8.0 ELECTRIC POWER

8.1 INTRODUCTION

8.1.1 Utility Grid Description

The transmission service providers for South Texas Project Electric Generating Station (STPEGS) are CenterPoint Energy, AEP Texas Central Company (TCC), City of Austin (COA), and City Public Service Board of San Antonio (CPS). The combined electrical grids of the four systems presently consist of interconnected fossil fuel plants which serve approximately 51,354 square miles with an overlaid 345/138/69 kV transmission system, as shown on Figure 8.1-1.

The four transmission service providers are members of the Electric Reliability Council of Texas (ERCOT). ERCOT consists of members engaged in generation, marketing, transmission, or distribution of electric energy within the State of Texas. ERCOT is the Independent System Operator (ISO), which oversees all generation and transmission functions.

The 345 kV switchyard at STPEGS has nine 345 kV transmission circuits which connect it to the four transmission service providers' transmission system. Two of the 345 kV transmission circuits connect to TCC's White Point 345 kV substation and the Blessing 345 kV autotransformer. These circuits are on separate rights-of-way. Five of the 345 kV transmission circuits connect to CenterPoint Energy's Hillje, W. A. Parish and Velasco 345 kV substations; two circuits to Velasco are on a double-circuit tower line and are on a separate and independent right-of-way from the W. A. Parish circuit. One 345 kV circuit continues on from Hillje to connect to the COA and Lower Colorado River Authority (LCRA) Holman joint substation. Two 345 kV transmission circuits to Elm Creek are built separate double-circuit towers and then combine on a single double-circuit tower from the end of the corridor at Hillje to Elm Creek near San Antonio, Texas. CN-2846

8.1.2 Onsite Electrical System

The Onsite Electrical System of each unit consists of four 13.8 kV auxiliary busses, three 13.8 kV standby busses, five 13.8/4.16 kV auxiliary transformers, two balance-of-plant (BOP) 4.16 kV auxiliary busses, and three Engineered Safety Feature (ESF) 4.16 kV auxiliary busses. The three ESF 4.16 kV auxiliary busses feed the redundant Class 1E AC power loads.

During normal operation, each unit's AC electrical power is supplied by its unit auxiliary and standby transformers. CN-2862

Power from the utility grid (the Offsite Electrical System) is made available to the Onsite Electrical System through the respective unit auxiliary transformer and/or the two plant standby transformers (no. l and no. 2) and the 138 kV emergency transformer (Figure 8.2-l). Onsite standby power is provided by three standby diesel generators (SBDGs) for each unit. These operate at 4.16 kV. (Two BOP busses per unit are served from separate 480 V and 4160 V diesel generators [DGs]. One BOP bus common to both units is served from a 480 V lighting DG). One standby DG (SBDG) is tied to one Class 1E AC bus per unit. The three SBDGs and their associated Class 1E AC Power Systems make up three independent systems which provide AC power to the three independent ESF load trains designated as Train A, Train B, and Train C. Each train of the Class 1E AC Power System is provided with an independent Class 1E 125 vdc system. Train A serves an additional Class 1E 125 vdc distribution system which supplies power to the fourth Reactor Protection System (RPS) channel. Each Class 1E 125 vdc system is designed to carry all of its required loads during design basis events. The non-Class 1E DC loads are supplied by 48 vdc, 125 vdc, and 250 vdc systems supplied by the respective batteries. In addition, the plant computer is served by its own 250 vdc battery system. These non-Class 1E DC systems are served from non-Class 1E 480 V motor control centers (MCCs).

The ESF AC and DC Power Systems are designed with redundancy and independence of onsite power sources, distribution systems, and controls in order to provide a reliable supply of electrical power to the ESF electrical loads necessary to achieve safe plant shutdown, or to mitigate the consequences of postulated accidents.

8.1.3 Offsite Electrical System

The Offsite Electrical System consists of the respective unit auxiliary transformers, (25-13.8/13.8 kV), two standby transformers, (362.25-13.8/13.8 kV) two main generators, two pairs of main power transformers (362.25-25 kV or 359.375-25kV), the 345 kV lines connecting the main power transformers and the standby transformers to the switchyard, the 345 kV switchyard, and the nine 345 kV transmission circuits from the STPEGS 345 kV switchyard to the four transmission service providers' interconnecting grids, and the 138 kV line from TCC's Blessing Substation to the 138 kV emergency transformer. The nine 345 kV transmission circuits connect the STPEGS 345 kV switchyard to the four transmission service providers' grids as follows:

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1. STPEGS to Elm Creek (CPS)
2. STPEGS to Elm Creek (CPS)

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3. STPEGS to White Point (TCC)
4. STPEGS to Blessing (TCC)
5. STPEGS to Velasco Circuit l (CenterPoint Energy)
6. STPEGS to Velasco Circuit 2 (CenterPoint Energy)
7. STPEGS to W. A. Parish (CenterPoint Energy)
8. STPEGS to Hillje (Centerpoint Energy)
9. STPEGS to Hillje (Centerpoint Energy)

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The standby transformers are connected on their high-voltage sides to the switchyard main busses (No. 1 transformer is connected to the north bus and No. 2 transformer is connected to the south bus). The low-voltage leads of each standby transformer may be connected to the 13.8 kV standby busses and to one of the four 13.8 kV auxiliary busses in each unit. The 138 kV emergency transformer is connected on its high-voltage side to a 138 kV transmission line between TCC's Blessing and Celanese Substations. The low-voltage leads may be connected to the 13.8 kV emergency busses. The plant Onsite Power System and its connections to the switchyard are shown on the main one-line diagram (Figures 8.3-1 and 8.2-1).

8.1.4 Design Bases

8.1.4.1 Offsite Power System. The transmission system provides reliable sources of offsite power for supplying plant auxiliary power systems for startup, shutdown, or any time power is unavailable from the unit's main generator.

The normal power supply to the 13.8 kV busses is provided through the unit auxiliary and standby transformers. Upon trip of the generator, turbine, or reactor, the generator circuit breaker automatically opens to maintain the supply of power from the 345 kV switchyard (through the main and unit auxiliary transformers) to all auxiliary busses and aligned standby busses. The BOP and ESF busses can be manually transferred to any of the offsite sources (i.e., the respective unit auxiliary transformer or the standby transformers.) All bus transfers are manual. The unit auxiliary transformer, when supplied from either the main generator or the 345 kV switchyard, has the capacity for all of one unit's loads. CN-2862

The standby transformers are individually supplied by separate and independent overhead 345 kV ties from the 345 kV switchyard. These 345 kV ties to the standby transformers are connected to two separate 345 kV busses (north and south) in the switchyard; however, the north and south busses are connected in normal operation. Each standby transformer has the capacity to supply all ESF busses in both units and two 13.8 kV auxiliary busses. The 138 kV emergency transformer is supplied by a separate and electrically independent 138 kV transmission line. The 138 kV emergency transformer and this line have sufficient capacity to provide power to one ESF bus of each unit. Each unit auxiliary transformer is individually connected to the 345 kV switchyard by a separate and independent overhead tie through the main transformer. These 345 kV ties are connected at separate positions on the breaker-and-a-half 345 kV switchyard. These transformers have the capacity for startup, full-load operation, and safe shutdown. Each unit auxiliary transformer has the capacity for the BOP loads and safe shutdown loads of all three of its ESF busses.

The switchyard station service is supplied by two 4.16 kV non-Class 1E feeders (one from each unit) via a local 480 V load center and is provided with two independent 125 vdc systems. This redundancy in power supplies assures that protective devices have a power source to maintain the reliability of the off-site supply.

The nine 345 kV transmission circuits connecting the STPEGS switchyard to the grid are routed so that loss of any independent right-of-way or outage of any two circuits may necessitate some reduction in generation output but would not significantly reduce the capability of the offsite supply of power. CN-2846

8.1.4.2 <u>Onsite Power System</u>. The Onsite Power System is designed to supply the power requirements of all auxiliary loads required for all modes of plant operation. Sufficient instrumentation and protective control devices are provided to ensure reliability and availability of the system.

A listing of safety systems and loads is given in Table 8.1-1 and Table 8.3-3, respectively. These tables indicate the redundant loads associated with Train A, Train B, and Train C safety features. Safety functions and power requirements (AC or DC) of these loads are listed for the various plant conditions.

Those portions of the Onsite Power System required for the distribution of power to Class 1E electrical subsystems and components which are safety-related meet the following safety design bases:

1. Each safety-related electrical load group (Train A, B, or C) is provided with an onsite standby power source, electrical busses, distribution cables, controls, relays, and other electrical devices separate from the other load groups.

2. Each onsite standby power source has sufficient capacity to provide power to its associated auxiliary power system to shut down and maintain the unit in a safe condition or to mitigate the consequences of a Design Basis Accident (DBA) in the event of a loss of the offsite power sources.

3. Redundant parts of the system are physically independent to the extent that a single event, including a single electrical failure, does not cause loss of power to redundant loads.

4. In the event of the loss of all offsite power, the safety-related loads are connected to the onsite standby power sources automatically and in sufficient time to safely shut down the unit or limit the consequences of a DBA to within applicable regulatory limits.

5. The Class 1E Electrical System (4.16 kV ESF busses, associated DGs and 480 vac, 120/208 vac and 125 vdc power and control systems) is installed in seismic Category I structures.

6. The Class 1E Electrical System is designed to withstand the effects of design basis natural phenomena, assuming single active failure, without loss of onsite power to those safety-related electrical components required to shut down the plant and maintain it in a safe condition or to mitigate the consequences of postulated accidents.

7. The three offsite AC power sources (two standby and the respective unit auxiliary transformers) are capable of supplying power to each Class 1E electrical system bus.

8. One standby DG set and one independent 125 vdc system are provided for each Class 1E load group. (An additional 125 vdc system for the fourth RPS channel is provided using Train A as the AC power supply.)

9. Physical separation and electrical isolation are provided to maintain independence of all redundant Class 1E circuits and equipment.

10. Manual initiation of each protective action at the system level is provided in the main control room.

11. Inoperability and bypassed status indication for the safety-related systems are provided at the ESF system level and component level in the main control room (Section 7.5.4).

The applicable criteria and codes, such as Regulatory Guides and Institute of Electrical and Electronic Engineers standards, concerned with power requirements of the safety-related electrical loads are met by these systems (Table 8.1-2).

TABLE 8.1-1

CLASS 1E SYSTEM LOAD IDENTIFICATION AND FUNCTIONS

Safety System	Function	Power
Chemical and Volume Control System	Controls reactor coolant volume	AC
Residual Heat Removal System	Removes residual heat from reactor coolant	AC
Containment Spray System	Provides cooling spray for control of pressure and temperature in Containment during DBA	AC
Reactor Makeup Water System	Provides makeup water to component cooling water and spent fuel pool	AC
Component Cooling Water System	Provides cooling water to safety-related equipment	AC
Essential Cooling Water System	Provides cooling water for standby DGs, safety-related ventilation, and Component Cooling Water System	AC
Auxiliary Feedwater System	Provides cooling water to steam generators	AC
Emergency Core Cooling System	Provides cooling water to reactor	AC
Diesel Generator Lube Oil System	Provides lube oil to DG	AC
Diesel Generator Fuel Oil Transfer System	Provides fuel oil transfer from bulk storage to the DG 7-day tanks	AC
Heating, Ventilating, and Air Conditioning System	Maintains environment in areas with safety-related equipment	AC
Spent Fuel Pool Cooling System	Provides spent fuel pool cooling	AC

TABLE 8.1-1 (Continued)

CLASS 1E SYSTEM LOAD IDENTIFICATION AND FUNCTIONS

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Safety System	Function	Power
Radiation Monitoring System	Monitors radiation levels	AC/ Vital AC
Diesel Generator Cooling Water System	Provides jacket cooling water to DG	AC
Post-Accident Monitoring System	Provides post-accident monitoring	DC/ Vital AC
Reactor Trip System	Trips reactor to reduce heat removal requirements and place reactor in a more controllable configuration	DC/ Vital AC
Engineered Safety Feature Actuation System	Activates equipment needed to mitigate the consequences of an accident	DC/ Vital AC

TABLE 8.1-2

LISTING OF APPLICABLE CRITERIA

Criteria		Title	Conformance Discussed In
1.	Regulatory Guides*		
2.	Institute of Electrical and Electronics Engineers Standards Not Otherwise Incorporated by RG Reference:		
	IEEE Std. 420-1973	IEEE Trial-Use Guide for Class 1E Control Switchboards for Nuclear Power Generating Stations	8.3.1.3
	IEEE Std. 485-1978	IEEE Recommended Practice for Sizing Large Lead Storage Batteries for Generating Stations and Substations	8.3.2.1.1
3.	Branch Technical Positions		
	BTP ICSB 8 (PSB)	Use of Diesel Generator Sets for Peaking	8.3.1.1.4
	BTP ICSB 11 (PSB)	Stability of Offsite Power Systems	8.2.2.1
	BTP ICSB 18 (PSB)	Application of the Single Failure Criterion to Manually-Controlled Electrically Operated Valves	6.3.1, 6.3.2.2, 6.3.5.5, 7.6.3, 7.6.7 See Figures 7.6-3 & 7.6-10

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* See Table 3.12-1 for revision and STP position on the following Regulatory Guides:
1.6, 1.9 (IEEE 387-1977), 1.22, 1.29, 1.30 (IEEE 336-1971), 1.32 (IEEE 308-1974), 1.40 (IEEE 334-1971), 1.41, 1.47 (IEEE 279-1971), 1.53 (IEEE 379-1972), 1.62 (IEEE 279-1971), 1.63 (IEEE 317-1976),
1.73 (IEEE 382-1972), 1.75 (IEEE 384-1974), 1.81, 1.89 (IEEE 323-1974), 1.93, 1.100 (IEEE 344-1975), 1.106, 1.108, 1.118 (IEEE 338-1977) 1.128 (IEEE 484-1975), 1.129 (IEEE 450-1975), and 1.131(IEEE 383-1974)

TABLE 8.1-2 (Continued)

LISTING OF APPLICABLE CRITERIA

Criteria	Title	Conformance Discussed In
BTP ICSB 21	Guidance for Application of RG 1.47	7.1.2.6
BTP PSB1	Adequacy of Station Electric Distribution System Voltages	8.3.1.1.4.6
BTP PSB2	Criteria for Alarms and Indications Associated with Diesel Generator Unit Bypassed and Inoperable Status	8.3.1.1.4.7
4. General Design Criteria		
GDC 2	Design Basis for Protection Against Natural Phenomena	3.1, 7.2.1.1
GDC 4	Environmental and Missile Design Bases	3.1, 3.11
GDC 5	Sharing of Structures, Systems, and Components	3.1
GDC 17	Electrical Power Systems	3.1.2.2.8.1 8.2.1.3 8.3.1.2.1 8.3.2.2.1
GDC 18	Inspection and Testing of Electric Power Systems	3.1.2.2.9.1 8.3.1.2 8.3.2.2.1
GDC 21	Protection System Reliability and Testability	3.1.2.2.12.1 8.3.1.2.1 8.3.2.2.1
GDC 50	Containment Design Basis	3.1

8.2 OFFSITE POWER SYSTEM

8.2.1 Description

This section provides a description of the Offsite Power System and components and a discussion of system compliance with the design criteria indicated in Section 8.1.4.1. Compliance with applicable regulatory guides is also addressed in Section 8.1. The systems, circuits, and components of this section designated as "345 kV" refer to the assigned nominal value of a given voltage class for convenient designation.

8.2.1.1 Transmission Lines. Nine 345 kV transmission circuits rated from 896 to 1,137 MVA connect the South Texas Project Electric Generating Station (STPEGS) 345 kV switchyard to the ERCOT grid, as shown on Figure 8.2-4. These nine 345 kV circuits provide the source of AC power to the 345 kV switchyard. The 345 kV transmission circuits terminate at six points in the four transmission service providers' systems as follows: at Velasco 345 kV Substation (CenterPoint Energy); at W. A. Parish 345 kV Substation (CenterPoint Energy); at Hillje 345 kV Substation (CenterPoint Energy); at Elm Creek 345 kV Substation (City of Public Service Board of San Antonio [CPS]); at White Point 345 kV Substation (AEP Texas Central Company [TCC]; and at Blessing 345 kV Substation autotransformer (TCC). The Blessing 345 kV autotransformer is connected to the TCC's Blessing 138 kV Substation.

Three rights-of-way commence from the STPEGS property toward the termination points described above as shown on Figure 8.2-5. The eastern right-of-way is 100 ft wide and contains two 345 kV circuits to Velasco (on double-circuit structures). The western right-of-way is 100 ft wide and contains a 345 kV circuit to Blessing. The middle or northwestern right-of-way is 400 ft wide and contains the six remaining circuits. These circuits are carried on three sets of double-circuit towers. The W. A. Parish and one Elm Creek are on the eastern structures, the second Elm Creek and one Hillje lines are on the middle structures, and the second Hillje and White Point lines are on the western structures. (There is adequate spacing between the middle and western towers to allow complete failure of one without jeopardizing the other. For the purpose of analysis, the right-of-way has been considered as two independent rights-of-way.) This right-of-way is approximately 20 miles long and terminates in four separate rights-of-way varying in width from 100 to 150 ft.

The Hillje transmission lines cross under the Elm Creek transmission lines at the Hillje substation. Since the Hillje lines are below the Elm Creek line, the Hillje lines are not allowed to be credited with being an offsite source of power in accordance with GDC 17. The 345 kV Blessing transmission line has limited capability as an independent source of offsite power. Therefore, the 345 kV Blessing line is not allowed to be credited as an offsite source of power in accordance with GDC 17.

The 138 kV emergency standby supply to STPEGS is furnished from a radial line out of TCC's Blessing Substation. The 138 kV service area of TCC is intertied with CenterPoint Energy at South Lane City Substation by the existing Blessing-South Lane City transmission circuit, Bay City-South Lane City circuit, and the El Campo-South Lane City circuit.

A list of all transmissions circuits from each of the four transmission service providers to the STPEGS plant site is given in Table 8.2-1. This table includes all termination points, ownership of the circuit, circuit operating voltage, and approximate circuit length in miles.

The 345 kV transmission circuits are routed on rights-of-way as described above except for the distance from the rights-of-way to the switchyard on the STPEGS plant property. In this small section, the 345 kV structures are arranged as depicted in Figure 8.2-1. The location of transmission circuits within this small section has been analyzed and failure of a tower due to failure of an adjacent tower has been determined not to adversely impact plant offsite power supply.

The 138 kV supply at the STPEGS is capable of furnishing power above the full-load rating of the 138 kV emergency transformer. The 138 kV transmission circuit crosses the middle or northwestern right-of-way and the 138 kV transmission circuit tap parallels the northern edge of the northwestern right-of-way out of STPEGS. The 138 kV transmission circuit and transmission circuit tap are crossed over by eight 345 kV transmission circuits.

The 345 kV transmission system from STPEGS to the ERCOT grid is designed so that any two of the 345 kV transmission circuits from the STPEGS may be outaged and the full-load generation of STPEGS Units 1 and 2 can still be transmitted to the load centers. The loss of any double-circuit structure or any two transmission circuits does not reduce the availability of the offsite supply of power to the STPEGS 345 kV switchyard.

All the transmission lines to the STPEGS plant are designed for maximum reliability and performance. The structures for these circuits, as well as the 345 kV switchyard, are built to withstand hurricane force winds. In this area, the ice-loading condition on transmission lines is not considered significant since it is less than the hurricane wind-loading on transmission or substation structures. The 345 kV structures have sufficient vertical spacing to minimize galloping conductor flashover. Galloping conductors have caused outages primarily of 138 kV and 69 kV vertically spaced circuits since the vertical spacing between conductors is much less than that for 345 kV circuits. Galloping conductors are considered a rare phenomenon in this area, since the condition has occurred only twice in the last 50 years (in sufficient magnitude to cause line outages). The galloping conductor conditions which have occurred in the Texas Gulf Coast area resulted in a large number of instantaneous line outages and reclosures of 138 kV and 69 kV transmission circuits, but no cascading system failures.

The isokeraunic level in thunderstorm days per year is moderate to moderately high for the Texas Gulf Coast area. Long-term historical data show this area to have approximately 50 thunderstorm days per year. Data published by the U.S. Weather Bureau in the greater Houston area show that over the past seven years, the average number of thunderstorm days per year has been 62. The transmission line design has sufficient basic insulation level to minimize lightning flashover from the expected number of lightning strokes (the number of lightning strokes is assumed proportional to the number of thunderstorm days per year).

The ERCOT System (as described in Section 8.1.1) grid and transmission system ensures that AC offsite power is available for shutdown of STPEGS Units 1 and 2 and for mitigating the consequences of postulated accidents at either unit.

8.2.1.2 Substation. As indicated on Figure 8.2-3, a breaker-and-a-half scheme is incorporated in the design of the 345 kV switchyard. The switchyard bus is a 40 Gva fault duty design. The 345 kV circuit breakers in the switchyard are rated according to the following criteria:

1. Circuit breaker continuous current ratings are chosen such that no single contingency in the switchyard (e.g., a breaker being out for maintenance) will result in a load exceeding 100 percent of the nameplate continuous current rating of the breaker.

2. Interrupting duties are specified such that no fault occurring on the system, operating in steady-state conditions, will exceed the breaker's nameplate interrupting capability.

3. Momentary ratings are specified such that no fault occurring on the system, operating in steady-state conditions, will exceed the breaker's nameplate momentary rating.

4. Voltage ratings are specified to be greater than the maximum expected operating voltage.

All 345 kV breakers have a minimum symmetrical interrupting capability of 50,000 amperes. The Onsite Electrical System is designed for a future maximum switchyard short circuit contribution of 30 Gva.

The north and south busses of the 345 kV switchyard each have connected to it a 150 MVAr shunt reactor. Each shunt reactor is connected to the bus by a 4000 ampere circuit breaker.

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The breaker-and-a-half switchyard arrangement offers the following operating flexibility:

1. Any transmission line into the switchyard can be cleared either under normal or fault conditions without affecting any other transmission line or bus.

2. Either bus can be cleared under normal or fault conditions without interruption of any transmission line or the other bus.

3. Any circuit breaker can be isolated for maintenance or inspection without interruption of any transmission line or bus.

4. A fault in a tie breaker or failure of the breaker to trip for a line or generator fault results only in the loss of its two adjacent circuits until it can be isolated by disconnect switches.

5. A fault in a bus side breaker or failure of the breaker to trip for a line or generator fault results only in the loss of the adjacent circuits and the adjacent bus until it can be isolated by disconnect switches.

A primary and secondary relaying system is included on each of the nine 345 kV transmission circuits from the STPEGS 345 kV switchyard to the ERCOT grid. The primary relaying consists of a multifunctional relay.

The secondary relaying consists of multifunctional relays of a different type or manufacturer than that of the primary. One transmission line, STPEGS-to-Elm Creek 27, uses forward-connected directional phase distance relays, a forward-connected directional over-current ground relay, and nondirectional instantaneous overcurrent relays and a forward-connected directional modified impedance (offset mho) phase distance relay. These relays are connected in conjunction with an auxiliary relay to form a step-time zone phase distance and instantaneous/time overcurrent ground relay system.

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The current input for the primary and secondary transmission circuit relaying systems is supplied from separate sets of circuit breaker bushing current transformers. The potential input for the primary and secondary transmission circuit relaying systems is supplied from fused branch circuits originating from a set of coupling capacitor potential devices connected to the associated transmission circuit. The control power for the primary and secondary transmission circuit relaying systems is supplied from separate 345 kV switchyard 125 vdc systems. A schematic showing each transmission circuit primary and secondary protection system is given on Figure 8.2-3a.

A primary and secondary relay system is included for protection of each of the STPEGS 345 kV switchyard busses. The zone of protection of each 345 kV bus protection system includes all the 345 kV circuit breakers adjacent to the protected bus, the associated bus 345 kV shunt reactor highside bushings, and the associated bus standby transformer highside bushings. The primary relay is the instantaneous high impedance type used for bus protection to detect both phase and ground faults. This relay is connected in conjunction with auxiliary relays and pilot wire relaying to form a differential protection, instantaneous auxiliary tripping, and transferred tripping relay system.

The secondary relay system and pilot wire relaying is a duplicate of the primary relay system.

The current input for the primary and secondary 345 kV bus relaying systems is supplied from separate sets of 345 k circuit breaker bushing current transformers, 345 kV shunt reactor bushing current transformers and standby transformer bushing current transformers. The control power for the relay terminals of the primary and secondary 345 kV bus relaying systems located in the STPEGS 345 kV switchyard control house is supplied from separate 345 kV switchyard 125 vdc systems. The control power for the relay terminals of the primary and secondary 345 kV bus relaying systems located at the non-Class 1E 13.8 kV standby busses is supplied from the respective unit non-Class 1E 125 vdc battery system. A schematic showing each 345 kV bus primary and secondary protection system is given on Figure 8.2-3a.

A primary and secondary relay system is included on each of the circuits connecting the main power transformers to their respective STPEGS 345 kV switchyard position. The zone of protection of each of the main power transformers circuit connection protection system includes two associated circuit breakers at the STPEGS 345 kV switchyard and the highside bushings of the main power transformers. The primary relay is a high speed, phase comparison, pilot wire relay to detect both phase and ground faults. This relay is connected in conjunction with an auxiliary relay to form a pilot wire differential protection, instantaneous transferred tripping relay system.

The secondary relay system is a duplicate of the primary relay system.

The current input for the primary and secondary main power transformer circuit connection relaying systems is supplied from separate sets of 345 kV circuit breaker bushing current transformers and main power transformer bushing current transformers. The control power for the relay terminals of the primary and secondary main power transformer circuit connection relaying systems located in the STPEGS 345 kV switchyard control house is supplied from separate 345 kV switchyard 125 vdc systems. The control power for the relay terminals of the primary and secondary main power transformer circuit connection relaying systems located at the unit relay room is supplied from the respective unit non-Class 1E 125 vdc battery system. A schematic showing each main power transformer circuit connection primary and secondary protection system is given on Figure 8.2-3a.

The protective relaying for each of the bus-connected 345 kV shunt reactors consists of nondirectional overcurrent relays and percentage differential relays. These relays are connected to form a phase/ground instantaneous/time overcurrent ground differential relay system. In addition, rate-of-rise pressure protection is provided.

The current input for the 345 kV shunt reactor relaying system is supplied from the shunt reactor bushing current transformers.

The control power for the 345 kV shunt reactor relaying system and rate-of- rise pressure protection is supplied from separate 345 kV switchyard 125 vdc systems.

A schematic showing each 345 kV shunt reactor protection system is given on Figure 8.2-3a.

In addition to the above described STPEGS 345 kV switchyard relaying systems, each of the 345 kV circuit breakers has an associated circuit breaker failure relaying system. Each circuit breaker failure relaying system consists of multifunctional relays or a static, nondirectional overcurrent relay connected in conjunction with auxiliary relays utilized to control the circuit breaker failure timing interval and initiate local tripping of adjacent breakers, stop transmission of adjacent transmission circuit primary relaying system pilot signal, initiate tripping of remote transmission circuit terminals by means of a dual frequency shift, direct transfer trip power line carrier channel, and transfer trip remote terminals at the unit (i.e., standby transformer lowside circuit breakers or main turbine-generator). CN-3180

The primary and secondary relaying systems of the STPEGS 345 kV switchyard are connected to separate trip circuits in each 345 kV circuit breaker. The control power provided for the 345 kV switchyard primary and secondary relaying protection and breaker control circuits consists of two 125 vdc systems. Each 125 vdc system consists of a battery, a battery charger and a 125 vdc distribution panel board. The two 125 vdc systems are connected by a normally open (negative terminals are normally tied) tie breaker.

Each battery charger is connected to a 480 vac distribution panel board located in the STPEGS 345 kV switchyard control house. The 345 kV switchyard 125 vdc systems are entirely independent of the unit non-Class 1E and unit Class 1E battery systems.

The STPEGS 345 kV switchyard 480 vac and 120/240 vac station service system consists of two 4.16 kV/480 vac load center transformers, a 480 vac double-ended load center, two 480 vac distribution panel boards, a 480/120-240 vac transformer bank and two 120/240 vac distribution panel boards.

The 4.16 kV/480 vac load center transformers are supplied by two 4.16 kV non-Class 1E feeders, one from each unit.

As illustrated on Figure 8.2-3b, the control cables for the switchyard breakers are routed through three parallel, independent cable trenches. The two outer trenches carry the primary relaying and control for all breakers. The center trench carries the secondary (or backup) relaying and control for all breakers. Cables are routed from each breaker to the respective trenches in such a fashion as to maintain separation between primary and secondary circuits.

