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8.0 ELECTRIC POWER

USAR Chapter 8 was originally prepared reflecting a dual-unit design. Construction of Unit 2 was not completed and the unit was abandoned (see PY-CEI/NRR-1899L). References to Unit 2 in this chapter pertain to aspects of the Unit 2 design that have been retained to support Unit 1 operation.

8.1 INTRODUCTION

The FirstEnergy service area in northern Ohio and western Pennsylvania (formerly the Cleveland Electric Illuminating Company, Ohio Edison Company, Toledo Edison Company, and Pennsylvania Power Company service area) encompasses approximately 13,200 square miles. Presently, FirstEnergy has two transmission voltages: 138 kV and 345 kV. The transmission system is shown in <Figure 8.1-1>.

The Perry Nuclear Power Plant consists of one 1,277 MWe (net) operating unit which generates power at 22 kV. The power from the unit is fed via an isolated phase bus to the unit's main transformer, stepped up to 345 kV and delivered to the adjacent 345 kV switchyard. The physical arrangement is further explained in <Section 8.2.1.2>.

The 345 kV switchyard includes four transmission circuit terminals. The switchyard is arranged in a minimum breaker-and-a-half configuration and serves as the interface between the preferred source (two startup transformers) and the offsite transmission network. The transmission system, switchyard and plant interfaces are further discussed in <Section 8.2.1>.

The loads connected to the Class 1E buses are normally supplied from the preferred offsite power system. On complete loss of offsite power or system voltage degradation, the Class 1E bus safety system loads are automatically transferred to the onsite diesel generators.

The power required for non-Class 1E station auxiliaries, during normal operation, is supplied from the generator through the unit auxiliary transformer. Upon loss of the normal source, these loads are automatically transferred to the unit's startup transformer.

8.1.1 SAFETY LOADS

The engineered safety feature power systems were originally designed to consist of three independent load groups per unit at a two-unit site. They are designated as Division 1, Division 2, and Division 3. Division 2 and 3 switchgear have been removed from Unit 2 due to abandonment of the unit. Remaining Unit 2 Division 1 switchgear is shown on <Figure 8.3-1>. Each group consists of 4,160 volt, 480 volt, 120 volt ac, and 125 volt dc systems. The redundant safety systems in Division 1, Division 2, and Division 3, required for safety functions, are listed in <Table 8.1-1> as an introduction, and detailed as part of <Table 8.3-1> for the ac loads and <Table 8.3-7> for dc loads.

DC systems supply power for circuit breaker control, selected critical loads and for vital instrumentation and control. Upon loss of offsite power, batteries supply stored energy to the dc systems until offsite power is restored, or until onsite standby generation is available. Critical 120 volt ac instrumentation and control is powered from the dc system through inverters to provide a reliable and transient free power supply.

Electric power systems and components essential for the plant's safety are designated Class 1E and designed in accordance with IEEE Standard 308 (Reference 1). The integrity is not impaired, either by the disturbances on the external electrical power system, or by the applicable design bases events defined in <10 CFR 50, Appendix A>, General Design Criteria 2, 3 and 4. A discussion of compliance to related general design criteria can be found in <Section 3.1>. <Table 8.1-2> contains the publications which serve as design bases for a Class 1E power system and its components.

8.1.2 REFERENCES FOR SECTION 8.1

1. Institute of Electrical and Electronic Engineers, "Criteria for Class 1E Electric Systems for Nuclear Power Generating Stations," IEEE Std. 308.

TABLE 8.1-1

VARIOUS REDUNDANT SAFETY SYSTEMS

Safety Function	Division 1	Division 2	Division 3
Core Cooling	RHR System "A" Low Pressure Core Spray Automatic Depressurization System "A"	RHR Systems "B" & "C" Automatic Depress. System "B"	High Pressure Core Spray
Containment Isolation	Outboard Valves Main Steam Shutoff Valves "A"	Inboard Valves Main Steam Shutoff Valves "B"	
Safe Shutdown	Standby Liquid Control "A" RCIC	Standby Liquid Control "B"	
Auxiliary Cooling Systems	Emergency Closed Cooling "A" Emergency Service Water "A" Control Complex Chiller "A"	Emergency Closed Cooling "B" Emergency Service Water "B" Control Complex Chiller "B"	Emergency Service Water "C"
Standby Power	D/G "A" Fuel Oil Transfer and Keep Warm Systems	D/G "B" Fuel Oil Transfer and Keep Warm Systems	HPCS D/G Fuel Oil Transfer
Safety-Related HVAC Systems	Annulus Exhaust "A" MCC, Switchgear Area "A" Battery Room "A" Control Room "A" ESW Pumphouse "A" Offgas Bldg. "A" RHR A Room RCIC, LPCS Rooms Fuel Handling Bldg. "A" Diesel Generator A Room	Annulus Exhaust "B" MCC, Switchgear, Area "B" Battery Room "B" Control Room "B" ESW Pumphouse "B" Offgas Bldg. "B" RHR B & C Rooms Fuel Handling Bldg. "B" Diesel Generator B Room	HPCS Room "C" HPCS D/G Room
Fuel Pool Cooling	Fuel Pool Cooling "A"	Fuel Pool Cooling "B"	
Combustible Gas Control	Combustible Gas Mix. System "A"	Combustible Gas Mix. System "B"	

TABLE 8.1-2

DESIGN BASES FOR CLASS 1E POWER SYSTEM

Publication	Discussion
<10 CFR 50, Appendix A> General Design Criteria 17	Offsite and onsite electric power systems are provided to ensure integrity of electric power service to Class 1E systems while withstanding a single failure.
<10 CFR 50, Appendix A> General Design Criteria 18	Electric power system components and systems are designed to permit periodic functional testing to ensure integrity of systems and operability of components.
IEEE Std. 279-1971	Protection systems are designed in accordance with IEEE Std. 279-1971.
IEEE Std. 308-1974	The design of the Class 1E Power System is in accordance with IEEE Std. 308-1974, as modified by <Regulatory Guide 1.32>.
IEEE Std. 317-1976	Electrical penetration assemblies are designed and applied in accordance with IEEE Std. 317-1976, as modified by <Regulatory Guide 1.63>.
IEEE Std. 323-1974	All Class 1E equipment is qualified in accordance with IEEE Std. 323-1974 with the exception of NSSS mild which was originally qualified to IEEE 323-1971. <Section 3.11> presents the details of the qualification program and compliance to IEEE Std. 323-1974 (as modified by <Regulatory Guide 1.89>) for certain components and equipment.
IEEE Std. 334-1971	Inside containment Class 1E motors are type tested in accordance with IEEE Std. 334-1971, as modified by <Regulatory Guide 1.40>. All Class 1E motors are qualified in accordance with IEEE Std. 323-1971.
IEEE Std. 336-1971	Methods for installation, inspection and testing of instrumentation and electric equipment are in accordance with IEEE Std. 336-1971.

TABLE 8.1-2 (Continued)

Publication	Discussion
IEEE Std. 338-1977	Periodic testing of electric power and protection systems is in accordance with IEEE Std. 338-1977, as modified by <Regulatory Guide 1.118> and described in the Technical Specifications, and as modified by Power Systems Branch Technical Position PSB-1 for the degraded voltage protection scheme.
IEEE Std. 344-1975	The seismic and dynamic qualification program for electrical equipment was designed to conform to the requirements of IEEE Standard 344-1975. BOP equipment meets IEEE 344-1975 as modified by <Regulatory Guide 1.100>. NSSS equipment in a harsh environment is qualified to IEEE Standard 344-1975, while that equipment in a mild environment is qualified to IEEE Standard 344-1971 and has been evaluated to the requirements of 344-1975.
IEEE Std. 379-1977	Single failure criteria is applied to Class 1E systems in accordance with IEEE Std. 379-1977.
IEEE Std. 382-1972	Qualification of electric valve operators is in accordance with IEEE Std. 382-1972, as modified by <Regulatory Guide 1.73>.
IEEE Std. 383-1974	Cables, field splices and connections are type tested in accordance with IEEE Std. 383-1974.
IEEE Std. 384-1974	Separation criteria for Class 1E equipment and circuits is in accordance with IEEE Std. 384-1974, as modified by the discussion under <Regulatory Guide 1.75>.
IEEE Std. 387-1977	Application of standby diesel generators to the Class 1E power system is in accordance with IEEE Std. 387-1977. Type testing modifications for the HPCS diesel generator units are described in GE Topical Report NEDO-10905-2 (High Pressure Core Spray Power Supply Unit, August 1979).

TABLE 8.1-2 (Continued)

Publication	Discussion
IEEE Std. 415-1976	Preoperational test programs for the Class 1E power system are in accordance with the guidelines in IEEE Std. 415-1976 as described in <Chapter 14>.

TABLE 8.1-2 (Continued)

Publication	Discussion
IEEE Std. 450-2002	Maintenance, testing and replacement of Class 1E lead storage batteries are in accordance with or meet the intent of IEEE Std. 450-2002. The performance of discharge test of battery capacity for a battery that shows signs of degradation or has reached 85% of the expected life with a capacity less than 100% of manufacturer's rating is performed every 12 months and performance of discharge test of battery capacity for a battery that has reached 85% of the expected life with a capacity of greater than or equal to 100% of manufacturer's rating is performed every 24 months. The testing frequencies are reflected in the plant Technical Specifications.
IEEE Std. 484-1975	Class 1E batteries are designed and installed in accordance with IEEE Std. 484-1975.
<Regulatory Guide 1.6>	The independence among standby power sources and among their distribution systems is in accordance with <Regulatory Guide 1.6>. HPCS system conformance to <Regulatory Guide 1.6> is discussed in <Section 8.3.1.2.3.4>.
<Regulatory Guide 1.9>	The standby diesel generators are selected in accordance with <Regulatory Guide 1.9>. The detailed design and testing criteria for the HPCS diesel generators is described in GE Topical Reports NEDO-10905 and NEDO-10905-2, and <Section 8.3.1.2.3.5>.
<Regulatory Guide 1.22>	The protective systems and components important to safety are designed to allow periodic testing in accordance with <Regulatory Guide 1.22>.
<Regulatory Guide 1.29>	The seismic design classification of electric equipment and components important to safety is in accordance with <Regulatory Guide 1.29>, as detailed in <Table 1.8-1>.

TABLE 8.1-2 (Continued)

Publication	Discussion
<Regulatory Guide 1.30>	Instrumentation and electric equipment are installed, inspected and tested in accordance with <Regulatory Guide 1.30>.

TABLE 8.1-2 (Continued)

Publication	Discussion
<Regulatory Guide 1.32>	The design of the Class 1E power system is in accordance with IEEE Std. 308-1974, as modified by <Regulatory Guide 1.32> with the exception that the battery performance test may be performed in lieu of the battery service test at the once per 60-month interval.
<Regulatory Guide 1.40>	Inside containment Class 1E motors are type tested in accordance with IEEE Std. 334-1971, as modified by <Regulatory Guide 1.40>.
<Regulatory Guide 1.41>	Preoperational testing of the Class 1E power system is in accordance with <Regulatory Guide 1.41>.
<Regulatory Guide 1.47>	Bypass and inoperable status indication is provided in the plant control room in accordance with <Regulatory Guide 1.47>.
<Regulatory Guide 1.53>	Single failure criteria is applied to protection systems in accordance with <Regulatory Guide 1.53>.
<Regulatory Guide 1.63>	Electrical penetration assemblies are designed and applied in accordance with IEEE Standard 317-1976 as modified by <Regulatory Guide 1.63>. Three applications exist with two protective devices in series. a. The first type is the 13,800 volt reactor recirculation pump motor circuits, which are actually provided with three breakers in series. These include the bus feeder breaker and two ATWS circuit breakers, one of which is sized for interrupting duty. b. The second type are circuits from the motor control centers to containment loads which were provided with two fuses in series both sized to protect the penetration. The fuse banks for nonsafety loads of this type were located in a safety class structure.

TABLE 8.1-2 (Continued)

Publication	Discussion
	c. Finally, other 120V circuits requiring dual protection have been provided with a fuse and a circuit breaker or two fuses in series both sized to protect the penetration.
<Regulatory Guide 1.68>	Preoperational and initial startup test programs are in accordance with <Regulatory Guide 1.68>, as discussed in <Chapter 14>.
<Regulatory Guide 1.73>	Qualification of electric valve operators is in accordance with IEEE Std. 382-1972, as modified by <Regulatory Guide 1.73>.
<Regulatory Guide 1.75>	Separation criteria for Class 1E equipment and circuits is in accordance with IEEE Std. 384-1974, as modified by <Regulatory Guide 1.75>, with the following design alternatives:
	a. Interrupting devices actuated only by fault current are not considered to be isolation devices unless i. Prior to March 1, 2016, acceptable coordination could be verified by test. ii. Beginning March 1, 2016, the device must comply with requirements of IEEE Std. 384-1992 and <Regulatory Guide 1.75 Rev. 3>.
	b. Associated circuits installed in accordance with Section 4.5(1) of IEEE Std. 384-1974 will be subject to the requirements of Class 1E circuits for cable derating, environmental qualification, flame retardance, splicing restrictions, and raceway fill, unless it is demonstrated that the Class 1E circuits are not degraded below an acceptable level by the absence of such requirements.

TABLE 8.1-2 (Continued)

Publication	Discussion
	c. Non-Class 1E instrumentation circuits may not be separated from associated circuits, provided they are not routed in the same raceway as power and control cables, or are not routed with associated cables of the redundant division.

TABLE 8.1-2 (Continued)

Publication	Discussion
	d. A confined space, such as a cable tunnel, that is effectively unventilated may be used when justified as adequate separation of redundant circuits.
	e. The method of identification, as discussed in IEEE Std. 384-1974, Section 5.1.2, will be simple and preclude the need to frequently consult reference material to distinguish between Class 1E and non-Class 1E circuits, between non-Class 1E circuits associated with different redundant Class 1E systems, and between redundant Class 1E systems.
	f. Position C.11 is implemented as follows: "...and should preclude the need to frequently consult reference..."
	g. If the FW MOVs (1B21-F065A/B) are closed using the alternate power supply from Division 3, electrical separation between Division 3 cables and Division 1 DC control cables may not be maintained.
<Regulatory Guide 1.81>	The recommendations in <Regulatory Guide 1.81> are followed for the Class 1E power systems. Each unit has separate, independent electric systems capable of supplying ESF and safe shutdown loads, assuming a single failure and loss of offsite power.

TABLE 8.1-2 (Continued)

Publication	Discussion
<Regulatory Guide 1.89>	Class 1E equipment is qualified in accordance with IEEE Standard 323-1974, as endorsed by <Regulatory Guide 1.89> with the following specific exceptions: a. NSSS Class 1E equipment located in mild environmental zones was procured and qualified to IEEE Standard 323-1971. b. Regulatory Position C2. The basis for radiological source terms used is discussed in <Section 3.11.5.2.2>. c. Additional specific guidance for type testing of cables, field splices and terminations is provided by IEEE Standard 383-1974, <Table 8.1-2>. d. Specific criteria for assessing the acceptability of the environmental qualification program for safety-related electrical equipment in a harsh environment is provided by <NUREG-0588> Category 1.

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e. The acceptance criteria for the environmental qualification of safety-related equipment located in a mild environment is the following:

1. The documentation required to demonstrate qualification of safety-related equipment in a mild environment is the "Design/Purchase" specifications. The specifications contain a description of the functional requirements for its specific environmental zone during normal and abnormal environmental conditions. A well supported maintenance/surveillance program in conjunction with a good preventive maintenance program will ensure that equipment that meets the specifications is qualified for the designed life.

2. The maintenance/surveillance program data and records will be reviewed periodically (not more than 24 months) to ensure that the design qualified life has not suffered thermal and cyclic degradation resulting from the accumulated stresses triggered by the abnormal environmental conditions and the normal wear due to its service condition. Engineering judgment shall be used to modify the replacement program and/or replace the equipment deemed necessary.

TABLE 8.1-2 (Continued)

Publication	Discussion
<Regulatory Guide 1.93>	The requirements of <Regulatory Guide 1.93> for Limiting Conditions for Operation are addressed in the technical specifications.
<Regulatory Guide 1.100>	All Class 1E electric equipment is seismically qualified in accordance with IEEE Std. 344-1971. <Section 3.10> presents the details of the seismic qualification program and describes further compliance to IEEE Std. 344-1975 (as modified by <Regulatory Guide 1.100>) for certain components and equipment.
<Regulatory Guide 1.106>	The Class 1E power system does not include thermal overload relays to protect motor-operated valves; therefore, this Regulatory Guide is not applicable to the design.
<Regulatory Guide 1.108>	The guidelines presented in <Regulatory Guide 1.108> are used in establishing preoperational and periodic test procedures for the standby and HPCS diesel generators. One exception is that “first out” annunciation is not used. The basis for this is individual protective trip alarms, which give the operator adequate information for correct action. Additionally, periodic testing is performed as described in the NRC-approved Technical Specifications, which meet the overall intent of Regulatory Position C.2, “Testing.”

TABLE 8.1-2 (Continued)

Publication	Discussion
<Regulatory Guide 1.118>	Periodic testing of electric power and protection systems is in accordance with IEEE Std. 338-1977, as modified by <Regulatory Guide 1.118>, and as modified by the Power Systems Branch Technical Position PSB-1 for the degraded voltage protection scheme.
<Regulatory Guide 1.120>	Refer to <Section 9.5.1> for details.
<Regulatory Guide 1.128>	Class 1E batteries are designed and installed in accordance with IEEE Std. 484-1975, as modified by <Regulatory Guide 1.128>, except that a hydrogen survey will not be performed. Calculations indicate that the maximum hydrogen concentration in the battery area will be less than 0.003%.
<Regulatory Guide 1.129>	Class 1E batteries are maintained and tested in accordance with IEEE 450-2002 endorsed by <Regulatory Guide 1.129>. The 60-month battery performance discharge test may be performed in lieu of the battery service test when they are scheduled coincidentally, as reflected in the plant Technical Specifications. The performance of discharge test of battery capacity for a battery that shows signs of degradation or has reached 85% of the expected life with a capacity less than 100% of manufacturer’s rating is performed every 12 months and performance of discharge test of battery capacity for a battery that has reached 85% of the expected life with a capacity of greater than or equal to 100% of manufacturer’s rating is performed every 24 months. The testing frequencies are reflected in the plant Technical Specifications.
Branch Technical Position ICSB 2	Standby diesel generators are type qualified in accordance with ICSB 2. The HPCS diesel generator is type qualified as described in <Section 8.3>.

TABLE 8.1-2 (Continued)

Publication	Discussion
Branch Technical Position ICSB 8	As required by ICSB 8, onsite diesel generators will not be used for peaking service.

TABLE 8.1-2 (Continued)

Publication	Discussion
Branch Technical Position ICSB 11	Stability studies for the offsite power system, outlined in ICSB 11, have been performed and are further discussed in <Section 8.2.2.2>.
Branch Technical Position ICSB 17	Standby diesel generator trip circuits comply with ICSB 17, in that, only engine overspeed and generator differential relaying trips are retained during accident conditions. Note: This is also true for bus under/degraded voltage conditions.
Branch Technical Position ICSB 18	Single failure criteria is applied to the design at the safety system level; therefore, the provisions described in this position are not applicable.
Branch Technical Position ICSB 21	The bypass and inoperable status indication system in the control room is in accordance with ICSB 21.

8.2 OFFSITE POWER SYSTEM

8.2.1 DESCRIPTION

8.2.1.1 Transmission System

The Perry Nuclear Power Plant is integrated into the FirstEnergy transmission network through the transmission switchyard at the Perry site. The FirstEnergy system supplies the offsite ac power for the starting, normal operation and safe shutdown of the Perry Plant. Offsite power is available to the plant onsite electrical system from the 345 kV switchyard, as further discussed in <Section 8.2.1.2>.

Offsite power is available to the 345 kV switchyard from four 345 kV transmission circuits, with symbols, approximate lengths and destinations as follows:

a. S-5-PY-GLW: (Existing) — 40.04 miles to the Glenwillow 345 kV Substation

b. S-6-PY-LC: (Existing) — 12.5 miles to the Leroy Center 345 kV Substation

c. S-8-PY-EL: (Existing) — 20.6 miles to the Eastlake Plant

d. S-29-PY-AT-ERW: (Existing) — 44.1 miles via the Ashtabula Plant to the Erie West Substation

Specific design features of the transmission system are as follows:

a. The 345 kV transmission lines, their associated structures and interconnections between the switchyard and the system, are designed to withstand the loading conditions for climatic

conditions prevalent in the area in regard to wind, temperature, lightning, flood, and ice loading.

b. The 345 kV transmission circuits to Eastlake, Ashtabula and Glenwillow/Leroy Center occupy separate right-of-way corridors, except within the vicinity of the plant. The circuits to Glenwillow/Leroy Center occupy a corridor with existing transmission lines for approximately 35 miles of the length.

c. The 345 kV system is protected from lightning by lightning protection equipment and overhead shield wires.

The transmission line layout in the plant vicinity is shown in <Figure 8.2-1>. The interconnection of the plant with neighboring transmission systems is shown on <Figure 8.1-1>.

The design and construction of the transmission lines is consistent with the established practices of the FirstEnergy Corporation. Experience has shown that these practices result in minimum line outages, as described in <Section 8.2.2.1>.

8.2.1.2 Preferred Power System

The preferred power system consists of at least two independent 345 kV circuits from the transmission network to the standby power distribution system. This section describes the various components of the preferred power system. Analysis of the system is discussed in <Section 8.2.2>.

8.2.1.2.1 Transmission Station

The 345 kV transmission station is a minimum breaker-and-a-half configuration, as shown on the main connection diagram, <Figure 8.2-2>. The plant's two startup transformers are directly connected to the 345 kV main

buses. The two full capacity main buses are on opposite sides of the transmission station and are physically independent, as shown in <Figure 8.2-3>. Specific design features of the transmission station are as follows:

a. 345 kV circuit breakers are rated 3,000 A, 50,000 AIC, with an SF_6 insulation system. Breakers are independent-pole tripping (mechanical and electrical) and gang closing. There are two trip coils per pole for primary and backup relaying systems.

b. Two separate 125-volt dc systems provide separate trip/close power supplies for breakers associated with the two (or more) preferred sources. Equipment for the two systems is located in the transmission station control house and is independent of the plant dc systems.

c. AC auxiliary power is provided from the 4 kV non-Class 1E plant power system with a backup power supply that is connectable (through a Class 1E isolation device) to the Division 2 Class 1E standby diesel generator. This will ensure ac power to the transmission station for critical functions (battery chargers, breaker heaters, etc.) during extended outage non-accident conditions.

d. A data acquisition and control (DAC) system provides information and breaker control to the system switching authority. Two separate DAC systems are provided for the transmission station, one for each of the preferred sources' associated breakers. The Unit 1 generator-associated breakers (S-610 and S-611) are controlled only from the plant control room. Corresponding Unit 2 breaker S-620 is controlled by the system dispatcher.

e. Physical design criteria for station and structures include:

   1. Structure wind pressure at 25 lb/ft^2.

   2. Tap structure designed to National Electric Safety Code, Grade B construction.

   3. Ice loading is designed to National Electric Safety Code, Grade B construction in the heavy loading district, Section 26, Rule 261A,3 for structural steel.

   4. Bare wire icing at 1/2 inch per National Electric Safety Code.

   5. Grounding in accordance with CEI design standards.

f. Equipment and components in the transmission station are not classified as nuclear safety-related. However, all materials are of the highest commercial grade quality, consistent with past practice in establishing improved reliability in similar transmission station applications.

8.2.1.2.2 Interface with Class 1E System

The interfaces between the transmission station and Class 1E power system consist of 345 kV transmission circuits, disconnect switches, startup transformers, circuits in cable tray and underground duct banks, interbus transformers, and 5 and 15 kV switchgear. The overview of this interface is shown on <Figure 8.2-3>. The one line diagrams are shown in <Figure 8.3-1> and <Figure 8.3-2>.

Several additional paths from the transmission system to the Class 1E system are available as alternate offsite power sources if loss of a startup transformer occurs. For example, for Unit 1, this includes

feeding 15 kV Bus L10 from Buses L11 or L12, via the unit auxiliary transformer. A motor-operated main generator disconnect switch is provided to facilitate the availability of this path. Each operating contingency is reviewed with respect to <Regulatory Guide 1.32>. In all cases, there are at least two separate paths, with sufficient capacity provided from the transmission network to the standby power distribution system, available in sufficient time, in accordance with General Design Criterion 17.

8.2.1.2.3 Surveillance

Surveillance methods for the preferred power system consist of information available at the transmission station control house, the system switching authority and the plant control room. In the transmission station control house, local annunciators are provided at each circuit breaker panel and at a master panel to monitor key parameters (gas pressure, heaters, etc.). High speed oscillographs (fault recorders) are also provided in the transmission station control house and plant control room. Transmission substation alarms are transmitted to the system switching authority. The system switching authority is responsible for corrective action when a "trouble" alarm is received. For critical operations (such as any breaker trips, differential relaying operation, etc.), individual indicators are available to the control room, as listed in <Table 8.2-1>. Critical transmission station and plant electrical information is also available to the system switching authority. Surveillance methods for other components in the preferred power system are also listed in <Table 8.2-1>.

8.2.2 ANALYSIS

8.2.2.1 Availability

The preferred power system is designed in accordance with General Design Criterion 17, in that, at least two physically independent circuits are provided from the transmission network to the onsite electric distribution system, in sufficient time to assure that core cooling, containment integrity and other vital safety functions are maintained. The availability of the preferred power system to provide power to the onsite system is substantial, based on the following design considerations:

a. The 345 kV switchyard is directly connected to four independent transmission stations (Eastlake Plant to the west and Ashtabula Plant to the east), the remaining FirstEnergy network (inland/ Glenwillow and Leroy Center) and the Pennsylvania-New Jersey-Maryland (PJM) network. Thus, the loss of any single transmission station will have a negligible impact on the availability of the preferred source.

b. Within the plant property, 345 kV transmission lines are supported on double circuit structures. Any two of the four 345 kV circuits exiting the switchyard may be out-of-service with the unit operating, and the remaining circuits will be capable of carrying the units' output.

c. The 345 kV transmission lines approach the transmission substation on a common right-of-way corridor within 0.9 miles of the transmission substation. The structures are set far enough apart to avoid the possibility of causing an outage of all lines due to postulated structural collapse of one line. The transmission towers have been designed for worst case environmental conditions and tested beyond the governing National Electric Safety Code requirements. The analysis and testing to this code show the

structural failure of one tower will not result in the loss of the preferred power supply to the onsite electrical distribution system. The Perry design meets the requirements of General Design Criterion 17.

d. Beyond the plant boundary, the 345 kV transmission circuits (except Glenwillow and Leroy Center) are supported on independent structures. The Glenwillow and Leroy Center circuits are supported on double circuit structures. Both the Glenwillow and Leroy Center circuits may be interrupted with Unit 1 operating, and the remaining circuits will be capable of carrying the load.

e. The switchyard components are arranged such that no single event will result in the loss of the unit and the availability of all offsite sources. With both preferred sources available, no single event results in the loss of both the unit and the immediately available source(s). If only one preferred source is available, no single event will result in the loss of the unit, and accessibility to the delayed source.

    1. Any transmission line can be cleared under normal or fault conditions without affecting any other transmission line.

    2. Any single circuit breaker can be isolated for maintenance without interrupting the power or protection to any circuit.

    3. Short circuits on a section of bus can be isolated without interrupting service to any circuits, other than those circuits connected to the faulted bus section.

    4. Short circuit failure of breaker S-611-PY-TIE will result in loss of Unit 1 and the startup transformer No. 2 until the point of fault is isolated by disconnect switches.

5. Short circuit failure of breaker S-610-PY-TIE will result in loss of Unit 1 and S-8-PY-EL until the point of fault is isolated by disconnect switches.

6. Short circuit failure of breaker S-612-PY-TIE will result in loss of the startup transformer No. 1 and S-8-PY-EL until the point of fault is isolated by disconnect switches.

7. Short circuit failure of breaker S-650-PY-TIE will result in loss of the startup transformer No. 2 and S-5-PY-GLW until the point of fault is isolated by disconnect switches.

8. Short circuit failure of breaker S-652-PY-TIE will result in loss of S-5-PY-GLW and the startup transformer No. 1 until the point of fault is isolated by disconnect switches.

9. Short circuit failure of breaker S-661-PY-TIE will result in loss of S-6-PY-LC and the startup transformer No. 2 until the point of fault is isolated by disconnect switches.

10. Short circuit failure of breaker S-660-PY-TIE will result in the loss of S-6-PY-LC until the point of fault is isolated by disconnect switches.

