric Power Systems at Nuclear Power Plants

The EDGs are designed to permit inspection and testing of all important areas and features, especially those that have a standby function, in accordance with GDC 18, 1971. This periodic testing ensures that the EDGs will meet their availability requirements. Periodic component tests are supplemented by extensive functional tests during refueling outages.

Additionally, Generic Letter 84-15 was issued to improve EDG reliability by reducing the number of cold fast starts and by eliminating excessive testing. Cold fast starting of EDGs is not applicable to DCPP as the EDGs are equipped with lube oil and water jacket heating devices to maintain the oil and water temperatures at levels which permit immediate assumption of load. Also, engine bearings are lubricated by motor-driven lube oil circulating pumps which run continuously prior to engine start.

8.3.1.1.6.4 Tests and Inspections

The electrical systems have been designed to permit inservice inspection and periodic functional testing. The tests and scheduling are specified in the Technical Specifications. These tests are made to demonstrate that all Class 1E electrical systems are capable of performing their safety functions.

All six Diablo Canyon diesel engine generator units have undergone extensive shop testing to qualify the units as emergency standby power sources. A large part of the shop testing at ALCO Engine Division of White Industrial Power, Inc. was in addition to the normal manufacturer performance tests for units of this type. Special shop tests were conducted to verify the unit design capabilities, their reliability, and their conformance to specification requirements.

A summary of the ALCO shop testing is shown in Table 8.3-8. In addition, extensive preoperational qualification testing was performed for the engine generator units during DCPP startup. A summary of preoperational testing for the engine generators at Diablo Canyon is shown in Table 8.3-9.

Automatic starting of the diesel generators is tested by removal of available power from its offsite source or its bus, simulating a bus UV condition, or by initiating a test from the RPS. The bus should transfer to the offsite source automatically, and the diesel generators should start and reach normal operating conditions if bus voltage is not restored within one second.

The absence of offsite power is simulated by opening the bus feeder breaker, simulating a bus UV condition, or removal of its potential to the transfer control circuits. The test is repeated, with the diesel generator as the source and the loading sequence for the absence of safety injection. In the presence of a test safety injection signal (SIS), the test is repeated with the loading sequence for this condition.

Should there be an actual SIS while the diesel generator is paralleled with the unit auxiliary transformer during a test, the SIS signal would trip the unit auxiliary transformer (preventing a potential overload of the diesel generators), and diesel generator breaker closed prevents transfer of this bus to the startup source. Loads already running on this bus will continue to run, other loads will be started by their SIS timers, and any containment fan coolers running on high will automatically be restarted on low speed.

8.3.1.1.6.5 Instrumentation Applications

All operating conditions that could normally be expected to render the diesel generators incapable of responding to an automatic emergency start signal are alarmed in the control room. A "diesel generator trouble" annunciator is alarmed in the main control room whenever any of the following conditions occur:

(1) Diesel is in manual or test condition

(2) Loss of dc control power

(3) Low fuel level in day tank

(4) Low starting air pressure

(5) Shutdown relay tripped

(6) Lube oil system trouble

(7) Primary filter high differential pressure (Unit 2 only)

In addition to the diesel generator trouble annunciator window, there are alarm annunciator windows and data logger printouts for each of the above seven conditions.

The following abnormal conditions are annunciated in the main control room for each unit:

(1) Engine generator on local control, manual control, or test

(2) Generator circuit breaker on local control

(3) DC control UV

  (a) Engine generator control

(b) Circuit breaker control

(4) Engine starting air pressure - low

(5) Engine fails to start (overcrank)

(6) Engine lube oil system trouble

(a) Low lube oil pressure

(b) Low lube oil level

(c) High lube oil filter differential pressure

(d) High lube oil temperature

(e) Low lube oil temperature

(f) Precirculating lube oil pump failure

(7) Engine cooling system trouble

(a) High jacket water temperature

(b) Low jacket water level

(c) High compartment air temperature

(d) High radiator discharge air temperature

(8) Engine fuel oil system trouble

(a) High/low engine fuel oil day tank level

(b) High/low storage fuel oil storage tank level

(c) Fuel oil transfer pump overcurrent

(d) Low engine fuel oil priming tank level

(e) Fuel oil transfer pump running

(9) Engine crankcase vacuum trouble

(10) Generator stator temperature - high

(11) Ground overcurrent

(12) Generator negative sequence

(13) Engine trip (shutdown relay tripped)

(14) Engine generator circuit breaker trip

(a) Reverse power

(b) Loss of field

(c) Generator differential overcurrent

(15) Auxiliaries UV or overcurrent

(16) Engine generator on backup dc supply

(17) High fuel oil transfer filter differential pressure (Plant common alarm annunciated in Unit 1 control room only)

(18) High diesel room temperature (temperature monitoring system)

If the engine generator unit is started automatically on loss of standby power, or safety injection, or both, the engine trip or shutdown functions are limited to the following:

(1) Engine overspeed

(2) Engine low lube oil pressure

(3) Generator current differential

(4) Emergency stop switch

The engine overspeed trip is a mechanical device relying on centrifugal force to release a spring that, by mechanical action alone, stops the flow of fuel and shuts down the engine. Although a mechanical failure of the device could occur and cause a spurious shutdown of the engine, the manufacturer has many years of satisfactory operational experience with this device in all types of service. Also, the engine overspeed trip is a single-purpose device, designed specifically as a secondary or backup device in the event the normal speed control system malfunctions. Normal engine speed control is provided by the governor. The governor and the overspeed trip are considered independent, redundant devices.

The low lubricating oil pressure shutdown is actuated by two pressure switches in the engine lubricating oil system. Both devices must be actuated by low pressure to shut down the engine. A malfunction by one can be postulated but, by itself, could not generate an engine trip. Also, the low lubricating oil pressure trip is actually a low-low lubricating oil pressure condition. The setpoint for shutdown is 20 psig below the low lubricating oil pressure alarm point at which the operator is informed of the low-pressure condition.

The generator current differential relay has successfully undergone seismic testing as part of the relay boards, as reported in Section 3.10, so false operation due to an earthquake should not occur. False operation under conditions other than an earthquake would occur only due to failure of a particular internal component of the relay.

If the engine generator unit is started manually in the test mode, greater engine protection is provided and the following abnormal conditions, in addition to the four for automatic mode, will also trip the engine:

(1) Engine overcrank (after 10 seconds of engine cranking and failure to start)

(2) Engine high jacket water temperature

Protection of the electrical equipment associated with the engine generator units is provided by opening the generator circuit breaker in the event of any of the trips listed above, and any of the following abnormal electrical conditions:

(1) Generator loss of field excitation

(2) Generator reverse power (antimotoring)

(3) Generator overcurrent

(4) 4.16-kV bus current differential

(5) Generator current differential

(6) Generator field shorting contactor de-energized (loss of jacket water pressure and nominal speed less than 100 rpm)

A trip cutout switch disables the loss of field, reverse power, and overcurrent protection for each diesel generator during normal operation; that is, when the diesel is not in test mode. The switch is located in each bus's respective safeguard relay board and activates an alarm whenever protection is cut in.

Generator loss of field relay, reverse power relay, overcurrent relays, and bus differential relays have been successfully tested for seismic loads, as detailed in Section 3.10, so false operation due to an earthquake will not occur.

8.3.1.2 Analysis

As previously described in this chapter, standby and preferred power supplies are provided, each adequately sized to permit functioning of systems, equipment, and components important to safety. An analysis of the preferred power supply is contained in Section 8.2.2. Section 8.3.1.1 contains an analysis and description of the design and operation of the preferred power supply, including a tabulation of diesel generator capabilities and loading.

The design bases established for the design of the Class 1E electrical circuits, their conductors, and raceways ensure that the nuclear reactor and safeguards system and equipment can operate properly at all times. These bases comply with GDC 17, 1971; GDC 18, 1971; Safety Guide 6, March 1971 (Reference 9); and IEEE 308-1971. In developing these design bases, careful consideration was given to the following factors:

(1) Separation and isolation of redundant electrical circuits

(2) Construction, capacity, and loading of electrical conductors and cables

(3) Construction, arrangement, and conductor fill of electrical raceways

(4) Environmental conditions and protection from physical hazards

(5) Electrical fault protection

The power and control cable insulation used has been specified and tested to meet requirements that exceed IEEE, National Electric Code, or Insulated Power Cable Engineers Association (IPCEA) standards for flame retardance and self-extinguishing capabilities.

8.3.1.3 Conformance with Appropriate Quality Assurance Standards

The Class 1E electrical systems, equipment, and components were designed, fabricated, installed, inspected, and tested under the formal quality assurance program developed during design and construction of the plant. The quality assurance program is described in Chapter 17. Reactor protection system testing is described in Chapter 7.

8.3.1.4 Independence of Redundant Systems

This section presents the criteria and bases for the installation of Class 1E electrical systems. These criteria establish the minimum requirements for preserving the independence of redundant Class 1E electrical systems to ensure that they remain operational during any design basis event.

Each of the redundant, onsite, ac power sources and its distribution system is independent from the others. The Class 1E Buses F, G, and H are each independently supplied by one diesel generator. No swing bus is utilized. There is no provision for automatically paralleling the standby power source of one load with the standby source of another load. There is no provision for automatically connecting one Class 1E load group with another load group or for the automatic transfer of load groups between redundant standby power sources.

8.3.1.4.1 Separation Criteria for Class 1E Systems

Mutually redundant Class 1E electrical power equipment, devices, and circuits are physically separated from each other to meet single failure criteria of the standards. Diablo Canyon is not committed to Regulatory Guide 1.75 separation and isolation requirements.

Major Class 1E electric power distribution equipment is located in individual rooms isolated from non-Class 1E equipment, and also from other mutually redundant Class 1E equipment. In this case, separation of internal wiring is inherently achieved by the amount of spacing of the equipment, isolation by fire-rated concrete walls and floors, and use of fire-rated doors. Where Class 1E circuits of more than one mutually redundant system are in proximity in the same enclosure, panel, board, or unit of equipment, these circuits are run in separate metallic wireways or conduits and are typically connected to different terminal blocks. Separate wireways are not provided for certain low-energy steam generator wide-range water level instrument loops resulting from original plant construction. Exposed wiring at end connections to control devices (such as control switches) is separated by at least 5 inches for mutually redundant circuits. Less than 5 inches of separation is allowed for (a) low-energy signal (instrument loop) connections to indicating devices (such as recorders) that must be functionally grouped to enhance operator comprehension, and (b) certain existing Class 1E ammeters with ≥ 3 inches separation resulting from original plant construction. Mutually redundant circuits in boards and panels are separated by one of the following methods:

(1) Five-inch minimum separation in air

(2) Metallic barrier

(3) Metallic conduit

(4) Glastic barrier

(5) Sealtite Flex

(6) "Scotch Brand" 7700 or equivalent electric arc and fireproofing tape with "Pluton" fabric exposed, and a minimum of a 1/4-inch overlap between wraps. This tape is held in place after application with AMP-TY stainless steel cable ties, or two complete wraps of Varglass silicone tying cord,

Type 46. Maximum length between steel or cord ties does not exceed 18 inches

(7) Varflex Type HA (heat-treated glassbraid)

(8) Varflex silifex sleeving

(9) Silicone RTV fire sealant material

Methods (1) through (5) are used wherever possible. Methods (6) through (9) are used only where methods (1) through (5) are not feasible. In the main control board and console, mutually redundant Class 1E devices are placed in individual modules, 5 inches apart, which provide two thicknesses of metallic or electrical insulating material between them, or the devices are separated by one of the above methods. For low-energy devices (indicators and recorders) unit cases are relied upon for adequate separation. External connections for mutually redundant circuits are brought through separate floor openings and risers. In addition, design for routing of interconnecting wiring is based on a requirement that there be no direct line of sight exposure between mutually redundant circuit conductors.

Electrical conductors that interconnect separate units of equipment or devices throughout the plant are separated for redundant systems in these ways:

(1) Where a separate room is provided exclusively for a group of redundant equipment requiring circuits, the cables may be placed in trays or troughs within the room. With the exception of underfloor wiring beneath the protection racks, these are the only areas where cable trays are used.

(2) In all other areas of the plant, Class 1E circuits are placed in metallic conduit for exposed conduit, and ABS plastic or rigid iron for embedded conduit.

(3) Nuclear protection instrumentation channels are placed in separate raceways. Cable trays under the protection racks are enclosed beneath a subfloor and barriered from each other by solid structural floor support beams. Each protection channel output from the same channel to the same logic train shares the same raceway. Separate raceways are used for the direct inputs to logic Trains A or B.

(4) In the cable spreading areas of each unit, electrical cables for redundant functions are placed in separate conduits. Circuit segregation can be on either a protection channel, train, Class 1E bus, or dc bus basis. All conductors in the cable spreading area associated with safety-related functions are enclosed in metallic conduits. Only non-Class 1E wiring is run in trays, with the exception of underfloor wiring beneath the protection racks.

For more details on separation of protective circuits, refer to Figure 7.3-50 (Sheets 1 and 2).

8.3.1.4.2 Separations and Isolations

Electrical circuits are separated from each other according to class of service and to redundancy group. Separation criteria for mutually redundant circuits are given in the preceding section. Separate raceway systems are used for each of the following service categories:

(1) High-Voltage Power - This category contains all of the power circuits above 600-V; in this case, the 4.16-kV and 12,000-V conductors.

(2) Low Voltage Power and Control - This category includes power circuits below 600-V; in this case, 480-V and 120-Vac/208-V, and also the 120-Vac and 125-Vdc control circuits.

(3) Instrumentation - This category contains the circuits transmitting low-level sensitive signals for instrumentation and process control. It includes the conductors for thermocouples, resistance temperature detectors, and the transducers and transmitters used in the fluid process and electric power instrumentation systems.

(4) Nuclear Instrumentation - This category contains the circuits for the nuclear instrumentation and control system.

8.3.1.4.3 Insulated Electrical Conductors

Electrical conductors are copper, except for some thermocouple wire, and are stranded except for thermocouple, communications, and lighting branch circuits. Conductor sizes are based on the current and temperature ratings given in the National Electric Code (Reference 10), the "Power Cable Ampacities," Publication S-135-1 (Reference 11) of the American Institute of Electrical Engineers (AIEE), or by the cable manufacturer, as appropriate. Cables have been derated for ambient temperature and cable grouping in a common raceway. Low-voltage small power cables have been derated as specified in the National Electric Code, 1968 Edition, Table 3.10-12, and Notes 8 and 15. High-voltage and large power cables have been derated as specified in AIEE Publication S-135-1, Tables VII, VIII, and IX for grouping, and by using a conductor temperature that is less than the rating of the insulation by the same amount that the ambient is above the standard used in the table. Cables located in cable trays may be derated in accordance with Insulated Cable Engineers Association (ICEA) P-54-440 (Reference 19).

8.3.1.4.3.1 Construction and Voltage Ratings

The insulation and jacket materials are selected for their superior electrical and physical characteristics and will perform their function under the most severe conditions expected for the application. The compounds are thermally stable and do not melt. All power and control cable jacket materials are flame retardant. Power and control cable insulations are also flame retardant.

Wire and cables run between equipment located in the conventional environment are insulated with ethylene-propylene rubber or cross-linked polyethylene (XLPE). Jacket materials are either neoprene, hypalon (chlorosulfonated polyethylene [CSPE]), XLPE or linear low density polyethylene. Silicon rubber, polyarlene, polyimide film, Tefzel, XLPE, or equivalent insulation material, with a silicone rubber, polyarlene, Tefzel, hypalon (CSPE), XLPE, or equivalent jacket material are used for circuits located where high ambient temperatures may be encountered.

Within equipment, boards, panels, and devices, insulation is either fluorinated ethylene-propylene, XLPE, polyvinyl chloride (PVC) with an asbestos jacket (NEC Type TA), or PVC alone. The use of PVC has been kept to a minimum and is used only where a manufacturer has standardized production with this material. No PG&E Design Class I or Class 1E panel, board, or equipment has PVC insulated wires, except that devices such as relays, transmitters, and instruments may have some PVC. The small amount of PVC present does not present any problems with respect to toxic effects or corrosive products in the event of fire.

The insulated electrical conductors that externally interconnect separate units of equipment throughout the plant are described in Appendix 8.3B

8.3.1.4.3.2 Test and Inspection

The construction and material composition of each type of cable has been selected based on careful investigation and analysis, including the results of tests performed in accordance with Underwriters' Laboratories (UL), IPCEA-NEMA, AEIC, and PG&E requirements.

All cables for circuits that externally interconnect separate units of equipment were given the production electrical and physical tests described in the standards. Flame tests for low-voltage power, control, and instrumentation cable were made according to UL and IPCEA standard procedures and to special PG&E methods using large groups of wires bundled in a cable tray and a large burner. The cable supplier was also required to make this test. Only cables that were self-extinguishing upon removal of the burner flame were selected. Refer to the previous section for those types of cables requiring flame retardant insulation. Conductors for equipment, boards, panels, and devices were selected and specified on the basis of UL approval for this service and special PG&E or manufacturer's tests.

Conductors required to operate in containment atmosphere during a LOCA were tested in a steam chamber, either by the manufacturer or PG&E, before approval for quotations. Refer to Section 3.11 for additional information on equipment required to operate during a LOCA.

A particular effort was made to ensure that manufacturing standards of the highest quality were maintained in the production of all cables for use in Class 1E circuits. To ensure that the cable, as manufactured, is of the highest quality, PG&E inspectors performed visual inspections and witnessed factory tests on sample reels from each production run of cable.

8.3.1.4.4 Electrical Raceways

The total cross-sectional area of conductors in trays is limited generally to 30 percent of the tray cross-sectional area, with a maximum limit of 32 percent unless otherwise approved by an engineering evaluation. Electrical conduits are designed to the limits given in the NEC. The limit of 40 percent conduit fill is generally required, with a maximum of 42 percent fill unless otherwise approved by an engineering evaluation.

Electrical raceways that interconnect individual sets or units of equipment throughout the plant are arranged to provide separate raceways for each class of service and redundancy group. Also, separate raceways are provided for Class 1E electrical systems. Exposed raceways are either cable tray or metallic electrical conduit. Embedded raceways are ABS plastic of standard iron pipe size, except that some very short lengths are rigid iron.