8.2.1.3 Standby Transformers. Each standby transformer has the capacity to supply all Engineered Safety Feature (ESF) busses in both units and two 13.8 kV auxiliary busses. These transformers can be shared between Units 1 and 2 and can supply the two preferred power sources (the north and south 345 kV busses). Each transformer has two low-voltage windings rated at 13.8 kV. Each of the low-voltage windings is connected to two 13.8 kV standby busses of one unit and one 13.8 kV standby bus and one auxiliary bus of the other unit. Each transformer is rated 46.5/62/77.5 mVA, oil-to-air/forced air/forced oil-and-air-cooled (OA/FA/FOA) at 55°C with a 12.5 percent supplementary rating at 65°C. Each low-voltage winding is rated 23.25/31/38.75 mVA, OA/FA/FOA at 55°C with a 12.5 percent supplementary rating at 65°C.

Figure 8.2-1 is a schematic representation of the physical layout of the preferred power supply circuits which connect the standby transformers to the switchyard.

As indicated on Figure 8.2-1, both transformers are connected to 345 kV busses in the switchyard by overhead conductors on steel structures. The No. 2 standby transformer is connected to the south bus and No. 1 to the north bus.

The following separation criteria apply to the standby transformers and associated leads in order to maintain their independence from each other and ensure conformance to General Design Criterion (GDC) 17 and Regulatory Guide (RG) 1.32.

1. The high-voltage circuit of each standby transformer is routed on separate steel structure and terminates on a separate bus in the 345 kV switchyard. The north bus is extended so the No. 1 standby transformer leads do not cross over the south bus.

2. The separation of the steel structure is so arranged that a complete failure of a structure serving one standby transformer could not jeopardize the integrity of a structure or its associated high-voltage leads serving the other standby transformer.

3. The No. 1 and No. 2 standby transformers are physically separated from each other to prevent a single accident affecting one transformer (e.g., fire) from jeopardizing the operation of the other transformer.

4. Each transformer's low voltage windings are connected to the associated 13.8 kV switchgear of each unit by cables (15 kV insulated) routed in underground concrete-encased duct banks and manholes and in air by nonsegregated phase bus duct. These cables terminate at the 13.8 kV switchgear of each unit.

5. The 138 kV transmission line does not cross any high-voltage lead from the 345 kV switchyard to the plant.

6. The 138 kV emergency transformer is physically separated from both the No. 1 and No. 2 standby transformers by a minimum of 800 feet. This will ensure that a single accident in the 138 kV emergency transformer will not jeopardize the standby transformers.

The impedances of the standby transformers have been selected to ensure satisfactory startup, acceleration, and operation of all safety-related motors during the most limiting conditions considering the short circuit and voltage requirements. All ESF motors are specified to start and accelerate satisfactorily with 80 percent of the motor's rated voltage applied at their terminals, except motors for the reactor Containment fan coolers which are capable of accelerating their associated loads with only 75 percent of motor nameplate voltage available at motor terminals without causing thermal damage to the motor.

Each of the standby transformers is protected by primary and backup relays. The primary relay is of the high speed, percentage slope, harmonic restraint, differential overcurrent type (87/ST1 or 87/ST2) to detect transformer internal faults. The backup relay is of the nondirectional, inverse time overcurrent, induction unit and instantaneous overcurrent unit type (50/51/ST1H or ST2H) to provide overload protection as well as backup protection to the transformer differential and transformer lowside relays. These relays are connected in conjunction with auxiliary relays (86/ST1 or ST2) to initiate the 13.8 kV standby bus supply breakers tripping and transferred tripping to 345 kV circuit breakers located in the switchyard and lockout closing of circuit breakers. The control power for these relays is supplied from the respective unit's non-Class 1E 125 vdc battery system.

Normal transfer of the source of power for the 13.8 kV auxiliary busses between the No. 1 and No. 2 standby transformers is initiated by the operator from the control room.

Normal bus transfers are "live bus" transfers; i.e., the incoming source feeder circuit breaker is momentarily paralleled with the outgoing source feeder circuit breaker. This results in transfers without power interruption.

8.2.1.4 138 kV Emergency Transformer. In addition to the auxiliary transformer and the No. 1 and No. 2 standby transformers, the 138 kV emergency transformer is a source of offsite power to the ESF Electrical System. This transformer has a rating equivalent to the requirements of one ESF bus of each unit.

Figure 8.2-1 is a conceptual representation of a physical layout of the circuit which connects the 138 kV emergency transformer to the 138 kV transmission line.

As indicated on Figure 8.2-1, this transformer is connected to a 138 kV transmission line which is not connected to the 345 kV switchyard transmission line or related structures.

The following separation criteria apply to the 138 kV emergency transformer and its associated leads.

1. The location of the 138 kV steel structures is such that a complete failure of a steel structure associated with the No. 1 or No. 2 standby transformer leads will not jeopardize the integrity of a 138 kV structure or its associated leads.

2. The 138 kV emergency transformer low voltage windings are connected to the associated motor-operated switches of each unit by cables (15 kV insulated) routed in underground concrete-encased duct banks, manholes and tray, and in air by nonsegregated phase bus duct.

The impedance of the 138 kV emergency transformer has been selected to ensure satisfactory startup, acceleration, and operation of all safety-related motors during the most limiting conditions with preferred (offsite) power available. This is accomplished as follows:

1. The impedance of the 138 kV emergency transformer is selected to maintain at least 80 percent of motor rated voltage while starting the largest ESF motor with the transformer loaded to its rating minus this motor load.

2. All ESF motors are specified to start and accelerate satisfactorily with 80 percent rated voltage applied at their terminals, except motors for the reactor Containment fan coolers which are capable of accelerating their associated loads with only 75 percent of motor nameplate voltage available at motor terminals without causing thermal damage to the motor.

As indicated on Figure 8.2-3, the 138 kV emergency transformer is connected to the 138 kV transmission line through a 1,200-ampere circuit switcher. The 138 kV emergency transformer is protected by primary and backup relays and a circuit switcher failure protection system. The primary relay is of the high speed, percentage slope, harmonic restraint, differential over-current type (87T/ET) to detect transformer internal faults. The backup relay is of the nondirectional, inverse time overcurrent, induction unit and instantaneous overcurrent unit type (50/51/ET) to provide overload protection as well as backup protection to the transformer instantaneous differential and transformer lowside relays. These relays are connected in conjunction with an auxiliary relay (86/ET) to initiate tripping and lockout closing of the 138 kV circuit switcher and transformer lowside breakers. In addition, rate-of-rise pressure relaying (63SP/ET) is also provided for transformer monitoring.

The circuit switcher failure protection system consists of a nondirectional instantaneous overcurrent relay (50/CSF) connected in conjunction with auxiliary relays (2/CSF) and (86/CSF) utilized to control the circuit switcher failure timing interval and initiate applied fault tripping (138 kV "C" phase ground switch) of the remote terminal.

Additionally, a nondirectional, instantaneous overcurrent relay (50B) is provided to block opening of the circuit switcher and permit remote terminal backup tripping should the fault current exceed the circuit switcher current interrupting rating. Figure 8.2-3C is a schematic of the protection system for the 138 kV emergency transformer. The control power for the 138 kV emergency transformer protection system is provided by a branch circuit from the STPEGS 345 kV switchyard 125 vdc system.

The 138 kV emergency transformer may be used as a source of power for one ESF bus of each unit by manual transfer from the control room. The normal balance-of-plant 4.16 kV and 13.8 kV busses are not fed from the 138 kV emergency transformer.

8.2.1.5 Main Generators. The main generators are rated 1,504.8 MVA, 0.9 PF and 25 kV. Each main generator is directly connected to the main transformers and unit auxiliary transformer through a 25 kV, 36,600-ampere, forced-air-cooled, isolated phase bus through disconnect links and a main generator circuit breaker. The main generator's voltage is stepped up and then tied to one bay of the 345 kV switchyard. Each main transformer bank consists of two three-phase transformers, either a pair of 850 MVA transformers for Unit 2 or a 700 MVA and a 650 MVA transformer pair for Unit 1. The Unit 1 transformers are FOA rated at 55°C temperature rise, with a supplemental rating at 65°C temperature rise. The Unit 2 transformers are rated ODAF at 65°C rise. Each transformer is connected delta on the low-voltage side and wye on the high-voltage side. These transformers are

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provided with lightning arresters on the high-voltage side. Each generator isolated phase bus is forced-air-cooled and rated at 65°C rise. Two 100-percent sets of cooling equipment are provided for each generator bus.

The generator circuit breaker is nominally rated at 25 kV, 37,500 amps continuous, 275,000 amps symmetrical interrupting, and a 4-cycle interrupting time. The generator circuit breaker is provided with redundant cooling units and air compressors. The breaker is automatically tripped upon turbine trip, reactor trip, generator trip, or trip of the applicable differential relays.

The main generator, main generator circuit breaker, isolated phase bus duct, main power transformers, and the unit auxiliary transformer are protected by the following complement of relays:

1. A high speed, product restraint, percentage slope, differential overcurrent relay (87/G1) is utilized to protect the main generator windings.

2. A high speed, percentage slope, harmonic restraint, differential overcurrent relay (87/T1) is utilized to protect the main generator circuit breaker, the isolated phase bus duct, and the main power transformers.

3. A high speed, percentage slope, harmonic restraint, differential overcurrent relay (87/UT1) is utilized to protect the unit auxiliary transformer.

4. A short time, low pickup, overvoltage relay (64R/G1) is utilized to provide ground fault protection on the main generator windings, the isolated phase bus duct, main generator circuit breaker, and the 25 kV windings of the transformers.

5. An instantaneous solenoid type, high-dropout voltage relay (64S/G1) is utilized to provide ground fault protection on the main generator windings during plant startup.

6. A nondirectional, inverse time overcurrent induction unit and instantaneous overcurrent unit type relay (50/51/UT1H) is utilized to provide overload and short circuit backup protection for the unit auxiliary transformer.

7. A three-phase, power directional relay (32/G1) with adjustable time delay is utilized to provide anti-motoring protection for the main generator.

8. Two directional, offset mho, instantaneous undervoltage relays (40-1/G1 and 40-2/G1) are connected in conjunction with an auxiliary relay to form a two-zone, loss-of-field protection for the main generator excitation.

9. A negative-sequence, time-overcurrent relay (46/G1) is utilized to protect the main generator rotor against possible damage due to high temperature caused by unbalanced currents.

10. Two single-phase, linear, constant volts-per-cycle-per-second (volts/Hz) relays (59/81) with adjustable time delay are utilized to provide overexcitation protection.

11. The impedance distance relay (21/G1) provides backup protection for the other generator relays. It does not operate on ground faults and does not provide a backup protection for the transmission line or the switchyard relays. Relay operation is supervised by the generator

voltage balance relay (60-1/G1) to prevent false tripping in the event of a blown potential circuit fuse.

12. The ground fault detection relay (64B/G1) is utilized to protect the isolated phase bus duct and transformer 25 kV windings on a ground fault when the generator circuit breaker is open. When the main generator is connected to the system this relay also provides backup ground fault protection to the 64R/G1 relay on the main generator. In both cases the relay trips the switchyard breaker.

13. The underfrequency relay (81/G1) provides underfrequency protection for the main generator.

14. The high speed, product restraint, percentage slope, differential overcurrent relay (87-1/G1) is utilized to protect the main generator, main generator circuit breaker, and the isolated phase bus duct for any fault in this zone.

15. The breaker failure relay (62BF/G1) provides main generator breaker failure protection for the main generator and transformers.

16. The circuit breaker pole failure relay (61/G1) is used to detect main generator pole disagreement.

17. Generator out-of-step protection is provided by a digital generator relay (78/G1).

8.2.1.6 Instrumentation and Control. Status of the switchyard is indicated and/or alarmed in the control room, including the following parameters and conditions:

1. North bus voltage
2. South bus voltage
3. Operation of protective relays
4. Breaker status of generator bay position breakers

A supervisory system is located in the switchyard control house. This system continuously transmits the following parameters to the CenterPoint Energy Control Center:

1. Breaker status and alarms
2. North and south bus voltage
3. Switchyard battery alarms
4. Each transmission line and generator breaker position, watt, var, and kilowatt-hour
5. Switchyard alarms (e.g., carrier check, close inhibit, reactor bank)

The 345 kV switchyard circuit breakers (except breakers Y5l0, Y520, Y590 and Y600 as indicated on Figure 8.2-3a) can be opened or closed by electrical control stations located in the 345 kV switchyard control house as well as remotely from the CenterPoint Energy Control Center by means of the supervisory system. The generator position breakers can be opened or closed by electrical control stations located in the respective unit control room (Y510 and Y520 can be controlled from the Unit 1 control room; Y590 and Y600 can be controlled from the Unit 2 control room). Any 345 kV circuit breaker, with its respective stored energy system charged to a sufficient level, can be opened or closed, without using control power, by operation of a mechanical device located at the circuit breaker control mechanism housing.

The 345 kV switchyard circuit breaker stored energy operating mechanisms are either hydraulic, pneumatic, or charged spring closing with spring opening main contacts synchronized with blast valve operation. The electrical power required for recharging the circuit breaker stored energy system, or 125 vdc for charged spring closing, is supplied from a 480 vac distribution panel board. The power source is located in the 345 kV switchyard control house. The control circuitry required for electrical activation of the circuit breaker is supplied from one of the two 125 vdc systems located in the 345 kV switchyard control house. Circuit breaker electrical control stations located remote to the 345 kV switchyard control house utilize interposing relays to achieve electrical separation between the 125 vdc switchyard system and the remote control source of power.

8.2.1.7 Testing. Periodic inspection and testing is performed on the 345 kV switchyard breakers protective relaying and 125 vdc systems.

Any 345 kV switchyard breaker can be isolated while the plant is in operation without interruption of any transmission line, main generator, or 345 kV bus to perform maintenance, inspection or testing, to the extent practicable. Any 345 kV switchyard breaker can be functionally tested while isolated or while in service when the plant is in operation without interruption of any transmission line, main generator, or 345 kV bus.

Any 345 kV switchyard primary or secondary relay system, as well as any primary or backup relay, can be removed from service for inspection and testing while the plant is in operation without interruption of any transmission line, generator, or 345 kV bus. In addition, each of the eight 345 kV transmission circuit primary relaying system on-off power line carrier pilot transmitter/receiver includes automatic carrier testing equipment. Each circuit breaker failure scheme, frequency shift power line carrier receiver includes indication for loss of the continuously transmitted guard signal. Each pilot wire relay system includes indication for abnormal magnitude of the continuously transmitted monitoring current.

Either 125 vdc battery charger or either battery can be removed from service for maintenance and testing while the plant is in operation.

Acceptance testing of the above 345 kV switchyard and 138 kV emergency transformer equipment has been performed. Periodic testing of this equipment is performed to the extent practicable, to detect the deterioration of equipment toward an unacceptable condition.

These tests demonstrate that the equipment operates within design limits, and that the system is operational and can meet its performance specification. The following are demonstrated:

1. All required Class 1E and non-Class 1E loads can operate from the offsite electrical system.

2. Loss of offsite electrical supply to the Class 1E power system can be detected.

3. Transfers between offsite electrical supplies and the Onsite Standby Power System can be accomplished.

4. The 345 kV switchyard 125 vdc system batteries can meet capacity requirements.

Equipment or systems of the offsite electrical supply which cannot be actuated for testing when the plant is in operation, because this testing may damage switchyard equipment or disrupt plant operation, (i.e., the generator breaker), are routinely tested when the plant is shut down.

8.2.2 Analysis

8.2.2.1 Steady State and Transient Stability Studies. The stability of offsite power systems is in compliance with Branch Technical Position ICSB-11. Steady-state (load flow) and transient stability studies demonstrate that the loss of both units at STPEGS, or the loss of one unit with the other unit either online or offline, does not impair the ability of the system to supply power to the ESF Electrical System. These studies further demonstrate that the loss of any double-circuit 345 kV transmission line, the loss of any two 345 kV transmission circuits, or the loss of all circuits on any single independent right-of-way, does not endanger the supply of offsite power to the ESF Electrical System.

The transmission system associated with STPEGS is designed and constructed so that no loss of offsite power to the 345 kV switchyard is experienced with the occurrence of any of the following single events:

a. Loss of any two transmission circuits

b. Loss of any one transmission circuit and any one generator

c. Loss of any two generators

d. A three-phase fault occurring on any transmission circuit which is cleared by either primary or backup relaying

Transient stability studies were run to demonstrate that the above events do not result in the nonavailability of offsite power. The transient stability studies included the modeling of variable flux linkages of the generator field and internal voltages represented on both the quadrature and direct axis. Where information was available, machines were modeled with full representation of excitation systems and voltage regulators as outlined in Institute of Electrical and Electronic Engineers publication "Computer Representation of Excitation Systems". Governor systems were represented in detail, including modeling of both reheat and nonreheat units. Governor systems of reheat units included modeling of the effects of the high-pressure section of the turbine and the combined effects of the intermediate and low-pressure sections of the turbine.

Results of the transient stability studies, such as plots of frequency versus time and machine angle versus time, are given on Figures 8.2-l0 through 8.2-12. Outages of critical generators and faulting of critical busses were selected as worst-case tests.

Load flows are performed yearly for the ERCOT system. The studies demonstrate that sufficient offsite power is available at the STPEGS switchyard when the postulated events are analyzed. The steady-state results further demonstrate that no inoperable voltage levels or overloaded transmission circuits, which would hinder the availability of the offsite power supply, would result for the conditions tested.

The transient stability results shown on Figures 8.2-l0 through 8.2-12 demonstrate that no system instability and subsequent loss of power result in the ERCOT systems for the conditions tested as set forth by the specified criteria. The amount of transient frequency decay (maximum of 59.5 Hz) due to the simulated losses of generation was acceptable because of the large amount of system inertia. Subsequent frequency recovery was evident by the end of each study. The frequency decrease was not severe enough or of long enough duration to result in damage to motors. The swing angle plots of internal machine angle versus time demonstrate that the system disturbances analyzed did not result in sufficient machine angle separation to cause system split-up or loss of synchronism of any units within the interconnected system. The transient stability results shown on Figures 8.2-l0 through 8.2-12 also substantiate the fact that the maximum credible grid frequency decay rate is less than the decay rate of 5 Hz/sec assumed by Westinghouse Electric Corporation in the analysis of the possibility of fuel damage caused by grid frequency decay without reactor coolant pump breaker trip. The underfrequency reactor trip setpoint for the STPEGS is provided in the Technical Specifications.

Both the transient stability and steady-state load flow studies represented the entire ERCOT systems. The results of the studies which are shown are representative of all studies made.

8.2.2.2 Grid Availability. ERCOT is composed of bulk power systems. The organization of ERCOT includes an engineering subcommittee which conducts joint studies testing the adequacy of the bulk power system. The studies performed jointly by the members of the ERCOT Engineering Planning Subcommittee include steady-state load flow, transient stability, and loss-of-load probability (generation planning). The load flow and transient stability cases are designed to test the ERCOT bulk power planning criteria for reliability given in Table 8.2-3. Of primary importance in these ERCOT studies is the adequacy of the interconnection and bulk power system (primary 345 kV) to provide import capability to any system.

The major load areas of the ERCOT systems are interconnected by a 345 kV transmission network. The 345 kV voltage level is used for the bulk transmission system because it provides a high degree of reliability and has sufficient transport capability between the major load and generation areas.

Of the four transmission service providers for STPEGS, CenterPoint Energy has the most experience with 345 kV transmission operation (Table 8.2-4). Thus, transmission system reliability supported by historical outage data from only CenterPoint Energy is discussed below.

CenterPoint Energy has been operating 345 kV transmission circuits since 1963 and has recorded all outages, classifying them as either instantaneous or sustained.

An instantaneous outage is defined as an outage in which the line breakers are tripped and one breaker is reclosed, thus reenergizing the circuit in a total elapsed time of less than one second. The other end of the line is automatically reclosed after verifying synchronization in no more than five seconds. Thus, after a total elapsed time of six seconds after a momentary fault has occurred, the line is available for power transfer. From historical data, the average frequency of instantaneous outages on the CenterPoint Energy 345 kV transmission system is 2.14 outages/year per l00 circuit-miles. The cause of these outages has been primarily either lightning flashover or flashover due to insulation contamination.

A sustained outage is defined as an outage due to a permanent fault which requires "manual" reclosing after the fault is corrected and the line is restored to operating condition. Usually there is some sort of damage associated with permanent faults which requires repairs to the particular transmission circuit. CenterPoint Energy has recorded 53 sustained outages on the 345 kV system since the first line was placed in service in 1963. The recorded frequency rate for sustained outages on the 345 kV CenterPoint Energy system is 1.34 outages/year per 100 circuit-miles. The average duration of these sustained outages has been 380 minutes.

The causes of sustained outages have been varied; some were due to damage to a tower, some to broken insulators, and some to broken conductors. Many of these sustained outages occurred during the first few years that the 345 kV transmission system was in service.

The 345 kV transmission system from STPEGS to the ERCOT grid is designed such that outages are minimized. Instantaneous outages are minimized by provision of sufficient basic insulation level to endure expected lightning and switching surge voltage and expected insulator contamination. Sustained outages are minimized by design of transmission towers and circuit components to conform with National Electric Safety Code guidelines. All studies and outage data demonstrate that offsite power to the ESF electrical system is highly reliable even if Units l and 2 are not operating and no improvement in line outage rate is experienced.

TABLE 8.2-1

TRANSMISSION LINES PROVIDING OFFSITE POWER TO SOUTH TEXAS PROJECT ELECTRIC GENERATING STATION UNITS 1 AND 2

Transmission Line	Ownership	Nominal Operating kV	ROW*	Approximate Line Length (mi)
STPEGS - W. A. Parish	CenterPoint Energy	345	NW	70
STPEGS – Velasco (double circuit)	CenterPoint Energy	345	E	45
STPEGS - Hillje	CenterPoint Energy	345	NW	20
STPEGS – Elm Creek	CPS	345	NW	155
STPEGS - Hillje	CenterPoint Energy	345	NW	20
STPEGS – Elm Creek	CPS	345	NW	155
STPEGS – White Point	TCC	345	NW	133
STPEGS - Blessing	TCC	345	W	15
Blessing - STPEGS	TCC	138	--	10.1

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* Refers to right-of-way coming out of South Texas Project plant property.

TABLE 8.2-2

MAIN GENERATOR DATA
SOUTH TEXAS PROJECT ELECTRIC GENERATING STATION UNITS 1 AND 2

Rating, mVA	1,504.8
Power factor	0.9
Voltage, kV	25 (Adjustable ±5%)
Frequency, Hz	60
Speed, rpm	1,800
Hydrogen pressure, psig	75
Direct axis synchronous reactance	Xd 153.7% (Unit 1) Xd 163.3% (Unit 2)
Direct axis transient reactance	X'di 36.2% @ rated current (Unit 1) X'di 35.6% @ rated current (Unit 2)
Direct axis subtransient reactance	X"di 27.4% @ rated current (Unit 1) X"di 27.8% @ rated current (Unit 2)
Direct axis transient reactance	X'dv 31.9% @ rated voltage (Unit 1) X'dv 31.3% @ rated voltage (Unit 2)
Direct axis subtransient reactance	X"dv 23.6% @ rated voltage (Unit 1) X"dv 25.6% @ rated voltage (Unit 2)
Negative sequence reactance	X_{2v} 23.6% @ rated voltage (Unit 1) X_{2v} 25.5% @ rated voltage (Unit 2)
Zero sequence reactance	Xoi 19.3% @ rated current (Unit 1) Xoi 19.0% @ rated current (Unit 2)

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TABLE 8.2-3

ELECTRIC RELIABILITY COUNCIL OF TEXAS PLANNING CRITERIA

1. RESOURCE CAPABILITY

On an annual planning basis, forecasted Net Capability will be provided by each Load Entity to ensure a reserve margin of at least 15 percent of its forecasted annual maximum hourly firm demand (alternatively expressible as a capacity margin of 13 percent).

2. TRANSMISSION RELIABILITY TESTING

The interconnection philosophy of ERCOT members is to minimize loss of load by remaining interconnected. Interconnected system planning will include steady state and dynamic simulated testing to represent specific occurrences for each type of contingency listed below. This testing should indicate that, for the occurrence of any of the contingencies tested, (1) neither uncontrolled islanding nor uncontrolled loss of large amounts of load will result, and (2) the facility loadings and/or voltage variations in each ERCOT member's system, would be acceptable under the criteria of that ERCOT member. The contingency tests will be performed for reasonable variations of load level, generation schedules, and anticipated power transfers. The ERCOT member utilities involved should plan to resolve any unacceptable tests results through the provision of transmission facilities, the alteration of operating procedures, or other means as appropriate.

Contingency Types

a. Loss of all generating capacity at any generating plant.

b. Loss of any two generating units.

c. Outage of any transmission circuit or generating unit during the scheduled outage of any other transmission circuit, generating unit, transformer, or bus section.

d. Outage of any single or multiple circuit transmission line, transformer, or bus section.

e. Simultaneous outage of overhead transmission lines which are parallel to each other for a substantial distance in which the failure of a transmission structure can result in the outage of a circuit not supported by the failed structures.

f. Any fault cleared by normal operation of backup relays.

g. Loss of any large load or concentrated load area.

TABLE 8.2-4

345-kV TRANSMISSION CIRCUIT-MILES OF STPEGS OWNERS

Owner	Existing 1983 Circuit Miles	First Year of Operation
HL&P	749	1963
CPS	506	1973
CP&L	199	1973
COA	176	1981

8.3 ONSITE POWER SYSTEMS

8.3.1 Alternating Current Power Systems

8.3.1.1 Description. The onsite alternating current (AC) Power Systems of Units 1 and 2 each consist of four major subsystems as follows.

1. 13.8 kV Auxiliary Power System (non-Class 1E)

2. 13.8 kV Standby Power System (non-Class 1E)

3. 138 kV Emergency Transformer Systems (non-Class 1E)

4. Onsite Standby Power System (Class 1E)

The arrangement of the AC Power Distribution Systems provides sufficient switching flexibility and equipment redundancy to ensure reliable power supply to the Class 1E and non-Class 1E plant loads during startup, normal operation, shutdown, and following a design basis event.

Figure 8.3-1 illustrates the bus arrangements and interconnections of Units 1 and 2. The arrangement of the electrical equipment is shown on the general arrangement drawings listed as Figures 1.2-5, 1.2-10, 1.2-26, 1.2-28, and 1.2-29 in Table 1.2-1.

Normally, the Class 1E AC Power Distribution Systems of Units 1 and 2 operate independently of each other, each being supplied power from a separate standby transformer. However, it is possible to energize the 13.8 kV auxiliary busses via breakers provided for interconnecting the secondary windings of the standby transformers to the 13.8 kV busses of both Units 1 and 2. This permits the operation of the Class 1E auxiliaries from either standby transformer.

The 138 kV emergency transformer, which is common to Units 1 and 2, can also be utilized to supply power to one train of Engineered Safety Features (ESF) load in each unit.

The following detailed descriptions explain how the major power distribution subsystems are employed to furnish power to the plant auxiliary loads under all expected modes of operation.

8.3.1.1.1 Main Auxiliary Power Distribution: During normal plant operation, auxiliary loads are energized from the main generator through the closed main generator breaker and the three-winding unit auxiliary transformer which is connected to the isolated phase bus of the main generator. Each unit auxiliary transformer has an automatic load tap changer and is rated 25 kV/13.8 kV/13.8, 84/112 Mva, oil-to-air (FOA), 65°C, three-phase, 60 Hz. Each transformer secondary winding is rated 42/56 mVA.

The secondary windings of the unit auxiliary transformer are loaded approximately equally. The “X” winding energizes two of the 13.8 kV auxiliary busses, and the “Y” winding energizes the remaining pair of 13.8 kV auxiliary busses of the unit, as shown in Table 8.3-1.

During plant startup, power to 13.8 kV auxiliary busses 1F, 1G, 1H, and 1J of each unit is supplied from offsite power sources through the unit auxiliary transformer via the main transformers with the main generator breaker open or the standby transformers.

The 13.8 kV auxiliary busses are standard, indoor, metal-clad, 15 kV class switchgear. All circuit breakers have an interrupting rating of 750 mVA. The continuous current rating of the incoming supply breakers, tie breakers, and feeder breakers is 1,200 amperes. All circuit breakers are electrically operated utilizing 125 vdc control power. CN-3125

Non-Class 1E Motors

Motors rated 1,500 hp and above are rated 13.2 kV; motors rated 300 to 1,250 hp are rated 4 kV; and motors rated ¾ hp to 250 hp are rated 460 V.

