ELECTRICAL SYSTEMS

CHAPTER 8

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8.0 ELECTRICAL SYSTEMS

8.1 INTRODUCTION

8.1.1 GENERAL

Florida Power & Light Company (FP&L) supplies electric service to most of the territory along the east and lower west coasts of Florida, including the Cape Canaveral area, the agricultural area around southern and eastern Lake Okeechobee, and portions of central Florida.

St. Lucie Unit 2 supplies power to the FP&L transmission system which is shown on Figure 8.1-1. The transmission system provides power to the plant for operation of the plant onsite auxiliary power system during start-up, or for plant operation, shutdown or accident conditions.

The St. Lucie switchyard is connected to the existing FP&L network at Midway Switching Station, Treasure Substation, and/or Turnpike Substation and then hence north and south to other FP&L power plants and to neighboring utilities through multiple lines. EC286688

Figures 8.1-1 and 8.1-2 are retained for historical purposes to depict FP&L's transmission system at the time of plant license. Technical Specifications provide the minimum requirement for offsite AC sources.

FP&L transmission grid is interconnected with utility members of the Florida Electric Power Coordinating Group, Inc. (FCG), which is a non-profit association of investor-owned, municipally- owned, and cooperatively-owned electric utilities engaged in the business of providing the majority of electric power to the public in the State of Florida.

For a description of the Offsite and Onsite Power Systems, see Sections 8.2 and 8.3, respectively.

8.1.2 CRITERIA, CODES AND STANDARDS

The electrical systems and equipment for the plant which are safety related are designed, manufactured, tested, installed and maintained to meet the requirements of the applicable General Design Criteria and in accordance with IEEE Standards as modified by the following Regulatory Guides. Wherever alternative approaches are used to meet the intent of some specific recommendations of Regulatory Guides and IEEE Standards, the method of attaining an acceptable level of safety is found in the discussion of these documents in Subsections 8.3.1.2 and 8.3.2.2.

a) General Design Criteria

   Compliance with the applicable General Design Criteria is discussed in Sections 3.1 and 8.3.

b) Regulatory Guide Implementation

   Section 1.8 discusses how the effective dates of the Regulatory Guides discussed below were selected.

For a discussion with respect to conformance and alternative approaches to Regulatory Guides refer to the subsection(s) referenced after each Regulatory Guide.

Regulatory Guide 1.6, "Independence Between Redundant Standby (Onsite) Power Sources and Between Their Distribution Systems," 3/71 (R0)

See Subsection 8.3.1.2

Regulatory Guide 1.9, "Selection of Diesel Generator Set Capacity for Standby Power Supplies," 3/71 (R0)

See Subsection 8.3.1.2

Regulatory Guide 1.22, "Periodic Testing of Protection System Actuation Functions" 2/72 (R0)

See Subsections 7.1.2.2 and 8.3.1.2

Regulatory Guide 1.29, "Seismic Design Classification," 2/76 (R2)

See Subsection 8.3.1.2

Regulatory Guide 1.30, "Quality Assurance Requirements for the Installation, Inspection, and Testing of Instrumentation and Electric Equipment," 8/72 (R0)

See Subsections 8.3.1.2 and 7.1.2.2.

Regulatory Guide 1.32, "Criteria for Safety-Related Electric Power Systems for Nuclear Power Plants," 8/72 (R0)

See Subsection 8.3.1.2

Regulatory Guide 1.40, "Qualification Tests of Continuous-Duty Motors Installed Inside the Containment of Water-Cooled Nuclear Power Plants," 3/73 (R0)

See Subsection 8.3.1.2

Regulatory Guide 1.41, "Preoperational Testing of Redundant On-Site Electric Power Systems to Verify Proper Load Group Assignments," 3/73 (R0)

See Subsection 8.3.1.2

Regulatory Guide 1.47, "Bypassed and Inoperable Status Indication for Nuclear Power Plant Safety Systems," 5/73 (R0)

See Subsections 8.3.1.2 and 7.1.2.2.

Regulatory Guide 1.53, "Application of the Single-Failure Criterion to Nuclear Power Plant Protection Systems," 6/73 (R0)

See Subsections 8.3.1.2 and 7.1.2.2.

Regulatory Guide 1.62, "Manual Initiation of Protective Actions," 10/73 (R0)

See Subsections 8.3.1.2 and 7.1.2.2.

Regulatory Guide 1.63, "Electric Penetration Assemblies in Containment Structures for Water-Cooled Nuclear Power Plants," 10/73 (R0)

See Subsection 8.3.1.2

Regulatory Guide 1.73, "Qualification Tests of Electric Valve Operators Installed Inside the Containment of Nuclear Power Plants," 1/74 (R0)

See Subsection 8.3.1.2

Regulatory Guide 1.75, "Physical Independence of Electric Systems," 1/75 (R1)

See Subsections 8.3.1.2 and 7.1.2.2.

Regulatory Guide 1.81, "Shared Emergency and Shutdown Electric Systems for Multi-Unit Nuclear Power Plants," 1/75 (R1)

See Subsection 8.3.1.2

Regulatory Guide 1.89, "Qualification of Class 1E Equipment for Nuclear Power Plants," 11/74 (R0)

See Subsection 8.3.1.2

Regulatory Guide 1.93, "Availability of Electric Power Sources," 12/74 (R0)

See Subsection 8.3.1.2

Regulatory Guide 1.100, "Seismic Qualification of Electrical Equipment for Nuclear Power Plants," 3/76 (R0)

See Subsection 8.3.1.2

Regulatory Guide 1.106, "Thermal Overload Protection for Electric Motors on Motor-Operated Valves," 3/77 (R1)

See Subsection 8.3.1.2

Regulatory Guide 1.108, "Periodic Testing of Diesel Generators Used as Onsite Electric Power Systems at Nuclear Power Plants," 8/76 (R0)

See Subsection 8.3.1.2

Regulatory Guide 1.118, "Periodic Testing of Electric, Power and Protection Systems," 6/76 (R0)

See Subsections 8.3.1.2 and 7.1.2.2

Regulatory Guide 1.128, "Installation Design and Installation of Large Lead Storage Batteries for Nuclear Power Plants," 4/77 (R0)

See Subsection 8.3.1.2

Regulatory Guide 1.129, "Maintenance, Testing, and Replacement of Large Lead Storage Batteries for Nuclear Power Plants," 4/77 (R0)

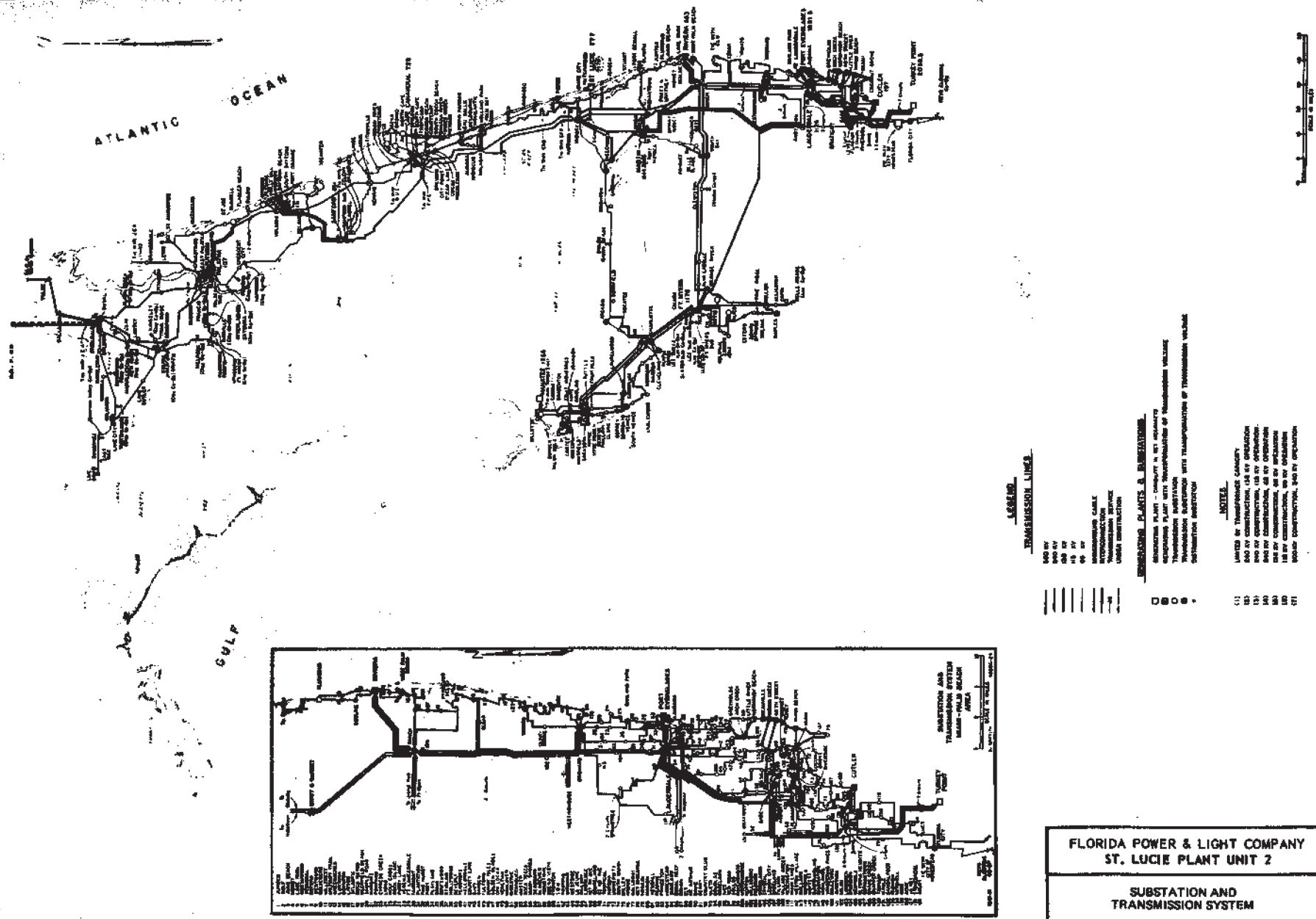
See Subsection 8.3-1.2

Regulatory Guide 1.131, "Qualification Tests of Electric Cables, Field Splices, and Connections for Light-Water-Cooled Nuclear Power Plants" 8/77 (R0)

See Subsection 8.3.1.2

IEEE 387, "IEEE Standard Criteria for Diesel-Generator Units Applied as Standby Power Supplies for Nuclear Power Generating Stations" (1972)

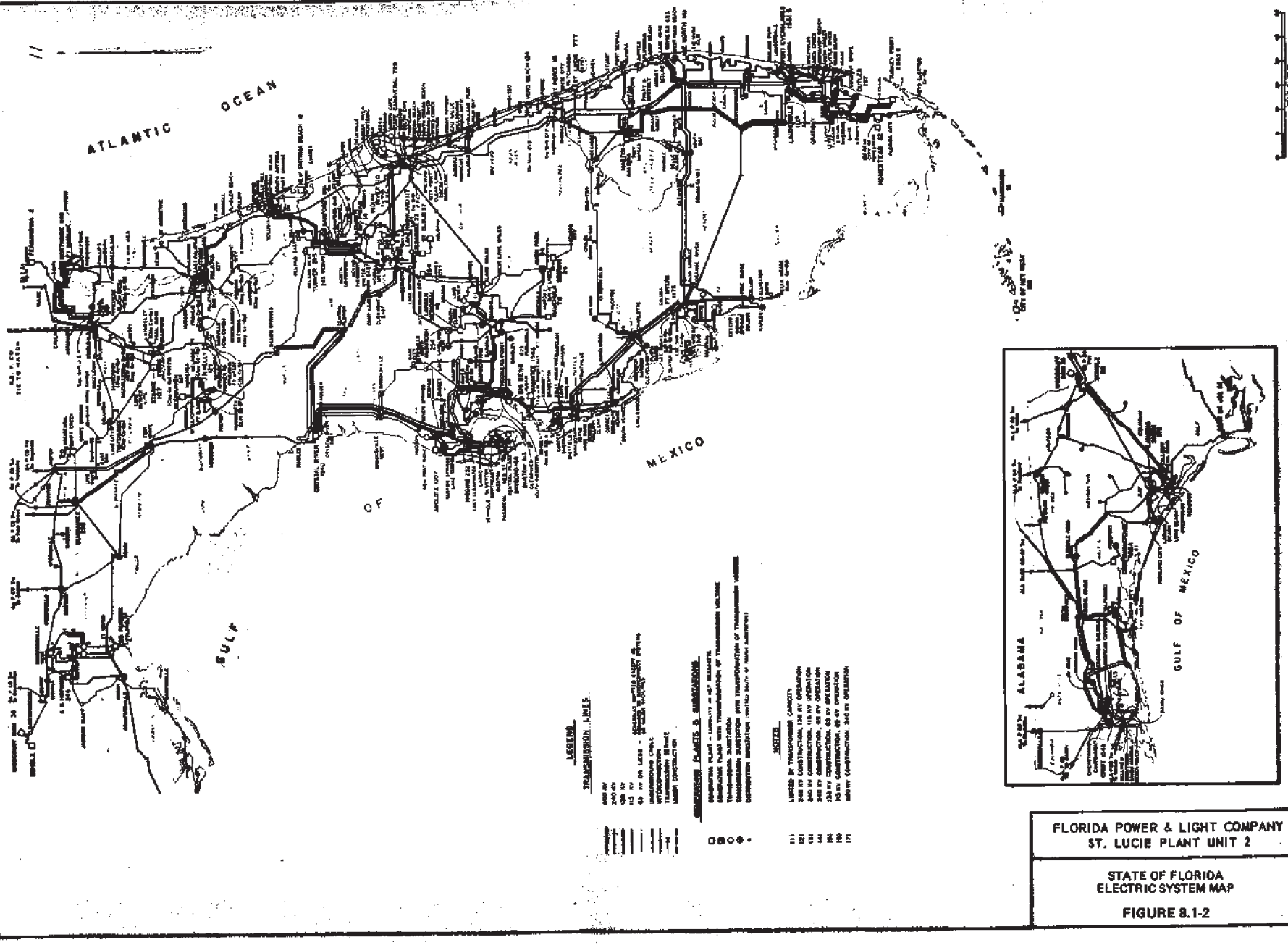
See Subsection 8.3.1.2



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

SUBSTATION AND
TRANSMISSION SYSTEM

FIGURE 8.1-1



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

STATE OF FLORIDA
ELECTRIC SYSTEM MAP

FIGURE 8.1-2

8.2 OFFSITE POWER SYSTEM

8.2.1 DESCRIPTION

The major components of the Offsite Power System are the:

a. Transmission lines between the utility grid and the switchyard

b. Switchyard

c. Plant Generation System, consisting of the:

   1. Generator

   2. Generator main leads

   3. Main transformer

d. Unit Auxiliary Transformers

e. Startup Transformers

f. Auxiliary Switchgear

g. Medium Voltage Non Segregated Phase Bus

The functions of the Offsite Power Systems are:

a. to provide startup auxiliary power;

b. to provide alternate power sources for the auxiliary loads.

c. to provide a preferred power source for the safety related electrical equipment during an emergency.

8.2.1.1 Transmission Lines Between the Utility Grid and the Switchyard

The Transmission System connections to the St. Lucie Plant Switchyard design consists of four separate transmission circuits; three of these transmission circuits are overhead lines. There are two separate 230[1] kV transmission circuits Midway 1 and 2 connecting the St. Lucie switchyard to the system transmission grid at Midway Substation and a third 230[1] kV circuit connects to Treasure Substation. These circuits are on three separate transmission lines and are located parallel to each other to within 9 miles of St. Lucie Plant. At that point Midway 1 & 2 continues to the Midway Substation for a total of approximately 11.7 miles total length. The Treasure line heads toward Treasure Substation from the 9 mile mark for another 1.5 miles making its total length approximately 10.5 miles. Each transmission circuit connecting the St. Lucie switchyard and the Midway Station is rated 1111 MVA at 230 kV or (1160 MVA at 240 kV) and is capable of EC286688 EC286688 EC286688

[1] In the past, FP&L's 230 kV system was referred to as 240 kV; therefore, some engineering documents may still refer to 240 kV.

handling the total net generation output from a single unit (St. Lucie Units 1 or 2). Each transmission line is also adequately sized to simultaneously handle the combined safe shutdown loads of one unit and the accident mitigation loads of the other unit. The estimated load in the event that one unit is at the initial point of orderly shutdown while the second is mitigating a design basis event is approximately 68 MVA or 7.1 percent of one transmission line capacity. The lines are spaced so that one tower and line cannot fall into another line. Each transmission line has two overhead ground wires along with driven grounds at each tower and structure. The three transmission lines are basically duplicates and are comprised of an Indian River crossing section and a mainland overland section. The fourth transmission line connected to the St. Lucie Plant switchyard has been installed underground from the Turnpike Substation with a length of approximately 13 miles. The new Turnpike transmission line increases the diversity and reliability of Offsite Power to the St. Lucie Plant switchyard. The Turnpike line has been sized to meet the capabilities of each of the three overhead transmission lines connected to the St. Lucie Plant switchyard. EC286688 EC286688

The Indian River crossing sections are 2.1 miles in length and are supported on steel towers. These transmission lines are spaced with the centerlines of the three lines 200 feet apart and they have spans up to 2005 feet in length. Each phase of these lines consists of a single 3400 kc mil conductor.

The overland sections are 9.6 miles in length and are supported on concrete structures. These sections of the transmission lines are spaced with the centerlines of the three lines 100 feet apart and they have spans up to 700 feet in length. The concrete structures rise 60 to 80 feet above ground. Each phase of these lines consists of two bundled 1691 kc mil conductors.

8.2.1.2 Switchyard

A six bay 230 kV (nominal) switchyard provides switching capability for two main generator outputs, four startup transformers, four outgoing transmission lines, and one distribution substation. EC286688

The four outgoing lines identified as Midway 1, 2, Treasure, and Turpike terminate at the pull-off towers for switchyard Bays 1A east, 2 – west, 3 – west, and 6 – east, respectively. The "Loop" feeds (two lines) for the Hutchinson Island distribution substation are fed from Bay 4 and Bay 6 (one distribution feeder line from each Bay). EC286688

The plant switchyard one line diagram is shown on Figure 8.2-1. The main generators for both St. Lucie Units 1 and 2 produce power at 22 kV which is transformed up to 230 kV nominal and enters the switchyard through overhead lines to the east pull-off tower in Bays 1 and 3, respectively.

The east pull-off tower in Bay 2 supplies power via a single over-head line to startup transformers 1A and 2A, located in the St. Lucie Unit 1 transformer yard. The east pull-off tower in Bay 4 supplies power via 3 single over-head line, to startup transformers 1B and 2B located in the St. Lucie Unit 2 transformer yard.

Either set of startup transformers can be fed from any one of the incoming transmission lines.

8.2.1.3 Plant Generation System

The main generator is directly connected through a 22 kV, 33,200 ampere isolated phase bus to the main transformers, where it is stepped up to 230 kV and then tied to bays of the switchyard.

The main generator is a 1200 MVA Westinghouse generator which provides power to the offsite transmission network. The main generator data are given in Table 8.2-1.

The generator isolated phase bus is forced air cooled and is rated for full unit output with both main transformers in service. Two 100 percent capacity sets of cooling equipment are provided.

The main transformer bank consists of two, three-phase transformers, 635 MVA each, oil directed air forced (ODAF) at 55°C temperature rise, connected in parallel with independent cooling equipment for each transformer.

8.2.1.4 Unit Auxiliary Transformers

Two unit auxiliary transformers are rated 21/28/35/39.2 MVA oil air/forced oil and air/forced oil and air at 55°C rise/forced oil and air at 65°C rise (OA/FOA/FOA at 55°C/FOA at 65°C) double secondary winding, 20.9-6.74-4.16 kv. The 6.74 kV secondary is rated 12.6/16.8/21/23.5 MVA, OA/FOA/FOA at 55°C/ FOA at 65°C; the 4.16 kV secondary is rated 8.4/11.2/14/15.7/MVA, OA/FOA/FOA at 55°C/FOA at 65°C.

The unit auxiliary transformer primary side is fed from a tap of the generator main leads and under normal conditions provides the bulk of the auxiliary power to the 6.9 kV and 4.16 kV buses.

8.2.1.5 Startup Transformers

Each Startup Transformer (SUT), 2A and 2B, is rated 21/28/35/39.2 MVA: SUT 2A - oil air/forced air/forced oil and air at 55°C rise/forced oil and air at 65°C rise (OA/FA/FOA at 55°C/FOA at 65°C); SUT 2B - oil air/forced oil air (one cooling bank)/forced oil air at 55°C rise (both cooling banks)/forced oil air at 65°C rise (both cooling banks) (OA/FOA/FOA at 55°C/FOA at 65°C), double secondary winding, 230-6.9-4.16KV. The SUT 2A 6.9 KV secondary is rated 12.6/16.8/21.0/23.6 MVA and 4.16 KV secondary is rated 8.4/11.2/14.0/15.7 MVA, OA/FA/FOA at 55°C rise/FOA at 65°C rise. The SUT 2B 6.9 KV secondary is rated 12.6/16.8/21.0/23.52 MVA and 4.16 KV secondary is rated 8.4/11.2/14.0/15.68 MVA, OA/FOA (one cooling bank)/FOA at 55°C rise (both cooling banks)/FOA at 65°C (both cooling banks).

The startup transformers do not perform a safety function and are not safety-related. During normal plant operation each of the two startup transformers is in standby and is available to provide offsite (Preferred) power. The startup transformers are sized to accommodate the auxiliary loads of the unit under any operating conditions, including the orderly shutdown and cooldown, or the mitigation of design basis accident (DBA) loads. Each set of startup transformers (1A-2A, 1B-2B) is provided with a manual switching arrangement which permits paralleling 4.16 kV power to St. Lucie Units 1 and 2 under administrative control. In the event one of the four startup transformers has to be removed from service for repair, the 4.16 kV power to both St. Lucie Units 1 and 2 could be paralleled to facilitate continued operation of both units. A single startup transformer is adequately sized to accommodate the auxiliary loads of either unit for a postulated DBA when aligned as described above (6.9 kV loads are not required for plant shutdown). However, if a startup transformer in the above alignment is required to

provide offsite power to one of the units, administrative and operator procedures would be developed to limit load sufficiently to prevent overloading the startup transformer or exceeding the short circuit rating of the switchgear. If it should ever be necessary to align one startup transformer to supply 4.16 kV power to both units, appropriate operating procedures would be developed to assure that the startup transformer is not overloaded should an accident condition arise.

Furthermore, should all preferred power be lost, both St. Lucie Units 1 and 2 have their own 100 percent capacity redundant diesel generator sets which are available for safe shutdown.

8.2.1.6 Auxiliary Switchgear

The 6.9 kV and 4.16 kV switchgear, located in the Turbine Building switchgear rooms receive power from the unit auxiliary or startup transformer and distribute power to non-safety related loads and the Onsite Power System.

Two 6.9 kV (2A1 and 2B1) and two 4.16 kV (2A2 and 2B2) buses are provided. Each bus is rated 2000 amps and 3000 amps respectively. Each of the eight medium voltage non-segregated bus ducts is connected to a bus through a drawout, metal-clad circuit breaker.

Circuit breakers are electrically operated by 125V dc control power supplied by the battery system (Subsection 8.3.2). Control Room and local electrical closing and tripping, are provided. The breakers may be withdrawn from the "operate" (or "normal") position to the "test" and "withdrawn" positions. In the "withdrawn" position, the breaker is completely disconnected from the ac and dc systems and may be inspected and tested.

The incoming breakers are arranged for automatic operation under control of the bus transfer scheme. In the "test" position, local electrical operation is possible, but the main power circuit is not completed when the breaker closes.

Breaker positions and status are indicated in the control room and at the switchgear.

8.2.1.7 Medium Voltage Non-Segregated Phase Bus

The eight medium voltage transformer windings (two each for the two startup and the two unit auxiliary transformers) are connected to the plant distribution system auxiliary switchgear through non-segregated bus ducts rated 2000 amps and 3000 amps. The 4.16 kV bus is rated 60 kV BIL and the 6.9 kV bus is rated 95 kV BIL.