8.3.1.4.5 Cable Trays

Cable trays are generally of the ventilated uncovered type. Solid bottom or covered trays are placed in locations where protection is needed and ventilation may be reduced. Trays are made of formed steel, hot-dip galvanized, with sides 3 inches high and widths up to 24 inches. The trays comply with NEMA Standard VE-1-1965 for Class 2 construction. Aluminum trays are used in a few cases where severe corrosion of steel is a problem, such as at the intake structure. Aluminum is not used in the containment. Cable trays for Class 1E systems are only installed where a separate room is provided exclusively for each mutually redundant group of Class 1E circuits.

8.3.1.4.6 Conduit

Metallic conduits are generally hot-dipped galvanized steel, either rigid iron or electrical metallic tubing. Aluminum conduit is used where magnetic induction may be a problem. Aluminum, Stainless Steel or PVC-coated rigid iron conduit may be used where corrosion is present, such as at the intake structure. Aluminum conduit is not used in the containment. Stainless steel conduit is used, as needed, for example where electrical circuits enter stainless steel liners. Flexible liquid-tight conduit is used in short sections where vibration or differential expansion may occur. An exception to this is the reactor head assembly where long flexible liquid-tight conduits exist for the convenience of the reactor head removal process upon refueling. Long flexible conduits in cable trays are also utilized in the cable spreading room for the white light circuits due to space limitations. Plastic (ABS) conduit is installed completely encased in concrete or in earth beneath a protective concrete slab. Metallic conduit is installed for mutually redundant Class 1E electrical circuits where they are close to, and exposed to, each other.

8.3.1.4.7 Supports

Cable trays are supported on spans of 8 feet or less, and also at each end of the fittings. Unless otherwise approved by an engineering evaluation, exposed conduits are supported at intervals of 8-1/2 feet or less, and also within 4 feet of any termination. Supports for Class 1E electrical raceways are designed to withstand the seismic forces established for the location. Refer to Section 3.10 for more information on seismic design. PG&E Design Class I supports are not normally shared by mutually redundant Class 1E circuits. Exceptions to this are areas such as in the cable spreading room under the control room and in the fuel handling building at elevation 100 feet. However, as stated earlier, all PG&E Design Class I supports are seismically qualified.

8.3.1.4.8 Penetrations

Cable penetrations through walls are (a) in jumboduct embedded in concrete (refer to Figures 8.3-21 and 8.3-22), (b) in conduit embedded in concrete (refer to Figure 8.3-23), or (c) in conduit passing through a wall opening with the space between the conduit and the concrete sealed as described below. Containment penetrations by high- and low-voltage and signal cables are either a canister-type design or feed through penetration modules that provide a single seal as part of the pressure barrier. Containment penetrations are also provided as part of the personnel and emergency airlocks. Additional information on the containment penetration design is provided in Section 3.8.2.1.1.3.1. These containment penetrations are LOCA qualified as described in Section 3.11.

Overcurrent protection of the containment electrical penetrations meets the requirements of Regulatory Guide 1.63, Revision 1 (Reference 12). In addition, non-Class 1E penetration overcurrent protection has procurement documentation or an engineering evaluation verifying the capability to protect the penetration during and after a DE.

The electrical penetrations are designed and built in accordance with IEEE 317-1971 (Reference 32) with the following exceptions:

(1) Prototype tests were not made with all of the physical conditions of the accident environment applied simultaneously with the electrical tests, although they were successfully made separately. For example, the momentary current tests on power penetrations are not run under

simulated accident conditions. It is felt that such tests need not be made simultaneously because the construction of the penetration assemblies is such that the outer seal is located about 4-1/2 feet away from the inner seal and the containment liner and, therefore, will not be exposed to accident environmental conditions. The integrity of the containment is, therefore, maintained at the penetration assemblies during a LOCA.

(2) Dielectric strength tests were conducted in accordance with the NEMA standard that permits testing of this type of equipment at 20 percent higher than twice-rated voltage plus 1000-V for 1 second.

Wire and cable splice samples used at the containment penetrations were tested under conditions simulating a LOCA environment. Refer to Section 3.11 for a discussion on Class I electrical equipment EQ.

8.3.1.4.9 Fire Barriers and Separation

Adequacy of design with regard to fire hazards in areas of concentration of electrical cables is analyzed in Section 8.3.1.4.10.1. Section 9.5.1 covers the fire protection program and system.

Penetration fire stops and seals between rooms, fire seals inside conduits, fire stops on vertical and horizontal trays, and fire seals under equipment all serve to control and prevent propagation of fire from one redundant system to another, and from one room to another. All jumbo ducts for cable trays are provided with fire stops where they penetrate walls, floors, ceilings, and electrical equipment. In addition, fire stops are installed at intervals of 5 feet on vertical trays and 12 feet on horizontal trays, and within 5 feet of tray crossings, either above or below. Reference drawing 050029, DCP A-47854, DCP M-049476, and FPEEs 101 and 103. Typical fire stops are shown in Figures 8.3-24 through 8.3-28. Conduits are provided with fire stops at the penetration of a fire barrier or at the nearest accessible point to that penetration. All cable entrances to the cable spreading room, control room areas, and interconnecting cable entrances between these two rooms are sealed to ensure the integrity of each area. Materials used for fire stops and seals are described in Appendix 8.3C.

8.3.1.4.10 Class 1E Separation and Protection Criteria

Separation and protection of mutually redundant Class 1E systems prevent the loss of safeguard functions. Thus, a function is available even if the use of one redundant system is lost.

The criteria discussed in this section ensure protection for safeguard functions in case of fire, missiles, pipe whip, and jet impingement. (Protection from natural hazards such as earthquake, flood, and tornado is discussed in Sections 3.10, 3.4, and 3.3, respectively.)

8.3.1.4.10.1 Fire

Specifications require that Class 1E cables be insulated with materials that do not support fire and are self-extinguishing. This prevents the spread or support of combustion from the original location of any fire along Class 1E cable. Outside of Class 1E equipment rooms, all mutually redundant Class 1E cables are required to be run in separate metallic conduit. This conduit prevents direct flame contact with Class 1E cable. Thus, it provides a second barrier to fire propagation along Class 1E cable.

Specifications require that electrical conductors have adequate ratings and overcurrent protection to prevent breakdown of insulation or excessive heating. Thus, fires will not be started in cable inside conduits due to overcurrent.

IEEE 308-1971 requires that Class 1E equipment be located in individual rooms. This isolates Class 1E equipment from non-Class 1E equipment and from mutually redundant Class 1E equipment. Isolation from fire is accomplished through the use of concrete walls with fire dampers and penetration seals, as necessary. It is not credible for fire to spread between rooms. Therefore, mutually redundant Class 1E equipment will not be disabled by a single fire.

10 CFR 50.48(c), National Fire Protection Association Standard NFPA 805 (Reference 13), provides criteria for protection of equipment and circuits required for safe shutdown. These criteria ensure that redundant safe shutdown trains will not be damaged as a result of a single fire. Protection of redundant trains is provided by a combination of physical separation, fire-rated barriers, and/or automatic suppression and detection. Exceptions to these criteria are documented based on the fire hazard in the area and/or other compensatory fire protection features provided.

The diesel generator and Class 1E cable spreading rooms are protected by an automatic CO_2 fire extinguishing system. Any fire starting in the cable spreading room will be extinguished in time to prevent the loss of safe shutdown capability. Class 1E cables are also run in rooms containing equipment that is not Class 1E. The possibility of fires starting in these rooms has been analyzed. It is not credible that any fire that may start in these rooms could destroy a protection function and impair plant safety.

As discussed above, fire will not cause a loss of any protection function for the following reasons:

(1) Class 1E equipment will not support fire or is protected by fire extinguishing equipment.

(2) Class 1E systems are physically separated.

(3) Redundant safe shutdown trains are separated and protected in accordance with NFPA 805, Section 4.2.3, with exceptions.

For further information on fire protection, refer to Section 9.5.1.

8.3.1.4.10.2 Missiles

The basic approach for protection of Class 1E equipment and cables from missiles is to ensure design adequacy against generation of missiles. Where missiles cannot be contained within parent equipment, missile protection is attained by routing or placing Class 1E cables and equipment in nonmissile-prone areas or by shielding the equipment.

Section 3.5 discusses postulated high-energy missiles. Class 1E cables and equipment are routed and placed so that they are protected from these missiles.

Outside of areas affected by high-energy missiles there is a very low probability of missile generation. Class 1E cables are protected from any possible low-energy missiles by the conduit in which they run.

Class 1E equipment, located in individual rooms, is protected from missiles generated outside the rooms by concrete walls and floors. After redundant Class 1E cables have passed into rooms where they make connections, they may be run in cable trays. However, mutually redundant wiring is not run in the same room. Therefore, missiles generated in the room will not cause a loss of any protection function.

8.3.1.4.10.3 Pipe Whip and Jet Impingement

The protection of Class 1E equipment and cables from pipe whip and jet impingement has been studied (refer to Section 3.6). All Class 1E cables and equipment required for this accident are protected from damage caused by these hazards.

8.3.1.5 Physical Identification of Safety-Related Equipment

Class 1E electrical power equipment is located in individual rooms isolated from non-Class 1E equipment and also from each other for mutually redundant sets of equipment. Nameplates on the sets of equipment and on the entrances to the rooms identify the equipment.

8.3.1.5.1 Color Coding

Some electrical systems are color-coded:

(1) The Class 1E electrical power systems and equipment for each mutually redundant system

(2) The RPSs

(3) The 120-Vac power circuits from the instrument inverters to the reactor protection channels

(4) Control, indication, and annunciation circuits that are not required for safe shutdown that are in Class 1E raceways

These colors are listed in Table 8.3-10 and have been applied to the Class 1E electrical circuits and their raceways that externally interconnect individual sets or units of equipment.

Internal wiring within units of equipment are not necessarily color-coded. Where a set of equipment is only one redundancy class that is clearly identified by other means, the circuits may have some or all of the conductors without any color coding. Standard Type TA switchboard wire, for example, is available in either black or gray colors only.

Where circuits of more than one mutually redundant system appear in the proximity or the same enclosure, the circuits have either the conductors, their bundling bands, or wireways identified by the assigned color code.

Conductors of control, indication, and annunciation circuits that are not required for safe shutdown may, to improve reliability, be purchased and installed as Class 1E and color-coded. These circuits are designed with sufficient isolation to ensure that a single failure does not propagate to the mutually redundant device. Circuits that do not serve safety-related functions, but are affiliated with safety-related devices, are colored consistent with the safety-related device, train, or circuit. Consequently, the coloring of these nonsafety-related circuits may not necessarily reflect the color code of their electric power sources.

Generally, non-Class 1E electric systems are assigned the color black. Because of certain industry standard practices, some non-Class 1E conductors are color-coded. These conductors are in circuits that are in no way related to those for operating the plant and are kept entirely separate. The functions of these systems are so obvious that there should be no confusion with the colors. These circuits are:

(1) Communication - these circuits are generally multiconductor with color-coded individual conductors.

(2) Thermocouple - these circuits are always multiconductor and have individual conductors colored according to the ISA standard to denote the type of metal. However, the jacket is generally color-coded to match the assigned redundancy group. Special applications and systems may have other color-coding.

(3) Lighting - these circuits have conductors color-coded according to the NEC.

Electrical conductors that interconnect separate units of equipment are identified by the color assigned to the system. On multiconductor cables, the color code is generally applied to the outer jacket and also to the individual conductors, except that thermocouple extension conductors have the ISA standard color designated for the type of metal. Each electrical raceway has its identification number stenciled in paint at readily visible places on its surface in the following colors:

(1) Black - all circuits 600-V and below

(2) Red - all circuits above 600-V

Cable tray designations are 1-inch high and spaced not more than 15 feet apart. Conduit designations are 1-inch high, except that designations for conduits smaller than 1 inch are 1/2-inch high, and placed at each end of the conduit, at pull boxes, and at intermediate points to effectively identify the run.

In addition, each Class 1E raceway, either conduit or tray, is distinctly marked at termination points and at intermediate points with a vertical stripe, 2-inches wide, and colored to match the circuits within. The color code is given under the description of electrical conductors.

8.3.1.5.2 Design and Installation

The design of electrical circuits is developed from the system requirements in conjunction with the manufacturer's circuits selected to perform the required functions. Past practices that have been successfully used by PG&E and the industry are also included in the design where possible. Functional analyses are made on the circuits by the designers and engineers during the completion of the schemes. Further review and coordination is made with persons whose interests are affected by the operation of the circuit. Final approval is made in the manner described in Chapter 17, Quality Assurance.

Electrical circuits are shown on the type of diagram appropriate to the information desired. Diagrams generally consist of these types: single line meter and relay, schematic, logic, block or functional, and connection. Conductor and main circuit numbers, as well as the equipment identification, are given in the schematic diagrams. Power conductor sizes are given in the single line meter and relay diagrams and checked by the responsible engineer.

Electrical circuits that interconnect separate units of equipment and devices throughout the plant are compiled, tabulated, and checked by electronic data processing equipment. Each termination point is given a unique designation, referred to as the location code, for convenience and to prevent ambiguity.

Each type of electrical conductor is given a unique code (known as the wire code) that identifies its class of service and redundancy group. Also, each individual electrical conductor has a unique identity given by its wire ID and circuit number.

Each circuit is listed, giving the size and number of conductors, the raceway routing and termination points, and the identification symbol, coded to denote the circuit class of service and redundancy group and the conductor type, rating, and color. These listings are then checked manually against approved electrical diagrams. Also, the connection diagrams and a computer listing of circuits and conductors arranged by termination location are cross-checked manually. In addition, the computer checks that the circuits and raceways selected are of the same class of service and redundancy group.

Each raceway, tray, or conduit is assigned a unique code, referred to as the tray or conduit number. The raceway is then listed, giving its type, size, terminating or junction points, and the arrangement drawings showing its physical layout.

Separate circuit schedules are made for each class of service except for lighting branch circuits and telephone cables that are shown only on diagrams. Circuit schedules are typically not utilized for loads fed from the 12-kV underground distribution system.

The circuit information is stored by computer using a software program in the form of electronic drawings distributed by downloading from the network to individual computers. The electronic drawings can then be printed for use in the field.
The circuit information software checks that the raceway contains only the allowable grouping of circuits according to the class of service and redundancy. The software also calculates the percentage fill. Any overfills are corrected manually.

Individual circuit installation records for the installation and termination of the electrical circuits are derived from circuit data stored by computer using a software program. Each circuit installation record consists of installation and termination data. All predetermined data is entered in these forms.

The installation data may include the circuit schedule, termination locations, raceway routing, cable data, and purchase order or stock code.

Termination data may provide the diagram of connection for each termination point and the type and size of connectors and tools used.

Circuit and raceway installation data is retained for quality assurance purposes.

The methods and procedures for the design and installation of Class 1E electrical equipment and material are described in Chapter 17, Quality Assurance.

8.3.1.6 Station Blackout

SBO at DCPP is defined as loss of power from the preferred power source concurrent with turbine trip and the failure of two emergency AC (EAC) sources (EDGs) in the unit experiencing the SBO (References 20 through 23). The other unit is assumed to experience only a LOOP.

To comply with the requirements of 10 CFR 50.63, a sixth EDG was added to Unit 2 and the existing (swing) fifth EDG was made Unit 1 specific. There are now three dedicated EDGs per unit.

The DCPP units are assigned an allowed EDG target reliability of 0.950 and a SBO duration of 4 hours. The Bus F EDGs 1-3 and 2-3, the designated AAC power sources, are available within ten minutes from the onset of the SBO event. These EDGs have sufficient capacity and connectability to operate systems necessary for mitigating a SBO event for the required duration of 4 hours to maintain the reactor in a safe shutdown condition (Mode 3).

The DCPP SBO analysis was performed using the guidance provided in NUMARC-8700, Rev. 0 (Reference 23) and Regulatory Guide 1.155, August 1988 (Reference 31), which contains guidance that is not provided in NUMARC-8700. Using this guidance, the postulated maximum SBO duration for DCPP was determined to be 4 hours. This SBO duration time was determined using the methodology in Reference 23 based on the following factors:

(1) The site susceptibility to grid-related LOOP events of greater than 5 minutes duration is less frequent than once per 20 years. Grid-related LOOP events are defined as losses of offsite power associated with the loss of the transmission and distribution system due to insufficient generating capacity, excessive loads, or dynamic instability. Although grid failure may also be caused by other factors, such as severe weather conditions or brush fires, these events are not considered grid-related since they are caused by external events.

(2) The probability of LOOP due to the occurrence of extremely severe weather at the plant site based on site specific wind speed data is low. The probability of loss of offsite power due to the occurrence of severe weather at the plant site is low based on historical weather data.

(3) The plant is served by two offsite power circuits connected to the plant's Class 1E buses through two electrically independent switchyards.

(4) Each unit has two redundant and independent EAC power sources not credited as an AAC power source; only one EAC power source per unit is necessary to operate safe shutdown equipment following a loss of offsite power (EAC Power Supply System Configuration Group C).

(5) The target reliability of the EDGs is equal to 0.95.

8.3.1.6.1 Emergency AC Analysis

As discussed in Section 8.3.1.6 above, the EAC classification for DCPP is Group C. For DCPP, the EAC criteria require that the unit under consideration be capable of attaining Mode 5 in the event of a loss of offsite power (LOOP) and single failure (within each unit), without use of the designated AAC source. The DCPP EAC analysis demonstrates that the plant can be safely shutdown to Mode 5 utilizing either Bus G or H and its normally connected EDG (EAC source) independent of the third EDG (considered the AAC source) and its Bus F.

When Bus G is the available bus, the turbine-driven AFW pump is credited for operation. When Bus H is the available bus, the motor-driven AFW pump powered by Bus H, supplemented by the turbine driven AFW pump, is credited for operation. The EAC analysis determined that the only required shutdown system not provided on Bus H is the ASW system. However, ASW can be made available (even given an active failure or bus failure on the other unit) through the ASW hydraulic interconnection between units. To accomplish the unit-to-unit ASW interconnection, the analysis assumes the common unit valve FCV-601 would be manually opened. One ASW pump is capable of supplying sufficient flow to both a Unit 1 and a Unit 2 CCW heat exchanger, thus handling the shutdown heat loads from both units.