Two feeders from the 13.8 kV auxiliary busses supply power to two auxiliary transformers serving non-Class 1E equipment. These transformers are of the oil-filled type, rated 13.8 kV /4.16 kV, 5,000/6,250/7000 kVA, OA/FA/FA, 55°C/55°C/65°C, three-phase, 60 Hz. Switchgear distributing power from these double-ended arrangement. Circuit breakers have interrupting ratings of 250 mVA. The continuous current rating of all breakers in this double-ended arrangement is 1,200 amperes. CN-3125

Other feeders from the 13.8 kV auxiliary busses are connected to low-voltage transformers supplying power through single and double-ended 480 V switchgear sections to non-Class 1E loads. These transformers are of the dry type rated 13.8 kV/480 V, 1,000/1,333 kVA, AA/FA, or 1,200/1,600 kVA, AA/FA, or oil-filled rated 500 or 1,200 kVA, three phase, 60 Hz. The switchgear sections consist of standard, indoor, metal-enclosed, 600 V class switchgear. All circuit breakers have an interrupting rating consistent with the short-circuit duty at the point of application. All circuit breakers are electrically operated with 125 vdc control power. Feeders from the 480 V load center busses energize non-Class 1E motors and motor control centers (MCCs) from which non-Class 1E small motors and miscellaneous loads are furnished power. CN-3125

Bus tie breakers between sections of the double-ended switchgear are under administrative control. These breakers can be closed during maintenance periods.

8.3.1.1.2 Normal ESF Power Distribution: For startup and normal operation of the plant, power to the ESF busses is distributed from the standby busses through the associated ESF bus transformers.

The standby transformer of each unit is a three-winding transformer, rated 362.25 kV/13.8 kV/13.8 kV, 46.5/62/77.5 (87.19) mVA, OA/FA/FOA, 55°C (65°C), three-phase, 60 Hz. The transformer secondaries are each rated 23.25/31/38.75 mVA.

During startup and normal plant operation the 13.8 kV standby busses are supplied power from the unit auxiliary and standby transformers. (Figure 8.3-1).

By means of manual transfer, the 13.8 kV standby busses can be supplied from the respective unit auxiliary transformer or from either of the standby transformers. Normal connections and possible interconnection from the 13.8 kV standby busses to the unit auxiliary and standby transformers are shown on Table 8.3-1. Normally, standby transformers nos. 1 and 2 supply only Unit 1 and 2, respectively. Normal connections and possible interconnection from the 13.8 kV standby busses to the standby transformers are shown in Table 8.3-2.

Power is supplied from 13.8 kV standby busses 1F, 1G, and 1H to 4.16 kV ESF busses E1A, E1B, and E1C, respectively, through the associated auxiliary ESF transformers.

Switchgear constituting the standby busses is of the same type and rating as switchgear constituting the auxiliary busses. The continuous current rating of the breakers in each standby bus is 1,200 amperes.

Auxiliary ESF transformers E1A, E1C, E2A, and E2C supplying the ESF busses are rated 13.8 kV/4.16 kV, 5,000/6250 (5600/7000) kVA, OA/FA at 55°C, (65°C), three-phase, 60 Hz. Auxiliary ESF transformers E1B and E2B are rated 13.8 kV/4.16 kV, 5000/6250 (5600/7000) kVA ONAF/ONAF at 55°C (65°C); three-phase, 60 Hz with an on-load automatic Load Tap Changer (LTC). The on-load automatic LTC is capable of a +/- 10% adjustment in 33 steps (+/-16 increments) on the secondary side of the ESF transformer. The LTC unit is a three phase fully insulated, wye connected on the secondary side of the transformer. Each transformer is connected by cable to Class 1E, 5 kV class, metal-clad switchgear.

8.3.1.1.3 Additional Source ESF Power Distribution: Another offsite power source, the 138 kV emergency transformer, is capable of supplying power concurrently to one ESF bus of each unit. The 138 kV emergency transformer is a three-winding transformer rated 138 kV/13.8 kV/ 13.8 kV, 12/16/20 mVA, (22.5) mVA, OA/FOA/FOA, 55°C (65°C) three-phase, 60 Hz. Each secondary winding is rated 9/12/15 (16.875) mVA, 55°C (65°C). Each of the secondary windings of this transformer is connected to a separate, outdoor-type, 13.8 kV circuit breaker. These circuit breakers make it possible to supply power to the Unit 1 or Unit 2 13.8 kV emergency busses (1L and 2L). These are interlocked with the normal supply to prevent both supplies from being tied together.

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Switchgear constituting the 13.8 kV emergency busses of Units 1 and 2 is of the same type and rating as switchgear constituting the auxiliary busses. The switchgear breakers have a continuous current rating of 1,200 amperes. Each of these breakers can supply power to one of the ESF busses, via the associated auxiliary ESF transformer, when the standby transformers are not available and the standby diesel generators (SBDGs) fail to start. Switching and control of this switchgear are nonautomatic and by operator action only.

8.3.1.1.4 Onsite Standby Power Supply and ESF Power Distribution: The Onsite Standby Power Supply Systems of Units 1 and 2 each consist of three independent, physically separated, SBDGs supplying power to three associated load groups designated Train A, Train B, and Train C. Each load group consists of a 4.16 kV ESF bus and the electrical loads connected to that bus. The Onsite Standby Power Supply Systems of Units 1 and 2 operate independently of each other. Each SBDG and load group of a particular unit is also physically separated and electrically independent from the other two SBDGs and their load groups. Each train (i.e., Load Group) is independent but is not totally redundant; two trains are necessary to mitigate the consequences of a design basis accident (DBA). Qualification of all Class 1E electrical equipment which is a part of the Onsite Standby Power Supply and ESF Power Distribution System is discussed in Sections 3.10 and 3.11.

Each SBDG is located in a separate room of the Diesel Generator Building (DGB), which is a seismic Category I structure (described in Section 3.8.4).

Each 4.16 kV ESF bus is provided with switching that permits energization of the bus by five alternative sources:

1. The respective unit auxiliary transformer
2. No. 1 standby transformer
3. No. 2 standby transformer
4. Standby diesel generator
5. 138 kV emergency transformer

Each SBDG is automatically started in the event of loss of offsite power (LOOP) or safety injection (SI) signal, as described in Section 8.3.1.1.4.4, and the required Class 1E loads connected to that ESF bus are automatically connected in a predetermined time sequence. Each SBDG is ready to accept load within 10 seconds after the start signal.

The SBDGs are not used for peaking and therefore the design complies with Branch Technical Position (BTP) Instrumentation and Controls System Branch (ICSB) 8.

Figure 8.3-1 shows the configuration of the ESF busses and the SBDGs. The assignments of loads connected to each bus are shown on single line diagrams references in Table 1.7-1. Emergency electrical loading requirements are addressed in Table 8.3-3.

8.3.1.1.4.1 ESF Busses – The three ESF busses are physically and electrically separated from each other to comply with the single-failure criterion. There are no automatic or manual interconnections between load groups.

Switchgear constituting the ESF busses is indoor-type, metal-clad, 5 kV switchgear qualified for Class 1E service. All circuit breakers have an interrupting rating of 250 mVA. The continuous current rating of circuit breakers in this switchgear is 1,200 amperes. All circuit breakers are electrically operated with 125 vdc control power. CN-3125

Feeders from the 4.16 kV ESF busses supply power to Class 1E motors with ratings greater than 300 hp.

Two feeders from each 4.16 kV ESF bus supply power to a double-ended 480 V switchgear assembly. The transformer sections of this switchgear assembly consist of dry-type transformers rated 4.16 kV/480 V, 1,000/1,333 kVA, AA/FA, three-phase, 60 Hz with impedance of 4.0 percent ± 7.5 percent tolerance. The switchgear sections consist of indoor, metal-enclosed, 600 V class switchgear.

All circuit breakers have interrupting ratings consistent with the short-circuit duty at the point of application. All circuit breakers are electrically operated with 125 vdc control power. Bus tie CN-3125 breakers between sections of the double-ended load centers are under administrative control and can be closed during maintenance periods.

Feeders from this 480 V switchgear supply power to ESF motors with ratings in the range of 150 hp to 300 hp. Other 480 V feeders supply power to Class 1E MCCs from which all 460 V motors with ratings equal to or less than 100 hp are controlled.

8.3.1.1.4.1.1 Non-Class 1E Loads Connected to Class 1E Power System: The non-Class 1E loads that can be powered from the SBDGs during loss of offsite power are included in Table 8.3-3 and include:

1. Pressurizer Heaters (Back-up Groups A and B)

2. Control Rod Drive Mechanism (CRDM) Cooling Fans

3. Reactor Cavity Vent Fans

4. Reactor Support Exhaust Fan

Redundant sets of pressurizer heaters are connected to 480 V ESF load centers E1A (Train A) and E1C (Train C) through qualified isolation devices which are tripped upon receipt of an SI signal (Section 8.3.1.4.4.14). As indicated in Table 8.3-3, these heaters are manually connected under administrative control during LOOP when an SI signal is not present.

The balance of the non-Class 1E loads indicated above (see detailed listing in Table 8.3-3) are connected to common MCCs. As shown in Figure 8.3-1, these non-Class 1E MCCs, one per train, are connected to Class 1E 480 V MCCs through qualified isolation devices which are tripped upon receipt of a SI signal (Section 8.3.1.4.4.14). As indicated on Table 8.3-3, these loads are either automatically sequenced or manually loaded onto the SBDGs during a LOOP when an SI signal is not present. In the event sequencing is initiated by an SI signal, these loads may be manually loaded after resetting the SI signal under administrative control.

8.3.1.1.4.2 Equipment Capacities and Loading Basis – Each SBDG has a continuous 8,760-hour rating of 5,500 kW. The loads are listed in Table 8.3-3. The design and continuous rating selected is consistent with the requirements of Regulatory Guide (RG) 1.9 and Institute of Electrical and Electronics Engineers (IEEE) Standard 387-1977. Capacities of individual loads are determined on the basis of motor brake horsepower ratings. The diesel engine, generator, and accessories are briefly described in the following:

1. The diesel generator (DG) set, manufactured by Cooper Energy Services, has the following ratings: 2,000-hour at 5,935 kW, 168-hour at 6,050 kW, and 30-minute at 6,050 kW. The 168-hour at 6,050 kW rating is an overload rating. Operation of the generator at the overload rating shall not exceed 2 hours in a 24-hour period. These ratings are based on a 95°F normal and 115°F maximum cooling water inlet temperature.

2. Each diesel engine is a cold starting, compression-ignition, multi-cylinder type. Each engine is a Type KSV-20-T, four-stroke, turbocharged machine.

3. The generator is a synchronous-type, model HS-160 ET, 4160 V, 60 Hz, three-phase AC machine, manufactured by Electric Product Division of Portec. The generator continuous rating at 80 percent power factor lagging is 6,875 kVA. The generator and exciter are capable of operating at 110 percent of the continuous voltage and power ratings for a period of 2 hours out of any 24 hours of operation with no reduction of annual maintenance interval. The generator insulation is designed for the special environmental conditions of the nuclear power plant The generator has nonhygroscopic sealed Class F insulation in accordance with National Electrical Manufacturers Association (NEMA) Standard MG1-22.40.

4. The generator excitation system manufactured by Electric Product Division of Portec, is a static-type exciter-regulator having response characteristics and sufficient capacity to provide the generator with the required excitation to allow startup of the loads listed in Table 8.3-3. The exciter voltage rating is consistent with the requirements of the generator field. Regulator sensing voltage is 120 vac, three-phase, 60 Hz, and is taken from the generator output by means of potential transformers.

5. Each engine has two independent air compressor skids each consisting of an air compressor, dryer, air receiver, and all piping and valves.

   Each engine has an auxiliary skid with standby jacket water circulating pump, lube oil circulating pump, lube oil heaters, and other equipment. The auxiliary skids are located adjacent to the engine and generator skid.

   Each engine has an engine control panel, a generator control panel, and a high voltage cubicle. The diesel and generator control panels are housed in a dust-tight enclosure.

   All these accessories are furnished by Cooper Energy Service (CES) but much of the equipment is fabricated by subvendors contracted to CES.

6. The diesel engine has slow starting capability, in the “Idle” mode, used for maintenance testing, as well as, fast starting capability, in the “Rated” mode, for operations as described in section 8.3.1.1.4.4.

The DG units are subjected to the qualification program in accordance with RG 1.9 and IEEE 387-1977.

ESF motors are sized equal to or greater than the maximum horsepower required by the driven load under normal running and runout condition. All motors are suitable for running at ±10 percent of the nominal voltage rating. The 4.0 kV class motors generally have a service factor ranging from 1.0 to 1.15, whereas 460 V motors generally have a service factor of 1.15. The effect of any overvoltage at the motor terminal is reviewed.

Motor insulation is selected on the basis of normal and design basis event ambient temperatures and anticipated temperature rise resulting from maximum loading conditions (Section 3.11.4). Class 1E motors are seismically and environmentally qualified as described in Section 3.10 and 3.11, respectively. Trouble alarms in the control room are provided for ESF motors.
Transformer impedances and SBDG voltage regulator and exciter characteristics are selected to permit starting the largest motor connected to a particular bus, when all other loads connected to the bus are energized, without the voltage at the terminals of all ESF motors falling below 80 percent of the nominal motor voltage rating.

8.3.1.1.4.3 Identification of Class 1E Equipment and Circuits- See Section 8.3.1.3 for identification of Class 1E equipment and circuits and Section 8.3.1.4 for separation of Class 1E equipment and circuits.

8.3.1.1.4.4 ESF Bus Load Shedding, Automatic Loading, and Standby Diesel Generator Starting- The automatic loading sequence of the Class 1E busses is shown in Table 8.3-3 and a typical logic for this sequence actuation is shown in Figure 8.3-4 (Sheet 2).

Automatic energization of the Class 1E busses is initiated by solid-state ESF Load Sequencers which also connect the required Class 1E loads at programmed time increments.

Each ESF load sequencer, one for each actuation train load group, has independent sensor channels, power supplies, and actuated devices. No credible sneak circuits can occur to render sensors, power supplies, or actuated devices inoperable.

Channel and load groups are isolated and separated in accordance with RG 1.75 (Section 8.3.1.4).

A sequencer design demonstration test is performed to verify that no credible common failure modes exist in the sequencer design. The test verifies response to credible input perturbation and series of events.

Each ESF load sequencer responds to three unique modes of operation as follows:

1. Mode I (SI) discussed in Section 8.3.1.1.4.4.1

2. Mode II (LOOP) discussed in Section 8.3.1.1.4.4.2

3. Mode III (SI coincident with LOOP) discussed in Section 8.3.1.1.4.4.3

8.3.1.1.4.4.1 Mode I (SI Actuation) ESF Load Sequence Operation: Each sequencer detects the existence of Mode I abnormal operation by the simultaneous receipt of any four or more of six SI signals generated by the Engineered Safety Features Actuation System (ESFAS) discussed in Section 7.3.1. The SI signal is generated by plant conditions as shown on Figure 7.2-8.

Upon detecting a Mode I condition, the ESF load sequencer logic verifies the nonexistence of a Mode III signal. The ESF load sequencer then automatically energizes the equipment required for this emergency in programmed steps as shown in Table 8.3-3 and Figure 8.3-4 (Sheet 2).

Loads which may be manually connected are also shown in Table 8.3-3.

Additionally, the SBDGs are started automatically by the ESFAS. The SBDGs run with their governors automatically set in the isochronous mode, and their voltage regulators automatically set in the automatic mode. All noncritical protection devices are bypassed as described in Section 8.3.1.1.4.6.

With an SI signal present and no loss of preferred (offsite) power, ESF loads are fed from the offsite source and the operator can reset the SI signal from the control room (based upon the plant emergency operating procedures). After the SI signal has been reset, the SBDG can then be manually shut down from the control room or locally.

The existence of the SI signal is memorized by the ESF load sequencer to enable recognition of a Mode III condition, as discussed in Section 8.3.1.1.4.4.3.2. This memory is shown on Figure 8.3-4 (Sheet 2).

Simulated testing and actuation of Mode I is discussed in Section 8.3.1.1.4.7.

8.3.1.1.4.4.2 Mode II (Loss of Offsite Power) ESF Load Sequence: The ESF load sequencer detects the existence of Mode II (LOOP) by the simultaneous receipt of any two out of four undervoltage, sustained degraded voltage, or degraded voltage plus SI signals which indicate that the normal preferred power source to the 4.16 kV ESF bus has dropped below acceptable limits, or has failed completely.

Upon receipt of any two out of four undervoltage, sustained degraded voltage or degraded voltage plus SI signals, the ESF load sequencer converts the recognition of these signals into maintained signal and checks for the non-existence of Mode III.

The ESF load sequencers then automatically implement the following:

(a) Shed all loads on the 4.16 kV ESF bus. However, shedding of the load center transformers distribution network is accomplished by tripping the breakers on the 480 V secondary side of the transformers only. The breakers on the primary side of the transformers remain connected.

(b) Start the SBDG with the governor in the isochronous mode and the voltage regulator in the automatic mode. Noncritical protective devices are bypassed as described in Section 8.3.1.1.4.6.

Note – the SBDG receives a simultaneous emergency startup signal directly from the ESFAS due to an SI signal.

(c) Trip the 4.16 kV ESF power supply breakers to disconnect the Class 1E onsite power system from the offsite source.

(d) Energize the equipment for this emergency event in programmed steps as shown in Table 8.3-3 and on Figure 8.3-4 (Sheet 2).

Disconnecting the Class 1E onsite power system from the offsite system precludes the possibility of subsequent interaction between the onsite and the offsite power systems. As each SBDG reaches rated voltage and frequency, the breaker connecting it to the corresponding 4.16 kV ESF bus closes. This automatic breaker closure is only possible when the offsite power supply breaker is open and the designed load shedding has been accomplished. Upon closure of the DG breakers, the sequencers begin sequencing the loads that are required during this event in programmed steps. When the preferred offsite power source again becomes available, the reconnection of the 4.16 kV ESF busses to this source and the shutdown of the SBDGs is accomplished manually.

The manually connected loads are shown in Table 8.3-3.

Subsequent to a Mode II recognition and the above events, if an SI actuation occurs, load shedding and load sequencing are initiated as described in Section 8.3.1.1.4.4.3.3.

Simulated testing of Mode II is discussed in Section 8.3.1.1.4.7.

8.3.1.1.4.4.3 Mode III (SI and Loss of Offsite Power): Mode III is the existence of both Mode I and Mode II conditions. The ESF load sequencer distinguishes four separate methods of entry into a Mode III condition, as follows:

1. The simultaneous existence of Mode I and Mode II

2. Mode I existing followed by Mode II

3. Mode II existing followed by Mode I

4. DG breaker closed followed by Mode I

The ESF load sequencer operation for the above Mode III variations is discussed below. Regardless of the method of entry, the manually connected loads for Mode III are shown in Table 8.3-3. Simulated testing of Mode III is discussed in Section 8.3.1.1.4.7.

8.3.1.1.4.4.3.1 Simultaneous Existence of Mode I and Mode II. Each ESF load sequencer automatically implements the Mode III loading sequence by the simultaneous presence of four or more SI signals from the ESFAS and the presence of two out of four undervoltage signals from the 4.16 kV ESF bus undervoltage relays. The ESF load sequencer then initiates the following:

(a) Shed all loads on the 4.16 kV ESF bus. However, shedding of the load center transformer distribution network is accomplished by tripping the breakers on the 480 V secondary side of the transformers only. The breakers on the primary side of the transformers remain connected.

(b) Start the SBDG with the governor in the isochronous mode and the voltage regulator in the automatic mode. All noncritical protective devices are bypassed as described in Section 8.3.1.1.4.6.

Note – the SBDG receives a simultaneous emergency startup signal directly from the ESFAS due to an SI signal

(c) Trip the 4.16 kV ESF offsite power supply breakers to disconnect the Class 1E onsite power system from the offsite source.

(d) Energize the equipment for this emergency event in programmed steps as shown in Table 8.3-3 and on Figure 8.3-4 (Sheet 2).

8.3.1.1.4.4.3.2 Mode I Existing Followed by Mode II at Some Later Time. Should an existing Mode I (SI) be followed by a Mode II (LOOP), the ESF load sequencers each automatically implement the following:

(a) Shed all loads on the 4.16 kV ESF bus. However, shedding of the load center transformers distribution network is accomplished by tripping the breakers on the 480 V secondary side of the transformers only. The breakers on the primary side of the transformer remain connected.

(b) Shed certain selected loads on the 480 V ESF distribution system, as applicable for that train (residual heat removal (RHR) pump, Reactor Containment Fan Cooler (RCFC) fans, Electrical Auxiliary Building (EAB) heating, ventilating and air-conditioning (HVAC) supply air fan, pressurizer heater, spent fuel pool cooling pump).

(c) Trip the 4.16 kV ESF power supply breakers to disconnect the Class 1E Onsite Power Systems from the offsite source.

(d) Since the SBDG has been previously started by the SI signal and is running at full speed when the Mode II occurs, the permissive to close the DG breaker is delayed to allow sufficient time to recharge breaker closing spring mechanisms.

(e) Energize the equipment for this emergency event in programmed steps as shown in Table 8.3-3 and on Figure 8.3-4 (Sheet 2).

The load shedding of Item (b) above removes all loads which are to be sequenced on or are manually loaded large loads.

8.3.1.1.4.4.3.3 Mode II Existing Followed by Mode I at Some Later Time. Should an existing Mode II (LOOP) be followed by a Mode I (SI), the ESF load sequencers then automatically implement the following:

(a) Shed all loads on the 4.16 kV ESF bus (except the load center transformers and their associated 480 V distribution system).

(b) Shed certain selected loads on the 480 V ESF distribution system, as applicable for that train (RHR pump, RCFC fans, EAB HVAC supply air fan, pressurizer heater, spent fuel pool cooling pump).

(c) Energize the equipment for this emergency event in programmed steps as shown in Table 8.3-3 and on Figure 8.3-4 (Sheet 2).

The load shedding of Item (b) above removes all loads which are to be sequenced on or are manually loaded large loads.

8.3.1.1.4.4.3.4 DG Breaker Closed Followed by Mode I at Some Later Time. If the DG breaker is closed followed by a Mode I (SI) event, the ESF load sequencers will automatically implement the following:

(a) Shed all loads on the 4.16 kV ESF bus (except the load center transformers and their associated 480 V distribution system).

(b) Shed certain selected loads on the 480 V ESF distribution system, as applicable for that train (RHR pump, RCFC fans, EAB HVAC supply air fan, pressurizer heater, spent fuel pool cooling pump).

(c) Energize the equipment for this emergency event in programmed steps as shown in Table 8.3-3 and on Figure 8.3-4 (Sheet 2).

The load shedding of Item (b) above removes all loads which are to be sequenced on or are manually loaded large loads.

8.3.1.1.4.5 Instrumentation and Control – Automatic and manual control of each of the SBDGs and the ESF equipment requiring automatic sequencing is provided. Controls for safety-related equipment are generally provided in the control room as well as at equipment locations. Redundant control circuitry and control power sources are compatible with their associated power circuits.

Instrumentation is provided to manually synchronize each SBDG with the ESF bus and to continuously monitor the status of the safety-related systems. Control power for the SBDG systems is obtained from the associated ESF 125 vdc systems. The status of each SBDG is indicated in the control room, including the following parameters:

1. Voltage, current, power, and frequency

2. Breaker position of each bus supply and feeder breaker

3. Cooling water pressure and temperature, lube oil pressure and temperature, starting air pressure, fuel level, and engine rpm

The bypass or inoperability status of each SBDG is automatically indicated in the control room through the ESF Status Monitoring System described in Section 7.5.4. The conditions alarmed through this system are the following:

1. DG not in remote mode

2. Loss of starting air/starting air system malfunction

3. Loss of control power

4. Start circuit inoperable

5. Emergency stop pushbutton not reset

6. Overspeed lockout not reset

7. Generator differential lockout not reset

8. DG lube oil not reset

Inoperability of the SBDGs may also be manually indicated through the ESF Status Monitoring System. These conditions each have their own alarm windows. The SBDG monitoring complies with guidelines of BTP PSB – 2.

These signals to the ESF Status Monitoring System, as well as other annunciator and computer alarms for various DG conditions, are shown on Figure 8.3-4 (Sheet 1).

AC control power for vital instrumentation and controls is supplied by six solid-state inverter/rectifier systems. The inverter/rectifiers are connected as shown on Figure 8.3-3. The inverter/rectifiers supplying power to instrumentation channels I and II are normally energized by 480 vac feeders from separate MCCs of Train A. The inverter/rectifiers supplying power to channels III and IV are normally energized by 480 vac feeders from MCCs connected to the 480 vac switchgear in Trains B and C, respectively. Upon loss of power from the 480 vac feeds, the inverter/rectifiers are automatically powered from the Class 1E DC system. Single-phase, vital AC power from the inverter/rectifier is distributed by the instrumentation power supply busses, which consist of Class 1E distribution panel boards. For each panel DP-001 and DP-002 and for each panel DP 1201 through DP 1204, a static transfer switch permits energization of the bus either by the corresponding inverter/rectifier or by an alternate single-phase regulated backup source. In case of static transfer switch failure or during testing, manually operated, bypass switches allowing "make-before-break" action permit energization of the bus either by the corresponding inverter/rectifier or by an alternate single phase, regulated backup source.

AC power for other instrumentation and controls is supplied by various systems, as shown on Figure 8.3-3.

8.3.1.1.4.6 Onsite Standby Power Supply System Protection – The Onsite Standby Power System is provided with protective devices to:

- Isolate faulted equipment and circuits from unfaulted equipment and circuits
- Prevent damage to equipment
- Protect personnel
- Minimize system disturbance

To ensure safe and proper operation of the system, the following interlocks and lockout features are provided:

1. Both the 4.16 kV ESF bus supply breakers (normal and standby generator feeds) are tripped and locked out upon the occurrence of a bus fault for that particular bus (Train A, B, or C).
2. Each 4.16 kV ESF bus supply breaker and the generator breaker for its corresponding SBDG are interlocked in such a manner that it is not possible for the DG breaker to close automatically unless the 4.16 kV ESF bus supply breaker is open. However, the bus normal supply and the DG breaker can be manually closed to provide parallel operation for periodic testing of the DG sets.

3. The motor-operated disconnect switches on the primary side of the auxiliary ESF transformer are mechanically interlocked to prevent simultaneous closing, thus avoiding a parallel connection between the standby transformers and the 138 kV emergency transformer.

4. In the automatic mode, the SBDG breaker control has permissive interlocks to prevent closing the breaker until the SBDG attains approximately 90 percent of rated speed. Whenever the SBDG is tripped or stopped, the DG breaker is automatically opened.

5. In the event of a normal supply breaker overcurrent trip, a signal is provided to a lockout relay which prevents closing of the generator breaker.

The details of the protection system are as follows:

1. 4.16 kV ESF System Protection – The bus incoming breaker is tripped by the auxiliary ESF transformer differential relay. A directionally controlled instantaneous overcurrent relay with timer is provided on the ESF bus incoming breaker. This relay operates to trip the DG feeder breaker only if offsite power is lost when the SBDG is operating in parallel with the offsite power source (under test conditions). In addition, time overcurrent relays are provided in each phase to protect against excessive current and provide backup protection to individual load feeders.

   Outgoing feeders from the 4.16 kV ESF switchgear are provided with overcurrent relays in each phase which trip the circuit breakers upon sensing overload and fault.

   Each motor circuit is provided with two sets of three-phase relays. One set of relays provides circuit protection; the other set provides an overload alarm.

   Each outgoing feeder is also provided with a ground sensor relay which provides a common alarm, along with the auxiliary ESF transformer ground sensing relay.

2. Diesel Generator Protection – Each SBDG is provided with the following protection:

   a. Generator differential

   b. Reverse power flow

   c. Loss of field excitation

   d. Low lube oil pressure (engine and turbocharger)

   e. Excess vibration

   f. Turbocharger thrust bearing failure

   g. Engine overspeed trip

   h. High jacket water temperature

   i. High engine/generator bearing temperature

j. Generator overcurrent

k. Generator underfrequency

l. Ground fault

m. Negative sequence

The above trips for the DG remain functional during periodic testing of the DGs. However, during emergency operation of the DGs all but the following protective trips are automatically bypassed:

a. Generator differential

b. Low lube oil pressure (engine and turbocharger, one-out-of-two taken twice)

c. Engine overspeed

The bypassed protective functions are alarmed in the control room to alert the operator to take appropriate action.