11. Short circuit failure of breaker S-660-PY-TIE will result in loss of the startup transformer No. 1 until the point of fault is isolated by disconnect switches.

12. Short circuit failure of breaker S-621-PY-TIE will result in loss of startup transformer No. 2 and S-29-PY-AT-ERW until the point of fault is isolated by disconnect switches.

13. Short circuit failure of breaker S-620-PY-TIE will result in the loss of S-29-PY-AT-ERW until the point of the fault is isolated by disconnect switches.

14. (Deleted)

f. The switchyard design incorporates primary and backup relaying, separate dc systems and separate DAC information systems, all arranged such that the loss of one preferred system circuit will not result in loss of the redundant counterpart, or the loss of any standby power system sources. Similarly, the redundant Class 1E switchgear is designed with separate incoming source breakers for the preferred power, the alternate preferred power and the standby power sources such that loss of any standby power source will not result in the loss of either of the preferred power sources (see <Section 8.3.1.1.2> for description of Class 1E power systems and <Section 8.3.1.2.1> for Class 1E system compliance with General Design Criteria 17).

The latest available statistics from the East Central Area Reliability (ECAR) council pertaining to the reliability of 345 kV circuits are contained in "ECAR Summary Report of Transmission Line Outages 1986." This report is a compilation of transmission line outages for the ECAR member companies. It covers 1986 and includes a 1977-1986 ten-year summary. The average availability of the 345 kV transmission lines in ECAR in 1986 was 99.34 percent. The average availabilities of the 345 kV ECAR circuits during the ten-year period ranged from a low of 98.65 percent in 1978 to a high of 99.34 percent in 1986. Based on the above data and considering the design features described earlier, the availability of the preferred power system to supply power to the onsite distribution system is expected to be substantial.

8.2.2.2 Stability

Load flow and stability studies performed for the initially planned two unit plant show that a full load trip of both units, or a tripping of one unit with the other online or offline, or the tripping of a double circuit line, will not impair the ability of the preferred source to provide power to the Class 1E system.

Results of stability studies indicate that three-phase faults (with backup clearing for stuck phases on the independent pole breakers) on the 345 kV system will not impair the ability of the preferred source to provide power to the Class 1E system. The conditions studied include faults which result in the outage of single circuits, two circuits or one circuit and the unit. Both Perry bus faults and far-end faults were considered.

ECAR has established certain criteria for evaluating the reliability of electrical power systems of its member companies. These criteria were reviewed with respect to the Perry design. The criteria applicable to FirstEnergy subsidiaries were tested. For every case tested, the planned Perry transmission system met the ECAR Criteria or Evaluation and Simulated Testing of the ECAR Bulk Power Supply Systems.

Overall, the FirstEnergy system is planned and constructed such that no loss of power will occur to any part of the system with a coincident loss of any one EHV transmission line and any one generator, or of two generators or of two EHV transmission lines.

8.2.2.3 Capacity

Each of the circuits from the transmission network to the onsite electric distribution system has the capacity and capability to supply the loads during normal and abnormal operating conditions, accident conditions or plant shutdown conditions. The most critically sized component is the startup transformer. The maximum load could occur

with one startup transformer out-of-service, an accident in one unit and a unit trip with shutdown in the other unit. Under these assumptions, all auxiliary load is transferred to the remaining startup transformer; each startup transformer is sized based on this criteria.

8.2.2.4 Operating Units

The Unit's rating is 1,446,700 kVA (capable of operating at 1,513,556 kVA) at 0.90 power factor and rated voltage of 22,000V with a tolerance of ±5%. The generator is designed to operate at or near 60 Hz (±5%) in synchronism with all other generators on the transmission system. These limits determine the magnitude of the current which the machine must carry and, therefore, the sizing of components and cost of the machine.

The system operator adheres to the system voltage schedule in order to maintain predetermined voltage levels at certain critical buses on the transmission system. This in turn supports the voltages on all other buses on the system. The system operator provides for an adequate supply of reactive power for voltage support through his selection of generating units to be brought on line, switching on capacitor banks, etc.

System frequency is maintained on a continuous basis by the actions of system operators who maintain a balance of load and generation on the system. During normal system operations, this consists of varying the power output of the generators via control of the steam (or water) to the turbines, with spinning reserve kept available on some or all of the machines. The speed governor, which is a local continuous control device, is adjusted for the desired frequency within a narrow range around the loading level on the machine. Under emergency conditions, i.e., system separation, where the system experiences an imbalance in load and generation, the generator will either speed up (generation exceeds load) or slow down (load exceeds generation). Relays set to

trip the unit on overspeed will initiate shutdown of the unit for the former case. The latter case is handled by shedding load as necessary until generation and load are once again in balance. If under emergency conditions frequency drops below the lowest acceptable machine level, relays will operate to trip the machine.

TABLE 8.2-1

PREFERRED POWER SYSTEM SURVEILLANCE METHODS IN PLANT CONTROL ROOM

Equipment	Breaker Position Indication	Indicating Lights & Breaker Control	Potential Lights	Annunciator	SER	Meter	Computer
345kV Transmission Substation Breakers:							
S-611	X	X					
S-610	X	X					
S-612	X						
S-650	X						
S-652	X						
S-661	X						
S-660	X						
S-621	X						
S-620	X	X[(1)]					
345kV Bus No. 1 and No. 2							
Differential Relaying					X		
Voltage			X			X	
Startup Transformer 100 PY-B, 200 PY-B							
Relaying					X		
Trouble				X			
Amperes						X	
345kV Disconnect Switch	X						
15kV Bus L10, L20 Volts			X			X	
Low Voltage (27)				X			
L1003		X		X			X
L1004, L2001		X		X			X (L1004 only)
L2003		X		X			
L2004, L1001		X		X			X (L1001 only)

TABLE 8.2-1 (Continued)

Equipment	Breaker Position Indication	Indicating Lights & Breaker Control	Potential Lights	Annunciator	SER	Meter	Computer
Interbus Transformer							
L1010, EH1101		X		X			X (L1010 only)
L2006, EH2101		X		X			
Amperes						X	
4.16kV Tie Buses TH1, TH21			X				
Voltage						X	X
4.16kV Tie Buses TH2, TH12 Voltage			X			X	
4.16kV EH Buses Volts			X			X	
EH1114, EH1115	X			X			X
EH1303, EH1302	X			X			X
EH1212, EH1213	X			X			X

NOTES:

[1] Presently controlled by the system switching authority.

8.3 ONSITE POWER SYSTEMS

8.3.1 AC POWER SYSTEMS

8.3.1.1 Description

<Figure 8.3-1> and <Figure 8.3-2> are the main one line diagrams for the onsite power system and depict key aspects of Unit 2 support for Unit 1. The onsite ac power system consists of two similar power distribution systems. Each system was originally intended to serve one of two units. The power distribution system for each unit is comprised of the following three distinct subsystems:

a. Startup and preferred power supply.

b. Non-Class 1E power system (unit auxiliary power system).

c. Class 1E power system (engineered safety features power system).

8.3.1.1.1 Non-Class 1E AC Power System

Non-Class 1E power is distributed at 13.8 kV from the unit auxiliary and startup transformers. A startup transformer for each unit is designated as the preferred power source for that unit's Class 1E buses. Unit 1 auxiliary transformer is also designated as a preferred power source for Unit 1 Class 1E buses. By virtue of physical and electrical separation, each startup transformer is designated as an alternate preferred power source for the Class 1E buses of the other unit (e.g., Unit 1 startup transformer is the preferred power source for Unit 1 Class 1E buses and the Unit 2 startup transformer is the alternate preferred power source for Unit 1 Class 1E buses).

Each startup transformer is sized to provide power for startup, normal operation (in the event of unit auxiliary transformer trouble), shutdown, and post shutdown requirements. Adequate capacity is available to permit safe shutdown of the operating unit under all conditions with only one startup transformer in service, as discussed in <Section 8.2.1.2.2>.

The preferred source of power to Class 1E equipment is from the unit startup transformer through the 13.8 kV startup bus and one winding of the 13.8/4.16 kV, two winding secondary, interbus transformer. One unit interbus transformer secondary winding feeds the 4.16 kV Class 1E load of the associated unit. The other secondary winding of the interbus transformer feeds the 4.16 kV Class 1E load of the other unit through a normally closed circuit breaker. The Unit 1 Class 1E system can also be fed from the Unit 1 auxiliary transformer. All power supply selections are accomplished manually from either the control room or from a remote location. Both the startup transformers and the interbus transformers are sized to supply power to the associated unit Class 1E buses under LOCA conditions, and to supply power to the other unit Class 1E buses for use in safely shutting down that unit. The startup transformer and interbus transformer impedances were selected with due consideration to the fault duty of the breakers and the voltage regulation on the Class 1E buses.

The impact of open phase conditions on the capability of the startup transformers to perform their intended safety functions was evaluated. The conditions analyzed consisted of a single open phase (one of three) and a double open phase (two of three), with and without a ground, on the high voltage (345kV) side of the startup transformers. Open phase detection systems for the startup transformers were installed to ensure that plant structures, systems, and components important to safety can perform their intended functions under postulated open phase conditions. Upon detection of an open phase condition, the associated control room annunciator will provide immediate operator indication of the condition so that appropriate actions can be taken.

8.3.1.1.2 Class 1E Power System

The Class 1E power system is illustrated on <Figure 8.3-1> and <Figure 8.3-2>. The system is designed with independent divisions having radial systems through all voltages at 4.16 kV and below. Complete physical and electrical separation is maintained to ensure maximum integrity. Note, Division 3 is capable of being manually cross-tied to Division 2 during a station blackout to provide power to some Division 2 loads. Refer to <Appendix 15H> for more information.

8.3.1.1.2.1 Power Supply Feeders

Power is normally supplied to each of the 4.16 kV Class 1E buses from the interbus transformer associated with that unit. The preferred power supply is the startup transformer through the unit interbus transformer. The Unit 1 auxiliary transformer can also be a preferred power supply for the Unit 1 Class 1E system through the interbus transformer. An alternate preferred supply is the startup transformer and interbus transformer associated with the other unit. This alternate preferred power supply feeds the 4.16 kV Class 1E buses through a manually operated, normally open circuit breaker (alternate preferred source feeder breaker) for each division. Three diesel generators fulfill onsite power requirements for the three load groups (Unit 1).

8.3.1.1.2.2 Supplied Loads

Safety system loads and loadings are listed in <Table 8.3-1>. Note that the common system engineered safety feature loads are supplied from the Unit 1 Class 1E power system.

8.3.1.1.2.3 Manual and Automatic Interconnections between Buses, Buses and Loads, and Buses and Power Supplies

No provision is made for automatic parallel operation of any onsite power supplies with other onsite power supplies. Neither buses nor loads can be interconnected through the onsite supplies nor are there any provisions for interdivisional connections between onsite supplies and buses. All divisions receive power from the non-Class 1E preferred power supply. The diesel generator breaker EH1102 (Division 1), EH1201 (Division 2) and EH1301 (Division 3) as shown in the breaker logic diagram, cannot close automatically on the bus under an undervoltage or LOCA condition unless the preferred and alternate preferred source breakers are both open. An interrupted manual transfer to the alternate preferred power supply can be accomplished by opening

the preferred supply feeder breaker for each division and closing the alternate preferred supply feeder beaker. Automatic transfer is not used. Circuit breakers which feed each 4.16 kV Class 1E bus from the preferred power supply and alternate preferred power supply are interlocked with each other to preclude paralleling of the preferred and alternate preferred power supplies.

8.3.1.1.2.4 Interconnections between Safety-Related and Nonsafety-Related Buses

Interconnections are made at the 4.16 kV level between Division 1 and a non-Class 1E bus, and between Division 2 and a non-Class 1E bus. These non-Class 1E buses ("stub" buses) supply critical non-Class 1E loads, such as the control rod drive pumps and nuclear closed cooling pumps <Figure 8.3-10>. Circuit breakers feeding the stub buses are qualified isolation devices, are housed in Class 1E switchgear, are tripped upon receipt of a LOCA signal, and satisfy the recommendations of <Regulatory Guide 1.75>. A keylocked NORMAL-BYPASS switch, one for each Division, enables the control room operator to override the LOCA signal and close the stub bus breaker for either Division using the breaker control switch <Figure 8.3-9>. Control of ESF safety function bypass is addressed in <Section 7.3.2.1.2.14>.

8.3.1.1.2.5 Equipment Capacities

Equipment capacities are listed in <Table 8.3-2>.

8.3.1.1.2.6 Automatic Bus Loading and Stripping

The diesel generator for each division is automatically started upon receipt of a LOCA signal, an undervoltage signal or a degraded voltage signal at the associated division bus. If the diesel generator is started by a LOCA signal only, the diesel generator is not connected to the bus but remains in standby operation, non-Class 1E 4.16 kV buses

(stub buses) fed from Division 1 and Division 2 buses are shed, and LOCA loads are started and fed from offsite power. If an undervoltage or degraded voltage signal also exists, Class 1E bus feeder breakers, except the 0 time load breakers shown in <Table 8.3-1>, are tripped by bus undervoltage or degraded voltage which is detected at each division bus by undervoltage relays. For Division 1 and Division 2, 4.16 kV load circuit breakers (except those protecting unit substations and LPCS Pump) are tripped; Division 3, 4.16 kV load circuit breakers remain closed following a 4.16 kV bus undervoltage signal.

If an undervoltage signal follows a LOCA, all 4.16 kV circuit breakers are tripped except for the low pressure core spray pump, high pressure core spray pump and those that protect the unit substations. Certain loads are sequentially connected to the bus after the diesel generator has reached rated voltage and frequency and 4.16 kV bus voltage is available. Loads are also sequentially started if an undervoltage condition occurs and a forced shutdown condition exists. <Table 8.3-1> lists load sequence times for either a forced shutdown or LOCA condition.

If a LOCA occurs following an undervoltage condition, LOCA loads are sequentially loaded and connected loads are not stripped from the buses.

When a diesel generator is started, the emergency service water pump discharge valve receives an open signal coincident to the diesel generator start signal since the emergency service water pump supplies diesel generator cooling water. The emergency service water pump start is interlocked to this valve opening and starts automatically approximately 20 seconds for Division 1 and Division 2 and 33 seconds for Division 3 after the diesel generator breaker closes.

8.3.1.1.2.7 Safety-Related Equipment Identification

Electrical equipment, cable, raceways, and associated items, designated as safety-related, are so identified and the division of enforced segregation with which such equipment is associated is indicated. Identification and segregation is accomplished by color coding equipment nameplates, cables, raceways, and associated items as detailed by <Table 8.3-3>.

Switchgear, motor control centers, unit substations, and racks are equipped with color coded tags to indicate the division with which they are associated. Field cable jackets or armor are color coded with the appropriate division marker color. Either the outer jacket or armor of the cable is continuously colored or striped, or colored tags are installed at both ends of the cable and at a sufficient number of intermediate points to facilitate initial verification that the installation is in conformance with the separation criteria.

Wiring within control panels is either color coded or tagged with the appropriate division marker color. Because wiring within switchgear, motor control centers and unit substations is generally associated with the same division inside the confines of each cubicle, such wiring is not color coded. In cases where non-Class 1E wiring exists with wiring that is predominantly Class 1E, the wiring is run separately and is tagged to identify it as non-Class 1E.

Independence of Class 1E equipment and circuits is in accordance with IEEE Standard 384 (Reference 1), as clarified in <Table 8.1-2>.

8.3.1.1.2.8 Instrumentation and Control Systems

DC control power for Class 1E switchgear is supplied from the same separation division as the switchgear being controlled. A discussion of the Class 1E dc power system is presented in <Section 8.3.2>.

8.3.1.1.2.9 Electric Circuit Protection System Network

a. Protective Relay Devices

Protective relay devices are provided for the interbus transformer, Class 1E 4.16 kV bus supply circuit breakers, standby power source, and load circuit breakers. These devices are as follows:

1. Interbus Transformer

(a) Transformer Differential Protection (87T): three phase, solid state

(b) High Voltage Overcurrent Protection (50/51): 3-single phase, electromechanical

(c) Low Voltage Overcurrent Switchgear Protection (51): 3-single phase, electromechanical

(d) Low Voltage Ground Protection (51NT): on each secondary neutral, electromechanical

(e) High Voltage Overcurrent Protection (5IN): a single phase ground overcurrent electromechanical

2. Voltage Relaying

Two levels of undervoltage protection, “Degraded Voltage” and “Loss of Power”, are provided on each Class 1E 4160V bus to conform to the requirements of the NRC Branch Technical Position PSB-1.

The first level is designed to protect the bus against a degraded grid voltage condition. This system consists of undervoltage relays, and associated time delay relays to perform the following if the 4 kV bus voltage degrades to a condition between the “Degraded Voltage” relay setpoint and the “Loss of Power” relay setpoint.

(a) Degraded voltage alarms are initiated after a brief period of sustained degraded voltage.

(b) The off site source breakers are tripped after an extended period of sustained degraded voltage without a concurrent LOCA, and the Class 1E bus is then energized from the diesel generator power supply.

(c) If a LOCA occurs concurrent with the degraded voltage (between the “Degraded Voltage” relay setpoint and the “Loss of Power” relay setpoint), the offsite circuit breakers are tripped after only a brief period of time.

The second level is designed to protect the bus against loss of power. This system consists of undervoltage relays, and an associated time delay relay. With a bus voltage below the “Loss of Power” relay setpoint, the offsite power source

breakers will be tripped after several seconds, the diesel will be started, and the diesel generator will be connected to the bus.

The overall design adequacy of the undervoltage protection system has been tested as described in <Section 8.3.1.1.2.12>.

The use of the undervoltage protection system in the automatic bus loading and shedding scheme is discussed in <Section 8.3.1.1.2.6>.

3. Preferred and Alternate Preferred Power Supply Bus Feeder Breakers

Bus feeder overcurrent protection for preferred and alternate preferred power supply bus feeder breakers consists of three single phase time overcurrent electromechanical relays (51) for each breaker and one ground overcurrent electromechanical relay (51N) for each breaker in Division 1 and Division 2 and one ground overcurrent solid state (50G) for each breaker in Division 3.

4. Standby Power Sources

The standby power source consists of the diesel generators, one for Division 1, one for Division 2 and one HPCS diesel generator for Division 3. Protective relaying for each diesel generator is comprised of the following:

(a) Generator Differential Protection

Generator differential protection is provided by a solid state differential relay (87G). This device uses dedicated CTs and is the only relay connected to trip the diesel generator in the LOCA or bus under/degraded voltage mode of operation.

(b) Voltage-Controlled, Overcurrent Protection

Protection against overcurrent in the event of a system fault is provided by two 3 phase, solid state relays. An undervoltage relay (27B) is used to block the operation of a definite-time overcurrent relay (50D) unless the low voltage condition typical of fault conditions is present.

(c) Voltage Supervision

Protective relays block closure of the diesel generator breaker until sufficient generator output voltage is established. Voltage supervision is provided by one 2 unit electromechanical voltage relay (59D) for each Division 1 and Division 2 diesel generator. On Division 3, voltage supervision is provided by a single unit solid state voltage relay (27G).

(d) Reverse Power Protection

Reverse power protection is provided by three single phase electromechanical reverse power relays (32). These devices protect the system against loading by a fuel starved diesel engine.

(e) Neutral Overvoltage Detection

Neutral overvoltage detection is provided by an electromechanical neutral overvoltage relay (59NG). This device detects a stator or AC system ground fault.

(f) Field Ground Detection

Field ground fault detection is provided via alarm by an electromechanical field ground relay (64F) (Division 1 and Division 2 only).

(g) Load Test Overload Protection

Load test overload protection when load testing in parallel with the offsite power source is provided by a single unit solid state underfrequency relay (81). Should an offsite power anomaly occur which overloads the diesel generator during load testing, this relay acts to trip the Class 1E offsite source breakers while leaving the diesel generator connected to the bus.

5. Class 1E 4.16 kV Feeder Breakers

Feeder breakers are equipped with a solid state ground fault relay (50G), and three single phase time and instantaneous overcurrent electromechanical relays (50/51). In addition to

the 50G and 50/51 relays, motor feeders whose 50/51 relays are connected to current transformers (CT's) with a ratio of 150/5 or smaller are provided with two additional instantaneous overcurrent electromechanical relays. These two relays are connected to their own 400/5 CT's and provide additional equipment protection should a high level fault condition occur on the affected motor feeder.

6. Class 1E 480 Volt Unit Substations

(a) Incoming Breakers

Incoming breakers are equipped with a solid state, long time and short time delay trip device.

(b) Feeder Breakers

Feeder breakers serving motor control centers and distribution panels are manually operated and are equipped with a long time delay and short time delay and instantaneous tripping devices.

Feeder breakers serving motors are electrically operated and are equipped with a long time delay and instantaneous tripping device.

7. Class 1E Motor Control Centers

Loads supplied from motor control centers are protected by fused combination motor starters or in some cases by fused disconnect switches. Dual element (time delay) Class K5 or RK5 fuses are used to provide overload and short circuit

protection. Single speed non-reversing motors are also protected by thermal overload devices located in the motor starter.

Thermal overload devices are not used for Class 1E motor-operated valve motors.

8. Class 1E 120-Volt AC Distribution Panels

Loads supplied from 120 volt ac distribution panels are protected by molded case circuit breakers or fuses. The exceptions are the M56 Hydrogen ignitor isolation panels. These panels are described in <Section 6.2.8.2>.

9. Class 1E 125-Volt DC Distribution Panels

Division 1 and Division 2 loads supplied from 125-volt dc distribution panels are protected by fused disconnects with dual element (time delay) Class K5 or RK5 fuses for loads up to 600 ampere and with Class L fuses for loads above 600 ampere. Division 3 125V dc distribution panel loads are protected by individual circuit breakers.

b. Protective Relaying and Protective Device Setting Criteria

1. Class 1E 4,160 and 480-Volt Switchgear

Protective devices on the 4,160 and 480-volt switchgear are set to meet the following criteria:

(a) The primary downstream protective devices are set to clear the fault in the least amount of time and to protect the end device from damage. These devices have

been strategically located in the electrical system to isolate the smallest portion of the system during fault conditions.

(b) In the event of a failure of a primary protective device, the backup devices are set to operate after a suitable coordination interval. Backup devices clear a larger portion of the electrical system.

(c) On Class 1E 4,160V pump motor circuits instantaneous overcurrent protection for phase and ground faults is provided. In backup, time overcurrent protection is provided for phase faults.

The instantaneous phase overcurrent relays (1 per phase) are set at a pickup level approximately equal to twice (2x) the locked rotor current of the pump motor at 100% rated voltage within the constraints of available taps. The 200% margin over the locked rotor current on starting is secure against false operations due to transient motor fault current contributions to bus faults and starting transients greater than predicted.

The instantaneous ground overcurrent relays (1 per circuit) are set at a pickup of 15 amperes primary and 2 cycles fixed time delay. The ground relays use a window current transformer or ground sensor for detection of cable and motor ground faults. This sensing arrangement in conjunction with the 15 ampere primary setting is inherently immune to false operations due to system disturbances.

Phase time overcurrent relays (1 per phase) are set at a pickup level approximately equal to one-and-one-half (1-1/2) times the full load current of the motor at 100% rated voltage within the constraints of available taps. The time dial setting is selected to provide for normal motor acceleration and coordination with upstream protective devices.

(d) On Class 1E 480V motor circuits solid state trip devices are provided with long time pickup and instantaneous pickup. These trip devices are not continuously adjustable but have fixed tap settings.

The instantaneous pickup is set at approximately 230 percent of the locked rotor current, within the constraints of available taps. The long time pickup is set at approximately 150% of full load current of the motor.

The protective relays are routinely checked per manufacturers instructions to verify operation and set points.

2. Class 1E Motor Control Centers

Class K-5 or RK-5 dual element (time delay) fuses are selected based on approximately 125 percent of the full rated load current (FLA) for Class 1E loads other than valves. When necessary for carrying a motor's starting current, fuses for loads other than valves can be selected based on up to a maximum of 225 percent of FLA.

Motors which serve valves are fused as follows:

(a) The fuse is selected so that the operating point is at least 200 percent of motor full load current during the normal operating time of the valve.

(b) The fuse will withstand locked rotor current for five seconds and will withstand 150 percent of locked rotor current associated with the normal motor starting time of 0.25 seconds.

3. Class 1E 120-Volt AC Distribution Panels

Molded case circuit breakers are selected, based on interrupting capacities, voltage rating and load current capabilities. Typically, load currents do not exceed 80 percent of the breaker current rating.

4. Class 1E 125-Volt DC Distribution Panels

Class K5 or RK5 dual element (time delay) or type TEB circuit breakers and Class L fuses are selected, based on interrupting capacities, voltage rating and load current capabilities, typically based on 125 percent of the full rated load current.

5. Electrical Penetration Protection

See <Section 8.3.1.4.5>.

8.3.1.1.2.10 Class 1E Protection System Testing During Power Operation

The Class 1E protection system can be tested during plant operation. Administrative procedures permit testing only one power division at a time. Tests include the following:

a. Protection System Response to an Undervoltage Signal

   The system undervoltage test is performed in conjunction with the diesel generator loading test. The preferred and alternate preferred power source circuit breakers, standby power source and 4.16 kV load circuit breakers are tested for response to an undervoltage signal. During testing, interlocks prevent interference with other plant functions.

   Undervoltage on the 4.16 kV bus is simulated by pulling the 4.16 kV bus PT secondary fuses in each set of undervoltage relay circuits. Functional status of the undervoltage logic circuit is indicated in the control room. The diesel generator is observed for response to a start signal and 4.16 kV circuit breakers are observed to trip (except those supplying unit substations). Loading of the diesel generator is then tested.

b. Standby Power Source Testing

   Standby power source testing is discussed in <Section 8.3.1.1.2.12>.

c. Engineered Safety Features Systems Testing

   Testing of ESF systems is discussed in <Section 7.3> and <Section 7.4>.

8.3.1.1.2.11 Electrical Systems Shared between Units

No Class 1E ac power systems are shared between Units 1 and 2. The interunit connections for the Class 1E dc power system are discussed in <Section 8.3.2.1.2.1>.

8.3.1.1.2.12 Preoperational and Initial Startup Testing of Class 1E 4.16 kV Standby Power Source

Testing of the standby power sources for Division 1 and Division 2 is treated separately from testing of the Division 3 standby power source.

a. Division 1 and Division 2 Standby Power Source Testing

   The two Class 1E 4.16 kV buses (EH11 and EH12), with associated feeder and load breakers, are designed to respond automatically to two abnormal voltage conditions and a LOCA condition. These abnormal voltage conditions are a bus undervoltage condition corresponding to a loss of offsite power supplies or a bus degraded voltage condition.

   Technical Specifications and approved test procedures verify the adequate performance of the integrated onsite power system. (Also refer to <Chapter 14> for descriptions of applicable preoperational tests.)

b. Division 3 HPCS Testing

   The HPCS 4.16 kV bus (EH13), with associated feeder and load breakers, are designed to respond automatically to two abnormal voltage conditions, and a LOCA condition. These abnormal voltage conditions are a bus undervoltage condition corresponding to a loss of offsite power supplies or a bus degraded voltage condition.

Testing of Division 3 equipment is in accordance with the applicable design bases <Table 8.1-2> and in particular <Regulatory Guide 1.68>. It is designed to permit inspection and testing of all important areas and features, especially those whose operation is not normally demonstrated. As detailed in the Technical Specifications, periodic component tests are supplemented by extensive functional tests during refueling outages, the latter based on actual accident simulated conditions. These tests demonstrate the operability of diesel generator, station battery system components and logic systems and thereby verify the continuity of the system and the operation of components. (Also refer to <Chapter 14> for applicable preoperational tests.)

8.3.1.1.3 Standby Power Sources

8.3.1.1.3.1 Description

Each division at Unit 1 is provided with a diesel engine driven, 4.16 kV, 3 phase, 60 Hz synchronous generator <Figure 8.3-1>. The diesel generator sets are electrically and physically isolated from each other and are located in a Seismic Category I structure adjacent to the control complex. Note, Division 3 is capable of being manually cross-tied to Division 2 during a station blackout to provide power to some Division 2 loads. Refer to <Appendix 15H> for more information. Also note that Division 3 is capable of being manually connected to Division 1 following a loss of coolant accident and a total loss of both the normal and emergency Division 1 AC electrical power sources, to provide power to the motor-operated gate valves in the Feedwater lines. <Figure 8.3-3> shows the locations of the standby power sources.