For purposes of the EAC analysis, to determine the adequacy of the Unit 1 or Unit 2 EDGs as EAC sources, no credit is taken for the plant procedure which allows for interconnecting 4.16-kV electrical buses. However, during an actual SBO event, appropriate use of electrically interconnected buses within existing procedural guidance will be made.
During a SBO event, operator action is necessary to energize the battery charger(s), within the 2-hour battery duty cycle, to provide at least two input channels of instrumentation to monitor system functions and actuate one train of safeguards equipment. This action involves closing an input and output breaker to battery charger 121(221) if Bus G is not available.

Sufficient input channels may be deenergized such that a SI signal may be initiated. However, it was determined that generation of an inadvertent SI signal is acceptable and does not interfere with maintaining the safe shutdown of the unit.

8.3.1.6.2 Alternate AC Analysis

The SBO AAC analysis demonstrates that the Bus F EDGs satisfy the criteria specified in Appendix B to NUMARC-8700, and will be available within ten minutes of the onset of the SBO event, and has sufficient capacity and capability to operate systems necessary for the required duration of 4 hours to maintain the unit in a safe shutdown condition (Mode 3). Although AAC analysis is focused on the Bus F EDGs as the AAC source, any EDG and Class 1E bus could act as the AAC source. Plant procedures, in recognition that multiple buses are likely to be available, take advantage of the ability to electrically cross-connect buses to most effectively provide the required functions to maintain safe shutdown. Because the AAC source will be available within 10 minutes, no coping analysis is required to be performed.

The SBO AAC analysis is not required to assume a concurrent single failure or design basis accident. In addition, Regulatory Guide 1.155 (Reference 31) permits the use of non-safety-related systems and equipment to respond to a SBO event. Based on the SBO AAC analysis, operation of required systems and components were evaluated for the required duration of 4 hours to maintain the unit in a safe shutdown condition. The only equipment not available from the AAC Bus F is the DFO transfer pumps which can be supplied from either Bus G or Bus H of the other unit, and one subtrain of control room cooling, which is available from the other unit.

During an SBO event, operator action is necessary to energize the battery charger(s) within the 2 hour battery duty cycle, to provide at least two input channels of instrumentation to monitor system functions and actuate one train of safeguards equipment. This action involves closing an input and an output breaker to Battery Charger 131 (231).

Sufficient input channels may be deenergized such that a SI signal may be initiated. The additional loading on Bus F of the SI pump can be accommodated; such an inadvertent SI is acceptable.

Plant-specific procedures were reviewed and updated to incorporate the requirements associated with the recovery from an SBO event. Recovery plans that include coordination with other power stations to re-route power to DCPP were also developed and implemented (Reference 21).

8.3.2 DC POWER SYSTEMS

There are two dc power systems in each unit at Diablo Canyon. One is a non-Class 1E system serving 125-Vdc and 250-Vdc non-Class 1E loads. The other is a Class 1E system serving Class 1E 125-Vdc loads that include ESF loads and some non-Class 1E loads (refer to Figures 8.3-17 and 8.3-18).

8.3.2.1 Design Bases

8.3.2.1.1 General Design Criterion 2, 1967 – Performance Standards

The Class 1E 125-Vdc system is designed to withstand the effects of or be protected against natural phenomena, such as earthquakes, tornadoes, flooding, winds, tsunamis, and other local site effects.

8.3.2.1.2 General Design Criterion 3, 1971 – Fire Protection

The Class 1E 125-Vdc system is designed and located to minimize, consistent with other safety requirements, the probability and effect of fires and explosions.

8.3.2.1.3 General Design Criterion 4, 1967 – Sharing of Systems

The 125-Vdc system or components are not shared by the DCPP units unless it is shown safety is not impaired by the sharing.

8.3.2.1.4 General Design Criterion 11, 1967 – Control Room

The Class 1E 125-Vdc system is designed to or contains instrumentation and controls that support actions to maintain the safe operational status of the plant from the control room or from an alternate location if control room access is lost due to fire or other cause.

8.3.2.1.5 General Design Criterion 12, 1967 – Instrumentation and Control

The Class 1E 125-Vdc system design has instrumentation and controls to monitor and maintain system variables within prescribed operating ranges.

8.3.2.1.6 General Design Criterion 17, 1971 – Electric Power Systems

The Class 1E 125-Vdc system design has sufficient capacity, capability, independence, redundancy, and testability to perform its safety function assuming a single failure.

8.3.2.1.7 General Design Criterion 18, 1971 – Inspection and Testing of Electric Power Systems

The Class 1E 125-Vdc system design permits appropriate periodic inspection and testing of functional and operational performance of the system as a whole and under conditions as close to design as practical.

8.3.2.1.8 General Design Criterion 21, 1967 – Single Failure Definition

The Class 1E 125-Vdc system is designed to remain functional after sustaining a single failure. Multiple failures resulting from a single event shall be treated as a single failure.

8.3.2.1.9 General Design Criterion 24, 1967 – Emergency Power for Protection Systems

The Class 1E 125-Vdc system provides an alternate source of power to permit the required functioning of the protection systems in the event of loss of all offsite power.

8.3.2.1.10 General Design Criterion 40, 1967 – Missile Protection

The ESF portion of the Class 1E 125-Vdc system is designed to be protected against dynamic effects and missiles that result from plant equipment failures.

8.3.2.1.11 General Design Criterion 49, 1967 – Containment Design Basis

The Class 1E 125-Vdc and non-Class 1E 125-Vdc circuits routed through containment electrical penetrations are designed to support the containment design basis so that the containment structure can accommodate, without exceeding the design leakage rate, the pressure and temperatures following a LOCA.

8.3.2.1.12 Class 1E 125-Vdc System Safety Function Requirements

(1) Protection from Missiles

The Class 1E 125-Vdc system is designed and located to be protected against the effects of missiles which may result from plant equipment failure and from events and conditions outside the plant.

(2) Protection Against High Energy Pipe Rupture Effects

The Class 1E 125-Vdc system is designed and located to accommodate the dynamic effects of a postulated high-energy pipe failure to the extent necessary to assure that a safe shutdown condition of the reactor can be accomplished and maintained.

(3) Protection from Moderate Energy Pipe Rupture Effects – Outside Containment

The outside containment portion of the Class 1E 125-Vdc system required to bring the plant to cold shutdown is designed to be protected against the effects of moderate energy pipe failure.

(4) Protection from Jet Impingement – Inside Containment

The inside containment portion of the Class 1E 125-Vdc system is designed to be protected against the effects of jet impingement which may result from high energy pipe rupture.

(5) Protection from Flooding Effects – Outside Containment

The outside containment portion of the Class 1E 125-Vdc system required to bring the plant to cold shutdown is to be protected from the effects of internal flooding.

8.3.2.1.13 10 CFR 50.49 – Environmental Qualification of Electric Equipment

The Class 1E 125-Vdc system electric components that require EQ are qualified to the requirements of 10 CFR 50.49.

8.3.2.1.14 10 CFR 50.62 – Requirements for Reduction of Risk from Anticipated Transients Without Scram Events for Light-Water-Cooled Nuclear Power Plants

The non-Class 1E 125-Vdc power source, as required for ATWS, provides a source that is independent form the protection system power supplies.

8.3.2.1.15 10 CFR 50.63 – Loss of All Alternating Current Power

The Class 1E 125-Vdc system provides power to the loads required to support systems that ensure core cooling and containment integrity is maintained from the AAC source following a SBO.

8.3.2.1.16 10 CFR 50.48(c) – National Fire Protection Association Standard NFPA 805

The Class 1E 125-Vdc system is designed to meet the nuclear safety and radioactive release performance criteria of Section 1.5 of NFPA 805, 2001 Edition.

8.3.2.1.17 Safety Guide 6, March 1971 – Independence Between Redundant Standby (Onsite) Power Sources and Between Their Distribution Systems

The Class 1E 125-Vdc system is designed so dc electrically powered safety loads are separated into redundant load groups so that loss of any one group will not prevent the minimum safety functions from being performed. Each dc load group should be energized by a battery and battery charger. The battery-charger combination should have no automatic connection to any other redundant dc load group. If means exist for manually connecting redundant load groups together, at least one interlock should be provided to prevent an operator error that would parallel the standby power sources.

8.3.2.1.18 Safety Guide 32, August 1972 – Use of IEEE Standard 308-1971 Criteria for Class 1E Electric Systems for Nuclear Power Generating Stations

Safety Guide 32, August 1972 identifies a conflict between IEEE 308-1971 and GDC 17, 1971, specifically with respect to battery charger supply. IEEE 308-1971 requires that each battery charger supply shall furnish electric energy for the steady-state operation of connected loads required during normal operation while maintaining its battery in a fully charged state, and have sufficient capacity to restore the battery from the design minimum charge to its fully charged state while supplying normal steady-state loads. In contrast, the equivalent provision of GDC 17, 1971 requires that the onsite electric power supplies shall have sufficient independence, redundancy, and testability to perform their safety functions assuming a single failure. This safety guide imposes GDC 17, 1971, which does not restrict the battery charger supply load to that of the steady-state condition during normal operation.

8.3.2.1.19 Regulatory Guide 1.63, Revision 1, May 1977 – Electrical Penetration Assemblies in Containment Structures for Light-Water-cooled Nuclear Plants

The Class 1E 125-Vdc and non-Class 1E 125-Vdc circuits routed through containment electrical penetrations are designed to the requirements of Regulatory Guide 1.63, Revision 1, for installation of redundant or backup fault current protection devices to limit fault current to less than that which the penetration can withstand, assuming a single random failure of the circuit overload protective device.

8.3.2.1.20 Regulatory Guide 1.97, Revision 3, May 1983 – Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant and Environs Conditions During and Following an Accident

The Class 1E 125-Vdc battery voltmeters and ammeters located in the control room are credited Regulatory Guide 1.97, Revision 3, indications for power supply status.

8.3.2.2 System Description

8.3.2.2.1 Non-Class 1E 125-Vdc / 250-Vdc Power System

The non-Class 1E system consists of three 60-cell, 125-Vdc nominally rated batteries. Two of these batteries are connected in series to provide 250-Vdc power to a 250-Vdc MCC. The MCC serves the non-Class 1E 250-Vdc loads, as shown in Figure 8.3-18, Sheet 1 of 2. The 125-Vdc distribution panels associated with these batteries supply power non-Class 1E 125-Vdc loads, as shown in Figure 8.3-18. The third battery provides non-Class 1E 125-Vdc power to the plant process computer UPS. Each of the three batteries is continuously charged by a battery charger. The battery chargers are powered from separate 480-V non-Class 1E buses.

8.3.2.2.2 Class 1E 125-Vdc Power System

The Class 1E dc system consists of, or has, the following features (refer to Figure 8.3-17):

(1) Three 60-cell (refer to Section 8.3.2.3.6.3 for 59-cell configuration), 125-Vdc batteries.

(2) Three separate 125-Vdc power distribution switchgear assemblies, each including a 125-Vdc bus, circuit breakers, fuses, metering, and two distribution panels.

(3) Five battery chargers. Each of the three 125-Vdc switchgear buses has a battery charger. Batteries 11(21)[a] and 12(22) have an additional swing

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[a] Each unit's dc power system is identical; therefore, unit identification is as follows: e.g., 11, 12, and 13 = Unit 1, and (21), (22), and (23) = Unit 2.

backup battery charger that can be connected to either bus by manually closing one of the two interlocked breakers. The fifth battery charger is a backup charger for battery 13(23). Manual operation of a circuit breaker is required to place this battery charger in service on the bus. No interlock is provided between the two battery chargers on this bus.

(4) The system and equipment is designed Class 1E from, and including, the batteries to, and including, the molded case distribution panel circuit breakers.

8.3.2.2.2.1 Class 1E Power Distribution System Equipment

The dc power distribution system for each unit consists of three completely metal-enclosed switchgear assemblies, as follows:

(1) Three separate 125-Vdc copper Buses 11(21), 12(22), and 13(23) are completely enclosed in their own metalclad switchgear. Each bus is rated at 1200 amperes continuous. There is one 125-Vdc, 60-cell (refer to Section 8.3.2.3.6.3 for 59-cell configuration) battery supplying each 125-Vdc bus. Source protection is provided by fuses rated at 3000 amperes.

(2) Two 125-Vdc circuit breaker distribution panels are connected to each of the 125-Vdc Buses 11(21), 12(22), and 13(23). The connection to Buses 11(21) and 12(22) is made through drawout, manually operated air circuit breakers[(b),] and Bus 13(23) connects directly to the panels. The air circuit breakers are rated 600 amperes with long- and short-time overcurrent elements. One panel per bus is generally utilized for Class 1E loads and the other typically used for non-Class 1E loads. The panels are an integral part of the respective switchgear and, therefore, they are all designed, engineered, and constructed as Class 1E panels. Each panel is ungrounded and has one main bus, rated 600 amperes continuous. Panel branch circuit breakers are molded case, thermal magnetic, quick-make and quick-break, rated 250-Vdc, ≥ 20,000-amperes interrupting capacity.

The two panels on each bus have the same designation (e.g., on Buses 11, both panels are called 125-Vdc distribution Panel 11) because they are electrically connected as one panel. However, typically they are physically separated on the left and right side of the switchgear to generally supply Class 1E and non-Class 1E loads, respectively.

The left side panels typically provide power to the following loads:

(a) Class 1E dc power and control

[(b)] These circuit breakers were required for the original design when buses 11(21) and 12(22) were connected in series to provide 250-Vdc non-Class 1E power.

(b) Class 1E dc diesel generator field flashing

(c) Class 1E dc instrumentation.

(d) Main annunciator

(e) UPSs for nuclear instrumentation

The right side panels typically provide power to the following loads:

(a) Non-Class 1E dc power and control

(b) Non-Class 1E dc instrumentation

(c) Auxiliary annunciators

An additional 125-Vdc distribution panel 14(24) is a subpanel of distribution panel 13(23) for non-Class 1E loads.

8.3.2.2.2.2 Class 1E 125-Vdc Battery Chargers

The 125-Vdc battery chargers are Class 1E power supplies. A total of ten battery chargers are supplied, five for Unit 1 and five for Unit 2. Three chargers serve two of the 125-Vdc buses (Buses 11[21] and 12[22]) and two chargers serve 125-Vdc Bus 13(23). Each of the chargers is connected to a bus through a molded case, manually operated thermal-magnetic 600 ampere breaker located in dc switchgear 11(21), 12(22), and 13(23). Normally, Buses 11(21), 12(22), and 13(23) are supplied by one battery charger each. Buses 11(21) and 12(22) share a swing backup battery charger for closing in on Bus 11(21) or 12(22) if either primary battery charger on 11(21) or 12(22) is not able to provide service. A second battery charger is a backup charger for Bus 13(23). Each charger is constructed of high quality, reliable, solid-state components conservatively rated for long life. The chargers provide rated direct current output continuously at a voltage smoothly adjustable from 118-Vdc to 144-Vdc, and regulated to $\pm$0.5 percent through the entire range of input and local variations. The maximum output current is 110 percent of rated output under any loads or short circuit conditions. The charger is self-protected against transient voltages that may occur on the dc system.

An alarm cutout switch is provided on the outside of each battery charger cabinet. Each cutout switch disables the following battery charger alarms:

(1) ac fuse failure

(2) dc UV and overvoltage

(3) ac breaker trip

(4) dc breaker trip

The cutout switch is used to avoid unnecessary alarms and operator distractions when a battery charger is out of service or receiving maintenance. Proper use of the cutout switches is administratively controlled by operating procedures.

8.3.2.2.2.3 Class 1E 125-Vdc Batteries

The 125-Vdc batteries are Class 1E power supplies. Mean life of the batteries is 20 years (refer to Section 3.10.3.8.1 for battery qualification). Each cell is contained in a sealed, heat resistant, shock absorbing, clear polycarbonate case. Similar cells were tested and met seismic and vibration requirements. A total of six batteries, 11(21), 12(22), and 13(23) are supplied for Unit 1 and Unit 2.

Battery racks are provided with an analytically calculated, earthquake-proof, engineered rigid rack design to meet the seismic requirements of the battery room. The battery racks are of Unistrut construction and mounted to the floor and wall for rigid seismic mounting.

Diffusion vents on battery filling openings provide continuous and uniform dispersion of hydrogen produced by the batteries. These vents are designed to prevent localized hazardous concentrations of hydrogen.

8.3.2.2.2.4 Safety-Related Loads

Normally, the battery chargers will supply the total load requirements of the dc system as well as maintain a constant floating charge on the batteries. The batteries are paralleled with the chargers and supply dc power to the system if the ac power fails. The nuclear instrumentation UPSs and the main annunciator are automatically supplied from either the 125-Vdc system or the 480-V system depending on their availability. The voltage level of the rectifier in the UPS unit is set such that the inverter preferentially feeds from the 480-V system via the rectifier. Considering normal starting times for the diesel generators and the battery charger dc output time delay circuit that prevents full charger output for 20 to 30 seconds, the first 40-second loads on each bus are supplied by its respective battery.

The dc loads on the bus after 40 seconds will be carried by the battery charger. The charger has sufficient capacity to carry loads up to 110 percent of its 400-ampere rating. When the chargers are not loaded to maximum rating, then excess capacity charges the battery (refer to Section 8.3.2.3.6).

8.3.2.3 Safety Evaluation

8.3.2.3.1 General Design Criterion 2, 1967 – Performance Standards

The Class 1E 125-Vdc system is located in the auxiliary building which is a PG&E Design Class I structure (refer to Figure 1.2-5). The auxiliary building is designed to withstand the effects of winds and tornadoes (refer to Section 3.3), floods and tsunamis (refer to Section 3.4), external missiles (refer to Section 3.5), and earthquakes (refer to Section 3.7), to protect Class 1E 125-Vdc SSCs from damage due to these events to ensure they will continue to perform their safety function.

Loss of the 125-Vdc inverter room ventilation system and Class 1E 125-Vdc raceways located outdoors, and exposed to the effects of tornadoes, has been evaluated and the consequences of a tornado do not compromise the capability to safely shut down the plant (refer to Section 3.3.2.3).