8.2.2 ANALYSIS

8.2.2.1 Switchyard and Grid

The requirements of General Design Criterion 17, "Electric Power Systems", are satisfied by the following:

1. The network interconnections consist of four transmission lines. Any two circuits may be interrupted with the remaining two circuits being capable of carrying the full net output of the station (St. Lucie Units 1 and 2 combined). EC286688

2. Although the switchyard is common to all four transmission lines, each line terminates in a separate bay and can be connected to either of two separate buses. Failure of the equipment in one bay does not result in loss of more than one transmission line. No lines are lost due to a failure to one of the buses. The fourth diverse 230 KV line runs directly from the Turnpike Substation to the St. Lucie Switchyard entirely underground and under the Indian River. EC286688 EC286688

3. A single breaker failing to trip does not result in loss of both lines to the startup transformers, because there are always at least two breakers in series between the two lines.

4. The three single 230 kV lines crossing the Indian River are designed to withstand hurricane winds of 153 mph; the lines west of the river are designed for winds of 140 mph. With a spacing of 200 ft. between the river towers, 173 ft. above mean sea level, and a spacing of 126 ft. between the 80 ft. high towers on land, the failure or collapse of one structure does not affect the other lines. The fourth diverse 230 KV line runs directly from the Turnpike Substation to the St. Lucie Switchyard entirely underground and under the Indian River. EC286688

5. The 230 kV system is protected from lightning and switching surges by overhead electrostatic shield wire and surge protection equipment.

6. The switching arrangement in the 230 kV switchyard includes two full capacity main buses which are tied to the generator, startup transformers and outgoing transmission lines through circuit breakers connected to each bus. Protective features provide reliable protection for isolation of faults to ensure continuity of power supply from alternate sources. The protective relay system includes high speed primary and secondary relaying. For each of the four 230 kV lines the primary and secondary relaying consists of phase and ground distance relays. Primary and secondary bus differential relaying, and backup protection for breaker failure to trip, is also provided. These provisions permit the following: EC286688

   a. Any circuit can be switched under normal conditions without affecting another circuit.

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

   c. Short circuits in a single main bus are isolated without interrupting service to any circuit.

   d. Short circuit failure of a single bay breaker does not result in the permanent loss of any transmission line or any startup transformer.

   e. Physical independence of power for the startup transformers is achieved by separating their switchyard 230kV connections in two different bays. Each bay consists of separate circuit breakers and associated equipment to connect the startup transformers with the two main 230kV buses. Two spatially separated over-head lines are used to supply power to the startup transformers (one line for startup transformers 1A and 2A in the Unit 1 transformer yard, and one line for startup transformers 1B and 2B in the Unit 2 transformer yard).

The offsite electrical grid is common to St. Lucie Units 1 and 2. See Section 8.2.2 of the St. Lucie Unit 1 UFSAR for the electrical grid transient stability analysis.

8.2.2.2 Transmission Lines and In-Plant Equipment

The requirements of General Design Criterion 17, are satisfied by the following:

a. Two physically independent circuits are provided for offsite power. Although in the same right of way, the two Startup Transformer lines are spaced sufficiently far apart, such that a failing tower cannot involve the other over-head line.

b. All circuits are normally energized so that either is available immediately to provide sufficient power to assure that fuel design and reactor coolant pressure design limits are not exceeded, assuming loss of all onsite power.

c. The transformers associated with the Offsite Power System are provided with a Fire Protection System. They are located sufficiently far apart so as to prevent any damage that may occur in one transformer from occurring in any other transformer. Two generator transformers when paralleled on both HV and LV sides, comprise in effect a single unit. A three hour rated fire wall is used to separate these two transformers rather than distance alone.

d. The two Startup Transformer line connections are electrically separated by at least two circuit breakers in series, at the switchyard. Two breakers would have to fail to trip in order for a fault in one line to involve the other.

The requirements of General Design Criterion 18, are satisfied by the following:

a. Each transmission line may be tested for operability and functional performance independently of the other. The lines are physically and electrically independent.

b. Transfer of power between the startup and the unit auxiliary transformers is provided by inplant equipment (not at the switchyard) and may be initiated by the plant operator at any time the unit is on line.

The "line bus" power transfer between the unit auxiliary and the startup transformers (and vice-versa) as described in Subsection 8.3.1.1.1, is demonstrated and exercised periodically when the plant is started up and shut down. This serves as adequate basis to verify the proper operation of the transfer breakers and associated equipment.

The "fast dead bus" power transfer from the unit auxiliary transformer to the startup transformer (only a one-way transfer) as described in Subsections 8.3.1.1.1 and 8.3.1.1.2(d) is tested on 18 month intervals.

8.2.2.3 Grid Availability

FP&L serves approximately 200 municipalities and over 30 counties in the state of Florida. The company's existing generating facilities consist of thirteen generating plants distributed geographically around its service territory. These plants are tied into a system wide transmission network, sometimes referred to as a grid, the purpose of which is to transport energy from the generating plants to the load areas and to assure system reliability. FP&L operates

approximately 4,600 circuit miles of transmission lines. Figure 8.2-12 is a one line representation showing FP&L's transmission network interconnections and lead flow.

As of January 1998, the FP&L transmission system, which ties the various areas of its service territory, is composed of 1107 miles of 500 kV and 2228 miles of 230 kV lines. The underlying network is composed of 1454 miles of 138 kV, 672 miles of 115 kV, and 177 miles of 69 kV transmission lines.

FP&L is directly interconnected with nine other Florida utilities, both public and private, which have significant generating capacity. FP&L maintains 14 normally closed interconnections and two normally open interconnections. Included in the normally closed interconnections are one 115 kV and two 230 kV interconnections with Progress Energy, which in turn has interconnections outside Florida: one 230 kV and four 115 kV ties to Georgia Power Company, and one 230 kV tie to Gulf Power Company.

FP&L is also directly interconnected with Georgia Power Company via one 230 kV tie between Yulee (FP&L) and Kingsland (GPC) and two 500 kV ties between Duval (FP&L) and Plant Hatch (GPC).

Historically, the present 230 kV built transmission system has provided a reliable grid. All outages on the 230 kV system from January 1975 through December 1978, classifying them as either instantaneous or sustained were investigated.

An instantaneous outage is defined as an outage in which the line breakers are tripped and reclosed re-energizing the circuit in a total elapsed time of 30 cycles or less. From historical data, the average frequency of instantaneous outages on the FP&L 230 kV transmission system is 6.25 outages per year per 100 circuit miles. The cause of these outages has been primarily lightning.

A sustained outage is defined as an outage due to a permanent fault which requires "manual" reclosing after the fault is corrected and the line is restored to the operating condition. Usually there is some sort of damage associated with permanent faults which requires repairs to the particular transmission circuit. The recorded frequency rate for sustained outages has averaged 2.56 outages per year per 100 circuit miles from January 1975 through December 1978. The average duration of these sustained outages has been 86 minutes.

The causes of sustained outages have been varied; some are due to broken lightning arrestors, some to broken insulators, and some to broken conductors.

In addition to those sustained outages which are localized in their impact, there have been several system outages that have impacted the grid as a whole. Table 8.2-2 summarizes these outages noting their impact at the time of occurrence.

8.2.2.4 Response to Generic Letter 2006-02

Generic Letter (GL) 2006-02, Grid Reliability and the Impact on Plant Risk and the Operability of Offsite Power, was issued to determine if compliance is being maintained with NRC requirements governing electric power sources and associated personnel training. The GL requested information in four areas (1) use of protocols between the nuclear power plant (NPP) and the transmission system operator (TSO), independent system operator (ISO), or reliability coordinator/authority (RC/RA) and the use of transmission load flow analysis tools (analysis

tools) by TSOs to assist NPPs in monitoring grid conditions to determine the operability of offsite power systems under plant technical specifications (TSs); (2) use of NPP/TSO protocols and analysis tools by TSOs to assist NPPs in monitoring grid conditions for consideration in maintenance risk assessments; (3) offsite power restoration procedures in accordance with Section 2 of NRC Regulatory Guide (RG) 1.155, "Station Blackout;" and (4) losses of offsite power caused by grid failures at a frequency equal or greater than once in 20 site-years in accordance with RG 1.155.

FPL provided response to GL 2006-02 in letter L-2006-073. The response included, in part, discussion of the formal interface agreement between St. Lucie and the FPL Transmission System Operator (TSO) as well as the associated implementing procedures, the TSO contingency analysis program, related operator and Work Control personnel training, offsite power operability declarations and entry into applicable Technical Specification action statements upon notification of potential degraded grid conditions, consideration of potential grid degradation/instability in the performance of risk assessments required by 10 CFR 50.65(a)(4), and compliance with GDC 17, Electric Power Systems.

TABLE 8.2-1

MAIN GENERATOR DATA

Rating, MVA	1200
Power factor	0.9
Voltage, kV	22
Frequency Hz	60
Speed, rpm	1800
Hydrogen pressure, psig	75
Synchronous reactance*	200.78
Transient reactance*	46.98
Subtransient reactance*	30.85

*Percent on rated base kVA and kV.

TABLE 8.2-2

MAJOR SYSTEM DISTURBANCES
(1973 - 1982)

Date	Causes	Result
April 3 & 4 1973	Loss of Turkey Point 3 followed by the loss of Port Everglades 3 & 4 due to the incorrect action of underfrequency relays.	3400 MW load lost (blackout) (FPL)
June 23 1973	Permanent fault on the Dade-Flagami 138 kV line and subsequent pumping (multiple reclosing) of Flagami breaker.	2300/2972 MW load shed (FPL/State)
March 1 1974	Loss of Turkey Point 3 & 4 due to voltage regulator problems.	200/390 MW load shed (FPL/State)
April 25 1974	Transformer fault at Turkey Point tripped Turkey Point 3 & 4.	850/1460 MW load shed (FPL/State)
June 28 1974	Single phase ground fault on Laudania-Port Everglades 230 kV circuit and slow (42 cycle) clearing resulted in loss of Turkey Point 3 & 4 due to low voltage trip.	2250 MW load lost (FPL)
May 16 1977	Loss of Turkey Point 3 and a fault on the Ft. Myers-Ranch 230 kV line (Orange River-Andytown 500 kV, not in service at the time).	3200 MW load lost (blackout) (FPL)
May 14 1978	St. Lucie-1 down for refueling. A fault on the Midway-Ranch 230 kV circuit and an incorrect relay action at Midway resulted in the de-energization of Midway Substation.	150 MW load lost. St. Lucie-1 automatically shifted to onsite power.
April 4 1979	Salt spray contamination causes all seven lines out of Turkey Point to trip, causing a loss of 1133 MW of generation.	470/451 MW load shed (FPL/State)
April 20 1981	Low frequency system oscillations cause Manatee #1 & #2 to pull out-of-step. TECO's Big Bend #2 also tripped. 1733 MW of generation lost.	1479/2463 MW load shed (FPL/State)

TABLE 8.2-2 (Cont'd)

Date	Causes	Result
April 29 1982	Loss of Turkey Points # 3 & #4 and subsequent tripping of Cape Canaveral #1 & #2.	2144 MW load shed (FPL)

Refer to Drawing 8770-G-417

AMENDMENT NO. 15 (06/03)

FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

SWITCHYARD
ONE-LINE DIAGRAM
FIGURE 8.2-1

Figures 8.2-2a through 8.2-8b
have been deleted.

Amendment No. 17 (12/06)

FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

FIGURE 8.2-2a

DELETED

FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

FIGURE 8.2-9

DELETED

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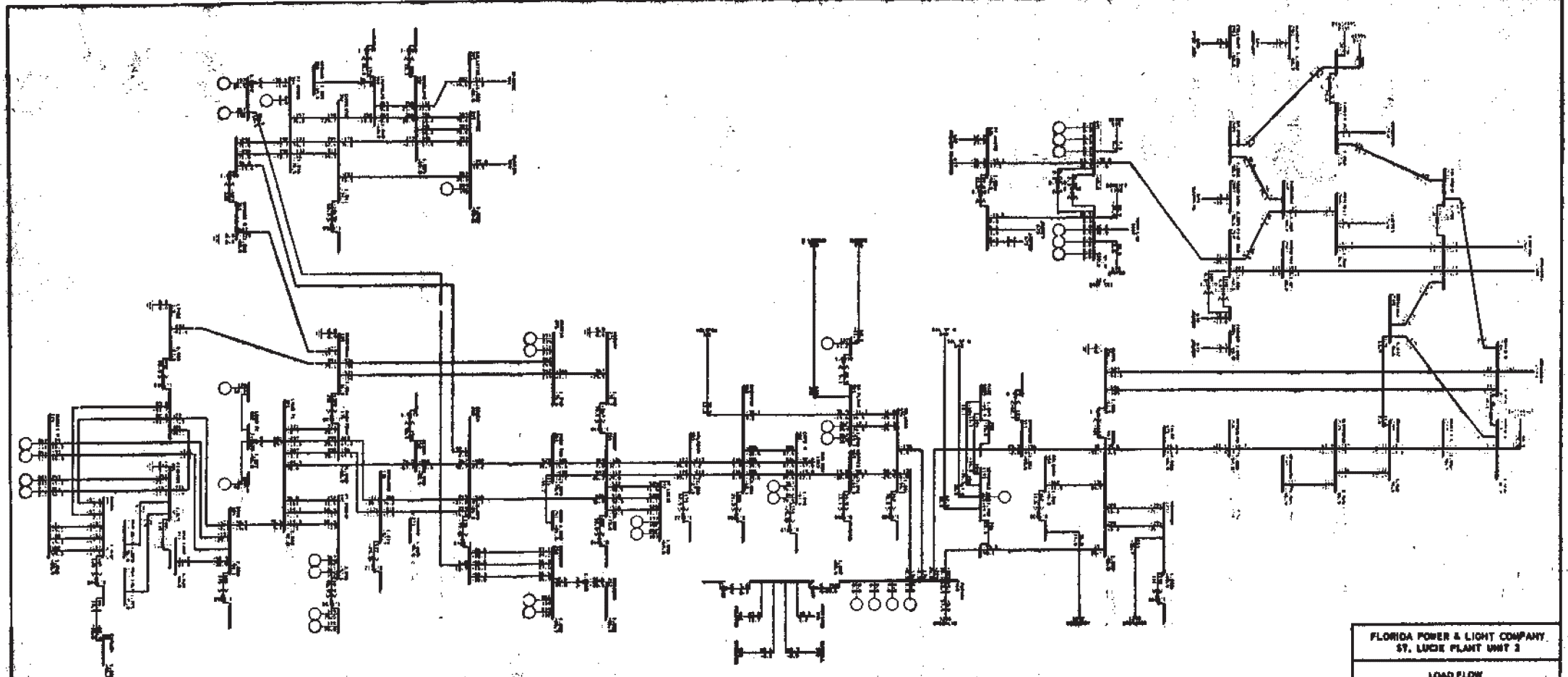
ST. LUCIE PLANT UNIT 2

FIGURE 8.2-10

DELETED

FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

FIGURE 8.2-11



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

LOAD FLOW

FIGURE 8.2-12

8.3 ONSITE POWER SYSTEM

The Onsite Power System one line diagrams are shown on Figures 8.3-1, 8.3-1a, 8.3-2 and 8.3-3.

8.3.1 AC POWER SYSTEMS

8.3.1.1 Description

8.3.1.1.1 General

The preferred source of auxiliary ac power for plant startup and shutdown is from the incoming offsite transmission lines, through the plant switchyard and startup transformers. The startup transformers step down the 230 kV incoming line voltage to 6.9 kV and 4.16 kV for auxiliary system use.

During plant operation, ac power is provided from the main generator through the unit auxiliary transformers.

Each unit auxiliary transformer is rated 21/28/35 MVA, OA/FA/FOA at 55 C rise double secondary, 20.9-6.74/4.16 kV. The 6.74 kV secondary is rated 12.6/16.8/21 MVA; the 4.16 kV secondary is rated 8.4/11.2/14 MVA, all at 55 C rise. Each unit auxiliary transformer has a 65 C rating of 39.2 MVA.

Preferred (offsite) power from the start-up transformers, or from the unit auxiliary transformers is distributed by two 6.9 kV buses (2A1 and 2B1) and by two 4.16 kV buses (2A2 and 2B2). The 6.9 kV buses serve only motors rated above 4000 hp; the 4.16 kV buses supply motors rated from 250 to 4000 hp, as well as all remaining motors and other loads through 4160-480 volt load centers and motor control centers (MCCs). Power is also distributed from the two 4.16 kV buses 2A2 and 2B2 to the safety related 4.16 kV buses 2A3 and 2B3, which supply all safety related loads as described below.

Transfer of the 6.9 kV or 4.16 kV auxiliary buses between the unit auxiliary and startup transformers is initiated by the operator from the control room. Routine bus transfers used on startup or shutdown of a unit are "live bus" transfers, i.e., the incoming source feeder circuit breakers are momentarily paralleled with the running source feeder circuit breakers. This results in transfers without power interruption.

Bus transfers, initiated automatically by protective relay action, are "fast-dead" bus transfers. A "fast-dead" bus transfer is accomplished by simultaneously tripping the auxiliary transformer secondary circuit breakers and closing the startup transformer secondary breakers. The approximate dead time is of three cycles duration. See Subsections 8.3.1.1.2(d) and 8.2.2.2 for additional information regarding the operation and testing of the "fast dead" bus transfer.

Each of the startup transformers and each emergency diesel generator has sufficient capacity to supply the safety related loads for safe plant shutdown or to mitigate the consequences of a design basis accident.

In the event of a loss of the preferred power sources, station onsite power is supplied by the onsite emergency diesel generators and station batteries.

a. 6.9 kV System

Two 6.9 kV buses 2A1 and 2B1 are provided, each supplied from a unit auxiliary or alternatively from a startup transformer. Each 6.9 kV bus serves two reactor coolant pump motors and one steam generator main feedwater pump motor. The 6.9 kV buses are quality related because inclusion of reactor coolant pump (RCP) discussion in Technical Specifications requires components associated with the circuit-path to provide power to the RCPs from offsite power to be considered quality related. Hence, they do not require backup from the emergency power system. The buses are rated at 2000 amps and are provided with 2000 amp incoming breakers and 1200 amp outgoing breakers, all with 500 MVA interrupting capacity. The buses are protected by differential relays which also protect the breakers. Incoming breakers are also protected by overcurrent relays and additional backup relaying has been added to trip the corresponding supply transformer breaker if any of the incoming breakers fail to open on faults. These breakers are tripped for bus overloads and short circuits. Short circuit tripping occurs only if a fault relay detection operates concurrently. The motors connected to these buses are protected by differential, short circuit and locked rotor relay devices. These devices are selectively set to trip the individual motor feeder in the event of a fault downstream of the motor breaker. Alarms are provided for motor overloads.

The neutrals of the 6.9 kV system are grounded through grounding transformers and current limiting resistors which enable the system to operate safely, if a ground should occur, until the grounded equipment is located and is removed from service.

b. 4.16 kV System

The 4.16 kV system consists of non-safety and safety related buses. Non-safety buses, 2A2 and 2B2, provide power to loads which are nonsafety related. The two non-safety buses receive power directly from either the unit auxiliary or startup transformers. Safety related loads are powered from the safety related buses.

The safety portion of the 4.16 kV system is arranged into two redundant load groups designated as load group A and load group B. Each of these load groups consists of the complement of safety related equipment needed to achieve safe plant shutdown and/or to mitigate the consequences of a design basis accident. Additional safety related equipment (e.g., the third component cooling water and intake cooling water pump motors) are arranged to function as a "third service" (swing) load group AB. This load group consists of equipment which can be used for backup or replacement purposes to the equipment in either of the main redundant load groups A or B. Load group A is powered by safety bus 2A3 and load group B is powered by safety bus 2B3. Load group AB is powered by safety bus 2AB.

The 4.16 kV safety related buses are of indoor, three phase, metalclad construction, with draw out SF_6 circuit breakers. The 4.16 kV non-safety buses 2A2 and 2B2 are rated 3000 amps and are provided with 3000 amp incoming

breakers of 350 MVA interrupting capacity. Safety buses 2A3, 2B3, and 2AB are rated 1200 amps. The incoming feeder breakers of 2A3 bus and outgoing breakers of 2A3 and 2A2 are 1200 amps, 250 MVA interrupting capacity and 80,000 amp momentary. The incoming feeder breakers of 2B3 and 2AB buses and the outgoing breakers of 2B2, 2B3 and 2AB 4.16 kV buses are 1200 amps, 350 MVA interrupting capacity and 132,000 amp momentary duty. Relay protection is similar to the 6.9 kV buses except that no motor differential protection is used. Backup relaying to trip preferred or normal power sources is provided on bus 2A2 and 2B2 only.

The neutrals of the 4.16 kV system are grounded through grounding transformers and current limiting resistors which enable the systems to operate safely if a ground should occur, until the grounded equipment is located and is removed from service.

The safety related circuit breakers operate from 125V dc control power which is supplied by the safety related protection of the 125V dc system of the appropriate division (A or B) as described in Subsection 8.3.2.1. Control power for the non-safety related system is obtained from the safety related dc panels through qualified isolation devices.

The safety related 4.16 kV switchgears are located within switchgear rooms in the Reactor Auxiliary Building which is a seismic Category I structure and is protected from potential missile hazards. Physical separation is maintained in the location and installation of the switchgear for the respective redundant systems.

Upon a loss of the preferred power source, the tie breakers between the non-safety and safety buses automatically open, and the emergency diesel generators automatically start, are brought to speed and begin supplying power directly to the emergency buses. The pressurizer heater transformers and CEDM cooling fan motors, which are nonsafety related loads, are supplied from the 4.16 kV safety buses. The loads are tripped from these buses upon loss of offsite power and can only be reconnected to the buses manually. The diesel generator automatic starting and loading sequence is discussed further in Subsection 8.3.1.1.2h.

In the unlikely event of a total loss of AC power, both onsite and offsite (Station Blackout), and a loss of one EDG on St. Lucie Unit 1, power can be provided to one of the Unit 2 Class 1E redundant divisions from the only available site EDG set. The power will be transferred via a cross-tie connecting the safety-related swing switchgear (1AB and 2AB) of the two units. The power transferred will be used to augment the DC coping program, i.e., to power battery chargers, UPS and other selected equipment until conclusion of the blackout. The cross-tie may also be used to transfer offsite power, if available, from Unit 1 to Unit 2. Station Blackout is further discussed in subsection 8.3.1.1.2p.

Each safety related 4.16 kV breaker can be electrically operated from the control room by the operator or is automatically operated in conjunction with the diesel generator loading sequence on loss of preferred power. Breaker operation locally at the switchgear for hot shutdown is also possible by manual operation of the

isolation switch also mounted on the switchgear. In the "test" position, breaker local electrical operation is possible, but the main power circuit is not completed when the breaker closes.

Breaker status is indicated by red (closed) and green (tripped) indicating lights in the control room and at the switchgear. These lights also indicate that the breaker is in the operating position.

The 4.16 kV safety-related distribution equipment including the raceway system is designed to meet the seismic requirements for Class 1E electric equipment as discussed in Section 3.10. The environmental qualification for the safety-related equipment is discussed in Section 3.11.

c. 480 Volt System

The arrangement of the 480 volt system is similar to that of the 4.16 kV system with buses designated as non-safety or safety. There are two non-safety 480 volt buses each powered by one of the non-safety 4.16 kV buses through a station service transformer. There are no interconnections between the non-safety and safety-related portions of the 480 volt system.

There are also two non-safety 480 volt buses fed from individual 750 KVA, 3 phase, 65 °C rise transformers, that feed the pressurizer heaters.

The 480 volt safety-related auxiliary system consists of five power centers, 11 motor control centers (MCCs), safety-related loads and the interconnecting cables and raceway systems.

The safety-related portion of the 480 volt system is arranged into redundant load groups A and B served by 480 volt switchgears 2A2, 2A5 and 2B2, 2B5 respectively, with a third service load group AB served by 480 volt switchgear 2AB. Power is transmitted from the 4.16 kV safety switchgears 2A3 and 2B3 through the respective station service transformer to 480 volt buses 2A2, 2A5 and 2B2, 2B5 respectively. The 480 volt switchgear 2AB is normally tied to either one of the redundant safety 480 volt switchgears. All the AB buses (4.16 kV, 480 volts and 125V dc) are connected to either the corresponding A division or B division at any one time. For example, the operation of the 480 switchgear AB connected to the 480 volt switchgear 2A3 and the 480 switchgear AB connected to the 480 volt switchgear 2B2, is not permitted. Alarms in the control room are provided to alert the operator if the AB buses on all voltage levels are not aligned properly. 480 volt switchgear 2A2, 2A5 and 2B2, 2B5 also feed non-safety-related loads through qualified isolation devices.