The Diesel-Generators may be operated within a tolerance band per the Technical Specifications for frequency and voltage. Various analyses/evaluations, as applicable, were performed documenting the effects of under-frequency/under-voltage to ensure that system

response requirements (e.g., flow, ECCS injection times) are met. Similarly, analyses/evaluations documenting the effects of over-frequency/over-voltage, as applicable, were performed to ensure system effects such as increased system pressure due to increased motor speeds remained within design parameters.

<Table 8.3-1> lists loads required for various maximum loading conditions, such as loss of offsite power (forced shutdown) and LOCA. The basis for the power required for each safety-related load is the

motor nameplate rating.

Safety-related control power and instrument power for each diesel generator are supplied from the 125-volt dc battery of the respective division. Two control circuits are provided for engine starting to increase reliability. These circuits are of the same division as the diesel generator with which they are associated. Class 1E motors, associated with diesel generator auxiliary systems which require 480 volt, 3 phase ac power, are supplied from motor control centers associated with the same division as the diesel generator. Motors associated with the diesel generator auxiliaries are listed in <Table 8.3-1>.

8.3.1.1.3.2 Division 1 and Division 2 Diesel Generators

a. Sizing Criteria

The continuous rating of the diesel generators (7,000 kW) is based upon the loading requirements indicated in <Table 8.3-1>. The short time rating of the units is 7,700 kW.

Application of the diesel generators complies with the recommendations of <Regulatory Guide 1.9>. Diesel generator ratings are based upon the concept that the continuous load rating exceed the sum of conservatively rated loads required at one time <Table 8.3-1>. In the case of mechanical equipment, such as pumps, loads were calculated using conservative mechanical design characteristics and the continuous rating of each diesel generator (7,000 kW). Loads are based upon equipment nameplate ratings.

Sequencing of large loads at five second intervals ensures that large motors will have attained rated speed and that voltage and frequency will have stabilized before succeeding loads are applied.

The decreases in frequency and voltage have been verified by qualification test to be not greater than 5 and 20 percent of nominal, respectively.

Recovery of voltage and frequency to 90 percent and 98 percent of nominal, respectively, has been verified to occur within 40 percent of the five second sequencing interval.

Diesel generator reliability has been substantiated by an extensive test program in accordance with IEEE Standard 387 (Reference 2). This testing has verified the following:

1. Diesel fast start capability.

2. Load carrying capability.

3. Load rejection capability.

4. Margin capability.

5. No load operating capability.

System reliability and qualification testing are discussed further in <Section 8.3.1.1.3.2.b.11>.

b. Design Aspects

1. Start Initiating Circuits

The diesel generators are automatically started upon receipt of a LOCA signal, an undervoltage signal or a degraded voltage signal from the associated bus. The diesel generators can also be manually started remotely from the control room or locally at the diesel generators (in either the fast start or

slow start modes). Note: The Slow/Fast switch is maintained in 'fast' until slow start switch position and associated circuit is fully tested and functional. A mode selector switch

located at the diesel generator permits transfer of manual control capability to and from the control room. <Figure 8.3-6> presents the logic diagram for Division 1 and Division 2 diesel generators. The diesel generators are capable of operating at rated speed and no load for seven days without degradation of engine performance or reliability. If the diesel generator is started in the slow start mode and the mode selector switch is aligned for control from the control room, an emergency start signal will override the slow start mode and the engine will reach rated voltage and frequency as assumed in the accident analysis. Note: The Slow/Fast switch is maintained in 'fast' until slow start switch position and associated circuit is fully tested and functional.

2. Starting Mechanism and System

The diesel generators are pneumatically started. Redundant starting air supplies are provided for each engine. Additional details concerning the starting air system are presented in <Section 9.5.6>.

3. Tripping Devices

Only the generator differential and overspeed trip functions will shut down the diesel generators after a start resulting from a LOCA or bus under/degraded voltage signal. The following additional, nonessential trip functions are bypassed upon receipt of a LOCA or bus under/degraded voltage signal but will shut down the diesel generators when operating in all other modes:

(a) High jacket water temperature.

(b) High engine bearing temperature.

(c) Low turbocharger oil pressure.

(d) Low lubricating oil pressure.

(e) (Deleted)

(f) High crankcase pressure.

(g) Reverse power.

(h) Voltage-controlled overcurrent.

(i) Lube oil temperature high.

The bypass circuits for items (g) and (h) above can be tested in accordance with NRC Branch Technical Position ICSB 17 (Reference 3) to ensure that these trip functions are not effective under accident conditions.* A bypass test switch located at the diesel generator circuit breaker cubicle is used to remove the protective trips from the lockout relay circuit. After expiration of a time delay, a protective trip is simulated causing actuation of the alarm. Operability of the bypass circuit is verified by the absence of the alarm in the control room (DG TRIP DIFFERENTIAL RELAY LOCKOUT for Division 1 and Division 2).

A bypass of the nonessential trips for the Division 1 diesel generator is provided by a keylock switch (1R43-S122SS) in the Division 1 Engine Control Panel (1H51P054A). This bypass switch will be positioned in the 'OFF' position during normal plant operation. This switch will have no effect on the plant when positioned in the 'OFF' position because this causes the switch contacts to be in an open condition. The switch will be placed in the 'ON' position in the event of a Control Room fire, or there is a need to restart the diesel generator following a high temperature trip.

*NOTE: These trip functions are also not effective during a bus under/degraded voltage condition.

4. Interlocks

No interlocks are provided in the diesel generator starting circuits. The diesel generator circuit breakers are interlocked with the associated preferred and alternate preferred power source circuit breakers. Both the preferred and alternate preferred power source circuit breakers must be open before the diesel generator circuit breaker can be closed following receipt of either a LOCA or a bus undervoltage signal. Interlocks also prevent the preferred and alternate preferred power source circuit breakers from being closed at the same time. However, the diesel generator can be manually paralleled with either the preferred or alternate preferred power sources.

The engine can be started in a “slow start” mode of operation for testing. This “slow start,” which is recommended by the manufacturer, extends the starting time of the diesel to minimize the aging effects associated with fast starts. The Slow/Fast switch is maintained in ‘fast’ until slow start switch position and associated circuit is fully tested and functional.

5. Permissives

Permissive conditions which must be satisfied for automatic diesel generator start are as follows:

(a) Maintenance switch must be in the normal position.

(b) Diesel generator differential relay lockout trip must be reset.

(c) Starting air supply sufficient to override the inhibit automatic start signal. (Pressure permissive, emergency only)

(d) Local-remote transfer switch must be in the remote position.

(e) Diesel generator control switch must be in the auto position.

6. Load Shedding Circuits

Load shedding circuits are discussed in <Section 8.3.1.1.2.6>.

7. Testability

The diesel generators can be tested during normal plant operation or during plant shutdown periods. Administrative controls allow testing of only one diesel generator at a time during normal plant operation. At least once every ten years, during refueling outage, all three diesel generators will be tested simultaneously.

In order to achieve this optimum equipment readiness status, the following requirements should be met:

(a) The surveillance instruction will have a requirement to load the diesel to a minimum of 25% full load for each diesel whenever the diesel is to be operated for more than 3 to 4 hours. The manufacturer's recommendations for no-load and light load operation will be implemented.

(b) A conflict between NRC guidelines in <Regulatory Guide 1.108> and the engine manufacturer's operating requirements does not exist.

(c) The preventative maintenance program will provide methods for data collection and review of any malfunction or discrepancies encountered. This data will be maintained in a computerized equipment history file along with corrective maintenance information.

The computerized maintenance system will permit ease of access to information for trending and evaluation. These evaluations will then be used to revise preventative and corrective maintenance practices and, as necessary, to initiate equipment repair, modification and replacement.

(d) Upon completion of repairs or maintenance, the applicable valve and electrical lineup sheets for the affected diesel auxiliary systems, diesel starting air, diesel fuel oil, diesel jacket water, diesel lube oil, and diesel intake and exhaust, will be completed to return the unit to the correct standby mode. A final equipment check will be made to assure that all electrical circuits are functional and all valves are properly positioned to permit a manual start of the equipment. After a

satisfactory manual startup and load test of the diesel generator unit, it will be placed in automatic standby service.

(e) During troubleshooting, no load operation will be minimized. If troubleshooting is extended beyond a 3 to 4 hour period, the engine shall be cleared in accordance with manufacturers recommendations for no-load and light load operation.

The standby power system can be tested from either the diesel generator room or the control room. When testing from the control room, circuitry is provided which overrides the test mode or slow start mode. Note: The Slow/Fast switch is maintained in 'fast' until slow start switch position and associated circuit is fully tested and functional. In the event of a LOCA signal (high drywell pressure or reactor vessel Level 1) or bus under/degraded voltage. The controls for the diesel generator are designed such that if a LOCA or bus under/degraded voltage start signal is initiated while the unit is undergoing its periodic exercise test, whether the unit is starting, running disconnected, running loading, tripping under a fault other than overspeed or generator differential, or coasting to a stop, the control system will cause the unit to return to rated speed and voltage, and will disarm all protection except overspeed and generator differential. When the unit comes up to speed and voltage as required, an electrical signal will be generated to use in the loading sequence circuit.

Manual synchronization capability of each diesel generator to the offsite power sources is possible from the control room or diesel generator room. From both of these locations, the

diesel generator can be paralleled to the Class 1E 4.16 kV bus when either the preferred or alternate preferred offsite power source is supplying the bus. When the diesel generator is the sole source of power supplying the bus, the Class 1E

4.16 kV bus can be paralleled to either offsite power source from the control room, and can be paralleled to the preferred source from the diesel generator room.

Trip inputs which are in effect during diesel generator testing are indicated by <Figure 8.3-6>. Testability of bypassed trip inputs is discussed in <Section 8.3.1.1.3.2.b.10>.

8. Fuel Oil Storage and Transfer System

The fuel oil storage and transfer system is discussed in <Section 9.5.4>.

9. Cooling and Heating Systems

Cooling and heating systems associated with the diesel generators are discussed in <Section 9.5.5>.

10. Instrumentation and Control Systems, Including Status Alarms and Indications

Safety-related control power for the diesel generators is supplied from the division with which each diesel generator is associated. There are no instrumentation and control power source interconnections between divisions. Instrumentation which does not perform a safety function is supplied from a non-Class 1E power supply. Control and monitoring instrumentation for the standby diesel generators is installed on free standing floor mounted panels separate from the engine skids.

Local and remote alarms are provided to indicate diesel generator and associated auxiliary equipment status as follows:

(a) A single out-of-service alarm annunciator window in the control room indicates the diesel generator is not capable of response to an emergency start signal. One alarm is provided for each diesel generator. The following conditions actuate this alarm:

   (1) Diesel generator maintenance switch in the inoperative position.

   (2) Starting air supply pressure less than 150 psig.

   (3) Engine-generator lockout trip not reset.

   (4) Loss of engine dc control power.

   (5) Local-remote switch not in the remote position.

   (6) Diesel generator circuit breaker not in operating position.

   (7) Loss of diesel generator circuit breaker dc control power.

   (8) Diesel generator unit not available - emergency status.

   (9) Diesel generator fuel oil transfer pumps inoperable.

   (10) Diesel generator building ventilation system inoperable.

(11) Emergency service water pump tripped or inoperable.

(b) Individual annunciator windows are provided in the control room to alert the operator to the following abnormal conditions:

(1) Emergency service water to diesel heat exchanger flow low.

(2) Fuel transfer pump 1A strainer differential pressure high.

(3) Fuel transfer pump 2A strainer differential pressure high.

(4) (Deleted)

(5) Lubricating oil temperature high.

(6) Starting air pressure low.

(7) Fuel day tank level high/low.

(8) Crankcase pressure high trip.

(9) Lubricating oil pressure low.

(10) Fuel storage tank level low (7 day level).

(11) Fuel storage tank 1A level low (1 day level).

(12) Engine bearing temperature high.

(13) Turbocharger oil pressure low.

(14) Jacket water temperature high.

(15) Diesel generator trouble.

(16) Diesel generator protective relay lockout trip.

(17) Diesel generator differential relay trip.

(18) Diesel generator start signal received.

(19) Diesel generator overspeed trip.

(20) Diesel generator failure to start.

(21) Diesel generator control in local.

(22) Diesel generator out-of-service.

The above alarms are for Division 1; Division 2 alarms are similar.

(c) Local alarms, as listed below, are also provided for each diesel generator:

(1) Any switch not in the auto position.

(2) Jacking device engaged.

(3) Fuel oil booster pump strainer differential pressure high.

(4) Fuel day tank level low.

(5) Fuel transfer pump 2 running.

(6) Lubricating oil filter differential pressure high.

(7) Lubricating oil inlet temperature low.

(8) Jacket water pressure low.

(9) Jacket water inlet temperature low.

(10) Loss of control air.

(11) Fuel transfer pump 1 filter differential pressure high.

(12) Fuel day tank level high.

(13) Lubricating oil inlet temperature high.

(14) Jacket water inlet temperature high.

(15) Generator
- neutral overvoltage
- field ground

(16) Starting air pressure low.

(17) Fuel transfer pump 2A filter differential pressure high.

(18) Fuel storage tank level low (7 day level).

(19) Fuel pump strainer differential pressure high.

(20) Field flashing 125-volt dc power loss.

(21) Generator stator temperature high.

(22) Fuel filter differential pressure high.

(23) Fuel storage tank level low (1 day level).

(24) Turbocharger oil left bank pressure low.

(25) Lubricating oil level low.

(26) Lubricating oil outlet temperature low.

(27) Jacket water standpipe level low.

(28) Jacket water outlet temperature low.

(29) Diesel generator failure to start.

(30) Fuel oil pressure low.

(31) Fuel pump/OS drive failure.

(32) Turbocharger oil right bank pressure low.

(33) Lubricating oil pressure low.

(34) Lubricating oil outlet temperature high.

(35) Jacket water outlet temperature high.

(36) Diesel generator start signal received.

(37) Diesel generator differential relay trip.

(38) Diesel generator overspeed trip.

(39) (Deleted)

(40) Crankcase pressure high trip.

(41) Turbocharger oil pressure low trip.

(42) Lubricating oil pressure low trip.

(43) Lubricating oil temperature high trip.

(44) Engine bearing temperature high trip.

(45) Jacket water outlet temperature high trip.

(46) Lube oil strainer differential pressure high trip.

(47) Protective relaying lost.

(48) Jacket water pump/heater undervoltage - loss of power.

(49) Lubricating oil circulating pump/heater undervoltage - loss of power.

(50) 125 Vdc Trouble.

(d) Local and remote indication is provided to indicate the following parameters related to the standby power source:

(1) Engine governor change.

(2) Breaker close or trip.

(3) Bus potential (light and meter).

(4) Preferred power source circuit breaker position.

(5) Non-Class 1E bus (stub bus) isolating breaker position.

(6) Alternate preferred power source circuit breaker position.

(7) Interbus transformer circuit breaker position.

(8) Synchronization (synchroscope).

(9) Diesel generator speed (tachometer).

(10) Watts and vars (meters).

(11) Field current and voltage.

(12) Phase current.

(13) Division battery voltage.

(14) DC bus voltage.

(15) Alternate preferred power source voltage.

(16) Generator phase voltage.

(17) Out-of-service status (lights).

(18) Fuel storage tank and day tank levels.

(19) Jacket coolant flow.

(20) Generator regulator change.

11. Qualification Program

The diesel generator was tested in accordance with the requirements of IEEE Standard 387 as modified by <Regulatory Guide 1.9> and Branch Technical Position ICSB2. The DeLaval Engine and Compressor Division performed the following qualification tests:

(a) Starting Air System

(1) Air Receiver

One starting air system was used in performing this test. The compressor was locked out and eight consecutive diesel engine starts were performed using one receiver that was initially at rated pressure.

(2) Air Compressor

The air compressor was operated to recharge the air receiver from a pressure equivalent to that in the receiver after the fifth consecutive start (see Item (1), above). The compressor operated until receiver pressure reached the cutoff point. Time to recharge the receiver was recorded. Then five diesel engine starts were performed with the receiver initially at rated pressure and the compressor locked out.

(b) Sequential Loading

Two sequential loading tests were performed. The first was performed with the diesel generator in an initially unloaded condition. The second was performed with the diesel generator operating at an initial load of 3,850 kW. <Table 8.3-4> presents test data.

(c) Start and Load Acceptance Test

The start and load acceptance test (300 start test) was performed using a prototype diesel generator intended for use at Grand Gulf Nuclear Station. The Grand Gulf standby power supplies are similar in continuous rating (7,000 kW) to the Perry Nuclear Power Plant diesel generators. An analysis was performed to justify the difference (generator manufacturer) between the prototype unit and the Perry units.

During the 300 start test the diesel engine was cycled from standby lubricating oil and coolant temperature conditions for 270 starts. The remaining 30 starts were performed with initial oil and coolant temperatures at half load values. Prior to each start oil and coolant were force cooled to "keep warm" temperatures. The engine was then operated until normal lubricating oil and coolant temperatures were reached. The engine attained synchronous speed under a load of 3,500 kW in less than 7 seconds after each start. The test was considered successful and was in accordance with the requirements of IEEE Standard 387.

(d) Load Rejection Test

The diesel generator was loaded to 7,000 kW (resistive load) and operated at rated frequency, voltage and engine temperature. All load was then removed simultaneously, placing the generator in a no load condition. The engine governor successfully maintained the diesel generator within the required speed range during the transient.

(e) Margin Tests

Two tests were performed to demonstrate the existence of adequate margin for the diesel generator to start and carry loads greater than the load resulting from the most severe step load change in the plant design loading sequence. Margin test results are presented by <Table 8.3-5>.

(f) Overspeed Test

The diesel generator was started and a 3,500 kW load was applied. Engine speed was then increased manually until the overspeed governor tripped the engine. A Visicorder chart indicated maximum speed at time of trip was 115 percent of synchronous speed.

(g) Starting and Loading Test

A starting and loading test was performed to demonstrate the ability of the diesel generator to operate under load without an engine jacket cooling water supply for 1.5 minutes without causing an alarm condition. The diesel generator was started and loaded to 7,700 kW and was operated until temperatures stabilized. It was then

shut down and service water pumps were stopped. A sequential load test was then performed with the service water pumps inoperable. The engine operated for 1.5 minutes without service water and without any alarm condition. <Table 8.3-6> presents the load sequence used for this test.

(h) Short Time Overload Test

The short time overload test was performed by operating the diesel generator at normal speed under a load of 7,700 kW (110 percent of continuous service rating) established by means of water rheostats. The diesel generator was operated under these conditions for two hours without observation of abnormal engine parameters, noise or vibration.

8.3.1.1.3.3 Division 3 Diesel Generator, High Pressure Core Spray Power Supply

a. Design Bases

The HPCS power system loads consist of the HPCS pump motor and associated 460-volt ac auxiliaries, such as motor operated valves, engine cooling water pump and miscellaneous engine auxiliary loads. <Figure 8.3-7> is the basic one line diagram of the system. <Figure 8.3-8> illustrates the system logic. <Table 8.3-9> details the diesel generator specifications.

The HPCS power system is self-contained, except for access to the preferred source of offsite power through the onsite ac power distribution system and the system actuation signal source. The system is operable as an isolated system independent of electrical connection to any other system by using the HPCS diesel generator.

Note, Division 3 is capable of being manually cross-tied to Division 2 to provide power to certain Division 2 loads during a station blackout. Refer to <Appendix 15H> for more information. Also note that Division 3 is capable of being manually connected to Division 1 following a loss of coolant accident and a total loss of both the normal and emergency Division 1 AC electrical power sources, to provide power to the motor-operated gate valves in the Feedwater lines. Class 1E auxiliary equipment, such as standby heaters and battery chargers, are supplied from the same source as the HPCS pump motor. The diesel generator is compatible with power available from the onsite ac power system.

The HPCS diesel generator is capable of quickly restoring power to the HPCS pump motor in the event that offsite power is unavailable and can provide all power for startup and operation of the HPCS system. The HPCS diesel generator starts automatically upon receipt of a signal from the plant protection system (low water level or high drywell pressure-LOCA initiation signals) or upon detection of HPCS bus undervoltage or degraded voltage. When the preferred power supply is unavailable, the HPCS diesel generator is automatically connected to the HPCS bus.

The HPCS electrical system is capable of functioning when subjected to design bases natural phenomena. In particular, the system is designed in accordance with Seismic Category I requirements and is housed within a safety class structure.

The HPCS system and its power supply unit is part of the ECCS. HPCS and the diesel generator by itself does not meet the single failure criterion, although the criterion is applicable at the ECCS level.

The HPCS diesel generator is provided with a separate fuel day tank and fuel storage tank of sufficient capacity to support operation

of the standby power source while supplying maximum postaccident HPCS power requirements for a time sufficient to bring the plant to a safe condition. Tank size is discussed in <Section 9.5.9.1>.

The HPCS diesel generator is provided with a cooling water system as described in <Section 9.5.9.2> and a lubrication system as described in <Section 9.5.9.4> and a combustion air intake and exhaust as described in <Section 9.5.9.5>. A general description of the application of the diesel generator is to be found in NEDO-10905 and supplements and a description of the HPCS system application is provided in <Section 7.3> <Table 8.3-9>. The HPCS diesel generator for the Perry project is a Stewart and Stephenson 1 X 20 cylinder EMD diesel generator equipped with a turbocharger driven by a heavy duty mechanical drive gear assembly. The qualification tests described in NEDO-10905-3 are applicable to the Perry application.

The position of the local-remote switch has no effect on response to an emergency start signal for the HPCS diesel generator. Control is accomplished from either the control room or the HPCS diesel room. The following conditions render the diesel generator incapable of responding to an automatic emergency start signal:

1. Diesel generator electrical or mechanical trouble lockout relays not reset.

2. Diesel generator engine mode switch in maintenance or test position.

3. Loss of dc power to diesel generator controls.

4. Loss of dc power to diesel generator output breaker control.

5. Diesel generator insufficient starting air pressure.

6. Diesel generator circuit breaker not in the operating position (not racked-in).

7. Diesel generator remote control switch in pull-to-lock position.

All the above conditions are displayed to the operator in the control room and to the diesel generator panel as described in <Section 8.3.1.1.3.3.b.10>. A discussion of the air start system is in <Section 9.5.9.3>.

The Division 3 Class 1E dc power supply system provides dc power to the HPCS system for control and protection.

<Figure 9.5-26> is a functional block diagram of the HPCS diesel generator. The diesel generator is required to operate in four modes:

1. To meet the periodic test requirements for the diesel generator.

2. With loss of offsite power, starts and supplies power to the bus.

3. In accident conditions with loss of offsite power, starts and supplies power to the bus.

4. In accident conditions with no loss of power, starts and stands by.

The diesel generator is only used for emergencies and testing. It is not used for peaking during normal operation of the station.

The turbocharger design currently installed complies with the recommendations of <NUREG/CR-0660>. It has light load service limits sufficiently high, that when reduced by a factor of 3, are not exceeded during normal operating or accident conditions over the service life of the turbocharger.

In Operating Mode 1 the diesel generator is not placed under no load or light load conditions for extended periods. Indeed, the cumulative operating time under low load conditions should be very small compared with the cumulative time limit provided that operating procedures are followed (which includes compliance with <Regulatory Guide 1.108>).

In Operating Modes 2 and 3, the diesel generator is likely to operate under low load conditions but in this instance the event is extremely rare and easily documented. To ensure adequate loading, the diesel generator shall be operated in accordance with the limitations and precautions of the manufacturer’s recommendations. Operating procedures have been developed to assure operation through prevention of lubricant oil exhaust as well as in consideration of turbocharger problems.

b. Design Aspects

1. Start Initiating Circuits

The Division 3 (HPCS) diesel generator is started automatically upon receipt of a LOCA signal (high drywell pressure or reactor vessel Level 2) or associated bus undervoltage signal or degraded voltage signal. Manual starting capability is provided in the control room (remote) and at the diesel generator (local). A mode selector switch

located in the control room transfers manual start-stop capability between the diesel generator panel and the control room. <Figure 8.3-8> illustrates system logic.

2. Starting Mechanism and System

The HPCS diesel generator is pneumatically started. Redundant starting air supplies are provided for each engine. Additional details concerning the starting air system are presented in <Section 9.5.9.3.>

3. Tripping Devices

Only the generator differential and overspeed trip functions will shut down the diesel generator after a start resulting from LOCA signal. The following additional, nonessential trip functions are bypassed upon receipt of a LOCA signal but will shut down the diesel generator when operating in all other modes:

(a) High jacket water temperature.

(b) Low lubricating oil pressure.

(c) Voltage-controlled, overcurrent.

(d) Reverse power.

(e) Overcrank (failure to start).

4. Interlocks

No engine and generator trip lockouts are provided in the HPCS diesel generator starting circuit. The diesel generator circuit breaker is interlocked with the associated preferred and alternate preferred power source circuit breakers. Both

the preferred and alternate preferred power source circuit breakers must be open before the diesel generator circuit breaker can be closed following receipt of a bus undervoltage signal. Also, the diesel engine no fuel start delay with concurrent emergency (undervoltage) start signal interlock contact must be closed before the diesel generator circuit breaker can be closed following the receipt of a bus undervoltage condition. Interlocks also prevent the preferred and alternate preferred power source circuit breakers from being closed at the same time. However, the diesel generator can be manually paralleled with either the preferred or alternate preferred power sources.

5. Permissives

Permissive conditions which must be satisfied for automatic HPCS diesel generator start are as follows:

(a) Engine mode switch must be in auto position.

(b) Diesel generator remote control switch must be in auto position.

(c) Engine and generator lockout relays must be reset.

(d) HPCS diesel generator circuit breaker must be racked-in.

6. Load Shedding Circuits

Load shedding circuits are discussed in <Section 8.3.1.1.2.6>.

7. Testing

(a) Periodic surveillance testing will be performed in accordance with <Regulatory Guide 1.108> and the manufacturer's operating manual, between which there are no conflicts. However, accelerated testing as recommended in position C.2.d of <Regulatory Guide 1.108> is not included in the periodic surveillance testing. <Generic Letter 94-01> allowed the requirement for accelerated testing to be deleted from the Technical Specifications when a program to meet the Maintenance Rule <10 CFR 50.65> was implemented for the diesel generators. It is not anticipated that the DG should experience no load or light load operation for extended periods during periodic testing <Section 8.3.1.1.3.3a>. Normal operating procedures will include a precautions such that the operation of the diesel generator with no or low load will be minimized. Maintenance will be performed in accordance with the manufacturer and Regulatory Guide recommendations.

Equipment failures will be monitored by a maintenance history and periodically reviewed for failure rates and trends by the Plant Staff, as described in <Section 8.3.1.1.3.2.b.7>.

(b) During troubleshooting, no load operation will be minimized. If troubleshooting is extended beyond a 3 to 4 hour period, the engine shall be cleared in accordance with manufacturers' recommendations for no-load and light load operation.

8. Fuel Oil Storage System

The HPCS diesel generator fuel oil storage system is discussed in <Section 9.5.4>.

9. Cooling and Heating Systems

Cooling and heating systems associated with the HPCS diesel generator are discussed in <Section 9.5.5>.

10. Instrumentation and Control Systems, Including Status Alarms and Indications

Safety-related control power for the HPCS diesel generator is supplied from Division 3. There are no interconnections with other divisions.

Alarms are provided to indicate HPCS diesel generator and associated auxiliary equipment status as follows:

(a) The HPCS Out-of-Service annunciator has multiple inputs which may indicate degraded components of either the Diesel Generator or the HPCS System. Further investigation is warranted when this annunciator actuates. The following conditions actuate this alarm:

(1) Engine-generator lockout trips not reset.

(2) HPCS diesel generator circuit breaker not in operating position. (Not racked-in)

(3) Engine mode switch in maintenance or test.

(4) Control room auto switch in the pull-to-lock position.

(5) Loss of power or overload to HPCS:

- Condensate Storage Tank (CST) suction valve
- Injection valve
- First test valve to CST

- Pump minimum flow valve
- Suppression pool suction valve
- Test valve to suppression pool
- Water leg pump
- Emergency Service Water (ESW) pump
- ESW pump discharge valve
- Diesel generator room ventilation temperature process instrumentation
- Diesel generator room ventilation fans
- Diesel generator room ventilation louvers
- Both HPCS diesel generator fuel oil transfer pumps

(6) HPCS line break

(7) HPCS Trip Unit in CAL or gross failure

(8) HPCS Trip Unit out of file or power loss

(9) HPCS logic power failure or in Test

(10) HPCS inverter power failure or in Test

(11) HPCS pump circuit breaker auto trip or loss of control power

(b) Additional control room alarms are provided to alert the operator to the following HPCS diesel generator conditions:

(1) Diesel generator trouble.