In addition, the normal supply breaker overcurrent trip provides input to a lockout relay, which locks out the DG supply breaker from closing.

3. Two undervoltage sensing schemes are employed for each Class 1E 4.16 kV bus to provide two levels of undervoltage protection. The first scheme detects loss of voltage and the second scheme detects degraded voltage conditions on the bus. Voltage signals to each scheme are provided through four potential transformers connected to each bus. Four solid-state type instantaneous undervoltage relays and four time delay relays are used for the first scheme (loss of voltage). The devices used for the second scheme (degraded voltage) include four solid-state type instantaneous undervoltage relays and two sets of four time delay relays. The first set provides for an alarm only, and the second set initiates a logic signal as shown on Figure 8.3-4.

   The adequacy of station electric distribution system voltages is in compliance with BTP PSB-1.

   The voltage setting on the relays is determined from an analysis of the voltage requirements of the safety-related loads at all distribution levels, taking into consideration the maximum and minimum voltage range of the offsite power system, various plant loading conditions, and selection of appropriate tap setting of the intervening transformers. The time delays for the relays are chosen such that:

   a. The allowable time delay, including margin, does not exceed the maximum time delay that is assumed in accident analysis.

   b. The selected time delay minimizes the ability of short duration disturbances to reduce the availability of the offsite power source.

c. The allowed time duration of a degraded voltage condition at all distribution system levels does not result in failure of safety systems or components.

4. 480 V ESF System Protection: Each 480 V ESF load center connected to the 4.16 kV ESF busses is protected against bus fault by a supply circuit breaker with a direct-acting, solid-state trip device having short-time and long-time trip functions. These breakers also provide backup protection to the individual load feeders. The 480 V feeders to MCCs and static loads are each similarly protected by a circuit breaker with short-time and long-time trip functions. Feeders to motors from the 480 V ESF load center breakers are provided with long-time and instantaneous trips. The 480 V Class 1E system is an ungrounded system and hence a ground fault is sensed at the switchgear bus; it is then alarmed in the control room.

   The 480 V ESF MCCs have the combination motor starters which are provided with magnetic, instantaneous trip circuit breakers for short-circuit protection. The static loads are provided with thermal-magnetic breakers which provide overcurrent and short-circuit protection. Motor circuits are provided with thermal overload devices in each of the three phases. The overload elements are set to protect the motor and the feeder cable. For all safety-related motor-operated valves, the thermal overload devices are used for alarm only.

5. Safety-related 120 vac ESF System: Each 120 vac ESF system outgoing feeder is provided with overcurrent and short circuit protection by a thermal magnetic breaker or fuse. Single pole breakers are used for 120 V single-phase circuits. The 120 vac ESF distribution panels are provided with a main circuit breaker which provides backup protection to the feeder circuit breakers or fuses.

   The 208/120 V system is solidly grounded through the 480-208/120 four-wire distribution transformers. The circuit breakers will trip on phase-to-phase or phase-to-ground fault. The 120 vac instrument (i.e., vital) bus is ungrounded.

The above described protection system for the safety-related power system is analyzed and relay settings are coordinated so that a fault at any point in the system is isolated quickly without excessively damaging the equipment or interfering with the operation of the rest of the system. The relay settings also provide selective tripping so that the protective device closest to the fault will trip before the backup device is actuated.

During prerequisite testing each protective device will be tested for proper operation to verify the relay settings obtained from the analysis.

Extensive use of solid-state protective relays and integral solid-state trip devices minimizes the set point drift on the relays. Also, periodic testing of the relays and verification of their settings provide reliable operation of the power system. The protective devices provide visual indication of their operation locally; e.g., target on the protective relays and trip position of the circuit breakers.

Limiting conditions for operation during the degraded ESF bus condition are included in the plant Technical Specifications with sufficient details.

The details of the Containment electrical penetrations protection (RG 1.63) are described in the following. Both safety-related and nonsafety-related electrical penetrations are protected against short-circuit. The protection is provided by source and feeder breakers with coordinated short-circuit protection. This protection limits the maximum I^2t at the penetration to a value far less than that resulting in thermal damage to the penetration seals. Table 8.3-14 identifies the Containment Penetration Conductor Overcurrent Protective Devices that are required to be OPERABLE. Details of the specific protection scheme are provided below:

1. The only medium voltage power circuits passing through the electrical penetrations are reactor coolant pump (RCP) motor power feeders. RCP motors are fed from 13.8 kV auxiliary busses 1F, 1G, 1H, and 1J through Building (TGB) which is a nonseismic Category I building. Protection for the penetration conductors is provided by coordinated primary and backup protection using feeder and supply breakers, respectively. The feeder and supply breakers are supplied with 125 vdc control power from separate 125 V battery systems.

2. The 480 V power circuits (Class 1E/non-Class 1E) are fed from load centers and MCCs. Protection for the penetration conductors is provided by coordinated primary and backup protection using feeder and supply breakers. Protection for each circuit is reviewed and when coordinated protection cannot be achieved, a redundant feeder breaker in series is provided with identical tripping characteristics.

3. 125 vdc control circuits are protected by fuses and the system is ungrounded. Any overcurrent condition is detected by two devices in series and, if one fails, the other provides the necessary protection.

4. 120 vac control circuits are low energy circuits and are protected by one fuse. The energy released by short circuits on control cable in general is sufficiently low that backup protective devices are not required. Control circuits will be analyzed and backup devices are provided where required.

5. For instrumentation circuits the possible energy release for a faulted circuit is compared to the maximum that the penetration can withstand so that redundant protective devices are not generally required. Backup devices provided where required.

6. 120 vac circuits powered from 120 vac, single-phase, ungrounded distribution panels are protected by two fuses. Any overcurrent condition is detected by two devices in series, and if one device fails the other provides the necessary protection.

8.3.1.1.4.7 Testing of Onsite Standby Power System Equipment – Provisions are made for periodic testing of the Onsite Standby Power System equipment in compliance with RG 1.22, IEEE 338-1977, and BTP PSB-2.

Each SBDG is subjected to standard factory tests and inspections prior to shipment to the site. In addition, prior to startup of the plant, each SBDG is subjected to the field acceptance tests of starting, load acceptance with design load, full load rejection, etc., in accordance with IEEE 387-1977 and RGs 1.9 and 1.108.

The ability to restart a DG by a “fast start” signal subsequent to normal shutdown of the DG is verified by functional and starting tests prior to startup of the plant.

The objectives and requirements of the above tests are detailed in IEEE 387-1977 and RGs 1.9 and 1.108. Periodic testing of the Onsite Standby Power System is conducted to verify its availability and capability to perform its safety functions as follows:

1. Tests are performed to verify that each SBDG can be started manually and automatically, synchronized, and loaded to nameplate rating in accordance with Technical Specification requirements.

   During testing, if an SI signal occurs while the SBDG is paralleled to the normal power source, the SI signal takes precedence, and the SBDG feeder breaker is automatically tripped by a signal directly from the ESFAS. The 4.16 kV ESF bus supply breaker remains closed, and the ESF loads are connected to the 4.16 kV ESF bus by the ESF load sequencer per the design, as described in Section 8.3.1.1.4.4.

   The SBDG continuous to run, its governor is automatically transferred to the isochronous mode, and its voltage regulator is put in the automatic mode, thereby enabling it to respond automatically to an emergency signal without the need for any operator action. Under these conditions, all noncritical protective devices are bypassed, as described in Section 8.3.1.1.4.6.

   If a noncritical trip occurs during testing, the SBDG shuts down. Upon a subsequent SI signal, the SBDG starts up automatically and runs with its governor in the isochronous mode with the noncritical protective devices bypassed.

   In the event the DG is operating in parallel with the offsite power source (under test conditions), and the offsite power is lost, the DG feeder breaker will automatically trip. The bus will then experience an undervoltage condition (same as LOOP) and the bus feeder breaker will automatically trip.

   Whether the SBDG had been operating in parallel with the offsite power source or operating but not connected to the bus, upon detection of undervoltage of the 4.16 kV ESF bus, Mode II is initiated by the ESF load sequencer, as described in Section 8.3.1.1.4.4.2. Closure of the DG feeder breaker is delayed, as shown on Figure 8.3-4 (Sheet 3), so that adequate time is provided for recharging of breaker closing springs. Load sequencing begins after closure of the DG feeder breaker, as shown on Figure 8.3-4 (Sheet 2).

   When the local control position is selected at the SBDG local control panel to perform maintenance and testing, the SBDG bypass or inoperable status window for mode selector switch not in “remote” position is lit in the main control room. An audible alarm is also sounded.

2. Tests are performed to demonstrate the readiness and the ability of each SBDG and ESF load sequencer to start automatically in response to a Mode I and Mode II, and for the DG to reach rated speed and voltage within 10 seconds as follows:

   a. Simulated SI signal (Mode I):

      With the ESFAS in test, the SBDG startup actuation slave relay can be operated directly from the Engineered Safeguards Test Cabinet. The SBDG starts automatically in the isochronous mode.

With the ESF load sequencer and the ESFAS in test, the operators are able to send any one out of six individual slave relay actuation signals from the Engineered Safeguards Test Cabinet to the ESF load sequencer.

The ESF load sequencer logic is so designed that the individual test signal from the Engineered Safeguards Test Cabinet causes a simulated actuation of Mode I (SI) time delay logic and contact closures. Under these test conditions, a low current is passed through the external circuits to verify continuity and circuit integrity. (Subsequent tests external to the ESF load sequencer are made to verify the operability of the external loads in accordance with IEEE 338-1977.)

The ESF load sequencer actuation logic is so designed that if an actual emergency signal occurred during testing, the testing is overridden, and the ESF load sequencer begins the proper mode of operation, as described in Section 8.3.1.1.4.4.

b. Simulated LOOP (Mode II):

With the ESF load sequencer in test position, the operators are able to actuate any one of the four undervoltage relay signals to the ESF load sequencer from the 4.16 kV ESF bus. The ESF load sequencer is so designed that the signal causes a simulated actuation of Mode II (LOOP) time delay logic and contact closures. Under these test conditions, al low current is passed through the external circuits to verify circuit continuity and integrity. (Subsequent tests external to the ESF load sequencer are made to verify the operability of the external loads in accordance with IEEE 338-1977.)

The SBDG starts up automatically in the isochronous mode with the voltage regulator in the automatic mode. The ESF load sequencer actuation logic is so designed that if an actual emergency signal occurred during testing, the testing is overridden, and the ESF load sequencer implements the proper mode of operation as described in Section 8.3.1.1.4.4.

3. Tests are performed to demonstrate the readiness and ability of each SBDG and ESF load sequencer to start automatically in response to a simulated Mode III and the DG to reach rated speed and voltage within 10 seconds as follows:

Simulated signals of Mode I and Mode II, described in 2a and 2b above, are initiated coincidentally. The ESF load sequencer logic is so designed that the coincident existence of Mode I and Mode II test signals causes a simulated actuation of Mode III time delay logic and contact closure. Under these conditions, a low current is passed through the external circuits to verify circuit continuity and integrity. (Subsequent tests external to the ESF load sequencers are made to verify the operability of the external loads in accordance with IEEE 338-1977.) The testing performed ensures that the ESF load sequencer responds properly to all three entry modes into Mode III, as described in Section 8.3.1.1.4.4.3.

The SBDG receives start signals form both the ESFAS and the ESF load sequencer, and starts automatically in the isochronous mode with the voltage regulator in the automatic mode.

The ESF load sequencer actuation logic is so designed that if an actual emergency signal occurs during testing, the testing is overridden, and the ESF load sequencer implements the proper mode of operation, as described in Section 8.3.1.1.4.4.

4. For normal starting operations (test mode) a timer called a “cranking limit timer”, with a range of 5-50 seconds, is provided to conserve air in the starting air tanks should the engine not start. The timer is initially set by the diesel engine manufacturer at 15 seconds. The timer is located in the “incomplete sequence” circuit of the engine control paned. When a start signal is given, the starting air solenoids are energized activating the starting air valve alarm check switches, the, the starting air valve relay which energizes the cranking limit timer. If the engine has not started in 15 seconds, the incomplete starting sequence relay deenergizes indicating an incomplete sequence activating the unit shutdown relay and thus engine cranking stops.

   The “cranking limit timer” is bypassed in the emergency mode of operation.

5. For testing purposes, the diesel engine is equipped with controls that enable slow starts. When in the “Idle” start mode, the diesel engine immediately accelerates to idle speed and then slowly accelerates at a programmed rate to rated speed. The slow start feature is expected to reduce engine wear and increase reliability. During normal operations, the start mode selector switch must be in the “Rated” position in order for the diesel engine to accelerate immediately to rated speed and be able to accept loads within 10 seconds. If an emergency signal is received from the sequencer during the ramp cycle from idle-to-rated speed, the emergency signal does not override the slow start feature and the diesel engine will not be able to accept loads until rated speed is achieved.

   The Idle/Rated start selector switch is alarmed when taken out of the “Rated” start position.

8.3.1.1.4.8 Optimum Emergency Diesel Generator Readiness – To assure optimum emergency DG readiness and availability on demand, South Texas Project Electric Generating System (STPEGS) is developing a periodic testing program and a preventive maintenance program. The following requirements will be met:

1. Plant procedures will include provisions for loading the DGs to a level that will remove gum and varnish buildup accumulated during periods of no load or light load operation.

2. Periodic surveillance testing will be performed in accordance with RG 1.108 with the expectations and interpretations in Section 8.3.1.2.10.

3. Diesel generator equipment history records will be maintained and repair records will be reviewed for repeated failures which would warrant further technical investigation.

4. Upon completion of repairs or maintenance and prior to an actual start, run, and load test in a final equipment check will be made to assure that electrical circuits are functional. In addition, testing procedures will contain instructions to have the DG returned to ready automatic standby service under the control of the control room operator.

8.3.1.1.4.9 Diesel Generator Fuel Oil Storage and Transfer System – Each SBDG is provided with a fuel oil storage tank having enough capacity to operate the diesel generator at engineered safety features load requirements for a duration of at least seven days.

The fuel oil system design and the factors considered in sizing the fuel oil storage tanks are described in Section 9.5.4. Electrical and mechanical equipment in this system are classified seismic Category I.

8.3.1.1.4.10 Diesel Generator Cooling and Heating System – The DG Jacket Water Cooling System is described in Section 9.5.5.

8.3.1.1.4.11 Diesel Generator Lubrication System – The DG Lubrication System is described in Section 9.5.7.

8.3.1.1.5 Physical Arrangement and Location of Major Electrical Equipment: The mechanical, structural, and electrical integrity of major electrical equipment is safeguarded by selecting locations for the equipment which reduce the likelihood of physical damage to redundant equipment simultaneously.

Class 1E equipment is separated as much as practicable from non-Class 1E equipment to eliminate the potential for degradation of the Class 1E equipment by failure or malfunction of non-Class 1E equipment. Separation between redundant Class 1E electrical equipment is primarily provided by physical separation as indicated on the general arrangement drawings listed as Figures 1.2-4, 1.2-5 (Sheet 1), 1.2-10, 1.2-26, 1.2-28, and 1.2-29 in Table 1.2-1.

The following is a general description of the separation provided between major electrical components:

1. The main transformers and the unit auxiliary transformer of each unit are located outdoors and are separated from each other by fire walls provided between the transformers.

   The standby transformer is located on the opposite side of the TGB from the main transformer and the unit auxiliary transformer.

   The 138 kV emergency transformer is located near the switchyard and remote from any of the other large transformers.

   Each of the above transformers, except the 138 kV emergency transformer, are protected by a water deluge fire protection system.

   The main generator breaker is located outside the TGB.

   A sum is provided under each oil-filled transformer to contain the transformer oil in the event of rupture of the transformer tank. These sumps drain to an oil separator pit for water removal. Each outdoor transformer is protected against lightning and switching surges.

2. Class 1E electrical equipment is located in structures or buildings which have seismic Category I classification. These buildings or structures are so designed as to protect the Class 1E electrical systems from such postulated events as floods, hurricanes, and other natural events, as outlined in Sections 3.3, 3.4, and 3.5.

   Major Class 1E electrical power distribution equipment located in the Mechanical-Electrical Auxiliaries Building (MEAB) is arranged so that each train of the three-train ESF System is located on a different floor elevation. Separate rooms or compartments are also provided within each elevation to enhance the physical and electrical independence of each redundant train.

The standby DGs are each located in a separate room of the DGB. The associated Class 1E electrical equipment located within each SBDG room is so located and protected within the room as to minimize the possibility of damage due to internally generated missiles, pipe ruptures, fires, etc. However, occurrence of any of these events does not affect the ability of the remaining trains of the ESF system to perform their safety function, since no two trains of Class 1E equipment or cables are located in or routed through any of the other SBDG rooms. Independent air intake and discharge air ducts for each DG room are furnished. Sufficient separation and isolation of air intake and exhaust gas ducts are provided to prevent dilution of the oxygen content to the diesel engines by the Air Exhaust System, as described in Section 9.5.8.

Non-Class 1E equipment located within seismic Category I structures or buildings is arranged so that a loss of or damage to this equipment cannot prevent the Class 1E equipment from performing its safety function. This is accomplished by isolation of such equipment from the Class 1E equipment by means of physical barriers, compartments, or suitable physical separation. Separation criteria for cable and raceways are discussed in Section 8.3.1.4.

The closest piping to the electric penetration inside the Containment Building are the component cooling water (CCW) lines (10" CC – 1117 WA3) at E1. 32 ft-9 in. with approximately 1 ft-10 in. metal-to-metal separation distance from the nearest electric penetration. Other piping runs, including the chilled water lines, condensate lines, instrument air lines, station air lines, and fire protection water lines are in the vicinity of the electric penetrations separated by distances of at least 7 ft from the penetrations.

3. Electric penetration assemblies are provided for cables entering the Reactor Containment Building (RCB). Separate quadrants at three different elevations are selected for locating these penetrations. Three penetration areas are utilized for separate ESF trains and the Reactor Protection System (RPS) channels. In areas where penetrations for both an ESF train and an RPS channel are located, the penetration assemblies are grouped separately. Centerline-to-centerline separation between adjacent electric penetrations within a given train or channel group is 4 ft.

   Control and instrumentation penetrations for RPS channels I and II are located at the same elevation. However, penetrations associated with these RPS channels are adequately separated to ensure their integrity during any possible event.

There is a total of 69 electric penetrations for each unit.

There are 27 electric penetrations located between E1. 19 ft-0 in. and 37 ft-3 in. inside the Containment (E1. 10 ft-0 in. and 35 ft-0 in. outside the Containment).

These groups of electric penetrations have been assigned to Train A, instrumentation channels I and II, and other miscellaneous circuits related to the above. (For all penetration locations and assignments refer to Table 8.3-12.)

There are 18 electric penetrations located between E1. 37 ft-3 in. and 52 ft-0 in. inside the Containment (E1. 35 ft-0 in. and 60 ft-0 in. outside the Containment). These groups of electric penetrations have been assigned to Train B, instrumentation channel III and all other miscellaneous circuits related to the above. (For penetration locations and assignments refer to Table 8.3-12.)

There are 24 electric penetrations located above E1. 68 ft-0 in. inside the Containment (above E1. 60 ft-0 in. outside the Containment). These groups of electric penetrations have been assigned to Train C, instrumentation channel IV, and miscellaneous circuits related to the above. (F or penetration locations and assignments refer to Table 8.3-12 and Figure 8.3-14.)

Design and qualification testing of electric penetrations is in accordance with IEEE 317-1976 and RG 1.63. Note, however, that electric penetrations for the Containment personnel airlock are qualified to IEEE 317-1976, which is endorsed by RG 1.63, Rev. 2.

Protection of the electric penetrations is provided to preclude a single failure from causing excessive currents in the penetration conductors which wold degrade the penetration seals.

Power and control field cable to the electric penetrations are capable of carrying the load current based on the penetration conductor ampacity as calculated for the electric penetration protection.

8.3.1.2 Analysis. The following summary describes how the AC Power Systems comply with the requirements of Nuclear Regulatory Commission (NRC) General Design Criteria (GDC), NRC RGs, and IEEE Standards.

8.3.1.2.1 Compliance with GDCs 17, 18, and 21 and RG 1.93: Sections 8.3.1.1.2 and 8.3.1.1.4 describe the normal power distribution system of each unit, with provision for connection to the respective unit auxiliary transformer and the standby transformers, and the onsite standby sources of each unit. This arrangement affords sufficient flexibility and redundancy to ensure the availability of power to the ESF loads in the event of a design basis event. SBDGs reestablish power to the ESF busses within 10 seconds. The offsite power sources comply with GDC 17 and RG 1.93.

In compliance with GDC 18 and 21, provisions are made to permit:

1. Periodic inspection and testing, during equipment shutdown, of wiring, insulation, connections, and relays to assess the integrity of the systems and the condition of components.

2. Periodic testing, during normal plant operation of the operability and functional performance of onsite power supplies, circuit breakers, and associated control circuits, relays, and busses.

3. Testing, during plant shutdown, of the operability of the Class 1E system as a whole. Under conditions as close to design as practicable, the full operation sequence that brings the system into operation, including operation of signals of the ESFAS and the transfer of powers between the offsite and the onsite power system is tested.

8.3.1.2.2 Compliance with RG 1.6: Section 8.3.1.1.4 describes the onsite standby power sources and explains the degree of separation and independence that exists between the three subsystems.

The three-train arrangement of power sources and load groups is designed to meet the single-failure criterion.

8.3.1.2.3 Compliance with RG 1.9: Each SBDG is rated on the basis of the sum of the brake horsepowers of the ESF loads it energizes during an accident. Prior to energizing actual loads, energization of the load center transformers will cause bus voltage to dip below 75 percent. During subsequent loading steps the bus voltage dip does not exceed 20 percent of the nominal voltage and 5 percent of the nominal frequency. Recovery from this variation is within the RG 1.9 position (i.e., voltage restored to within 10 percent of nominal and frequency within 2 percent of nominal within 60 percent of each load sequence time interval). The DG protective trips are tagged by the Emergency Response Facilities (ERF) computer with a time, but time resolution provided may not be sufficient to identify the first trip as depicted by Rev. 2 of RG 1.9.

8.3.1.2.4 Compliance with IEEE 279-1971 and RG 1.32: Class 1E systems and equipment comply with the requirements of IEEE 279-1971 (as amended by RGs 1.47, 1.62 and RG 1.32) by virtue of the separation, redundancy, and independence provided in the various systems and the location of equipment in seismic Category I buildings and structures. Surveillance of Class 1E systems are described in the Technical Specifications.

8.3.1.2.5 Failure Mode Analysis: Application of the single-failure criterion to safety-related systems is used to analyze failures of components and causes and effects of failures in systems. Tabulations of failure modes and effects are shown in Tables 8.3-9 and 8.3-13.

8.3.1.2.6 Effects of Hostile Environments on Electrical Equipment: Class 1E electrical equipment is designed to withstand the effects of the environment existing at the equipment locations. All equipment located inside the Containment and required to operate during and after a design basis event is identified in Table 3.11-3.

8.3.1.2.7 Compliance with RG 1.75: The design and layout of the electric system is in accordance with RG 1.75, as noted in Sections 7.1.2.2, 7A.II.F.2.3, and 8.3.1.4.

8.3.1.2.8 Compliance with RG 1.53: The design of the safety-related electrical system is in accordance with the single failure criterion as discussed in RG 1.53.

8.3.1.2.9 Conformance with Appropriate Quality Assurance Standards: Conformance to RG 1.30 is as stated in Table 3.12-1.

8.3.1.2.10 Compliance with RG 1.108: The requirements of RG 1.108 are met with following interpretations and exceptions:

1. Starting Air System – System boundary starts at air receivers (isolation valve downstream of the air dryer). Air compressors and dryers are not included since the engine can be started five times from air stored in 100 percent redundant (2 full-capacity) receivers for each engine.

2. Fuel Oil System – Fuel oil system boundary starts from the diesel fuel oil tanks which will be tested per RG 1.108.

3. Cooling Water System – The Essential Cooling Water System (ECWS) cools the engine jacket water, lube oil, turbocharger discharge and intake air, and governor oil cooler. The ECWS is not part of the diesel generator unit.

4. Position on Paragraph C.2.a.(3) – STPEGS takes a partial exception to the periodic operational load testing of the SBDGs. The type qualification test performed on an SBDG proved that SBDG can operate for two hours at the two-hour rating. STPEGS will perform the two-hour run with the SBDG loaded to 5700-6050 kW in accordance with the Technical Specifications. The auto-connected loads will not exceed the 2000 hour rating of 5935kW. STPEGS will run the SBDG for 22 consecutive hours loaded to 5000-5500 kW in accordance with Technical Specifications. Ref. ST-AE-HL-94442.

5. Position on Paragraph C.2.a(5): Clarification is as follows: If the rerunning of the tests of Positions C.2.a (1) and C.2.a (2), as required by Position C.2.a (5), is not completed satisfactorily, it is not necessary to repeat the 24-hour test of Position C.2.a (3); the DG may be operated at the continuous rated load for 1 hour or until operating temperature has stabilized.

6. Position on Paragraph C.2.d: In addition t the above stated exceptions, the increased frequency of diesel testing in section C.2.d is excessive and may cause premature engine degradation. It is STPEGS's intent to base the increase in testing frequency on the last 20 valid tests instead of the last 100 valid tests. This will reduce the RG 1.108 established reliability goal of .99 by four percentage points to .95, and will significantly reduce the rate of engine wear. The reliability goal of .95 is consistent with Generic Letter 84-15.

The criterion of first-out alarm for DG protection is not implemented as it does not reduce the damage to the DG or the down time of the DG.

8.3.1.2.11 Compliance with RG 1.81: Safety-related electrical systems are not shared between Units 1 and 2. Therefore, the design is in compliance with RG 1.81.

8.3.1.2.12 Compliance with RG 1.106: Thermal overload units on safety-related motor-operated valves are used to provide alarm only under all conditions. Activation of these thermal overload units is alarmed only in the control room.

8.3.1.3 Physical Identification of Safety-Related Equipment. Class 1E equipment is provided with nameplates having a colored background, in accordance with the color designation indicated in Section 8.3.1.4, for easy identification of separation groups.

Safety-related cables are identified by color designation indicated in Section 8.3.1.4. Color-coding is provided by colored jackets during manufacturing or in the field by using colored markers of sufficient durability on black cables, prior to or during installation, at intervals not exceeding 5 feet in accordance with RG 1.75.

The safety-related tray and conduit system is identified by unique numbers and colors to designate trains, channels, or separation groups. Trays and conduits outside the Containment are identified with adhesive-backed stickers having a colored background and the printed raceway number. Trays and conduits inside the Containment have the raceway number stenciled using colored pigment of the train or channel color. Color-coding of the trays and conduits is done at intervals not exceeding 15 feet, prior to installation of cables. Where cables and conduits penetrate walls and floors, the color markings are applied on both sides of the wall or floor penetration.

A description of the Class 1E control boards, panels, etc., furnished by Westinghouse Electric Corporation (Westinghouse) as part of the Nuclear Steam Supply System (NSSS), including such items as the Solid-State Protection System (SSPS), Process Control System, and reactor trip switchgear, is provided in Section 7.1.2.3. Other Class 1E equipment supplied by the owner conforms to IEEE Standard 420-1973 and RG 1.75.

Class 1E cables or wire bundles within control boards or relay racks are identified by color codes and/or tags to distinguish between Class 1E redundant separation groups and between cables of Class 1E systems and non-Class 1E systems.

8.3.1.4 Separation of Redundant Systems. Separation is accomplished for redundant equipment and circuits by the following methods:

1. Physically separate areas

2. Separation by distance

3. Separation by barriers

8.3.1.4.1 Separation Groups: Separation groups are identified as groups A, B, C, D, R, S, N, or M defined as follows.

Separation Group A

A Class 1E instrumentation control or power cable, raceway, or equipment related to ESF Train A, DC Subsystem I, vital AC instrumentation and control (I&C) channel I or Post-Accident Monitoring (PAM) channel 1.

Separation Group B

A Class 1E instrumentation, control or power cable, raceway, or equipment related to ESF Train B, DC Subsystem III, or vital AC I&C channel III.

Separation Group C

A Class 1E instrumentation, control or power cable, raceway, or equipment related to ESF Train C, DC Subsystem IV, vital AC I&C channel IV or PAM Channel 2.