Physical and electrical separation of the redundant load groups is discussed in Subsections 8.3.1.1.2.f and 8.3.1.2.2.

The six 480 volt station service transformers, four safety and two non-safety, are rated 1500/1725 KVA, OA/FA, 55 °C rise and 1680/1932 KVA OA/FA, 65 °C rise, 3 phase, 4160-480 volt delta-wye.

The 480V buses, 2A1, 2B1, 2A2, 2B2, 2A5, and 2B5, are connected to their respective station service transformers through 3000 amp continuous breakers. Each of these buses is split into two sections, connected through a 1600 amp current limiting reactor. The first section, connected to the station service transformer, feeds motors generally between 100 and 250 hp through 800 amp frame continuous / 30,000 amp symmetrical interrupting capacity breakers; the second section feeds 480 volt MCCs and other loads throughout the plant, through 800 amp frame continuous / 30,000 amp symmetrical interrupting capacity breakers. The 480V switchgear bus is rated 50,000 amp symmetrical.

Safety-related 480 volt switchgear 2AB may be connected to either (but not both with the plant in Modes 1, 2, 3 and 4) 480 volt switchgear 2A2 or 480 volt switchgear 2B2 through 1600 amp breakers with delayed trips. There are two breakers in series in each tie. The incoming breakers are electrically interlocked to prevent the 2AB switchgear from being simultaneously connected to switchgear 2A2 and 2B2. The short circuit level of this section is 50,000 amp symmetrical. This section feeds a third charging pump and the safety-related "third service" MCC 2AB through a 600 amp frame breaker for the 2A2 feed through an 800 amp frame continuous / 30,000 amp symmetrical breakers.

The MCCs consist of metal enclosed groups of motor starters, feeder circuit breakers and control devices assembled in a common structure with horizontal and vertical buses. Feeder circuit breakers in MCCs are manual, thermal magnetic trip or solid state trip molded case units in 100 amp frame size or larger is required.

Motor starters are combination type, consisting of a three pole magnetic trip circuit breaker, a magnetic contactor, a three pole thermal overload device, a 480-120V control transformer and control devices.

Motor operated valves located inside the containment which have their thermal overloads bypassed are provided with thermal magnetic circuit breakers as part of their starter.

The MCCs except 2AB, 2A9, and 2B9 are fed from the reduced short circuit level sections of the 480 volt buses as explained above. In no case are two redundant pieces of equipment connected to the same motor control center. For both non-safety and safety services, there are two redundant MCCs in each area, each one connected to a redundant 480 volt switchgear. The single exception is the 480V Drumming Station MCC 2A11, which is fed from 480V switchgear 2A1. There is no corresponding (redundant) MCC on the "B" train for this service. This equipment is used to service the Concentrator Bottoms Tank equipment. This (Concentrator Bottoms) is a non-safety related system and is operated on a very infrequent basis. (See Subsection 11.2.2.2 for a description of the Concentrator Bottoms Tank and its associated equipment.)

All 480V bus circuit breakers with the exception of 480V MCCs and power panels operate from 125V dc control power which is supplied by the safety-related 125V dc system of the appropriate division (A or B) as described in Subsection 8.3.2. Control power for the non-safety related system is obtained from the

safety-related dc panels through qualified isolation devices (i.e., fuses/ breakers, see Subsection 8.3.2.1).

The safety-related power centers and MCCs are located within switchgear rooms in the Reactor Auxiliary Building and within the Diesel Generator and Fuel Handling Buildings, all of which are seismic Category I structures and are protected from potential missile hazards. Physical separation or fire walls are provided for redundant components. For example, power center 2A2 is physically separated from its redundant counterpart, power center 2B2. Likewise, MCCs are separated from their redundant counterparts by physical separation or by walls.

Each 480 volt switchgear safety related feeder breaker with the exception of the 480 volt feeder breaker for MCCs are electrically operated directly from the control room by the operator. They remain closed to allow operation in conjunction with the diesel generator loading on loss of preferred power (see Subsection 8.3.1.1.2.b).

Breaker status is indicated by red (closed) and green (tripped) indicating lights at the control room and/or at the switchgear. These lights also indicate that the breaker is in the operating position.

The criteria for the protection and grounding of the 480 volt system is the same as for the 4.16 kV system except where grounding transformers are not utilized.

The 480 volt safety related distribution equipment is designed to meet the seismic requirements for Class 1E electric equipment as discussed in Section 3.10. The environmental qualification for the safety related equipment is discussed in Section 3.11.

In some cases, there are non-safety loads connected to safety MCCs. Wherever this occurs, the MCC bus is split into an essential and a non essential section connected through a bus isolating contactor that automatically opens during an undervoltage condition, thus separating the non emergency loads from these MCCs. These non emergency loads consist of normal lighting, normal power panels, and power receptacles. There also exist certain connections of nonsafety related plant investment loads to safety related portions of the MCCs. These connections are by means of isolation devices, i.e. circuit breakers.

d. 120/208 Volt System

Safety related loads such as Engineered Safety Features process monitoring instrumentation are powered from, 120/208 volt panels. Safety related Panels are supplied from safety related step down transformers which in turn are fed from a safety related MCC.

The 120/208 volt safety related distribution equipment is designed to meet the seismic requirements for Class 1E electric equipment discussed in Section 3.10. The environmental qualification for the safety related equipment is discussed in Section 3.11.

Power is supplied for normal lighting and other plant loads requiring an unregulated power supply by the 120/208 volt system. This system consists of distribution panels and transformers fed from 480 volt MCCs. For further discussion of the plant lighting system, refer to Subsection 9.5.3.

e. Instrument Power Supply System

Four pairs of redundant 120V ac single phase ungrounded instrument buses (2MA, 2MA-1, 2MB, 2MB-1, 2MC, 2MC-1, 2MD, and 2MD-1) provide uninterruptible power to Engineered Safety Features Actuation System (ESFAS) and Reactor Protective System (RPS) instrumentation. Buses 2MA-1, 2MB-1, etc. are extensions of buses 2MA, 2MB, etc. to allow for future expansion of the instrument power supply system. Each bus is supplied separately from an inverter connected to one of the two safety related 125V dc panels described in Subsection 8.3.2. The instrument power buses are located in the Reactor Auxiliary Building.

To permit maintenance of any inverter without disabling the corresponding instrument bus, maintenance bypass transformers and voltage regulators are provided for each inverter system. Each of the four redundant measurement channels of the nuclear instrumentation and Reactor Protective Systems equipment described in Section 7.2 is supplied from a separate bus. Also, each instrumentation channel of the four redundant measurement channels of the Engineered Safety Features Actuation System described in Section 7.3 is supplied from a separate bus. The system is arranged so that any single failure does not prevent the Reactor Protective System and Engineered Safety Features Actuation System from performing their safety functions.

The four instrument inverters are each rated 125V dc-120V ac (± two percent ac), single phase, 10 KVA, 60 Hz (± one percent Hz), voltage and frequency regulated and are ungrounded.

The maintenance bypass is provided by an isolimiter for 10 KVA, single phase, 480/120V ac (+/-) ten/ two percent, 60 Hz. Isolimiter is a trade name of a unit which is a combination of a transformer and voltage regulator. The instrument power supply system equipment is designed to meet the seismic requirements for Class 1E electric equipment as discussed in Section 3.10. The environmental qualification for the safety related equipment is discussed in Section 3.11.

In addition to the four instrument buses above, two redundant 120V ac single phase ungrounded buses (PP-266 and PP-267) provide uninterruptible power to the Qualified Safety Parameter Display System (QSPDS). Each bus is supplied separately from a 120 VAC single phase ungrounded instrument bus; PP-266 is fed by 2MC-1 through an isolation transformer and PP-267 is fed by 2MD-1 through an isolation transformer. The QSPDS power buses are located in the Reactor Auxiliary Building.

For a description of the dc instrument power supply system refer to Subsection 8.3.2.1.

A total of four non-class 1E uninterruptible power supplies are provided. Two non-Class 1E, uninterruptible power supplies are provided to supply power to non-safety instrumentation and control circuits, communication security, fire detection and radiation monitoring systems. They are both rated 120V ± two percent ac, 60 Hz, single phase, 20 KVA and 30 KVA respectively. Two additional 20 KVA uninterruptible power supply are provided for SAS.

f. Standby Power Supply

The Onsite Power distribution System receives power from either the Preferred (offsite) power system (Section 8.2) or from, the standby power system (safety related) which consists of two diesel generators, 2A and 2B. Each diesel generator set is rated at 3685 kW, 0.8 power factor, 4.16 kV and is complete with its own air starting system, fuel supply system, and automatic control circuitry. Design data for the diesel generator sets are given in Table 8.3-1.

The generators have open self ventilated frames, Class F insulation and are wye connected with a synchronous revolving field, and static solid state excitation system, capable of carrying full rated load continuously without exceeding temperature rises at 40°C ambient. Each diesel generator is furnished with automatic dc field flashing equipment for quick voltage buildup during the start-up sequence.

Each diesel generator set consists of two diesel engines mounted in tandem with a 3800 kW generator coupled directly between the engines.

Each engine in each diesel generator set has a self contained cooling system which consists of a forced circulation cooling water system which cools the engine directly and an air cooled radiator system which removes the heat from the cooling water. The cooling water pump and radiator fan are belt driven from the engine crankshaft.

The engine of each diesel generator set has a self contained lube oil system consisting of a lube oil sump located at the base of the engine, an engine driven lube oil pump, piping, and a heat exchanger. The lube oil heat exchanger is served by the diesel generator set cooling water system. No external source of power or other plant systems are required for the diesel generator set lube oil system during emergency operation.

The Diesel Generator Fuel Oil Storage and Transfer System is described in Subsection 9.5.4.

The Diesel Generator Cooling Water System, Starting System, and Lubrication System are discussed in Subsections 9.5.5, 9.5.6, and 9.5.7, respectively.

The ventilation system provided for each diesel generator room is described in Subsection 9.4.5. The Diesel Generator Combustion Air Intake and Exhaust System is described in Subsection 9.5.8.

Control and monitoring (local and control room) of the diesel generator sets is accomplished through five bay control switchgear that is floor mounted (free standing) in each diesel generator building.

Each of the five bays of the control switchgear has a specific function as briefly described below:

a. Engine control cubicle: The front of this panel contains the necessary relays, lights, switches, annunciator for the proper and complete operation of the engine.

   The rear section mainly contains the terminal blocks required for the interconnection of engine mounted devices. These devices include pressure and temperature switches, air valves, governor devices, etc.

b. Metering Cubicle: The next section contains the instrumentation and relaying required for the control and protection of the generator. The engine, electric governor control unit is also located in this cubicle.

c. Voltage-Regulator-Exciter Cubicle: Meters, protective relays, and voltage regulator controls are mounted on the door of this cubicle. Inside the cubicle is the voltage regulator.

d. Transformer-Reactor Cubicle: EDG 2B -This contains the power transformer and the reactors which are a part of the static exciter. EDG 2A - This contains the power potential transformer and the power chassis which are a part of the static exciter.

e. Potential Transformer and Current Transformer Cubicle: EDG 2B - This contains the exciter current transformers. The main load and generator loads come into this cubicle. EDG 2A - This contains the exciter power current transformers and the droop current transformer. The main cables from the output of the diesel generator come into this cubicle.

   Each diesel engine is also provided with an engine mounted terminal box where engine mounted sensors and/or switches are terminated for external connection to devices located in the free standing control panel or switchgear.

   The controls and instrumentation that are mounted in or on the engine terminal box are listed below: (equipment mounted in the cabinet is marked by an asterisk(*)

   AC/DC turbo lube oil pump
   AC/DC soak back pump contactor
   Turbo lube oil filter low pressure indicating switch
   AC/DC soak back pump lube oil low/high pressure indicating switch
   AC/DC turbo lube oil pump low pressure indicating switch
   Engine lube oil pump pressure switch
   Low engine oil pressure shutdown
   Engine overspeed switch
   High crankcase pressure switch
   Start cutoff backup engine water pressure switch
   Low engine oil pressure alarm switch
   *Engine shutdown reset switch
   *Engine emergency shutdown switch
   Engine low lube oil idle pressure switch

Engine low standby pressure switch
Engine low water pressure switch
Motor driven pump discharge header pressure switch
Engine driven pump discharge header pressure switch
Fuel oil pressure switch
Fuel oil level switch
Low starting pressure switch
*Normal stop pushbuttons
Air start cutoff backup pressure switch
Low lube oil sump level switch
Low lube oil temperature switch
High jacket water temperature switch
Low water level switch
Immersion heater switches
*Local start push button
*Exhaust temperature monitors
*Engine fuel oil transfer relays
Governor limit switches
*Electronic speed switch
Immersion heater starters
Speed switch magnetic sensor
*Engine fuel oil level transfer switches control
Electronic governor inductive speed sensor
*Electronic load controller
*Digital reference unit

Below is the list of items and their function. Also indicated is the effect on the diesel generator in an emergency situation.

1. Engine Manual start P/B. The engines can be manually started by means of these pushbuttons. Failure of these pushbuttons has no effect on the diesel running in the emergency mode.

2. Safety shutdown reset switch. This switch is used to reset the lockout relay enabling the diesel generator to restart. Failure of these pushbuttons has no effect on the diesel running in the emergency mode.

3. Engine Emergency Shutdown Switch. This switch is provided for emergency shutdown of the diesels. During diesel generator emergency operation this switch is bypassed. Failure of this switch during emergency operation has no effect on the diesel generator.

4. Normal stop pushbutton. This switch is provided for normal shutdown of the diesel generator. It only shutdowns the diesel if the generator breaker is open. During emergency operation the generator breaker is closed. Failure of this pushbutton with the diesel generator in the emergency mode has no effect on the diesel generator.

5. Fuel oil transfer relays and fuel oil level transfer switch controls. This equipment controls the refilling of the DG day tanks. Failure could cause the diesel to run out of fuel. Because of this, these relays have been located in the diesel generator Control Switchgear.

6. The Electronic Speed Switch. This electronic speed switch takes a signal from the engine mounted speed sensor and converts it to an RPM signal. This information is used by various systems (e.g., air start) of the diesel generator. This speed switch is located in the diesel generator Control Switchgear.

7. Exhaust temperature monitors. This device alarms only on exhaust temperature differential and does not shutdown the engine. Failure of this device does not have any effect on the diesel generator.

8. Electronic load controller. The electronic load controller, in conjunction with the digital reference unit, controls the speed of the diesel generator during startup, idle and full speed operation. An inductive speed sensor is mounted on the EDG to provide a reference speed signal to the electronic load controller. The governor system is reverse- acting; therefore, failure of the electronic load controller would result in the EDG speeding up until the mechanical governor takes control.

The diesel generator sets 2A and 2B supply reliable power to those electrical loads which are needed to achieve safe shutdown of the plant or to mitigate the consequences of a design basis accident in the event of a loss of preferred ac power supplies. Table 8.3-2 lists the equipment and loads supplied by the diesel generator. Figure 8.3-4 shows a load profile for the loss of coolant and main steam line break accidents.

In the event of loss of preferred sources of power to the Onsite Power System, each diesel generator set is automatically started and loaded by controls and circuitry which are independent of those used to start and load the redundant set. The diesel generator starting and loading logic is as follows:

1. The diesel generator sets start upon loss of voltage in the safety 4.16 kV buses or actuation of the safety injection actuation signal (SIAS).

2. Upon loss of voltage on the 4.16 kV safety buses, these buses are automatically separated from the non-safety supply buses.

3. After each diesel generator set has attained normal frequency and voltage, the respective breaker closes if preferred ac power has been lost, thus immediately starting all loads belonging to the first block for which "starting required" signals are present (from ESFAS) or from circuit conditions indicating that they were previously running. If preferred ac power is still present, the diesel generator breaker does not close but the set remains at full frequency and voltage until manual actions are taken.

4. The starting of subsequent loads are delayed by timing relays using a design minimum of three second intervals between them. Load sequencing of the diesel generator is shown on Table 8.3-2.

5. If preferred ac power is lost but no Engineered Safety Features actuation signal is present, only the loads shown under the column "Loss of Offsite Power" in Table 8.3-2 are automatically started.

6. If, while operating as per step (5) above an SIAS appears, all loads are stripped and loading is performed per Table 8.3-2.

7. Means are provided for periodic testing of the diesel generator sets under load when preferred bus supply is from the unit auxiliary transformer. If preferred ac power is lost or an accident occurs during this testing, the diesel generator breaker is opened and the sequence returns to step (3).

The starting and loading circuitry for the diesel generator and 4.16 kV buses are listed in Section 1.7.

Means are provided to permit applying any load in the plant to the diesel generator. However, this is strictly a manual operation under the operator's full control. Such additional loading is limited by the rated capacity of the diesel generators. A wattmeter, a varmeter and an ammeter are provided for continuous indication of diesel generator loading. Administrative control is exercised to prevent loading the diesel generators over their rated capacities.

The diesel generator circuit protection is discussed in Subsection 8.3.1.1.2k(ii).

By means of potential and current transformer test blocks and a test position of the diesel generator circuit breakers, capability is provided to periodically test the protective relaying components and the auxiliaries which support the diesel function.

The power supply sources for the diesel generator instrumentation and control system are in accordance with the redundancy criteria discussed in Subsection 8.3.1.2.

For diesel generator parameters that are monitored and are indicated locally and/or in the control room, see Table 8.3-11.

Local and control room alarms are provided for conditions causing diesel generator lockout even if a lockout is overridden. Local alarms and/or control room annunciation are also provided as indicated in Table 8.3-12.

Control circuits for each diesel generator operate from separate Class 1E 125V dc circuits supplied from the station battery of the same division.

The standby power system components are designed to meet the seismic requirements for Class 1E electric equipment as described in Section 3.10. The environmental qualification for the standby power supply system is described in Section 3.11. Class 1E components are located within the Diesel Generator Building, a seismic Category I structure and are protected from potential missiles. Physical separation and isolation has been maintained by the installation of a wall between the redundant systems.

8.3.1.1.2 Specific Details of the Onsite AC Power System

a. Power Supply Feeders

Power for onsite distribution is normally obtained from the Offsite Power System through 4.16 kV buses 2A2 and 2B2. Connections between these buses and the safety related buses, 2A3 and 2B3, are comprised of three conductors of 500 kcmil per phase. Cable consisting of one conductor of 500 kcmil per phase is used to connect buses 2A3 and 2B3 to bus 2AB.

Cable feeders consisting of two 500 kcmil conductors per phase are used from diesel generators 2A and 2B to their 4.16 kV safety buses 2A3 and 2B3 respectively.

b. Busing Arrangements

Figures 8.3-1 and 8.3-2 show the busing arrangements for the Onsite Power System.

There are no direct connections between parts of the system which serve load group A and those parts which serve load group B. There is no automatic transfer of loads between load groups A and B. Buses serving load group AB can be manually connected with either of the buses serving load groups A or B but not simultaneously with the plant in Modes 1, 2, 3 or 4. Ties from the AB buses to the A or B buses have a breaker at each end of the tie. There are two breakers in series in each tie. The incoming breakers at the 2AB bus are electrically interlocked to prevent the 2AB bus from being simultaneously connected to 2A and 2B buses. In addition, captive key switches are located at the reactor turbine Generator Board to prevent simultaneously closing A&B bus breakers. Under normal operating conditions, load group AB is connected to load group A (or B) through two normally closed breakers in series. These breakers are controlled by their associated captive key type switches. The keys, which must be inserted to close the breakers, are "captured" and cannot be removed until the breaker switch is placed in the open position. These same keys are also used to unlock and operate the switches controlling the breakers between load group B (A) and load group AB. Therefore, whenever load group A (B) is connected to load group AB, the breaker control switches are in the closed position, the keys to operate the switches are "captured", and the control switches for the breakers between load group B (A) and load group AB cannot be operated.

The operation of these switches is the same as that described for the 125V dc bus ties described in Subsection 8.3.2.1.

Administrative procedures call for tying the AB buses on all of the ac and dc voltage levels to the same load group (either A or B). In this way, the split bus system is maintained throughout the plant, including the supply of dc power for proper breaker operation. See Subsection 8.3.2.1 and Figure 8.3-6 for a description of this transfer. A violation of the administrative control is annunciated in the control room. The alarms are activated whenever 4.16 kV, 480 volt and 125V dc loads are not all aligned to the same A or B load group. There are two

alarms provided; one uses auxiliary contacts from the AB bus breakers while the other uses auxiliary contacts from the A and B breakers feeding the AB bus breakers. See Subsection 8.3.2.1 and Figure 8.3-6 for a further description of this transfer.

The elimination of direct ties between buses serving load groups A and B and the provision of double breakers and interlocks on tie lines to AB buses prevent a single fault from affecting both redundant systems or from accidentally paralleling the emergency power source.

c. Loads Supplied from Each Bus

The Total Equipment Database shows each load in the plant and the bus to which it is connected. The criterion governing the assignment of loads is that redundant loads are assigned to both A and B groups.

The design criterion which pertains to the assignment of third service loads (the third component cooling water pump, intake cooling water pump and related equipment) is that of ensuring the availability of one component in each division during periods of maintenance. For example, prior to rendering any one of three pumps inoperable, administrative controls require that the remaining two pumps be connected to redundant buses. This is done by connecting bus 2AB to bus 2A3 or 2B3 to whichever the inoperable pump is connected. At the same time, at the 480V level, the 480V bus 2AB is connected to the bus corresponding to the 4.16 kV connection. This ensures that all safety related "AB" loads are connected to the same division at all times. Once any third service bus is assigned to a safety division A or B, the loads served by that bus are committed to that safety division. In addition, the 125V dc breaker controls are connected to the respective safety division.

In the control room, alarms are provided to alert the operator if the AB buses on all voltage levels are not aligned properly.

Once any third service bus is assigned to a safety division, either A or B, the loads served by that bus are committed to that safety division. The third buses are manually switched to the appropriate division A or B bus.

Physical separation is provided between load group A and load group B and between load group AB and both load group A and B since load group AB may at various times function as part of either load group A or B. Separate cable tray and conduit systems are provided for each of the redundant load groups.

All SAB cables are permitted to be routed only with their own safety class cables and not safety A or safety B. This is a design requirement to which cables are routed in their respective raceways. Separate tray and conduit systems are furnished for the following classes of cable: 5 kV, 600 Volt power, 600 Volt control and 300 Volt shield instrument cable. Physical separation is further discussed in Subsection 8.3.1.2, "Regulatory Guide 1.75 Rev. 1."

There are no AB instrumentation protective systems.

The physical location of the third channel actuated equipment is shown on Figures 1.2-12 (Charging pumps), 1.2-20 (CCW pumps) and 1.2-22 (Intake Cooling Water Pumps).

d. Manual and Automatic Interconnections Between Buses, Between Buses and Loads, and Between Buses and Supplies

Bus transfers used on startup of the main generator are manual "live bus" transfers (i.e., the incoming source feeder circuit breaker is closed onto the energized bus section), as described in Section 8.3.1.1.1.

Safety bus transfers, used on the loss of the main generator or unit auxiliary transformer, are automatic fast-dead bus transfers. The normal source feeder circuit breaker is tripped, and the alternative source circuit breaker is closed, resulting in a transfer within a few cycles, (i.e., the station auxiliary buses rated 6.9 kV and 4.16 kV are automatically transferred from the Station Auxiliary Transformer to the Startup Transformer by tripping either one of the two generator lockout relays. Testing of the transfer feature is performed in accordance with the Technical Specifications.

If the incoming preferred source is not available, as indicated by a voltage relay on the incoming feeder, transfer does not occur. The resultant loss of voltage at the safety related bus thereupon trips the tie feeder breaker(s) and starts the diesel generator(s).

Control of the 4.16 kV feeders to the 480V switchgears is manual, as is switching of MCCs to the 480V switchgear. Most loads are manually controlled, but safety related loads are automatically or manually controlled on occurrence of an event as required.

The third service buses or AB buses are manually switched to the appropriate division A or B bus, as described in Subsection 8.3.1.1.2b.