Equipment included in the dc system was proved to be acceptable to seismic requirements by testing, analytical calculations, or testing on similar equipment. The manufacturers were required to conform to approved quality assurance procedures. Refer to Section 3.10.3.8 for a description of the seismic qualification for batteries, battery racks, battery chargers and dc switchgear.

Although the ventilating system for the battery rooms is PG&E Design Class II, the supply and exhaust ductwork serving the battery rooms are designed and installed to meet Seismic Category I criteria.

8.3.2.3.2 General Design Criterion 3, 1971 – Fire Protection

The Class 1E 125-Vdc system is designed to meet the requirements of 10 CFR 50.48(a) and (c) (refer to Section 9.5.1).

Ventilation for the Class 1E dc equipment is provided as follows:

(1) Battery rooms are ventilated to prevent accumulation of hydrogen gas and to maintain ambient temperature. For each unit, the three battery rooms are constructed of reinforced concrete and cement block grout walls. Ventilation air is supplied by a common duct and supply fan, and is exhausted through an exhaust fan to a common duct that exhausts directly to the atmosphere. The ventilation system is PG&E Design Class II

(2) The dc switchgear rooms have PG&E Design Class I ventilation supply and exhaust systems and are described in Section 9.4.9. These three separate rooms, housing separate buses, panelboards, and battery chargers, have a common ventilation system.

In case of loss of forced ventilation, the calculated natural ventilation rate due to the thermal stack effect will maintain hydrogen gas below 1 percent by volume. This accumulation is below the allowable limit of 2 percent by volume as recommended by Regulatory Guide 1.128, Revision 1 (Reference 17).

8.3.2.3.3 General Design Criterion 4, 1967 – Sharing of Systems

The Class 1E 125-Vdc system for each unit is not shared with the other unit. The Class 1E 125-Vdc system is a support system for common unit systems and components listed in Section 1.2.2.10.

8.3.2.3.4 General Design Criterion 11, 1967 – Control Room

Each Class 1E bus is provided with a voltmeter and ammeter mounted on the control room main control board for remote indication.

The chargers have voltmeters and ammeters remotely located on the main control board to indicate operational status of battery chargers.

8.3.2.3.5 General Design Criterion 12, 1967 – Instrumentation and Control Systems

Each Class 1E bus is provided with a voltmeter mounted on the switchgear for local indication. Each charger has a locally mounted voltmeter, ammeter, and instrumentation for alarming dc UV, dc overvoltage, ac fuse failure, dc breaker trip, and ac breaker trip (refer to Section 8.3.2.2.2.2), adjustable controls for both normal and equalizing charge settings, and a manually adjustable equalizing timer.

Each of the Class 1E battery rooms is provided with an air temperature monitoring system. Refer to Section 3.11.3.1 for details.

8.3.2.3.6 General Design Criterion 17, 1971 – Electric Power Systems

Sufficient physical separation, electrical isolation, system coordination, and redundancy are provided to ensure availability of required dc power and to prevent the occurrence of common mode failure of each unit's Class 1E dc systems.

The codes and standards that have been implemented, where applicable, in the design of the dc systems are listed in Section 8.1.4.

8.3.2.3.6.1 Class 1E 125-Vdc Distribution

The Class 1E dc power circuits from the separate battery rooms 11(21), 12(22), and 13(23) are run in separate conduits to dc equipment rooms 11, 12, and 13. The battery chargers are in these rooms and are connected to the buses in the dc switchgear. The dc buses are connected to the molded case breaker panel board with load circuits channeled throughout the plant in Class 1E circuit systems with power (600-V and under) and control systems. The non-Class 1E dc power feeders are channeled with non-Class 1E (600-V and under) ac power and control systems. DC feeder instrumentation circuits are channeled with low-level instrumentation circuits.

The dc system redundancy follows the redundant lines delineated by the 4.16-kV and 480-V Class 1E systems:

(1) Battery 11(21), battery charger 11(21), switchgear Bus 11(21), and distribution panel 11(21) are associated with 4.16-kV Bus 1F(2F) and 480-V Bus 1F(2F), and diesel 13(23).

(2) Battery 12(22), battery charger 12(22), switchgear Bus 12(22), and distribution panel 12(22) are associated with 4.16-kV Bus 1G(2G) and 480-V Bus 1G(2G), and diesel 12(21).

(3) Battery 13(23), battery charger 132(232), switchgear Bus 13(23), distribution panel 13(23), and distribution Panel 14(24) are associated with 4.16-kV Bus 1H(2H) and 480-V Bus 1H(2H) and diesel 11(22).

(4) Instrumentation dc circuits are also separated similarly to Items 1, 2, and 3 above.

(5) Breakers on the distribution Panels 11(21), 12(22), and 13(23) can be used to disconnect all non-Class 1E loads from the batteries.

8.3.2.3.6.2 Class 1E 125-Vdc Battery Charger

The input to the chargers is 480-V, 3-phase, 60 Hz. The 480-V Buses F, G, and H supply chargers 11(21), 12(22), and 132(232), respectively. Backup battery chargers 121(221) and 131(231) receive their inputs from 480-V Buses H and F, respectively. The chargers provide rated output voltage and current with an input voltage range from 432-V to 528-V. Each input is provided with a manual circuit breaker mounted on the front and an UV alarm relay on the ac side of the rectifiers.

During normal operation, power is furnished by these 480-V battery chargers at approximately 135-Vdc, with the electric storage batteries floating on the dc buses. Sufficient battery charger capacity, 400 amperes per charger, is provided to carry the normal continuous load and to recharge the batteries in a reasonable time with any one charger out of service.

Battery chargers have sufficient capacity to carry the normal continuous load and to recharge the battery within 12 hours. The battery charger sizing is within the guidelines of IEEE-946, IEEE Recommended Practice for the Design of Safety Related DC Auxiliary Power Systems for Nuclear Power Generating Stations and Safety Guide 32, August 1972, B-2 and C-b (Reference 16) (refer also to Section 8.3.2.3.18).

8.3.2.3.6.3 Class 1E 125-Vdc Batteries

The batteries are sized to provide sufficient power to operate the dc loads for the time necessary to safely shut down the unit, should a 480-V source to one or more battery chargers be unavailable. Although each battery consists of 60 cells, the battery sizing calculations are in place to support a 59-cell configuration. The 59-cell configuration may be necessary in case a defective cell needs to be bypassed. The battery cells are lead-acid type with lead-calcium grids. Each battery is rated at 2320 ampere-hours (8-hour rate, discharged to 1.75-V per cell) and has current ratings as follows:

1 minute	1 hour	8 hours
2080 amperes	1120 amperes	290 amperes

Sufficient capacity is provided for all simultaneous loads to be superimposed for the following durations:

(1) Two hours for continuous loads, such as instrumentation and annunciation

(2) One minute for all momentary loads such as dc control power for switchgear devices, inrush to continuous loads, and diesel generator field flashing

The method used to determine battery sizing and recommendation for replacement of batteries is based on IEEE 485-1983 (Reference 15).

If a diesel generator associated with a particular bus fails to start and a redundant charger supplied from another Class 1E 480-V bus is not available, the battery has sufficient capacity to continue to carry dc loads for 2 hours on the associated bus.

8.3.2.3.7 General Design Criterion 18, 1971 – Inspection and Testing of Electric Power Systems

Battery capacity is verified by performing a battery performance test in accordance with IEEE 450-1995 (Reference 18) with the exception that if the battery shows signs of degradation, or if the battery has reached 85 percent of its expected service life and capacity is less than 100 percent of the manufacturer's rated capacity, the performance test is required on a 24-month frequency to coincide with a refueling outage instead of on an annual frequency as required by IEEE 450-1995. Battery monitoring and maintenance is controlled by a battery monitoring and maintenance program based on the recommendations of IEEE 450-1995.

8.3.2.3.8 General Design Criterion 21, 1967 – Single Failure Definition

DC loads for control of ESFs are divided into three groups, each served from a 125-Vdc battery. The grouping corresponds to the grouping of the ac loads and provides redundant service to ESFs (refer to Figure 8.3-17).

Should a failure occur on any 125-Vdc distribution circuit on panel 11(21) the associated molded case circuit breaker would trip to isolate this failure while the unaffected circuits in panel 11(21) would remain energized. If the distribution panel molded case circuit breaker failed to trip, the 600 ampere drawout breaker would trip to isolate distribution panel 11(21) from 125-Vdc Bus 11(21). This latter event would be a single failure in the ESF panel 11(21). Similar analysis was applied to the 125-Vdc distribution circuits on panel 12(22).

This would result in the loss of 125-Vdc power and control to 4.16-kV Bus F and other related Bus F power and control circuits. The ESFs would then be performed by 4.16-kV and 480-V Buses G and H, and 125-Vdc Buses 12(22) and 13(23), respectively.

8.3.2.3.9 General Design Criterion 24, 1967 – Emergency Power for Protection Systems

The safety-related loads on individual dc buses are as listed in Table 8.3-11.

The dc power and control systems are specified, designed, engineered, and manufactured to perform the required ESF functions.

The dc systems for control of ESFs are divided into three groups, each served from a 125-Vdc battery bus. The grouping corresponds to the grouping of the ac loads and provides redundant service to ESFs (refer to Table 8.3-11). A descriptive analysis of the dc system is provided in Section 8.3.2.2.2.

8.3.2.3.10 General Design Criterion 40, 1967 – Missile Protection

The ESF portions of the Class 1E 125-Vdc system that are located in zones where provision against dynamic effects must be made, are protected from missiles, pipe whip, or jet impingement from the rupture of any nearby high-energy line (refer to Sections 3.5, 3.6, and 8.3.1.4.10.2).

8.3.2.3.11 General Design Criterion 49, 1967 – Containment Design Basis

The Class 1E 125-Vdc and non-Class 1E 125-Vdc circuits routed through containment electrical penetrations are each provided with electrical protection devices. This arrangement is such that with the failure of one device, the penetration remains protected from high current temperature by the other in-series device to ensure the containment penetration remains functional. Refer to Section 3.8.2.1.1.3 and 8.3.1.4.8 for additional details.

8.3.2.3.12 Class 1E 125-Vdc System Safety Function Requirement

(1) Protection from Missiles

The provisions taken to protect the Class 1E portion of the 125-Vdc system from missiles resulting from plant equipment failures and from events and conditions outside the plant are discussed in Sections 3.5 and 8.3.1.4.10.2.

(2) Protection Against High Energy Pipe Rupture Effects

The provisions taken to protect the Class 1E portion of the 125-Vdc system from damage that might result from dynamic effects associated with a postulated rupture of high-energy piping are discussed in Sections 3.6 and 8.3.1.4.10.3.

(3) Protection from Moderate Energy Pipe Rupture Effects – Outside Containment

The provisions taken to provide protection of the Class 1E portion of the 125-Vdc system portion located outside containment from the effects of moderate energy pipe failure are discussed in Section 3.6.

(4) Protection from Jet Impingement – Inside Containment

The provisions taken to provide protection of the Class 1E portion of the 125-Vdc system portion located inside containment from the effects of jet impingement which may result from high energy pipe rupture are discussed in Section 3.6 and 8.3.1.4.10.3.

(5) Protection from Flooding Effects – Outside Containment

The provisions taken to provide protection of the Class 1E portion of the 125-Vdc system portion located outside containment from flooding that might result from the effects associated with a postulated rupture of piping are discussed in Section 3.6.

8.3.2.3.13 10 CFR 50.49 – Environmental Qualification of Electric Equipment

The Class 1E 125-Vdc system SSCs required to function in harsh environments under accident conditions are qualified to the applicable environmental conditions to ensure that they will continue to perform their safety functions. Section 3.11 describes the DCPP EQ program and the requirements for the environmental design of electrical and related mechanical equipment. The affected components are listed on the EQ Master List.

8.3.2.3.14 10 CFR 50.62 – Requirements for Reduction of Risk from Anticipated Transients Without Scram Events for Light-Water-Cooled Nuclear Power Plants

The AMSAC is designed to comply with 10 CFR 50.62. The AMSAC is required to be powered from a non-Class 1E 125-Vdc electrical power source that is independent from the protection system power supplies. Refer to Section 7.6.2.3 and 7.6.3.6 for additional details.

8.3.2.3.15 10 CFR 50.63 – Loss of All Alternating Current Power

With respect to battery adequacy, for an actual SBO response, procedures would provide battery charging and operation for all Class 1E instrument channels and RPS output trains.

The Class 1E 125-Vdc system serves to distribute power to the 125-Vdc loads required to bring the plant to a safe shutdown condition (Mode 3) following a SBO event.

For purposes of the SBO analysis, it is assumed that operator action is taken within 2 hours to provide at least two input channels of instrumentation to monitor system functions and actuate one train of safeguards equipment. Refer to Section 8.3.1.6 for additional details.

8.3.2.3.16 10 CFR 50.48(c) – National Fire Protection Association Standard NFPA 805

The Class 1E 125-Vdc system is designed to meet the nuclear safety and radioactive release performance criteria of Section 1.5 of NFPA 805, 2001 Edition (refer to Section 9.5.1).

8.3.2.3.17 Safety Guide 6, March 1971 – Independence Between Redundant Standby (Onsite) Power Sources and Between Their Distribution Systems

Each of the three 125-Vdc switchgear buses has a battery charger. Batteries 11(21) and 12(22) have an additional swing backup battery charger that can be connected to either bus by manually closing one of the two interlocked breakers. The fifth battery charger is a backup charger for battery 13(23). Manual operation of a circuit breaker is required to place this battery charger in service on the bus. No interlock is provided between the two battery chargers on this bus. Refer to Section 8.3.2.2.2 for additional detail.

8.3.2.3.18 Safety Guide 32, August 1972 – Use of IEEE Standard 308-1971 Criteria for Class 1E Electric Systems for Nuclear Power Generating Stations

The supply to battery chargers is designed using the criteria of Safety Guide 32, August 1972 (Reference 16), paragraphs B-2 and C-b, so that abnormal long-term loads (e.g., hot or cold shutdown and post-accident shutdown) are not greater than the steady state loads during normal operation. The design requirements of the battery charger supply are as covered within GDC 17, 1971. Accordantly the capacity of the battery charger supply is based on the largest combined demands of the various steady-state loads and the charging capacity to restore the battery from the design minimum charge state to the fully charged state, irrespective of the status of the plant during which these demands occur.

8.3.2.3.19 Regulatory Guide 1.63, Revision 1, May 1977 – Electrical Penetration Assemblies in Containment Structures for Light-Water-Cooled Nuclear Plants

The Class 1E and non-Class 1E 125-Vdc circuits routed through containment electrical penetrations are designed to provide overcurrent protection. Refer to Section 8.3.1.4.8 for additional details.

8.3.2.3.20 Regulatory Guide 1.97, Revision 3, May 1983 – Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant and Environs Conditions During and Following an Accident

Each 125-Vdc Class 1E bus is provided with a voltmeter and ammeter mounted on the control room main control board for remote indication. Refer to Table 7.5-6 for additional detail.

8.3.2.4 Tests and Inspections

Refer to Section 8.3.2.3.7 for test and inspection details.

8.3.2.5 Instrumentation Applications

Refer to Sections 8.3.2.3.4 and 8.3.2.3.5 for instrumentation applications

8.3.3 REFERENCES

1. Deleted in Revision 21.

2. NUREG 0737, Clarification of TMI Action Plan Requirements, November 1980.

3. IEEE 308-1971, Criteria for Class IE Electric Systems for Nuclear Power Generating Stations.

4. IEEE 279-1971, Criteria for Protection Systems for Nuclear Power Generating Stations.

5. Technical Specifications, Diablo Canyon Power Plant Units 1 and 2, Appendix A to License Nos. DPR-80 and DPR-82, as amended.

6. NFPA 12, Carbon Dioxide Extinguishing Systems, 1973.

7. NFPA 37, Installation and Use of Stationary Combustion Engines and Gas Turbines, 1970.

8. Safety Guide 9, Selection of Diesel Generator Set Capacity for Standby Power Supplies, March 1971.

9. Safety Guide 6, Independence Between Redundant Standby (Onsite) Power Sources and Between Their Distribution Systems, March 1971.

10. National Electric Code (NFPA 70-1968).

11. AIEE S-135-1, Power Cable Ampacities, 1962.

12. Regulatory Guide 1.63, Electric Penetration Assemblies in Containment Structures for Light-Water- Cooled Nuclear Power Plants, USNRC, Revision 1, May 1977.

13. 10 CFR 50.48(c), National Fire Protection Association Standard NFPA 805, Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants, 2001 Edition.

14. Diablo Canyon Power Plant, Unit Nos. 1 and 2 – Amendments 225 to Facility Operating License No. DPR-80 and Amendment No. 227 to Facility Operating License No. DPR-82 regarding Transition to a Risk-Informed Performance-Based Fire Protection Program in Accordance with 10 CFR 50.48(c).

15. IEEE 485-1983, Recommended Practice for Sizing Large Lead Storage Batteries for Generating Stations and Substations.

16. Safety Guide 32, Use of IEEE Standard 308-1971 Criteria for Class 1E Electric Systems for Nuclear Power Generating Stations, August 1972.

17. Regulatory Guide 1.128, Revision 1, Installation Design and Installation of Large Lead Storage Batteries for Nuclear Power Plants, USNRC, October 1978.

18. IEEE 450-1995, Recommended Practice for Maintenance, Testing, and Replacement of Large Lead Storage Batteries for Generating Stations and Substations.

19. ICEA P-54-440, Cables in Open-Top Cable Trays, 1975.

20. 10 CFR 50.63, Station Blackout (SBO) Rule, Loss of All Alternating Current Power.

21. PG&E Letter DCL-92-084 to USNRC, Revised Response to Station Blackout, April 13, 1992.

22. Supplemental Safety Evaluation of PG&E Response to Station Blackout Rule (10 CFR 50.63) for Diablo Canyon, USNRC, (TAC Nos. M68537 and M68538), May 29, 1992.

23. NUMARC-8700, Rev. 0, Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors, November 1987.

24. Deleted in Revision 21.

25. Regulatory Guide 1.108, Revision 1, August 1977 – Periodic Testing of Diesel Generating Units Used as Onsite Electric Power Systems at Nuclear Power Plants,

26. NRC (Mr. John Stolz) Letter to PG&E (Mr. John Morrissey), dated November 22, 1977, Request for Additional Information – Diablo Canyon Nuclear Power Plant, Units 1 & 2.