(2) Emergency service water to diesel heat exchanger flow low.

(3) Fuel transfer pump 1C strainer differential pressure high.

(4) Fuel transfer pump 2C strainer differential pressure high.

(5) HPCS day tank level high/low.

(6) Lubricating oil pressure low.

(7) HPCS fuel storage tank level low (7 day level).

(8) HPCS fuel storage tank level low (1 day level).

(9) Diesel generator lockout relay trip.

(10) Jacket water temperature high.

(11) Diesel generator differential relay trip.

(12) Diesel generator control in local.

(13) Diesel generator overspeed trip.

(14) Starting air pressure low.

(15) Diesel generator failure to start (signifying overcrank condition).

(16) Diesel generator emergency start signal received.

(17) Diesel generator protective relay trip.

(c) Local alarms, as listed below, are also provided for the HPCS diesel generator:

(1) Failure to start/run (signifying overcrank condition).

(2) Charger failure.

(3) Control power failure.

(4) High water temperature.

(5) Overspeed.

(6) Low starting air pressure.

(7) High stator temperature.

(8) Low expansion tank water level.

(9) Low fuel level.

(10) Engine tripped.

(11) Low turbocharger lubricating oil pressure.

(12) Low cooling water pressure.

(13) Crankcase pressure high.

(14) Main fuel pump failure.

(15) Reserve fuel pump failure.

(16) Restricted fuel oil filter.

(17) High lubricating oil temperature.

(18) Low lubricating oil temperature.

(19) Low lubricating oil pressure.

(20) Restricted lubricating oil filter.

(21) Protective relaying lost.

(22) High dew point.

(23) Circulating oil pump overload/power loss.

(24) Starting air compressor overload/power loss.

(25) Generator heater overload/power loss.

(26) Generator neutral ground over voltage.

(27) Jacket Water Heater Overload/Power loss

The HPCS diesel generator controls are installed on a free standing floor mounted panel, i.e., the DG control panel is separate from the engine skid. The location of this panel and its design is such that it is able to withstand continuous vibrational stresses anticipated during operation. Only sensors and other equipment which by their nature require attachment to the engine generator and associated equipment are to be found there.

11. Qualification Program

The HPCS diesel generator qualification program is discussed in <Section 8.3.1.1.6.11>.

8.3.1.1.4 Design Criteria

8.3.1.1.4.1 Electric Motors

a. Motor Size

Motors supplied with driven equipment are sized by the equipment vendor to ensure that the maximum required horsepower of the driven equipment does not exceed the motor nameplate horsepower rating. Driven equipment, for which motors are supplied separately, consists of primarily pumps. The pump motor is sized to ensure that the motor nameplate horsepower rating exceeds the maximum required brake horsepower of the pump.

b. Minimum Motor Accelerating Voltage

The electric power system is designed so that the minimum voltage that will exist for Class 1E motor circuits is 75 percent of nominal. This minimum may occur during the diesel generator loading sequence. Motors, except those associated with valve

operators and the standby liquid control pumps, are specified to be capable of starting from rest and accelerating the connected equipment with 75 percent of nominal voltage at the motor terminals.

c. Motor Starting Torque

Motors, except those associated with valve operators and the standby liquid control pumps, are specified to produce starting torque well above that required by the driven equipment and to accelerate to full load speed at 75 percent of nominal voltage without injurious motor heating.

d. Minimum Motor Torque Margin over Pump Torque through Acceleration Period

The minimum margin of motor torque over pump torque through the acceleration period is determined by comparison of the pump speed-torque curve with the motor speed-torque curve at 75 percent of nominal voltage at the motor terminals. The pump motor assembly must attain rated speed with not less than 15 percent decrease in the torque margin.

e. Motor Insulation

Motor insulation is selected based upon the specified ambient conditions (temperature, pressure, humidity, and radiation) to which the motor is expected to be exposed. For Class 1E motors located inside containment, insulation is selected to withstand the postulated accident environment. Motors inside containment have Class F insulation. Motors outside containment have minimum Class B insulation. Motors used as valve operator motors inside containment have Class H insulation. Motors used as valve operator motors outside containment have minimum Class B insulation.

f. Temperature Monitoring Devices in Large Horsepower Motors

Class 1E driven equipment motors supplied separately, rated 200 horsepower or more, are equipped with six embedded, standard accuracy, chromel-constantan thermocouples for monitoring stator winding temperature. These thermocouples are located so that at least one of the sensors will detect the winding hot spot temperature. A chromel-constantan thermocouple is provided for each bearing.

8.3.1.1.4.2 Interrupting Capacity of Switchgear, Load Centers, Motor Control Centers, and Distribution Panels

Interrupting capacities of switchgear, load centers, motor control centers, and distribution panels are listed in <Table 8.3-2>.

Switchgear interrupting capacities are greater than the maximum short circuit current available at the point of application. Short circuit current in medium voltage systems is determined in accordance with ANSI C37.010 (Reference 4). The power system, a single standby power source and running motor contributions are considered in determining the fault level.

Unit substation, motor control center and distribution panel interrupting capacities are greater than the maximum short circuit current available at the point of application. The magnitude of short circuit currents in low voltage systems is determined in accordance with ANSI C37.13 (Reference 5).

8.3.1.1.4.3 Electric Circuit Protection

Electric circuit protection is discussed in <Section 8.3.1.1.2.9>.

8.3.1.1.4.4 Grounding Requirements

The grounding system provides a low resistance path to ground for all metallic parts, thereby limiting potential differences which may exist between metallic components and ground. The system provides: safety for personnel, instrument signal reference, lightning and surge protection, and limits line-to-ground voltages for single phase-to-ground faults.

The plant ground grid consists of buried metal steel plates, bare copper wire, steel pilings, and ground rods. Steel plates are buried below the foundation mats of several buildings at the lowest available elevations in the plant. Bare copper wire is buried in grid fashion within the plant and switchyard and around the perimeter fence. The grid is concentrated in each area according to the fault current available in the area. Steel pilings at the barge slip on Lake Erie add an underwater conductor to the system. Copper clad ground rods are driven throughout the grid to achieve an overall ground resistance of 1 ohm or less from any test point to earth.

Bare stranded copper wire is arranged in loops around the interior perimeter of each building along routes of cable tray or building steel. All metallic electrical raceways, including trays, boxes and conduit, are part of the plant ground system.

The number and type of terminations for grounding items or equipment are selected on the basis of the size of equipment or electrical service. One or more ground pads provide a convenient location for ground connections to large items. On smaller items the ground connection may be made at a mounting point. Welded or bolted connections are used.

An instrument ground system provides a low impedance path to ground for process instrumentation. This system consists of a radial network of

bare copper buses located in the Control Room floor. This network is connected directly to the plant ground grid via insulated cable. This network is connected to building steel in the Control Room. Local panels and equipment requiring instrument ground are connected to the instrument ground system by their own insulated cables. The reactor vessel skirt which is connected to the plant ground grid is connected to the instrument ground system with insulated cable. Bolted disconnect points for monitoring are available on the instrument ground system.

8.3.1.1.4.5 Logic and Schematic Diagrams

<Figure 8.3-6>, <Figure 8.3-8>, and <Figure 8.3-9> indicate the logic for the standby power supply and the preferred and alternate preferred power supply circuit breakers. One line drawings are provided by <Figure 8.3-7>, <Figure 8.3-10>, <Figure 8.3-11>, <Figure 8.3-12>, and <Figure 8.3-13>. <Figure 8.3-1> and <Figure 8.3-2> provide the main one line diagrams.

8.3.1.1.5 Reactor Protection System Power System

8.3.1.1.5.1 General

The reactor protection system (RPS) power system is designed to provide power to the logic system that is part of the RPS. It prevents auxiliary power system switching transients from causing an inadvertent reactor scram due to a transient disturbance of power to the reactor scram logic. The RPS power system includes two high inertia, alternating current, motor generator sets, and distribution equipment.

Each motor generator set supplies control power for independent trip systems of the nuclear steam supply shutoff system, power range neutron monitoring system, parts of process radiation monitoring system, and reactor protection trip system. The RPS power is classified as

nonessential because failure of the power supply causes a reactor scram. However, the power feeds to independent divisions are physically separated and supply redundant logic.

Safety-related signal cables, power cables and cable trays are identified by nameplates and/or color codes to distinguish them from nonsafety-related equipment and to distinguish among redundant, safety-related equipment.

Safety-related instrument panels are identified by color coded nameplates to distinguish them from nonsafety-related equipment and to distinguish among redundant, safety-related equipment.

Since the RPS power is classified as nonessential, PNPP has electrical protective assemblies (EPAs) which consists of Class 1E protective circuitry between the RPS and each of the power sources. Two EPAs provide redundant protection to each RPS bus by acting to disconnect the RPS from the power source circuits.

The EPA consists of a circuit breaker with a trip coil driven by logic circuitry which senses line voltage and frequency and trips the circuit breaker open on the conditions of overvoltage, undervoltage and under-frequency. Provision is made for setpoint verification, calibration and adjustment under administrative control. After tripping, the circuit breaker must be reset manually. Trip setpoints are based on providing 120 volt ac, 60 Hz power at the RPS logic cabinets. The protective circuit functional range is ±10% of nominal ac voltage and -5% of nominal frequency.

The EPA assemblies are packaged in an enclosure designed to be wall mounted. The enclosures are mounted on a Seismic Category I structure separately from the motor generator sets and separate from each other. Two EPAs are installed in series between each of the two RPS motor generator sets and the RPS busses and between the auxiliary power

sources and RPS busses. The block diagram in <Figure 8.3-23> provides an overview of the four EPA units and their connections between the power sources and the RPS busses. The EPA is designed as a Class 1E electrical component. It is designed and fabricated to meet the quality assurance requirements of <10 CFR 50, Appendix B>.

The enclosures containing the EPA assemblies are located in equipment qualification zone CB-2. The circuits within the enclosure are qualified to operate under accident conditions from 40°F to 137°F, at 10 to 95 percent relative humidity and survive a total integrated radiation dose of 2×10^5 rads. The assemblies are seismically qualified to the Safe Shutdown Earthquake and Operating Base Earthquake acceleration response spectra and environmentally qualified.

8.3.1.1.5.2 Components

Each of the high inertia motor generator sets has a voltage regulator which is designed to respond to a step load change of 50 percent of rated load with an output voltage change of not more than 15 percent. The motor generator sets require no manual operation or adjustment during the coastdown or acceleration period. High inertia is provided by a flywheel. The inertia is sufficient to maintain the voltage and the frequency of generated voltage within 5 percent of the rated values for at least 2 seconds following a total loss of power to the drive motor.

8.3.1.1.5.3 Sources

Power to each of the RPS buses is supplied from two 120-volt ac sources. The primary source of power is the motor generator sets. The alternate source of 120-volt ac power is the station non-Class 1E power supply. The two motor generator sets are supplied from separate 480 volt

non-Class 1E buses. The alternate power switch design and arrangement prevents paralleling of the power sources. Indicating lights are provided in the control room to monitor the status of both the motor generator sets and the alternate supply.

8.3.1.1.5.4 Operating Configuration

During operation, the RPS buses are energized by the respective motor generator sets. Either motor generator set can be taken out-of-service by manually operating the power source selector switch which disconnects the motor generator set and connects the respective RPS bus to the alternate power source. Provision is made to prevent connection of both RPS buses to the alternate source at the same time. A loss of power to either motor generator set is monitored in the control room where the operator, upon detecting such a condition, can switch to the alternate power source. A loss of RPS power supply results in a single RPS trip system trip. A sustained loss of electrical power to both RPS buses results in a scram.

8.3.1.1.6 High Pressure Core Spray System Power System

8.3.1.1.6.1 General

Refer to <Section 8.3.1.1.3.3>.

8.3.1.1.6.2 Equipment Identification

Major HPCS power system equipment, such as the diesel generator, switchgear, motor control center, and transformers, is identified in accordance with <Section 8.3.1.1.2.9>.

8.3.1.1.6.3 HPCS Class 1E Electrical Equipment Capacity

HPCS power system electrical apparatus is sized on the basis of the most severe conditions to which it will be subjected, for either continuous or intermittent conditions in any mode of operation. Intermittent loads are factored in on the basis of heating (e.g., short time peaks are not added directly to determine total continuous load imposed). Adverse environmental conditions have been taken into consideration (e.g., derating of cable for temperatures higher than the basic rated values and use of multipliers on actual service hours for motors operated at higher than normal rated temperatures).

The HPCS load center transformer (EHF-1-E) is sized for the largest combination of continuous loads that it may be required to carry, plus an allowance for intermittent loads.

The switchgear ratings established are consistent with bus loading and interrupting capacity requirements and are compatible with maximum available short circuit current values at the points where feeders connect to Class 1E switchgear. HPCS distribution system ratings are given in <Table 8.3-2>.

The HPCS motors are designed to start and accelerate the pump loads with 75 percent voltage applied to the motor terminals.

The minimum difference between the motor torque and the pump torque at any given speed during acceleration is 10 percent of motor rated torque.

The HPCS motor is provided with thermocouples on bearings and in windings to verify that temperature rise is acceptable.

The HPCS motor is initially tested in accordance with NEMA MG-1 (Reference 6).

The Division 3 HPCS diesel generator is capable of starting the HPCS motor within the required time although voltage and frequency drop will exceed the limits specified in <Regulatory Guide 1.9>. See <Section 8.3.1.2.3.5> for a discussion of <Regulatory Guide 1.9> and the HPCS diesel generator.

8.3.1.1.6.4 HPCS 120 Volt AC Class 1E Instrument Power System

The Class 1E instrument power system consists of a distribution panel fed from a transformer connected to the Division 3 load centers.

All equipment associated with the Class 1E instrument power system is readily accessible for inspection and testing. Service will be done on a routine basis in accordance with the manufacturer's recommendations. Testing is described in <Section 8.3.1.1.6.5.d>, HPCS Class 1E Electrical Equipment Testing.

8.3.1.1.6.5 HPCS Class 1E Electric Equipment Considerations

For Class 1E equipment aspects of the HPCS power system, the following guidelines are utilized:

a. Physical Separation and Independence

   Equipment of Division 3 is segregated from the equipment of other divisions in accordance with documents, codes and standards cited in the design basis. In general, electrical equipment and wiring for the safeguards systems are segregated into separate divisions and separated so that no design basis event is capable of disabling

sufficient equipment to prevent reactor shutdown, removal of decay heat from the core or isolation of the containment in the event of a design basis accident.

b. Class 1E Electrical Equipment Design Bases and Criteria Aspects

Motors are sized in accordance with NEMA standards and manufacturers' ratings to be at least large enough to produce the starting, pull-in and driving torque calculated to be needed for the particular application, with due consideration for capabilities of the power sources.

Power sources, distribution system and branch circuits are designed to maintain acceptable voltage and frequency.

The selection of motor insulation from alternative types, such as Class F or Class B, is a design consideration based predominately upon environment. Class F insulation is used for all ECCS motors.

Interrupting capacity of switchgear, motor control centers and distribution panels is compatible with the short circuit current available at the HPCS bus. <Table 8.3-2> lists equipment capacities. The calculation of available short circuit currents in the HPCS power system is in accordance with ANSI C37.010 (Reference 7).

c. HPCS Class 1E Electrical Equipment Circuit Protection

Circuit protection of the HPCS bus is coordinated with the design of the overall protection system for the plant auxiliary electrical system. Protection of the HPCS diesel generator is described in <Section 8.3.1.1.3.3>. The HPCS motor and load center supply breakers have instantaneous and inverse time overcurrent phase relaying and instantaneous ground overcurrent relaying. These relays are coordinated so that motor or transformer protective trips are selectively coordinated with the source breakers for bus EH13.

d. HPCS Class 1E Electrical Equipment Testing

Means are provided for periodically testing the chain of system elements from sensing devices through driven equipment to assure that Class 1E equipment is functioning in accordance with design requirements.

Startup of the HPCS diesel generator can be effected by simulation of LOCA signal or loss of power to the engineered safety feature power system. Connection of the HPCS diesel generator to the HPCS bus takes place automatically upon loss of engineered safety feature power system to the HPCS bus.

8.3.1.1.6.6 HPCS Diesel Generator

The HPCS diesel generator supplies power to the HPCS system in the absence of the preferred power supplies. <Figure 8.3-1> shows the interconnections between the preferred power system and the HPCS diesel generator. <Figure 8.3-7> presents the HPCS 4.16 kV one line diagram and <Figure 8.3-2> shows the 480 volt one line diagram for the HPCS system. <Table 8.3-1> lists HPCS diesel generator loads under forced shutdown and LOCA conditions.

The HPCS diesel engine is provided with a closed cooling water system containing immersion heaters, expansion tank, temperature regulating valve, and lubricating oil cooler. The immersion heater is thermostatically controlled and, in conjunction with the temperature regulating valve, maintains the jacket water at a steady temperature. Under engine shutdown conditions, jacket water heated by the immersion heater is circulated through the lubricating oil cooler by thermo-syphon action to warm the lubricating oil which is circulated by an ac motor driven pump. This “keep warm” feature provides the engine with the capability of quick start and load acceptance. An engine low lube oil temperature condition is alarmed locally and annunciated on the main control room HPCS diesel generator trouble alarm.

The HPCS diesel generator is rated to have sufficient capacity to start and run the connected loads <Table 8.3-1> and to start and supply the HPCS system loads within the time requirements described in <Section 6.3>.

8.3.1.1.6.7 HPCS Diesel Generator Starting, Lubricating and Fuel Oil Systems

The starting, lubricating and fuel oil systems for the HPCS diesel generator are discussed in <Section 9.5.9>.

8.3.1.1.6.8 HPCS Diesel Generator Control Power

DC control power for the HPCS diesel generator is supplied from its own 125-volt dc system which consists of a battery and associated battery charger. The battery charger is designed to carry the largest combination of steady-state loads in any mode of operation in addition to battery charging requirements. The dc system is discussed in <Section 8.3.2.1.3>.

8.3.1.1.6.9 HPCS Diesel Generator Actuation

Three signals automatically start the HPCS diesel generator. The first is an undervoltage or degraded voltage condition at the HPCS bus. The other two signals are LOCA signals (reactor low water level and/or high drywell pressure) which are described in detail in <Section 7.3.1>. Upon reaching rated speed and voltage, the generator is automatically connected to the HPCS bus if the preferred power supply is not available. Once the diesel generator has been started, it continues to operate until manually stopped or one of the protective devices causes it to trip. Start logic for the HPCS diesel generator is illustrated by <Figure 8.3-8>.

8.3.1.1.6.10 HPCS Diesel Generator Protective Devices

When the HPCS diesel generator is called upon to operate under accident conditions, only the emergency protective devices are functional. These are the generator differential overcurrent relays and the engine overspeed trip device. These trips are annunciated in the control room. Other protective devices, such as reverse power, voltage-controlled, overcurrent, high jacket water temperature, and low lubricating oil pressure, are used to protect the HPCS diesel generator during operation in parallel with the normal power system during periodic tests. These relays are automatically blocked from the tripping circuits under accident conditions.

The generator differential overcurrent relays and overspeed trip device are retained under emergency conditions to protect against major faults which would cause immediate system failure and major damage. All bypassed trip devices actuate alarms in the control room and provide the operator with sufficient information to take appropriate corrective action. Since the HPCS diesel generator is performing a safety-related

core cooling function under accident conditions, these trip devices cannot be permitted to interrupt HPCS diesel generator operation. The decision to operate the diesel generator under these abnormal conditions is left to the operator.

8.3.1.1.6.11 HPCS Diesel Generator Prototype Qualification Program

The HPCS diesel generator is a Stewart and Stevenson diesel generator package with one EMD 20 cylinder diesel engine. A prototype diesel generator qualification program is described in NEDO-10905-3. During this program, tests were performed at LaSalle. The loads and environmental conditions found at Perry are similar. As part of the program, the HPCS diesel generator <Section 7> and associated equipment (e.g., switchgear, MCC transformer) were qualified in accordance with IEEE Standard 323 1971 and IEEE Standard 344 1971. Qualification of the diesel generator is in accordance with <Regulatory Guide 1.6>, <Regulatory Guide 1.9> and IEEE Standard 387 as described in <Section 8.3.1.2.3>. A comprehensive discussion of the qualification program is provided in <Section 3.10> and <Section 3.11>. Prior to initial fuel loading, the HPCS diesel generator was subject to preoperational testing as defined in the operating procedures and in accordance with <Regulatory Guide 1.68>.

8.3.1.1.6.12 Acceptability Criteria for HPCS Diesel Generator

The HPCS diesel generator is acceptable if it is capable of starting and accelerating the design load to the desired speed within the specified time while maintaining voltage and frequency within limits that will not degrade the performance of the system below requirements during load application and/or load removal and it demonstrates a torque margin, i.e., a torque capability 10 percent in excess of the starting period torque requirements.

8.3.1.2 Analysis

8.3.1.2.1 Compliance with General Design Criterion 17, Regulatory Guides, and Standards

The ESF onsite distribution system has been segregated into three separate and distinct load groups. These load groups are Division 1, Division 2 and Division 3. This arrangement complies with General Design Criterion (GDC) 17 and the recommendations of <Regulatory Guide 1.6>, in addition to other design bases described in <Table 8.1-2>. Each load group is complete with respect to 4.16 kV and 480-volt switchgear, 120-volt ac and 125-volt dc equipment and standby power source. Each load group also has access to the preferred power source and the alternate preferred power source. Control power for operating circuit breakers in a particular division is supplied from the associated 125 volt battery. These batteries are maintained at a constant voltage and are continuously monitored for voltage variations or undesired ground connections. Each motor and distribution feeder is equipped with protective devices which disconnect the motor or feeder under abnormal or potentially damaging conditions to limit degradation of the Class 1E electric power system. No provision exists for transfer of loads between the segregated load groups or for automatic switching which could parallel separate load groups except for the spent fuel pool area ventilation system.

The preferred power source and alternate preferred power source supply circuit breakers are manually operated either from the control room or a remote location. These circuit breakers in each division are

interlocked with each other and with the division standby power source supply circuit breaker. Interlock contacts prevent the following:

a. Closure, at the same time, of the preferred power source and alternate preferred power source supply circuit breakers.

b. Automatic closure of the standby power source supply circuit breaker when either the preferred power source or alternate preferred power source supply circuit breaker is closed.

In addition, administrative controls prevent testing of more than one standby power source at any one time.

As shown by <Figure 8.3-3> and <Figure 8.3-4>, the 4.16 kV and 480-volt switchgear, 120-volt ac equipment, battery chargers, dc switchgear, dc distribution panels, batteries, and vital distribution panels for each division are located in separate rooms within the control complex. IEEE Standard 308 (Reference 9) as modified in <Regulatory Guide 1.32> and <Regulatory Guide 1.6> are used for guidance in the design of electrical systems with the exceptions listed in <Table 1.8-1>. The criteria of IEEE Standard 387 and the recommendations of <Regulatory Guide 1.9> are adhered to in selecting the capacity and operating characteristics of the standby power sources (diesel generators), except as noted in <Section 8.3.1.2.3.5.d>.

8.3.1.2.2 Compliance with General Design Criterion 18

The Class 1E electric system will be tested and inspected periodically to determine that settings and adjustments are within specified design limits. In addition to test facilities for switchgear, described in <Section 8.3.1.1.2.12>, required inservice testing of protective relaying and instrumentation is accomplished by use of test plugs or

test switches associated with these devices. These devices, in addition to the test facilities described, satisfy the intent of GDC 18, the recommendations of <Regulatory Guide 1.22> and the applicable design bases of <Table 8.1-2>.

Automatic starting and loading of diesel generators and the ability to test such functions are an essential part of the ESF system design. Testing of diesel generators is discussed in <Section 8.3.1.1.3.2.b(7)> and <Section 8.3.1.1.3.3.b(7)>.

8.3.1.2.3 High Pressure Core Spray Division 3 Compliance

The HPCS (Division 3) diesel generator unit supplies power for the HPCS system and associated equipment. Failure of any single component does not prevent start and operation of any other standby power supply. Thus, the requirements of GDC 17 and the recommendations of <Regulatory Guide 1.6> are satisfied. The design of the HPCS diesel generator also conforms to applicable sections of IEEE Standard 308.

8.3.1.2.3.1 Compliance with General Design Criterion 17

Compliance of the HPCS power supply with GDC 17 is addressed in <Section 8.3.1.2.1>.

8.3.1.2.3.2 Compliance with General Design Criterion 18

The auxiliary electrical system is designed to permit inspection and testing of all important equipment and features, especially those that have a standby function and the operation of which is not normally demonstrated. As detailed in the Technical Specifications, periodic component tests are supplemented by extensive functional tests during refueling outages. These tests are based upon simulation of actual accident conditions and demonstrate the operability of the diesel

generator set, battery system components and logic systems. Thereby, the continuity of the system and the operation of components are verified.

Because the diesel generator is a standby unit, readiness is of prime importance. Readiness is demonstrated by periodic testing. The testing program is designed to test the ability to start the HPCS diesel generator and system loads, as well as to run under load long enough to bring all components of the system into equilibrium conditions. This ensures that cooling and lubrication are adequate for extended periods of operation. Full functional tests of the automatic control circuitry can be conducted as required on a periodic basis to demonstrate correct operation <Section 7.3.2>.

8.3.1.2.3.3 Compliance with General Design Criterion 21

The HPCS diesel generator supply is designed to be highly reliable and testable during reactor operation. The HPCS diesel generator is the only onsite power supply for the high pressure core cooling function. However, if it fails, the automatic depressurization feature will permit low pressure core cooling.

8.3.1.2.3.4 Conformance with <Regulatory Guide 1.6>

The HPCS diesel generator unit supplies power only for the HPCS system, including auxiliaries. Therefore, failures within the HPCS diesel generator system cannot prevent the startup and operation of any other standby power supply. Thus, the recommendations of <Regulatory Guide 1.6> are satisfied.

Conformance with <Regulatory Guide 1.6> is described for each regulatory position of Paragraph D of the guide as follows:

a. Position 1 Conformance

The HPCS Class 1E loads are assigned to a single division of the load groups. The assignment is determined by the nuclear safety functional redundancy of the loads so that loss of any one division does not prevent the minimum safety functions from being performed.

b. Position 2 Conformance

The HPCS bus (Division 3 of the ac load group can be connected to two different (preferred) offsite power sources <Figure 8.3-1>. The HPCS bus can also be connected to the HPCS diesel generator which is the standby power source for Division 3.

The HPCS diesel generator breaker can be closed automatically only if all other source breakers to the HPCS bus are open. There is no automatic connection to any other division load group.

c. Position 3 Conformance

There is no automatic or manual connection of the HPCS system dc load group to any other load group except a maintenance tie to Unit 2 as described in <Section 8.3.2.1.3.1>.

d. Position 4 Conformance

Position 4 conformance is as follows:

1. The diesel generators connected to the divisions of load groups are physically and electrically independent of each other. The diesel generator connected to the HPCS division of

a load group cannot be automatically paralleled with the diesel generator that is connected to another division of the load group.

2. The HPCS diesel generator is connected to one independent division (or load group). No means exist for connecting the HPCS load group with any other.

3. The HPCS load group is fed from only one diesel generator, as shown by <Figure 8.3-1>. No means are provided for transferring HPCS loads to any other diesel generator.

4. No means exist for manually connecting the HPCS load group to another division. The HPCS load group is physically and electrically independent of all others.

e. Position 5 Conformance

To comply with the recommendations of Position 5, and those of <Regulatory Guide 1.108> as referenced in <Table 1.8>, the following starting and loading reliability tests are performed:

1. Prior to initial reactor fuel loading, a series of tests were conducted to establish the capability of the HPCS diesel generator to consistently start and load within the required time.

2. With the exception of those diesel engine/generator designs that are identical (minor changes may be justified by analysis) to the diesel generator(s) which have been previously qualified for the HPCS application, all other different diesel engine/generator combinations are individually qualified for reliable start and load acceptance requirements.

3. An acceptable start and load reliability test is defined as follows: A total of 69 valid starting and loading tests with no failures. Failure of the diesel generator to successfully complete this series of tests as prescribed requires a review of system design adequacy, correction of the cause of the failure and continuation of the tests, until 69 consecutive starting and loading tests are achieved.

In the course of performing the 69 consecutive start and load tests, at least 90 percent of these tests are performed with the engine initially at or below normal operating temperature but above the "warm standby" engine temperature.

The remaining percentage of these tests are performed with the diesel generator set initially at "warm standby," based upon jacket water and lubricating oil temperatures at or below values recommended by the engine manufacturer. After load is applied, the diesel generator set will continue to operate until jacket water and lubricating oil temperatures are within ±10°F of the normal engine operating temperatures for the corresponding load. A minimum of five "warm standby" starts will be made during the 69 consecutive start and load tests.