The electrical system design does not include provisions for crosstie connections, either manual or automatic, between redundant safety related buses. There are also no interconnections between the 120V uninterruptible instrumentation ac buses, although the two supply inverters for channels MA and MC (or MB and MD) are powered normally by 125V dc feeders of the safety related load group A (or B) respectively. The same is true of the 125V dc instrumentation buses MA, MB, MC and MD.

e. Interconnections Between Safety Related and Non-Safety Related Buses

Apart from the preferred source connections from bus 2A2 and bus 2B2 to bus 2A3 and bus 2B3, respectively, other interconnections between safety related and non-safety related buses occur at the MCCs where non-safety loads are connected to safety related buses. Wherever this occurs, the MCC bus is split into an essential (safety and plant investment loads) and non-essential (non-safety related loads) section connected through a bus isolating contactor that opens automatically during an undervoltage (i.e., loss of voltage) or safety

injection actuation signal, thereby separating the non-essential loads from these MCCs.

Safety related loads as well as non-safety related loads are connected to the 480V switchgear and selected 125V dc panels.

In all cases, any non-safety related load connected to a safety related bus is fed from a circuit breaker or fuse qualified as an isolation device. In addition, barriers are provided within each switchgear/panel to assure nonsafety components i.e. breakers, wires, etc. cannot cause the failure of any safety component. The discussion in section 8.3.1.2.2 for Regulatory Guide 1.75 describes the separation and isolation of non-safety related loads connected to safety related buses.

f. Redundant Bus Separation

Separation of 4.16 kV and 480V redundant switchgear, the 480V redundant MCCs and power panels, the 120V uninterruptible ac buses and inverters and the 125V dc batteries, chargers and distribution panels is accomplished through spatial separation or provision of fire resistant barriers. The two redundant diesel generators are separated by three hour firewalls in the Diesel Generator Building which is a seismic Category I structure.

g. Electrical System Sizing Requirements

Equipment capacities have been conservatively selected. The two redundant diesel generators each have adequate capacity to supply all safety related and uninterruptible equipment loads required for safe shutdown of the plant. Table 8.3-2 lists the safety related loads connected to each of the diesel generators under emergency conditions.

Brake horsepower ratings listed in the above table for safety related motors are based on loads under expected flow and pressure. Safety related equipment functional capability is verified by preoperational tests.

h. Automatic Tripping and Loading of Buses

Loads connected to the safety related switchgear are deenergized when voltage is lost on the 4.16 kV safety related buses. Only the safety related loads, plant normal/emergency lighting and certain plant investment loads are automatically reenergized when voltage is restored to these buses.

Non-safety loads connected to the safety buses can be manually reconnected by the operator.

Automatic tripping by protective relays is discussed in Subsection 8.3.1.1.2.k.

i. Safety Related Equipment identification

Safety related equipment is identified by means of nameplates and color coded tape, paint or tags in accordance with its respective safety related system or channel. A further discussion is found in Subsection 8.3.1.3.

j. Instrumentation and Control Systems with Assigned Power Supply

The Reactor Protective System (RPS) and Engineered Safety Features Actuation System (ESFAS) are supplied with power from four uninterruptible ac inverters. There are four separate channels in these control systems, each of which operates from one of the four inverters.

Each inverter is supplied from a safety related dc bus. For maintenance purposes only 480V ac power is also available through a transformer and voltage regulator and a manual transfer switch to bypass the normal dc supply without interruption of services connected to the inverter's ac output. The ac and dc supplies for the inverters are taken from the same load group, A or B, as the inverter serves, so as to provide full separation between redundant divisions. Isolimiters are provided to isolate the instrument buses from unacceptable voltage surges that may result when the bypass system is in operation.

The Qualified Safety Parameter Display System (QSPDS) is supplied with power from two instrument buses, 2MC-1 and 2MD-1, both of which are on separate channels and protected with dedicated isolation transformers.

k. Electric Circuit Protection Systems

Electrical protection for safety related equipment is as follows:

i. Safety related 4.16 kV System Protection

Safety related 4.16 kV switchgears 2A3 and 2B3 are protected against bus faults by differential relays which trip each respective incoming bus breaker in the unlikely event of a fault on the switchgear bus. In addition inverse time overcurrent relays, one in each phase, provide additional protection against bus faults and backup protection to individual load feeders.

Safety related 4.16 kV switchgear 2AB is similarly protected by bus differential relays and three inverse time overcurrent relays which trips the incoming breaker from bus 2A3 or 2B3, whichever is closed.

All outgoing feeders from safety related 4.16 kV, switchgears 2A3, 2B3 and 2AB are protected against feeder short circuit by instantaneous relays in each phase. Motor feeders are provided with relays for locked rotor protection and overload alarms. Feeders for the 4160/480V switchgear transformers are provided with relays for overload trip. Each feeder is equipped with a ground fault alarm.

ii. Diesel Generator Protection

When offsite power is available or during normal testing operation the diesel generator is shut down and its breaker is tripped whenever diesel generator lockout occurs. In the absence of a SIAS or loss of offsite power the following conditions cause a lockout:

1) Low engine oil pressure
2) High engine water temperature
3) Engine overspeed
4) Generator differential
5) Generator overcurrent
6) Reverse power flow to generator
7) Loss of generator excitation
8) Crankcase pressure

These lockouts are alarmed locally and are annunciated in the control room as a lockout of the 2A or 2B diesel generator. Besides the above lockouts, the generator breaker is tripped and the engine is left running if a 4.16 kV bus failure occurs. Each diesel generator can be manually started or stopped both locally and from the control room.

If the diesel is started as a result of a SIAS or loss of offsite power, all but two diesel generator lockout signals are overridden. Those which remain functional are engine overspeed and generator differential.

Overriding all but two of the lockout signals reduces the probability of spuriously tripping a diesel generator when it may be required to shut down the plant or mitigate the consequences of an accident. The rationale for retaining the engine overspeed and generator differential lockouts is to mitigate the probability of seriously damaging a diesel should one of these adverse conditions occur. The two trips that are not overridden are commonly used in power plant application and have histories of highly reliable operation. The reliability of the two lockouts discussed above warrants maintaining their protective capability during normal and accident conditions. This rationale is in accordance with the intent of BTP EICSB 17, "Diesel Generator Protective Trip Circuit Bypass."

Monitoring the diesel generator protective trips for a "first-out" indication, as discussed in Section C.1b.5 of Regulatory Guide 1.108 (R1), has no safety function and only has application when the DG is under test. In the event that a DG trip occurs during a test FP&L analyzes the cause of the trip and take corrective action accordingly. During this time the unit is under technical specifications as required. Refer to Technical Specification 3/4.8.1. (See also Subsection 8.3.1.2.2.)

iii. Safety Related 480 Volt System Protection

Feeders to safety related 480V MCCs are protected by ac breakers, each provided with an electronic trip device trip having short time and long time trip elements. The feeders for MCCs 2A9 and 2B9 provide long time and instantaneous trips as the MCCs supply one motor load each.

Feeders to 460V motors from the 480V safety related switchgears are provided with long time and instantaneous trips.

Each 480V switchgear feeder is also provided with a ground fault alarm.

The 480V MCC combination motor starters for motors and valve operators are provided with an instantaneous trip circuit breaker (for short circuit protection) and thermal overload devices for each phase. The overload elements are set to protect the connected motor and its connected cable.

Those motor operated valves that are located in the containment contain thermal magnetic circuit breakers that provide overcurrent and short circuit protection as the overload elements have been bypassed to prevent any hindrance to the performance of the valves function.

In the case of the selective safety related valve operators, the thermal overload devices are prevented from tripping the valve operators when the appropriate Engineered Safety Features Actuation System signal is present. For a discussion of Regulatory Guide 1.106, "Thermal Overload Protection for Electrical Motors on Motor-Operated Valves," 3/77 (R1), see Subsection 8.3.1.2.2.

Static 480V motor control center loads are fed from thermal magnetic breaker or solid state breaker providing overcurrent and short circuit protection.

iv. Safety Related 120 Volt AC System Protection

Each outgoing feeder is provided with overcurrent and shortcircuit protection by a thermal magnetic breaker. Single pole breakers are used for 120V single phase circuits and double pole breakers are used on 208V single phase circuits.

Most panel buses are directly connected to the secondary terminals of a three phase 480V/208-120V transformer, the primary of which is protected by a three pole thermal magnetic breaker or solid state breaker located in a MCC. The instantaneous trip setting of this breaker is set high enough to trip only on faults on the feeder cable or within the transformer itself, thus ensuring that faults in the branch circuits trip only the affected secondary breaker and not the transformer primary circuit breaker. Other panels are fed from these panels.

v. 120 Volt Instrument Power Supply

The 120 volt output from the safety related instrument inverters is ungrounded. The outgoing feeders are protected with current limiting fuses.

vi. Ground Fault Protection

High resistance grounding is used on the 4.16 kV and 480V systems so that ground fault currents are sufficiently low such that tripping of the affected breaker is not required. Ground faults are detected and alarmed locally or in the control room.

The 208V/120V systems are effectively grounded, so that ground faults are seen by the breaker as equivalent to phase-to-phase faults and tripping occurs.

The diesel generator is high resistance grounded through a transformer and resistor connected to the generator neutral.

The high resistance grounding system alarms only, thus permitting continued operation in the unlikely event of a single ground.

The safety related 120V instrument power supply systems are effectively ungrounded. A ground detector is provided on the bus to alarm on occurrence of a ground anywhere on the system; two ground faults on different poles of the system are required for tripping.

l. Testing of Power Systems During Operation

For a discussion of operational testing, see the Technical Specifications.

m. Diesel Generators

i. Automatic Starting Initiating Circuits

Each diesel generator is started automatically either by the appropriate Engineered Safety Features Actuation System signal or by the undervoltage relay on the respective 4.16 kV safety related bus.

ii. Starting Mechanism and System

Each diesel engine is started by compressed air which is stored in two separate air tanks. Each tank pair has sufficient air to start each engine five times without recharging. The air starting system is described in Subsection 9.5.6.

iii. Tripping Devices

Diesel generator protection is described in Subsection 8.3.1.1.2.k which gives the conditions under which automatic shutdown of the set occurs.

iv. Interlocks

Interlocks are provided in the closing and tripping circuits to prevent closing of the diesel generator breaker and connected safety related loads under the following conditions:

(a) If a lockout relay is tripped, the closing circuit is interrupted.

(b) If safety related bus is energized, the generator breaker is prevented from automatic closure. Automatic connection of the safety related loads with voltage on the associated safety related bus is prevented by a contact of the bus voltage sensing relays in the closing circuits of the individual breakers.

v. Permissives

Permissives are designed as follows:

1) To start the diesel generator:

(a) 125V dc control power available
(b) diesel generator lockout relay in reset position.

2) To trip the emergency diesel generator when the unit is on auto operation:

This is covered in Subsection 8.3.1.1.2.k

3) To close the diesel generator air circuit breaker Manual with live bus (test condition)

(a) diesel generator lockout relay in reset position
(b) correct voltage and frequency on the diesel generator
(c) synchronizing switch is in ON position

4) Synchronism check relays:

The synchronism switch is in the “on” position and verification is made by checking the synchroscope.

vi. Load Shedding

Upon sensing of the loss of offsite sources of power to the plant Onsite Power System, the safety portion of the system is automatically electrically isolated from the non-safety portion of the system by the operation of circuit breakers on the lines between non-safety and safety related buses.

vii. Testing

Periodic testing and frequencies at which it is performed are a part of the Technical Specifications.

Each diesel generator is equipped with a means for starting periodically to test for readiness, a means for synchronizing the unit onto the bus without interrupting the service, and a means for loading and for shutdown after test.

viii. Fuel Oil Storage and Transfer System

The Diesel Generator Fuel Oil Storage and Transfer System is described in Subsection 9.5.4.

ix. Diesel Generator Cooling Water System

The Diesel Generator Cooling Water System is described in Subsection 9.5.5.

x. Instrumentation and Control for Standby Power Supply

Manual and automatic control of the diesel generators is described in Subsection 8.3.1.1.1(f).

Performance of the engine, generator and auxiliaries is monitored locally and selectively at the control room. See Subsection 7.5.1 for a discussion of safety-related display instrumentation.

xi. Basis for Diesel Generator Sizing

Table 8.3-2 lists the loads which are used in sizing the diesel generator. This table shows the nature of the various loads, each load that is connected to the safety- related bus, rating of each load in brake horsepower, the loading sequence step time and other details. The continuous rating of each diesel generator is based on the total calculated consumption of the loads, plus margin, that are powered by the system under design basis accidents or safe shutdown conditions.

The diesel generator ratings are identified on Table 8.3-1:

xii. Diesel Generator Loading

Table 8.3-2 shows the automatic and manual loading sequence of the emergency power supply system. The essential loads are started automatically by their respective ESFAS signals in a predetermined step-by-step loading sequence. Equipment which may require manual startup is started after the initial automatic sequential loading.

In an event of a Unit 1 Station Blackout, Unit 2 diesel generator(s) may be used to supply power to the Unit emergency buses via the station blackout tie. Plant procedures define the appropriate actions to be taken and limit the maximum loading on the diesel generator to be 3936 kW.

xiii. Preventative Maintenance

The Emergency Diesel Generators will be inspected in accordance with a Licensee-controlled maintenance program. This program will require inspections based on procedures prepared in conjunction with the manufacturer’s recommendations for this class of standby service. Changes to the maintenance program will be controlled under 10 CFR 50.59.

St. Lucie Unit 2 monitors equipment and component failure on plant systems, including the diesel generators in three ways. One method is by NRC required Licensee Event Reports (LERs). The applicant is required

to list the failure; determine that this is or is not the first failure of its type; if it is not the first, how often it has previously happened; and describe in detail the action taken to ensure the problem does not recur.

Another method is via a users group that monitors problems at many plants and informs plants with similar equipment of generic problems.

The third method is via a company-wide maintenance monitoring program, referred to as the GEM's program. Reports are completed and records maintained such that generic problems can be quickly identified. This program is initiated and perpetuated by company procedures.

The Emergency Diesel Generator Reliability Program for St. Lucie Unit 2 meets the guidelines of Regulatory Guide 1.155, "Station Blackout," Position 1.2 "Reliability Program". These Regulatory Guide requirements are satisfied through plant surveillance, administrative and maintenance procedures. The Regulatory Guide requirements are:

a) Unit "average" reliability of 0.975 for a four (4) hour blackout duration.

b) Surveillance testing and reliability monitoring program to track EDG performance are included in plant procedures.

c) Maintenance program that assures target EDG reliability is achieved and provides the capability to perform root causes analyses.

d) System to collect the data and compare the achieved reliability level with the target value.

e) Identifies responsibilities for the program's major elements and management oversight for reviewing reliability levels and ensuring that the reliability program is functioning properly.

xiv. Training

Some operations personnel (RCOs and above) are provided with a diesel generator training program which addresses, in detail, theory, mechanical design, electrical characteristics, instrumentation, operation, load carrying and Technical Specifications.

St. Lucie has maintenance personnel who have been factory trained on diesel generator maintenance. All three maintenance departments have training programs which include diesel generator information. As future needs require, maintenance personnel who supervise diesel generator maintenance are also factory trained.

n. Power Lockout to Motor Operated Valves

The only 480V motor operated valves that require power lockout are safety injection tank valves (V3614, V3624, V3634, V3644). In accordance with BTP

ICSB 18 the safety injection valves (V3614, V3624, V3634, V3644) are not considered active valves and, therefore, restoring power to the valve from the control room is not required. In addition, control circuit to the valves is designed such that power to the pickup coil can be defeated and reinstated from the control room.

To assure that the valves are open, the following instrumentation and controls are provided:

1) Valve (open/close) indicating lights. These lights are connected to the valve position limit switches and obtain its control power from the starter control transformer. The illumination of these valve indicating lights reflect the actual valve position. Also, it reminds the operator that the valve operating power has not yet been removed (i.e., the circuit breaker has not physically locked open).

2) When the reactor is not in shutdown mode, the valves operating power is removed (i.e., circuit breakers locked open). The absence of the indicating lights indicates to the operator that the valve breaker is locked open. In addition, the annunciator indicates that the power is removed and control circuit is de-energized.

3) As a redundant measure, slidewire valve position transmitter/indicator is used to monitor valve position at all times, regardless of breaker positions.

4) Furthermore, an annunciation window is provided to assure "open" valve position and quickly annunciates if the valve is not fully open.

A list of the above valves and appropriate actions is found in the Technical Specifications.

In addition, each safety injection tank is provided with two redundant safety grade solenoid vent valves. The addition of these valves allows depressurization of the safety injection tank from the control room, thereby eliminating the need for isolating these tanks using valves (V3614, V3624, V3634, V3644). The valves are controlled from the control room with key operated control switch.

o. Undervoltage Protection for Class 1E Buses (Branch Technical Position PSB-1)

In accordance with PSB-1 the first level of undervoltage protection is provided to detect a loss of offsite power. Two (2) solid state undervoltage relays are provided on each of the Class 1E A and B 4.16KV buses, and are set at no less than 3120 volts with undervoltage tripping within 1 second. The relays are connected for a coincident logic and are mounted in the Class 1E 4.16 Kv switchgear. Upon detection of a loss of voltage condition, these relays automatically initiate diesel generator starting and disconnection of the offsite source on a loss of offsite power.

In accordance with PSB-1 a second level of undervoltage protection is provided for the Class 1E buses. Florida Power and Light meets the requirements of the

position for St. Lucie Unit 2 by providing for each Class 1E division, a 2 out of 3 coincident logic protection scheme consisting of three solid state undervoltage relays set at approximately 93 percent of 4.16 Kv and provided with a 10 second time delay. The relay logic actuates control room annunciation to alert the operator to a degraded voltage condition and aligns the trip circuitry associated with the undervoltage logic such that subsequent occurrence of a safety injection actuation signal (SIAS) separates the Class 1E system from the offsite power system automatically. The 10 second time delay is based on preventing the worst case motor starting transient from causing spurious alarms in the control room. (The 4.16Kv Condensate Pump accelerates to full speed with the minimum voltage conditions expected on the main generator or switchyard in six seconds.)

An additional set of three solid state undervoltage relays is provided on each of the Class 1E A and B 4.16KV buses. These relays are located downstream of the 480V ac power center reactors. The output of the relays provides a trip signal, in a coincident logic arrangement (2 out of 3), via an appropriately set timer. The relays will separate the Class 1E buses from the offsite source and transfer them to the emergency diesel generator in accordance with the selected time settings should the operator fail to restore system voltages.

The setting of the relaying scheme at approximately 90 percent of 480V ac with a time delay of approximately 21 seconds insures adequate protection against potential damage due to operation with inadequate supply voltage for all Class 1E equipment.

The most limiting equipment was considered to be the 460V ac motors which are rated at 90 percent of nameplate operating voltage. Should 480V ac bus voltage decrease to 90 percent of 480V ac, voltage at the worst case motor control center will be at least 90 percent of 460V ac or 86.2 percent of 480V ac. Should the 480V ac bus voltage continue to decrease an additional set of relays identical to the degraded voltage relays described above will shorten the time to trip. These relays are set at approximately 75% of 480 volts with a time delay of approximately 1.5 seconds.

The minimum acceptable operating voltage at the 120V ac level was established by equipment ratings to be 90 percent of 120V ac.

To evaluate the acceptability of the relay setting an analysis of station electric system voltages was performed under steady-state conditions with the full plant running loads and minimum design main generator voltage supplying the onsite system through the Unit Auxiliary Transformers. The results of this analysis demonstrates that voltages on Class 1E systems at the 4.16 kV level, the 480V ac level and the 120V ac level remain above the design limits of the equipment. The voltage level on the 4.16 kV buses remains above the setpoint which insures that the alarm and SIAS alignment relays described above are not actuated during this steady state operating condition. 480V ac bus voltage remains above the setpoints of the undervoltage relays, preventing spurious actuation of the protection feature during steady-state conditions.

Analysis of station electric system voltages was also performed under steady-state conditions with the full plant running load and minimum design switchyard voltage supplying the onsite system through the Startup Transformers. The results of this analysis demonstrate that, as shown in the analysis of the Unit Auxiliary Transformer, all voltages on the Class 1E systems remain above minimum acceptable design conditions.

The worst case starting transient was also analyzed for the most limiting conditions (the 2A system, since this is the most heavily loaded with all normal plant running loads on the buses) when the Startup Transformer is supplying the system and offsite switchyard voltage is at the design minimum of 230 kV. The analysis indicates that following the starting transient, voltages on all Class 1E buses remain at values above the acceptable design limits and that the voltage on the 4.16 kV buses returns to above the relay setpoint of approximately 93 percent within the time delay setting of 10 seconds. In accordance with Branch Technical Position, PSB-1, relay actuation during the worst case motor starting transient does not occur.

An additional analysis was performed on the onsite system to evaluate the impact of an SIAS and resultant fast dead bus transfer when the offsite source is at the minimum design voltage conditions.

The results of this analysis demonstrate that the voltages on the 4.16 kV level, 480V ac level and 120V ac level remain with acceptable design limits following the fast dead bus transfer.

The relays and all associated equipment are Class 1E and are located in the relay panels in the Reactor Auxiliary Building. The capability exists for test and calibration during power operation.

FP&L has performed a verification test of the analysis to establish adequate station electric system voltages prior to fuel loading.

The above scheme meets the requirements of Branch Technical Position PSB-1 Section B.1.6(i).

p. Station Blackout

Station blackout (i.e., total loss of ac power- offsite and onsite) was considered in the design for the St. Lucie Unit 2. The current design has been analyzed for station blackout for a period of four hours without unacceptable consequences (see Section 15.10).

In the unlikely event of a complete loss of ac power (onsite and offsite) for St. Lucie Unit 2 and, the simultaneous loss of offsite power and one diesel generator at St. Lucie Unit 1, the remaining diesel generator in St. Lucie Unit 1 is able to operate the minimum selected loads such that both units are maintained in a safe, hot standby condition. A cable tie is provided connecting Class 1E swing switchgear 1AB and 2AB. This tie can be used only when an actual blackout condition exists (or under test conditions with one of the swing buses disconnected from the other parts of its units' system) and will be implemented

under procedural controls assuring that the diesel generator capability will not be exceeded.

Upon completion of the inter-tie and manual loading, both plants remain in the safe hot standby condition until the conclusion of the event or approximately four hours. Per the SBO analysis, the SBO cross-tie was originally intended for use for SBO events initiated with both units operating in Mode 1. Additionally, the SBO analysis did not consider the availability of offsite power to the opposite unit. If, during a blackout event, offsite power is available to Unit 1, the SBO cross-tie may be used to provide offsite power from Unit 1 to Unit 2, regardless of the initial operating Mode of either unit. Use of the cross-tie for these non-licensed blackout events is controlled via plant procedures.

Further, the present St. Lucie design also does have the capability of electrically connecting the two units' 4.16 kV buses 1A2 and 2A2 (1B2 and 2B2) through 4.16 kV bus 2A4 (2B4).

q. Open Phase Protection for Class 1E Busses

The function of the Open Phase Detection and Protection (OPDP) system are to: EC285638

a) trip the low side breakers of Startup Transformers (SUTs) 2A and 2B (both the 4.16 kV and 6.9 kV Switchgear incoming breakers) upon detecting and Open Phase Condition (OPC) on the high side of the transformers if the transformers are loaded OR,

b) provide only and OPC alarm in the control room if the SUTs are not loaded

Each SUT has a dedicated OPDP system with three independent channels. Each channel uses fiber optic current sensors that cover the range from unloaded to fully loaded conditions. The three channel architecture allows the OPDP system to use a 2-out-of-3 logic for indicating an OPC to minimize spurious alarms. If one of the three independent channels is out of service for any reason, the OPDP system defaults to a 2-out-of-2 logic.

The NRC has agreed to allow the industry to operate the OPDP System in a monitoring mode for approximately 2 years. During the monitoring mode, the automatic trip of the transformer breakers will be disabled. Upon receipt of an OPC alarm, Operators will validate the alarm via bus current indication and a visual inspection of the switchyard and Startup Transformer (SUTs) 2A or 2B overhead lines. If an alarm is validated, then the low side breakers of SUT 2A or 2B (both the 4.16 kV and 6.9 kV Switchgear incoming breakers) will be tripped manually and disabled to prevent closing.

The OPDP system is classified as quality related due to regulatory requirement per section 4.2.1.2 (I) of the NEE fleet procedure EN-AA-203-1102 (Safety Classification Determination), though, the system is installed on the non-Class 1E side of the SUT. It is electrically separated from the Class 1E safety related circuits by safety related breakers.

Indication is provided in the control room for an OPDP system trouble alarm as well as detection of an OPC. EC285638

8.3.1.1.3 Design Criteria for Class 1E Equipment

Design criteria are discussed below for certain Class 1E equipment:

a. Motors

Motor sizes are selected based on calculations of load, torque requirements or on the basis of equipment (pump, fan compressor, etc.) supplier recommendations.