Separation Group D

A Class 1E instrumentation, control or power cable, raceway, or equipment related to DC Subsystem II, or vital AC I&C channel II.

Separation Group R

Reactor trip and ESF actuation train “R” as identified by Westinghouse. All cables are equivalent to Separation Group A and can be installed in the Group A raceway system with the exception of (1) the interconnecting cables between logic cabinet R and the output actuation cabinets, and (2) the 48 V undervoltage trip signals from the SSPS to the reactor trip switchgear. These are to be installed in dedicated steel conduits.

Separation Group S

Reactor trip and ESF actuation train “S” as identified by Westinghouse. All cables are equivalent to Separation Group B and can be installed in the Group B raceway system with the exception of (1) the interconnecting cables between logic cabinet R and the output actuation cabinets, and (2) the 48 V undervoltage trip signals from the SSPS to the reactor trip switchgear. These are to be installed in dedicated steel conduits.

Separation Group N (Designated M for the reservoir makeup pump facility)

All non-Class 1E cable, raceways and equipment.

8.3.1.4.2 <u>Separation Color Codes and Measurements</u>: Separation groups A through D and R, S, N, and M shall be color-coded as follows:

(Protection channels and DC subsystems of a separation group use same color)

Group A: Red (red may be replaced by violet for cables and equipment tags)

Group B: Blue (blue may be replaced by brown for cables and equipment tags)

Group C: Yellow (yellow may be replaced by gray for cables and equipment tags)

Group D: White

Group R: Orange

Group S: Green

Group N or M: Black (black may be replaced by black/white, black/blue, black/yellow, black/violet, black/brown, black/red, or black/gray, for cables)

Grounding: Bare copper or green jacketed cable with (HMWPE) high molecular weight polyethylene imprinted on the jacket.

The single conductor lighting wires, which are installed in dedicated nonsafety-related raceways, are of various colors.

Horizontal separation is measured to the side rail of a tray. Vertical separation is measured from the bottom of the upper tray to the top of the side rail of the lower tray.

Horizontal, vertical, or diagonal separation for conduit is measured to the closest point on the conduit, fitting body, or box.

8.3.1.4.3 Equipment Separation: Equipment separation is described in Section 8.3.1.1.5.

8.3.1.4.4 Raceway and Cable Separation: Raceways within a given train or a separation group are separated on the basis of function and voltage class. In general, separate reaceways are provided for the following services in each separation group:

1. 13.8 kV circuits

2. 4.16 kV circuits

3. 600 V power circuits

4. Control circuits

5. Instrumentation circuits

Vertical tiers of cable trays carry the highest-energy-level cables in the top tier. Other tiers carry lower-energy-level cables in decreasing order to the lowest energy level in the lowest tier. Instrumentation cabling occupies the lowest tier.

Both AC and DC circuits rated 600 V and below utilize 600 V class cables. The 600 V class AC and DC power cables are routed in common cable trays. Control cables are routed in cable trays separate from power circuits as much as possible but they may be combined in one tray due to physical restraints. Instrumentation cables and other low-level signal cables are routed in separate raceways from power and control cables.

Class 1E circuits of redundant separation groups are routed in separate penetrations, cable trays, conduits, and other totally enclosed raceways to assure complete separation. Separation of raceway systems is as follows:

8.3.1.4.4.1 Cable Spreading Areas Tray Separation: Cable spreading areas consist of the control room, the relay room and the cable spreading rooms on E1. 21 ft-0 in., 60 ft-0 in., and 74 ft-9 inches.

The separation distance in these areas is based on open cable tray of either the ladder or solid bottom type, The minimum horizontal separation distance between different separation group trays is 1 ft. The minimum vertical separation distance between different separation group trays is 3 ft.

8.3.1.4.4.2 General Plant Areas Tray Separation: The separation distance in general plant areas is based on open cable tray of either the ladder or solid bottom type. The minimum horizontal separation distance between trays of different separation groups is 3 ft. The minimum vertical separation distance between different separation group trays is 5ft.

8.3.1.4.4.3 Conduit-to-Conduit Separation – All Areas: The minimum horizontal, vertical, or diagonal separation between conduits of different separation groups is 1 inch.

8.3.1.4.4.4 Class 1E Conduit-to-Open Tray Separation:

8.3.1.4.4.4.1 Cable Spreading Areas – The minimum horizontal separation between conduit of any one Class 1E separation group and open cable trays of any other separation group is 1 ft. The minimum vertical separation between conduit of any one Class 1E separation group and open cable trays of any other separation group is 3 ft.

8.3.1.4.4.4.2 General Plant Areas – The minimum horizontal separation between conduit of any one Class 1E separation group and open cable trays of any other separation group is 3 ft. The minimum vertical separation between conduit of any one Class 1E separation group and open cable trays of any other separation group is 5 ft.

8.3.1.4.4.4.3 Class 1E Conduit to Solid Bottom and/or Solid Top Tray Separation – The minimum separation distance between a Class 1E conduit and solid bottom and/or solid top of a tray is 1 inch. If the conduit is located above the tray, a top tray cover is placed on the tray. If the conduit is located at the side of the tray, top and bottom tray combers are placed on the tray.

8.3.1.4.4.4.4 Non-Class 1E Conduit to Open Tray Separation – All Areas – The minimum horizontal or vertical separation between totally enclosed raceway (described in Section 8.3.1.4.4.7) of non-Class 1E separation Groups N or M and open ventilated cable trays or cables in free air of any Class 1E separation group is 1 inch.

8.3.1.4.4.5 Exceptions to Area Separation Requirements – Where termination arrangements or plant arrangements preclude maintaining the minimum separation distances, a barrier is placed between trays or the circuits may be analyzed.

There are several groups of installation configurations where analysis and/or test data are used to justify lesser separation distances. These are identified and analyzed as follows:

> All exceptions are limited to cables with circuit backup protective device (circuit breaker) nominally set at 640 A or less, and carrying voltages of 480 volts and lower. Exceptions to power cable separation originated from 480 vac load centers are limited to Section 8.3.1.4.4.5.4.

8.3.1.4.4.5.1 Low-Energy Circuits – Analysis shows that in the event of a failure, low-energy circuits cannot affect any other cables in their vicinity. There is no minimum separation requirement for these circuits to other circuits. Examples of such circuits are:

- Non-Class 1E Fiber Optic Cables
- Non-Class 1E Fire Detection Protectowire
- Non-Class 1E Fire Detector Cables (ALS)
- Non-Class 1E Plant Telephone System

- Non-Class 1E Plant Paging System
- Maintenance Jack and Fueling/Refueling Communication System

8.3.1.4.4.5.2 Free Air Cable to Lighting Fixture Cord – The minimum separation distance requirement between Class 1E free air cables and lighting fixture cords is 1 inch (Ref. 8.3-1).

8.3.1.4.4.5.3 Conduits with PVC Coating (Jacket) – A 9-in. minimum horizontal separation is acceptable between flexible metal conduits with polyvinyl chloride (PVC) jacket, and between free air cable and flexible metal conduit with PVC jacket (Ref. 8.3-2).

8.3.1.4.4.5.4 Cables from 480 vac Load Centers – Each cable of a group of 750 MCM cables wrapped in WT-65 Siltemp tape may touch other cables in free air (Ref. 8.3-3).

8.3.1.4.4.5.5 Cables in Rigid Steel Conduit to Tray or to Free Air Cables – For cables in conduit, a ½ - in. minimum separation is acceptable (Ref. 8.3-4).

8.3.1.4.4.5.6 Conduit to Conduit Separation – Zero inch minimum separated is acceptable between cables of different separation groups when all cables are in conduits, provided not more than one of the conduits is a flexible conduit with PVC jacket (Ref. 8.3-5).

8.3.1.4.4.5.7 Conduit to Free Air Cable Separation – One inch minimum separation is acceptable between cables in conduit and free air cables provided any flexible conduits do not have PVC jacket. A maximum of ¼-in. exposed PVC jacket at fittings is acceptable. A 1-in. minimum separation is acceptable for cables in conduits if any flexible conduits with PVC jacket are wrapped with Siltemp WT-65 tape or PMT-886A or approved alternate cloth material (Ref. 8.3-6). CN-3120

8.3.1.4.4.5.8 Free Air Cables –

a. One inch minimum separation is acceptable horizontally provided cables of one separation group are wrapped with either Siltemp WT-65 tape or PMT-886A or approved alternate cloth material. In a very limited case cables wrapped with Siltemp PMT-886A or approved alternate cloth may be in contact. One-inch vertical separation is acceptable provided cables of one separation group are wrapped with Siltemp PMT-886A or approved alternate cloth. Siltemp WT-65 tape is not acceptable for wrapping on cables which are separated vertically (Ref. 8.3-7). CN-3120

b. When the potential damage source is of low-level power capacity (circuit backup protective device-circuit breaker is rated nominally 35A or less), and in the event of maximum fault current (long time rating of breaker), the temperature of the faulted cable (in the worst case) stabilizes below the overload rating of the cable (130°C). The heat generated due to this value of fault current is negligible and cannot raise the operating temperature of other cables, at least one inch away, to unacceptable levels. Based on this free air cable to cable, or cable to tray, separation of one inch minimum is acceptable (Ref. 8.3-8).

8.3.1.4.4.5.9 Maximum ½ - Inch Gap in Cable Tray Cover – In the case where a gap exists in a tray cover, up to a maximum of ½ - in., The minimum separation distance between cables of a different separation group crossing the tray at any angle from the gap is 9 in. horizontally and 1 in. vertically. The vertical separation distance of cables from the gap is as required by RG 1.75 (Ref. 8.3-9).

8.3.1.4.4.6 Separation Within Enclosures – Cables within an enclosure maintain a 6-in. minimum separation between redundant safety-related group cables and between safety-related and nonsafety-related group cables. Where a 6-in. physical separation cannot be maintained, one of the following alternatives is provided:

1. Power Cables

    a. Each Class 1E separation group is installed in a totally enclosed metallic raceway. Minimum spacing between enclosed raceways is one inch or equivalent in thermal insulation material. The raceway is installed over the entire length of the cables or cable conductors from/to the point where a 6-in. minimum separation distance can be established; e.g., from the point of entry into the cabinet to the point of termination of the cable conductor.

    b. A metal barrier is erected between the cabling, terminal blocks, or components of the redundant separation groups. A minimum separation of 1 in. or equivalent in thermal insulating material is maintained between the barrier and the cable, terminal blocks, or components. The barrier is extended a sufficient distance beyond the outer edge of the separation group cable or cable bundle such as to allow a minimum of 6 in. of air space between cables of redundant separation groups.

    c. In case of less than a 6-in. separation between non-Class 1E cables and Class 1E cables, either the Class 1E cables or the non-Class 1E cables are placed in totally enclosed metallic raceway and a minimum separation of 1 in. or equivalent in thermal insulating material is maintained between the totally enclosed raceway and the other cables. When a 1 in. air space cannot be provided within the enclosure, a thermal insulating material my be used to provide the 1 in. air space equivalence. Minimum separation may also be established by analysis in accordance with IEEE 384-1974.

2. Control and Instrumentation Cables

    a. Each Class 1E separation group is installed in a totally enclosed metallic raceway. The raceway is installed over the entire length of the cables or cable conductors from/to the point where a 6-in. minimum separation distance can be established; e.g., from the point of entry into the cabinet to the point of termination of the cable conductor.

    b. A metal barrier is erected between the cabling, terminal blocks, or components of the redundant separation groups. The barrier is extended a sufficient distance beyond the outer edge of the separation group cable or cable bundle such as to allow a minimum of 6 in. of air space between cables of redundant separation groups.

    c. In case of less than a 6 in. separation between non-Class 1E cables and Class 1E cables, either the Class 1E cables, or the non-Class 1E cables are placed in totally enclosed metallic raceway. Minimum separation may also be established by analysis in accordance with IEEE 384-1974.

8.3.1.4.4.7 Totally Enclosed Raceway – The following raceways are considered totally enclosed raceways:

- Rigid steel conduit
- Aluminum-sheathed cable and copper-sheathed cable
- Uncoated flexible metal conduit
- PVC-coated flexible metal conduit containing non-Class 1E control or instrumentation cables only
- Ventilated steel cable trays with corrugated steel covers installed at top and bottom of tray
- Solid bottom tray with corrugated steel covers
- Thermal Science Inc.'s (TSI) Thermo-Lag 330 fire barrier envelope system (1-hour and 3-hour)

8.3.1.4.4.8 Seperation Criteria for Pipe Failure Hazard Areas – Separation of conduit and cable trays from potential pipe failure hazards in all areas is accomplished by the use of barriers, restraints, separation distance, or the appropriate combination thereof. Where it is not possible to prevent damage to a Class 1E raceway in the event of a pipe failure, an analysis is performed to assure that safe shut down capability is maintained. The protective mechanisms provided for pipe failure are further discussed in Section 3.6.1.3.2 and 3.6.2.4.

8.3.1.4.4.9 Separation Criteria for Missile Hazard or Flooding Areas – Separation of conduit and cable trays from potential missile hazards or flooding is accomplished where possible by the use of barriers, orientation, separation distance, or the appropriate combination thereof. Where it is not possible to prevent damage to a Class 1E raceway in the event of a missile hazard or flooding, an analysis is performed to assure that safe shutdown capability is maintained.

8.3.1.4.4.10 Underground Class 1E Ductbanks – Where Class 1E cables must be installed between seismic Category I structures and no physical connections exist for continuation of exposed trays or conduits, underground Class 1E duct systems are provided.

Separate ducts are provided for each redundant Class 1E separation group; however, since the ducts are enclosed in reinforced concrete, the duct enclosure for several separation groups may be common. Instrumentation cable and cables of different voltage levels are routed within manholes in a manner that maintains a separation commensurate with that outlined for general plant areas.

8.3.1.4.4.11 Electrical Penetration Area – Containment electric penetrations are physically separated and located at different elevations in the Containment wall. The vertical and horizontal separation distances between redundant separation distances of 3 ft horizontally and 5 ft vertically for general plant areas.

Electric penetrations and piping penetrations are located in different quadrants of the Containment circumference. All nonconducting, nonmetallic materials are flame-retardant. The evaluation of potential missile sources in the electric penetration areas is included in the overall internal missile evaluation discussion in Section 3.5.

Assignment of penetrations is tabulated in Table 8.3-12 and locations of penetrations are shown on Figure 8.3-14.

8.3.1.4.4.12 Raceway Supports – Raceway supports for Class 1E circuits are designed to comply with seismic Category I requirements; except in the TGB. The Class 1E Anticipatory Trip Signals (reactor trip on turbine trip) in the TGB are supported by seismically qualified hangers. Refer to Section 7.2.1. Raceway supports for non-Class 1E raceways which are located in areas which contain safety-related or Class 1E equipment are designed such that they will not fail during a safe-shutdown earthquake (SSE) to the degree that they will degrade, to an unacceptable level, the ability of safety-related, seismic Category I structures, systems, or components to perform their required safety function.

8.3.1.4.4.13 Cable Routing and Cable – Cables going to the control room belonging to separation groups A and D, or B and C, are generally routed through separate cable chases and cable spreading room within the EAB. Separation groups A and D cables enter the lower cable spreading room while Separation groups B and C cables enter the upper cable spreading room.

Non-Class 1E cables are not routed through Class 1E raceways.

Cable trays penetrating fire rated walls or vertically through floors are provided with fire stops.

Barriers may be used to achieve required separation in lieu of spatial separation.

Ampacity rating and group derating factors of cables are in accordance with manufacturer's standards which comply as a minimum, with Insulated Power Cable Engineers Association (IPCEA) P-46-426 for cables in conduit or ducts and with IPCEA P-54-440 for cables in trays. Power cables rated at 5 kV and 15 kV are installed in trays with ¼-diameter or greater maintained spacing. For power conductors rated at 2 kV and below, tray fill is generally limited to 35 percent of the usable cross section of a 5-inch-deep tray. In cases where this condition is exceeded, each individual case is reviewed for adequacy of the design. For trays containing only control or instrumentation cables, a 40 percent fill of a 5-inch-deep tray limitation is applied in general.

As a minimum, power cables are sized using 100 percent load factor except for intermittent loads and rated for 90°C conductor temperature. Correction factors for ambient temperature other than 40°C are incorporated in accordance with IPCEA publication P-54-440 and IPCEA 42-426.

As stated in Section 3.11, cables are qualified in accordance with RG 1.131.

Conduit fill is based on 53 percent fill for one conductor, 31 percent fill for two conductors and 40 percent fill for three conductors or more.

8.3.1.4.4.14 Associated Circuits and Isolation Devices – Circuits for electrical equipment which are not qualified as Class 1E and do not perform a safety function, but which are connected to the Class 1E system through isolation devices, are classified as "associated" by RG 1.75 definition. These circuits are identified as Class 1E from the Class 1E source up to and including the isolation device. The circuit from the isolation device to the equipment is identified as non-Class 1E. Non-Class 1E circuits which share an enclosure or raceway with Class 1E equipment or circuits subsequent to the isolation device, but which are not connected to Class 1E circuits, are identified as class 1E. Therefore, associated circuits are not identified as such but either as Class 1E or non-Class 1E.

The following equipment items are qualified as isolation devices:

1. Class 1E isolation transformers
2. Class 1E devices which are tripped on receipt of an SI signal.
3. Class 1E digital isolators (Section 8.3.1.5.1)
4. Class 1E analog isolators (Section 8.3.1.5.2)
5. Class 1E control switches with 6-in. separation or barriers between separation groups
6. Control circuit fuses (Class 1E) which isolate the non-Class 1E circuit prior to the operation of the Class 1E circuit protective device.
7. Class 1E relays with barriers
8. Redundant Class 1E thermal magnetic trip devices in series
9. Class 1E current transformers

Devices which are located in the TGB (a nonseismically designed building) but which are connected in Class 1E circuits are routed in dedicated non-Class 1E rigid steel conduit in accordance with Section 8.3.1.4)

8.3.1.4.4.15 Administrative Responsibilities and Controls for Assuring Separation Criteria- The cable and raceway channel identification described in Section 8.3.1.3 and 8.3.1.4.2 facilities and ensures the maintenance of separation in the routing of cables and the connection of equipment control boards and panels. At the time of the cable routing assignment during design, those responsible for cable and raceway scheduling check t ensure that the separation group designation in the cable number is compatible with a single-line-diagram load-group designation. Extensive use of computer facilities assists in ensuring separation. Each cable and raceway is identified in the computer program, and the identification includes the applicable separation group designation. Auxiliary programs are made available specifically to ensure that cables of a particular separation group are routed through the appropriate raceways. The routing is also confirmed by quality control personnel during installation to be consistent with the design document. Color identification of equipment, raceways, and cabling assist field personnel in this effort.

8.3.1.5 Engineered Safety Signal Isolation System. The Engineered Safety Signal Isolation System provides Class 1E to non-Class 1E and non-Class 1E to Class 1E digital and analog signal isolation while maintaining Class 1E integrity in accordance with RG 1.75. This system uses solid-state components to the maximum extent practicable, consistent with interface and reliability requirements. Interchangeability is provided for all similar modules, components, or assemblies. Dissimilar modules, components, and assemblies do not permit interchangeability. To prevent incorrect insertion or interchange, cable connectors, if required, are keyed and identified. The isolation device terminal arrangement provides physical separation in accordance with RG 1.75. When isolation barriers are required, they are in accordance with RG 1.75.

To comply with RG 1.75, additional consideration is emphasized as follows:

- Mercury wetted relays are not used.
- Printed circuit board layout provides separate input and output patterns and components.

- Relay sockets ensure separation of relay coils and contact connections.

8.3.1.5.1 Digital Isolation: Digital isolators are optical components. Separation is maintained in the interrogation of Class 1E field contacts; e.g., Class 1E train A designated field contacts are interrogated only by Class 1E train A power.

8.3.1.5.2 Analog Isolators: Analog isolators are transformer-coupled or optically-coupled types whose functions and operation are neither disturbed by nor transmit electromagnetic or noise interference. Analog isolator linearity and stability does not decrease significantly as a function of time and temperature. The isolators are accurate within 0.5 percent of the input span.

8.3.2 Direct Current Power Systems

8.3.2.1 Description. The direct current (DC) Power Systems of Units 1 and 2 each consist of four Class 1E 125 vdc battery systems and Balance-of-Plant (BOP) battery systems including one 48 vdc, two 125 vdc, and one 250 vdc battery in each unit as shown in Figure 8.3-3. There are separate batteries provided for the plant computer and other data acquisition systems. These batteries do not interface with the rest of the plant DC Power System.

8.3.2.1.1 Class 1E Battery System: The Class 1E 125 vdc Battery System of each unit consists of four independent, physically separated busses, each energized by one of the two available battery chargers and one battery. Voltage on any separate bus varies between 105-137.5 vdc depending upon the operating mode of battery charging equipment and system loads. The batteries are sized in accordance with IEEE 485-1978.

Emergency power required for plant protection and control is supplied by the batteries without interruption when the power from AC sources is interrupted. Each battery system also supplies power to its associated inverter system, which converts the DC power to AC power for the vital instrumentation and protection system, as discussed in Section 8.3.1.1.4.5.

The ampere-hour capacity of each battery is sufficient to provide, for a minimum of 2 hours, the power required by emergency DC controls and the vital AC instrumentation and protection system. Only small DC loads and DC controls are supplied from the 125 vdc batteries.

The four vdc batteries are each located in separate rooms in a seismic Category I building which inhibits the propagation of fire and provides protection against missiles. Battery chargers and distribution panels associated with a given battery are located outside of the battery room. Each battery room is ventilated by the HVAC (Section 9.4.1) using fans which are energized from the ESF busses.

The Class 1E DC Power Systems are designed to withstand the effects of tornadoes, fires, and the SSE without loss of function. Flooding of the battery rooms is precluded by the elevation and location of the battery rooms in the MEAB.

The environmental and seismic qualification program of the Class 1E Battery System are discussed in Sections 3.10 and 3.11. The Class 1E Battery System is designed to comply with requirements of NRC RGs 1.6 and 1.32.

Each DC System is provided with an annunciator window having inputs from each of the two chargers and the switchboard. The ERF computer may be used to identify which of the three inputs is being alarmed. ERF computer calculations are used to inhibit nuisance and/or duplicate alarms.

Each battery charger is provided with the following alarm circuits which are connected in common to the control room annunciator/ERF computer to indicate battery charger trouble:

1. Output under and overvoltage (DC)

2. DC ground

Each 125 vdc switchboard has the following alarm circuits which are connected in common to the control room annunciator/ERF computer:

1. Input breaker position from battery charger (alarm when tripped)

2. Input breaker position from battery (alarm when tripped)

3. Output breaker positions of selected loads (alarm when tripped)

4. DC bus ground and over/undervoltage (combined)

In addition to these annunciator alarms, the ESF Status Monitoring System, described in Section 7.5.4, is used to indicate bypassed or inoperable status of the battery or battery chargers. Component-level windows provided for the DC system indicate the following conditions.

1. Input undervoltage, charger output breaker open position, or charger input to switchboard breaker open position for each battery charger. (ERF computer is used to indicate which condition caused the window to light.) Since only one charger is required, a single window for both chargers is provided. This window is lit when both output breakers are open or when an inservice charger (indicated by closed output breakers) has an input undervoltage condition.

2. Battery output breaker open position.

As indicated in Section 7.5.4, actuation of any component-level window also actuates the system-level window for that system and affected systems.

The following indicating instrumentation for each DC system is provided in the control room:

1. Switchboard bus voltage

2. Battery current

3. Battery charger current from each charger

Each battery is protected by an air circuit breaker with long-time and short-time protection.

Identification of Class 1E DC Systems and equipment is discussed in Section 8.3.1.3.

8.3.2.1.2 Class 1E Batteries: Class 1E 125 vdc batteries are 59-cell lead-calcium type, assembled in shock-absorbing, clear plastic, sealed containers. Spacers are provided between cells and cell clamps to prevent shifting during seismic events. The battery cells are mounted on seismic Category I, corrosion-resistant, steel racks.

The batteries are suitable for continuous float duty and are maintained in a nominally fully charged state by the battery chargers. The batteries are sized to carry their connected ESF loads for 2 hours without power flow from the chargers in the event of loss of AC power. Analysis and an emergency operating procedure are in place for defense in depth to support 4 hours of use for the four Class l E batteries through implementation of load shedding within 30 minutes following a loss of all AC power, as discussed in Reference 8.3-11. CN-3150

A single line diagram of the Class 1E 125 vdc system is given in Figure 8.3-3. More specific information regarding the Class1E 125 vdc system is given in Reference 8.3-15.

Upon loss of power from the AC System to the battery chargers, the batteries automatically assume the load without switching. In the event all off-site AC sources are lost, AC power to the battery chargers is supplied by the SBDGs.

Each battery is sized to provide a minimum of 1.78 V/cell at the end of 2 hours.

8.3.2.1.3 Battery Chargers: There are two battery chargers associated with each of the four 125 vdc busses. These chargers are connected to their train-related AC busses. One charger is required for each of Channels I, II, III and IV.

The battery charger configurations, as stated above, are sized to recharge the battery to where charging current has stabilized at the charging voltage within 12 hours after the battery being discharged for the batteries' 2-hour duty cycle. The batteries are floated at 2.22 V/cell (nominal 131 vdc) and equalized at 2.31 (±1%) V/cell (137.5 vdc maximum).

These battery charger configurations have sufficient capacity to restore the battery from the design minimum charge to its fully charged state while supplying normal and post-accident steady-state loads.

The output voltage of each battery charger is adjustable to ±10 percent of 141 vdc if required for equalizing charging when the battery is disconnected from the system.

AC power to the Class 1E battery chargers associated with a given battery is supplied from independent MCCs connected to double-ended sections of switchgear. The switchgear sections are energized from the ESF busses and supplied with power from the SBDGs when offsite sources are unavailable.

Independence of the four battery systems is achieved by separation of cables and equipment and by prohibiting cross-ties between load groups in different trains.

Each battery charger is equipped with a DC voltmeter and ammeter. Protection against power feedback from the battery to the charger and AC source, upon loss of the AC source, is provided.

8.3.2.1.4 Testing: Periodic testing of Class 1E DC Power System equipment is performed in accordance with RG 1.32 to verify its ability to perform its safety function.

The batteries and chargers are inspected and tested in accordance with the Technical Specifications and the Technical Requirements Manual.

Visual inspection, liquid level, specific gravity, and cell voltage and temperature checks are performed routinely on the batteries.

8.3.2.1.5 Service Equipment: Equipment of the DC Power System is located in ventilated, controlled environments outside of the RCB.

Class 1E DC Power System circuits penetrating into the RCB are designed to operate in the post-accident environment for the period of time required to maintain the plant in a safe shut down conditions following a Design Basis Accident (DBA), as discussed in Section 3.11.

8.3.2.1.6 Non-Class 1E Battery Systems: The non-Class 1E Battery Systems in each unit consist of one 48 vdc distribution panel bus, two 125 vdc distribution panel busses and one 250 vdc distribution panel bus. These busses are energized by two battery chargers and a battery.

The plant computer and other data acquisition systems are supplied with separate batteries. These battery systems do not interface with the other DC Systems.

These non-Class 1E battery systems are entirely independent of the Class 1E batteries and the Class 1E AC Distribution System. There are no interconnections between the two classes of systems. The 250 vdc system generally supplies the large BOP loads, such as the turbine generator emergency lube oil pump and other similar loads. The 125 vdc systems supply smaller BOP loads, such as switchgear control power. The 48 vdc system is used exclusively for the plant annunciator and has no interface with the Class 1E DC Power System.

Generally, characteristics and specifications of these batteries and battery chargers are similar to those of the Class 1E Battery Systems, but it is not intended that they necessarily meet Class 1E equipment requirements.

8.3.2.2 Analysis. The following summary highlights the compliance of the design of the Class 1E DC Power Systems with the NRC GDC, and NRC RGs.

Failure modes and effects analysis for the Class 1E DC System is presented in Table 8.3-8.

8.3.2.2.1 Compliance with GDCs 17, 18, and 21: As described in Section 8.3.2.1, the Class 1E DC Power Systems are designed with sufficient flexibility and redundancy to ensure the availability of power to the plant protection systems under all postulated design basis events. In addition, when all off-site AC sources are lost, the stored energy in the batteries is sufficient to supply the power needs of critical I&C systems for a duration sufficiently long to restore AC power sources. Therefore, the design is in compliance with GDC 17.

Provision for periodic inservice testing of Class 1E DC Power System equipment is made in compliance with GDC 18 and 21. This testing verifies the availability and capability of equipment to perform design functions.