In addition to the above reliability test, a test was conducted to demonstrate required load carrying capability of the HPCS diesel generator as follows:

1. Engine cranking was begun upon receipt of the start signal, and the diesel generator set will accelerate to specified frequency and voltage within the required time interval.

2. Immediately following Step No. 1 (Paragraph (a)) the diesel generator set accepted a single step load consisting of the main HPCS pump motor load (full loaded) and additional loads (inductive and/or resistive) as required to simulate the accident loading sequence of the HPCS diesel generator.

If the cause for failure to start or accept load in accordance with the preceding sequence falls under any of the categories listed below, that particular test may be disregarded, and the test sequence resumed without penalty following identification of the cause for the unsuccessful attempt:

1. Unsuccessful start attempts which can definitely be attributed to operator error, including setting of alignment control switches, rheostats, potentiometers, or other adjustments that may have been changed inadvertently prior to that particular start test.

2. A starting and/or loading test performed for verification of a scheduled maintenance procedure required during this series of tests. This maintenance procedure is defined prior to conducting the start and load acceptance qualification tests and then becomes a part of the normal maintenance schedule after installation.

3. Failure of any of the temporary service systems, such as dc power source, output circuit breaker, load, interconnecting piping, and any other temporary setup which is not part of the permanent installation.

4. Failure to carry load which can be definitely attributed to loadings in excess of required loading.

8.3.1.2.3.5 Conformance with <Regulatory Guide 1.9>

Conformance with <Regulatory Guide 1.9> is described for each regulatory position of Paragraph C of the guide as follows:

a. Position 1 Conformance

<Table 8.3-1> shows that the continuous rating of the diesel generator is greater than the maximum coincidental steady-state loads requiring power at any time (when considering actual HPCS loading verses nameplate). Intermittent loads, such as motor operated valves, are not considered for long term loads.

b. Position 2 Conformance

The short time HPCS diesel generator rating is greater than the maximum coincidental load as listed in <Table 8.3-1>.

c. Position 3 Conformance

Load requirements were verified and test data was provided following the preoperational tests.

d. Position 4 Conformance

The HPCS diesel generator unit performance, with respect to voltage and frequency limits during the initial loading for a transient, is considered as a justifiable departure from literal conformance to <Regulatory Guide 1.9>. The HPCS system consists of one large pump and motor combination which represents more than 90 percent of the total load. Consequently, limiting the momentary voltage drop to 25 percent and the momentary frequency drop to 5 percent would not significantly enhance the reliability of HPCS operation. To satisfy these regulatory guide recommendations, a diesel generator

approximately two to three times as large as that required to carry the continuous rated load would be necessary. However, all other recommendations, including the frequency and voltage overshoot requirements of <Regulatory Guide 1.9>, are satisfied. A factory testing program on a production diesel generator has verified the following functions:

1. System fast start capabilities.

2. Load carrying capability.

3. Load rejection capability.

4. Ability of the system to accept and carry the required loads.

5. The mechanical integrity of the diesel engine generator unit and all of the major system auxiliaries.

The design of the HPCS diesel generator conforms with the applicable sections of IEEE Standard 308. In addition, see <Section 8.3.1.1.6.11>.

The generator has the capability of providing power for starting the required loads with operationally acceptable voltage and frequency recovery characteristics. A partial or complete load rejection will not cause the diesel engine to trip on overspeed.

8.3.1.2.3.6 Conformance with <Regulatory Guide 1.29>

The HPCS power supply system is capable of functioning when subjected to the effects of design bases natural phenomena. In particular, it is designed in accordance with Seismic Category I criteria and is housed in a safety class structure.

8.3.1.2.3.7 Conformance with <Regulatory Guide 1.32>

The design of the HPCS diesel generator conforms with the applicable sections of IEEE Standard 308.

8.3.1.2.3.8 Conformance with <Regulatory Guide 1.47>

All the bypassed trip devices actuate alarms in the control room so that conditions which can render the HPCS diesel generator system unavailable for automatic start are automatically annunciated in the control room. See <Section 8.3.1.1.3.3.b(10)> for HPCS diesel generator alarms.

8.3.1.2.3.9 Conformance with <Regulatory Guide 1.62>

Manual controls are provided to permit the operator to select the most suitable power supply for the HPCS bus. Provision is made for system level manual control and testing from the control room, as well as from a local panel. Momentarily placing the engine mode switch in the test position allows a local start and blocks the auto start. Once released the switch will return to the auto position which will allow an ECCS signal to override the test start signal. Equipment common to manual and automatic control is limited to a practical minimum.

8.3.1.2.3.10 Conformance with <Regulatory Guide 1.75>

The HPCS diesel generator and supporting auxiliaries are Division 3 equipment separated from, and independent of, equipment of other divisions. All major components are marked with a Division 3 name tag. See <Section 8.3.1.1.2.7> for a discussion of safety-related equipment identification.

8.3.1.2.3.11 Conformance with IEEE Standard 279

See <Section 7.3> for compliance of the HPCS system (including diesel generator) with IEEE Standard 279 (Reference 10).

8.3.1.2.3.12 Conformance with IEEE Standard 308

All electrical system components supplying power to the HPCS Class 1E electrical equipment are designed to perform functional requirements under the conditions produced by the design basis events. All HPCS equipment is physically separated from other ESF equipment to maintain independence and reduce the possibility of a common mode failure. All Class 1E HPCS equipment is located in Seismic Category I structures.

The HPCS equipment is uniquely identified by color coding of the components or identification tags as detailed in <Section 8.3.1.1.2.7>.

Surveillance of the Class 1E electric systems will be in compliance with IEEE Standard 308, as are all other aspects applicable to the station design.

8.3.1.2.3.13 Conformance with IEEE Standard 344

The HPCS power supply unit components are seismically qualified in accordance with IEEE Standard 344 (Reference 11) <Section 3.10.>.

8.3.1.2.3.14 Conformance with IEEE Standard 387

The HPCS diesel generator satisfies the applicable requirements of IEEE Standard 387. The HPCS diesel generator is designed to satisfy the following requirements:

a. Operate in the service environment during and after any design basis event without support from the preferred power source.

b. Start, accelerate and be loaded with the design load within an acceptable time under the following conditions:

   1. From the normal standby condition.

   2. With no cooling available, for a time equivalent to that required to bring the cooling equipment into service with energy from the diesel generator.

   3. On a restart with an initial engine temperature equal to the continuous rating, full load engine temperature.

c. Carry the design load for 2,000 hours.

d. Maintain voltage and frequency within limits that will not degrade, below minimum requirements, the performance of any of the loads composing the design load, including the duration of transients caused by load application or load removal, except as noted in <Section 8.3.1.2.3.5.d>.

e. Withstand any anticipated vibration and overspeed conditions. No flywheel is coupled to the HPCS diesel generator. The generator and exciter are designed to withstand 25 percent overspeed without damage.

The HPCS diesel generator has continuous and short term ratings consistent with the requirements of IEEE Standard 387, Section 5.1.

Mechanical and electrical system interactions between the HPCS diesel generator and other units of the standby power supply, the nuclear plant, the conventional plant, and the Class 1E electrical systems are coordinated so that the HPCS diesel generator design function and capability are realized for any design basis event, except failure of the HPCS diesel generator.

8.3.1.2.4 Safety-Related Equipment in Hostile Environments

Safety-related equipment that may be required to operate in a hostile environment and the corresponding specified normal and accident design environments are presented in <Section 3.11>.

Class 1E electrical cable for use inside the drywell and containment are qualified to satisfy the normal and accident conditions and are also discussed in <Section 3.11>.

Class 1E equipment, whether located inside or outside the containment, which must function during an accident is designed to withstand the temperature, humidity and other conditions expected at the specified location.

8.3.1.3 Physical Identification of Safety-Related Equipment

Identification of safety-related equipment is addressed in <Section 8.3.1.1.2.7>.

8.3.1.4 Independence of Redundant Systems

8.3.1.4.1 Physical Separation Requirements for Class 1E Equipment

8.3.1.4.1.1 General Requirements

Electrical equipment and wiring for Class 1E electrical systems are segregated into separate independent divisions, designated Division 1, Division 2 and Division 3, such that no single credible event is capable of disabling sufficient equipment to prevent reactor shutdown, removal

of decay heat from the core and isolation of containment in the event of an accident. Division separation requirements apply to equipment and wiring systems concerned.

Switchgear, batteries and similar major electrical equipment for each division are housed in separate rooms within the control complex and/or associated buildings, and are completely separate from redundant divisional equipment.

The design is in accordance with the criteria established in IEEE Standard 384 as modified by <Regulatory Guide 1.75> as described in <Table 8.1-2>.

8.3.1.4.1.2 Cable Routing through Mechanical Damage Zones

Arrangement and/or protective barriers for cable trays are such that no locally generated force or missile impact can disable any ESF function. The following rules are applicable:

a. In rooms or compartments housing heavy rotating machinery, such as the main turbine generator or the reactor feed pumps, or in rooms containing high pressure feedwater piping or high pressure steam lines, such as the lines between the reactor and the turbine, separation consists of a concrete wall barrier to assure that the minimum ESF functions are preserved, regardless of any incident.

b. In any compartment housing an operating crane, such as the turbine building main floor and the region above the reactor pressure vessel, the separation is designed to assure that the minimum ESF functions are preserved, regardless of any incident.

c. A design basis event will not damage sufficient safety system cabling of redundant systems to impair the ability to perform the safety function required to mitigate the effects of the design basis event coincident with a single failure.

8.3.1.4.1.3 Cable Routing through Fire Hazard Areas

Routing of cable is arranged to eliminate, insofar as practical, the risk of fire damage to cables and to separate the divisions so that fire in one division will not propagate to another division.

Routing of cables for Class 1E system through rooms or spaces where there is potential for accumulation of large quantities (gallons) of oil or other combustible fluids, as a result of leakage from or rupture of lubricating oil or cooling systems, is avoided. Where such routing is unavoidable, cables of only one division are allowed in any such space.

8.3.1.4.1.4 Cable Routing in General Plant Areas

In any room, compartment or area of the plant, except the cable spreading rooms, cable trays of different divisions have a minimum horizontal separation of 3 feet when there is no physical barrier between trays. Where a horizontal separation of 3 feet is unattainable, the trays will be separated and protected by fire resistant materials. Vertical stacking of cable trays of different divisions is avoided wherever possible. In cases where trays requiring separation must be stacked one above another, a minimum vertical separation of 5 feet is maintained. Where vertical separation of 5 feet cannot be maintained, the trays will be separated and protected by fire resistant materials.

In the case of a cross over of two trays of different divisions with separation of less than 5 feet, fire resistant materials are provided between trays.

Separation and independence criteria is in accordance with IEEE Standard 384 as described in <Table 8.1-2>.

8.3.1.4.1.5 Cable Routing in Cable Spreading Rooms

The cable spreading rooms are provided to allow for the convergence and grouping of cables in the control room, prior to entering the respective panels or termination cabinets.

Physical separation and independence of cable trays is reduced to 1 foot minimum for horizontal and 3 foot minimum for vertical distances in accordance with IEEE Standard 384 as described in <Table 8.1-2>. Where minimum separation cannot be maintained, the trays will be separated and protected by fire resistant materials.

8.3.1.4.1.6 Separation of Components and Wiring in Panels

No single control room panel, local panel or instrument rack includes wiring essential to the protective function of two redundant ESF systems, except as allowed below:

a. Where two local panels or instrument racks containing circuits of different divisions are less than 3 feet apart, but not less than 1 inch, there is a steel barrier between the two panels or racks. Panel ends, closed by steel end plates are acceptable barriers. End plates separated by less than 1 inch must have terminal boards and wireways separated from the end plates by a minimum of 1 inch of air space or a thermal insulating barrier.

   Where two control room panels containing circuits of redundant divisions are less than 1 foot apart but not less than 1 inch apart, a steel barrier or panel end, closed by steel end plates, are acceptable barriers. Where two control room panels containing circuits of redundant divisions are less than 1 inch apart, panel

ends closed by steel end plates is an acceptable barrier, provided that terminal boards and wireways are separated from the end plates by a minimum of 1 inch of air space or a thermal insulating barrier.

b. Adjacent control room panels of different divisions mounted on a common cable chase are provided with vertical floor to panel fire resistant barriers between them.

c. Penetration of separation barriers within a subdivided panel is permitted. Such penetrations are sealed or otherwise treated so that an electrical fire cannot reasonably propagate from one section to another.

d. Where, for operational reasons, locating manual control switches on separate panels is considered prohibitively (or unduly) restrictive to manual operation of equipment, then the switches are located on the same panel, provided no credible single event in the panel can disable both sets of redundant manual or automatic controls. Wherever wiring of two different divisions exists in a single panel section, separate terminal boards are provided and spacing of terminal boards and wiring is such that the possibility of fire propagation from wiring of one division to that of another is precluded. One of a redundant pair of devices in close proximity within a single panel is considered adequately separated from the other if wiring to one of the devices has flame retardant insulation and is totally enclosed, including outgoing terminals at the control panel boundary, as well as the device itself. However, consideration is given to locating redundant switches on opposite sides of the barrier formed by the end closures of adjacent panels wherever operationally acceptable.

8.3.1.4.1.7 Separation of Class 1E and Non-Class 1E Cables

A separate tray system, consisting of power, control and instrumentation trays, is used for non-Class 1E circuits. This nonsafety-related tray system does not connect to any tray containing Class 1E circuits. No Class 1E cables are installed in trays containing non-Class 1E circuits. Associated circuits are installed in trays containing Class 1E circuits. This tray system is separated from Class 1E trays utilizing the same criteria as two Class 1E trays of the different divisions.

Separate safety-related and nonsafety-related tray systems, consisting of power, control and instrumentation trays are provided to ensure the independence and separation of Class 1E and non-Class 1E circuits. The nonsafety-related tray system does not connect to any tray containing Class 1E circuits. Similarly, no Class 1E cables are installed in tray systems containing non-Class 1E circuits. Associated circuits designated as Class 1E are installed in safety-related trays containing the same division of Class 1E circuits.

A separate safety-related and nonsafety-related conduit system comprising rigid and/or flexible metal conduit is installed to ensure the proper isolation and separation of Class 1E and non-Class 1E circuits. The separation is 1 inch minimum. For Class 1E cables and non-Class 1E cables less than 125V (such as heat tracing, cathodic protection, lighting or communications) run in conduit, the separation may be less than 1 inch provided there is no physical contact between the conduits.

Equipment internal wiring separation is to be a minimum of 6 inches for Class 1E and non-Class 1E. In areas where this separation cannot be maintained, additional barriers, raceways and/or enclosures shall be utilized.

The separation for tray to tray, conduit to conduit, conduit to tray and internal panel wiring is in accordance with the criteria established in IEEE Standard 384, as modified by <Regulatory Guide 1.75> as shown in <Table 8.1-2>.

8.3.1.4.1.8 Special Cable Routing Requirements

The RPS and nuclear steam supply shutoff subsystem trip inputs have a minimum of four independent channels for each measured variable. Field wiring for these independent channels is installed in four separate systems used for no other wiring. The neutron monitoring system cables associated with the RPS are installed in four separate, enclosed metal raceway systems.

The 120V ac power supplies to the pilot scram valve solenoids are designated as non-Class 1E. Each valve contains two (2) actuating trip solenoids. Solenoid valve A is powered from the RPS "A" bus and solenoid valve B is powered from the RPS "B" bus. Although classified as non-Class 1E, each pilot scram valve power feeder is isolated and separated with respect the RPS divisional grouping to ensure the independence and isolation of power circuits so that the proper operating functions and fail safe de-energization can be accomplished.

8.3.1.4.2 Cable Tray Selection

Power and control cable trays are of the galvanized steel, ladder type with nominal 9 inch rung spacing, in widths of 9” to 36” trade sizes. These trays have 4 or 6 inch side rails with a normal available loading depth of 3 or 5 inches, respectively.

Instrumentation cable trays are of the galvanized steel, solid bottom ladder type, in widths of 9” to 30” trade sizes. All instrumentation trays with exception to applications in the cable spreading room are covered to minimize radio frequency and associated induced noise. Available loading depths are restricted to 3 inches.

8.3.1.4.3 Cable Derating and Cable Tray Fill

Large power cables (4 AWG and larger) for Class 1E systems are primarily of interlocked armor construction, rated for 5 kV and with copper conductors having ampacities as listed in ICEA P-54-440 (Reference 12), for 1.0 inch cable depth. This loading depth is used due to the as-built, single layer arrangement of this size cable in the trays. The ampacities listed in the standard were calculated assuming all cables will be fully loaded with no cable spacing or load diversities included.

Non-armored 600-volt copper conductor cable, 14 AWG to 4 AWG, is derated according to ICEA P-54-440 (Reference 12), Table 3, with a theoretical loading depth of 1.5 or 2.5 inches. This loading depth is derived by dividing the area computed by summing the cable diameter squared for all cables by the width of the tray. This value corresponds to a design objective of 50 percent of the 3 inch or 5 inch usable depth of the tray.

A tray fill of 50 percent, using the cable diameter squared for the cross sectional area is the design objective for instrument and control cable trays (this corresponds to approximately 40 percent tray fill using actual cable cross sectional area in the computation).

To assure that cable thermal limits and tray hanger structural limits are not exceeded, any increase in tray fill in excess of the 50 percent design objective is subject to approval by the Project Electrical Engineer.

8.3.1.4.4 Tray Allocation of Cables by Construction and Voltage Level

Non-shielded, 5 kV class cable with interlocked armor is used for 4.16 kV feeders and large power (4 AWG and larger) 480-volt feeders. No other types of cable are run in these trays.

Non-armored 600-volt insulated power cables (4 AWG and smaller) and control cables are run in control trays. Power cables are derated as specified in <Section 8.3.1.4.3>. Low level signal cables are run in shielded raceways separated from power and control cables and from unshielded cables carrying digital or pulse type signals.

In continuous runs of vertically stacked cable trays the highest voltage cables are located at the highest tray level wherever practical.

8.3.1.4.5 Electrical Penetration Assemblies

Electrical penetration assemblies are designed, fabricated, tested, and installed in accordance with IEEE Standard 317 (Reference 14), thus assuring that the penetration assemblies will function satisfactorily during normal operation and all postulated design basis events.

Any deterioration of the epoxy insulation is monitored by a leakage monitoring system using nitrogen. During normal operation, the nitrogen pressure will be kept at or above 10 psig, the Perry containment accident pressure plus margin. This pressure is maintained in a very small volume between the seals of each penetration module to achieve high sensitivity in leak monitoring. Penetration pressures will be routinely inspected during plant operation to assure prompt detection of leaky penetrations.

The electrical penetration assemblies are arranged in divisional groups <Figure 8.3-19> to maintain separation of electrical cables to comply with the single failure criterion. Within each divisional group, separate penetrations are provided for large power cables, small power and control cables, and instrument cables. Individual penetration modules are provided for each of the RPS trip channels.

For those Class 1E and non-Class 1E power circuits which penetrate the containment, the power system is designed such that it will isolate faults while subjected to a single random failure of a protective device without exceeding the penetration rating. The rating is based on established criteria in IEEE Standard 317. For 120Vac/125Vdc loads, fault isolation is accomplished by back-up fusing or an analysis performed to demonstrate that the available fault currents are less than the penetration conductor I^2t capability.

The fault isolation is accomplished by backup fusing for 480-volt loads and by backup protective relaying on the 15kV ATWS circuit breaker for the reactor recirculation pump motors. <Table 8.3-11> lists each size of penetration conductor serving 480V and 13.8kV loads by voltage class and the type of protective device used. Note that any combination of current limiting, UL Class K5, RK5 time delay, J non-time delay, and

J time delay fuses are used to provide primary and secondary fault current isolation for the penetrations, connected in series with 480V loads.

Power circuit protection has been analyzed by voltage class and meets the requirements of <Regulatory Guide 1.63>.

Power circuit field cables inside containment are connected to the containment penetrations as follows:

a. Cables 8 AWG and larger are connected to penetration pigtails by inline splices.

b. Cables less than 8 AWG in inaccessable locations and those in harsh environments are connected to penetration pigtails by inline splices.

c. All other cables are connected using connectors and terminal blocks.

The connections have been qualified to IEEE Standard 323-1974. (Also refer to <Table 8.3-11>.) The documentation to support the electrical penetration table calculations and the environmental qualification (LOCA or SLB environment) are on file for staff review at the Perry site.

8.3.1.4.6 Fire Detection and Protection Equipment

Fire detection and protection equipment is installed in the diesel generator rooms, control room and in areas of heavy cable concentration <Section 9.5.1>. Fire stops are provided at cable tray penetrations through floors and fire barrier walls.

8.3.2 DC POWER SYSTEMS

8.3.2.1 Description

Five independent 125-volt dc power systems are provided for each unit. Each of these systems consists of a battery, one or two battery chargers, dc load center, distribution panels, and associated equipment. The five systems are identified as follows:

a. Non-Class 1E 125-volt dc system A.

b. Non-Class 1E 125-volt dc system B.

c. Class 1E Division 1, 125-volt dc system.

d. Class 1E Division 2, 125-volt dc system.

e. Class 1E Division 3, 125-volt dc system.

8.3.2.1.1 Non-Class 1E 125-Volt DC Systems

At Unit 1, Non-Class 1E 125-volt dc system A supplies power for the inverter associated with the vital ac system. At both units it powers instrumentation and control type loads, such as the main annunciator and the fire detection system. Non-Class 1E 125-volt dc system B supplies power for loads such as motors, switchgear and transformer controls, and emergency lighting. This equipment is located in the turbine power complex. There is no interaction between the non-Class 1E 125-volt dc systems and the Class 1E 125-volt dc systems.

If the dc batteries are the only available power source, the maintenance tie circuit breakers may be closed to allow the Unit 1 - Unit 2 batteries to be paralleled.

8.3.2.1.2 Class 1E Division 1 and Division 2, 125-Volt DC Systems

8.3.2.1.2.1 General

The Class 1E, Division 1 and Division 2, 125-volt dc systems are two completely redundant systems. Each is capable of supplying required dc power to associated loads needed for safe shutdown. (No non-Class 1E loads are supplied from a Class 1E dc system). Each system includes a 1260 ampere hour battery, a 400 ampere battery charger and a load center. Division 1 has a 61 cell battery. Division 2 system has a 60 cell battery. The Division 1 system also includes a motor control center and a distribution panel. The Division 2 system has two distribution panels. In addition, 400 ampere reserve battery charger is provided for each division. These battery chargers are located with the equipment associated with Unit 1 but can be connected to the appropriate division of either the Unit 1 or Unit 2, Class 1E, 125-volt dc system by means of the maintenance tie buses. No interdivisional ties are provided between the divisions associated with Unit 1 or Unit 2. Maintenance tie buses connect only the same divisions of the two units (i.e., Unit 1, Division 1 to Unit 2, Division 1). If the dc batteries are the only available power source, the maintenance tie circuit breakers may be closed to allow the Unit 1 - Unit 2 batteries to be paralleled.

<Figure 8.3-21> illustrates the connection of batteries, battery chargers, load centers, motor control centers, and distribution panels of the Unit 1 Class 1E, Division 1 and Division 2, 125-volt dc systems. Each of these systems is of the two wire, ungrounded type.

Maintenance tie bus circuit breakers are normally open. These circuit breakers are manually operated under administrative control. They permit isolation of the battery and normal battery charger associated with either Unit 1 or Unit 2 for purposes of maintenance or equalizing the battery. Independence of the individual Unit 1 Class 1E, Division 1 and Division 2, 125-volt dc system is shown by <Figure 8.3-21>.

A reserve battery charger in each division is installed at Unit 1 only and is supplied from the associated Unit 1 480-volt ac system. The Division 1 and Division 2 reserve battery chargers are supplied from different 480-volt switchgear sections than those which supply the normal battery chargers. Thus, a single failure in the 480-volt ac system will not disable both battery chargers.

Batteries, battery chargers and distribution equipment for the Class 1E, Division 1 and Division 2, 125-volt dc systems are located in separate rooms in a Seismic Category I structure <Figure 8.3-4>. DC system safety-related equipment is identified in accordance with <Section 8.3.1.1.2.7> and <Table 8.3-3>.

Each Class 1E, 125-volt dc system is equipped with a bus undervoltage relay and a battery undervoltage relay. Upon detection of a battery undervoltage condition, a dc system trouble alarm is activated in the control room. Two voltage relays are also provided for each dc bus for purposes of ground fault detection. One of these relays is connected from positive to ground; the other, from negative to ground. These relays are set so that a ground on either the positive or negative side of the system causes a voltage imbalance across the relay coils, resulting in actuation of a dc bus ground fault alarm in the control room.

The DC systems are normally powered from the battery chargers, with the batteries in float charge on the system. In the event AC power is lost to the battery charger, the DC load is automatically and seamlessly powered from the station batteries.

8.3.2.1.2.2 Capacity

The Class 1E, Division 1 and Division 2, 125-volt dc systems batteries are sized to supply the required dc loads <Table 8.3-7> for a minimum of two hours and to meet the criteria given in IEEE Standard 308 and applicable design basis listed in <Table 8.1-2>. Sizing of the batteries (1.875 volts/cell for Division 1; 1.863 volts/cell for

Division 2) also includes a design margin of 1.15 and an aging factor of 1.25. During normal operation the battery chargers supply the continuous dc load of the associated divisions while maintaining a float charge on the batteries. The battery chargers are sized to supply the continuous load of both units while simultaneously recharging the

battery to a fully charged condition from the design minimum charge of 1.875 volts/cell for Division 1 and 1.863 volts/cell for Division 2 within 12 hours. Since the maintenance tie buses connect the same safety divisions of each unit, the sources (batteries and battery chargers) are sized to provide dc power under LOCA conditions in the operating unit coincident with the continuous load of the other unit. Switching required to make the reserve battery charger available in the event of failure of the normal division battery charger would be accomplished well within the two hour time limit.

8.3.2.1.2.3 Equipment

The 125-volt dc system and the associated loads and controls supplied by the 125-volt dc system are designed to operate from 140-volt dc (maximum corrected equalizing charge) to the minimum device voltage consistent with the design basis battery voltage profile and device operating time.

a. Batteries and Battery Racks

The storage batteries are of the large stationary, lead acid type and are suitable for float service. Cell covers are equipped with flame arresting fused alumina vents. The battery cells are mounted on steel two step, corrosion resistant, seismically designed racks. Rack rails and retaining rods that connect the cells are covered with plastic channels to avoid high resistance grounding due to moisture.

b. Battery Chargers

The solid state battery chargers each have a filtered dc output for float and equalizing modes. Battery charger input is 3 phase, 480-volt ac power. Each battery charger is equipped with a dc voltmeter and ammeter, high voltage relay, and low voltage relay. Battery charger malfunctions actuate alarms in the control room.

If the Division 1 reserve battery charger is in service, the alarm system is designed so that a malfunction actuates an alarm only in the control room of the unit which the reserve battery charger is serving. The Division 2 reserve battery charger alarms in the Unit 1 control room if it is in service for either the Unit 1 or Unit 2 battery.

c. DC Load Centers

The dc load center for each dc system consists of a metal enclosed switchgear lineup. One cubicle of the line contains two drawout fuses for the battery connection. Two cubicles house the alarm relays and local metering. The remaining cubicles contain manually operated, drawout type, two pole circuit breakers with indicating flag, cell switches, auxiliary switches, and a fault trip alarm.

d. DC Motor Control Centers

The dc motor control centers consist of totally enclosed, free standing vertical sections. Motor control center compartments contain combination type starters. All combination starters include a fusible disconnect switch with dual element (time delay), Class RK-5 fuses.

e. DC Distribution Panels

The dc distribution panels are comprised of a metal enclosed panel assembly of dead front construction. Individual branch feeders are two pole, fusible disconnect switches with dual element (time delay), Class RK-5 fuses.

8.3.2.1.2.4 Charging

The emergency power system battery chargers output voltage is adjusted to the proper float or equalize values at installation, and the sensing and control features of Thyristors, power diodes, resistors, and capacitors will control the output voltage to the set point value whether the batteries are connected or disconnected from the bus.