27. License Amendments 200/201, Technical Specifications Change to Relocate Surveillance Test Intervals to a Licensee-Controlled Program, issued by the NRC, October 30, 2008.

28. License Amendments 105/104, Revision of Technical Specification for Diesel Generator Surveillance Testing, issued by the NRC, June 26, 1995.

29. License Amendments 135/135, Conversion to Improved Technical Specifications, issued by the NRC, May 28, 1999.

30. License Amendments 211/213, Revision to Technical Specification 3.8.1, "AC Sources – Operating," to Incorporate TSTF-163, Revision 2, issued by the NRC, March 29, 2012.

31. Regulatory Guide 1.155, Station Blackout, August 1988.

32. IEEE Standard 317-1971, Electric Penetration Assemblies in Containment Structures for Nuclear Fueled Power Generating Stations, The Institute of Electrical and Electronics Engineers, Inc.

33. License Amendments 218/220, Revision to Technical Specification 3.8.1, “AC Sources – Operating,” issued by the NRC, July 1, 2015.

8.3.4 REFERENCE DRAWINGS

Figures representing controlled engineering drawings are incorporated by reference and are identified in Table 1.6-1. The contents of the drawings are controlled by DCPP procedures.

TABLE 8.1-1

APPLICABLE DESIGN BASIS CRITERIA

CRITERIA	TITLE	APPLICABILITY									
Electrical Power System		230-kV	500-kV	25-kV	12-kV	4.16-kV	480-V	120-Vac	EDG	SBO	125-Vdc
Section		8.2.1	8.2.2	8.3.1.1.1	8.3.1.1.2	8.3.1.1.3	8.3.1.1.4	8.3.1.1.5	8.3.1.1.6	8.3.1.6	8.3.2
1. <u>10 CFR 50 - Domestic Licensing of Production and Utilization Facilities</u>											
50.48(c)	National Fire Protection Association Standard NFPA 805	X				X	X	X	X		X
50.49	Environmental Qualification of Electric Equipment Important to Safety for Nuclear Power Plants					X	X	X			X
50.55a(g)	Inservice Inspection Requirements								X		
50.62	Requirements for Reduction of Risk from Anticipated Transients Without Scram (ATWS) Events for Light-Water-Cooled Nuclear Power Plants							X			X
50.63	Loss of All Alternating Current Power	X	X	X	X	X	X	X	X	X	X
2. <u>General Design Criteria</u>											
Criterion 2, 1967	Performance Standards				X	X	X	X	X		X
Criterion 3, 1971	Fire Protection					X	X	X	X		X
Criterion 4, 1967	Sharing of Systems	X			X		X	X	X		X
Criterion 11, 1967	Control Room				X	X	X	X	X		X
Criterion 12, 1967	Instrumentation and Control				X	X	X	X	X		X

Systems

CRITERIA	TITLE	APPLICABILITY									
Electrical Power System		230-kV	500-kV	25-kV	12-kV	4.16-kV	480-V	120-Vac	EDG	SBO	125-Vdc
Section		8.2.1	8.2.2	8.3.1.1.1	8.3.1.1.2	8.3.1.1.3	8.3.1.1.4	8.3.1.1.5	8.3.1.1.6	8.3.1.6	8.3.2
2. <u>General Design Criteria (continued)</u>											
Criterion 15, 1967	Engineered Safety Features Protection Systems				X						
Criterion 17, 1971	Electric Power Systems	X	X	X	X	X	X	X	X		X
Criterion 18, 1971	Inspection and Testing of Electric Power Systems	X	X	X	X	X	X	X	X		X
Criterion 21, 1967	Single Failure Definition					X	X	X	X		X
Criterion 24, 1967	Emergency Power For Protection Systems							X			X
Criterion 40, 1967	Missile Protection					X	X	X			X
Criterion 49, 1967	Containment Design Basis				X		X	X			X
3. <u>Design Basis Functional Criteria</u>											
Transmission Capacity Requirements		X	X								
Single Failure Requirements (Preferred Power Supply)		X	X	X	X						
Protection from High and Moderate Energy Systems and Internal Missiles									X		
4. <u>Atomic Energy Commission (AEC) Safety Guides</u>											
Safety Guide 6, March 1971	Independence Between Redundant Standby (Onsite) Power Sources and Between Their Distribution Systems					X	X	X			X

CRITERIA	TITLE	APPLICABILITY									
Electrical Power System		230-kV	500-kV	25-kV	12-kV	4.16-kV	480-V	120-Vac	EDG	SBO	125-Vdc
Section		8.2.1	8.2.2	8.3.1.1	8.3.1.2	8.3.1.3	8.3.1.4	8.3.1.5	8.3.1.6	8.3.1.6	8.3.2
4. Atomic Energy Commission (AEC) Safety Guides (continued)											
Safety Guide 9, March 1971	Selection of Diesel Generator Set Capacity for Standby Power Supplies								X		
Safety Guide 32, August 1972	Use of IEEE Std 308-1971 "Criteria for Class 1E Electrical Systems for Nuclear Power Generating Stations"	X	X	X	X						X
5. Regulatory Guides											
Regulatory Guide 1.63, May 1977	Electric Penetration Assemblies in Containment Structures for Light Water Cooled Nuclear Power Plants				X		X	X			X
Regulatory Guide 1.97, Revision 3, May 1983	Instrumentation For Light-Water-Cooled Nuclear Power Plants to Assess Plant and Environs Conditions During and Following an Accident					X	X		X		X
Regulatory Guide 1.108, Revision 1, August 1977	Periodic Testing of Diesel Generator Units Used as Onsite Electric Power Systems at Nuclear Power Plants								X		

TABLE 8.1-1

CRITERIA	TITLE	APPLICABILITY									
Electrical Power System		230-kV	500-kV	25-kV	12-kV	4.16-kV	480-V	120-Vac	EDG	SBO	125-Vdc
Section		8.2.1	8.2.2	8.3.1.1.1	8.3.1.1.2	8.3.1.1.3	8.3.1.1.4	8.3.1.1.5	8.3.1.1.6	8.3.1.6	8.3.2
6. <u>NRC NUREGs</u>											
NUREG-0737	Clarification of TMI Action Plan Requirements						X	X			
7. <u>NRC Generic Letters</u>											
1984-15	Proposed Staff Actions to Improve and Maintain Diesel Generator Reliability								X		

TABLE 8.3-1

NOTES FOR TABLES

(a) When supplied from the diesel generators, these motors are started automatically in the absence of a safety injection signal.

(b) The containment fan cooler unit (CFCU) motors are two-speed, rated 300 and 100 horsepower, and are fed from the vital 480-V load centers. The low speed is used under loss-of-coolant accident (LOCA) and auto-bus transfer conditions. There are five motors: two on bus F, two on bus G, and one on bus H.

(c) 1. The EDG net power factor is expected to be not less than the EDG rated power factor of 80 percent.

2. The power factor of the containment fan cooler units (CFCUs) at slow speed, however, is 49.0 percent.

(d) Deleted

(e) Deleted

(f) For total time, add approximately 1 second for offsite power, and 10 seconds for the diesel generators.

(g) These loads are not required for nuclear safety but will probably operate at the same time to perform other important plant functions.

(h) These items are shared between Units 1 and 2.

(i) Two of the battery chargers are spares. Only one battery charger can be connected to a bus except during an abnormal operating condition which is time limited.

(j) The Technical Support Center, pressurizer heaters, containment hydrogen purge system fans, spent fuel pit pump, internal hydrogen recombiners, and charcoal filter preheater are manually controlled loads that can be added to the vital buses, providing the load demand has diminished and the diesel generators will not be overloaded.

(k) Containment spray is initiated after the time shown, provided "S" and "P" signals are present. All other components are started on the occurrence of an "S" signal.

(l) Deleted in Revision 7.

(m) Does not include loads that are cut off prior to diesel generator connection to bus.

(n) Only one group of control room air conditioning and vent equipment can be connected to a bus at one time.

(o) All tests conducted on all six diesel engine generator units, except as noted.

(p) The following Design Basis Accidents (DBAs) are considered in the EDG Load Study Analyses:

1. Event 1: Large Break Loss of Coolant Accident (LBLOCA)
2. Event 2: Small Break Loss of Coolant Accident (SBLOCA)
3. Event 3: Steam Generator Tube Rupture (SGTR)
4. Event 4: Steamline Rupture Inside Containment at Power
5. Event 5: Steamline Rupture Inside Containment at Hot Zero Power
6. Event 6: Feedwater Line Break (FWLB)
7. Event 7: Loss of Normal Feedwater (LONF)
8. Event 8: Loss of Offsite Power (LOOP)
9. Event 9: Station Blackout (SBO)

(q) The following Class 1 E 4160 V ESF bus loading cases are considered for each of the postulated DBAs evaluated in the EDG Load Study Analyses. (Refer to Table 8.3-12 for maximum steady loads at 4340 V and 60.8 Hz).

1. Case 1: All EDGs operating energizing Class 1 E 4160 V ESF buses (F, G, & H) and supplying all associated accident loads with single component failure Considerations.

2. Case 2: The EDG associated with Class 1 E 4160 V ESF bus F failed resulting in Class 1 E 4160 V ESF bus F being deenergized with accident loads supplied by Class 1 E 4160 V buses G and H and associated EDGs.

3. Case 3: The EDG associated with Class 1 E 4160 V ESF bus G failed resulting in Class 1 E 4160 V ESF bus G being deenergized with accident loads supplied by Class 1 E 4160 V buses F and H and associated EDGs.

4. Case 4: The EDG associated with Class 1 E 4160 V ESF bus H failed resulting in Class 1 E 4160 V ESF bus H being deenergized with accident loads supplied by Class 1 E 4160 V ESF buses F and G and associated EDGs.

5. Case 5: Failure of SSPS Train A will result in the EDG associated with Class 1 E 4160 V Bus F to fail and to fail one train of safeguards equipment which will render certain pump/fan mechanical load demands to not load on a Class 1 E 4160 V Bus.

6. Case 6: Failure of SSPS Train B will result in the EDG associated with Class 1 E 4160 V Bus G to fail and to fail one train of safeguards equipment which will render certain pump/fan mechanical load demands to not load on a Class 1 E 4160 V Bus.

TABLE 8.3-2

TIMING SEQUENCE AND INTERVALS - NO SAFETY INJECTION SIGNAL

Loads	Starting Delay in Seconds After Power is Restored to the Vital Buses[f]			Minimum Number Required
	Bus F	Bus G	Bus H	
Small loads (480 and 120 V) on vital 480-V load centers	0	0	0	2
Component cooling water pumps	5	5	5	2
Auxiliary saltwater pumps	10	10	-	1
Auxiliary feedwater pumps[a]	14	-	14	1
Centrifugal charging pumps (CCP1 and CCP2)	20	20	-	1
Containment fan coolers[b]	25	25	25	3

TABLE 8.3-3

IDENTIFICATION OF MAJOR LOADS - NO SAFETY INJECTION SIGNAL

Load	Rating (each)	EDG 1-3 U1 Bus F	EDG 1-2 U1 Bus G	EDG 1-1 U1 Bus H	EDG 2-3 U2 Bus F	EDG 2-1 U2 Bus G	EDG 2-2 U2 Bus H
480-V load Center Transformer	1000 kVA	1F	1G	1H	2F	2G	2H
Centrifugal Charging Pump	600 hp	1-1	1-2	---	2-1	2-2	---
Auxiliary Saltwater Pump	400 hp	1-1	1-2	---	2-1	2-2	---
Motor Driven Auxiliary Feedwater Pump[(a)]	600 hp	1-3	---	1-2	2-3	---	2-2
Component Cooling Water Pump	400 hp	1-1	1-2	1-3	2-1	2-2	2-3
Containment Fan Cooler Unit[(b)]	100 hp	1-1 & 1-2	1-3 & 1-5	1-4	2-1 & 2-2	2-3 & 2-5	2-4

Diesel Generator Rating[1]:

Continuous = 2600 kW | 2000 Hours per one year period = 2750 kW

2 Hours per 24 hour period = 2860 kW | 30 minute = 3056 kW

[1] In accordance with the manufacturer's engine description and data sheet, the DGs are required to be derated if the inlet combustion air at the engine air intake filter is greater than 90°F and/or the jacket water temperature to the aftercooler inlet exceeds 160°F.

TABLE 8.3-4

DIESEL GENERATOR LOADING
TIMING SEQUENCE AND INTERVALS - WITH SAFETY INJECTION SIGNAL
CHANGES ON THIS PAGE APPLY TO BOTH UNTIS 1 & 2

Loads	Starting Delay in Seconds After Power is Restored to the Vital Buses[f]			Minimum Number
	Bus F	Bus G	Bus H	Required
Small loads (480 and 120 V) on vital 480-V load centers	0	0	0	2
Centrifugal charging pumps (CCP1 and CCP2)	2	2	-	1
Safety injection pumps	6	-	2	1
Residual heat removal pumps	-	6	6	1
Containment fan coolers[b]	18,22	18,22	22	2
Component cooling water pumps	10	10	14	2
Auxiliary saltwater pumps	14	14	-	1
Auxiliary feedwater pumps	26	-	18	1
Containment spray pumps[k]	-	26	26	1

TABLE 8.3-5

DIESEL GENERATOR LOADING FOLLOWING A LOSS-OF-COOLANT ACCIDENT

Load	Rating (each)	EDG 1-3 U1 Bus F	EDG 1-2 U1 Bus G	EDG 1-1 U1 Bus H	EDG 2-3 U2 Bus F	EDG 2-1 U2 Bus G	EDG 2-2 U2 Bus H
480-V load Center Transformer	1000 kVA	1F	1G	1H	2F	2G	2H
Centrifugal Charging Pump	600 hp	1-1	1-2	---	2-1	2-2	---
Safety Injection Pump	400 hp	1-1	---	1-2	2-1	---	2-2
Residual Heat Removal Pump	400 hp	---	1-1	1-2	---	2-1	2-2
Auxiliary Saltwater Pump	400 hp	1-1	1-2	---	2-1	2-2	---
Motor Driven Auxiliary Feedwater Pump	600 hp	1-3	---	1-2	2-3	---	2-2
Containment Spray Pump	400 hp	---	1-1	1-2	---	2-1	2-2
Component Cooling Water Pump	400 hp	1-1	1-2	1-3	2-1	2-2	2-3
Containment Fan Cooler Unit(b)	100 hp	1-1 & 1-2	1-3 & 1-5	1-4	2-1 & 2-2	2-3 & 2-5	2-4

Diesel Generator Rating[1]:

Continuous = 2600 kW　　2000 Hours per one year period = 2750 kW

2 Hours per 24 hour period = 2860 kW　　30 minute = 3056 kW

[1] In accordance with the manufacturer's engine description and data sheet, the DGs are required to be derated if the inlet combustion air at the engine air intake filter is greater than 90°F and/or the jacket water temperature to the aftercooler inlet exceeds 160°F.

TABLE 8.3-8

SUMMARY OF SHOP TESTING OF DIABLO CANYON DIESEL ENGINE GENERATOR UNITS BY ALCO ENGINE DIVISION (Note 1)

Test and Purpose[o]	Conduct of Tests	Results of Test
1. Standard Shop Tests To check out manufacturing and assembly	A. Calibration testing of all meters, switches, and gauges. B. Engine "break in" running and check out pressures. C. Electrical wire-by-wire functional testing. D. Matching tests for engine with governor and generator with regulator.	Engine generator units satisfactorily met all test requirements.
2. Performance Run To prove performance and rating	Unit performance run at 50, 75, 100, and 115% of full load, while recording pressures, temperatures, fuel consumption, etc.	Engine generator units satisfactorily met all test requirements.

TABLE 8.3-8

Test and Purpose[o]	Conduct of Tests	Results of Test
3. Starting Capability To show capacity of starting air systems (conducted on one engine generator unit).	A. Demonstrate 45 seconds of engine cranking for starting, with each of two redundant starting air systems, and without recharging air receivers. B. Demonstrate the number of successful engine starts, with each of two redundant starting air systems, and without recharging air receivers.	A. Forty-five seconds of continuous cranking with each starting air system.
4. Starting Reliability To show reliability of starting (conducted on one engine generator unit).	Demonstrate 100 consecutive engine generator unit starts, 50 with each redundant starting air system.	Fifty consecutive successful unit starts with each start ing air system.
5. Acceleration To show capability of fast starting.	Recorded time to accelerate units from standby condition (zero rpm) to rated speed (frequency) and voltage, with both redundant starting systems and with single failures in redundant start ing systems.	All engine generator units accelerated to rated speed (frequency) and voltage in less than 8.5 seconds with both starting systems, and in less than 12.3 seconds with simulated failure in a redundant starting system.

TABLE 8.3-8

Test and Purpose[o]	Conduct of Tests	Results of Test
6. <u>Motor Start</u> To show capability of starting and accelerating a large induction motor (conducted on one engine generator unit).	Recorded speed (frequency) and voltage decrease and time to recover to nominal when starting and accelerating an 800 hp induction motor, which is larger than any Diablo Canyon LOCA loads.	Maximum voltage decrease did not exceed 75% of nominal, and maximum speed decrease (frequency) did not exceed 95% of nominal. Voltage was restored to within 10% of nominal, speed (frequency) was restored to within 2% of nominal, in less than 2 seconds. Engine generator unit is capable of starting and accelerating an induction motor larger than any for Diablo Canyon.
7. <u>Dead Load Pick Up</u> To show capability of picking up large resistive loads and, by evaluation, to show capability of starting and accelerating large induction motors.	Recorded speed (frequency)and volt age decrease and the time to recover to nominal when picking up large resistive loads, starting with 500 kW and picking up successive loads in 100 kW increments up to at least 1300 kW. Performance of all units evaluated against the performance of the unit tested for motor start capability. (Test No. 6.)	All engine generator units picked up resistive loads with speed (frequency) and voltage decrease and time to recover evaluated to satisfactorily show capability for starting and accelerating the large induction motors of the Diablo Canyon LOCA loads.