8.3.2.2.2 Compliance with RG 1.6: Figure 8.3-3 and Section 8.3.2.1 describe the separation, redundancy, and independence which exist within the Class 1E DC Power System to meet the single-failure criterion.

8.3.2.2.3 Compliance with RG 1.32: To comply with RG 1.32, a study of DC loads under normal operating conditions and under accident conditions was made to determine the largest demand on each battery. Each battery was sized on the basis of meeting DC loads determined by the load study. Each battery charger is sized as discussed in Section 8.3.2.1.3. Battery performance and service test will be as described in Section 8.3.2.2.5.

8.3.2.2.4 Compliance with RG 1.75: The design and layout of the Electrical Raceway System and circuits comply with the requirements of RG 1.75, as discussed in Section 8.3.1.4.

8.3.2.2.5 Compliance with RGs 1.128 and 1.129: The Class 1E DC System complies with RG 1.129 as described in Note 26 of Table 3.12.2, and with RG 1.128 with the exception of Section 5.2.2(12) of IEEE 484-1975 endorsed by RG 1.128. Testing is described in Section 8.3.2.1.4.

8.3.2.2.6 Conformance with Appropriate Quality Assurance Standards: Quality assurance, described in Chapter 17, applies to all equipment of the Class 1E DC Power Systems and equipment installation, in accordance with IEEE Standard 336-1971 and NRC RG 1.30. Conformance with RG 1.30 is as stated in Chapter 17 and Table 3.12-1.

8.3.2.2.7 Compliance with RGs 1.22, 1.47, 1.53, 1.62, 1.81, 1.93, and 1.106: The class 1E DC Systems are in compliance with RGs 1.22, 1.47, 1.53, 1.62, 1.81, 1.93, and 1.106 similar to Class 1E AC Systems as stated in Section 8.3.1.

8.3.3 Fire Protection for Cable Systems

The measures employed for prevention of and protection against fires in electrical cables are described in Section 9.5.1 and in the Fire Hazards Analysis Report.

8.3.4 Station Blackout

8.3.4.1 Definition. NUMARC Document 87-00, Revision 0, “Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors,” defines Station Blackout as the complete loss of alternating current electric power to the essential and nonessential switchgear buses in a nuclear power plant (i.e, loss of offsite electric power system concurrent with a turbine trip and the unavailability of the onsite emergency AC power system). Station Blackout does not include the loss of available AC power to buses fed by station batteries through inverters, or by Alternate AC sources as defined in NUMARC 87-00. A concurrent single failure or design basis accident is not assumed during a Station Blackout event.

8.3.4.2 Requirements. The requirements for Station Blackout are established in 10CFR50.63, the Station Blackout Rule. Guidance for interpreting the regulatory requirements is presented in Regulatory Guide 1.155 and in NUMARC 87-00, Revision 0. The STPEGS Station Blackout position was developed utilizing NUMARC 87-00, Revision 0, and complies with Regulatory Guide 1.155.

8.3.4.3 Station Blackout Duration. The required coping duration category determined for Station Blackout is a minimum of four hours, based on the guidance of NUMARC 87-00, Section 3. This duration is based on an offsite AC power design characteristic of "P3*", an emergency AC (EAC) configuration of Group C, and a Standby Diesel Generator (SDG) reliability target of 0.975. The "P3*" characteristic is based on an expected frequency of grid-related LOOPS of less than one per twenty years, an offsite power independence classification of "I1/2", a Severe Weather (SW) classification of Group 1, an Extremely Severe Weather (ESW) classification of Group 5, and implementation of the 73 mph pre-hurricane shutdown requirements based on NUMARC 87-00, Section 4.2.3. As discussed in Section 8.3.4.6, STP's procedures include provisions for deviating from the NUMARC guidance when the shutdown could increase the likelihood of a LOOP. The EAC Group C classification is based on two SDGs not credited to operate safe shutdown equipment following a LOOP. The SDG target reliability is based on the SDGs having a unit-average reliability through December 1994 of greater than 0.90 over the last 20 demands, greater than 0.94 over the last 50 demands, and greater than 0.95 over the last 100 demands.

8.3.4.4 Alternate AC Power Source. The NUMARC 87-00 guidelines permit the use of an "Alternate AC" (AAC) approach for coping with a postulated Station Blackout. Per NUMARC 87-00, if an Alternate AC power source can be shown by test to be available within 10 minutes of the onset of station blackout, then no coping analysis is required. An AAC Source is defined as an AC power source that is located at or nearby and is available to nuclear power plant. An AAC Source must also: (1) be connectable to but not normally connected to the preferred or onsite emergency AC power systems; (2) have minimal potential for common cause failure with the other offsite and onsite power sources; (3) be available in a timely manner after the Station Blackout onset; (4) have sufficient capacity and reliability for all systems required for SBO coping for the postulated SBO duration; and (5) be inspected, maintained and tested periodically to demonstrate operability and reliability.

The STPEGS Station Blackout position credits any one of the three Standby Diesel Generators as the AAC source. Each SDG can energize an independent train of Auxiliary Feedwater (AFW), Essential Cooling Water (ECW), Component Cooling Water (CCW), Steam Generator power operated relief valves, High Head Safety Injection (HHSI) and EAB/Control Room HVAC. Each SDG meets or exceeds the NUMARC 87-00, Appendix B, criteria for capacity, capability and connectability. Each SDG is periodically tested to demonstrate the capability to power the equipment credited for coping within ten minutes of Station Blackout event initiation.

8.3.4.5 Station Blackout Coping Capability. This Section Deleted.

8.3.4.6 Procedures and Training. The guidelines for response to a Station Blackout event are incorporated into the plant emergency and off-normal operating procedures. These procedures address responding to conditions including a loss of AC power, reactor trip or safety injection, loss of primary or secondary coolant, primary system cooldown and depressurization, and loss of EAB/Control Room HVAC.

The guidelines for AC power restoration following a postulated Station Blackout are incorporated into the Electric Reliability Council of Texas (ERCOT) operating and black start guidelines, and in the CenterPoint Energy Control Emergency Operating Plan.

The guidelines for preparation for and response to a severe weather event (e.g., hurricane or tornado) are presented in two STPEGS procedures, one of which documents the overall site Severe Weather Plan, and the other providing specific guidance to the plant operators during severe weather events. As discussed in Section 8.3.4.3, STP is classified as P3* according to the NUMARC 87-00 criteria. This is based in part on procedures requiring the plant to be in Hot Standby at least two hours before the onset of sustained 73 mph winds onsite. Since hurricane season coincides with the summer peak electrical demand, it is likely that the electrical grid will be heavily loaded at the time a hurricane is threatening in the Gulf of Mexico. In such a situation, close coordination with the system dispatcher and Independent System Operator (ISO) will be required to assure grid stability as STP, which is one of the largest power sources on the grid, is taken off-line in an orderly fashion. The STP procedures allow STP management to authorize deviation from the NUMARC 87-00 criteria for grid conditions where an untimely shutdown may increase the likelihood of a LOOP. The NUMARC 87-00 criteria remain the target and the procedures require that STP be in Hot Standby before the expected arrival onsite of sustained winds exceeding 96 mph.

Plant operator training required to implement the specific Station Blackout response guidelines as defined in the plant procedures is conducted in accordance with the STP operator training program.

8.3.4.7 Quality Assurance Program. The equipment credited for Station Blackout operation is classified as safety-related or Class 1E. The quality assurance requirements for the credited equipment meet or exceed the guidelines of Regulatory Guide 1.155, Appendix A. Refer to UFSAR Section 3.2 for details of the quality classification and quality assurance program requirements.

8.3.4.8 Standby Diesel Generator Reliability Program. A Standby Diesel Generator reliability program which complies with Regulatory Guide 1.155, Position C.1.2 has been established. STPEGS has established a reliability target level of 0.975 based on criteria provided in NUMARC 87-00, Revision 0. This reliability level is consistent with the plant coping duration category derived utilizing NUMARC 87-00, Revision 0, Section 3.

STPEGS has implemented reliability monitoring programs which support SDG monitoring activities. These programs monitor and trend the condition of diesel engine fuel oil, lubricating oil, and jacket water. Trending and analysis programs identify opportunities for SDG performance improvements, and calculate and monitor the individual SDG reliability values. Root cause investigation and failure analysis actions are initiated when selected demand failure trigger values are exceeded.

Maintenance of the STPEGS SDGs and associated equipment is typically conducted in accordance with manufacturer’s recommendations. These maintenance activities, which help ensure the SDG target reliability values are met, are implemented by a defined maintenance program utilizing specific maintenance procedures and preventive maintenance actions.

STPEGS is implementing a new control system for the emergency diesel governors such that slow start testing is possible. The slow start testing is expected to reduce engine wear and increase reliability.

REFERENCES

Section 8.3

8.3-1 Wyle Test Report No. 53575, Test No. 1-3

8.3-2 Wyle Test Report No. 53575, Test No. 3.6, 3.7, and 4.1

8.3-3 Wyle Test Report No. 53575, Test No. 2.4

8.3-4 Wyle Test Report No. 53575, Test No. 3.2

8.3-5 Wyle Test Report No. 53575, Test No. 4.2 and 5.1

8.3-6 Wyle Test Report No. 53575, Test No. 3.1-1, 3.3, and 3.8

8.3-7 Wyle Test Report No. 53575, Test No. 2.1-1, 2.2, 2.3, and 2.5-1

8.3-8 Wyle Test Report No. 53575, Test No. 7.5

8.3-9 Wyle Test Report No. 53575, Test No. 8.1 and 8.2-2

8.3-10 Implementation of the Station Blackout Rule (10CFR50.63) – July 17, 1991 (ST-AE-HL-92805)

8.3-11 Revised Station Blackout (SBO) Position, South Texas Project, Units 1 and 2 (STP), July 24, 1995 (ST-AE-HL-94257)

8.3-12 Revised Position on 10CFR50.63, “Loss of All Alternating Current Power”, March 1, 1995 (ST-HL-AE-5010)

8.3-13 Supplemental Information to Revised Position on 10CFR50.63, “Loss of All Alternating Current Power”, June 14, 1995 (ST-HL-AE-5103)

8.3-14 NUMARC 87-00, “Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors”

8.3-15 EC-5008, “Class IE System Scenario, Battery / Charger / Inverter sizing & System Voltage Calculation”

TABLE 8.3-1

CONNECTION BETWEEN 13.8-Kv AUXILIARY BUSSES AND UNIT AUXILIARY TRANSFORMER

13.8kV Bus	Transformer Secondary Winding
Auxiliary 1F & 1H …………………………………………………	
Standby 1F …………………………………………………………	X
Standby 1H …………………………………………………………	
Auxiliary 1G & 1J ——————————————————	Y
Standby 1G …………………………………………………………	

————————Normal connection (Reference Figure 8.3-1)

………………Possible connection

Standby Bus 1F Supplies ESF Bus E1A
Standby Bus 1G Supplies ESF Bus E1B
Standby Bus 1H Supplies ESF Bus E1C

TABLE 8.3-2

CONNECTION BETWEEN UNITS 1 AND 2 13.8Kv STANDBY BUSSES

Unit No. 1			Unit No. 2
	STANDBY TRANSFORMER NO.1	STANDBY TRANSFORMER NO. 2	
13.8 kV Bus	Secondary Winding	Secondary Winding	13.8 kV
Auxiliary Bus 1F & 1H……………..			………………Auxiliary Bus 1F & 1H
Standby Bus 1H ……………………	X	X	………………Standby Bus 1H
Standby Bus 1F……………………..			………………Standby Bus 1F
Standby Bus 1G……………………			………………Standby Bus 1G
Auxiliary 1J & 1G…………………..	Y	Y	………………Auxiliary Bus 1J & 1G

———Normal connection (Reference Figure 8.3-1)

……………Possible connection

It is also possible to connect Unit 1 and 2 busses to the opposite winding of standby Transformer No. 2 and No. 1, respectively.

Standby Bus 1F Supplies ESF Bus E1A
Standby Bus 1G Supplies ESF Bus E1B
Standby Bus 1H Supplies ESF Bus E1C

TABLE 8.3-3

EMERGENCY ELECTRICAL LOADING REQUIREMENTS

								LOCA - Notes B & D			LOOP - Note C			
Equipment Name	TPNS Number	Rated HP	Brake HP	Motor Eff	Run PF Start PF	Load (kw)	LRC (amps)	Tr. 'A' (kw)	Tr. 'B' (kw)	Tr. 'C' (kw)	Tr. 'A' (kw)	Tr. 'B' (kw)	Tr. 'C' (kw)	Notes
Step 1 (See Note A)														A
Step 2	1 Second After Diesel Generator Breaker is Closed													
Miscellaneous MCC Loads	3E171EMCE1A1, 2, 3, 4; E1B1, 2, 3, 4; E1C1, 2, 3, 4 & 8E171EMC01A5, B5, C5							716	577	555	843	614	591	E, H, I, J, L
Step 3	6 Seconds After Diesel Generator Breaker is Closed													
HHSI Pumps	2N121NPA101A, B, C	1000	950	.95	.92 .20	745.8	749	745.8	745.8	745.8	-	-	-	K
Step 4	10 Seconds After Diesel Generator Breaker is Closed													
LHSI Pumps	2N121NPA102A, B, C	400	400	.93	.90 .27	319.4	303	319.4	319.4	319.4	-	-	-	K

TABLE 8.3-3 (Continued)

EMERGENCY ELECTRICAL LOADING REQUIREMENTS

								LOCA - Notes A & D			LOOP - Note C			
Equipment Name	TPNS Number	Rated HP	Brake HP	Motor Eff	Run PF Start PF	Load (kw)	LRC (amps)	Tr. 'A' (kw)	Tr. 'B' (kw)	Tr. 'C' (kw)	Tr. 'A' (kw)	Tr. 'B' (kw)	Tr. 'C' (kw)	Notes
Step 5	15 Seconds After Diesel Generator Breaker is Closed													
Containment Spray Pumps	2N101NPA102A, B, C	400	400	.93	.90 .27	319.4	303	319.4	319.4	319.4	-	-	-	F
Reactor Containment Fan Coolers	2V141VFN001 through 006 (6 fans, 2/train)	150	150/SI 64/LOOP	.93	.85 -	119.1 53.2	1486	238.2	238.2	238.2	106.4	106.4	106.4	
Step 6	20 Seconds After Diesel Generator Breaker is Closed													
Component Cooling Water Pumps	3R201NPA101A, B, C	800	800	.94	.91 -	632.5	671	632.5	632.5	632.5	632.5	632.5	632.5	K
Step 7	25 Seconds After Diesel Generator Breaker is Closed													
Essential Cooling Water Pumps	3R281NPA101A, B, C	800	710	.95	.82 .22	562.3	555	562.3	562.3	562.3	562.3	562.3	562.3	K
Step 8	30 Seconds After Diesel Generator Breaker is Closed													
Auxiliary Feedwater Pumps	3S141MPA0143, 0243, 0343	800	700	.95	.93 .20	551.3	637	551.3	551.3	551.3	551.3	551.3	551.3	K

TABLE 8.3-3 (Continued)

EMERGENCY ELECTRICAL LOADING REQUIREMENTS

								LOCA - Notes A & D			LOOP - Note C			
Equipment Name	TPNS Number	Rated HP	Brake HP	Motor Eff	Run PF Start PF	Load (kw)	LRC (amps)	Tr. 'A' (kw)	Tr. 'B' (kw)	Tr. 'C' (kw)	Tr. 'A' (kw)	Tr. 'B' (kw)	Tr. 'C' (kw)	Notes
Step 9	35 Seconds After Diesel Generator Breaker is Closed													
EAB Main Area Supply AHU Fans	3V111VFN014, 015, 016	190	190	.96	.90	148.0	1290	148.0	148.0	148.0	148.0	148.0	148.0	
Other EAB HVAC MCC Loads	Various					177.5		177.5	177.5	177.5	177.5	177.5	177.5	E
Step 10	40 Seconds After Diesel Generator is Closed													
Containment Spray Pumps (2nd permiss.)	2N101NPA102A, B, C													F
Step 11	65 Seconds After Diesel Generator is Closed													
Essential Chiller - 300 Ton	3V111VCH004, 005, 006	500	500	.95	.86 .22	392.5	381	392.5	392.5	392.5	392.5	392.5	392.5	G

TABLE 8.3-3 (Continued)

EMERGENCY ELECTRICAL LOADING REQUIREMENTS

SDG Loading and Margin Summary														
								LOCA - Notes A & D			LOOP - Note C			
Equipment Name	TPNS Number	Rated HP	Brake HP	Motor Eff	Run PF Start PF	Load (kw)	LRC (amps)	Tr. 'A' (kw)	Tr. 'B' (kw)	Tr. 'C' (kw)	Tr. 'A' (kw)	Tr. 'B' (kw)	Tr. 'C' (kw)	Notes
Step 12	180 Seconds After Diesel Generator Breaker is Closed													
Step 13	270 Seconds After Diesel Generator Breaker is Closed													
Essential Chiller - 300 Ton														G
	TOTAL LOAD AFTER STEP 13							4802.9	4663.9	4641.9	3868.3	3184.5	3616.3	M, N
	LESS INTERMITTENT LOADS							169.7	167.3	166.4	171.3	168.9	168.0	J
	TOTAL LOAD AFTER AUTO-SEQUENCE PERIOD							4633	4497	4476	3697	3016	3448	O
	MARGIN, IN KW, TO SDG 2000-hr RATING OF 5935 KW							1302	1438	1460	2238	2919	2487	P
	MARGIN, IN PERCENT, TO SDG 2000-hr RATING OF 5935 KW							21.9	24.2	24.6	37.7	49.2	41.9	P

TABLE 8.3-3 (Continued)

EMERGENCY ELECTRICAL LOADING REQUIREMENTS

SDG Manual Loads (See NOTE Q)

								Powered from Train:			
Equipment Name	TPNS Number	Rated HP	Brake HP	Motor Eff	Run PF	Load (kw)	LRC (amps)	Tr. 'A' (kw)	Tr. 'B' (kw)	Tr. 'C' (kw)	Notes
Centrifugal Charging Pumps	2R171NPA101A, 101B	600	570	.94	.92	454.8	642	X		X	K, R
Pressurizer Heaters	7R111EHT101A, 101B					431		X		X	
RHR Pumps	2R161NPA101A, 101B, 101C	300	260	.94	.86	208.3	2275	X	X	X	
	2R162NPA201B	30	260	.956	.863	192	2181		X		
SFPCCS Pumps	3R211NPA101A, 101B	200	175	.95	.89	139.6	1285		X	X	K
Non-1E Battery Charger	8E231EBC125D					60		X			I, R
RMW Pumps	3R271NPA101A, 101B	50	50	.91	.90	41.2	358		X	X	K
Reactor Cavity Vent Fans	8V141VFN023, 024	40	32.1	.90	.89	26.6	310	X		X	I
CRDM Fans	8V141VFN017, 018, 019	40	29.7	.88	.85	26.1	-	X	X	X	I
Boric Acid Transfer Pumps	3R171NPA103A, 103B	32.5	34.4	.87	.90	29.5	126	X		X	K
RV Support Exhaust Fans	9V141VFN036, 037	20	10	.86	.87	8.9	138	X	X		I
SDG Air Compressors	9Q151MC0134, 0234, 0334, 0434, 0534, 0634 (2/train)	15	15	.89	.84	14.1	120	X	X	X	I, R
Reactor Cubicle Exhaust Fans	3V141VFN027, 028, 029, 030	7.5	7.5	.85	.86	6.6	53	X	X	X	R
SDG FOST Room Exhaust Fans	8V131VFN004, 005, 006	1.5	1.5	.75	.70	1.5	14.3	X	X	X	I
Hydrogen Recombiner Panel	3N151ZRR021, 022	—	—	—	—	75	—	—	X	X	I, R

TABLE 8.3-3 (Continued)

EMERGENCY ELECTRICAL LOADING REQUIREMENTS

Notes:

A. The emergency loading scenario begins (time = 0 seconds) when the diesel generator breaker is closed.

B. Unless otherwise indicated in the table, Loss of Coolant Accident (LOCA) loads will be required during injection phase (half an hour for large break or two hours for small break), and recirculation phase in large/small break.

C. Unless otherwise indicated in the table, loads needed during Loss of Offsite Power (LOOP) will be required for hot standby following LOOP and shutdown below 350°F reactor coolant temperature.

D. This table also includes loads required under LOCA concurrent with LOOP conditions as the worst case.

E. Step 2 includes all MCC loads which are auto-connected or auto-sequenced to the ESF bus when it is energized. It also includes any loads powered from the ESF busses which are process-controlled and which may start at any time based on temperature, pressure, level, or radiation conditions. Selected MCC loads receive their own start signal; these are the EAB HVAC components modelled to start in Step 9.

F. The containment spray pump starts based on a spray actuation signal due to containment pressure reaching the Hi-3 setpoint. The ESF load sequencer provides a 2-second start permissive window for these pumps at 15 seconds. If it doesn't receive its actuation signal during this window, it is blocked from starting until 40 seconds (Step 10) when a second permissive window opens for the duration of the event.

G. Essential chillers will start at Step 11 or a time between step 11 and step 13 or at step 13 (65 seconds to 270 seconds) depending on the timing in the Essential Chiller circuit. The pre-lube pumps for these chillers receive a start signal in Step 9. The pre-lube pumps for these chillers start on the restoration of power to the bus and complete their lubrication cycle. The SDG loading analysis conservatively models the pre-lube pumps starting in Step 2 and the chillers as if they had been in standby; this imposes a larger step load on the SDG.

H. Where the size of a component used in a given application may differ between trains or between units, the larger load size has conservatively been modelled. For example, the lube oil heaters may be either 19 KW or 12 KW; the jacket water heaters may be either 40 KW or 18 KW.

TABLE 8.3-3 (Continued)

EMERGENCY ELECTRICAL LOADING REQUIREMENTS

NOTES:

I. MCC 1A5, 1B5, and 1C5 are non-Class 1E and power non-safety related loads. These MCCs are shed on an SI signal and the loads may be manually loaded only after clearing the safety injection signal. Selected loads on these MCCs may be auto-started following a LOOP.

J. Intermittent loads include the motor-operated valves and the SDG auxiliary equipment, which is not expected to run after the engines have reached operating conditions (the jacket water and lube oil circulation pumps and heaters). These loads are modelled as starting in Step 2 and are off after Step 13. They are not considered in determining the margin available for manual load addition.

K. This component has associated cooling equipment which will start when the component starts. The cooling equipment would also start on high area temperatures and has been conservatively modelled as starting as a process-controlled load in Step 2.

L. Transformers losses vary with loads on the transformer; the initial losses have been conservatively modelled in Step 2.

M. The SDG standby lube oil (LO) and jacket water pumps operate when the respective engine-driven pumps fails. The engine driven pumps are assumed to operate in the loading analysis.

N. The sum of the auto-sequenced loads remains below the continuous rating of the SDG.

O. The Total Load after the auto-sequence period is adjusted upward to reflect the load flow analysis results. The amount of adjustment varies from 2.5 to 7.6 kw. This adjustment accounts for cable and transformer losses, which increase slightly with increasing loads.

P. The margin available for manual load addition considers the 2000-hr rating of the SDG of 5935 kw. Manual load additions are administratively controlled; the operator is may add loads if the actual loading condition at that time provides sufficient margin to 5935 kw to accommodate the desired load.

Q. These loads include the equipment capable of being powered from the ESF busses which were not automatically started. These loads may be started at the discretion of the operator following either a LOCA or a LOOP. While not listed, it is recognized that selected MOVs may be operated remote-manually; these are considered to be small intermittent loads.

R. Component may be automatically powered following a LOOP and was included in the auto-sequence LOOP loading data. Listed as possible manual load following a LOCA for completeness. Reactor cubicle exhaust fans may be required to support operation of the RHR pumps.

TABLE 8.3-8

FAILURE MODES AND EFFECTS ANALYSIS CLASS 1E DC SYSTEM

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Function Capability	General Remarks
Loader Feeder Breaker	Protect 125 vdc Bus and load	All	Failure to open on Overload or fault Current	The supply breaker from the battery will trip to protect the system. Tripping the supply breakers is indicated in the CR on the computer. The supply breaker from the charger will not trip due to the 110% current limit of the charger; a low DC output voltage relay with the charger provides alarm in the CR.	None - Redundant safety-related channels/trains are provided.	Abnormal 125 vdc bus voltage is also annunciator alarmed. Additionally, bus voltage and battery charger current are displayed in CR.
			Failure to close (Closing is manual)	Immediately apparent to person attempting to close.	None - Redundant safety-related channels/trains are provided.	

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*Plant Modes

1. Power Operation	4. Hot Shutdown
2. Startup	5. Cold Shutdown
3. Hot Standby	6. Refueling

TABLE 8.3-8 (Continued)

FAILURE MODES AND EFFECTS ANALYSIS
CLASS 1E DC SYSTEM

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Function Capability	General Remarks
Battery Charger	Supply 125 vdc	All	Failure of battery charger or 480 vac supply to battery charger.	Indication is provided in CR by battery charger alarm and current display.	None - Battery supplies loads for 2 hours. Also redundant safety-related trains are provided.	Channels I, II, III and IV have redundant battery chargers.
Battery	Emergency supply to 125 vdc loads	All	Loss of Output	Periodic testing Battery current is also displayed in CR.	None - Redundant safety-related channels/trains are provided.	

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*Plant Modes

1. Power Operation	4. Hot Shutdown
2. Startup	5. Cold Shutdown
3. Hot Standby	6. Refueling

TABLE 8.3-8 (Continued)

FAILURE MODES AND EFFECTS ANALYSIS
CLASS 1E DC SYSTEM

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Function Capability	General Remarks
Supply breakers from battery chargers	Protect 125 vdc bus	All	Failure to open on overload or fault current	See Load Feeder Breaker	None - Redundant safety-related channels/trains are provided	
Supply breaker from battery	Protect battery and 125 vdc bus	All	Failure to open on overload or fault current	Battery would discharge. Indication in CR is provided by battery over-current alarm and battery current is also displayed in CR.	None - Redundant safety-related channels/trains are provided.	