The equalize operation may require disconnection of the batteries from the system when the battery receives an equalize voltage in excess of the 140 volts dc maximum capability of connected equipment. The direct current voltage equipment installed on the emergency power buses have been specified and tested to withstand a high voltage of 140 volts dc. This value is in excess of the normal equalize voltage of the battery charger. When the battery receives an equalize voltage in excess of 140 volts, the batteries are disconnected from the bus. In the event of faulty regulation or operator error, a high voltage relay will activate an alarm in the control room. The long-term battery performance is supported by maintaining float voltage greater than or equal to the minimum established design limits provided by the battery manufacturer. The nominal float voltage is 135 V. The Minimum established design limit of the battery terminal float voltage is determined by taking the minimal allowable/acceptable Float Voltage Volts per Cell (Vpc) provided by the battery manufacturer and multiplying that by the number of cells in the battery. From the Division 1 and 2 vendor’s documentation and manual, the acceptable float range is 2.17 to 2.26 Vpc. Therefore, the minimum established design limit for the battery terminal float voltage for Division 1 is 132.37 V and for Division 2 is 130.2 V.

8.3.2.1.2.5 Sizing

The Division 1 and Division 2 DC system battery sizing was determined utilizing the guidance of IEEE Std. 485-1997, which specifies adding a general design margin, an aging factor, and a temperature correction factor. The general design margin of 15% was incorporated to allow for

future additions of DC loads. An Aging Factor of 125% was added to ensure that the battery is capable of meeting its design loads throughout its service life. This is based on the IEEE recommendation of replacing the battery at 80% of its rated performance. The electrolyte temperature correction is based on the Table 1 "Cell size correction factors for temperature" in IEEE Std 485-1997. The electrolyte temperature is monitored routinely and verified to be greater than or equal to 72-degree F. The correction factors for Division 1 and Division 2 batteries were selected to be 72-degree F (1.029) and 71-degree F (1.034) respectively. These correction factors are multiplied together with the corrected number of positive plates required to determine the minimum battery size required to support the design bases loading. Sizing the battery with a 15 percent design margin ensures that the battery is fully capable of performing its design function when the 2-amp float current limit is reached. These margins are maintained under formal design change processes. Addition of new DC load will be evaluated to ensure the battery system will continue to be capable of supplying its design bases load with the required margins.

For the Division 1 battery, the entire 120-minute design basis scenario uses approximately 300 amp-hours (AH) of the battery's 1260 AH nameplate rating, which equates to a 24 percent capacity discharge. Per the manufacturer, the reduced capacity at the start of the design basis event due to the use of the 2-amp charging current criteria equals 92 percent. This is acceptable. A battery at that capacity will still have ability to supply all required design basis loads for the 2-hour event.

For the Division 2 battery, the entire 120-minute design basis scenario uses approximately 262 AH of the battery's 1260 AH nameplate rating, which equates to a 21 percent capacity discharge. Per the manufacturer, the reduced capacity at the start of the design basis event due to the use of the 2-amp charging current criteria equals 96 percent. This is

acceptable. A battery at that capacity will still have ability to supply all required design basis loads for the 2-hour event.

8.3.2.1.3 High Pressure Core Spray - Division 3 - Engineered Safety Features DC System

8.3.2.1.3.1 General

The objective of the Division 3, 125-volt dc power system is to provide a continuous and independent 125-volt dc source of control and motive power as required for HPCS system logic, HPCS diesel generator control and protection and all Division 3 related 125-volt dc control. A normal and a reserve battery charger are provided. The reserve battery charger is connected to the tie bus between Units 1 and 2. The Division 3, 125-volt dc system is classified as Class 1E. The system is independent of all other divisional batteries and there is no manual or automatic connection to Division 1 and Division 2 battery systems. A manually operated maintenance tie between Unit 1 and Unit 2 Division 3 dc systems is provided for the purpose of maintenance or equalizing the battery. If the dc batteries are the only available power source, the maintenance tie circuit breakers may be closed to allow the Unit 1 - Unit 2 batteries to be paralleled.

The DC systems are normally powered from the battery chargers, with the batteries in float charge on the system. In the event AC power is lost to the battery charger, the DC load is automatically and seamlessly powered from the station batteries.

8.3.2.1.3.2 High Pressure Core Spray DC Loads

Division 3, 125-volt dc power is required for HPCS diesel generator field flashing, control logic and the control and switching function of circuit breakers. <Table 8.3-7> lists Division 3, 125-volt dc loads.

8.3.2.1.3.3 Battery and Battery Charger

The 125-volt dc system for the HPCS power supply has a 60 cell, lead calcium battery (250 ampere-hours at 8 hours) at each unit, one 50 ampere battery charger at each unit, one 50 ampere reserve battery charger, and a distribution panel with molded case circuit breakers. <Figure 8.3-22> shows the connection of batteries, battery chargers and distribution panel (Unit 1 only).

The 125-volt dc system equipment is designed as Class 1E in accordance with the applicable clauses of IEEE Standard 308. It is designed so that no single failure in the system will result in conditions that prevent safe shutdown of the plant. The plant design and circuit layout of the dc systems provide physical separation of equipment, cabling and instrumentation essential to plant safety.

As shown by <Figure 8.3-3>, the Unit 1 battery is located with the battery chargers. All components of the Division 3, 125-volt dc system are housed in a Seismic Category I structure.

8.3.2.1.3.4 System Identification

<Figure 8.3-22> shows the Unit 1 Division 3, 125-volt dc system. The battery feeds into the distribution panel. The battery charger is fed from the 480-volt ESF motor control center which is supplied by the HPCS diesel generator bus. The Division 3, 125-volt dc system distribution panel serves the various HPCS system dc loads.

8.3.2.1.3.5 Battery Capacity

The ampere-hour capacity and short time rating of the Division 3 battery are in accordance with criteria given in IEEE Standard 308 and applicable design bases listed in <Table 8.1-2>. The battery has sufficient stored energy to operate required connected essential loads for as long as each may be needed during a loss of the ac bus supplying

the battery chargers under normal or emergency conditions. The Division 3 battery charger is capable of recharging the Division 3 battery from a fully discharged condition in eight hours while also supplying the steady-state dc bus loads. Capacity is large enough to cope with LOCA conditions or any other emergency shutdown. Each distribution circuit is capable of transmitting sufficient energy to start and operate all required loads in that circuit. The Division 3, 125-volt battery is sized in accordance with the principles set out in IEEE Standard 308.

8.3.2.1.3.6 Charging

The normal battery charger and the reserve battery charger for the Division 3 (HPCS) dc system are each capable of carrying the normal dc system load and, at the same time, keeping the battery in a fully charged condition. Sizing of the battery chargers satisfies IEEE Standard 308. Equipment protection during battery charging is discussed in <Section 8.3.2.1.2.4>.

The 480-volt ac system feeds to the Unit 1 normal and reserve battery chargers are from the HPCS motor control center to maintain functional association. Probability of a system failure resulting in prolonged loss of dc power is extremely low. Important system components are either self-alarming upon failure or are capable of being tested during service to detect faults. It is inherent in the design of the battery chargers to include diodes which will prevent the ac supply source from becoming a load on the battery if the ac input power is lost. All abnormal conditions of selected system parameters important to surveillance of the system are annunciated in the control room.

The long-term battery performance is supported by maintaining float voltage greater than or equal to the minimum established design limits provided by the battery manufacturer. The Minimum established design limit of the battery terminal float voltage is determined by taking the minimal allowable/acceptable Float Voltage Volts per Cell (Vpc) provided

by the battery manufacturer and multiplying that by the number of cells in the battery. From the Division 3 vendor’s documentation and manual, the acceptable float range is 2.20 to 2.25 Vpc. Therefore the minimum established design limit for the battery terminal float voltage for Division 3 is 132.0 V.

Control power for the circuit breakers in the HPCS switchgear is supplied from the Division 3 (HPCS) battery, ensuring the following:

a. The unlikely loss of the HPCS system will not jeopardize the supply of offsite or onsite power to other ESF buses.

b. The differential relays and all interlocks associated with HPCS are supplied from the Division 3 (HPCS) 125-volt dc system only. Thereby, any cross connections between the redundant dc systems are eliminated.

8.3.2.1.3.7 Sizing

The Division 3 DC system battery sizing was determined utilizing the guidance of IEEE Std. 485-1997, which specifies adding a general design margin, an aging factor, and a temperature correction factor. The general design margin of 15% was incorporated to allow for future additions of DC loads. An Aging Factor of 125% was added to ensure that the battery is capable of meeting its design loads throughout its service life. This is based on the IEEE recommendation of replacing the battery at 80% of its rated performance. The electrolyte temperature correction is based on the Table 1 “Cell size correction factors for temperature” in IEEE Std 485-1997. The electrolyte temperature is monitored routinely and verified to be greater than or equal to 72-degree F. Conservatism was added and the correction factor for 71-degree F, 1.034, was used. These correction factors are multiplied together with the corrected number of positive plates required to determine the minimum battery size required to support the design bases loading. Sizing the battery with a 15 percent design margin ensures

that the battery is fully capable of performing its design function when the 2-amp float current limit is reached. These margins are maintained under formal design change processes. Addition of new DC load will be evaluated to ensure the battery system will continue to be capable of supplying its design bases load with the required margins.

The Division 3 battery is sized accounting for a 1.25 aging factor and a 1.15 design margin. The entire 120-minute design basis scenario uses approximately 57 AH of the battery's 250 AH nameplate rating, which equates to a 23 percent capacity discharge. Per the manufacturer, the reduced capacity at the start of the design basis event due to the use of the 2-amp charging current criteria equals 95 percent. This is acceptable. A battery at that capacity will still have ability to supply all required design basis loads for the 2-hour event.

8.3.2.1.4 Ventilation

Complete details of battery room and dc equipment room ventilation systems are presented in <Section 9.4.1>. Each room is provided with smoke detection which, upon detection of smoke, actuates an alarm in the control room.

8.3.2.1.5 Maintenance and Test

Periodic maintenance tests will be performed on the 125-volt dc systems to determine the condition of each individual component. Batteries will be checked for electrolyte level, specific gravity, cell voltage, and visual indications of deterioration. A performance discharge test of the batteries will be conducted regularly. Battery chargers will be visually inspected and performance tests will be conducted on a regularly scheduled basis. Electrolyte level is kept greater than the minimum level indication mark.

General maintenance and testing procedures will be in accordance with IEEE Standard 450 (Reference 15), for Class 1E equipment as detailed in the technical specifications.

8.3.2.2 Analysis

8.3.2.2.1 Compliance with General Design Criteria and Regulatory Guides

Design of the 125-volt dc systems for the engineered safety features provided for this plant is based upon the criteria described in IEEE Standard 308, the recommendations of <Regulatory Guide 1.32> and applicable design bases described in <Table 8.1-2>.

The 125-volt dc systems, including the power supply, distribution system and load groups, are arranged to provide dc electric power for control and switching of the components of Class 1E systems.

Batteries consist of industrial type storage cells designed for the type of service in which they are to be used. Ample capacity is available to serve the loads connected to the system for the duration of the time of the designed duty cycle. Each division of Class 1E equipment is provided with a separate 125-volt dc system, to avoid a single failure involving more than one system.

The battery charger has enough power output capacity for the steady-state operation of connected loads required during normal or emergency operation (whichever is larger), while maintaining the associated battery in a fully charged state. Each battery charger supply has enough capacity to restore the battery from the design minimum charge to a fully charged state while supplying normal steady-state loads. The normal and reserve battery charger supplies are from ESF motor control and load centers of the appropriate division. Since the dc power systems are operated ungrounded, a ground detection feature is provided. Indicators are provided to monitor the status of

the battery charger supply. This instrumentation includes indication of output voltages, output current, battery ground status, and main circuit breaker position. Indications and alarms of the Division 1 and Division 2 Class 1E dc power systems status are provided in <Table 8.3-10>. Bus undervoltage is annunciated in the control room, to meet the requirements of IEEE Standard 279, Paragraph 4.13 and <Regulatory Guide 1.47> for auxiliary systems, as discussed in <Section 7.1.2>. Battery chargers are provided with disconnecting means and feedback protection. Periodic tests will be performed to assure the readiness of the system to deliver the power required.

8.3.3 FIRE PROTECTION FOR CABLE SYSTEMS

A detailed description of fire detection and suppression equipment and the measures employed for the prevention and suppression of fires in electrical cables is provided in <Section 9.5.1> and in (Reference 16).

Criteria for cable derating and cable tray fill are described in <Section 8.3.1.4.3>.

Criteria for separation between redundant cable trays and the use of fire barriers are described in <Section 8.3.1.4.1.3>, <Section 8.3.1.4.1.4>, and <Section 8.3.1.4.1.5>.

8.3.4 REFERENCES FOR SECTION 8.3

1. Institute of Electrical and Electronics Engineers, "Criteria for Separation of Class 1E Equipment and Circuits," IEEE Std. 384.

2. Institute of Electrical and Electronics Engineers, "Standard Criteria for Diesel Generator Units Applied as Standby Power Supplies for Nuclear Power Generating Stations," IEEE Std. 387.

3. U.S. Nuclear Regulatory Commission, "Diesel-Generator Protective Trip Circuit Bypasses," Branch Technical Position ICSB 17, November 24, 1975.

4. American National Standards Institute, "Applicable Guide for AC High-Voltage Circuit Breaker Rated on a Symmetrical Current Basis," ANSI C37.010, 1972.

5. American National Standards Institute, "Low-Voltage AC Power Circuit Breakers Used in Enclosures," ANSI C37.13, 1973.

6. National Association of Electrical Manufacturers, "Motors and Generators," NEMA MG-1, 1972.

7. American National Standards Institute, "Application Guide for AC High-Voltage Circuit Breakers," ANSI C37.010, 1964.

8. General Electric Company, "High Pressure Core Spray Power Supply Unit." NEDO-10905-2, 1979.

9. Institute of Electrical and Electronics Engineers, "Criteria for Class 1E Electric Systems for Nuclear Power Generating Stations," IEEE Std. 308.

10. Institute of Electrical and Electronics Engineers, “Criteria for Protection Systems for Nuclear Power Generating Stations,” IEEE Std. 279.

11. Institute of Electrical and Electronics Engineers, “Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations,” IEEE Std. 344.

12. Insulated Power Cable Engineers Association, “Ampacities of Cables in Open-Top Cable Trays,” ICEA P-54-440, 1979.

13. (Deleted)

14. Institute of Electrical and Electronics Engineers, “Electric Penetration Assemblies in Containment Structures for Nuclear Power Generating Stations,” IEEE Std. 317.

15. Institute of Electrical and Electronics Engineers, “Recommended Practice for Maintenance, Testing and Replacement of Large Stationary Type Power Plant and Substation Lead Storage Batteries,” IEEE Std. 450.

16. Gilbert Associates, Inc., “Fire Protection Evaluation Report, Perry Nuclear Power Plant Units 1 and 2, Cleveland Electric Illuminating, Co.,” GAI Report No. 1958, Revision 1, 1980.

TABLE 8.3-1

CONNECTED, AUTOMATIC AND MANUAL LOADING AND UNLOADING OF SAFETY SYSTEM SWITCHGEAR
Maximum Operating Requirements Without Offsite Power Available

Equipment Description	Number on Bus	kW[16] Total	HP Each	Inrush Current (Amperes)	Loss of Offsite Power (LOOP) Time of Start[9][22]	Loss of Offsite Power (LOOP) Req'd Running Time	Loss of Offsite Power (LOOP) Type of Control	Loss of Offsite Power (LOOP) & Loss-of-Coolant Accident (LOCA) Time of Start[9][22]	Loss of Offsite Power (LOOP) & Loss-of-Coolant Accident (LOCA) Req'd Running Time	Loss of Offsite Power (LOOP) & Loss-of-Coolant Accident (LOCA) Type of Control
Unit 1, Division 1										
Safety System Loads										
Low Pressure Core Spray Pump (1E21-C001)	1	1,400	1,750	1,443	-	Cont	See Note[1]	0 sec[15]	Cont	See Note[3]
Residual Heat Removal Pump A (1E12-C002A)	1	729[19]	900	748	-	Cont	See Note[1]	5 sec	Cont	See Note[3]
Emergency Service Water Pump A (1P45-C001A)	1	634	800	618	20 sec	Cont	See Note[2]	20 sec	Cont	See Note[2]
Emergency Closed Cooling Pump A (1P42-C001A)	1	82	100	710	0 sec	Cont	See Note[3]	0 sec	Cont	See Note[3]
Low Pressure Core Spray and Residual Heat Removal A Water Leg Pump (1E21-C002)	1	5	5	46	-[8]	Cont	See Note[1]	-[8]	Cont	See Note[1]
Reactor Core Isolation Cooling Water Leg Pump (1E51-C003)	1	5	5	46	-[8]	Cont	See Note[1]	-[8]	Cont	See Note[1]
Standby Liquid Control Pump A (1C41-C001A)	1	33	40	256	-	Cont	See Note[1]	-	Cont	See Note[1]
Fuel Pool Cooling and Circulating Water Pump A (0G41-C003A)	1	162	200	1,450	-[8]	Cont	See Note[1]	-[8]	Cont	See Note[1]
Diesel Room Supply Fans (1M43-C001A)(1M43-C002A)	2	82	50	376[7]	0 sec	Cont	See Note[3][2]	0 sec	Cont	See Note[3][2]
Residual Heat Removal A Pump Room Cooling Fan (1M39-B001A)	1	17	20	130	-	Cont	See Note[2]	5 sec	Cont	See Note[2]

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TABLE 8.3-1 (Continued)

Equipment Description	Number on Bus	kW[16] Total	HP Each	Inrush Current (Amperes)	Loss of Offsite Power (LOOP): [9] [22] Time of Start	Loss of Offsite Power (LOOP): Req'd Running Time	Loss of Offsite Power (LOOP): Type of Control	LOOP & Loss-of-Coolant Accident (LOCA): [9] [22] Time of Start	LOOP & LOCA: Req'd Running Time	LOOP & LOCA: Type of Control
Unit 1, Division 1 (Continued)										
Safety System Loads (Continued)										
Low Pressure Core Spray Pump Room Cooling Fan (1M39-B006)	1	17	20	130	-	Cont	See Note[2]	0 sec[15]	Cont	See Note[2]
Annulus Exhaust Fan A (1M15-C001A)	1	13	15	105	0 sec	Cont	See Note[2]	0 sec	Cont	See Note[3]
Annulus Exhaust System Heating Coil A (1M15-D001A)	1	20	-	-	-	Cycles	See Note[1]	0 sec	Cycles	See Note[3]
Control Room Supply Fan A (0M25-C001A)	1	49	60	436	0 sec	Cont	See Note[3]	0 sec	Cont	See Note[3]
Control Complex Chiller A (0P47-B001A)	1	580	-	540	81 sec	Cont	See Note[3][13]	81 sec	Cont	See Note[3][13]
Control Complex Chiller A Oil Pump (0P47-C5011A)	1	2	1.5	13.4	53 sec	Cont	See Note[3]	53 sec	Cont	See Note[3]
Control Complex Chilled Water Pump A (0P47-C001A)	1	82	100	710	35 sec	Cont	See Note[3]	35 sec	Cont	See Note[3]
Control Room Return Fan A (0M25-C002A)	1	49	60	436	-	Cont	See Note[3]	-	-	See Note[3]
Control Room Recirculation Fan A (0M26-C001A)	1	82[23]	100	710[23]	0 sec	Cont	See Note[3]	0 sec	Cont	See Note[1][3]
Control Room Emergency Recirculation A Electric Heating Coil (0M26-D001A)	1	100	-	-	0 sec	Cont	See Note[2]	0 sec	Cont	See Note[3]
Battery Room Exhaust Fan A (0M24-C001A)	1	9	10	80.3	15 sec	Cont	See Note[3]	15 sec	Cont	See Note[3]

TABLE 8.3-1 (Continued)

Equipment Description	Number on Bus	kW[16] Total	HP Each	Inrush Current (Amperes)	Loss of Offsite Power (LOOP) Time of Start[9][22]	Loss of Offsite Power (LOOP) Req'd Running Time	Loss of Offsite Power (LOOP) Type of Control	Loss of Offsite Power (LOOP) & Loss-of-Coolant Accident (LOCA) Time of Start[9][22]	Loss of Offsite Power (LOOP) & Loss-of-Coolant Accident (LOCA) Req'd Running Time	Loss of Offsite Power (LOOP) & Loss-of-Coolant Accident (LOCA) Type of Control
Unit 1, Division 1 (Continued)										
Safety System Loads (Continued)										
Motor Control Center, Switchgear, and Battery Room Supply Fan A (0M23-C001A)	1	81	100	660	25 sec	Cont	See Note[3][2]	25 sec	Cont	See Note[2]
Motor Control Center and Switchgear Room Return Fan A (0M23-C002A)	1	81	100	660	25 sec	Cont	See Note[3]	25 sec	Cont	See Note[3]
Emergency Closed Cooling Pump Area Cooling Fan A (0M28-B001A)	1	17	20	130	0 sec	Cont	See Note[2]	0 sec	Cont	See Note[2]
Offgas Building Vent Fan A (1M36-C001A)	1	33	40	255	0 sec	Cont	See Note[2]	0 sec	Cont	See Note[2]
Fuel Handling Building Supply Fan A (0M40-C001A)	1	25	30	210	-[8]	Cont	See Note[1]	-[8]	Cont	See Note[1]
Fuel Handling Building Exhaust Fan A (0M40-C002A)	1	33	40	255	-[8]	Cont	See Note[1]	-[8]	Cont	See Note[1]
Fuel Handling Building Exhaust Fan C (OM40-C002C)	1	33	40	255	-[8]	Cont	See Note[1][11]	-[8]	Cont	See Note[11][1]
Fuel Handling Building Exhaust Fan A Heating Coil (0M40-D001A)	1	50	-	-	-[8]	Cont	See Note[1]	-[8]	Cont	See Note[1]
Fuel Handling Building Exhaust Fan C Heating Coil (0M40-D001C)	1	50	-	-	-[8]	Cont	See Note[11]	-[8]	Cont	See Note[11][1]
Reactor Core Isolation Cooling Pump Room Cooling Fan (1M39-B004)	1	5	5	42.7	-	Cont	See Note[1]	0 sec	Cont	See Note[2]

TABLE 8.3-1 (Continued)

Equipment Description	Number on Bus	kW[16] Total	HP Each	Inrush Current (Amperes)	Loss of Offsite Power (LOOP) Time of Start[9][22]	Loss of Offsite Power (LOOP) Req'd Running Time	Loss of Offsite Power (LOOP) Type of Control	LOOP & Loss-of-Coolant Accident (LOCA) Time of Start[9][22]	LOOP & LOCA Req'd Running Time	LOOP & LOCA Type of Control
Unit 1, Division 1 (Continued)										
Safety System Loads (Continued)										
Emergency Service Water Pumphouse Vent Supply Fan A (1M32-C001A)	1	25	30	290	20 sec	Cont	See Note[2]	20 sec	Cont	See Note[2]
Emergency Service Water Pumphouse Intake Screen Wash Pump A (0P49-C002A)	1	41	50	362	-	Cont	See Note[1][5]	0 sec	Cont	See Note[3]
Emergency Service Water Pumphouse Traveling Screen A (0P49-D001A)	1	14	15	103	-	Cont	See Note[1][5]	0 sec	Cont	See Note[3]
Emergency Service Water Suction Sluice Gate A (0P45-D004A)	1	1	1	16	-	-	See Note[28]	-	-	See Note[28]
Diesel Generator Fuel Oil Transfer Pump (1R45-C001A)	1	12	15	116	12 min	Cycles[6]	See Note[2]	12 min	Cycles[6]	See Note[2]
Diesel Generator Fuel Oil Transfer Backup Pump (1R45-C002A)	1	12	15	116	12 min	Cycles[6]	See Note[2][14]	12 min	Cycles[6]	See Note[2][14]
Diesel Generator Jacket Water Keep Warm Pump (1R46-C005A)	1	3	3	32	-	-	See Note[12]	-	-	See Note[12]
Diesel Generator Jacket Water Keep Warm Heater (1R46-D006A)	1	75	-	-	-	-	See Note[10]	-	-	See Note[10]
Diesel Generator Lube Oil Keep Warm Pump (1R47-C002A)	1	13	15	116	-	-	See Note(12)	-	-	See Note(12)
Diesel Generator Lube Oil Keep Warm Heater (1R47-D004A)	1	50	-	-	-	-	See Note[10]	-	-	See Note[10]

TABLE 8.3-1 (Continued)

Equipment Description	Number on Bus	kW[16] Total	HP Each	Inrush Current (Amperes)	Loss of Offsite Power (LOOP) Time of Start[9][22]	Loss of Offsite Power (LOOP) Req'd Running Time	Loss of Offsite Power (LOOP) Type of Control	LOOP & Loss-of-Coolant Accident (LOCA) Time of Start[9][22]	LOOP & LOCA Req'd Running Time	LOOP & LOCA Type of Control
Unit 1, Division 1 (Continued)										
Safety System Loads (Continued)										
125-Volt DC Battery Charger (1R42-S006)	1	50	-	-	0 sec	Cont	See Note[4]	0 sec	Cont	See Note[4]
125-Volt DC Reserve Battery Charger (0R42-S007)	1	50	-	-	-	-	See Note[1]	-	-	See Note[1]
Hydrogen Recombiner A (1M51-D001A)	1	75	-	-	-	-	See Note[1]	-	Cont	See Note[1]
Hydrogen Mixing Compressor A (1M51-C001A)	1	53	60	614	-	-	See Note[1]	-	Cont	See Note[1]
Emergency Service Water Screen Wash Pump Discharge Strainer A (0P49-D003A)	1	1	.5	14.5	-	Cont	See Note[1][2][5]	-	-	See Note[3]
Radiation Monitors (1D19-P300, 1D19-P400, 2D19-P300)	3	10	-	-	0 sec	Cont	See Note[4]	0 sec	Cont	See Note[4]
Distribution Transformers[24]	5	36	-	-	0 sec	Cont	See Note[4]	0 sec	Cont	See Note[4]
Hydrogen Analyzer Control Panel (1H51-P022A)	1	1	1	-	-	-	See Note[1]	10 min	Cont	See Note[1]
Hydrogen Igniter Transformer (1M56-S201)	1	15	-	-	-	-	See Note[1]	10 min	Cont	See Note[1]
Standby Liquid Control System Transfer Pump (0C41-C002A)	1	5	5	46	-	Cycles	See Note[1][14]	-	-	See Note[1][14]
Anticipated Transient With Scram Uninterruptible Power Supply (1R14-S012)	1	8	-	-	0 sec	Cont	See Note[4]	0 sec	Cont	See Note[4]
Motor Operated Valves	-[17]	-[17]	-[17]	-[17]	-[17]	30 sec	See Note[17]	-[17]	30 sec	See Note[17]

TABLE 8.3-1 (Continued)

Equipment Description	Number on Bus	kW[16] Total	HP Each	Inrush Current (Amperes)	LOOP: Time of Start[9][22]	LOOP: Req'd Running Time	LOOP: Type of Control	LOOP & LOCA: Time of Start[9][22]	LOOP & LOCA: Req'd Running Time	LOOP & LOCA: Type of Control
Unit 1, Division 1 (Continued)										
Safety System Loads (Continued)										
Containment Isolation Valves (1D17-F071A, -F081A)	2	1	.3[7]	-	-	30 sec	See Note[1]	-	30 sec	See Note[1]
Emergency Closed Cooling System Temperature Control Valve (1P42-F665A)	1	1	.125	2.58	0 sec	Cont	See Note[1][2][5]	0 sec	Cont	See Note[1][2][5]
Nonsafety Feature Loads										
Nuclear Closed Cooling Pump A (0P43-C001A)	1	553	700	585	0 sec	Cont	See Note[3]	-	-	-
Control Rod Drive Pump A (1C11-C001A)	1	324	400	312	-	Cont	See Note[1]	-	-	-
Control Room Lighting Transformer (1R71-S083)	1	45	-	-	0 sec	Cont	See Note[4]	-	-	See Note[3]

	Time Sequence	Loss of Offsite Power (LOOP) Cont.	Loss of Offsite Power (LOOP) Cyclic	Loss of Offsite Power (LOOP) Loss-of-Coolant Accident (LOCA) Cont.	Loss of Offsite Power (LOOP) Loss-of-Coolant Accident (LOCA) Cyclic
Subtotal, kW per Time Sequence	0 sec	1,031.4	0	1,899.2	55.1
	5 sec	0	0	745.7	0
	15 sec	9.0	0	9.0	0
	20 sec	658.9	0	658.9	0
	25 sec	161.3	0	161.3	0
	35 sec	82.0	0	82.0	0
	53 sec	1.6	0	1.6	0
	81 sec	580.0	0	580.0	0
	10 min	0	0	0	0
	12 min	0	12.4	0	12.4
	20 min	0	0	0	0
Total Automatic Continuous Load[21]		2,524.2		4,137.7	
Total Automatic Cyclic Load[17][21]			12.4		67.5
Total Automatic Load[21]			2,536.6		4,205.2
Total Manual Load[21]		566.7		1,403.5	
Total Load (Auto & Manual)[21]		3,103.3		5,608.7	