Test and Purpose[o]	Conduct of Tests	Results of Test
8. <u>Motor Starting - LOCA Sequence</u> To show capability of starting and accelerating large induction motors in rapid succession. (Conducted on one engine generator unit.)	Recorded speed (frequency) and voltage decrease and time to recover to nominal when starting and accelerating large induction motors, 400, 600, and 800 hp, in rapid succession and in the Diablo Canyon LOCA sequence. Load sequence time interval was 5 seconds.	Maximum voltage decrease did not exceed 75% of nominal, and maximum speed decrease (frequency) did not exceed 95% of nominal. Voltage was restored to within 10% of of nominal, and speed (frequency) was restored to within 2% of nominal, in less than 2 seconds (40% of load sequence time interval). Engine generator units are capable of starting and accelerating large induction motors in rapid succession.
9. <u>Simulated Motor Starting - LOCA Sequence</u> To show capability of picking up resistive loads (simulating induction motors) in rapid succession and, by evaluation, to show capability of starting and accelerating large induction motors in rapid succession.	Recorded speed (frequency) and voltage decrease and time to recover to nominal when picking up resistive loads in rapid succession and in Diablo Canyon LOCA sequence. Load sequence time interval was 5 seconds. Resistive loading schedule simulated the LOCA load demand by the large induction motors. Performance of all units evaluated against the performance of the unit tested for Motor Starting LOCA sequence capability (Test No. 8.)	All engine generator units picked up resistive loads with speed (frequency) and voltage decrease and time to recover evaluated to satisfactorily show capability for starting and accelerating in rapid succession the large induction motors of the Diablo Canyon LOCA sequence.

TABLE 8.3-8

Test and Purpose(o)	Conduct of Tests	Results of Test
10. Full Load Drop To show capability of large load step decrease (2,600 kW).	Recorded speed (frequency) and voltage increase and time to recover to nominal following a full load drop (2,600 kW).	Speed of the diesel generator units did not exceed 75% of the difference between the nominal speed, and either the overspeed trip setpoint or 115% of nominal. Engine generator units are capable of recovery from the largest load reduction, a full load drop.

Note 1: Original testing was done using a nominal 5-second load sequence time interval with the KWS relay installed. Since a nominal 4-second load sequence time interval is used in the design basis loading scenario and the EDG loading capability is demonstrated through computer simulation without KWS relays, the test results of Table 8.3-8 are of historical value.

TABLE 8.3-9

SUMMARY OF PREOPERATIONAL TESTING OF DIABLO CANYON DIESEL ENGINE GENERATOR UNITS BY PG&E DURING STARTUP

Test and Purpose	Conduct of Tests
1. Standard Startup Tests To check out installation and onsite performance.	Startup, cleaning, flushing, performance checks, load capability, acceleration tests, etc., were performed on all engine generator units.
2. Integrated Safety Injection To verify capability to accept loads in rapid succession following the LOCA.	Safety injection was initiated manually with offsite power not available. The sequential loading of all engine generator units was monitored by recording voltage and current decrease.
3. Onsite Power Redundancy To prove auxiliary devices of one unit are not affected by failures in other units.	Test procedures used AEC Regulatory Guide 1.41 as an outline. Test was conducted in the same time period and in sequence with the Integrated Safety Injection tests described above.

TABLE 8.3-10

IDENTIFICATION OF ELECTRICAL SYSTEMS

Class 1E Equipment and Associated Buses[(a)]

	AC Systems		DC Systems	
	Unit 1	Unit 2	Unit 1	Unit 2
Orange	Bus 1F	Bus 2F	Bus 11	Bus 21
Gray	Bus 1G	Bus 2G	Bus 12	Bus 22
Purple	Bus 1H	Bus 2H	Bus 13	Bus 23

Reactor Protection Systems

Red	Channel 1	Reactor protection system instrumentation
White	Channel 2	Reactor protection system instrumentation
Blue	Channel 3	Reactor protection system instrumentation
Yellow	Channel 4	Reactor protection system instrumentation
Brown	Train A	Direct logic inputs
Green	Train B	Direct logic inputs

Power Circuits from Instrument Inverters

Orange	Reactor Protection Channel I
Gray	Reactor Protection Channel II
Purple	Reactor Protection Channel III
Black/Yellow	Reactor Protection Channel IV

(a) Circuits that do not serve a required Class 1E function may also be color-coded. (For instance, the main annunciator circuits are color-coded although the main annunciator system is not mutually redundant or required for safe shutdown.) In such cases, the color coding will normally follow the above conventions. There may, however, be infrequent instances where this is not practical; color coding in these instances will primarily indicate that these circuits were purchased and installed as Class 1E conductors.

TABLE 8.3-11

UNIT 1 - 125-VDC DISTRIBUTION PANEL
SAFETY-RELATED LOADS[a]

DESCRIPTION	Battery 11	Battery 12	Battery 13
Nuclear instrumentation UPS[b]	11	12 & 14	13
4-kV switchgear	Bus F	Bus G	Bus H
DG Gauge Panel Normal Source	DG 13	DG 12	DG 11
DG Gauge Panel Emergency Source	DG 12	DG 11	DG 13
NU safeguards control board solenoid valves	F	G	H
Safeguards relay board	F	G	H
Reactor control board solenoid valves	X	X	X
480-V MCC relay board	F	G	H
Auxiliary safeguards cabinet	Train A	Train B	-
Reactor trip breakers	X	X	-
FWP turbine local control board	12	11	-
Auxiliary relay rack	-	X	-
Dedicated shutdown panel	-	-	X

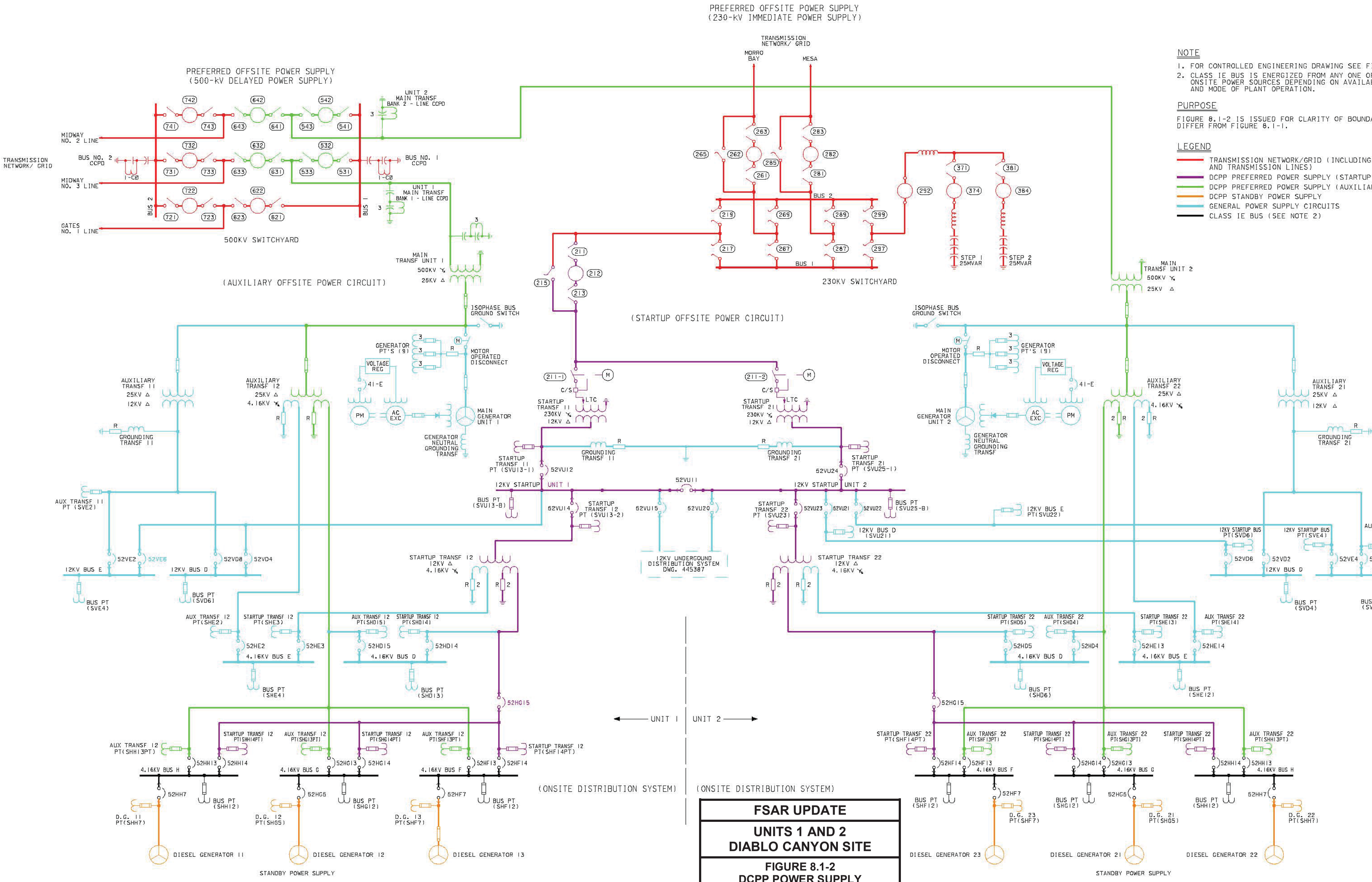
(a) Unit 2 loads are similar.

(b) UPS fed via 480 V when bus is transferred to the diesel generator.

TABLE 8.3-12

MAXIMUM STEADY STATE DG LOADING AT 4340 V AND 60.8 HZ [(p)(q)]

Unit	DG	Bus	Description	Loading (kw)	Power Factor
1	1-3	F	Event 1, Case 4; LBLOCA, Bus H is De-Energized	2654	84.6%
	1-2	G	Event 1, Case 4; LBLOCA, Bus H is De-Energized	2648	85.4%
	1-1	H	Event 1, Case 3; LBLOCA, Bus G is De-Energized	2614	86.6%
2	2-3	F	Event 1, Case 4; LBLOCA, Bus H is De-Energized	2663	84.6%
	2-1	G	Event 1, Case 4; LBLOCA, Bus H is De-Energized	2641	85.1%
	2-2	H	Event 1, Case 3; LBLOCA, Bus G is De-Energized	2592	86.6%



NOTE

1. FOR CONTROLLED ENGINEERING DRAWING SEE FIGURE 8.1-1
2. CLASS IE BUS IS ENERGIZED FROM ANY ONE OF THE OFFSITE OR ONSITE POWER SOURCES DEPENDING ON AVAILABILITY OF POWER AND MODE OF PLANT OPERATION.

PURPOSE

FIGURE 8.1-2 IS ISSUED FOR CLARITY OF BOUNDARIES AND MAY DIFFER FROM FIGURE 8.1-1.

LEGEND

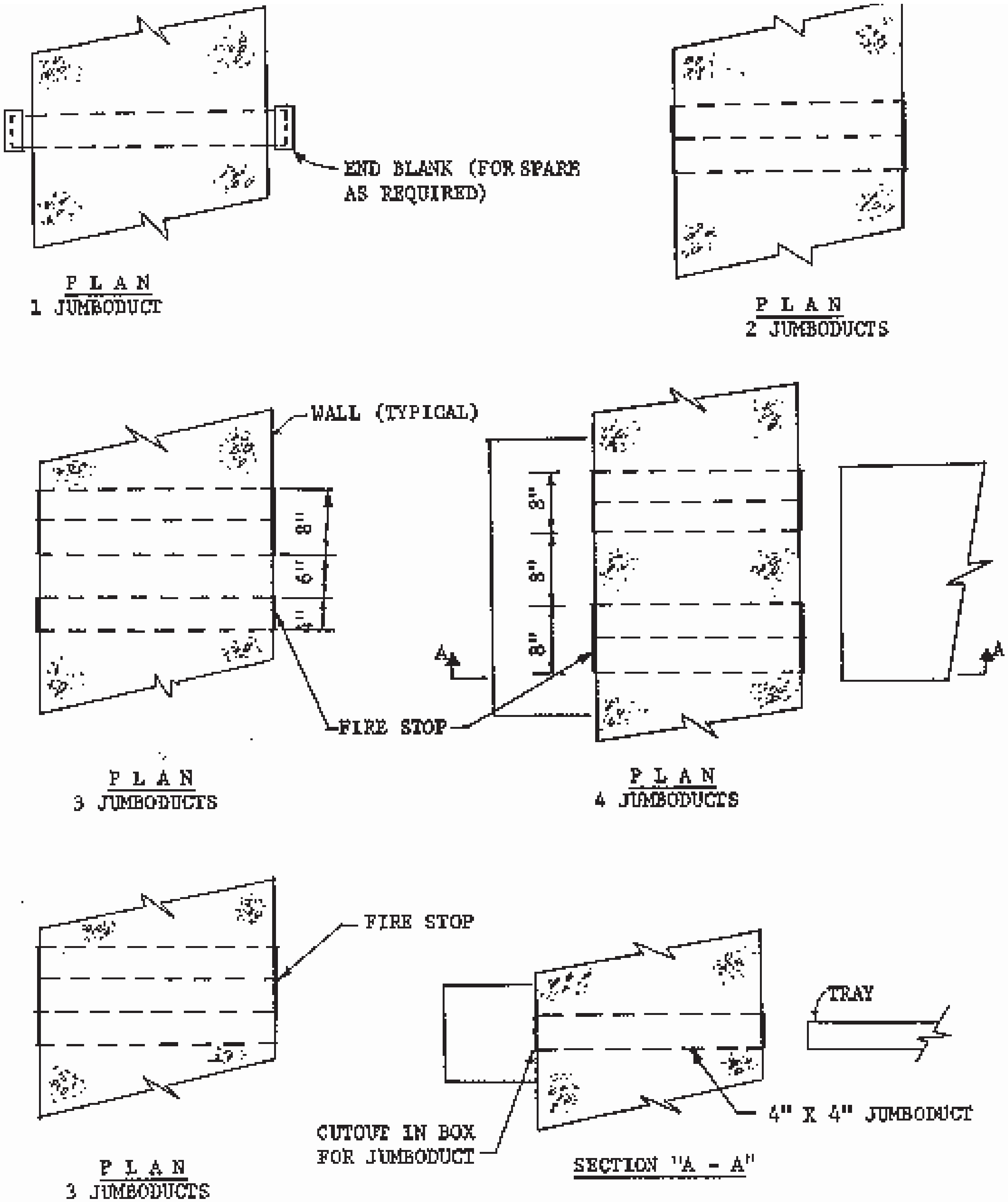
- TRANSMISSION NETWORK/GRID (INCLUDING SWITCHYARD AND TRANSMISSION LINES)
- DCPP PREFERRED POWER SUPPLY (STARTUP OFFSITE CIRCUIT)
- DCPP PREFERRED POWER SUPPLY (AUXILIARY OFFSITE CIRCUIT)
- DCPP STANDBY POWER SUPPLY
- GENERAL POWER SUPPLY CIRCUITS
- CLASS IE BUS (SEE NOTE 2)