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*Plant Modes

1. Power Operation	4. Hot Shutdown
2. Startup	5. Cold Shutdown
3. Hot Standby	6. Refueling

TABLE 8.3-9

CLASS 1E AC (EXCEPT VITAL 120 VAC)
AND 13.8 kV SYSTEM (AUX. & STANDBY SYSTEMS)

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Function Capability	General Remarks
Distribution breakers 120 vac	Protect distribution bus and loads	All	Failure to open on overload or fault current	Distribution panel main feeder breaker will trip to protect system. Loss of load function is alarmed at system level due to pressure, temperature, flow, etc.	None - Redundant safety-related trains are provided	MCC-Motor Control Center LC-Load Center CR-Control Room
			Failure to close (closing is manual)	Immediately apparent to person attempting to close	None - Redundant safety-related trains are provided	
MCC feeder breaker	Protect MCC bus and load	All	Failure to open on overload or fault current	Feeder breaker to MCC from LC will trip to protect system. Tripping LC breaker is alarmed in CR.	None - Redundant safety-related trains are provided	
			Failure to close (closing is manual)	Immediately apparent to person attempting to close	None - Redundant safety-related trains are provided	
MCC starter	Regulate load and protect MCC bus and load	All	Failure to open on overload or fault current	LC feeder breaker to MCC will trip to protect system. Tripping LC feeder breaker is alarmed in CR.	None - Redundant safety-related trains are provided	

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*Plant Modes

1. Power Operation	4. Hot Shutdown
2. Startup	5. Cold Shutdown
3. Hot Standby	6. Refueling

TABLE 8.3-9 (Continued)

CLASS 1E AC (EXCEPT VITAL 120 VAC) AND 13.8 kV SYSTEM (AUX. & STANDBY SYSTEMS)

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Function Capability	General Remarks
MCC starter (continued)			Failure to close (automatically initiated)	System alarm: pressure, temperature, flow, etc.	None - Redundant safety-related trains are provided	Failure to close when manually initiated is immediately apparent to person attempting to close
LC feeder breaker to MCC (typically)	Protect LC and MCC	All	Failure to open on overload or fault current	LC supply will trip to protect system. Tripping LC supply is indicated in CR by indicating lights and undervoltage alarm	None - Redundant safety-related trains are provided	
			Failure to close (closing is manual)	Immediately apparent to person attempting to close	None - Redundant safety-related trains are provided	

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*Plant Modes

1. Power Operation	4. Hot Shutdown
2. Startup	5. Cold Shutdown
3. Hot Standby	6. Refueling

TABLE 8.3-9 (Continued)

CLASS 1E AC (EXCEPT VITAL 120 VAC) AND 13.8 kV SYSTEM (AUX. & STANDBY SYSTEMS)

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Function Capability	General Remarks
LCC feeder breaker other than to MCC (typically)	Protect LC and load	All	Failure to open on overload or fault current	LC supply breaker will trip to protect system. Tripping LC supply breaker is indicated in CR by indicating lights and undervoltage alarm	None - Redundant safety-related trains are provided	
			Failure to close (automatically initiated)	System alarm: pressure, temperature, flow, etc.	None - Redundant safety-related trains are provided	Failure to close when manually initiated is immediately apparent to person attempting to close
LC supply breaker (typically)	Protect LC	All	Failure to open on overload or fault current	4.16 kV feeder breaker will trip to protect system. Tripping 4.16 kV breaker is indicated in CR by indicating lights and undervoltage alarm	None - Redundant safety-related trains are provided	
			Failure to close (closing is manually initiated)	Immediately apparent to person attempting to close. Indicated in CR by indicating lights.	None - Redundant safety-related trains are provided	

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*Plant Modes

1. Power Operation
2. Startup
3. Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

TABLE 8.3-9 (Continued)

CLASS 1E AC (EXCEPT VITAL 120 VAC) AND 13.8 kV SYSTEM (AUX. & STANDBY SYSTEMS)

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Function Capability	General Remarks
LC transformer (typically)	Supply loads	All	Failure to function	Indicated in CR by undervoltage and ground fault alarms	None - Redundant safety-related trains are provided	
4.16 kV feeder breaker to LC (typically)	Protect 4.16 kV bus and LC	All	Failure to open on overload or fault current	4.16 kV supply breaker will trip to protect system. Tripping 4.16 kV supply is indicated in CR by indicating lights and undervoltage alarm	None – Redundant safety-related trains are provided	
			Failure to close (closing is manually initiated)	Immediately apparent to person attempting to close. Indicated in CR by indicating lights	None - Redundant safety-related trains are provided	
4.16 kV breaker to other than LC (typically)	Protect 4.16 kV bus and load	All	Failure to open on overload or fault current	4.16 kV supply breaker will trip to protect system. Tripping 4.16 kV supply breaker is indicated in CR by indicating lights, by system alarms, and undervoltage alarm	None - Redundant safety-related trains are provided	

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*Plant Modes

1. Power Operation
2. Startup
3. Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

TABLE 8.3-9 (Continued)

CLASS 1E AC (EXCEPT VITAL 120 VAC) AND 13.8 kV SYSTEM (AUX. & STANDBY SYSTEMS)

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Function Capability	General Remarks
			Failure to close (automatically initiated)	Indicated in CR by system alarm: pressure, temperature, flow, etc.	None - Redundant safety-related trains are provided offsite power	Failure to close when manually initiated is immediately apparent to person attempting to close
4.16 kV supply breaker (typically)	Protect 13.8 kV system and 4.16 kV bus	All	Failure to open on overload or fault current	13.8 kV feeder breaker will trip to protect system. Tripping 13.8 kV feeder breaker is indicated in CR by indicating lights and undervoltage alarm	None - Redundant safety-related trains are provided offsite power	
4.16 kV breaker to standby diesel generator (typically)	Protect standby diesel generator and 4.16 kV bus		Failure to open	Indicated in CR by indicating lights	None - Redundant safety-related trains are provided	Applicable during LOOP or LOOP and safety injection signal
			Failure to close	Indicated in CR by indicating lights, breaker open alarm, and system alarms	None - Redundant safety-related train are provided	
Standby diesel generator (typically)	Provide emergency 4.16 kV power	All	Loss of output	Undervoltage alarm is provided in CR	None - Redundant safety-related trains are provided	Applicable during LOOP

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*Plant Modes

1. Power Operation
2. Startup
3. Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

TABLE 8.3-9 (Continued)

CLASS 1E AC (EXCEPT VITAL 120 VAC)
AND 13.8 kV SYSTEM (AUX. & STANDBY SYSTEMS)

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Function Capability	General Remarks
ESF load sequencer	Sequentially load 4.16 kV bus		Failure to operate	Sequencer trouble alarm in CR	None - Redundant safety-related trains are provided	Applicable during LOOP or LOOP and safety injection signal
13.8 kV feeder breaker to aux ESF transformer (typically)	None – As required, the 4.16 kV supply breaker provides isolation of safety systems	All	Failure to open on overload or fault current	13.8 kV supply or tie breaker will trip to protect system. Tripping 13.8 kV supply or tie breaker is indicated in CR by indicator lights and is alarmed	None - Redundant safety-related trains are provided offsite power	CR – Control Room LOOP – Loss of offsite power Not applicable during LOOP
13.8 kV feeder breaker to RCP motor (typically)	None	All	Failure to open on overload or fault current	13.8 kV supply or tie breaker will trip to protect system. Tripping 13.8 kV supply or tie breaker is indicated in CR by indicator lights and is alarmed	None - Redundant safety-related trains are provided offsite power	Not applicable during LOOP
			Failure to close (closing is manually initiated)	Immediately apparent to person attempting to close. Indicated in CR by indicating lights	None - Plant output is limited	

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*Plant Modes

1. Power Operation	4. Hot Shutdown
2. Startup	5. Cold Shutdown
3. Hot Standby	6. Refueling

TABLE 8.3-9 (Continued)

CLASS 1E AC (EXCEPT VITAL 120 VAC) AND 13.8 kV SYSTEM (AUX. & STANDBY SYSTEMS)

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Function Capability	General Remarks
13.8 kV feeder to other than RCP motor or Class1E 4.16 kV bus (typically)	None	All	Failure to open on overload or fault current	13.8 kV supply or tie breaker will trip to protect system. Tripping 13.8 kV supply or tie breaker is indicated in CR by indicating lights and is alarmed	None - Redundant safety-related trains are provided	Not applicable during LOOP
			Failure to close (automatically initiated)	System alarm in CR: pressure, temperature, flow, etc.	None	Failure to close when manually initiated is immediately apparent to person attempting to close
13.8 kV tie breaker (typically)	None	All	Failure to open on overload or fault current	13.8 kV supply breaker will trip to protect system. Tripping 13.8 kV supply breaker is indicated in CR by indicating lights and is alarmed	None - Redundant safety-related trains are provided offsite power	Not applicable during LOOP

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*Plant Modes

1. Power Operation
2. Startup
3. Hot Standby
4. Hot Shutdown
5. Cold Shutdown
6. Refueling

TABLE 8.3-9 (Continued)

CLASS 1E AC (EXCEPT VITAL 120 VAC) AND 13.8 kV SYSTEM (AUX. & STANDBY SYSTEMS)

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Function Capability	General Remarks
			Failure to close (closing is manually initiated)	Immediately apparent to person attempting to close. Indicated in CR by indicating lights	None	
13.8 kV supply breaker (typically)	None	All	Failure to open on overload or fault current	345 kV switchyard breaker will trip to protect system. Indicated in CR by indicating lights and is alarmed	None - Redundant safety-related trains are provided offsite power	If this stuck supply breaker is to the unit auxiliary transformer the tie breaker can be manually opened from CR and supply breaker to standby transformer closed (in CR) to supply standby bus or vice versa
			Failure to close (closing is manually initiated)	Immediately apparent to person attempting to close. Indicated in CR by indicating lights	None	Not applicable during LOOP

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*Plant Modes

1. Power Operation	4. Hot Shutdown
2. Startup	5. Cold Shutdown
3. Hot Standby	6. Refueling

TABLE 8.3-9 (Continued)

CLASS 1E AC (EXCEPT VITAL 120 VAC)
AND 13.8 kV SYSTEM (AUX. & STANDBY SYSTEMS)

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Function Capability	General Remarks
13.8 kV breaker at bus 1L	None		Failure to open	13.8 kV breaker at bus 1K will open to protect system. Tripping 13.8 kV breaker is indicated in CR by indicating lights	None	Applicable to emergency using the emergency transformer to power one or more of the safety buses
			Failure to close	Immediately apparent to person attempting to close	None	
13.8 kV breaker at bus 1K	None		Failure to open	13.8 kV breaker will open, indication in CR is by undervoltage alarms	None	Applicable to emergency using the emergency transformer to power one or more of the safety buses
Unit auxiliary transformer or standby transformer(s) or emergency transformer (typically)	None	All	Loss of Output	Loss of 13.8 kV bus voltage is alarmed and voltage is displayed in CR.	None	Busses can be manually transferred in CR to alternate offsite power sources

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*Plant Modes

1. Power Operation	4. Hot Shutdown
2. Startup	5. Cold Shutdown
3. Hot Standby	6. Refueling

TABLE 8.3-12

ELECTRICAL PENETRATION ASSIGNMENTS

Penetration No. [1]	Service	Separation Group [2]
01	Instr (RPS)	D
02	Future	
03	Future	
04	Future	
05	Instr	A
06	Instr	A
07	Instr (RPS)	A
08	Instr	N
09	Instr	A
10	Instr	D
11	Instr	N
12	Future	
13	Future	
14	Control	A
15	Future	
16	Control	N
17	480 V	A
18	Control	A
19	480 V	A
20	480 V	N
21	Future	
22	Future	
23	Future	
24	13.8 kV	N
25	Control	D
26	Future	
27	480 V	N
28	Instr	B
29	Control	B
30	Instr	N
31	Control	N
32	Control	B
33	Instr	B
34	Instr (RPS)	B
35	Instr	N
36	480 V	B
37	480 V	N
38	480 V	B
39	Future	
40	13.8 kV	N
41	Future	
42	13.8 kV	N

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1. See Figure 8.3-14
2. See Section 8.3.1.4.4.11

TABLE 8.3-12 (Continued)

ELECTRICAL PENETRATION ASSIGNMENTS

Penetration No. [1]	Service	Separation Group [2]
43	480 V	B
44	Future	
45	480 V	N
46	Instr (RPS)	C
47	Control	N
48	Instr	N
49	Future	
50	Instr	C
51	Instr	C
52	Control	N
53	Instr	C
54	480 V	C
55	Control	C
56	Instr	C
57	480 V	C
58	Control	C
59	Instr	N
60	480 V	N
61	480 V	N
62	Future	
63	480 V	N
64	13.8 kV	N
65	Future	
66	480 V	C
67	480 V	N
68	Future	
69	480 V	N

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1. See Figure 8.3-14
2. See Section 8.3.1.4.4.11

TABLE 8.3-13

FAILURE MODES AND EFFECTS ANALYSIS CLASS 1E VITAL 120 VAC SYSTEM

Description of Component	Plant Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
Feeder breaker	Protect 120 vac vital bus and loads	All	Failure to open on overload or fault current	The supply breaker from inverter/rectifier or regulating transformer will trip to protect system. Tripping these breakers is alarmed. The static transfer switch will autotransfer from the inverter position to the alternate power source. Undervoltage is alarmed in the control room.	None – Redundant safety-related channels are provided	CR – control room See drawing 9-E-AAAB-01
			Failure to close (closing is manual)	Immediately apparent to person attempting to close	None – Redundant safety-related channels are provided	
Supply breaker or static transfer switch from inverter/rectifier	Protect inverter/rectifier and 120 vac vital bus	All	Failure to open on overload or fault current	The supply breaker to the inverter/rectifier will trip to protect system. Tripping this breaker is alarmed in CR.	None – Redundant safety-related channels are provided	Supply to 120 vac vital bus can be manually (local only) transferred to regulating transformer source
			Failure to close (closing is manual)	Immediately apparent to person attempting to close	None – Redundant safety-related channels are provided	
			Failure of static transfer switch to autotransfer or to retransfer	The supply breaker to the static transfer switch will trip to protect system.	None – Redundant safety-related channels are provided.	

Plant Modes

1. Power Operation	4. Hot Shutdown
2. Startup	5. Cold Shutdown
3. Hot Standby	6. Refueling

TABLE 8.3-13 (Continued)

FAILURE MODES AND EFFECTS ANALYSIS
CLASS 1E VITAL 120 VAC SYSTEM

Description of Component	Safety Function	Plant Operating Mode*	Failure Mode(s)	Method of Failure Detection	Failure Effect on System Safety Function Capability	General Remarks
Supply breaker from regulating transformer	Protect regulating transformer and 120 vac bus	Panels DP1201 – DP1204: only operated to perform maintenance or to autotransfer from inverter position.	Failure to open on overload or fault current	The supply breaker to the regulatory transformer is tripped to protect system. Tripping this breaker is alarmed in CR	None – Redundant safety-related channels are provided	Supply to 120 vac vital bus can be manually (local only)/ automatically transferred back to the inverter/rectifier source
			Failure to close (closing is manual)	Immediately apparent to person attempting to close	None – Redundant safety-related channels are provided	
Inverter/rectifier	Supply 120 vac	All	Loss of output	Indicated by bus undervoltage alarm	None – Redundant safety-related channels are provided	Supply to 120 vac vital bus can be manually/ automatically transferred to regulating transformer
Regulating transformer	Supply 120 vac	Panels DP1201 – DP1204: only operated to perform maintenance or to autotransfer from inverter position.	Loss of output	Indicated by bus undervoltage alarm	None – Redundant safety-related channels are provided	Supply to 120 vac vital bus can be manually/ automatically transferred back to inverter/tectifier

Plant Modes

1. Power Operation	4. Hot Shutdown
2. Startup	5. Cold Shutdown
3. Hot Standby	6. Refueling

TABLE 8.3-14

CONTAINMENT PENETRATION CONDUCTOR OVERCURRENT PROTECTIVE DEVICES

Protective Device Number and Location	Powered Equipment
13.8 kV Switchgear	
P-7E151ESG151F, CUB 11 B-7E151ESG151F, CUB 14 B-7E151ESG151F, CUB 5	Reactor coolant pump 1R131NPP101A
P-7E151ESG151G, CUB 11 B-7E151ESG151G, CUB 14 B-7E151ESG151G, CUB 5	Reactor coolant pump 1R131NPP101B
P-7E151ESG151H, CUB 11 B-7E151ESG151H, CUB 14 B-7E151ESG151H, CUB 5	Reactor coolant pump 1R131NPP101C
P-7E151ESG151J, CUB 11 B-7E151ESG151J, CUB 14 B-7E151ESG151J, CUB 2 B-7E151ESG151J, CUB 4	Reactor coolant pump 1R131NPP101D
480 V Load Centers	
P-3E161ESGOE1A, CUB 3A B-3E161ESGOE1A, CUB 2A	Reactor containment Fan cooler supply fan 12A 2V141VFN002
P-3E161ESGOE1A, CUB 4C B-3E161ESGOE1A, CUB 2A	Residual heat Removal pump 1A 2R161NPA101A
P-3E161ESGOE1A, CUB 2D B-3E161ESGOE1A, CUB 2E	Reactor containment Fan cooler supply fan 11A 2V141VFN001
P-3E161ESGOE1B, CUB 2B B-3E161ESGOE1B, CUB 2A	Residual heat Removal pump 1B 2R161NPA101B
P-3E161ESGOE1B, CUB 3A B-3E161ESGOE1B, CUB 2A	Reactor containment Fan cooler supply fan 12B 2V141VFN004
P-3E161ESGOE1B, CUB 2E B-3E161ESGOE1B, CUB 2F	Reactor containment Fan cooler supply fan 11B 2V141VFN003

TABLE 8.3-14 (Continued)

CONTAINMENT PENETRATION CONDUCTOR OVERCURRENT PROTECTIVE DEVICES

Protective Device Number and Location	Powered Equipment
480 V Load Centers (Cont’d)	
P-3E161ESGOE1C, CUB 3A B-3E161ESGOE1C, CUB 2A	Reactor containment Fan cooler supply fan 12c 2V141VFN006
P-3E161ESGOE1C, CUB 2D B-3E161ESGOE1C, CUB 2E	Reactor containment Fan cooler supply fan 11C 2V141VFN005
P-3E161ESGOE1C, CUB 3D B-3E161ESGOE1C, CUB 2E	Residual heat Removal pump 1C 2R161NPA101C
P-8E161ESG001L, CUB 4E B-8E161ESG001L, CUB 2F B-8E161ESG001L, CUB 2C	Reactor building Polar crane 7C101NCP101A
480 V Motor Control Centers	
P-3E17EMCE1A1, CUB B1 B-3E17EMCE1A1, CUB KIR	RCDT HX and excess letdown HX isol MOV-0297 3R201TCC0297
P-3E17EMCE1A1, CUB B2 B-3E17EMCE1A1, CUB V5L	RCFC 12A CCW inlet Isol MOV-0060 3R201TCC0060
P-3E17EMCE1A1, CUB B3 B-3E17EMCE1A1, CUB N4L	RCP CCW outlet Containment isol MOV-0542 2R201TCC0542
P-3E17EMCE1A1, CUB C1 B-3E17EMCE1A1, CUB N4R	LWPS containment Isol MOV-0312 2R301TWL0312
P-3E17EMCE1A1, CUB C2 B-3E17EMCE1A1, CUB V2R	RHR-CVCS isol MOV-0066A 2R161XRH0066A
P-3E17EMCE1A1, CUB C3 B-3E17EMCE1A1, CUB V6L	LHSI pump 1A to cold Leg injection MOV-0031A 2R161XRH0031A

TABLE 8.3-14 (Continued)

CONTAINMENT PENETRATION CONDUCTOR OVERCURRENT PROTECTIVE DEVICES

Protective Device Number and Location	Powered Equipment
480 V Motor Control Centers (Cont'd)	
P-3E171EMCE1A1, CUB D1 B-3E171EMCE1A1, CUB V6R	HHSI pump 1A to hot Leg injection MOV-0008A 2N121XSI0008A
P-3E171EMCE1A1, CUB G3 B-3E171EMCE1A1, CUB V3L	CCW RHR outlet inside Containment isol MOV-0189 2R201TCC0189
P-3E171EMCE1A1, CUB G1 B-3E171EMCE1A1, CUB V2L	RHR inlet isol MOV-0060A 1R161XRH0060A
P-3E171EMCE1A1, CUB F3 B-3E171EMCE1A1, CUB L1L	RCFC 11A CCW inlet Isol MOV-0064 3R201TCC0064
P-3E171EMCE1A1, CUB F2 B-3E171EMCE1A1, CUB V1R	RHR inlet Isol MOV-0061C 1R161XRH0061C
P-3E171EMCE1A1, CUB E3 B-3E171EMCE1A1, CUB L1R	CVCS normal charging MOV-0003 2R171XCV0003
P-3E171EMCE1A1, CUB H1 B-3E171EMCE1A1, CUB V5R	RCFC 11A CCW outlet Isol MOV-0067 3R201TCC0067
P-3E171EMCE1A1, CUB H2 B-3E171EMCE1A1, CUB V3R	CCW RCFC outlet inside Containment isol MOV-0208 2R201TCC0208
P-3E171EMCE1A1, CUB H3 B-3E171EMCE1A1, CUB V4L	HHSI pump 1A to cold Leg injection MOV-0006A 2N121XSI0006A
P-3E171EMCE1A1, CUB J3 B-3E171EMCE1A1, CUB K4L	Normal containment purge Isol MOV-0009 2V141ZHC0009
P-3E171EMCE1A1, CUB S1 B-3E171EMCE1A1, CUB K4R	CVCS letdown stop valve LCV-0465 1R171XCV0465

TABLE 8.3-14 (Continued)

CONTAINMENT PENETRATION CONDUCTOR OVERCURRENT PROTECTIVE DEVICES

Protective Device Number and Location	Powered Equipment
480 V Motor Control Centers (Cont'd)	
P-3E171EMCE1A1, CUB T1 B-3E171EMCE1A1, CUB V4R	LHSI pump 1A to hot Leg injection MOV-0019A 2R161XRH0019A
P-3E171EMCE1A2, CUB J1 B-3E171EMCE1A2, CUB K1L	Pressurizer PORV Isol MOV-0001A 1R141XRC0001A
P-3E171EMCE1A2, CUB V1 B-3E171EMCE1A2, CUB K1R	Containment cubicle Exhaust fan 3V141VFN029
P-3E171EMCE1A4, CUB A2 B-3E171EMCE1A4, CUB C2L	CVCS excess letdown Isol MOV-0082 1R171TCV0082
P-3E171EMCE1A4, CUB A3 B-3E171EMCE1A4, CUB C2R	RCFC 12A CCW outlet Isol MOV-0063 3R201TCC0063
P-3E171EMCE1A4, CUB D2 B-3E171EMCE1A4, CUB E1L	Containment cubicle Exhaust fan 3V141VFN027
P-3E171EMCE1A4, CUB E3 B-3E171EMCE1A4, CUB G1	Accumulator 1A Discharge isol MOV-0039A 2N121XSI0039A
P-3E171EMCE1B1, CUB A4 B-3E171EMCE1B1, CUB W2R	LHSI Pump 1B to cold Leg injection MOV-0031B 2R161XRH0031B
P-3E171EMCE1B1, CUB B1 B-3E171EMCE1B1, CUB V1R	RHR inlet Isol MOV-0060B 1R161XRH0060B
P-3E171EMCE1B1, CUB B2 B-3E171EMCE1B1, CUB V2L	RHR inlet Isol MOV-0061A 1R161XRH0061A
P-3E171EMCE1B1, CUB C1 B-3E171EMCE1B1, CUB W1L	HHSI pump 1B to cold Leg injection MOV-0006B 2N121XSI0006B

TABLE 8.3-14 (Continued)

CONTAINMENT PENETRATION CONDUCTOR OVERCURRENT PROTECTIVE DEVICES

Protective Device Number and Location	Powered Equipment
480 V Motor Control Centers (Cont'd)	
P-3E171EMCE1B1, CUB C3 B-3E171EMCE1B1, CUB W1R	HHSI pump 1B to hot Leg injection MOV-0008B 2N121XSI0008B
P-3E171EMCE1B1, CUB D1 B-3E171EMCE1B1, CUB X2R	RHR-CVCS isol MOV-0066B 2R161XRH0066B
P-3E171EMCE1B1, CUB D3 B-3E171EMCE1B1, CUB W2L	LHSI pump 1B to hot Leg injection MOV-0019B 2R161XRH0019B
P-3E171EMCE1B1, CUB H1 B-3E171EMCE1B1, CUB W5R	CCW excess letdown Heat exchanger isol MOV-0393 3R201TCC0393
P-3E171EMCE1B1, CUB G3 B-3E171EMCE1B1, CUB W5L	CCW RCP outlet inside Containment isol MOV-0403 2R201TCC0403
P-3E171EMCE1B1, CUB N3 B-3E171EMCE1B1, CUB L1L	RCFC 11B CCW outlet Isol MOV-0146 3R2O1TCC0146
P-3E171EMCE1B1, CUB F3 B-3E171EMCE1B1, CUB W4L	Supplementary containment purge Exhaust isol MOV-0005 2V141THC0005
P-3E171EMCE1B1, CUB F2 B-3E171EMCE1B1, CUB W4R	Supplementary containment purge Supply isol MOV-0003 2V141THC0003
P-3E171EMCE1B1, CUB H2 B-3E171EMCE1B1, CUB W6L	Containment sump discharge Isol MOV-0064 2Q061TED0064
P-3E171EMCE1B1, CUB H3 B-3E171EMCE1B1, CUB W6R	CCW RHR outlet inside Containment isol MOV-0049 2R201TCC0049

TABLE 8.3-14 (Continued)

CONTAINMENT PENETRATION CONDUCTOR OVERCURRENT PROTECTIVE DEVICES

Protective Device Number and Location	Powered Equipment
480 V Motor Control Centers (Cont'd)	
P-3E171EMCE1B1, CUB J1 B-3E171EMCE1B1, CUB W3R	Normal containment purge Isol valve MOV-0008 2V141ZHC0008
P-3E171EMCE1B1, CUB J2 B-3E171EMCE1B1, CUB L1R	Pressurizer PORV Isol MOV-0001B 1R141XRC0001B
P-3E171EMCE1B1, CUB U2 B-3E171EMCE1B1, CUB V2R	RCB atmosphere radiation monitor Containment isol Exhaust MOV-0003 2V141TRA0003
P-3E171EMCE1B1, CUB U1 B-3E171EMCE1B1, CUB X2L	RCB atmosphere radiation monitor Containment isol Exhaust MOV-0001 2V141TRA0001
P-3E171EMCE1B1, CUB P3 B-3E171EMCE1B1, CUB V1L	RCFC 12B CCW inlet Isol MOV-0139 3R201TCC0139
P-3E171EMCE1B1, CUB T1 B-3E171EMCE1B1, CUB X1L	RCFC CCW outlet inside Containment isol MOV-0068 2R201TCC0068
P-3E171EMCE1B1, CUB N1 B-3E171EMCE1B1, CUB W3L	RCFC 12B CCW outlet Isol MOV-0142 3R201TCC0142
P-3E171EMCE1B1, CUB X4 B-3E171EMCE1B1, CUB X1R	RCFC 11B CCW inlet Isol MOV-0143 3R201TCC0143
P-3E171EMCE1B2, CUB J2 B-3E171EMCE1B2, CUB K4L	CVCS excess letdown Isol MOV-0083 1R171TCV0083
P-3E171EMCE1B4, CUB B1 B-3E171EMCE1B4, CUB B3L	Containment cubicles Exhaust fan 3V141VFN028
P-3E171EMCE1B4, CUB F1 B-3E171EMCE1B4, CUB J4	Accumulator 1B Discharge isol MOV-0039B 2N121XSI0039B

TABLE 8.3-14 (Continued)

CONTAINMENT PENETRATION CONDUCTOR OVERCURRENT PROTECTIVE DEVICES

Protective Device Number and Location	Powered Equipment
480 V Motor Control Centers (Cont’d)	
P-3E171EMCE1C1, CUB A2 B-3E171EMCE1C1, CUB S5L	HHSI pump 1C to hot Leg injection MOV-0008C 2N121XSI0008C
P-3E171EMCE1C1, CUB A3 B-3E171EMCE1C1, CUB S5R	LHSI pump 1C to hot Leg injection MOV-0019C 2R161XRH0019C
P-3E171EMCE1C1, CUB B3 B-3E171EMCE1C1, CUB S1L	CVCS letdown containment Isol MOV-0023 2R171XCV0023
P-3E171EMCE1C1, CUB C1 B-3E171EMCE1C1, CUB S6L	RHR CCW outlet containment Isol MOV-0129 2R201TCC0129
P-3E171EMCE1C1, CUB C2 B-3E171EMCE1C1, CUB S6R	RCFC CCW outlet inside Containment isol MOV-0147 2R201TCC0147
P-3E171EMCE1C1, CUB C3 B-3E171EMCE1C1, CUB K1L	HHSI pump 1C to cold Leg injection MOV-0006C 2N121XSI0006C
P-3E171EMCE1C1, CUB DI B-3E171EMCE1C1, CUB S4R	LHSI pump 1C to cold Leg injection MOV-0031C 2R161XRH0031C
P-3E171EMCE1C1, CUB F3 B-3E171EMCE1C1, CUB S3L	RHR inlet Isol MOV-0061B 1R1XRH0061B
P-3E171EMCE1C1, CUB F1 B-3E171EMCE1C1, CUB S2R	RHR inlet Isol MOV-0060C 1R161XRH0060C
P-3E171EMCE1C1, CUB E4 B-3E171EMCE1C1, CUB S2L	Seal water Return isol MOV-0077 2R171TCV0077
P-3E171EMCE1C1, CUB E3 B-3E171EMCE1C1, CUB S1R	CCW RCDT HX Isol MOV-0392 3R201TCC0392

TABLE 8.3-14 (Continued)