TABLE 8.3-1 (Continued)

Equipment Description	Number on Bus	kW[16] Total	HP Each	Inrush Current (Amperes)	Loss of Offsite Power (LOOP) Time of Start[9][22]	Loss of Offsite Power (LOOP) Req'd Running Time	Loss of Offsite Power (LOOP) Type of Control	Loss of Offsite Power (LOOP) & Loss-of-Coolant Accident (LOCA) Time of Start[9][22]	Loss of Offsite Power (LOOP) & Loss-of-Coolant Accident (LOCA) Req'd Running Time	Loss of Offsite Power (LOOP) & Loss-of-Coolant Accident (LOCA) Type of Control
Unit 1, Division 2										
Safety System Loads										
Residual Heat Removal Pump B (1E12-C002B)	1	729[19]	900	748	-	Cont	See Note[1]	5 sec	Cont	See Note[3]
Residual Heat Removal Pump C (1E12-C002C)	1	729[19]	900	748	-	Cont	See Note[1]	0 sec	Cont	See Note[3]
Emergency Service Water Pump B (1P45-C001B)	1	634	800	618	20 sec	Cont	See Note[2]	20 sec	Cont	See Note[2]
Emergency Closed Cooling Pump B (1P42-C001B)	1	82	100	710	0 sec	Cont	See Note[3]	0 sec	Cont	See Note[3]
Residual Heat Removal B and C Water Leg Pump (1E12-C003)	1	5	5	46	-[8]	Cont	See Note[1]	-[8]	Cont	See Note[1]
Standby Liquid Control Pump B (1C41-C001B)	1	33	40	256	-	Cont	See Note[1]	-	Cont	See Note[1]
Fuel Pool Cooling and Circulating Water Pump B (0G41-C003B)	1	162	200	1,450	-[8]	Cont	See Note[1]	-[8]	Cont	See Note[1]
Diesel Room Supply Fans (1M43-C001B) & (1M43-C002B)	2	82	50	376[7]	0 sec	Cont	See Note[3][2]	0 sec	Cont	See Note[2][3]
Emergency Service Water Screen Wash Pump Discharge Strainer B (0P49-D003B)	1	1	.5	14.5	-	Cont	See Note[1][2][5]	-	-	See Note[3]
Residual Heat Removal B Pump Room Cooling Fan (1M39-B001B)	1	17	20	130	-	Cont	See Note[2]	5 sec	Cont	See Note[2]
Residual Heat Removal Pump C Room Cooling Fan (1M39-B002)	1	17	20	130	-	Cont	See Note[2]	0 sec	Cont	See Note[2]

TABLE 8.3-1 (Continued)

Equipment Description	Number on Bus	kW[16] Total	HP Each	Inrush Current (Amperes)	Loss of Offsite Power (LOOP) [9] [22] Time of Start	Loss of Offsite Power (LOOP) Req'd Running Time	Loss of Offsite Power (LOOP) Type of Control	Loss of Offsite Power (LOOP) & Loss-of-Coolant Accident (LOCA) [9] [22] Time of Start	Loss of Offsite Power (LOOP) & Loss-of-Coolant Accident (LOCA) Req'd Running Time	Loss of Offsite Power (LOOP) & Loss-of-Coolant Accident (LOCA) Type of Control
Unit 1, Division 2 (Continued)										
Safety System Loads (Continued)										
Annulus Exhaust Fan B (1M15-C001B)	1	13	15	105	0 sec	Cont	See Note[2]	0 sec	Cont	See Note[3]
Annulus Exhaust System Heating Coil B (1M15-D001B)	1	20	-	-	-	Cycles	See Note[1]	0 sec	Cycles	See Note[3]
Control Room Supply Fan B (0M25-C001B)	1	48	60	416	0 sec	Cont	See Note[3][2]	0 sec	Cont	See Note[3]
Control Complex Chiller B (0P47-B001B)	1	580	-	540	81 sec	Cont	See Note[3][13]	81 sec	Cont	See Note[3][13]
Control Complex Chiller B Oil Pump (0P47-C5011B)	1	2	1.5	13.4	53 sec	Cont	See Note[3]	53 sec	Cont	See Note[3]
Control Complex Chilled Water Pump B (0P47-C001B)	1	82	100	710	35 sec	Cont	See Note[3]	35 sec	Cont	See Note[3]
Control Room Return Fan B (0M25-C002B)	1	48	60	416	-	Cont	See Note[1][3]	-	-	See Note[3]
Control Room Recirculation Fan B (0M26-C001B)	1	82[23]	100	710[23]	0 sec	Cont	See Note[3]	0 sec	Cont	See Note[1][3]
Control Room Emergency Recirculation B Electric Heating Coil (0M26-D001B)	1	100	-	-	0 sec	Cont	See Note[2]	0 sec	Cont	See Note[3]
Battery Room Exhaust Fan B (0M24-C001B)	1	9	10	80.3	15 sec	Cont	See Note[3]	15 sec	Cont	See Note[3]
Motor Control Center, Switchgear, and Battery Room Supply Fan B (0M23-C001B)	1	82	100	710	25 sec	Cont	See Note[3]	25 sec	Cont	See Note[2]

TABLE 8.3-1 (Continued)

Equipment Description	Number on Bus	kW[16] Total	HP Each	Inrush Current (Amperes)	Loss of Offsite Power (LOOP) [9][22] Time of Start	Loss of Offsite Power (LOOP) Req'd Running Time	Loss of Offsite Power (LOOP) Type of Control	Loss of Offsite Power (LOOP) & Loss-of-Coolant Accident (LOCA) [9][22] Time of Start	Loss of Offsite Power (LOOP) & Loss-of-Coolant Accident (LOCA) Req'd Running Time	Loss of Offsite Power (LOOP) & Loss-of-Coolant Accident (LOCA) Type of Control
Unit 1, Division 2 (Continued)										
Safety System Loads (Continued)										
Motor Control Center and Switchgear Room Return Fan B (0M23-C002B)	1	81	100	660	25 sec	Cont	See Note[3]	25 sec	Cont	See Note[3]
Emergency Closed Cooling Pump Area Cooling Fan B (0M28-B001B)	1	17	20	130	0 sec	Cont	See Note[2]	0 sec	Cont	See Note[2]
Offgas Building Vent Fan B (1M36-C001B)	1	33	40	255	0 sec	Cont	See Note[2]	0 sec	Cont	See Note[2]
Fuel Handling Building Supply Fan B (0M40-C001B)	1	25	30	210	-[8]	Cont	See Note[1]	-[8]	Cont	See Note[1]
Fuel Handling Building Exhaust Fan B (0M40-C002B)	1	33	40	255	-[8]	Cont	See Note[1]	-[8]	Cont	See Note[1]
Fuel Handling Building Exhaust Fan C (0M40-C002C)	1	33	40	255	-[8]	Cont	See Note[1][11]	-[8]	Cont	See Note[11][1]
Fuel Handling Building Exhaust Fan B Heating Coil (0M40-D001B)	1	50	-	-	-[8]	Cont	See Note[1]	-[8]	Cont	See Note[1]
Fuel Handling Building Exhaust Fan C Heating Coil (0M40-D001C)	1	50	-	-	-[8]	Cont	See Note[1][11]	-[8]	Cont	See Note[11][1]
Emergency Service Water Pumphouse Vent Supply Fan B (1M32-C001B)	1	25	30	290	20 sec	Cont	See Note[2]	20 sec	Cont	See Note[2]
Emergency Service Water Pumphouse Intake Screen Wash Pump B (0P49-C002B)	1	41	50	362	-	Cont	See Note[1][5]	0 sec	Cont	See Note[3]
Emergency Service Water Pumphouse Traveling Screen B (0P49-D001B)	1	14	15	103	-	Cont	See Note[1][5]	0 sec	Cont	See Note[3]

TABLE 8.3-1 (Continued)

Equipment Description	Number on Bus	kW[16] Total	HP Each	Inrush Current (Amperes)	Loss of Offsite Power (LOOP) [9][22] Time of Start	Loss of Offsite Power (LOOP) Req'd Running Time	Loss of Offsite Power (LOOP) Type of Control	Loss of Offsite Power (LOOP) & Loss-of-Coolant Accident (LOCA) [9][22] Time of Start	LOOP & LOCA Req'd Running Time	LOOP & LOCA Type of Control
Unit 1, Division 2 (Continued)										
Safety System Loads (Continued)										
Emergency Service Water Suction Sluice Gate B (0P45-D004B)	1	1	1	16	-	-	See Note[28]	-	-	See Note[28]
Diesel Generator Fuel Oil Transfer Pump (1R45-C001B)	1	12	15	116	12 min	Cycles[6]	See Note[2]	12 min	Cycles[6]	See Note[2]
Diesel Generator Fuel Oil Transfer Backup Pump (1R45-C002B)	1	12	15	116	12 min	Cycles[6]	See Note[2][14]	12 min	Cycles[6]	See Note[2][14]
Diesel Generator Jacket Water Keep Warm Pump (1R46-C005B)	1	3	3	32	-	-	See Note[12]	-	-	See Note[12]
Diesel Generator Jacket Water Keep Warm Heater (1R46-D006B)	1	75	-	-	-	-	See Note[10]	-	-	See Note[10]
Diesel Generator Lube Oil Keep Warm Pump (1R47-C002B)	1	13	15	116	-	-	See Note[12]	-	-	See Note[12]
Diesel Generator Lube Oil Keep Warm Heater (1R47-D004B)	1	50	-	-	-	-	See Note[10]	-	-	See Note[10]
125-Volt DC Battery Charger (1R42-S008)	1	50	-	-	0 sec	Cont	See Note[4]	0 sec	Cont	See Note[4]
125-Volt DC Reserve Battery Charger (0R42-S009)	1	50	-	-	-	-	See Note[1]	-	-	See Note[1]
Hydrogen Recombiner B (1M51-D001B)	1	75	-	-	-	-	See Note[1]	-	Cont	See Note[1]
Hydrogen Mixing Compressor B (1M51-C001B)	1	53	60	614	-	-	See Note[1]	-	Cont	See Note[1]

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TABLE 8.3-1 (Continued)

Equipment Description	Number on Bus	kW[16] Total	HP Each	Inrush Current (Amperes)	Loss of Offsite Power (LOOP): Time of Start[9][22]	Loss of Offsite Power (LOOP): Req'd Running Time	Loss of Offsite Power (LOOP): Type of Control	LOOP & Loss-of-Coolant Accident (LOCA): Time of Start[9][22]	LOOP & LOCA: Req'd Running Time	LOOP & LOCA: Type of Control
Unit 1, Division 2 (Continued)										
Safety System Loads (Continued)										
Radiation Monitors (1D19-P500)	1	3	-	-	0 sec	Cont	See Note[4]	0 sec	Cont	See Note[4]
Hydrogen Igniter Transformer (1M56-S202)	1	15	-	-	-	-	See Note[1]	10 min	Cont	See Note[1]
Hydrogen Igniter Control Panel (1H51-P022B)	1	1	1	-	-	-	See Note[1]	10 min	Cont	See Note[1]
ATWS Uninterruptible Power Supply (1R14-S013)	1	8	-	-	0 sec	Cont	See Note[4]	0 sec	Cont	See Note[4]
SLCS Transfer Pump (0C41-C002B)	1	5	5	46	-	Cycles	See Note[1][14]	-	-	See Note[1][14]
Motor Operated Valves	-[17]	-[17]	-[17]	-[17]	-[17]	30 sec	See Note[17]	-[17]	30 sec	See Note[17]
Containment Isolation Valves (1D17-F071B, -F081B)	2	1	.3	-	-	30 sec	See Note[1]	-	30 sec	See Note[1]
Distribution Transformers[24]	5	37	-	-	0 sec	Cont	See Note[4]	0 sec	Cont	See Note[4]
Emergency Closed Cooling Temperature Control Valve (1P42-F665B)	1	1	.125	2.58	0 sec	Cont	See Note[1][2][5]	0 sec	Cont	See Note[1][2][5]
Nonsafety System Loads										
Nuclear Closed Cooling Pump B (0P43-C001B)	1	553	700	585	0 sec	Cont	See Note[3][2]	-	-	-
Control Rod Drive Pump B (1C11-C001B)	1	324	400	312	-	-	See Note[1]	-	-	-

TABLE 8.3-1 (Continued)

Equipment Description	Number on Bus	kW[16] Total	HP Each	Inrush Current (Amperes)	Loss of Offsite Power (LOOP): [9][22] Time of Start	Loss of Offsite Power (LOOP): Req'd Running Time	Loss of Offsite Power (LOOP): Type of Control	LOOP & Loss-of-Coolant Accident (LOCA): [9][22] Time of Start	LOOP & LOCA: Req'd Running Time	LOOP & LOCA: Type of Control
Unit 1, Division 2 (Continued)										
Nonsafety System Loads										
Service Water Pump B (0P41-C001B)	1	780	1,000	794	17 sec	Cont	See Note[3][2]	-	-	-
Standby Liquid Control Operating Heater (1C41-D002)	1	10	-	-	0 sec	Cont	See Note[2]	-	-	-
Hydrogen Main Seal Oil Pump (1N42-C001)	1	16	20	145	0 sec	Cont	See Note[1]	-	-	-
Hydrogen Recirculating Seal Oil Pump (1N42-C002)	1	7	7.5	63.5	0 sec	Cont	See Note[1]	-	-	-
Hydrogen Seal Oil Vapor Extractor (1N42-C004)	1	2	2	25	0 sec	Cont	See Note[1]	-	-	-
Turbine Turning Gear Motor (1N39-C002)	1	51	60	435	30 sec	Cont	See Note[2]	-	-	-
Turbine Turning Gear Piggy Back Motor (1N39-C001)	1	10	10	94	0 sec	Cont	See Note[2]	-	-	-
Turbine Bearing Lift Pumps[24]	9	47	5	46[7]	0 sec	Cont	See Note[2]	-	-	-
Turbine Lube Oil Motor Suction Pump (1N34-C006)	1	39	50	363	0 sec	Cont	See Note[2]	-	-	-
Turbine Turning Gear Oil Pump (1N34-C008)	1	39	50	363	0 sec	Cont	See Note[2]	-	-	-
Reactor Feedwater Pump Turbine A Turning Gear (1N27-C009A)	1	2	1.5	23.4	0 sec	Cont	See Note[2]	-	-	-

TABLE 8.3-1 (Continued)

Equipment Description	Number on Bus	kW[16] Total	HP Each	Inrush Current (Amperes)	Loss of Offsite Power (LOOP) Time of Start[9][22]	Req'd Running Time	Type of Control	Loss of Offsite Power (LOOP) & Loss-of-Coolant Accident (LOCA) Time of Start[9][22]	Req'd Running Time	Type of Control
Unit 1, Division 2 (Continued)										
Nonsafety System Loads										
Reactor Feedwater Pump Turbine B Turning Gear (1N27-C009B)	1	2	1.5	23.4	0 sec	Cont	See Note[2]	-	-	-
Diesel Generator Starting Air Compressors (1R44-C001A) (1R44-C002A,B)	3	75	30	217[7]	10 min	Cycles	See Note[2]	-	-	-
Diesel Generator Starting Air Aftercoolers (1R44-B001A,B) (1R44-B002A,B)	4	4	1	15[7]	10 min	Cycles	See Note[2]	-	-	-
Reactor Protection System Set A Motor Generator (1C71-S001A)	1	25	25	351	-	Cont	See Note[1]	-	-	-
Reactor Water Cleanup Pumps (1G33-C001A,B)	2	90	60	475	-	Cont	See Note[1]	-	-	-
Lower Drywell Cooling Fans (1M13-C001A,B)	2	100	60	435[7]	0 sec	Cont	See Note[2]	-	-	-
Middle Drywell Cooling Fans (1M13-C003A,B)	2	100	60	435[7]	0 sec	Cont	See Note[2]	-	-	-
Upper Drywell Cooling Fans (1M13-C002A,B)	2	100	60	435[7]	0 sec	Cont	See Note[2]	-	-	-
Diesel Driven Fire Pump A Fan (0M46-C009A)	1	7	7.5	63.5	0 sec	Cont	See Note[2]	-	-	-
Local Rad. Monitoring & Misc. Control Panels[24]	17	43	-	-	-	Cont	See Note[1]	-	-	-
Diesel Generator Starting Air Compressors (1R44-C001B)	1	35	40	290	10 min	Cycles	See Note[2]	-	-	-

TABLE 8.3-1 (Continued)

Equipment Description	Number on Bus	kW[16] Total	HP Each	Inrush Current (Amperes)	Loss of Offsite Power (LOOP): [9][22] Time of Start	Loss of Offsite Power (LOOP): Req'd Running Time	Loss of Offsite Power (LOOP): Type of Control	Loss of Offsite Power (LOOP) & Loss-of-Coolant Accident (LOCA): [9][22] Time of Start	Loss of Offsite Power (LOOP) & Loss-of-Coolant Accident (LOCA): Req'd Running Time	Loss of Offsite Power (LOOP) & Loss-of-Coolant Accident (LOCA): Type of Control
Unit 1, Division 2 (Continued)										
Nonsafety System Loads										
125-Volt DC System A Battery Charger (1R42-S005)	1	75	-	-	0 sec	Cont	See Note[4]	-	-	-
125-Volt DC System A Reserve Battery Charger (0R42-S026)	1	75	-	-	-	-	See Note[1]	-	-	-
125-Volt DC System B Battery Charger (1R42-S019)	1	38	-	-	0 sec	Cont	See Note[4]	-	-	-
Essential Lighting[24]	17	465	-	-	0 sec	Cont	See Note[4]	-	-	-
Vital AC Distribution System Alternate Supply Transformer (1R14-S007)	1	50	-	-	0 sec	Cont	See Note[4]	-	-	-
Distribution Panel Transformers[24]	7	104	-	-	0 sec	Cont	See Note[4]	-	-	-
SLCS Mixing Tank (0C41-C003)	1	2	2	5.3	-	Cont	See Note[1]	-	-	-
SLCS Transfer Tank Immersion Heater (0C41-D010)	1	48	-	-	-	Cycles	See Note[1]	-	-	-
Drywell Floor Drains Sump Pump (1P87-C001)	1	4	5	43	-	Cycles	See Note[1]	-	-	-
Suppression Pool Sample Pump (1P87-C002)	1	4	5	43	-	Cont	See Note[1]	-	-	-
RCIC Testable Check Valve Pump (1E51-C005)	1	8	10	81	-	Cont	See Note[1]	-	-	-

TABLE 8.3-1 (Continued)

Equipment Description	Number on Bus	kW[16] Total	HP Each	Inrush Current (Amperes)	LOOP: Time of Start[9][22]	LOOP: Req'd Running Time	LOOP: Type of Control	LOOP & LOCA: Time of Start[9][22]	LOOP & LOCA: Req'd Running Time	LOOP & LOCA: Type of Control
Unit 1, Division 2 (Continued)										
Nonsafety System Loads										
Pit Sump Pump (0G60-C002)	1	2	1.5	24.6	0 sec	Cycles	See Note[2]	-	-	-
Refueling Platform (1F15-E003)	1	16	16	101.5	-	-	See Note[1]	-	-	-
CC Elevator (0L51-E009)	1	24	30	100	-	Cycles	See Note[1]	-	-	-
Underdrain Backup Pump (0P72-C002A)	1	8	5	45	0 sec	Cont	See Note[2]	-	-	-
Fuel Pool Receptacle	1	6	-	-	0 sec	Cont	See Note[4]	-	-	-
Transmission Station	1	300	-	4,320	0 sec	Cont	See Note[2]	-	-	-
TSC & SB AHU/Cond.[24]	11	480.7	-	2,623	0 sec	Cycles	See Note[2]	-	-	-
TSC & SB Heaters[24]	8	112	-	843	-	Cycles	See Note[1][2]	-	-	-
Telephone System XFMR's Service Bldg. (0R55S0008 & 0R55S0010)	2	36	-	-	0 sec	Cont	See Note[2]	-	-	-
TSC UPS Isolation Transformer (1R15-S003)	1	150	-	3,600	0 sec	Cont	See Note[4]	-	-	-
Clearwell Pump A (0P20-C001A)	1	20	25	201	0 sec	Cont	See Note[2]	-	-	-
Motor Operated Valves	-[17]	-[17]	-[17]	-[17]	-[17]	30 sec	See Note[17]	-	-	-
CRD Aux Lube Oil Pump A,B (1C11-C002A,B)	2	2	0.33	4.2[7]	-	-	See Note[1]	-	-	-
Security Lighting Transformer (OR71-S0132)	1	131	-	164.7	0 sec	Cont	See Note[4]	-	-	-
Electrical Panel (1H51-P00857)	1	1	-	2	0 sec	Cont	See Note[4]	-	-	-

TABLE 8.3-1 (Continued)

	Time Sequence	Loss of Offsite Power (LOOP) Cont.	Loss of Offsite Power (LOOP) Cyclic	Loss of Offsite Power (LOOP) Loss-of-Coolant Accident (LOCA) Cont.	Loss of Offsite Power (LOOP) Loss-of-Coolant Accident (LOCA) Cyclic
Subtotal, kW per Time Sequence	0 sec	1,173.2	81.0	1,152.6	0
	5 sec	0	0	745.7	0
	15 sec	8.6	0	8.6	0
	17 sec	780.4	0	0	0
	20 sec	658.9	0	658.9	0
	25 sec	162.7	0	162.7	0
	30 sec	51.0	0	0	0
	35 sec	82.0	0	82.0	0
	53 min	1.6	0	1.6	0
	81 min	580.0	0	580.0	0
	10 min	0	103.1	0	0
	12 min	0	12.4	0	12.4
	20 min	0	0	0	0
Total Automatic Continuous Load[21]		3,624.0		3,517.6	
Total Automatic Cyclic Load[17][21]			196.5		12.4
Total Automatic Load[21]		3,820.5			3,530.0
Total Manual Load[21]		2,985.0		3,226.7	
Total Load (Auto & Manual)[21]		6,805.5		6,756.7	

Equipment Description	Number on Bus	kW[16] Total	HP Each	Inrush Current (Amperes)	LOOP Time of Start[9][22]	LOOP Req'd Running Time	LOOP Type of Control	LOOP & LOCA Time of Start[9][22]	LOOP & LOCA Req'd Running Time	LOOP & LOCA Type of Control
Unit 1, Division 3										
Safety System Loads										
High Pressure Core Spray Pump (1E22-C001)	1	2,397[19]	3,000	2,418	0 sec[2]	Cont	See Note[2]	0 sec[18]	Cont	See Note[3]
High Pressure Core Spray Emergency Service Water Pump (1P45-C002)	1	63	75	557	33 sec	Cont	See Note[2]	33 sec	Cont	See Note[2]
High Pressure Core Spray Water Leg Pump (1E22-C003)	1	5	5	46	0 sec[8]	Cont	See Note[1]	0 sec[8]	Cont	See Note[1]
High Pressure Core Spray Pump Room Cooling Fan (1M39-B003)	1	17	20	130	0 sec[2]	Cont	See Note[1][2]	0 sec[18]	Cont	See Note[2]

TABLE 8.3-1 (Continued)

Equipment Description	Number on Bus	kW[16] Total	HP Each	Inrush Current (Amperes)	Loss of Offsite Power (LOOP): Time of Start[9][22]	Loss of Offsite Power (LOOP): Req'd Running Time	Loss of Offsite Power (LOOP): Type of Control	LOOP & Loss-of-Coolant Accident (LOCA): Time of Start[9][22]	LOOP & LOCA: Req'd Running Time	LOOP & LOCA: Type of Control
Unit 1, Division 3 (Continued)										
Safety System Loads (Continued)										
High Pressure Core Spray Diesel Generator Room Fan (1M43-COO2C)	1	41	50	376	0 sec	Cont	See Note[2]	0 sec	Cont	See Note[2]
High Pressure Core Spray Diesel Generator Fuel Oil Transfer Pump (1R45-C001C)	1	12	15	116	40 min	Cycles[6]	See Note[2]	40 min	Cycles[6]	See Note[2]
High Pressure Core Spray Diesel Generator Fuel Oil Transfer Backup Pump (1R45-C002C)	1	12	15	116	40 min	Cycles[6]	See Note[2][14]	40 min	Cycles[6]	See Note[2][14]
125-Volt DC Battery Charger (1E22-S006)	1	25	-	-	0 sec	Cont	See Note[4]	0 sec	Cont	See Note[4]
High Pressure Core Spray Diesel Generator Room Fan (1M43-C001C)	1	41	50	376	10 sec	Cont	See Note[2]	10 sec	Cont	See Note[2]
125-Volt DC Reserve Battery Charger (0R42-S011)	1	25	-	-	-	-	See Note[1]	-	-	See Note[1]
Motor Operated Valves	-[17]	-[17]	-[17]	-[17]	-[17]	30 sec	See Note[17]	-[17]	30 sec	See Note[17]
High Pressure Core Spray Diesel Generator Jacket Water Heater (1E22-D010)	1	15	-	-	-	-	See Note[3][10]	-	-	See Note[3][10]
High Pressure Core Spray Diesel Generator Space Heater (1E22-D011)	1	2	-	-	-[8]	-	See Note[3][10]	-	-	See Note[3][10]
Distribution Transformers (1R25-S0029, 1R25-S0100)	2	17	-	-	0 sec	Cont	See Note[4]	0 sec	Cont	See Note[4]

TABLE 8.3-1 (Continued)

Equipment Description	Number on Bus	kW[16] Total	HP Each	Inrush Current (Amperes)	Loss of Offsite Power (LOOP): [9] [22] Time of Start	Loss of Offsite Power (LOOP): Req'd Running Time	Loss of Offsite Power (LOOP): Type of Control	Loss of Offsite Power (LOOP) & Loss-of-Coolant Accident (LOCA): [9] [22] Time of Start	Loss of Offsite Power (LOOP) & Loss-of-Coolant Accident (LOCA): Req'd Running Time	Loss of Offsite Power (LOOP) & Loss-of-Coolant Accident (LOCA): Type of Control
Unit 1, Division 3 (Continued)										
Safety System Loads (Continued)										
High Pressure Core Spray Diesel Generator Lube Oil Circulating Pump (1E22-C007)	1	1	1	-	-[8]	Cont	See Note[3][10]	-	-	See Note[3][10]
High Pressure Core Spray Diesel Generator Starting Air Compressor (1E22-C004A)	1	9	10	80	0 sec	Cycles	See Note[2]	-	-	See Note[3]
High Pressure Core Spray Diesel Generator Starting Air Compressor (1E22-C004B)	1	9	10	84	0 sec	Cycles	See Note[2]	-	-	See Note[3]

	Time Sequence	Loss of Offsite Power (LOOP): Cont.	Loss of Offsite Power (LOOP): Cyclic	Loss of Offsite Power (LOOP) Loss-of-Coolant Accident (LOCA): Cont.	Loss of Offsite Power (LOOP) Loss-of-Coolant Accident (LOCA): Cyclic
Subtotal, kW per Time Sequence	0 sec	2,454.3	17.3	2,454.3	0
	10 sec	40.8	---	40.8	---
	33 min	63.3	---	63.3	---
	40 min	0	0	0	0
Total Automatic Continuous Load[21]		2,558.4	17.3	2,558.4	
Total Automatic Cyclic Load[17][21]					2,558.4
Total Automatic Load[21]			2,575.7		
Total Manual Load[21]			62.6	58.9	
Total Load (Auto & Manual)[21]		2,638.3		2,617.3	

NOTES:

[1] Type of control - equipment energized manually.
[2] Type of control - equipment started automatically with associated equipment, instruments.
[3] Type of control - equipment started or stopped automatically by LOCA signal, LOOP signal or high radiation signal.
[4] Type of control - equipment continuously energized; requires no manual or automatic operation.
[5] This load is conservatively considered to be continuous. Under Loop conditions the load may be manually cycled.
[6] Cycles based on the time necessary to fill the fuel oil tank and deplete the supply in the tank.
[7] Average value.

TABLE 8.3-1 (Continued)

NOTES: (Continued)

(8) Manually operated load considered capable of starting at 0 seconds post-LOOP or LOOP/LOCA. Load kW included in 0 second Continuous Load Totals.