FSAR UPDATE

UNITS 1 AND 2
DIABLO CANYON SITE

FIGURE 8.1-2
DCPP POWER SUPPLY
BOUNDARY DIAGRAM

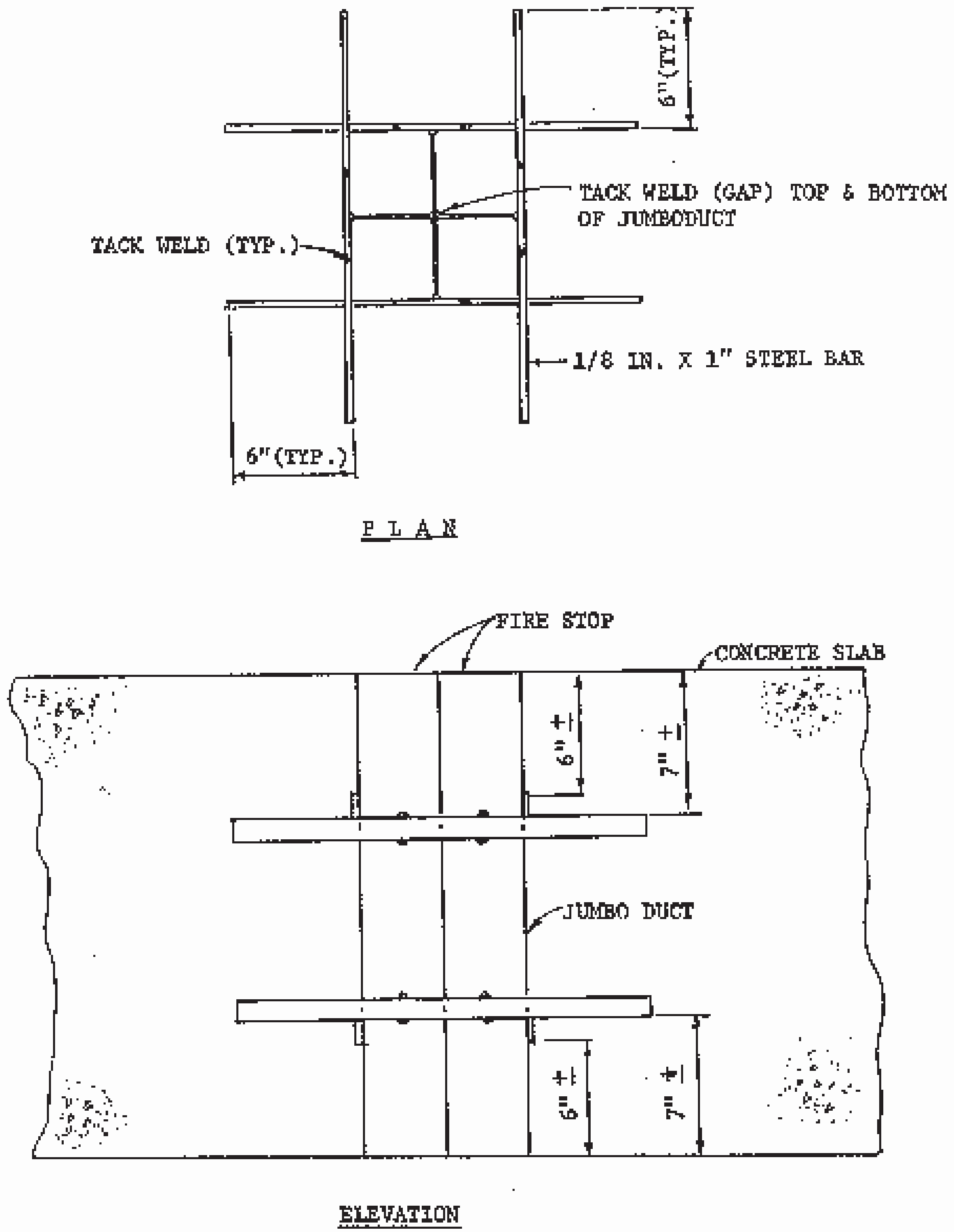
Revision 22 May 2015



FSAR UPDATE

UNITS 1 AND 2
DIABLO CANYON SITE

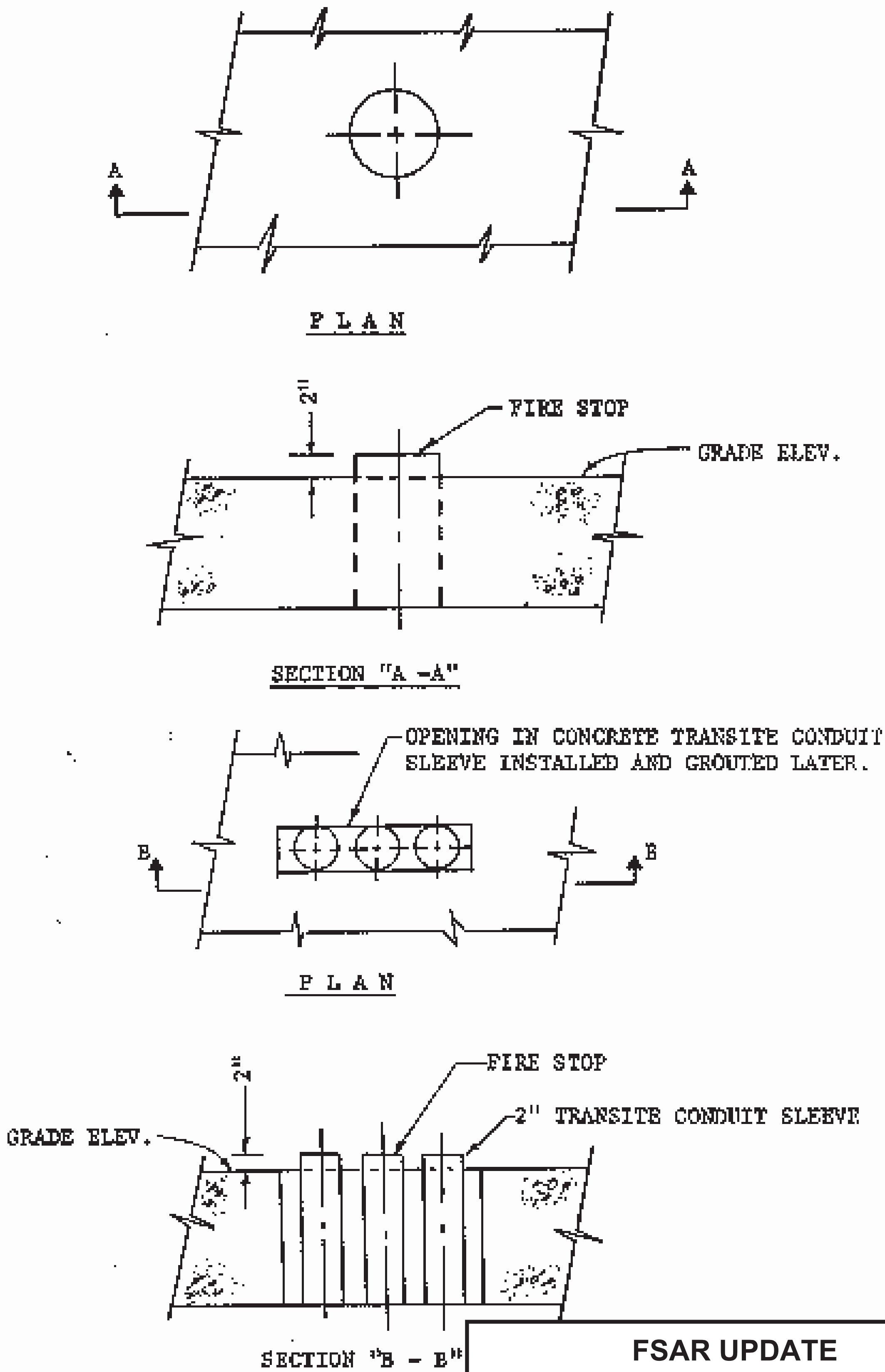
FIGURE 8.3-21
TYPICAL ARRANGEMENT OF JUMBODUCT SLEEVE THROUGH CONCRETE



FSAR UPDATE

UNITS 1 AND 2
DIABLO CANYON SITE

FIGURE 8.3-22
TYPICAL DETAIL OF FOUR OR MORE JUMBODUCTS IN CONCRETE SLAB



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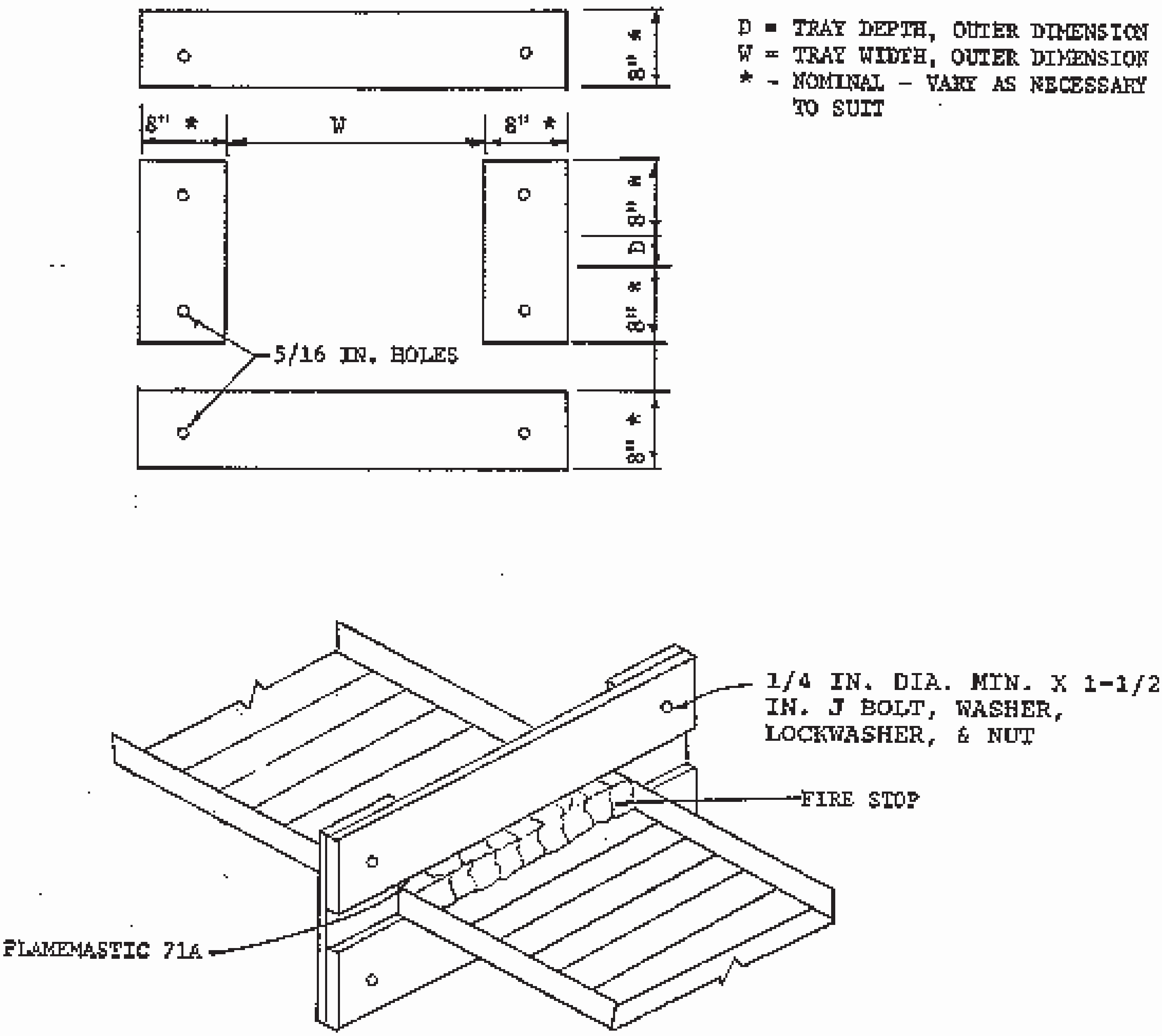
UNITS 1 AND 2
DIABLO CANYON SITE

FIGURE 8.3-23
TYPICAL ARRANGEMENT OF TRANSITE CONDUIT SLEEVE FOR ELECTRICAL CABLES THROUGH CONCRETE



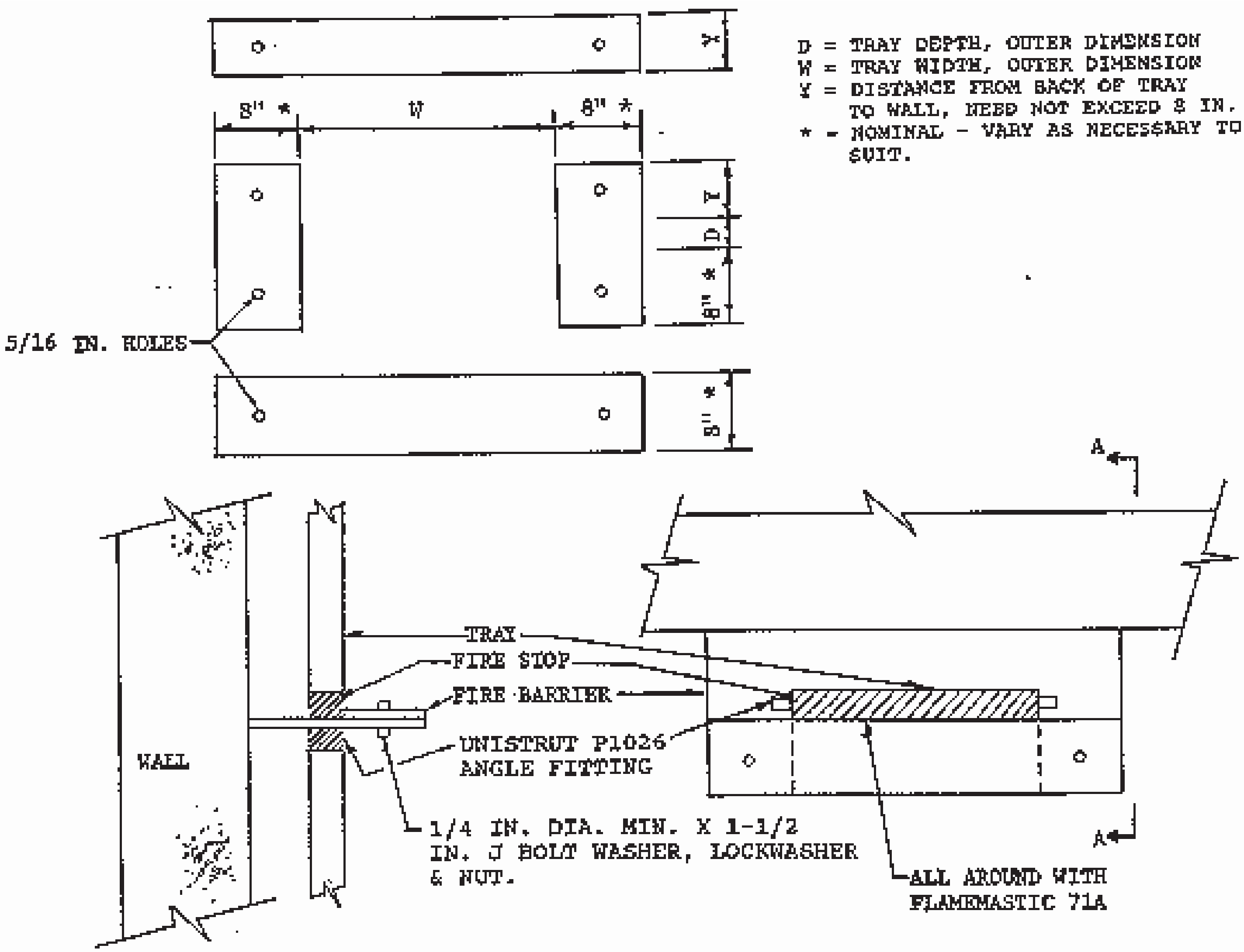
NOTES:

1. FIRE BARRIER BOARD MATERIAL MIN.- 1/2 IN. MARINITE XL PANEL. ALTERNATE MATERIAL - MIN. 1/2 IN. M BOARD OF CERAMIC FIBER.

2. FIRE STOP MATERIAL SHALL BE 4 IN. OF LOSE OR 10 IN. RTV 3-6548.

3. FOR ALTERNATE HORIZONTAL TRAY FIRESTOP DESIGN - SEE FIGURE 8.3-28.

FSAR UPDATE
UNITS 1 AND 2 DIABLO CANYON SITE
FIGURE 8.3-24 TYPICAL FIRE STOP FOR HORIZONTAL CABLE TRAYS



SECTION "A - A"

NOTES:

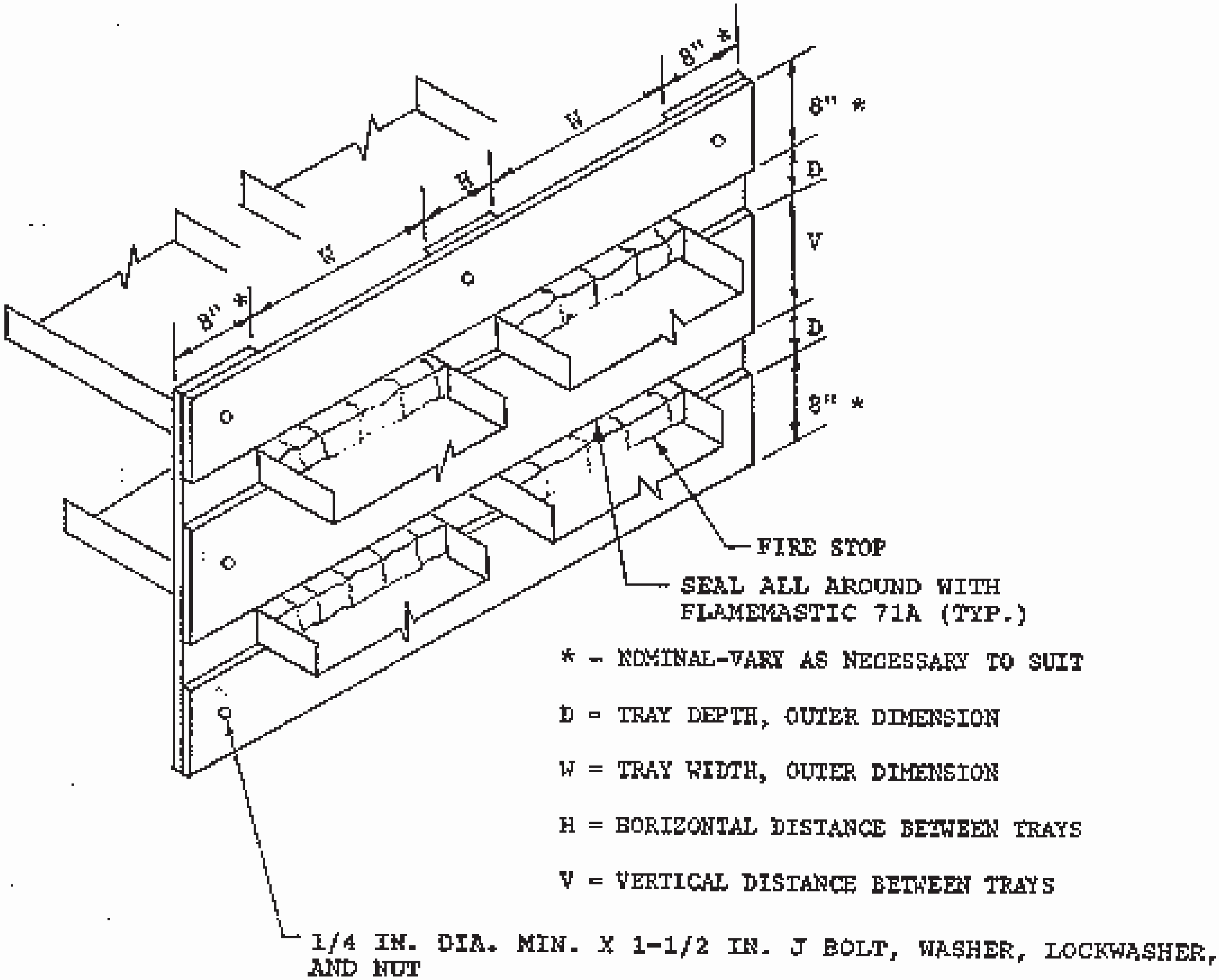
1. FIRE BARRIER BOARD MATERIAL - MIN. 1/2 IN. MARINITE XL PANEL. ALTERNATE MATERIAL - MIN. 1/2 IN. KAOWOOL M BOARD OF CERAMIC FIBER.