The 4.16 kV safety-related motors are specified to start their respective driven equipment with 75 percent of rated motor terminal voltage. The 480V safety-related motors are specified to start and accelerate their respective driven equipment with 90 percent of rated motor terminal voltage.

When ESF motors are sequenced onto the diesel generator the voltage at the motor terminals must be sufficient to start and accelerate the motor and driven equipment without damage to the motor or impact to the accident analysis. Motors that are supplied for St. Lucie Unit 2 and that are rated 460 volts are designed as standard motors (90 percent start or specially designed for 75 percent starting voltage).

When the ESF motors are sequenced onto the diesel generators, three motors experience starting voltages less than their 460 volt 90 percent design. They are the Containment Fan Coolers quantity 2, and the Shield Building Exhaust Fan.

The voltage of the Containment Fan Cooler motor experiencing the worst starting transient is 84.4% of motor nameplate voltage at the instant that the motor applied to the diesel generator. This voltage recovers to 94.4% of motor nameplate voltage as the result of the recovery of the diesel generator voltage brought about by the voltage regulator action. The next load block to be started by the diesel generator occurs in three seconds subjecting these motors to a motor terminal voltage of approximately 87 percent at the instant the load block is connected which recovers as a result of the diesel generator voltage regulator action to 91.8% motor terminal voltage.

To assure that the motor has sufficient torque to accelerate the driven equipment under this type of transient, the motor manufacturer supplied speed torque curves for motor acceleration considering a constant motor terminal voltage of 80 percent which is bounding to the starting transient described above. This curve is shown in Figure 8.3-7. From this curve net torque (motor torque minus loading torque) was determined using 12 speed intervals and the acceleration time of the motor was calculated to be 5.19 seconds. Comparing this acceleration time to the acceleration time measured in the accident analysis, ie. 10 seconds, indicates that the motor is accelerated in sufficient time as to not impact the accident analysis. To assure that the motors are not damaged during this starting transient, the motor acceleration time was compared to the safe stall time of the

motor. From manufacturer's data applied, the safe stall time at 100 percent starting voltage is 12 seconds (hotstart). The acceleration time of 5.19 seconds is less than 12 seconds and therefore motor damage will not occur. It must be noted that the safe stall time of a motor increases as a result of lower starting voltage since the inrush current is less. Therefore, comparing the acceleration time at the lower voltage (5.19 seconds) to the safe stall time at the higher voltage (12 seconds) is very conservative. Actual manufacturers data for starting transients such as described above indicates that the safe stall time is increased to 15 seconds.

During the third diesel generator load block and the acceleration of the containment fan coolers, the Shield Building Exhaust Fan is started. The voltage at its motor terminals is approximately 87 percent of motor nameplate voltage. Since this motor is a 90 percent motor, the motor load was analyzed in a similar manner as the containment fan coolers described above utilizing the same conservative constant 80 percent motor terminal voltage. The speed torque curve, taken from manufacturers data for the motor and load is shown on Figure 8.3-8. The acceleration time is calculated for this motor is 4.9 seconds. Again comparing this time to the time assumed in the accident analysis, 10 seconds, and comparing this time to the safe stall time typical for motors this size, 11 seconds, indicates that the reduced voltage starting of this motor and load does not impact the safety analysis or damage the motor.

b. Motor Starting Torque

The motor starting torque is capable of starting and accelerating the connected load to normal speed within time to permit its safety function for all expected operating conditions including the design minimum terminal voltage of the diesel generator.

c. Motor Insulation

Insulation systems are selected based on the particular ambient conditions to which the insulation is exposed. 4.16 kV safety related motors are provided with Class B or F insulation systems. 480V safety related motors are provided with Class B, F or H insulation systems.

d. Interrupting Capacity of Switchgears, Load Centers, and Motor Control Centers

The interrupting capacity of switchgear, load centers, and motor control centers are selectively designed such that 1) any bus is capable of starting the largest motor with the other equipment in operation and 2) the interrupting devices can safely interrupt any short circuit that may occur in the system.

e. Electric Circuit Protection

Refer to Subsection 8.3.1.1.2.k.

f. Grounding

Electrical equipment frames are solidly grounded to the station ground grid; an instrument ground system is also provided. For a discussion of ground fault protection, see Subsection 8.3.1.1.2.k(vi).

8.3.1.1.4 Cables and Raceways

The 5 kV and 15 kV power cables are insulated with unfilled cross linked polyethylene, wrapped with an extruded layer of semiconducting insulation shield material compatible with the insulation, and covered with a lead sheath and a heavy duty overall neoprene jacket. These cables have a 100 percent insulation level and are rated for continuous temperature operation at a conductor temperature not to exceed 90°C.

The 600 volt power cables are insulated with a high temperature Kerite insulation (HTK) and covered with black heavy duty flame resistant (FR) jacket.

The 600 volt control cables are insulated with Kerite flame resistant (FR or FR-2) insulation and covered with heavy flame resistant (FR) jackets. Okonite Co. cables are also utilized, with an X-Olene FMR (flame retardant cross-linked polyethylene) extruded insulation and Okolon (Hypanlon) jackets.

600 & 300 volt instrumentation cables consist of twisted, paired, shielded and unshielded cables. Unshielded cables consist of twisted pairs with Kerite flame resistant (FR or FR-2) insulation covered with an extruded polymer layer and having an overall flame resistant (FR) jacket. Okonite cables are of the same construction as described above for the 600V control cables. Shielded cables in addition to the above have a drain wire with each pair in direct contact with aluminum mylar tape. Each shielded pair is separated by glass mylar tape.

The power, control and instrumentation cables are rated for continuous operation at a conductor temperature not to exceed 90°C.

Prefabricated 600 volt cable assemblies are used for the CEA position, CEDM power and incore monitoring instrumentation (self powered neutron detectors [SPND]). The cable configurations from the penetrations to the disconnect panels located near the refueling cavity consist of the following:

- CEDM power cable assemblies are insulated with 30□C FR-EP and jacketed with the CPE material.

- Incore monitoring assemblies utilize MI cable.

- CEA cable assembly conductors are insulated with 200°C Kapton PYRE-ML varnish, covered with a Kapton PYRE-ML varnish jacket and an overall stainless steel armor weave to protect the jacket.

From the panels located near the refueling cavity out to the instrument connections in the reactor vessel head area all of the CEDM, CEA (RSPT) and ICI cables consist of multiconductor pre-manufactured cable assemblies. Each assembly is made up of individual conductors covered with silicone insulation rated at 125°C, an overall silicone jacket rated at 125°C, and an outer 30 AWG stainless steel armor braid. These cables are not safety related. Nonsafety related cable supplied by a respective equipment manufacturer that is not flame resistant is not routed with other qualified plant cable.

Coaxial cables are constructed with a Rockbestos Firewall III Polymer LD first insulation, radiation cross linked cellular modified polyolefin or radiation cross linked modified polyolefin second insulation, covered with a tin coated copper shield and a radiation cross linked, non-corrosive, flame retardant modified polyolefin overall jacket. These cables are rated for continuous service up to 110°C.

All cable is flame resistant and is qualified in accordance with IEEE 383 or approved equivalent per PSL-FPER-04-017 (Reference 2), described in the Fire Protection Design Basis Document (Reference 1) with these exceptions; the lighting branch circuit cable, cables supplied for use with the humidity detectors of the ILRT system, cables for the Fire Sprinkler Systems, cables for Security System, and thermocouple extension cables for the Shield Building Ventilation Fan Heater Controls. However, these cables are uniquely identified and are assigned to a dedicated raceway system. At no time are these cables permitted to be routed with the other plant cable.

In addition, portions of the self-powered neutron detector instrumentation utilized mineral insulated cable assemblies. Both the core exit thermocouples (CET) and the heated junction thermocouples (HJTC) will utilize mineral insulated cable assemblies to comprise the safety related portion of the incore monitoring instrumentation system. Ampacities for cables are in general accordance with IPCEA 54-440-1975 and the methods presented in P-46-426.

Environmental conditions under which cables must operate are given in Section 3.11.

Raceways are galvanized steel conduits, trays or wireways, or tube track for all exposed circuits within buildings. Embedded conduits are either PVC or galvanized steel.

PVC coated steel conduit is utilized in exposed applications at the intake cooling water structure.

Flexible metal conduit is used wherever raceway connections are made to vibrating equipment.

Trays, with the exception of the reactor head area, are solid bottom galvanized steel ventrib trays. The reactor head area cable trays are ladder type to facilitate easy exiting of cable from the tray to the reactor head area.

Raceways are supported securely at intervals governed by the span loading.

- The Class 1E underground raceway system consists of Class 1E cables in directly buried ducts utilizing PVC conduit, protected by concrete slabs and Class I fill.

- The Class 1E underground system is in conformance with applicable industry standards, is designed similar to St. Lucie Unit 1 and is in accordance with 10 CFR 50 General Design Criteria 1,2,3,4,17,18 and IEEE 308-71 Subsection 5.2.1.

- The specific design criteria are addressed as follows for the Class 1E underground cable system.

Seismic design of the duct runs is accomplished by using a rigid design (concrete encasement) or a flexible (unencased) design. The flexible design concept for underground electrical duct runs was decided upon in 1970. The flexible design is verified for seismic loadings utilizing

concepts derived from N. M. Newmark's paper, "Earthquake Response Analysis of Reactor Structures," Nuclear Engineering and Design, Vol. 20 pp. 303-322. The design method utilizes soil strains induced by seismic waves and frictional resistance between the duct and soil to determine the shear and moment acting on a particular buried element. Relative displacement is considered by using flexible joints at the end of manholes. The results show that the calculated stresses are well below acceptable stress levels. The St. Lucie Unit 2 installation duplicates the St. Lucie Unit 1 design concept.

Where seismic design is considered, the seismic effects of the soil on the ducts is a relevant consideration. Ideally, the ducts should move with the soil. This condition is approached in the St. Lucie design by utilizing a conduit system with sufficient flexibility in soil and by separation of the manhole from other structures. At St. Lucie, the soil surrounding the Class 1E duct runs is comprised entirely of Class 1 backfill for which the pertinent physical soil parameters are known and condition of isolation is documented. Flexibility is achieved by not encasing the duct runs in concrete; the moment of inertia and modulus of elasticity of the unencased duct bank is considerably less than that of an encased duct run. Structural separation of the duct runs from other structures is achieved by use of three inch isolation joints permitting three dimensional movement between the structures and the manholes.

The unencased ducts are backfilled after the duct bank is completed. Backfilling is accomplished by a combination of hydraulically placed backfill and vibration in accordance with approved procedures. This assures that a high soil density in duct run is achieved. Density checks of the backfill are made to determine that the 98 percent Modified Proctor Density is achieved. The results of these tests are documented and test results are retrievable.

Protection from excavation damage, normally achieved by concrete encasement, is obtained by the installation of reinforced concrete slab over the Class 1E duct runs. These slabs are nine inches thick except under roadways where the slabs are one foot three inches thick. Non-Class 1E runs are concrete encased because there are no seismic considerations.

The Class I soil in the area of the St. Lucie Unit 1 duct banks has been chemically analyzed with the results being typical for beach sand except for a somewhat higher than normal level of calcium carbonate (sea shells). The same fill is used for St. Lucie Unit 2. Leaching of chemical compounds in the soils does not have any detrimental effect upon the cables or ducts.

Protection against a tornado missile is provided by a minimum of two feet of soil cover with a nine inch reinforced concrete slab or a minimum of one foot of soil cover with a 15 inch reinforced concrete protective slab. The inherent capability of this protection is equivalent to two feet of reinforced concrete criterion for tornado missiles. For the underground Class I raceways that go to-the Main Steam Trestle Area Specific protection is accomplished by the following means:

a. For manholes located above grade, a one inch steel plate is provided.

b. For conduits, a twelve inch reinforced slab plus a one inch steel plate is provided.

The ducts are protected from the direct effects of the winds associated with the design basis natural phenomena by virtue of being below grade.

All underground electrical system components are located at least seven feet above the normal groundwater level. Due to maintenance considerations, manholes are constructed to minimize the infiltration of water. A gravity or pumped drainage system is provided where necessary.

During severe hurricanes, or excessive rain storms, flooding of the areas surrounding the plant island could result in backup of the storm water system which in turn could result in a wetting of underground cables; no adverse effect results from this condition.

The strength of the PVC schedule 40 ducts have been analyzed as flexible buried pipes. Analysis methods in American Water Works Association Manual M11 entitled, "Steel Pipe Design Manual," are used to determine the magnitude of loading transmitted from the surface to the buried ducts and the resulting deflection and stressing of the duct. The maximum design roadway loading is that associated with movement of the St. Lucie Unit 2 steam generator (in the order of 650 tons divided over two transporters). This results in a roadway surface loading of 5000 psf and 3000 psf at the top of the duct bank. Calculated stresses (buckling) in the ducts due to the steam generators load are 118 psi (the ducts can accommodate buckling stresses of 566 psi).

The results of the analysis demonstrate that the ducts can withstand this surface loading with ample margins of safety against crushing or overstressing. The steam generator transporter is considered the design basis load.

As per Supplement No. 1 to the Safety Evaluation of St. Lucie Unit 2 (Docket No. 50-339, dated March 3, 1976), it was concluded that the Class 1E underground system provides reasonable assurance that the cables and cable/duct system withstand the specified design conditions without impairment of structural integrity.

8.3.1.2 Analysis

Class 1E electric components are designed to insure that any of the design events listed in IEEE 308-1971 do not prevent operation of the minimum number of safety-related loads and protective devices that would be required to mitigate the consequences of an accident and/or safely shutdown the reactor.

The General Design Criteria are covered in Section 3.1. The following design aspects illustrate the extent of conformance with respect to Regulatory Guides, IEEE Standards, and General Design Criteria (GDC).

8.3.1.2.1 General Design Criteria

<u>General Design Criterion 17</u>

Redundancy of the emergency auxiliary power system is provided for the operation of redundant safety related electrical load groups. This redundancy extends from the emergency power source, through 4.16 kV buses, station service transformers, 480 volt buses, MCCS, distribution cables, 120V/208V and 120V panels, inverters, and protective devices.

Each of the redundant onsite emergency power sources and associated load groups independently provide for safe shutdown of the plant and/or mitigation of the consequences of a design basis accident.

General Design Criterion 18

Inspection and Testing is carried out in three ways:

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

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

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

8.3.1.2.2 Regulatory Guide Implementation

Regulatory Guide 1.6, "Independence Between Redundant Standby (Onsite) Power Sources and Between Their Distribution Systems," 3/71 (R0)

As stated in the Safety Evaluation Report of St. Lucie Unit 2 (Docket No. 50-389) the electrical design is in compliance with the requirements of the Regulatory Guide. The Regulatory Guide is met as follows:

a. The electrically powered safety loads, both ac and dc are separated into redundant load groups such that the loss of any one load group does not prevent the performance of the minimum safety functions.

b. Each ac load group has a connection to the preferred (offsite) power source and a connection to a standby (onsite) power source, consistent with the design of other existing licensed nuclear plants.

   Each standby power source has no connection to the other redundant load group.

c. Each dc load group is energized by a separate battery and battery chargers.

   Each battery and battery charging system has no automatic connection to the other redundant dc load group.

d. The standby ac power source consists of two redundant diesel generator sets. For further discussion see Subsection 8.3.1.1.2.

e. No means are provided to automatically parallel the standby source associated with load group A with the standby source associated with load group B. See Subsection 8.3.1.1.2.

f. Each diesel generator set consists of two diesel engines mounted in tandem with a generator coupled directly between the engines.

The equivalent reliability of the tandem diesel generators has been demonstrated on St. Lucie Unit 1. The diesel generators are subjected to a 100 start test by the manufacturer at the factory to determine their performance reliability.

Regulatory Guide 1.9, "Selection of Diesel Generator Set Capacity For Standby Power Supplies," 3/71 (R0)

As stated in the Safety, Evaluation Report of St. Lucie Unit 2 (Docket No. 50-389) the electrical design is in compliance with the requirements of Regulatory Guide 1.9 (R0).

Compliance to each Regulatory Guide position is as follows:

The diesel generator sets are designed, constructed and installed in accordance with IEEE 387-1972. They are provided with surveillance systems to indicate occurrence of abnormal, pretrip or trip conditions. Periodic tests are performed on the power and control circuits and components, including protective relays, meters, and instruments to demonstrate that the emergency power supply equipment and other components that are not exercised during normal operation of the station are operable. The operational tests are performed at scheduled intervals to test the ability to start the system and run under load for a period of time long enough to establish that the system meets its performance specifications.

The intent of Regulatory Guide 1.9 (R0) is met as follows:

a. The maximum automatically started load on each diesel generator is within the continuous rating of 3685 kW. The total maximum load, including manually started loads, is within the 2000 hour rating.

b. The total predicted loads, at either hot or cold conditions (automatic and manual loads) do not exceed 90 percent of the 30 minute rating of the diesel generator set. The 90 percent of the 30 minute rating (3586 kW) is less than the 2000 hour rating (3935 kW).

c. Predicted loads of each diesel generator set are verified during preoperational testing.

d. Each diesel generator set is capable of starting, accelerating to rated speed and supplying, in required sequence, all the needed emergency shutdown loads. At no time during the loading sequence does the voltage and frequency decrease to less than 75 percent of nominal generator terminal voltage or 95 percent of nominal generator frequency, respectively. Voltage and frequency are restored to within 90 percent and 97 percent of nominal, respectively, within 40 percent of each load sequence.

   The speed of the diesel generator set does not exceed 111 percent of nominal speed (900 rpm) during recovery from transients caused by disconnection of the largest single load. The engine trip set point is 1035 rpm (115.00 nominal) to ensure that the unit does not trip on rejection of the largest single load.

   Each diesel generator set is capable of reaching full speed and voltage within 10 seconds after receiving a signal to start.

e. Prototype qualification test data and preoperational tests are performed to confirm the suitability of the diesel generators.

Regulatory Guide 1.22, "Periodic Testing of Protection System Actuation Functions," 2/72 (R0)

The extent of compliance with this regulatory guide is discussed in Subsection 7.1.2.2.

Regulatory Guide 1.29, "Seismic Design Classification," 2/76 (R2)

Qualification of seismic Category I/Class 1E electrical equipment is discussed in Section 3.10.

Regulatory Guide 1.30, "Quality Assurance Requirements for the Installation, Inspection, and Testing of Instrumentation and Electric Equipment," 8/72 (R0)

See subsections 8.3.1.2 and 7.1.2.2.

Regulatory Guide 1.32, "Criteria for Safety-Related Electric Power Systems for Nuclear Power Plants," 8/72 (R0)

As stated in the Safety Evaluation Report of St. Lucie Unit 2 (Docket No. 50-389) the electrical design is in compliance with the requirements of Regulatory Guide 1.9 (R0). The Class 1E electric systems comply with the requirements of IEEE 308-1971 as modified by Regulatory Guide 1.32 (R0) as follows:

a. Design Criteria

1) Conditions of operation, due to design basis events, both natural and postulated, are defined in Sections 3.10 and 3.11; Class 1E electric systems design was developed and equipment purchased such that their safety related functions can be performed, in the respective operating environment, under normal and design basis events conditions.

2) The quality of the Class 1E electric system output is such that all electrical loads are able to function in their intended manner, without damage or significant performance degradation.

3) Control and indicating devices, required to switch between the preferred and standby power supplies and to control the standby power supply system, are provided inside and outside the control room.

4) All Class 1E electric system components are uniquely identified.

5) Class 1E electric equipment is physically located in seismic Category I structures and separated from its redundant counterpart.

6) Equipment qualification by analysis, tests, successful use under similar conditions, or a justifiable combination of the foregoing, ensures that the performance of safety related functions under normal and design basis event conditions is demonstrated (refer to Sections 3.10 and 3.11).

7) Tables 8.3-6 through 8.3-10 depict the failure modes and effects analysis for the Class 1E electric systems.

b. AC Power Systems

1) Alternating current power systems include power supplies, a distribution system and load groups arranged to provide ac electric power to Class 1E loads. Sufficient physical separation, electrical isolation and redundancy have been provided to prevent the occurrence of common failure modes in the Class 1E systems

2) The electric loads are separated into redundant groups.

3) The safety actions by each load group are redundant and independent of the safety actions provided by the redundant counterparts.

4) Each of the load groups has access to both a preferred and a standby power supply

5) The preferred and the standby power supplies do not have a common failure mode between them. This is ensured by means of administrative controls that allows only one diesel generator to be tested at any time. Also, protective relaying is included to isolate the standby sources from the preferred power sources in order to preserve the availability of the standby sources.

c. Distribution System

1) All distribution circuitry is capable of starting and sustaining required loads under normal and design basis event conditions.

2) Physical isolation between redundant counterparts ensures independence.

3) Local and/or remote control and indicating components monitor distribution circuits at all times.

4) Auxiliary devices that are required to operate equipment are supplied from a related bus section to prevent loss of electric power in one load group from causing the loss of equipment in another load group.

5) All Class 1E electrical power circuits have provision for isolation from non-Class 1E circuits through circuit breakers and or contactors located in Class 1E equipment.

d. Preferred Power Supply

1) The preferred power supply derives power from two alternative sources.

2) Energy in sufficient quantities is available for normal, standby, and emergency shutdown conditions of the plant.

3) Offsite power is available to start and sustain all required loads.

4) Surveillance of the availability and status of the preferred power supply is maintained to ensure readiness when required.

e. Standby Power Supply:

1) The standby power supply consists of two diesel generators, each connected to one of the safety related 4.16 kV ac buses. Each diesel generator represents a complete, independent source of standby power.

2) The redundant standby power supplies provide energy for the safety related systems when the preferred power supply is not available.

3) Independence of the two standby power systems ensures that a failure of either standby power source does not jeopardize the capability of the remaining standby power source to start and run the required 1E loads.

4) Each diesel generator is available for service within the time specified upon loss of the preferred power supply.

5) Status indicators, in the control room and remotely located, provide monitoring and alarm for the surveillance of all vital functions for each diesel generator with respect to standby and operating modes (see Section 7-5).

6) Sufficient fuel is provided at the site to sustain the operation of both standby diesel generators continuously for seven days, or of one unit for 14 days (see Subsection 9.5.4).

7) Automatic and/or manual controls are provided for the selection, disconnection and starting of all loads supplied by the standby power sources.

8) Automatic devices disconnect and isolate failed equipment and indication to this effect is provided.

9) Test starting and loading can be accomplished during normal station operation.

Regulatory Guide 1.40, "Qualification Tests of Continuous - Duty Motors Installed Inside the Containment of Water-Cooled Nuclear Power Plants," 3/73 (R0)

For qualification of continuous-duty motors installed inside containment, see Section 3.11.

Regulatory Guide 1.41, "Preoperational Testing of Redundant On-Site Electric Power Systems to Verify Proper Load Group Assignments," 3/73 (R0)

See Section 14-2.

Regulatory Guide 1.47, "Bypassed and Inoperable Status Indication for Nuclear Power Plant Safety Systems," 5/73 (R0)

The extent of compliance with this Regulatory Guide is discussed in Subsection 7.1.2.2.

Regulatory Guide 1.53, "Application of the Single-Failure Criterion to Nuclear Power Plant Protection Systems," 6/73 (R0)

The extent of compliance with this Regulatory Guide is discussed in Subsection 7.1.2.2.

Regulatory Guide 1.62, "Manual Initiation of Protective Actions," 10/73 (R0)

The provisions of Regulatory Guide 1.62 (R0) and IEEE 279-1971 relate mainly to the instrumentation and control systems and are discussed in Subsection 7.1.2.2. The electrical system supplying power to the Reactor Protective System is designed to ensure that failures in the supply system result in consequences no more limiting than failures in the Reactor Protective System, as follows:

a. Power supply to the protection systems is from four (one for each channel) power supply inverters as described in Subsection 8.3.1.1.1. No random single failure in any one inverter degrades the performance of the other three. With one measurement channel bypassed for testing, failure of a second channel inverter still leaves two channels functional, thus providing protection without unnecessary tripping as described in Subsection 7.2.1.

b. Any one of the four power supply units can be isolated for maintenance at the same time as the remaining protective channel equipment is being maintained.

c. A common alarm in the control room provides an annunciation when undervoltage or overvoltage conditions are detected in the inverter's dc supply and an undervoltage, overvoltage, or out of frequency condition in the output.

d. Each power supply unit is so constructed as to facilitate repair by replacement of defective components or modules, to ensure a minimum of downtime.