(9) Zero seconds (0 sec) is the time that the 4.16 kV bus voltage is available after the diesel generator breaker closes. The time period from diesel generator breaker to zero seconds includes undervoltage relay and auxiliary relay pickup and dropout items. Load center transformers, which are not load shed, are energized immediately after diesel generator breaker closure. Non-safety stub bus loads will also restart following manual restoration of the stub bus post LOCA. These loads are identified in calculations maintained by engineering and are included in the kW load totals, manually restored loads are considered to have a 20-minute start time to account for operator response time.

(10) For each diesel generator, the jacket water and lube oil keep warm heaters, and the Div. 3 lube oil circ. pump and space heater are prevented from operating in the event of a LOOP and/or a LOCA signal.

(11) Fuel Handling Building Exhaust Fan C and Fan C Heating Coil are shown in Div. 1 and Div. 2 summaries but are key interlocked to be connected to only one division at a time.

(12) For each diesel generator, the jacket water and lube oil keep warm circulating pumps are prevented from operating when the diesel generator is running at rated speed.

(13) If chiller was running at time of accident, then restart time will be 150 seconds.

(14) Not required, but can be used.

(15) Time of start is 15 sec during a LOCA only, and 0 sec during a simultaneous LOOP and LOCA.

(16) Rounded to the nearest whole number.

(17) Motor-Operated Valve (MOV) loads are cyclic and have widely varied post-LOOP and/or LOCA starting times. They are assumed to cycle for only the first 30 seconds post-LOOP and/or LOCA as required. They are not included in the net total load values due to the combined affect of their short operation period and their less than cyclic frequency of operation.

(18) Time of start is 10 sec during a LOCA only, and 0 sec during a simultaneous LOOP and LOCA.

(19) Actual test data has shown that the high pressure core spray and RHR pump loads at rated conditions are less than 2,330 and 725 kW respectively.

(20) (Deleted)

(21) These totals were obtained from calculations which are maintained by Engineering.

(22) The start time is a nominal value. Tolerance of the timing relays which control the equipment is indicated in the Master Setpoint List or General Electric instruction.

(23) kW, and Inrush values are "worst case" (maximum) values, based on data from both the Reliance Electric and Westinghouse motors approved for use.

(24) Equipment numbers of this load are shown in calculation which is maintained by Engineering.

(25) Service Building Telephone System XFMR’s 0R55S0008 & 0R55S0010 share the telephone system load equally. Therefore, only one equipment load is included in the total kw and full load current columns.

(26) Consistent with USAR <Section 8.3.1.1.3.2.a>, the RHR Pump “A” and “B” motors (1E12-C002A and 1E12-C002B) represent the only diesel generator Division 1 and Division 2 block loads that require load sequence times (set @ 5 seconds).

(27) “-” represents a manual load or a load which is not required to operate during a LOOP or a LOCA. The system operating characteristics were not considered.

(28) Not required for LOOP or LOOP/LOCA. Functions upon loss of intake tunnel which is not postulated to occur with other events.

TABLE 8.3-2

CLASS 1E EQUIPMENT CAPACITIES

Equipment	Capacity
4.16 kV Switchgear	
Buses EH11, EH12	2,000 A, continuous rating; 350 mVA, interrupting
Bus EH13	1,200 A, continuous rating; 350 mVA, interrupting
Incoming Breakers (preferred source)	1,200 A, continuous rating; 350 mVA, interrupting
Feeder Breakers	1,200 A, continuous rating; 350 mVA, interrupting
Incoming Breaker (alternate source)	2,000 A, continuous rating; 350 mVA, interrupting
Standby Diesel Generator Breakers	2,000 A, continuous rating; 350 mVA, interrupting
HPCS Diesel Generator Breaker	1,200 A, continuous rating; 350 mVA, interrupting

TABLE 8.3-2 (Continued)

Equipment	Capacity
480-Volt Unit Load Center Substation	
Transformers	
Division 1 and Division 2	1,500/2,000 kVA (AA, FA rating) 3 phase, 60 Hz, 4.16 kV/480 volt
Division 3	300 kVA (AA rating), 3 phase, 60 Hz, 4.16 kV/480 volt
Buses, Division 1 and Division 2	3,000 A, continuous rating
Supply Breakers	3,000 A, continuous rating; 65,000 A, interrupting
Tie Breakers	1,600 A, continuous rating; 50,000 A, interrupting
480-Volt Motor Control Centers	
Horizontal Bus	600 A, continuous rating; 42,000 A, rms symmetrical
Vertical Bus	400 A, continuous rating

TABLE 8.3-2 (Continued)

Equipment	Capacity
480-Volt Motor Control Centers (Continued)	
Fused Disconnect Switches	Class K5 or RK-5 fuses, 200,000 A interrupting; switches rated 30 A to 200 A
Distribution Panels	
120-Volt AC Panels	Lugs only; mounted in 480 volt motor control center; 10,000 A, rms symmetrical; molded case load breakers
125-Volt DC Panels	600 A, continuous rating; 50,000 A, short circuit rating Class L, K5 or RK-5 fuses, 200,000 A, interrupting

TABLE 8.3-3

SAFETY-RELATED EQUIPMENT IDENTIFICATION

Separation Category	Division Marker Color/Letter Color	System
Division 1	Yellow/Black	ESF Division 1, reactor protection system Channel A, and equipment fed directly from Division 1 buses.
Division 2	Blue (Med.)/ White[1]	ESF Division 2, reactor protection system Channel B, and equipment fed directly from Division 2 buses.
Division 3	Green (Med.)/ White[1]	ESF Division 3, reactor protection system Channel C, and equipment fed directly from Division 3 buses.
Division 4	Orange/Black	ESF Division 4 and reactor protection system Channel D.
Non-divisional	White/Black	Non-Class 1E.

NOTE:

[1] Black letters may be used where that color contrast provides better visibility.

TABLE 8.3-4

DIESEL GENERATOR SEQUENTIAL LOADING TEST DATA

Time (sec)	Load	Minimum Voltage	Voltage Recovery Time to 90% of Rated (sec)	Minimum Frequency (Hz)	Frequency Recovery Time to 98% of Rated (sec)	Cumulative Load (kW)
Test 1[1]						
7.3	2,500 hp 2,252 kW	3,450	0.4	57.5	0.9	2,300
12.3	1,000 hp 769 kW	3,800	0	59.3	0	3,200
17.3	300 hp 156 kW	4,100	0	59.8	0	3,400
22.3	1,000 hp 668 kW	3,900	0	59.3	0	4,150
Test 2[2]						
0	3,850 kW	-	-	-	-	3,850
10.3	1,300 hp 875 kW	3,750	0	58.8	0	4,850
15.3	1,000 hp 575 kW	3,800	0	59.0	0	5,500
20.3	700 hp 601 kW	3,950	0	59.0	0	6,100

TABLE 8.3-4 (Continued)

Time (sec)	Load	Minimum Voltage	Voltage Recovery Time to 90% of Rated (sec)	Minimum Frequency (Hz)	Frequency Recovery Time to 98% of Rated (sec)	Cumulative Load (kW)
25.3	500 hp 668 kW	4,050	0	59.2	0	6,500

NOTES:

(1) Test 1 performed from initially unloaded condition.
(2) Test 2 performed with base load of 3,850 kW retained; all other load shed upon receipt of start signal.

TABLE 8.3-5

DIESEL GENERATOR MARGIN TEST RESULTS

Test	Time (sec)	Load	Minimum Voltage	Voltage Recovery Time to 90% of Rated (sec)	Minimum Frequency (Hz)	Frequency Recovery Time to 98% of Rated (sec)	Cumulative Load (kW)
1	7.0	2,700 hp 2,500 kW	3,400	0.5	57.4	1.1	2,650
2	7.0	2,700 hp 2,500 kW	3,400	0.4	57.3	1.0	2,800

TABLE 8.3-6

DIESEL GENERATOR STARTING AND LOADING TEST WITHOUT SERVICE WATER

Time (sec)	Load	Minimum Voltage	Voltage Recovery Time to 90% of Rated (sec)	Minimum Frequency (Hz)	Frequency Recovery Time to 98% of Rated (sec)	Cumulative Load (kW)
6.2	2,500 hp 2,252 kW	3,250	0.5	59.7	0	2,600
11.2	1,000 hp 769 kW	3,850	0	59.2	0	3,550
16.2	1,300 hp 824 kW	 3,850	0	58.8	0	4,800

TABLE 8.3-7

LOAD REQUIREMENTS, 125 VOLT DC CLASS 1E BATTERIES

Load Description	Amperes Required after A-C Power Loss Coincident with LOCA 0 to 1 Min	1 to 2 Min	2 to 3 Min	3 to 4 Min	4 to 11 Min	11 to 119 Min	119 to 120 Min
Division 1, Unit 1 Battery					See Note(6)		
Reactor Core Isolation Cooling Isolation Valves							
Residual Heat Removal Metering and Control							
ATWS Uninterruptible Power System							
Recirculation Pump Trip Control Logic							
ATWS Panels							
Reactor Core Isolation Cooling Control							
Emergency Response Information System							
Automatic Depressurization System Control							
Class 1E to Non-Class 1E Circuit Isolators							
Deluge Valve Control, LOCA Relays, and Miscellaneous Instrumentation							

TABLE 8.3-7 (Continued)

Load Description	Amperes Required after A-C Power Loss Coincident with LOCA						
	0 to 1 Min	1 to 2 Min	2 to 3 Min	3 to 4 Min	4 to 11 Min	11 to 119 Min	119 to 120 Min
Division 1, Unit 1 Battery (Continued)							
Analog Loop Instrumentation							
Remote Shutdown Panel							
Diesel Generator Control Panel							
Diesel Generator Start Control							
Diesel Generator Redundant Start Control							
Diesel Generator Field Flash							
Switchgear							
Total Amperes per Interval	360	165	140	235	140	116	140
Division 2, Unit 1 Battery					See Note[6]		
Residual Heat Removal Metering and Control							
Recirculation Pump Trip Control Logic							
ATWS Uninterruptible Power System							

TABLE 8.3-7 (Continued)

Load Description	Amperes Required after A-C Power Loss Coincident with LOCA						
	0 to 1 Min	1 to 2 Min	2 to 3 Min	3 to 10 Min	10 to 11 Min	11 to 119 Min	119 to 120 Min
Division 2, Unit 1 Battery (Continued)							
Automatic Depressurization System Control							
Class 1E to Non-Class 1E Circuit Isolators							
ATWS Panels							
Deluge Valve Control, LOCA Relays, and Miscellaneous Instrumentation							
Emergency Response Information System							
Analog Loop Instrumentation							
Diesel Generator Control Panel							
Remote Shutdown							
Diesel Generator Start Control							
Diesel Generator Redundant Start Control							
Diesel Generator Field Flash							
Switchgear							

TABLE 8.3-7 (Continued)

Load Description	Amperes Required after A-C Power Loss Coincident with LOCA						
	0 to 1 Min	1 to 2 Min	2 to 3 Min	3 to 10 Min	10 to 11 Min	11 to 119 Min	119 to 120 Min
Division 2, Unit 1 Battery (Continued)							
Total Amperes per Interval	210	105	125	105	125	105	125

Division 1, Unit 2 Battery[4]

(Deleted)

Division 2, Unit 2 Battery[5]

(Deleted)

	Amperes Required after A-C Power Loss		
	0 to 1 Min	1 to 119 Min	119 to 120 Min
Division 3 Battery[3]		See Note[6]	
Diesel Engine Control Cabinet			
Generator Auxiliary Control			
Control Room Panel			
Field Flashing			
Solenoid Valves			
D.G. Protection Relay Panel			

TABLE 8.3-7 (Continued)

	Amperes Required after A-C Power Loss		
	0 to 1 Min	1 to 119 Min	119 to 120 Min
Division 3 Battery[3] (Continued)			
Indicator Lamps Control Room Panel			
Switchgear (Breakers Closing)			
Diesel Standby Fuel Pump & Turbo Charger Pump			
Total Amperes per Interval	75	30	55

NOTES:

(1) (Deleted)
(2) (Deleted)
(3) Division 3 battery capacity (for each unit):

a. 250 ampere - hours at 8 hours
b. 303 ampere - hours at 1 minute

(4) See Unit 1, Division 1 battery load descriptions. This Unit 2 battery may be connected to support Unit 1, Division 1 Loads.
(5) See Unit 1, Division 2 battery load descriptions. This Unit 2 battery may be connected to support Unit 1, Division 2 Loads.
(6) See below the total ampere requirements for this battery.

TABLE 8.3-8

POWER CONTROL SOURCES FOR SWITCHGEAR

Switchgear (By Bus Nomenclature)	Control Power Source (125Vdc) Bus	Breaker	Fused Disc Switch No.
L1102	D1B	D1B07[1]	6
L1103	D1B	D1B06[1]	19
L1104	D1B	D1B06[1]	19
L1105	D1B	D1B06[1]	19
L1106	D1B	D1B06[1]	19
L1107	D1B	D1B06[1]	19
L1108	D1B	D1B06[1]	19
L1109	D1B	D1B06[1]	19
L1110	D1B	D1B06[1]	19
L1202	D1B	D1B07[1]	8
L1203	D1B	D1B06[1]	21
L1204	D1B	D1B06[1]	21
L1205	D1B	D1B06[1]	21
L1206	D1B	D1B06[1]	21
L1207	D1B	D1B06[1]	21
L1208	D1B	D1B06[1]	21
L1209	D1B	D1B06[1]	21
L1210	D1B	D1B06[1]	21
L1001	D1B	D1B06[1]	17
L1003	D1B	D1B06[1]	17
L1004	D1B	D1B06[1]	17
L1006	D1B	D1B07[1]	16
L1007	D1B	D1B07[1]	16
L1008	D1B	D1B07[1]	16
L1009	D1B	D1B07[1]	16
L1010	D1B	D1B07[1]	16
L2001	D2B	D2B06	17
L2001	D2B	D2B07	16

TABLE 8.3-8 (Continued)

Switchgear (By Bus Nomenclature)	Control Power Source (125Vdc)		
	Bus	Breaker	Fused Disc Switch No.
L2003	D2B	D2B06	17
L2003	D2B	D2B07	16
L2004	D2B	D2B06	17
L2004	D2B	D2B07	16
L2006	D2B	D2B06	17
L2007	D2B	D2B06	17
L2008	D2B	D2B06	17
L2009	D2B	D2B06	17
L2010	D2B	D2B06	17
H1101	D1B	D1B07(1)	15
H1102	D1B	D1B07(1)	15
H1103	D1B	D1B06(1)	3
H1104	D1B	D1B06(1)	3
H1105	D1B	D1B06(1)	3
H1106	D1B	D1B06(1)	3
H1107	D1B	D1B06(1)	3
H1108	D1B	D1B06(1)	3
H1109	D1B	D1B06(1)	3
H1110	D1B	D1B06(1)	3
H1111	D1B	D1B06(1)	3
H1112	D1B	D1B06(1)	3
H1201	D1B	D1B07(1)	5
H1202	D1B	D1B07(1)	5
H1203	D1B	D1B06(1)	5
H1204	D1B	D1B06(1)	5
H1205	D1B	D1B06(1)	5
H1206	D1B	D1B06(1)	5
H1207	D1B	D1B06(1)	5
H1208	D1B	D1B06(1)	5

TABLE 8.3-8 (Continued)

Switchgear (By Bus Nomenclature)	Control Power Source (125Vdc) Bus	Breaker	Fused Disc Switch No.
H1209	D1B	D1B06[(1)]	5
H1210	D1B	D1B06[(1)]	5
H1211	D1B	D1B06[(1)]	5
H1212	D1B	D1B06[(1)]	5
H1213	D1B	D1B06[(1)]	5
H1214	D1B	D1B06[(1)]	5
EH1101	D1B	D1B06[(1)]	12
EH1102	ED1A	ED1A06	24
EH1104	ED1A	ED1A06	23
EH1105	ED1A	ED1A06	23
EH1106	ED1A	ED1A06	23
EH1107	ED1A	ED1A06	23
EH1109	ED1A	ED1A06	23
EH1110	ED1A	ED1A06	23
EH1111	ED1A	ED1A06	23
EH1113	ED1A	ED1A06	23
EH1114	ED1A	ED1A06	24
EH1115	ED1A	ED1A06	24
EH1116	ED1A	ED1A06	24
XH1101	D1B	D1B06[(1)]	12
XH1102	D1B	D1B06[(1)]	12
EH1201	ED1B	ED1B06	22
EH1203	ED1B	ED1B06	21
EH1204	ED1B	ED1B06	21
EH1205	ED1B	ED1B06	21
EH1206	ED1B	ED1B06	21
EH1207	ED1B	ED1B06	21
EH1208	ED1B	ED1B06	21
EH1209	ED1B	ED1B06	21

TABLE 8.3-8 (Continued)

Switchgear (By Bus Nomenclature)		Control Power Source (125Vdc) Bus	Breaker	Fused Disc Switch No.
EH1210		ED1B	ED1B06	21
EH1211		ED1B	ED1B06	21
EH1212		ED1B	ED1B06	22
EH1213		ED1B	ED1B06	22
EH1214		ED1B	ED1B06	22
XH1201		D1B	D1B07[(1)]	10
XH1202		D1B	D1B07[(1)]	10
XH1203		D1B	D1B07[(1)]	10
XH1204		D1B	D1B07[(1)]	10
EH1301		ED1C	11	N/A
EH1302		ED1C	11	N/A
EH1303		ED1C	11	N/A
EH1304		ED1C	11	N/A
EH1305		ED1C	11	N/A
EF1A03		ED1A	ED1A06	20
EF1A04		ED1A	ED1A06	19
EF1A05		ED1A	ED1A06	19
EF1A06	(Manual)	N/A	N/A	N/A
EF1A07	(Manual)	N/A	N/A	N/A
EF1A08	(Manual)	N/A	N/A	N/A
EF1A09	(Manual)	N/A	N/A	N/A
EF1A10		ED1A	ED1A06	19
EF1A11		ED1A	ED1A06	19
EF1A12	(Manual)	N/A	N/A	N/A
EF1B03		ED1A	ED1A06	20
EF1B04		ED1A	ED1A06	19
EF1B05		ED1A	ED1A06	19
EF1B06	(Manual)	N/A	N/A	N/A
EF1B07	(Manual)	N/A	N/A	N/A

TABLE 8.3-8 (Continued)

Switchgear (By Bus Nomenclature)		Control Power Source (125Vdc)		
		Bus	Breaker	Fused Disc Switch No.
EF1B08	(Manual)	N/A	N/A	N/A
ED1B09	(Manual)	N/A	N/A	N/A
EF1B10		ED1A	ED1A06	19
EF1B11	(Manual)	N/A	N/A	N/A
EF1B12	(Manual)	N/A	N/A	N/A
EF1B13	(Manual)	N/A	N/A	N/A
EF1C03		ED1B	ED1B06	20
EF1C04		ED1B	ED1B06	19
EF1C05		ED1B	ED1B06	19
EF1C06	(Manual)	N/A	N/A	N/A
EF1C07	(Manual)	N/A	N/A	N/A
EF1C08	(Manual)	N/A	N/A	N/A
EF1C09	(Manual)	N/A	N/A	N/A
EF1C10		ED1B	ED1B06	19
EF1C11		ED1B	ED1B06	19
EF1C12	(Manual)	N/A	N/A	N/A
EF1C13	(Manual)	N/A	N/A	N/A
EF1D03		ED1B	ED1B06	20
EF1D04		ED1B	ED1B06	19
EF1D05		ED1B	ED1B06	19
EF1D06	(Manual)	N/A	N/A	N/A
EF1D07	(Manual)	N/A	N/A	N/A
EF1D08	(Manual)	N/A	N/A	N/A
EF1D09	(Manual)	N/A	N/A	N/A
EF1D10		ED1B	ED1B06	19
EF1D11	(Manual)	N/A	N/A	N/A
EF1D12	(Manual)	N/A	N/A	N/A
F1A03		D1B	D1B07[(1)]	7
F1A04	(Manual)	N/A	N/A	N/A
F1A05	(Manual)	N/A	N/A	N/A

TABLE 8.3-8 (Continued)

Switchgear (By Bus Nomenclature)		Control Power Source (125Vdc) Bus	Breaker	Fused Disc Switch No.
F1A06	(Manual)	N/A	N/A	N/A
F1A07	(Manual)	N/A	N/A	N/A
F1A08	(Manual)	N/A	N/A	N/A
F1A09		D1B	D1B06(1)	7
F1A10	(Manual)	N/A	N/A	N/A
F1A11		D1B	D1B06(1)	7
F1A12	(Manual)	N/A	N/A	N/A
F1A13		D1B	D1B06(1)	7
F1A14		D1B	D1B06(1)	7
F1A15		D1B	D1B06(1)	7
F1A16	(Manual)	N/A	N/A	N/A
F1A17	(Manual)	N/A	N/A	N/A
F1B03		D1B	D1B07(1)	7
F1B04	(Manual)	N/A	N/A	N/A
F1B05	(Manual)	N/A	N/A	N/A
F1B06	(Manual)	N/A	N/A	N/A
F1B07	(Manual)	N/A	N/A	N/A
F1B08	(Manual)	N/A	N/A	N/A
F1B09		D1B	D1B06(1)	7
F1B10		D1B	D1B06(1)	7
F1B11		D1B	D1B06(1)	7
F1B12	(Manual)	N/A	N/A	N/A
F1B13		D1B	D1B06(1)	7
F1B14		D1B	D1B06(1)	7
F1B15	(Manual)	N/A	N/A	N/A
F1B16		D1B	D1B06(1)	7
F1C03		D1B	D1B07(1)	9
F1C04		D1B	D1B06(1)	9
F1C05		D1B	D1B06(1)	9
F1C06	(Manual)	N/A	N/A	N/A

TABLE 8.3-8 (Continued)

Switchgear (By Bus Nomenclature)		Control Power Source (125Vdc) Bus	Breaker	Fused Disc Switch No.
F1C07	(Manual	N/A	N/A	N/A
F1C08	(Manual)	N/A	N/A	N/A
F1C09		D1B	D1B06[(1)]	9
F1C10	(Manual)	N/A	N/A	N/A
F1C11		D1B	D1B06[(1)]	9
F1C12	(Manual)	N/A	N/A	N/A
F1C13		D1B	D1B06[(1)]	9
F1C14		D1B	D1B06[(1)]	9
F1C15		D1B	D1B06[(1)]	9
F1C16		D1B	D1B06[(1)]	9
F1C17	(Manual)	N/A	N/A	N/A
F1D03		D1B	D1B07[(1)]	9
F1D04		D1B	D1B06[(1)]	9
F1D05	(Manual)	N/A	N/A	N/A
F1D06	(Manual)	N/A	N/A	N/A
F1D07	(Manual)	N/A	N/A	N/A
F1D08	(Manual)	N/A	N/A	N/A
F1D09		D1B	D1B06[(1)]	9
F1D10	(Manual)	N/A	N/A	N/A
F1D11		D1B	D1B06[(1)]	9
F1D12	(Manual)	N/A	N/A	N/A
F1D13	(Manual)	N/A	N/A	N/A
F1D14		D1B	D1B06[(1)]	9
F1D15		D1B	D1B06[(1)]	9
F1D16		D1B	D1B06[(1)]	9
F1E03		D1B	D1B07[(1)]	11
F1E04	(Manual)	N/A	N/A	N/A
F1E05	(Manual)	N/A	N/A	N/A
F1E06	(Manual)	N/A	N/A	N/A
F1E07		D1B	D1B06[(1)]	11

TABLE 8.3-8 (Continued)

Switchgear (By Bus Nomenclature)		Control Power Source (125Vdc) Bus	Breaker	Fused Disc Switch No.
F1E08		D1B	D1B06[1]	11
F1E09	(Manual)	N/A	N/A	N/A
F1E10		D1B	D1B06[1]	11
F1E11		D1B	D1B06[1]	11
F1E12	(Manual)	N/A	N/A	N/A
F1E13		D1B	D1B06[1]	11
F1E14	(Manual)	N/A	N/A	N/A
F1E15	(Manual)	N/A	N/A	N/A
F1E16		D1B	D1B06[1]	11
F1F03		D1B	D1B07[1]	11
F1F04	(Manual)	N/A	N/A	N/A
F1F05	(Manual)	N/A	N/A	N/A
F1F06		D1B	D1B06[1]	11
F1F07		D1B	D1B06[1]	11
F1F08		D1B	D1B06[1]	11
F1F09		D1B	D1B06[1]	11
F1F10		D1B	D1B06[1]	11
F1F11		D1B	D1B06[1]	11
F1F12		D1B	D1B06[1]	11
F1F13	(Manual)	N/A	N/A	N/A
F1F14	(Manual)	N/A	N/A	N/A
F1F15	(Manual)	N/A	N/A	N/A
F1F16		D1B	D1B06[1]	11
F1F17	(Manual)	N/A	N/A	N/A
F1G03		D1B	D1B06[1]	13
F1G04	(Manual)	N/A	N/A	N/A
F1G05	(Manual)	N/A	N/A	N/A
F1G06		D1B	D1B06[1]	13
F1G08		D1B	D1B06[1]	13

TABLE 8.3-8 (Continued)

Switchgear (By Bus Nomenclature)	Control Power Source (125Vdc) Bus	Breaker	Fused Disc Switch No.
F1G09	D1B	D1B06[1]	13
F1G10 (Manual)	N/A	N/A	N/A
XF1A01 (Manual)	N/A	N/A	N/A
XF1A02 (Manual)	N/A	N/A	N/A
XF1A03 (Manual)	N/A	N/A	N/A
XF1A04 (Manual)	N/A	N/A	N/A
XF1A05 (Manual)	N/A	N/A	N/A
XF1A06 (Manual)	N/A	N/A	N/A
XF1A07 (Manual)	N/A	N/A	N/A
XF1A08	D1B	D1B06[1]	14
Reactor Recirc. Brkr. 2A 1R22-S010	D1B	D1B06[1]	20
Reactor Recirc. Brkr. 2B 1R22-S011	D1B	D1B06[1]	20
Reactor Recirc. Brkr. 3A 1R22-S012	ED1A	ED1A06	26
Reactor Recirc. Brkr. 3B 1R22-S013	ED1A	ED1A06	26
Reactor Recirc. Brkr. 4A 1R22-S014	ED1B	ED1B06	26
Reactor Recirc. Brkr. 4B 1R22-S015	ED1B	ED1B06	26

NOTE:

[1] Alternate source (maintenance breaker) at D1B04 breaker position shall be used during times when breaker D1B06 or D1B07 is periodically maintained.

TABLE 8.3-9

HPCS DIESEL GENERATOR

DIESEL ENGINE/GENERATOR

Diesel engine	
Type	Stationary, injection water cooled, turbocharged two stroke cycle inline, compression ignition type.
Auxiliaries	Compressed air starting systems (including compressor and accumulators), engine control panel; cool-water system (including pump and heat exchanger, and standby heater with temperature control), lubrication oil system (including oil reservoir, pumps, strainer, filter, cooler and standby heaters with temperature control).
Diesel engine	
Accessories	Fuel filter, intake air filter/silencer, exhaust muffler, ladders and catwalks, overspeed trip devices.
Generator	
Voltage	4,160
Current	494 amps
Frequency	60 Hz
Auxiliaries	Generator control panel including exciter and voltage regulator; generator grounding system.
Accessories	Grounding compartment including grounding transformer and grounding resistor; resistance temperature detectors with common terminal box; current transformer.
Seismic classification	Class I

TABLE 8.3-10

INDICATIONS AND ALARMS OF THE DIVISION 1 AND DIVISION 2
CLASS 1E DC POWER SYSTEMS

Battery current (ammeter-charge/discharge)	Local and control room indication
Battery charger output current (ammeter)	Local indication
DC bus voltage (voltmeter)	Control room indication
Battery charger output voltage (voltmeter)	Local indication
Battery Voltage	Local and control room indication
DC bus undervoltage alarm	Control room alarm
DC bus ground alarm (for ungrounded system)	Control room alarm
Battery breaker(s) and fuse(s) open alarm	Common control room alarms
Battery charger input and output breakers	Common control room trouble alarm
Battery charger failure, undervoltage, overvoltage alarm	Local and common control room alarm

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TABLE 8.3-11

PENETRATION PROTECTION

Voltage Class Nominal	Conductor	Protection Type Primary	Protection Type Secondary
15,000 volts	1,000 MCM	50/51 relays in circuit breaker	50/51 relays in circuit breaker
600 volts	4/0 AWG	Fuse	Fuse
	2/0 AWG	Fuse	Fuse
	1/0 AWG	Fuse	Fuse
	2 AWG	Fuse	Fuse
	4 AWG	Fuse	Fuse
	6 AWG	Fuse	Fuse
	8 AWG	Fuse	Fuse
	10 AWG	Fuse	Fuse
	12 AWG	Fuse	Fuse