2. FIRE STOP MATERIAL SHALL BE 4 IN. OF LDSE OR 10 IN. RTV 3-6548.

FSAR UPDATE

UNITS 1 AND 2
DIABLO CANYON SITE

FIGURE 8.3-25
TYPICAL FIRE STOP FOR VERTICAL TRAYS



NOTES:

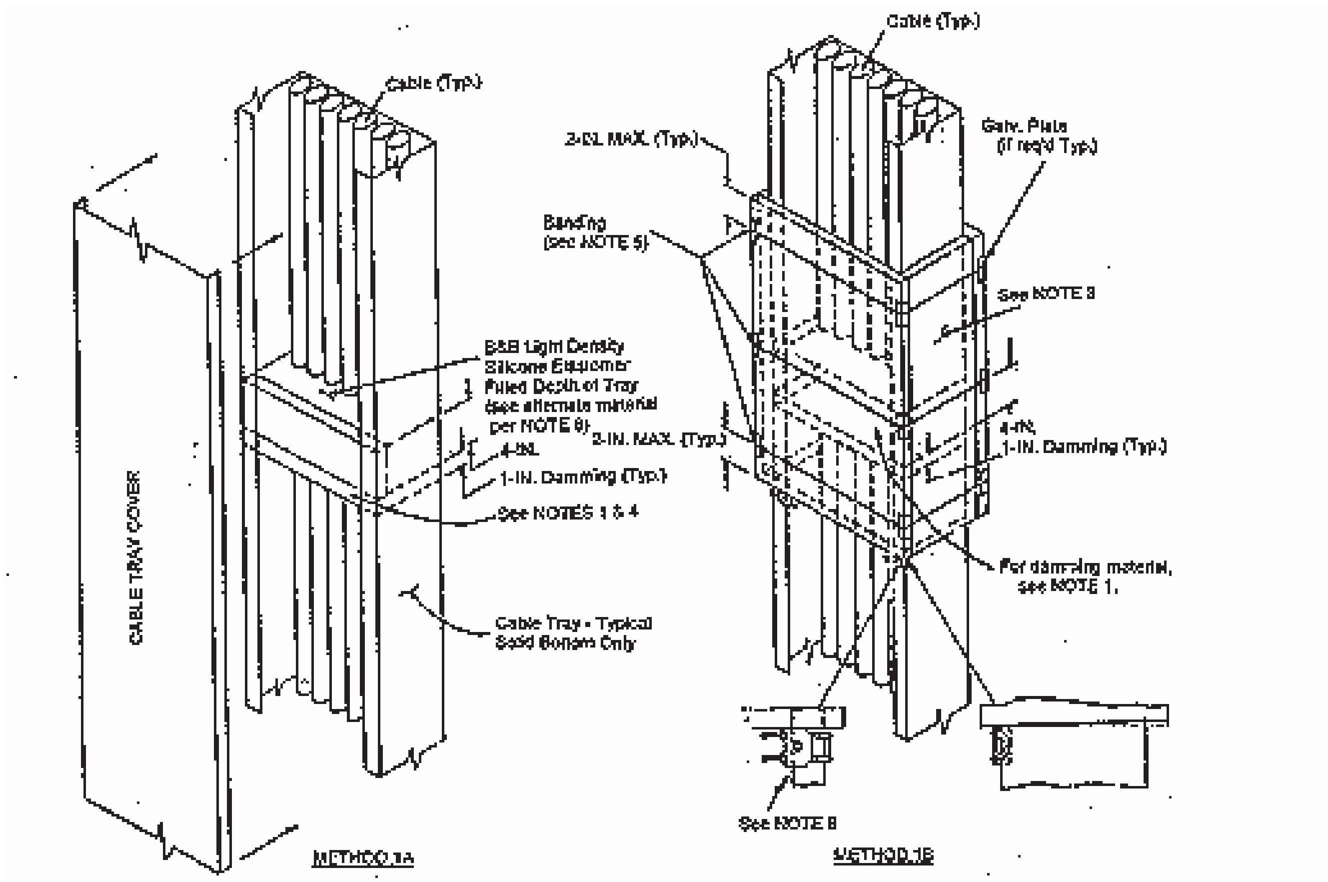
1. FIRE BARRIER BOARD MATERIAL - MIN. 1/2 IN. MARINITE XL PANEL. ALTERNATE MATERIAL - MIN. 1/2 IN. KAOWOOL M BOARD OF CERAMIC FIBER.

2. FIRE STOP MATERIAL SHALL BE 4 IN. OF LDSE OR 10 IN. RTV 3-6548.

FSAR UPDATE

UNITS 1 AND 2
DIABLO CANYON SITE

FIGURE 8.3-26
TYPICAL FIRE STOP
FOR PARALLEL TRAYS



NOTE 1 Damming (typ.)
Damming is to be left in place and fire rated materials such as J-M Cera Products or B & W Kaowool Products, shall be utilized. Such products shall be board form only.

NOTE 2 Cable separation
J-M or B & W bulk fiber shall be used at point of damming for cable separation, where possible, to facilitate flow of seal material.

NOTE 3 For open and ladder type trays, enclose tray with 3'-0" of fire rated board, as referred in NOTE 1 above, and locate board material to suit field installation, but maintain cover of entire firebreak face.

NOTE 4 For open solid back trays, install firebreak per Method 1A (excluding Cover), and install fire board over open area, using banding material as noted in Method 1B.

NOTE 5 Banding material shall be 3/4" X 0.020" stainless steel band with stainless steel wing seals. Banding shall be installed at three (3) approx. equally spaced locations.

NOTE 6 Alternate to the 4" of B & B Light Density Silicone Elastomer (LDSE) is 10" of Dow Corning 3-6548 Silicone RTV Foam. All other requirement per the above notes and details, to be incorporated.

NOTE 7 If necessary, add galvanized angle plate (approx. 1" X 2") under banding at corners.

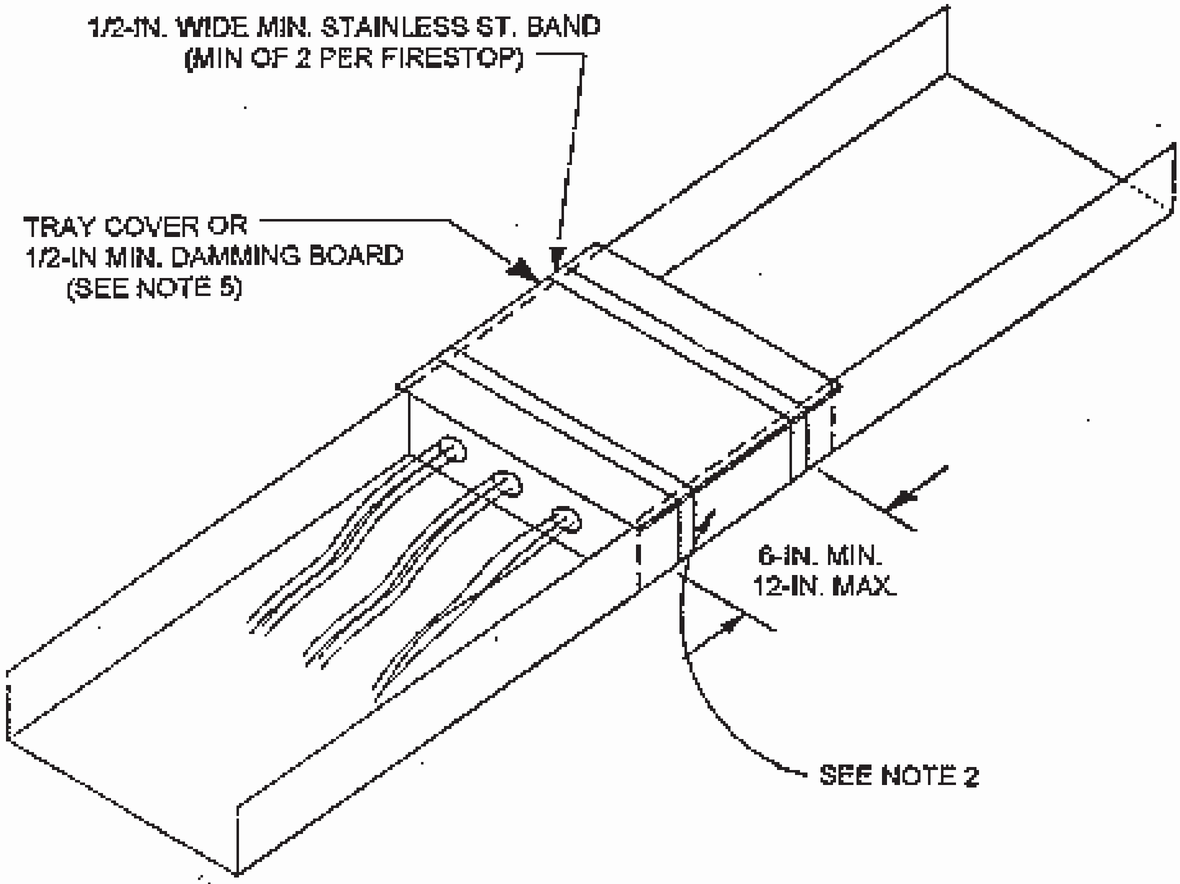
NOTE 8 B-line clamp 0400-101 and/or 97-1555 to be installed in the front side of cable tray on the bottom of the firebreak (for vertical tray only).

FSAR UPDATE

UNITS 1 AND 2
DIABLO CANYON SITE

FIGURE 8.3-27

TYPICAL VERTICAL TRAY FIRE STOP



NOTES:

1. 12 FEET FOR HORIZONTAL RUNS AND WITHIN 5 FEET OF TRAY CROSSINGS.

2. FILL WITH DOW CORNING RTV 3-6548 SILICONE RTV FOAM. ALL CABLES IN TRAY SHOULD BE COVERED WITH FOAM. COVER TRAY VENTILATION OPENING WITH TAPE WHILE FOAM IS CURING. THEN REMOVE TAPE.

3. FOR OTHER "FIRE BARRIER FOR VENTILATED TRAY" DESIGN, SEE FIGURE 8.3-24.

4. IN CASES WHERE DAMMING BOARD CANNOT BE INSTALLED DUE TO AMOUNT OF CABLES, A MINIMUM OF 8 INCHES OF RTV FOAM SHALL BE USED.

5. DAMMING BOARD MATERIAL TO BE 1-INCH KAOWOOL M BOARD OF CERAMIC FIBERS OR EQUIV.

FSAR UPDATE
UNITS 1 AND 2 DIABLO CANYON SITE
FIGURE 8.3-28 TYPICAL FIRE BARRIER FOR HORIZONTAL TRAYS

APPENDIX 8.3B

INSULATED CABLE CONSTRUCTION AND VOLTAGE RATINGS

Appendix 8.3B

INSULATED CABLE CONSTRUCTION AND VOLTAGE RATINGS

The insulated cables that externally interconnect separate units of equipment throughout the plant are described below:

(1) High-voltage power cables for 4160- and 12,000-V service are rated 5000 and 15,000 V, respectively, for ungrounded or high-resistance grounded operation. All of these cables are rated 90°C because they are expected to operate only in an environment having a normal maximum temperature of 40 to 50°C. These cables are all single conductor, with ethylene-propylene insulation and a neoprene, hypalon (chlorosulfonated polyethylene (CSPE)), or linear low density polyethylene (LLDPE) jacket. These cables are provided with an extruded semiconducting shield surrounding the conductor and another over the insulation, all covered by a tinned or bare copper tape. A polyester-polypropylene tape and a nylon-neoprene tape are used as a heat shield between the copper tape and the jacket. A stress cone is provided at each terminal, with one of them grounded.

(2) Low-voltage power cables are all of the single conductor type, rated 600 V. Generally, those expected to operate in a maximum ambient temperature of 40 to 50°C are rated 90°C and have ethylene-propylene insulation and a hypalon (CSPE) jacket for sizes 8 AWG and larger. Smaller cables are insulated with flame-retardant cross-linked polyethyelene (XLPE). Those cables located very near or connected to hot equipment and devices, or those required to operate in the atmosphere of the containment during a loss-of-coolant-accident (LOCA), are insulated with silicon rubber, XLPE, Tefzel, or equivalent insulation material and covered by a hypalon (CSPE), XLPE, Tefzel, or equivalent jacket material (except for power cables to the containment fan cooler motors and pressurizer heaters). Cables for the containment fan cooler motors are insulated with a combination of silicone resin-impregnated glass braid, polyimide (Kapton) tapes, an asbestos mat, and a jacket of hypalon. Heat-shrinkable tubing is provided at terminations and splices to seal the cable. Cables for the pressurizer heaters are rated 600 V, 1000°F, and are insulated with a combination of mica and glass tapes with a glass braid jacket.

(3) Cables for control circuits are single and multiple conductor, rated 600 V. Generally, single conductor cables are not less than 12 AWG, and multiple conductor cables are not less than 14 AWG. Cables operating in normal maximum ambient temperature are rated 90°C and are insulated with cross-linked polyethylene with multiple conductor cables having an overall jacket of the same material. Cables that are located very near or connected to hot

equipment and devices, or required to operate in the atmosphere of the containment during a LOCA, are insulated with silicone rubber, XLPE, Tefzel, or equivalent insulation material and covered by a hypalon (CSPE), XLPE, Tefzel, Stilan, or equivalent jacket material.

(4) Instrument cables composed of adjacent conductors have the conductors twisted and shielded with an aluminized mylar tape in continuous contact with a copper drain wire, grounded only at one point. Signal circuits are generally 16 AWG copper, and thermocouple circuits are also 16 AWG. Those cables operating in a normal environment are insulated with cross-linked polyethylene (XLPE) and covered by a jacket of the same material. Cables that are located very near or connected to hot equipment and devices, or required to operate in the atmosphere of the containment during a LOCA, are insulated with silicone rubber and covered by a silicone rubber, Tefzel, Stilan, XLPE, or equivalent jacket material.

(5) Instrument cables of the coaxial and triaxial types have insulations of alkane-imide polymer and cross-linked polyolefin, and jackets of cross-linked polyethylene. Incore thermocouple extension wire is 20 AWG Chromel-Alumel for use in ambient up to 400°F. Primary insulation is a heavy polyimide enamel, and silicone-impregnated fiberglass braid covers the insulation.

APPENDIX 8.3C

MATERIALS FOR FIRE STOPS AND SEALS

Appendix 8.3C

MATERIALS FOR FIRE STOPS AND SEALS

Materials used for fire stops and penetration seals are as follows:

(1) **Refractory Ceramic Damming Materials -** Approved damming material, when required as part of a PG&E Approved penetration seal design, is installed on the bottom of the penetration seal in floors/ceilings and on both sides of the penetration seal in walls. Variations are not allowed without Fire Protection Engineering Approval. Kaowool M board, or engineering approved equivalent, is also used as cable tray fire stop damming. Damming materials consist of the following:

Board:
- Thermal Ceramics Kaowool M Board
- Johns-Manville (JM) Ceraform Board Type 103
- Johns-Manville (JM) Ceraboard Type 126/103
- Fire Protection Design Engineer, or designee, approved equivalent

Blanket:
- Thermal Ceramics Kaowool blanket
- Chemtrol CT-23B alumina silica blanket
- Johns-Manville (JM) Cerablanket
- Fire Protection Design Engineer, or designee, approved equivalent

Bulk Fiber:
- Thermal Ceramics Kaowool bulk fiber
- Chemtrol CT-23F alumina silica bulk fiber
- Johns-Manville (JM) Cerafiber Bulk
- Fire Protection Design Engineer, or designee, approved equivalent

(2) **Marinite Panels -** These panels are composed of calcium silicate and inorganic binders. Can be used as tray fire stop damming or shielding. Can only be used as part of a penetration seal with engineering evaluation. ASTM Specification C5676.

(3) **Flamemastic 77 -** This material, as manufactured by Flamemaster Corporation, is used in conjunction with Kaowool M board or Marinite Panels for tray fire stop construction. This material can only be used as part of a penetration seal design with engineering evaluation.

(4) **Dow Corning 3-6548 Silicone RTV Foam -** This material, as manufactured by Down Corning Corporation, is used in PG&E Engineering approved penetration seal and cable tray fire stop designs.

(5) **Dow Corning Sylgard 170 Silicone Elastomer -** This material, as manufactured by Dow Corning Corporation, is used in PG&E Engineering approved penetration seal designs.

(6) **LDSE (Light Density Silicone Elastomer) -** This material, as manufactured by PROMATEC, Inc., is used in PG&E Engineering approved penetration seal designs.

(7) **TS-MS-45B (Medium Density Silicone Elastomer) -** This material, as manufactured by PROMATEC, Inc., is used in PG&E Engineering approved penetration seal designs and for internal bus duct sealing.

(8) **HDSE (High Density Silicone Elastomer) -** This material, as manufactured by PROMATEC, Inc., is used in PG&E Engineering approved penetration seal designs, typically where gamma radiation shielding is a concern.

(9) **RADFLEX -** This material, as manufactured by PROMATEC, Inc., is used in PG&E Engineering approved penetration seal designs, typically where gamma radiation shielding and mechanical pipe movement is a concern.

(10) **PROMAFLEX -** This material, as manufactured by PROMATEC, Inc., is used in PG&E Engineering approved penetration seal designs, typically where mechanical pipe movement is a concern.

(11) **Approved Boot Fabric Material -** This material is used in conjunction with PG&E Engineering approved penetration seal designs, typically where mechanical pipe movement is a concern.

- Connecticut Hard Rubber (CHR) 1032
- Keene Grade 56493F031
- Fire Protection Design engineer, or designee, approved equivalent

(12) **Silicone Adhesive Sealant -** Approved material is used in conjunction with PG&E Engineering approved penetration seal designs, or as an engineering approved sealant in other specific design applications.

- Dow Corning 732 silicone adhesive sealant
- Dow Corning 96-081 silicone adhesive sealant
- Fire Protection design Engineer, or designee, approved equivalent

(13) **Grout -** This material is used in PG&E Engineering approved penetration seal designs, and as a barrier restoration material for poured n place concrete and concrete block barriers. Typically, the only approved grout material is a cement based grout. With limitation in certain design applications, Ceilcote 658N Epoxy resin grout is approved.

(14) **Pyrocrete -** This material, as manufactured by Carboline, Inc., is used as a PG&E Engineering approved penetration seal design as a barrier restoration material around penetrants through Pyrocrete construction barriers. The specific type, grade, and thickness of Pyrocrete is dependent on the barrier contraction, or engineering evaluated equivalent.

(15) **Plaster -** This material is used as a PG&E Engineering approved penetration seal design as a barrier restoration material around penetrants through Plaster construction barriers. The specific type, grade, and thickness of Plaster is dependent of the barrier construction or engineering evaluated equivalent.

(16) **Epoxy XR5126 -** This material is used where electrical and pressure isolation is required.

Fire barrier penetration seals and credited cable tray fire stops are visually inspected periodically.