IEEE 279-1971 has also been used as a guide in the design of all safety related power systems. In particular, the power systems are designed to meet the single failure criterion; electrical equipment may be tested for functional integrity when the loads it supplies are tested; and all bypasses in safety related circuits (e.g., thermal overload relays in selected valve-operating motor starters) are provided with indication.

Regulatory Guide 1.63, "Electric Penetration Assemblies in Containment Structures for Water-Cooled Nuclear Power Plants," 10/73 (R0)

The intent of Regulatory Guide (RG) 1.63 (R0) is met as follows:

The electrical penetrations for St Lucie Unit 2 are designed in accordance with IEEE 317-1972 and are qualified and tested in accordance with IEEE 317-1976, "IEEE Standards for Electric Penetration Assemblies in Containment Structures for Nuclear Power Generating Stations," as modified by the appropriate quality assurance related positions of RG 1.63, Rev 2.

Conax Corporation is the supplier of all electrical penetration assemblies for St. Lucie Unit 2. The following types of electrical circuits penetrate containment:

a. Medium Voltage Power Circuits

b. Low Voltage Power Circuits

c. AC and DC Control Circuits

d. Instrumentation Circuits

All electrical penetration assemblies are designed to meet the maximum containment internal pressure of 44 psig. In addition, all electrical penetration assemblies are designed to withstand an overload pressure of 50 psig for one hour.

The electrical penetration assemblies are designed to IEEE 317, 278 and 383.

The Quality Assurance (QA) program is in accordance with the Engineering QA program previously approved by the NRC during the construction permit review.

480V switchgear circuits, control circuits, and instrumentation circuits are designed in compliance with position C.1 of Regulatory Guide 1.63.

The specific methods utilized to meet position C.1 to RG 1.63 revision 2 (i.e., "electrical penetration assembly should be designed to withstand, without loss of mechanical integrity, the maximum short-circuit vs time conditions that could occur given single random failures of circuit overload protection devices") are different in accordance with the electrical service class (i.e., a, b, c and d above) and the function of the circuit (e.g., certain circuits shall be de-energized prior to entering the plant modes shown on Table 8.3-13).

The single failure concern of position C.1 (RG 1.63, Rev 2) may be considered credible, however, the following design, installation, and quality assurance features utilized for St. Lucie 2 provide confidence that such an event is indeed unlikely.

a. The low voltage and medium voltage power systems (i.e., nominal 480V ac, 4.16 kV ac, 6.9 kV ac) are high impedance grounded (i.e., connected to station ground through an impedance value aimed to limit line-to-ground faults to less than approximately 10-15 amperes). When an electrical short circuit fault occurs, the predominant fault mode is typically a single line to ground fault as documented in IEEE Standard 500-1977, "IEEE Guide to the Collection and Presentation of Electrical, Electronic and Sensing Component Reliability Data for Nuclear-Power Generating Stations." A high impedance grounding system limited ground fault current would not result in unacceptable degradation of the penetration assembly (e.g., the additional ground current of 10-15 amperes to the 50 amperes full load current of the 4000V CEDM cooling fan motors, has no impact on the penetration which has a 500 ampere continuous current capability). This allows continued system load operation under single line-to-ground fault which for Class 1E circuits provides a margin above the single failure criterion to promote continuity of service. The failure rates for copper conductor power cable reported in Chapter 10 of IEEE Std 500 (listing 10.1.1.1 Power) would indicate that there may be no multiphase shorts for power cables in containment over the licensed plant life.

b. The DC Power Distribution Systems are designed for ungrounded operation (i.e., without any intentional design connection to ground except through very high impedance measurement and ground indication circuitry). Consequently, a single line-to-ground fault results in virtually no ground fault current flow.

c. All cables are installed and documented against controlled installation procedures and verified by quality control procedures. Each power cable has its insulation resistance tested after installation to verify integrity.

d. Protective devices (e.g., relays, overload elements, etc.) are provided in the three phases of the three phase power system. The high impedance grounding limits the destructive short circuits to line-to-line and line-to-line-to-line faults. Consequently, a single failure of protective relaying or overload elements does not preclude tripping the circuit for a line-to- line fault. Two failures of relaying/overload elements does not preclude tripping the circuit for a line-to-line-to-line fault.

e. Stringent design provisions for in-containment equipment, as described in Chapter 3, of this SAR minimize damage potential due to seismically induced failures, missile generation, etc.

f. The failure modes of the circuit protective devices (i.e., the failure to open the circuit under maximum overcurrent conditions) have a low failure rate as identified in IEEE Std 500.

Medium Voltage Power Circuits

There are two medium voltage power penetration classes; one class rated 5 kV and one class rated 15 kV. The method of compliance with RG 1.63 Rev 2 position C.1 is as follows for the two classes of medium voltage electrical penetration assemblies:

a. Type MVP-A

   Two penetration assemblies provide power for 4000 Volt rated, 400 hp CEDM Cooling Fan Motor Drives.

   1. Primary Protection: Overcurrent relays (device 50/51/83) are provided for all three phases of each motor feeder circuit. These relays are housed in their respective 5 kV metal clad switchgear cubicles.

      The control (i.e., breaker trip) voltage is 125V dc nominal from Class 1E dc buses.

   2. Backup Protection: Fuses are provided to backup the relays in a coordinated manner as described in Subparagraph (3) below.

   3. Fault-current-versus-time coordination:

      The largest short-circuit current anticipated downstream of the penetration assembly is approximately 30,000 amperes symmetrical. Primary protection is provided by an overcurrent relay (Figure 8.3-9(a)) which has its instantaneous setting at approximately twice locked rotor current.

      The interrupting time of the medium voltage switchgear is approximately 5.5 cycles, which includes relay pickup time. Consequently, the primary

protection will clear any fault which exceeds the instantaneous setting in approximately 5.5 cycles. Smaller fault or overload currents will result in circuit opening in accordance with the inverse time element of the primary protective relay (see Figure 8.3-9(a)).

Fuses are provided to backup the primary relays and are mounted in their own enclosure. This entire assembly is purchased as Class 1E and qualified to IEEE 323-1974 and IEEE 344-1975. Each fuse is connected in series with each pole of the three phase switchgear breaker. They are selected so that they will clear a fault or overload condition before the current capabilities of the 750 kcmil penetration feedthroughs are reached (RG. 1.63). They are also coordinated to allow the existing switchgear circuit breaker sufficient time to clear a fault or overload condition before opening and will clear before any upstream breaker is affected (RG. 1.75). The cable between the switchgear and the new fuse is run in its own dedicated seismically supported conduit and is thus separated from any other safety or non-safety cable. To prevent non-three phase operation of the fan motors due to individual fuse operation, a negative sequence current relaying scheme was added to the affected switchgear cubicle.

b. Type MVP-B

Four penetration assemblies are provided designated A3, A4, A7, A8 to service 6600 volt rated, 6500 hp Reactor Coolant Pump Motor Drives.

1. Primary Protection: Overcurrent relays (device 50/51/83) are provided for all three phases of each motor feeder circuit. The control (i.e., breaker trip) voltage is 125V dc nominal derived from Class 1E dc buses.

2. Backup Protection: Overcurrent (device 50/51) and fault detection (device 50FD) relays are provided to backup the primary relays in a coordinated manner as described in Subparagraph (3) below. The control circuit for backup protection has a power source that is fused separately from the primary protection control circuits.

3. Fault current versus time coordination:

4. The largest short circuit current anticipated downstream of the penetration assembly is approximately 31,000 amperes symmetrical.

   Primary protection is provided by an overcurrent relay (device 50/51/83) which has its instantaneous setting at approximately 180% of locked rotor current. The interrupting time of the medium voltage switchgear is approximately 5.5 cycles, which includes relay pickup time. Consequently the primary protection clears any fault which exceeds the instantaneous setting within approximately 5.5 cycles. Smaller fault or overload currents results in circuit opening in accordance with the inverse time element of the primary protective relay (Figure 8.3-9(b)).

Backup protection is provided by a relay scheme consisting of an overcurrent relay (device 50/51), a fault detector (device 50FD) and a time delay relay (device 62). The backup protection scheme opens the backup circuit breaker for a short circuit exceeding the instantaneous setting of the overcurrent relay upon the failure of the primary protection. The Time Delay Relay, delays tripping to allow the primary protection to clear the fault. A small fault or overload current results in circuit opening in accordance with the inverse time element of the backup protective relay.

Low Voltage Power Circuits

As described in Subsection 8.3.1.1.1.c, "480 Volt System" low voltage power circuits are protected by 480 volt switchgear or 480V Motor Control Centers. The following describes the typical methods utilized.

a. 480 Volt Switchgear

The only power circuit penetrating the containment powered directly from 480 volt switchgear is the Reactor Containment Building Polar Crane. The penetration assembly provides service to the Reactor Containment Building Polar Crane utilizing 500 kcmil conductors.

As the polar crane is not required during plant operating modes, Regulatory Guide 1.63 Rev 2, position C.1, is met by adherence to the Technical Specification limitation on power delivery to the polar crane (e.g., breaker locked open).

b. 460 Volt Pressurizer heater Bus

Power circuits penetrating containment serve in-containment power panels which distribute power to the heater circuits which form the first level of protection for a short circuit at the heaters. The field cable is 2-4/0 AWG conductors per phase and the penetration conductor sizes are two 350 kcmil conductors per phase.

In the unlikely event of a fault at or downstream of the penetration assembly, primary and backup overcurrent protection is provided as illustrated in current vs time plots of Figure 8.3-9(c).

The 480 Volt Pressurizer Heater Bus Breaker is a thermal magnetic molded case circuit breaker. The incoming power to the Pressurizer Heater Buses is derived through a 4160/480 volt 750/1000 kVA transformer from Class 1E Switchgear as shown on Figure 8.3-9(c). The molded case circuit breaker requires no external power supply to trip the circuit on overcurrent.

The Pressurizer Heater Buses are supplied from Class 1E qualified 4.16 kV Switchgears 2A3 and 2B3 for Pressurizer Heater, Buses 2A3 and 2B3 respectively. As indicated on Figure 8.3-9(c) the Class 1E switchgear breaker backs up the 480 Volt Pressurizer Heater Bus Breaker and opens the circuit, prior to exceeding the maximum I^2t capability of the penetration seal, under maximum fault conditions.

c. Containment Cooling Fan Motors

Four Containment Cooling Fan Motors, (125/83 hp) located in containment, are served by combination starters which provide the necessary two-speed two-winding control functions. Each starter is individually served by a 480 volt switchgear breaker.

Figure 8.3-9(d) provides the time-current plots which demonstrate that the penetration integrity is protected with two independent tripping devices. Primary protection is provided by a thermal magnetic circuit breaker which is backed up by a circuit breaker. All protective devices are Class 1E commensurate with the safety function of the Containment Cooling Fan Motors.

d. 480V AC Motor Control Center Circuits

Small 460 volt ac, rated 3 Φ motor loads (maximum motor load being 40 hp), and 480 volt ac static or intermittent loads (e.g., power receptacles) are powered from 480 volt ac Motor Control Centers as described in Subsection 8.3.1.1.2.

The circuit overload protective devices and the MCCs themselves, which supply circuits which penetrate containment are Class 1E.

1. Motor Circuit & Static Devices

   These circuits are protected with two fault current interrupting devices in series.

2. Normal/Emergency Service

   Lighting systems and other non-Class 1E 208Y/120V ac systems which derive "emergency power" from the Class 1E power (distribution system for personnel safety (e.g., safe egress from containment upon loss of plant normal or preferred power) are powered from Power Panels PP 210 or 214. These panels derive their power through a Class 1E qualified dry type 45 kVA Transformer with Class 1E primary and secondary breaker protection.

   A failure of either the primary or secondary breaker, device 1 and device 2, as respectively described on Figure 8.3-9(e) does not prevent the alternate circuit breaker from opening the penetration circuit without violation of containment integrity.

Control Circuits

Control circuits which penetrate containment typically utilize a #16 AWG conductor for field cable and #8 AWG penetration conductor. The control circuits are typically provided with fuse protection. Furthermore, DC Control Circuits for control valves and similar devices have several levels of circuit protection (e.g., 2-6 ampere fuses backed up by 15 ampere thermal magnetic breakers). AC control circuits (e.g., MCC control circuits) which penetrate containment utilize fuses rated six amperes or less.

DC control circuits utilize two fuses (i.e., one for positive and one for negative leads) so that a single fuse failure to clear the circuit does not prevent the second fuse to clear the circuit. Furthermore, a ground fault produces negligible currents. It is worth noting that failure of a fuse to clear a circuit when properly installed would be an incredible event (i.e., IEEE 500 does not indicate any failures other than misapplication).

Site construction verification and/or pre-operational verification ensure the fuse, as specified, is installed. Ac control circuits derived from MCC control circuits have control transformer sizes of 150 through 500 Va and maximum secondary fuse of six amperes.

In the extremely unlikely event of fuse failure the impedance of the circuit elements (i.e., magnetic only circuit breaker, control transformers, and control cable) would limit the maximum fault to less than the mechanical integrity limit of the penetration assembly.

Instrument Circuits

These circuits supply signals from devices such as transmitters (e.g., pressure, flow, etc.), thermocouples, annunciators and other limited energy circuits. These instrument circuits are typically dc, low voltage circuits derived from current limited instrument power supplies. Faults on such circuits therefore are of low energy value such that penetration mechanical integrity is not jeopardized.

Regulatory Guide 1.73, "Qualification Tests of Electric Valve Operators Installed Inside the Containment of Nuclear Power Plants," 1/74 (R0)

Qualification of electric valve operators installed inside the containment and compliance to IEEE 382, see Section 3.11.

Regulatory Guide 1.75, "Physical Independence of Electric Systems," 1/75 (R1)

The intent of Regulatory Guide 1.75 (R1) is met as follows (See Figure 8.3-5).

The Class 1E electric system complies with the requirements of IEEE 384-1974 (other IEEE Standards discussed in Section 8.3.1.2.3). The extent to which this standard has been followed is described below.

a) General Separation Criteria

   Separation is provided to maintain independence of electrical circuits and equipment so that the protective functions required during any design basis event can be accomplished. The degree and method of separation varies with the potential hazards in a particular area.

   Equipment and circuits requiring separation are identified on drawings and identification in the field is in a distinctive manner as described in Subsection 8.3.1.3. Separation of equipment and circuits is achieved by safety class structures, distance, or barriers, or any combination thereof. Electrical equipment, circuits, and raceways are separated into three distinct categories.

   1) Class 1E safety related: equipment, circuits, or raceways that are essential to emergency reactor shutdown, containment isolation, reactor

core cooling and containment and reactor heat removal, or are otherwise essential in preventing significant release of radioactive material to the environment. Safety related equipment, circuits, and raceways are separated per the "Specific Separation Criteria" below.

2) Associated Circuits and Equipment: Non-Class 1E circuits or equipment that share power supplies, enclosures or raceways with Class 1E circuits or are not physically separated from class 1E circuits or equipment by acceptable separation distance or barriers.

   Associated circuits and equipment comply with one of the following:

   i) They are uniquely identified as such or as class 1E and remain with or are separated the same as those Class 1E circuits with which they are associated; the cables are subject to all requirements placed on Class 1E circuits such as cable derating, environmental qualification, flame retardance, splicing restrictions and raceway fill, unless the absence of such requirements could not significantly reduce the availability of the Class 1E circuits, or

   ii) They are in accordance with (i) above from Class 1E equipment to and including an isolation device. Beyond the isolation device a circuit is considered a non-Class 1E circuit provided it does not again become associated with a Class 1E system. St. Lucie Unit 2 is designed such that those non-safety loads connected to the Class 1E busses which are not considered important for operation and plant investment will be shed from the Class 1E buses by a Safety Injection Actuation Signal (SIAS) or will be locked out of service during plant operation in accordance with the Technical Specifications. An example is the pressurizer heater bus circuit which is shed by a Safety Injection Actuation Signal (SIAS).

      Those non-safety loads which are considered important for operation and plant investment remain connected to the Class 1E buses, however, they are provided with two, Class 1E, fault current interrupting devices.

Preferred power supply circuits from the transmission network and the similar power supply circuits from the unit generator that become associated circuits solely by their connection to the Class 1E distribution system input terminals are exempt from the requirements of the above.

Isolation devices are devices in a circuit which prevent malfunctions in one section of a circuit from causing unacceptable influences in other sections of the circuit or other circuits. Class 1E qualified circuit interrupting devices actuated by fault current are considered to be isolation devices.

3) Non-Class 1E Circuits and Equipment: Non-Class 1E circuits, equipment, and raceways do not perform any safety operation within the plant.

i) Non-Class 1E circuits are routed in separate raceway systems from Class 1E circuits. These raceway systems are separated from Class 1E raceway systems by the minimum separation requirements specified in b) "Specific Separation Criteria," below. Non-Class 1E circuits are separated from associated circuits by the minimum separation requirements in b) Specific Separation Criteria" below, or the effects of lesser separation between non-Class 1E circuits and associated circuits are analyzed to demonstrate that the Class 1E circuits are not degraded below an acceptable level or,

ii) The non-Class 1E circuits are treated as associated.

b) Specific Separation Criteria

1) Separation criteria for Cables and Raceways

i) General Plant Areas: In general redundant Class 1E raceway systems are separated spatially by three feet horizontally and five feet vertically. This separation distance is based upon the following:

- Cable splices in raceways are prohibited
- Cables are flame retardant
- Power cable trays are designed to be no more than 40 percent full
- Hazards are limited to failures or faults internal to the electric equipment or cables

If, in addition, high energy electric equipment such as 4.16 kV or 6.9 kV switchgear, transformers over 480V or large rotating equipment are excluded and power cables are installed in enclosed raceways or there are no power cables, the minimum separation distance is one foot horizontally and three feet vertically.

ii) Cable and Raceway Hazard Areas

Analyses of the effects of pipe whip, jet impingement, missiles, fire and flooding demonstrate that safety-related electrical circuits, raceways and equipment are not degraded beyond an acceptable level.

The analyses are referenced as follows:

Pipe Rupture	(Section 3.6)
Missiles	(Section 3.5)

Flammable Material	(the Fire Protection Design Basis Document (Reference 1))
Flooding	(Section 2.4)

iii) Cable Spreading Area and Control Room: The cable spreading area is the space below the control room where the instrumentation and control cables converge prior to entering the control, termination, or instrumentation panels. The cable spreading area and control room do not contain high energy equipment* such as high energy switchgear, transformers over 480 volts, high energy rotating equipment, or potential sources of missiles or pipe whip, and are not used for storing flammable materials. Circuits in the cable spreading area and control room are limited to control functions, instrument functions and those power supply circuits and facilities serving the control room and instrument systems.

There are two pressurizer heater transformers each rated 750 kVA, 4.16 kV to 480V, 3 phase, dry type that are located adjacent to the Unit 2 cable spreading area. These non-safety transformers are powered from Class 1E 4.16 kV switchgear through qualified isolation devices. The 4.16 kV cable, that connects the switchgear bus with the transformer high side winding and enters through the bottom of the floor at EL. 43.00, is qualified to the requirements of IEEE 383. Sprinklers are provided above the transformers on EL. 43.00 as a result of fire protection reviews.

Transformers are built in accordance with ANSI Standard C57.12.00-1973. They are designed to sustain external short circuit faults on any one set of terminals.

The minimum separation distance between redundant Class 1E cable trays is one foot between trays separated horizontally and three feet between trays separated vertically. This separation distance is based upon the following:

- Cable splices in raceways are prohibited.
- Cables are flame retardant.
- Hazards are limited to failures or faults internal to the electric equipment or cables.

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* High energy circuits are considered to be those with available fault currents in excess of the interrupting rating of the 480V motor control centers.

- No high energy equipment such as high energy switchgear, transformers over 480 volts, high energy rotating equipment are located in this area.

- There are no potential sources of missiles or pipe whip.

- Refer to the Fire Protection Design Basis Document (Reference 1) for a discussion of the fire safety analysis.

Where the minimum separation distance described in i, ii and iii above cannot be maintained, the redundant circuits are enclosed in raceways that qualify as barriers or the tray is coated with fire retardant spray or other barriers are provided between redundant circuits. The minimum distance between the redundant enclosed raceways and between barriers and raceways is one inch. Horizontal separation is measured from the side rail of one tray to the side rail of the adjacent tray. Vertical separation is measured from the bottom of the top tray to the top of the side rail of the bottom tray.

DC power supply feeders from redundant MA, MB, MC and MD instrument buses to the control room are installed in enclosed raceways that qualify as barriers.

For identification of cable and raceways, refer to Subsection 8.3.1.3.

2) Separation Criteria for Emergency Power Supply

i) Emergency Diesel Generators: Redundant Class 1E emergency diesel generators are located in separate safety class structures and have independent air supplies.

ii) Auxiliaries and Local Controls. The auxiliaries and local controls for redundant emergency diesel generators are located in the same safety class structure as the unit they serve or are physically separated in accordance with the requirements of a) "General Separation criteria" above.

iii) Cable and Raceway: Cable and Raceway separation is in accordance with b) "Specific Separation Criteria", item 1.

Separate electrical equipment rooms are provided in the Reactor Auxiliary Building for redundant 4.16 kV safety buses. The spatial separation is provided between redundant 480V switchgear. The 480 volt safety MCCs are located inside the Reactor Auxiliary Building, Fuel Handling Building and Diesel Generator Building. Spatial separation is provided between redundant MCCs.

3) DC System

i) Batteries: Redundant Class 1E batteries are placed in separate rooms. These rooms are served by independent ventilation systems.

ii) Battery Chargers: Battery chargers for redundant Class 1E batteries are physically separated in accordance with the requirements of a) "General Separation Criteria" above.

4) Separation Criteria for Distribution System

i) Switchgear: Redundant Class 1E distribution switchgear groups are physically separated in accordance with the requirements of a) "General Separation Criteria" above.

ii) Motor Control Centers: Redundant Class 1E motor control centers are physically separated in accordance with the requirements of a) "General Separation Criteria" above.

iii) Distribution Panels: Redundant Class 1E distribution panels are physically separated in accordance with the requirements of a) "General Separation Criteria" above.

In some cases, non-safety related equipment is fed from safety related distribution buses. In such cases, barriers are provided and cable entrances are designed such that all nonsafety related cables are not routed in the same raceways as safety related cables.

The emergency diesel generator sets are located in the Diesel Generator Building with each diesel generator set and its auxiliary equipment in separate rooms. The wall separating the diesel generator sets is floodlight and fire resistant, and protects the redundant sets against internally generated missiles. Missile protection is described in Section 3.5. Figures 1.2-20 and 21, Diesel Generator Building plan and sections, show the size and location of both the intake and exhaust parts.

5) Separation Criteria for Containment Electrical Penetrations

Redundant Class 1E containment electrical penetrations are physically separated in accordance with the requirements of a) "General Separation Criteria" above. The minimum physical separation for redundant penetrations meets the requirements for cables and raceways given in b) "Specific Separation Criteria" item 1. Non-Class 1E circuits routed in penetrations containing Class 1E circuits are treated as associated circuits in accordance with the requirements of a) "General Separation Criteria" above.

For cables entering the containment, there are a total of 48 electrical penetrations. The 6.9 kV and two 4.16 kV power penetrations use 18 inch sleeves. All other service penetrations use 12 inch sleeves except for two low level penetrations which utilize 18 inch sleeves. Cables terminate on the penetrations via bushing terminations, lug to lug connectors, in line

splices, connectors or terminal blocks located inside a terminal box. All cables entering these terminal boxes are run in flexible conduits. The penetrations are arranged in five horizontal rows of 10 penetrations each. The spacing between penetrations is approximately 44 inches horizontally and 36 inches vertically, center to center. In the penetration room outside the Shield Building, a vertical wall divides the penetration area into two separate compartments with 25 penetration sleeves on each side.* This wall extends from floor to ceiling and prevents damage in one compartment from affecting penetrations or cables in the other compartment. Cables serving load group A are run in one compartment and cables serving load group B are run in the other. In addition, one composite penetration for load group AB powered equipment is run in area B.

In the annulus within the Shield Building, each penetration has a protective sleeve. The sleeves are designed to allow for differential movement between the Shield Building and containment vessel and allow any leakage past the containment canister seal to vent into the annulus. The sleeves prevents damage in one penetration from affecting other penetrations. Inside the containment vessel, the cables are run into cable trays as near to the penetration as possible. The cable separation criteria described previously are applied for the cable tray runs located inside the containment.