CONTAINMENT PENETRATION CONDUCTOR OVERCURRENT PROTECTIVE DEVICES

Protective Device Number and Location	Powered Equipment
480 V Motor Control Centers (Cont'd)	
P-3E171EMCE1C1, CUB R2 B-3E171EMCE1C1, CUB K1R	CVCS letdown stop valve 1CV-0468 1R171TCV0468
P-3E171EMCE1C2, CUB R2 B-3E171EMCE1C2, CUB Q4L	CVCS letdown orifice Isol MOV-0014 2R171TCV0014
P-3E171EMCE1C2, CUB N2 B-3E171EMCE1C2, CUB Q1R	RCFC 12C CCW outlet Isol MOV-0203 3R201TCC0203
P-3E171EMCE1C2, CUB M2 B-3E171EMCE1C2, CUB J3L	RCFC 11C CCW inlet Isol MOV-0204 3R201TCC0204
P-3E171EMCE1C2, CUB C2 B-3E171EMCE1C2, CUB J4L	RCFC 12C CCW inlet Isol MOV-0200 3R201TCC0200
P-3E171EMCE1C2, CUB L3 B-3E171EMCE1C2, CUB J3R	RCFC 11C CCW outlet Isol MOV-0207 3R201TCC0207
P-3E171EMCE1C12 CUB J2 B-3E171EMCE1C2, CUB J4R	CVCS alternate Charging MOV-0006 2R171XCV0006
P-3E171EMCE1C4, CUB B3 B-3E171EMCE1C4, CUB C3L	Containment cubicle Exhaust fan 3V141VFN030
P-3E171EMCE1C4, CUB D4 B-3E171EMCE1C4, CUB J4	Accumulator 1C Discharge isol MOV-0039C 2N121XSI0039C
P-8E171EMC01J1, CUB F2 B-8E171EMC01K2, CUB K3R	RCP oil lift pump 1A 9R091NPA101A
P-8E171EMC01J1, CUB F2 B-8E171EMC01K2, CUB K3R	RCP 2A oil lift Pump 9R09NPA101A
P-8E171EMC01J1, CUB E3 B-8E171EMC01J1, CUB A4R	Reactor coolant Drain tank pump 1B 7R301NPA107B

TABLE 8.3-14 (Continued)

CONTAINMENT PENETRATION CONDUCTOR OVERCURRENT PROTECTIVE DEVICES

Protective Device Number and Location	Powered Equipment
480 V Motor Control Centers (Cont'd)	
P-8E171EMC01J1, CUB C4 B-8E171EMC01J1, CUB Q4R	Containment secondary Sump pump 1A 9Q061NPA102A
P-8E171EMC01J1, CUB E1 B-8E171EMC01J1, CUB A6L	RCP 1A motor Space heater 1R131NPP101A
P-8E171EMC01J1, CUB F3 B-8E171EMC01J1, CUB A5R	RCP 1A thermal barrier CCW discharge valve 3R201TCC0339
P-8E171EMC01J1, CUB B2 B-8E171EMC01J1, CUB A4L	Containment carbon unit A Supply fan 11A 8V141VFN029
P-8E171EMC01J1, CUB H2L B-8E171EMC01J1, CUB Q2R	Lighting transformer LT11A 9E301ELT0001
P-8E171EMC01J1, CUB A2L B-8E171EMC01J1, CUB Q3L	Incore detector Drive unit A 9Z131ZCCADU
P-8E171EMC01J1, CUB A2R B-8E171EMC01J1, CUB E4R	Lighting transformer LT11C 9E301ELT0007
P-8E171EMC01J1, CUB B3L B-8E171EMC01J1, CUB Q3R	Incore detector Drive unit B 9Z131ZCCBDU
P-8E171EMC01J1, CUB P3 B-8E171EMC01J1, CUB M2	480 Vac distribution panel 9E511EDP0304
P-8E171EMC01J1, CUB A1L B-8E171EMC01J1, CUB B5L	Lighting transformer LT11F 9E301ELT0010
P-8E171EMC01J1, CUB K4L B-8E171EMC01J1, CUB B5R	Lighting transformer LT11E 9E301ELT0009
P-8E171EMC01J1, CUB K4R B-8E171EMC01J1, CUB K3R	Lighting transformer LT11H 9E301ELT0002
P-8E171EMC01J1, CUB A3L B-8E171EMC01J1, CUB Q2L	Lighting transformer LT11D 9E301ELT0008

TABLE 8.3-14 (Continued)

CONTAINMENT PENETRATION CONDUCTOR OVERCURRENT PROTECTIVE DEVICES

Protective Device Number and Location	Powered Equipment
480 V Motor Control Centers (Cont'd)	
P-8E171EMC01J2, CUB B1L B-8E171EMC01J2, CUB B1R	Welding Receptacle 9E591ERP5301
P-8E171EMC01J2, CUB K1 B-8E171EMC01J2, CUB H1	480 Vac distribution panel DP0303 9E511EDP0303
P-8E171EMC01J2, CUB E2 B-8E171EMC01J2, CUB B5R	Containment normal sump Duplex sump pump 1B 9Q061NPA101B
P-8E171EMC01K1, CUB A2L B-8E171EMC01K1, CUB E4L	Incore Instrumentation Drive unit C 9Z131ZCCCDU
P-8E171EMC01K1, CUB A2R B-8E171EMC01K1, CUB J3R	Refueling machine 8R231NCB101A
P-8E171EMC01K1, CUB A3L B-8E171EMC01K1, CUB F3R	Lighting transformer LT11N 9E301ELT0012
P-8E171EMC01K1, CUB A3R B-8E171EMC01K1, CUB D4L	Fuel Hndlg Cont Pnl REA SD 9R231ZLP111
P-8E171EMC01K1, CUB A4R B-8E171EMC01K1, CUB U3R	Lighting transformer LT11M 9E301ELT0011
P-8E171EMC01K1, CUB A5L B-8E171EMC01K1, CUB A6L	Incore instrumentation Drive unit D 9Z131ZCCDDU
P-8E171EMC01K1, CUB A5R B-8E171EMC01K1, CUB A6R	Lighting transformer LT11B 9E301ELT0006
P-8E171EMC01K1, CUB D3 B-8E171EMC01K1, CUB H3R	RCP 1D motor Space heater 1R131EHT101D

TABLE 8.3-14 (Continued)

CONTAINMENT PENETRATION CONDUCTOR OVERCURRENT PROTECTIVE DEVICES

Protective Device Number and Location	Powered Equipment
480 V Motor Control Centers (Cont'd)	
P-8E171EMC01K1, CUB D1 B-8E171EMC01K1, CUB D4R	Containment carbon unit B Supply fan 12B 8V141VFN032
P-8E171EMC01K1, CUB C4 B-8E171EMC01K1, CUB E4R	Containment carbon unit A Supply fan 12A 8V141VFN030
P-8E171EMC01K1, CUB C3 B-8E171EMC01K1, CUB B3L	Containment normal sump Duplex sump pump 1A 9Q061NPA101A
P-8E171EMC01K1, CUB C1 B-8E171EMC01K1, CUB H3L	RCP 1B motor Space heater 1R131EHT101B
P-8E171EMC01K1, CUB B1 B-8E171EMC01K1, CUB B3R	RCP 1D thermal barrier CCW discharge MOV-0356 3R201TCC0356
P-8E171EMC01K1, CUB G1 B-8E171EMC01F4, CUB G2	RCP oil lift Pump 1D 9R091NPA101D
P-8E172EMC01K1, CUB G1 B-8E172EMC01F4, CUB J4	RCP 2D oil lift Pump 9R091NPA101D
P-8E171EMC01K1, CUB G3 B-8E171EMC01K1, CUB J3L	RCP oil lift Pump 1B 9R091NPA101B
P-8E171EMC01K1, CUB K1 B-8E171EMC01K1, CUB U4L	RCP 1B thermal barrier CCW discharge MOV-0374 3R201TCC0374
P-8E171EMC01L1, CUB A1L B-8E171EMC01L1, CUB A4R	Lighting transformer LT11J 9E301ELT003
P-8E171EMC01L1, CUB A3L B-8E171EMC01L1, CUB A4L	Lighting transformer LT11A 9E301ELT005
P-8E171EMC01L1, CUB B3L B-8E171EMC01L1, CUB B4L	Incore instrumentation Drive unit F 9Z131ZCCFDU

TABLE 8.3-14 (Continued)

CONTAINMENT PENETRATION CONDUCTOR OVERCURRENT PROTECTIVE DEVICES

Protective Device Number and Location	Powered Equipment
480 V Motor Control Centers (Cont'd)	
P-8E171EMC01L1, CUB B4R B-8E171EMC01L1, CUB N3L	Reactor containment Equipment hatch control panel 6C261ZLP600
P-8E171EMC01L1, CUBC1L B-8E171EMC01L1, CUB N3R	Lighting transformer LT11P 9E301ELT0013
P-8E171EMC01L1, CUB C2L B-8E171EMC01L1, CUB N4R	Incore instrumentation Drive unit E 9Z131ZCCEDU
P-8E171EMC01L1, CUB D1 B-8E171EMC01L1, CUB K4L	RCP 1C motor space heater 1R131EHT101C
P-8E171EMC01L1, CUB E4 B-8E171EMC01L2, CUB F4L	RCP oil lift pump 1C 9R091NPA101C
P-8E172EMC01L1, CUB E4 B-8E172EMC01L2, CUB E5R	RCP 2C oil lift Pump 9R092NPA101C
P-8E171EMC01L1, CUB F3 B-8E171EMC01L1, CUB F4R	Reactor coolant drain tank pump 1A 7R301NPA107A
P-8E171EMC01L1, CUB G1 B-8E171EMC01L1, CUB N4L	RCP 1C thermal barrier CCW discharge MOV-0390 3R201TCC0390
P-8E171EMC01L1, CUB H4 B-8E171EMC01L1, CUB K4R	Containment carbon unit B Supply fan 11B 8V141VFN031
P-8E171EMC01L1, CUB K1R B-8E171EMC01L1, CUB E2R	Lighting transformer LT11V 9E301ELT0017
P-8E171EMC01L1, CUB M3L B-8E171EMC01L1, CUB M3R	Rod Cluster Control Changing Fixture 9R231NTH101
P-8E171EMC01L1, CUB M4R B-8E171EMC01L1, CUB A1R	Lighting Transformer LT11V 9E301ELT0015
P-8E171EMC01L1, CUB N1 B-8E171EMC01L1, CUB N2	Welding Receptacle 9E591ERP5300
P-8E171EMC01L1, CUB A2 B-8E171EMC01L1, CUB B1	480V Receptacle for Jib Crane 7C101ERP5504 (Unit 2 Only)

TABLE 8.3-14 (Continued)

CONTAINMENT PENETRATION CONDUCTOR OVERCURRENT PROTECTIVE DEVICES

Protective Device Number and Location	Powered Equipment
480 V Motor Control Centers (Cont'd)	
P-8E171EMC01L1, CUB J1 B-8E171EMC01L1, CUB J3	480V Receptacle for 2nd Jib Crane 7C101ERP5507
P-8E171EMC01L2, CUB D2 B-8E171EMC01L2, CUB C1L	RCB elevator #3 fan 8V141VFN035
P-8E171EMC01L2, CUB A3R B-8E171EMC01L2, CUB C1R	RCB elevator #3 8C161AEL003
P-8E171EMC01L2, CUB A1L B-8E171EMC01L2, CUB B1L	Lighting transformer LT11T 9E301ELT0016
P-8E171EMC01L2, CUB A4L B-8E171EMC01L2, CUB F3L	Lighting transformer LT11R 9E301ELT0014
P-8E171EMC01L2, CUB E4L B-8E171EMC01L2, CUB B1R	Lighting transformer LT11K 9E301ELT0004
P-8E171EMC01L2, CUB E1R B-8E171EMC01L2, CUB F3R	Stud tensioning feeder 9R101NH0101
P-8E171EMC01A5, CUB E2 B-8E171EMC01A5, CUB E2	Reactor cavity Vent fan 11B 8V141VFN024
P-8E171EMC01A5, CUB D3 B-8E171EMC01A5, CUB D3	Reactor support Exhaust fan 9V141VFN036
P-8E171EMC01A5, CUB B2 B-8E171EMC01A5, CUB B2	CRDM vent fan 8V141VFN017
P-8E171EMC01A5, CUB C2 B-8E171EMC01A5, CUB C2	RHR pump 1A Miniflow MOV-0067A 2R161XRH0067A
P-8E171EMC01B5, CUB A2 B-8E171EMC01B5, CUB A2	RHR pump 1B Miniflow MOV-0067B 2R161XRH0067B
P-8E171EMC01B5, CUB D2 B-8E171EMC01L5, CUB D2	CRDM vent fan 8V141VFN018
P-8E171EMC01B5, CUB B1 B-8E171EMC01B5, CUB B1	Reactor support Exhaust fan 9V141VFN037

TABLE 8.3-14 (Continued)

CONTAINMENT PENETRATION CONDUCTOR OVERCURRENT PROTECTIVE DEVICES

Protective Device Number and Location	Powered Equipment
480 V Motor Control Centers (Cont'd)	
P-3N151ZRR021 B-3E171EMCE1B4, CUB JI	Electric Hydrogen Recombiner 1A 2N151NR101A
P-3N151ZRR022 B-3E171EMCE1C2, CUB H3	Electric Hydrogen Recombiner B 2N151NHR101B
P-8E171EMC01C5, CUB A3 B-8E171EMC01C5, CUB A3	RHR pump 1C Miniflow MOV-0067C 2R161XRH0067C
P-8E171EMC01C5, CUB C3 B-8E171EMC01C5, CUB C3	Reactor cavity Vent fan 11A 8V141VFN023
P-8E171EMC01C5, CUB D2 B-8E171EMC01C5, CUB D2	CRDM vent fan 8V141VFN019
480 V Distribution Panel	
P-9E511EDP0271, CKT#1 B-9E511EDP0271, CKT#1	Pressurizer heater group 1A Htr #3, 4 & 37 7R111EHT101A
P-9E511EDP0271, CKT#2 B-9E511EDP0271, CKT#2	Pressurizer heater group 1A Htr #7, 8 & 42 7R111EHT101A
P-9E511EDP0271, CKT#3 B-9E511EDP0271, CKT#3	Pressurizer heater group 1A Htr #11, 12 & 46 7R111EHT101A
P-9E511EDP0271, CKT#4 B-9E511EDP0271, CKT#4	Pressurizer heater group 1A Htr #26, 27, & 64 7R111EHT101A
P-9E511EDP0271, CKT#5 B-9E511EDP0271, CKT#5	Pressurizer heater group 1A Htr #52, 93 & 94 (Unit 2 Only) 7R111EHT101A
P-9E511EDP0271, CKT#6 B-9E511EDP0271, CKT#6	Pressurizer heater group 1A Htr #60, 102, & 103 7R111EHT101A
P-9E511EDP0271, CKT#7	Pressurizer heater group 1A

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B-9E511EDP0271, CKT#7	Htr #67, 110 & 111 7R111EHT101A

TABLE 8.3-14 (Continued)

CONTAINMENT PENETRATION CONDUCTOR OVERCURRENT PROTECTIVE DEVICES

Protective Device Number and Location	Powered Equipment
480 V Distribution Panel (Cont'd)	
P-9E511EDP0271, CKT#8 B-9E511EDP0271, CKT#8	Pressurizer heater group 1A Htr #72, 116 & 117 7R111EHT101A
P-9E511EDP0275, CKT#1 B-9E511EDP0275, CKT#1	Pressurizer heater group 1E Htr #18, 19 & 55 7R111EHT101E
P-9E511EDP0275, CKT#2 B-9E511EDP0275, CKT#2	Pressurizer heater group 1E Htr #38, 77 & 78 7R111EHT101E
P-9E511EDP0275, CKT#3 B-9E511EDP0275, CKT#3	Pressurizer heater group 1E Htr #58, 100 & 101 7R111EHT101E
P-9E511EDP0275, CKT#4 B-9E511EDP0275, CKT#4	Pressurizer heater group 1E Htr #63, 106 & 107 7R111EHT101E
P-9E511EDP0275, CKT#5 B-9E511EDP0275, CKT#5	Pressurizer heater group 1E Htr #68, 112 & 113 7R111EHT101E
P-9E511EDP0275, CKT#6 B-9E511EDP0275, CKT#6	Pressurizer heater group 1E Htr #43, 83 (Unit 2 only) & 84 7R111EHT101E
P-9E511EDP0275, CKT#7 B-9E511EDP0275, CKT#7	Pressurizer heater group 1E Htr #48 (Unit 2 only), 89 & 90 7R111EHT101E
P-9E511EDP0273, CKT#1 B-9E511EDP0273, CKT#1	Pressurizer heater group 1C Htr #5, 6 & 40 7R111EHT101C
P-9E511EDP0273, CKT#2 B-9E511EDP0273, CKT#2	Pressurizer heater group 1C Htr #13(Unit 2 only) ,#48(Unit 1 only) 14 & 49 7R111EHT101C

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P-9E511EDP0273, CKT#3 B-9E511EDP0273, CKT#3	Pressurizer heater group 1C Htr #17, 53 & 95 7R111EHT101C

TABLE 8.3-14 (Continued)

CONTAINMENT PENETRATION CONDUCTOR OVERCURRENT PROTECTIVE DEVICES

Protective Device Number and Location	Powered Equipment
480 V Distribution Panel (Cont'd)	
P-9E511EDP0273, CKT#4 B-9E511EDP0273, CKT#4	Pressurizer heater group 1C Htr #20, 21 & 57 7R111EHT101C
P-9E511EDP0273, CKT#5 B-9E511EDP0273, CKT#5	Pressurizer heater group 1C Htr #36, 75 & 76 7R111EHT101C
P-9E511EDP0273, CKT#6 B-9E511EDP0273, CKT#6	Pressurizer heater group 1C Htr #45, 85 & 86 7R111EHT101C
P-9E511EDP0273, CKT#7 B-9E511EDP0273, CKT#7	Pressurizer heater group 1C Htr #61, 104 & 105 7R111EHT101C
P-9E511EDP0273, CKT#8 B-9E511EDP0273, CKT#8	Pressurizer heater group 1C Htr #70, 114 & 115 7R111EHT101C
P-9E511EDP0273, CKT#9 B-9E511EDP0273, CKT#9	Pressurizer heater group 1C Htr #28, 29 & 66 7R111EHT101C
P-9E511EDP0272, CKT#1 B-9E511EDP0272, CKT#1	Pressurizer heater group 1B Htr #1, 2 & 35 7R111EHT101B
P-9E511EDP0272, CKT#2 B-9E511EDP0272, CKT#2	Pressurizer heater group 1B Htr #9, 10 & 44 7R111EHT101B
P-9E511EDP0272, CKT#3 B-9E511EDP0272, CKT#3	Pressurizer heater group 1B Htr #24, 25 & 62 7R111EHT101B
P-9E511EDP0272, CKT#4 B-9E511EDP0272, CKT#4	Pressurizer heater group 1B Htr #32, 33 & 71 7R111EHT101B

P-9E511EDP0272, CKT#5 B-9E511EDP0272, CKT#5	Pressurizer heater group 1B Htr #41, 81 & 82 7R111EHT101B
P-9E511EDP0272, CKT#6 B-9E511EDP0272, CKT#6	Pressurizer heater group 1B Htr #50, 91 & 92 7R111EHT101B

TABLE 8.3-14 (Continued)

CONTAINMENT PENETRATION CONDUCTOR OVERCURRENT PROTECTIVE DEVICES

Protective Device Number and Location	Powered Equipment
480 V Distribution Panel (Cont’d)	
P-9E511EDP0272, CKT#7 B-9E511EDP0272, CKT#7	Pressurizer heater group 1B Htr #56, 98 & 99 7R111EHT101B
P-9E511EDP0272, CKT#8 B-9E511EDP0272, CKT#8	Pressurizer heater group 1B Htr #65, 108 & 109 7R111EHT101B
P-9E511EDP0274, CKT#1 B-9E511EDP0274, CKT#1	Pressurizer heater group 1D Htr #15 (Unit 2 only), 16 & 51 7R111EHT101D
P-9E511EDP0274, CKT#2 B-9E511EDP0274, CKT#2	Pressurizer heater group 1D Htr #22, 23 & 59 7R111EHT101D
P-9E511EDP0274, CKT#3 B-9E511EDP0274, CKT#3	Pressurizer heater group 1D Htr #30, 31 & 69 7R111EHT101D
P-9E511EDP0274, CKT#4 B-9E511EDP0274, CKT#4	Pressurizer heater group 1D Htr #34, 73 & 74 7R111EHT101D
P-9E511EDP0274, CKT#5 B-9E511EDP0274, CKT#5	Pressurizer heater group 1D Htr #39 (Unit 2 only), 79 & 80 7R111EHT101D
P-9E511EDP0274, CKT#6 B-9E511EDP0274, CKT#6	Pressurizer heater group 1D Htr #47, 87 & 88 7R111EHT101D
P-9E511EDP0274, CKT#7 B-9E511EDP0274, CKT#7	Pressurizer heater group 1D Htr #54, 96 & 97 7R111EHT101D
Low Voltage Power and Control	
P-3E171EDPA435, CKT 27 B-3E161ESGOE1A, CUB 2D	RCFC supply fan 11A Motor space heater 2V141VFN001

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TABLE 8.3-14 (Continued)

CONTAINMENT PENETRATION CONDUCTOR OVERCURRENT PROTECTIVE DEVICES

Protective Device Number and Location	Powered Equipment
Low Voltage Power and Control (Cont'd)	
P-3E171EDPA435, CKT 28 B-3E161ESGOE1A, CUB 3A	RCFC supply fan 12A Motor space heater 2V141VFN002
P-3E171EDPA435, CKT 29 B-3E161ESGOE1A, CUB 4C	RHR pump 1A Motor space heater 2R161NPA101A
P-3E171EDPB435, CKT 27 B-3E161ESGOE1B, CUB 2E	RCFC supply fan 11B Motor space heater 2V141VFN003
P-3E171EDPB435, CKT 28 B-3E161ESGOE1B, CUB 3A	RCFC supply fan 12B Motor space heater 2V141VFN004
P-3E171EDPB435, CKT 29 B-3E161ESGOE1B, CUB 2B	RHR pump 1B Motor space heater 2R161NPA101B
P-3E171EDPC435, CKT 27 B-3E161ESGOE1C, CUB 2D	RCFC supply fan 11C Motor space heater 2V141VFN005
P-3E171EDPC435, CKT 28 B-3E161ESGOE1C, CUB 3A	RCFC supply fan 12C Motor space heater 2V141VFN006
P-3E171EDPC435, CKT 29 B-3E161ESGOE1C, CUB 3D	RHR pump 1C Motor space heater 2R161NPA101C
P-8E171EMC01A5, CUB B2 B-8E171EDPJ134, CKT 29	CRDM vent fan FN017 Motor space heater 8V141VFN017
P-8E171EMC01B5, CUB D2 B-8E171EDPK134, CKT 29	CRDM vent fan FN018 Motor space heater 8V141VFN018
P-9E511EDP0209, CKT 29 B-8E171EMCO1C5, CUB D2	CRDM vent fan FN019 Motor space heater 8V141VFN019

TABLE 8.3-14 (Continued)

CONTAINMENT PENETRATION CONDUCTOR OVERCURRENT PROTECTIVE DEVICES

Protective Device Number and Location	Powered Equipment
Low Voltage Power and Control (Cont'd)	
P-9E511EDP0209, CKT 7 B-9E511EPP0701, FU-1	Fuel pool & fuel storage panel 7R211ZLP187
P-9E511EDP0209, CKT 10 B-9E511EPP0701, FU-2	In containment storage pool Temperature gauge N1FC-TIS-1421
P-9E511EDP0209, CKT 35 B-9E511EPP0701, FU-5	FHB fuel transfer panel (RCB) 9R231ZLP111
P-N1RATB8101, CB-1 B-8E171EDPK234, CKT 13	Radiation Monitor N1RARI8055 N1RARI8056 N1RARI8099
P-9E511EDP0209, CKT 12 B-8E171EMC01C5, CUB C3	Reactor cavity vent fan FN023 Motor space heater 8V141VFN023
P-9E511EPP0701, FU-4 B-9E511EDP0209, CKT 24	Instrument Enclosure N1HCZLC1003
P-9E511EPP0701, FU-6 B-9E511EDP0209, CKT 26	Instrument Enclosure N1HCZLC1004
P-6C261ZLP606 B-9E511EDP0209, CKT 9	Auxiliary Air Lock 2C261SPM091A
P-9E511EDP0209, CKT 25 B-9E511EPP0701, FU-3	Excess Letdown Valve N1CVHCV0227
P-8E171EMCO1K2, CUB A3R B-8E171EDPK234, CKT 29	Excess Letdown Valve Space heater N1CVHCV0227
125 vdc Switchboard	
P-3E231EPL037A, BKR 15 B-3E231EPL037A, BKR 16	Reactor Coolant Pressurizer Power Relief Valve A1RCPCV0655A
P-3E231EPL037C, BKR 15 B-3E231EPL037C, BKR 16	Reactor Coolant Pressurizer Power Relief Valve B1RCPCV0656A

TABLE 8.3-14 (Continued)

CONTAINMENT PENETRATION CONDUCTOR OVERCURRENT PROTECTIVE DEVICES

Protective Device Number and Location	Powered Equipment
480 V Distribution Panel	
P-N1XCPALJBE B-9E511EDP0279, CKT 8	Personnel Air Lock 2C261SPM090A
Low Voltage Power and Control	
P-8E241EDP003, CKT 11 B-N1VCLD004, CKT5	DRPI Data Cabinet A 9Z171ZLPP607
P-8E241EDP003, CKT 12 B-N1VCLD004, CKT 7	DRPI Data Cabinet B 9Z171ZLP608
P-8E241EDP004, CKT 2 B-N1VCLD004B, CKT 2a	Multiple Rod Drop I/O Chassis In DRPI Data Cabinet A-9Z171ZLP607 In DRPI Data Cabinet B-9Z171ZLP608
P-9Z131ZCP012 B-9Z131ZCP012, A5-CB2	Flux Mapping System Drive Control Assy. N1IIZCCADU N1IIZCCBDU N1IIZCCCDU N1IIZCCDDU N1IIZCCEDU N1IIZCCFDU
P-9Z131ZCP012 B-8E241EDP003, CKT 31	Flux Mapping System CO2 Leak Detection and Drain Solenoid N1IIFV1000 N1IIFV1002 N1IILSH1001
P-8E171EMCO1A5, CUB E2 B-8E171EDPJ234, CKT 8	Reactor Cavity Vent Fan FN024 Motor Space Heater 8V141VFN024

TABLE 8.3-14 (Continued)

CONTAINMENT PENETRATION CONDUCTOR OVERCURRENT PROTECTIVE DEVICES

Protective Device Number and Location	Powered Equipment
Low Voltage Power and Control (Cont'd)	
P-N1RATB8100, CB-1 B-8E171EDPK234, CKT14	Radiation Monitor N1RARI8052 N1RARI8053 N1RARI8054
Auxiliary Relay Panel	
P-9E251ERR113, DS-13 B-9E251ERR113, CB-2	SG 1D blowdown Flow control valve N1SBFY4178A
P-9E251ERR113, DS-14 B-9E251ERR113, CB-2	SG 1C blowdown Flow control valve N1SBFY4179A
P-9E251ERR113, DS-1 B-9E251ERR113, CB-2	RCDT drain valve N1WLFY4903
P-9E251ERR113, DS-2 B-9E251ERR113, CB-2	RCDT recirculation valve N1WLLY4910
P-9E251ERR113, DS-8 B-9E251ERR113, CB-2	RCDT level control valve N1WLFY4911
P-9E251ERR113, DS-3 B-9E251ERR113, CB-2	RCDT pressure relief valve N1WLLY4907
P-9E251ERR114, DS-6 B-9E251ERR114, CB-2	Containment carbon unit Fan damper N1HCFY9738
P-9E251ERR114, DS-7 B-9E251ERR114, CB-2	Containment carbon unit Fan damper N1HCFY9759
P-9E251ERR114, DS-8 B-9E251ERR114, CB-2	Containment carbon unit Fan damper N1HCFY9760
P-9E251ERR114, DS-5 B-9E251ERR114, CB-2	Containment carbon unit Fan damper N1HCFY9737

TABLE 8.3-14 (Continued)

CONTAINMENT PENETRATION CONDUCTOR OVERCURRENT PROTECTIVE DEVICES

Protective Device Number and Location	Powered Equipment
Auxiliary Relay Panel (Cont'd)	
P-9E251ERR114, DS-9 B-9E251ERR114, CB-2	Containment carbon unit Fan damper N1HCFY9761
P-9E251ERR114, DS-10 B-9E251ERR114, CB-2	Containment carbon unit Fan damper N1HCFY9762
P-9E251ERR114, DS-1 B-9E251ERR114, CB-2	Pressurizer spray valve N1RCPCV0655B
P-9E251ERR114, DS-2 B-9E251ERR114, CB-2	Pressurizer spray valve N1RCPCV0655C
P-9E251ERR115, DS-6 B-9E251ERR115, CB-2	SG 1B blowdown Flow control valve N1SBFY4180A
P-9E251ERR115, DS-7 B-9E251ERR115, CB-2	SG 1A blowdown Flow control valve N1SBFY4181A