6) Separation Criteria for Class 1E Control Boards

   i) All Class 1E control boards are located in seismic Category I structures.

   ii) Internal Separation: The minimum separation distance between redundant Class 1E equipment and circuits internal to the control board is six inches. In the event the above separation distances are not maintained, barriers are installed between redundant Class 1E wiring.

   iii) Internal Wiring Identification: Class 1E wire bundles or cables internal to the control boards are identified in a distinct permanent manner at a sufficient number of points to readily distinguish redundant Class 1E wiring, and non-Class 1E wiring.

   iv) Common Terminations: Where redundant Class 1E circuits are terminated at a common point locally qualified isolators are utilized to assure that the separation of either circuit is not compromised.

   v) Non-Class 1E wiring: Non-Class 1E wiring not separated from Class 1E wiring by the minimum separation distance or by a barrier is treated as associated circuits.

* There are 24 penetrations and one spare nozzle on each compartment.

vi) Cable Entrance: Redundant Class 1E cables entering the control board enclosure meet the requirements of b) "Specific Separation Criteria", item iii.

7) Separation Criteria for Instrument Panels

The separation requirements of a) "General Separation Criteria" above apply to instrumentation racks. Redundant Class 1E instruments are located in separate panels or compartments of a panel. Where redundant Class 1E instruments are located in separate compartments of a panel, attention is given to routing of external cables to the instruments to assure that cable separation is retained. The separation requirements of a) "General Separation Criteria" above apply to instrumentation racks.

8) Separation Criteria for Sensors and Sensor-to-Process Connections

Redundant Class 1E sensors and their connection to the process system are sufficiently separated that functional capability of the protection system can be maintained despite any single design basis event or result therefrom. Consideration is given to secondary effects of design basis events such as pipe-whip, steam release, radiation, missiles, and flooding.

Large components such as the reactor vessel are considered a suitable barrier if the sensor-to-process connecting lines are brought out at widely divergent points and routed so as to keep the component between redundant lines. Redundant pressure taps located on opposite sides of a large pipe are considered to be separated by the pipe.

9) Separation Criteria for Actuated Equipment

Locations of Class 1E actuated equipment, such as pump drive motors and valve operating motors are normally dictated by the locations of the driven equipment. The resultant locations of this equipment are reviewed to ensure that separation of redundant Class 1E actuated equipment is acceptable.

By implementing the above criteria, physical separation as a protection against common mode failure of emergency power to both redundant electrical loads groups is achieved between the redundant emergency portions of the standby power system.

Physical separation is provided between load group A and load group B and between load group AB and both load groups A and B since load group AB may at various times function as part of either load group A or B. Separate cable tray and conduit systems are provided for each of the redundant load groups.

In addition, to enhance the above separation criteria the following specific criteria are applied for cable runs:

- Separate tray and conduit systems are furnished for the following classes of cable: 5kV, 600 volt power, 600 volt control and 300 volt shielded instrument cable.

  Different parameter signal cables are in the same wireway as long as they do not belong to separate redundant channels.

  The correct routing of all cabling is assured by a design and engineering review of all cable runs by following a stringent document control procedure.

- Base ampacity rating of cables in trays is based on the general methods of IPCEA P54440 (1972 edition).

- Power cable trays are designed to be no more than 40 percent full.

- All cables are inspected by site quality control to assure that they are not damaged in the process of cable pulling. The inspection of these cables is documented and subject to random audit by quality compliance.

Compliance to Regulatory Guide 1.75 (R1) regulatory positions are as follows:

Position C1: The design of the Class 1E portions of the Onsite Power System includes fault current interrupting devices which serve an isolation function. Approval of this design approach has been accepted by the NRC in the Safety Evaluation Report (Docket #50-389). Circuit interrupting devices actuated by fault current (fuses, circuit breakers) are commonly used as isolating devices. Once actuated these devices prevent the faulted circuit from influencing the unfaulted circuit in an unacceptable manner. The St. Lucie Unit 2 design will be modified such that those non-safety loads connected to the Class 1E buses which are not considered important for operation and plant investment will be shed from the Class 1E buses by a Safety Injection Signal or will be locked out of service during plant operation in accordance with the Technical Specifications.

Those non-safety loads which are considered important for operation and plant investment will remain connected to the Class 1E busses, however, they will be provided with two, Class 1E, fault current interrupting devices.

Since these changes will require new hardware and engineering changes which cannot be accomplished prior to fuel load these modifications will be installed on, or before, the first refueling outage.

Position C2: Interlocked armored cable is not used as a raceway system.

Position C3: The separation of circuits and equipment is achieved by seismic Category I structures, distance or barriers or any combination thereof. In general, locating redundant circuits and equipment in separate safety class structures affords a greater degree of assurance that a single event does not affect redundant systems. Therefore, this method of separation is used whenever practical and its use does not conflict with other safety objectives.

Position C4: Associated circuits comply as described in a) "General Separation Criteria" above.

Position C5: The offsite power system meets the requirements of GDC 17. See Subsection 8.3.1.2.1.

Position C6: The analyses identified in this Regulatory Guide correspond to those contained in a) "General Separation Criteria" above.

Position C7: Non-Class 1E circuits comply as described in a) "General Separation Criteria" above.

Position C8 Cable tunnels are not utilized.

Position C9: Cable splices are avoided. However, if the need for a splice arises, it is made in:

i) FS boxes when connections are made to valve limit switches, solenoids and also at instruments

ii) Cable terminations at the electrical containment penetrations for safety related cables other than those with connectors

iii) A terminal box or a manhole/handhole.

Position C10: Cables installed in Class 1E raceways are marked in a manner of sufficient durability and at a sufficient number of points to ensure initial verification that the installation is in conformance with the separation criteria. The cable markings are applied prior to or during installation. Refer to Subsection 8.3.1.3.

Position C11: The method of identification readily distinguishes between redundant Class 1E systems, associated circuits assigned to redundant Class 1E divisions and non-Class 1E systems. Color coding is used. Refer to Subsection 8.3.1.3.

Position C12: Circuits in the control room are limited to control functions, instrument functions and those power supply circuits and facilities serving the control room and instrument systems.

Redundant Class 1E standby generating units are placed in separate rooms of the Diesel Generator Building, a seismic Category I structure and have independent air supplies.

Redundant Class 1E batteries are placed in separate rooms in the Reactor Auxiliary Building, a seismic Category I structure and are served by independent ventilation systems.

The separation requirements of b7) "Separation Criteria for Instrument Panels" above apply to instrumentation racks. In addition, redundant Class 1E instruments are located on separate racks or compartments of a cabinet. Where redundant Class 1E instruments are located in separate compartments of a single cabinet, attention is given to routing of external cables to instruments to assure that cable separation is retained. In locating Class 1E instrument cabinets, attention is given to the effects of all pertinent design basis events.

Regulatory Guide 1.81, "Shared Emergency and Shutdown Electric Systems For Multi-Unit Nuclear Power Plants," 1/75 (R1)

There are no shared onsite safety related systems between St. Lucie Units 1 and 2. Therefore the regulatory positions of Regulatory Guide 1.81 (R1) do not apply.

Regulatory Guide 1.89, "Qualification of Class 1E Equipment for Nuclear Power Plants," 11/74 (R0)

For a discussion of the environmental qualification of Class 1E equipment and compliance to IEEE 323, see Section 3.11.

Regulatory Guide 1.93, "Availability of Electric Power Sources," 12/74 (R0)

The limiting conditions of operation with respect to available electric power sources presented in Regulatory Guide 1.93 (R0) are incorporated into the Technical Specifications.

Regulatory Guide 1.100, "Seismic Qualification of Electrical Equipment for Nuclear Power Plants," 3/76 (R0)

As indicated in the implementation section of Regulatory Guide 1.100 (R0) the positions of this guide are to be used to evaluate construction permit (CP) applications docketed after November 15, 1976; the St. Lucie Unit 2 CP application was docketed in September, 1973. Although Regulatory Guide 1.100 (R0) is not applicable to this operating license application, Section 3.10 presents a discussion of seismic qualification of Class 1E electrical equipment.

Regulatory Guide 1.106, "Thermal Overload Protection for Electric Motors on Motor-Operated Valves," 3/77 (R1)

As indicated in the implementation section of Regulatory Guide 1.106 (R1), the positions of this guide are to be used to evaluate current submittals for construction permits (CP); the St. Lucie Unit 2 CP was issued May, 1977. Although Regulatory Guide 1.106 (R1) is not applicable to this operating license application, the design complies with the recommendations of this Regulatory Guide as follows:

The design of control circuits for MOVs includes the use of thermal overload (TOL) relays and their associated TOL heaters. It is desirable for specific safety related MOVs to have these devices bypassed during design basis accident conditions. “Maintenance Bypass” switches are provided for these specific valves which allow the TOL relays to be in the control circuit for maintenance or testing activities. For plant operation, these switches are placed in the “Bypass position” to defeat the TOL relay function except for an annunciation function. To provide electrical penetration protection for safety related valves located inside containment with bypass switches in their control circuits, thermal magnetic feeder breakers are provided to maintain the integrity of the penetration if the valve motor continues to draw locked rotor current.

The safety injection operated flow control valves thermal overloads are by-passed in both manual and automatic valve activation mode. Manual valve activation is required to adjust safety injection flow rate after the valves were opened automatically.

Regulatory Guide 1.108, "Periodic Testing of Diesel Generators Used as Onsite Electric Power Systems at Nuclear Power Plants," 8/76 (R0)

As indicated in the implementation section of Regulatory Guide 1.108 (R0), the positions of this guide are to be used to evaluate construction permit (CP) applications docketed after April 1, 1977; the St. Lucie Unit 2 CP application was docketed in September, 1973. Although Regulatory Guide 1.108 (R0) is not applicable to this operating license application, diesel generator functional testing is presented in the Technical Specifications. Per 58 Federal Register 41813, 8/5/1993, RG 1.108 was withdrawn by the NRC.

Regulatory Guide 1.118, "Periodic Testing of Electric Power and Protection Systems," 6/76 (R0)

As indicated in the implementation section of Regulatory Guide 1.118 (R0), the positions of this guide are to be used to evaluate submittals for construction permit (CP) applications docketed after February 15, 1977; the St. Lucie Unit 2 CP was docketed in September, 1973. Although Regulatory Guide 1.118 (R0) is not applicable to this operating license, the design and construction of the electrical distribution system does allow for a certain level of periodic testing in accordance with IEEE 338-1971.

Periodic testing is infrequently required for the Class 1E electrical distribution system other than of the power supplies. The majority of equipment is continuously monitored (e.g., medium voltage switchgear voltage and current) or is tested with the process equipment (e.g., the pumps are tested by closing the switchgear to power the pump drive).

In practice, voltmeters, power available alarms, breaker position switches, etc., facilitate the ability to monitor the electrical distribution system. Due to the separation of all safety related electrical equipment into at least two redundant groups, it is possible to test the power equipment while testing the signal and control system.

The instrumentation and control to support the electrical distribution systems are discussed in Chapter 7.

Diesel generator and battery functional testing is presented in the plant Technical Specifications.

Regulatory Guide 1.128, "Installation Design and Installation of Large Lead Storage Batteries for Nuclear Power Plants," 4/77 (R0)

As indicated in the implementation section of Regulatory Guide 1.128 (R0) the positions of this guide are to be used to evaluate submittals for construction permit (CP) applications docketed after December 1, 1977; the St. Lucie Unit 2 CP was docketed in September, 1973. Although Regulatory Guide 1.128 (R0) is not applicable to this operating license the intent of the Regulatory Guide is met as follows:

The installation procedures for the Class 1E batteries meet in general the requirements of IEEE 484-1975.

The Class 1E batteries are installed in accordance with Construction Procedure IP-E-1 entitled, "Installation of 125V dc Station Batteries and Chargers," as well as the instructions of the battery vendor.

Safety procedures which require the use of protective equipment are implemented. In the battery installation the batteries are mounted in accordance with the manufacturer's instructions.

The location of the batteries takes into account ventilation conditions and water facilities, alloted space for maintenance conditions and lighting facilities. The batteries are protected against natural phenomena such as, flooding, winds as well as induced events such as missiles and environmental hazards. The batteries and racks meet the seismic criteria as described in Section 3.10.

The batteries are separated in divided rooms as per the requirement of IEEE 384-1974.

The intent of the Regulatory Guide positions are as follows:

a) The percentage of hydrogen accumulation is no greater than two percent of the volume of the battery room.

b) The battery rack is coated with an epoxy powder and plastic covers fit over the rails on which the cells are placed. Restraining channel beams and tie rods are insulated from the cells.

c) The acceptance test is a capacity discharge test that when required is conducted in accordance with IEEE 450-1972.

d) The reference as listed in Section 7 of IEEE 484-1975 with the exception of IEEE 100-1972 and IEEE 380-1972 are discussed elsewhere in Section 8.3.

e)
1) The battery rooms are ventilated and provisions are made for adequate aisle space and for space above the cells.

2) Extreme ambient temperatures are prevented from occurring in the battery room.

3) No significant temperature differential exists between cells, localized sources of heat are avoided.

4) The emergency showers and sinks are separated from the batteries by an eight ft high wall.

5) The batteries are mounted on a battery rack.

6) Fire detection sensors are provided, however, hydrogen sensors are not.

7) Deleted.

8) As per the equipment instruction manual, during unpacking the process of inspecting the battery cells and the electrolyte level is observed.

9) The cells are stored in an indoor area that is weather proof, cool and dry.

10) Deleted.

11) After the initial charge has been performed, the batteries are connected to their respective chargers and thus no freshening charge is required.

12) No initial hydrogen survey base line data for locating hydrogen detectors are provided. However, records are kept as follows:

    a) Records of protective measures
    b) Total cell storage
    c) Cell electrolyte level
    d) Cell voltage after initial charge
    e) Hydrometer readings
    f) Electrolyte temperature
    g) Specific gravity

Regulatory Guide 1.129, "Maintenance, Testing, and Replacement of Large Lead Storage Batteries for Nuclear Power Plants," 4/77 (R0)

As indicated in the implementation section of Regulatory Guide 1.129 (R0), the positions of this guide are to be used to evaluate submittals for construction permits (CP) applications docketed after December 1, 1977; the St. Lucie Unit 2 CP was docketed in September, 1973. Although Regulatory Guide 1.129 (R0) is not applicable to this operating license, this Regulatory Guide used to be included in Section 14.0 of the original FSAR.

Regulatory Guide 1.131, "Qualification Tests of Electric Cables, Field Splices, and Connections for Light-Water-Cooled Nuclear Power Plants," 8/77 (R0)

As indicated in the implementation section of Regulatory Guide 1.131 (R0), the positions of this guide are to be used to evaluate construction permit applications docketed after May 1, 1979; the St. Lucie Unit 2 CP application was docketed in September, 1973. Although Regulatory Guide 1.131 (R0) is not applicable to this operating license application, Section 3.11 presents environmental qualification of Class 1E electrical equipment.

8.3.1.2.3 IEEE Standards

IEEE 387, "IEEE Standards Criteria for Diesel-Generator Units Applied as Standby Power Supplies for Nuclear Power Generating Stations," (1972)

The diesel generator sets are designed, constructed and installed in accordance with the provisions within this standard.

Two redundant 100 percent capacity diesel generators are provided. Each diesel generator design is such that it can be started without any ac power from the preferred power supply. The diesel engine-generator is capable of remote unattended automatic starting reaching full speed and rated voltage in a maximum of 10 seconds after initiation of a starting signal and picking up full nameplate rated load in not more than 50 seconds after initiation of the start signal. The diesel generator can be automatically started from the normal standby condition. In addition, if the diesel generator is in the running/testing mode and an emergency start signal is initiated, the diesel will automatically transfer from the parallel mode to the isochronous mode. The diesel generator is capable of being started with an initial engine temperature equal to the continuous full load rating engine-temperature. The diesel generator continuous rating exceeds the total load which the diesel must carry. Based on actual tests and a computer program/ analysis

simulating actual loading sequence, the diesel voltage and frequency remain within acceptable levels during load application.

The diesel generators are inspected and maintained periodically using the manufacturer's recommendations. Unscheduled maintenance will be performed in accordance with need as indicated by the periodic inspection and as suggested by the manufacturer's recommendations.

The diesel generators are interconnected with the rest of the system to utilize the diesel generators for the design basis events indicated in Table 8.3-2 (refer to Subsection 8.3.1.1.1 and Section 9.5 for diesel generator interfaces with the rest of the plant).

The diesel generator has been environmentally qualified in accordance with IEEE 323-1971 to the extent defined in Section 3.11.

The diesel generator was designed and built to operate at 115 percent of rated speed without overstressing any part of the engine generator. The completely assembled engine-generator unit was designed to be free of torsional vibration at any speed between 90 and 115 percent of rated speed. The diesel generator overspeed trip is set at 115 percent of rated speed. The diesel generator was tested for full load rejection without exceeding 115 percent speed.

The diesel can be controlled from the control room as well as from the diesel-generator local panel.

The diesel generator has surveillance systems permitting remote and local surveillance. These include abnormal, pretrip and trip conditions. During emergency operations only a diesel generator overspeed and generator differential will cause the unit to trip.

Refer to Tables 8.3-11 and 8.3-12 for diesel generator alarms and indicators.

8.3.1.3 Physical Identification of Safety Related Equipment

Cables, except those for lighting receptacles and small power cables, are tagged at their termination with a unique identifying number. Electrical safety related equipment (switchgear, motor control centers, junction boxes, cables, cable trays, conduits, etc.) are identified by color coded tags, paint or tape according to the following scheme:

System A (Power, Control, and Instrumentation)	(SA):	orange
System B (Power, Control, and Instrumentation)	(SB):	purple
System AB (Power, Control, and Instrumentation)	(SAB):	pink
Measurement Channel A	(MA):	red
Measurement Channel B	(MB):	yellow
Measurement Channel C	(MC):	green
Measurement Channel D	(MD):	blue
Associated System A (Power, Control, and Instrumentation)	(ASA):	orange white
Associated System B (Power, Control, and Instrumentation)	(ASB):	purple white
Associated System AB (Power, Control, and Instrumentation)	(ASAB):	pink white

Associated Measurement Channel A	(AMA):	red white
Associated Measurement Channel B	(AMB):	yellow white
Associated Measurement Channel C	(AMC):	green white
Associated Measurement Channel D	(AMD):	blue white
Non-Safety Systems		black

Color coded tray numbers are either stencilled or engraved on both sides of cable trays at 15 ft. intervals. Additional tray identifications are placed at elbows, room entrances and other areas of possible congestion.

For verification during initial installation, safety-related cables are identified by color at every five ft. and safety-related conduits are identified by color at intervals of 15 ft.

8.3.1.4 Independence of Redundant Systems

The redundant systems are designed to be physically independent of each other so that failure of any part or the whole of one train, channel or division does not prevent safe shutdown of the plant.

The Class 1E electric systems are designed to ensure that a design basis event does not prevent operation of the minimum amount of safety related equipment required to safely shutdown the reactor and to maintain a safe shutdown condition.

The Class 1E power system is designed to meet the requirements of IEEE 279-1971, IEEE 308-1971, applicable portions of 10 CFR Part 50 Appendices A and B, and Regulatory Guide 1.6 (R0). Safety related loads are separated into two completely redundant load groups. Each load group has adequate capacity to start and operate a sufficient number of safety related loads to safely shut down the plant, without exceeding fuel design limits or reactor coolant pressure boundary limits, during normal operation or a design basis event. As required by IEEE 308-1971 and General Design Criterion 17 each redundant safety related load can be powered by both onsite and offsite power supplies. Consistent with Regulatory Guide 1.6 (R0), no provision exists for automatically transferring loads between the redundant power sources. Furthermore, the redundant load groups cannot be automatically connected to each other, nor can the two emergency power sources be paralleled automatically. Separation and independence have been maintained between redundant systems, including the raceways, so that any component failure in one safety related channel does not disable the other safety related division.

A discussion of the independence of redundant Class 1E electric systems including electrical and physical separation of cables, cable tray fill, cable derating, tray marking and fire protection is contained in Subsection 8.3.1.2 (the Regulatory Guide 1.75 (R1) discussion).

8.3.2 DC POWER SYSTEM

8.3.2.1 Description

The DC Power System is shown on Figure 8.3-3. Power is provided at 125 volts dc (ungrounded) for plant control and instrumentation and for operation of dc motor operated equipment such as valve operators. Similar to the 4.16 kV and 480V ac emergency systems, the 125V dc system is arranged into two main redundant load groups, SA and SB, and a third

service (swing load) group SAB. Load groups SA and SB are each capable of supplying the minimum dc power requirements to safely shutdown the plant and/or mitigate the consequences of a DBA.

Load group SA is served by dc buses 2A and 2AA and load group SB by dc buses 2B and 2BB. Load group SAB is served by dc bus 2AB which is normally tied to either (but never both) dc bus 2A or 2B, corresponding to the manner in which the 4.16 kV and 480V AB buses are connected to their respective SA or SB buses. There are two breakers in series in each tie which are key interlocked to prevent the 2AB bus from being simultaneously connected to both the 2A and 2B buses. The dc loads served by each bus are given in Tables 8.3-3, 4, and 5.

Should the operator desire to change the 125V dc, 480V ac and 4160V ac AB buses from one battery source to the other, the following operator action is required (assume all AB buses are connected to their respective A bus).

Transfer of 125V dc AB bus - Four control switches with key locks are switched from the A-AB(AB-A) positions to the B-AB(AB-B) positions. The design of the key locks (key removable in breaker open position only) precludes cross connecting of power sources. Figure 8.3-6 depicts the 125V dc bus transfer circuit capability in the control room. When the transfer is complete, two misalignment alarms are annunciated indicating improper alignment of 4160 and 480 volt buses. The operator dispatches a member of the operating crew to manually open these breakers to clear the alarm. After opening locally the tie breakers from the A system, the operator will tie AB 480 and 4160 tie breakers of the B system.

8.3.2.1.1 Batteries and Battery Chargers

Each 125V dc battery is supplied from two 125V dc battery chargers connected in parallel, both of which are normally operating. Each charger system is sized to carry normal dc load and to recharge a battery from 1.75 volts per cell to full charge. The worst case loading condition on the battery chargers occurs during a post LOCA condition with loss of offsite power. Each of the two parallel 125V dc battery chargers operate separately on the SA and SB buses. A fifth 125V dc battery charger on the SAB bus provides a backup for the four operating 125V dc chargers.

Each of the two 125V lead-calcium type safety related batteries consists of 60 cells and is rated 2400 ampere hours for eight hours and has a capacity of 3040 amps for one minute at 77□F. The above rating is sufficient to supply dc loads until which time the battery chargers are loaded onto the diesel generators. (Note: The above stated ratings are original design values. For current values, refer to latest battery design margin calculation.)

The battery chargers are automatically loaded on the diesel generators approximately forty seconds after loss of offsite power, thus returning the dc system to normal. The above battery rating, when compared to the one minute loading of Table 15.10-5, is more than adequate for this design limiting case of forty second battery operation.

The batteries are qualified for a period of at least twenty years. At the end of this period, these batteries will be either replaced or requalified for an extended period of time.

Among the alarms and indications for the dc systems, battery breaker position alarm, battery high discharge rate alarm and battery ammeter have been provided in the Control Room.

The turbine generator dc emergency bearing oil pump motor is fed from the non-safety 2C battery and dc bus 2C. The non-safety 2C is normally supplied from a 300 ampere charger similar to the safety system chargers and, on loss of offsite power from a 60 cell 2,340 ampere-hour eight hour discharge rate battery.

The turbine generator dc emergency seal oil pump motor is fed from the non-safety 2D battery and dc bus 2D. The non-safety 2D battery bus and charger system is similar to the 2C dc system.

The ties between the safety-related 125V DC BUS 2AB and the non-safety 125V DC Buses 2C and 2D are through non-automatic circuit breakers (two per tie). Each pair of breakers is key interlocked such that the ties can not be accidently closed (completion of each tie requires that each of the two breakers be independently key operated).

The emergency batteries described above comply with the intent of IEEE 450-1975, "IEEE Recommended Practice for Maintenance, Testing, and Replacement of Large Lead Storage Batteries for Generating Stations and Substations," and Regulatory Guide 1.129, "Maintenance, Testing, and Replacement of Large Lead Storage Batteries for Nuclear Power Plants." Station battery maintenance is performed only by persons knowledgeable of batteries and the safety precautions involved. Protective equipment and fixed water facilities are provided for maintenance personnel safety.

Regular inspections are performed based on schedules set in the operating and maintenance procedures.

Acceptance testing of all batteries is satisfactorily completed at the manufacturers' shop. In addition, battery capacity testing is conducted as per the Technical Specifications.

Two separate dc systems are provided for the 230 kV circuit breakers, control and protective relaying. The system consists of two 125 volt batteries, three battery chargers, and two dc distribution panels.

The two 125V lead-calcium switchyard batteries consist of 60 cells and are rated 400 ampere-hr at eight hour discharge rate. The three switchyard battery chargers are rated at 50 amp each.

8.3.2.1.2 DC SA and SB Buses and Panels

Two dc main buses 2AA and 2BB and their respective bus extensions 2A and 2B rated at 1200 amperes and one SAB bus rated at 400 amperes are provided; all five buses are rated at 20,000 amps interrupting capacity. Certain non-Class 1E loads are supplied with 125V dc power from these buses. In such cases, separation is provided as described in the discussions for R.G. 1.75 (Section 8.3.1.2.2). Each bus and each panel has a steel barrier which provides separation between safety and non-safety related circuits.

Four dc panels are provided for the measurement channels 2MA, 2MB, 2MC, and 2MD. These four dc panels facilitate maintenance and/or periodic testing of each measurement channel and minimize the possibility of a spurious reactor trip.

8.3.2.1.3 System Operation

Because the dc system operates ungrounded, at least two grounds are necessary to trip a feeder circuit breaker. Ground fault annunciation provides an opportunity to correct a fault condition before a second fault occurs.

One undervoltage relay is provided on each bus section to initiate an alarm if voltage on the bus drops to a preset value. A charger failure relay, provided on each charger, detects and annunciates failures in ac power input and dc power output.

Cables and raceways for the dc power supply systems are as described in Subsection 8.3.1.1.4.

8.3.2.1.4 Equipment Separation and Redundancy

The 125V dc system is designed to meet the seismic Category I requirements as stated in Section 3.10. The two redundant batteries and their related accessories are separated by full height walls in the Reactor Auxiliary Building which is a seismic Category I structure.

Each battery room is provided with its own eyewash and shower.

The showers located in the battery rooms are designed to deter the splashing of water directly onto battery. This is accomplished by providing walls on 3 sides of the shower. In addition the shower is provided with its own roof. The showers are provided with floor drains to carry away all the water from the shower.

The safety-related dc loads have been grouped into two redundant load groups such that the loss of either group does not prevent the minimum safety function from being performed.

Complete separation and independence are maintained between components and circuits of the two 125 V safety related dc systems, including the raceways. For the raceway separation criteria, see Subsection 8.3.1.2 (Regulatory Guide 1.75 (R1) discussion). Because of the physical and electrical separation provided for the batteries, chargers, distribution equipment and wiring for the 125V dc safety-related systems, a single failure at any point in either system does not disable both systems. Non-Class 1E loads are provided with isolation devices to protect the bus in the event of an emergency.

8.3.2.1.5 Ventilation

Each 125V dc system battery equipment room is served by an exhaust fan. Supply air is effected by two redundant Electrical Equipment Room Supply Fans fed from redundant safety related motor control centers (see Subsection 9.4.3).

8.3.2.1.6 Inspection, Servicing, Testing, and Installation

The station batteries and their associated equipment are easily accessible for inspection, servicing, and testing. Servicing and testing is performed on a routine basis in accordance with the manufacturer's recommendations and the Technical Specifications. Typical inspection includes visual inspection for leaks, corrosion, or other deterioration, and checking all batteries for voltage, specific gravity, level of electrolyte, and temperature. At the time of installation, rated discharge acceptance tests are made to verify that the battery capacity meets the manufacturer's rating.

8.3.2.2 Analysis

The 125V dc electric system is Class 1E and is designed to meet the requirements of IEEE 279-1971, IEEE 308-1971, IEEE 450-1972, General Design Criteria 17 and 18, Regulatory Guides 1.6 (R0), 1.32 (R0) 1.62 (R0), 1.63 (R0), 1.75 (R1), 1.81 (R1), 1.118 (R0), 1.128 (R0), 1.129 (R0). The system also meets the requirements of the design basis accidents described and evaluated in Chapter 15.

8.3.2.2.1 General Design Criteria

General Design Criterion 17

The two systems which supply the 125V dc power to redundant Class 1E load groups from the two separate 125V dc buses are electrically independent and physically separated from each other. Each of the two systems has adequate capacity to supply the 125V dc power for the safety related loads required for safe shutdown of the plant.

General Design Criterion 18

The Class 1E dc system is designed to permit appropriate periodic inspection and testing.

8.3.2.2.2 Regulatory Guide Implementation

Regulatory Guide 1.6, "Independence Between Redundant Standby (Onsite) Power Sources and Between Their Distribution Systems," 3/71 (R0)

As stated in the Safety Evaluation Report of St. Lucie Unit 2 (Docket No. 50-389) the dc onsite power system is in compliance with the requirements of Regulatory Guide 1.6 (R0).

As described in Subsection 8.3.1.2.2 the Class 1E dc system is designed with sufficient independence to perform its safety functions assuming a single failure.

Regulatory Guide, 1.32, "Criteria for Safety-Related Electric Power Systems For Nuclear Power Plants," 8/72 (R0)

As stated in the Safety Evaluation Report of St. Lucie Unit 2 (Docket No. 50-389) the dc onsite power system is in compliance with IEEE 308-1971as modified by Regulatory Guide 1.32 (R0).

The intent of RG 1.32 is met as follows:

The dc Power System meets IEEE 308-1971. The Class 1E dc system provides dc electric power to the Class 1E dc loads and for control and switching of the Class 1E systems. Physical separation, electrical isolation, and redundancy are provided to prevent the occurrence of common failure modes. The design of the Class 1E dc system includes the following features:

a) The dc system is separated into two main redundant systems.

b) The safety actions by each group of loads are independent of the safety actions provided by its redundant counterpart.

c) Each redundant dc system includes power supplies that consist of one battery and two battery chargers.

d) Redundant batteries cannot be interconnected. Alarm circuits are provided to ascertain this requirement.

e) The batteries are physically separated.

Each distribution circuit is capable of transmitting sufficient energy to start and operate the required loads in that circuit. Distribution circuits to redundant equipment are independent of each other. The dc auxiliary devices required to operate equipment of a specific ac load group are supplied from the same load group.

Each battery supply is continuously available during normal operation and, following a loss of power from the ac system, to start and operate all required loads.

Instrumentation is provided to monitor the status of the battery supply as follows:

a) dc bus undervoltage alarm (control room);

b) battery current indication (local room and control room)

c) dc voltage indication (local room and control room); and

d) dc ground indication and alarm (control room)

e) battery high discharge rate alarm (control room)

f) battery breaker in open position alarm position alarm (control room)

The batteries are maintained in a fully charged condition and have sufficient stored energy to operate all necessary circuit breakers and to provide an adequate amount of energy for all required emergency loads.

The battery chargers of one redundant system are independent of the battery chargers for the other redundant system. Instrumentation is provided to monitor the status of each battery charger as follows:

a) output voltage of the charger;

b) output current of the charger;

c) charger trouble common alarm including input ac undervoltage, dc undervoltage, and loss of dc output current which is indicative of output breaker open (in control room).

Each battery charger has an input ac and output dc circuit breaker for isolation of the charger. Each battery charger power supply is designed to prevent the ac supply from becoming a load on the battery due to a power feedback as the result of the loss of ac power to the chargers.

Equipment of the Class 1E dc system is protected and isolated by fuses or circuit breakers in case of short circuit or overload conditions. Indications provided to identify equipment that is made unavailable are the following:

	Event	Available Indication
a)	Battery charger ac input breaker trip	Charger trouble alarm
b)	Loss of battery charger dc output current	Charger trouble alarm
c)	Distribution circuit breaker trip	Individual equipment alarm. or supervisory light (for Class 1E circuits)

For a further discussion of Regulatory Guide 1.32 (R0) and IEEE 308-1971, see Subsection 8.3.1.2.2.

Regulatory Guide 1.62, "Manual Initiation of Protective Actions," 10/73 (R0)
For a discussion of this Regulatory Guide see Subsection 8.3.1.2.2.

Regulatory Guide 1.63, "Electric Penetration Assemblies in Containment Structures for Water-Cooled Nuclear Power Plants," 10/73 (R0)
For a discussion of this Regulatory Guide see Subsection 8.3.1.2.2.

Regulatory Guide 1.75, "Physical Independence of Electric Systems," 1/75 (R1)
For a discussion of this Regulatory Guide see Subsection 8.3.1.2.2.

Regulatory Guide 1.81, "Shared Emergency and Shutdown Electric Systems for Multi-Unit Nuclear Power Plants," 1/75 (R1)
For a discussion of this Regulatory Guide, see Subsection 8.3.1.2.2.

Regulatory Guide 1.118, "Periodic Testing of Electric Power and Protection Systems" 6/76 (R0)
For a discussion of this Regulatory Guide see Subsection 8.3.1.2.2

Regulatory Guide 1.128, "Installation Design and Installation of Large Lead Storage Batteries for Nuclear Power Plants, " 4/77 (R0)
For a discussion of this Regulatory Guide see Subsection 8.3.1.2.2.

Regulatory Guide 1.129, "Maintenance, Testing, and Replacement of Large Lead Storage Batteries for Nuclear Power Plants," 4/77 (R0)
For a discussion of this Regulatory Guide see Subsection 8.3.1.2.2.

8.3.3 FIRE PROTECTION FOR CABLE SYSTEM

This is covered in the Fire Protection Design Basis Document (Reference 1).

REFERENCES

1. DBD-FP-1, Fire Protection Design Basis Document.

2. PSL-FPER-04-017, Acceptable Electrical Cable Flame Propagation Tests In Addition to IEEE 383-1974.

TABLE 8.3-1

DIESEL GENERATOR DESIGN DATA

1. Diesel Engine

Manufacturer	General Motors EMD
Model and type	645-E4
Total No. of Cylinders per set	28 (One 16 cylinder engine and one 12 cylinder engine)
Set arrangement	Two engines in tandem, with generator in the middle
Rated Speed	900 rpm
Continuous (8000) hr rating at 90°F	5375 bhp
8000 hr/yr rating at 104°F	5160 bhp
30 min/yr rating at 90°F	6095 bhp
30 min/yr rating at 104°F	5851 bhp
Method of cooling	Air radiators with shaft driven fans
Starting Time	10 seconds maximum, including generator breaker closing time

2. Generator

Manufacturer	Electric Products Div.
Voltage, phase & frequency	4160 V, 3 phase, 60 Hz
kW, KVA, power factor	3800 kW, 4750 KVA, 0.8 P.F.
Synchronous reactance, X_d	86.9 percent
Transient reactance, X'_d (Direct Axis)	17.4 percent
Subtransient reactance, X''_d (Direct Axis)	9.6 percent
Excitation system	Solid state, forced excitation

3. D-G Set Rating at 104 F

Continuous – 8760 hrs	3685 kW	5136.78 bhp
30 Minute to 7 day	3985 kW	5485.27 bhp

TABLE 8.3-2

EMERGENCY DIESEL GENERATOR
LOADING SEQUENCE

Load Block	Timing* Sequence	Item No.	Equipment Description	Per DG Qty.	Rated HP (KW)	LOOP	Running Load KW LOOP/LOCA	LOOP/MSLB
1	0 Secs	11	Component Cooling Water Pump	1	450	362.9	362.9	362.9
1	0 Secs	2	Motor Operated Valves	Lot	0	0	0	0
1	0 Secs	2	Motor Operated Valves	Lot	13.22	0	11.9	0
1	0 Secs	2	Motor Operated Valves	Lot	12.89	0	0	11.6
1	0 Secs	3	Emergency Lighting	Lot	(114.9)	114.9	114.9	114.9
1	0 Secs	4	Power Panels	Lot	(139.4)	139.4	139.4	139.4
1	0 Secs	5	RCP Oil Lift Pump	2	10	18	18	18
1	0 Secs	6A	Plant Vital AC UPS	1	(20)	20	20	20
1	0 Secs	6B	Security UPS	1	(30)**	40	40	40
1	0 Secs	7B	Air Conditioner HVA-10A	1	10	8	8	8
1	0 Secs	7C	Hydrogen Analyzer Cub. SA	1	(1.6)	1.6	1.6	1.6
1	0 Secs	8A	EDG Turbo Lube Oil Pumps	2	2	3.6	3.6	3.6
1	0 Secs	8B	EDG Soak Back Lube Oil Pumps	2	1	1.8	1.8	1.8
1	0 Secs	8C	EDG Air Compressor Motor	1	7.5	6.7	6.7	6.7
1	0 Secs	32	Charging Pump	2	125	118.8	59.3	118.8
1	0 Secs	33	Boric Acid Makeup Pumps	2	25	13	21.4	21.4
1	0 Secs	39	Fuel Hdlg Bldg H&V Room Fan	1	3	2.7	2.7	2.7
1	0 Secs	40	DG Cooling Water Heaters	4	(15)	60	60	60
1	0 Secs	27	CVCS Heat Tracing	Lot	(3.8)	1.9	1.9	1.9
1	0 Secs	41	Transformer & Cable Losses	Lot	(22.7)	22.7	22.7	22.7
1	0 Secs	42	Isolimiters	3	(5.3)	5.3	5.3	5.3
2	3 Secs	9	LPSI Pump	1	400	0	317.5	165
1	0 Secs	24A	Control Room Air Conditioner Fan	1	15	13.5	13.5	13.5
1	0 Secs	24B	Control Room Air Conditioner Transfmr	1	(5)	5	5	5
2	3 Secs	10	Containment Fan Coolers (Note 3)	2	125/83	331.8	235.5	235.5
2	3 Secs	17	Diesel Oil Transfer Pump	1	3	1.99	1.99	1.99
3	6 Secs	1	HPSI Pump	1	400	0	324.3	324.3
3	6 Secs	12	Shield Building Exhaust Fan	1	60	0	40	40
3	6 Secs	13	Shield Building Vent Heaters	Lot	(31.5)	0	31.5	31.5
4	9 Secs	14	Intake Cooling Water Pump	1	600	482.3	482.3	482.3
4	9 Secs	10	Containment Fan Coolers (Note 3)	2	125/83	0 [331.8]	-136.4 [99.1]	-136.4 [99.1]

* Counting from time the EDG Output Breaker closes.

** Security UPS is rated for 30KW output with a 50KW input.

Notes: 1. M = Manual Operation
2. Numbers not in brackets indicate load changes, numbers in brackets indicate running loads.
3. Due to long acceleration, initial loading is due to locked rotor current. This is reduced to running current after the acceleration period.

TABLE 8.3-2 (Cont'd)

EMERGENCY DIESEL GENERATOR
LOADING SEQUENCE

Load Block	Timing* Sequence	Item No.	Equipment Description	Per DG Qty.	Rated Hp (KW)	LOOP	Running Load KW LOOP/LOCA	LOOP/MSLB
5	12 Secs	15	Containment Spray Pump	1	500	0	398.9	398.9
5	12 Secs	16	Hydrazine Pump	1	3	0	2.9	2.9
5	12 Secs	10	Containment Fan Coolers (Note 3)	2	125/83	-193.8 [138]	0 [99.1]	0 [99.1]
6	18 Secs	18	Electrical Equipment Room Supply Fan	1	100	69.7	69.7	69.7
6	18 Secs	19	Reactor Cavity Supply Fan	1	20	13.7	0	0
6	18 Secs	20	Reactor Support Cooling Fan	1	40	21.8	0	0
7	21 Secs	21	Electrical Equipment Room Roof Vent Fan	1	5	4.4	4.4	4.4
7	21 Secs	22	Battery Room Ventilator	1	0.75	0.8	0.8	0.8
7	21 Secs	23	Intake Structure Exhaust Fan	1	7.5	6.5	6.5	6.5
8	24 Secs	25	Control Room Filter Fan	1	10	0	7	7
8	24 Secs	26	ECCS Area Exhaust Fan (Note 3)	1	60	0	69.3	69.3
9	27 Secs	28	Battery Chargers	2	(68)	100	100	100
10	30 Secs	29	Aux. Feedwater Pump	1	350	246.8	282.3	282.3
10	30 Secs	26	ECCS Area Exhaust Fan (Note 3)	1	60	0	-22.7 [46.6]	-22.7 [46.6]
11	33 Secs	30	Reactor Aux. Building Supply Fan	1	150	106.9	106.9	106.9
12	38 Secs	31	Electrical Equipment Room Exhaust Fan	1	50	41.7	41.7	41.7
12	38 Secs	24	Control Room Air Conditioner Compressor	1	65	53	53	53
13	90 Secs	2	Motor Operated Valves	Lot	0	0	0	0
13	90 Secs	2	Motor Operated Valves	Lot	13.22	0	-11.9	0
13	90 Secs	2	Motor Operated Valves	Lot	12.89	0	0	-11.6
13	90 Secs	40	DG Cooling Water Heaters	4	(15)	-60	-60	-60
14	5 Mins	7A	Air Conditioner 2ACC-4/HVA-4	1	(11.7)	11.7	11.7	11.7
14	5 Mins	28	Battery Chargers	2	(68)	-52 [48.0]	-52 [48.0]	-52 [48.0]
15	30 Mins	37	Pressurizer Heaters	1	(200)	200 M	0	0
15	30 Mins	34	Instrument Air Compressor	1	40	32.3 M	0	32.3 M
15	30 Mins	38	Instr. Air Comp. Clg. Pump & Fan	1	12.5	11.2 M	0	11.2 M

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* Counting from time the EDG Output Breaker closes

Notes: 1. M = Manual Operation
2. Numbers not in brackets indicate load changes, numbers in brackets indicate running loads.
3. Due to long acceleration, initial loading is due to locked rotor current. This is reduced to running current after the acceleration period.

TABLE 8.3-2 (Cont'd)

EMERGENCY DIESEL GENERATOR
LOADING SEQUENCE

Load Block	Timing* Sequence	Item No.	Equipment Description	Per DG Qty.	Rated Hp (KW)	LOOP	Running Load KW LOOP/LOCA	LOOP/MSLB
16	1 Hour	8C	EDG Air Compressor Motor	1	7.5	-6.7	-6.7	-6.7
16	1 Hour	33	Boric Acid Makeup Pumps	2	25	0	-21.4 M	0
16	1 Hour	35	Fuel Pool Cooling Pump	1	40	26.2 M	0	26.2 M
16	1 Hour	1	HPSI Pump	1	400	0	0	-324.3 M
16	1 Hour	9	LPSI Pump	1	400	0	0	-165 M
16	1 Hour	15	Containment Spray Pump	1	500	0	0	-347.1M
16	1 Hour	37	Pressurizer Heaters	1	(200)	0	0	200 M
17	73 Mins	9	LPSI Pump	1	400	0	-317.5 M	0
17	73 Mins	34	Instrument Air Compressor	1	40	0	32.3 M	0
17	73 Mins	35	Fuel Pool Cooling Pump	1	40	0	26.2 M	0
17	73 Mins	36	Hydrogen Recombiner	1	(75)	0	75 M	0
17	73 Mins	2	Motor Operated Valves	Lot	2.93	0	2.6	2.6
17	73 Mins	38	Instr. Air Comp. Clg. Pump & Fan	1	12.5	0	11.2 M	0
18	4 Hours	5	RCP Oil Lift Pump	2	10	-18 M	-18 M	-18 M
18	4 Hours	29	Aux. Feedwater Pump	1	350	0	-282.3 M	0
18	4 Hours	33	Boric Acid Makeup Pumps	2	25	-13.0 M	0	-21.4 M
18	4 Hours	36	Hydrogen Recombiner	1	(75)	0	0	75 M
19	8 Hours	9	LPSI Pump	1	400	0	0	271.4 M
20	12 Hours	9	LPSI Pump	1	400	271.4 M	0	0
20	12 Hours	16	Hydrazine Pump	1	3	0	-2.9 M	-2.9 M
20	12 Hours	29	Aux. Feedwater Pump	1	350	0	0	-282.3 M
20	12 Hours	32	Charging Pumps	2	125	-55.5 [48]	0	-55.3 [48]
20	12 Hours	37	Pressurizer Heaters	1	(200)	-200 M	0	-200 M
21	30 Hours	29	Aux. Feedwater Pump	1	350	-246.8 M	0	0

EC283797

*Counting from time the EDG Output Breaker closes.

Notes: 1. M = Manual Operation
2. Numbers not in brackets indicate load changes, numbers in brackets indicate running loads.
3. Due to long acceleration, initial loading is due to locked rotor current. This is reduced to running current after the acceleration period..

TABLE 8.3-3

BATTERY LOAD GROUP B-DC LOADS

LOAD DESCRIPTION	Ckt. NO.
Hydrogen Panel	1
Turbine Oil Hydrogen Seal Oil & Heater Drain Fire Protection	3
480V Swgr 2B2	7
480 Swgr 2B1	11
125V DC PP-219	13
480 Swgr 2B2	15
IRS Valve 2B SE-07-3B	17
Diesel Gen 2B Control Pnl	19
Diesel Gen 2B Cntl Pnl	21
Plant Aux Cntrl BD Ann-LB	23
RTGB 203, 205	27
480V Swgr 2B5	29
RTGB206	31
125V DC Bus MB	33
Charging Line 2B1 Valve SE-02-01	35
Isolation Cab "SB"	37
125V DC Bus "2AB"	43
DC LP 228	2
Start-up Standby Transf 2B Cntl Cab	4
Main TR 2B Cntl Cab	6
Unit Aux Transf 2B Contr Cab	8
6900V Swgr 2B1	12
4160V Swgr 2B2	14
Aux Spray Valve SE-02-4	16
4160V Swgr 2B3	18
Control Transfer Pnl 2B	24
RTGB 201	10

TABLE 8.3-3 (cont'd)

BATTERY LOAD GROUP B-DC LOADS

LOAD DESCRIPTION	Ckt. NO.
Static Inverter Cab 2B	26
125V DC PP-239	28
Diesel Gen Ann Ckts	30
Control Transfer Panel 2B	32
125V DC Bus MD	34
Relief Valve V1475	36
HVCB	38
125V DC PP-255	40
Static Inverter Cab 2D	2
RTGB 205 (NB)	3
4160v Swgr 2AB	21
Isolation Cabinet "SAB"	23
HVCB	2
RTGB 205 (NA)	4
125V dc Bus 2C	10
Isolation Term Cab 3	12
Aux FW Pump 2C - MV-08-03	20
480V Swgr 2AB	22
125V dc PP240	24
125V dc Bus 2D	9
Gen Prot Relay Cab	1

For current load listings, refer to the latest design margin calculation.

TABLE 8.3-4

BATTERY LOAD GROUP AB-DC LOADS

LOAD DESCRIPTION
Refer to Table 8.3-3 for listing of AB-DC loads.

TABLE 8.3-5

BATTERY LOAD GROUP A-DC LOADS

LOAD DESCRIPTION	
Instrument Bus 2A Inverter	
Instrument Bus 2C Inverter	(Bus 2AA)
480V Swgr 2A2 & 2A5	
480V Swgr 2A1	
4160V Swgr 2A3	
4160V Swgr 2A2	
6900V Swgr 2A1	
DC Bus 2AB	
DC Pnl 218	
DC Pnl 238	
DC Ltg Pnl	
DC Bus MA	
DC Bus MC	
Diesel Generator 2A Control Pnl	
Diesel Generator 2A Excitation	
RTGB 205 & 203	
Unit Auxiliary 2A	
RTGB 206	
Main Transf 2A	
Start-up Transf 2A	
Miscellaneous	
Relief Valve V1474	
PCV-18-5, 6	
HVCB	
Plant Aux. Control "Ann"	
Isolation Cabinet "SA"	
V2516	
SE-02-3	
V2523	
SE-02-2	
SE-07-3A	
Isolation Box B-2952	
CCW Surge Tank	
DC-Pnl 254	
RTGB-201	

Note:

1) Part of the switchgear's loads include non-safety related equipment.

2) The loading and duty cycle of safety battery 2B is larger than battery 2A. Therefore, the Safety Related Batteries 2A & 2B sizing calculation used the 2B loads. See Table 8.3-3 for loads used for sizing.

TABLE 8.3-6

4.16 KV SAFETY RELATED SYSTEM - FAILURE MODES AND EFFECTS ANALYSIS

	FAILURE		CAUSE		CONSEQUENCES AND COMMENTS
1.	4.16 kV power to bus 2A3 or 2B3 assuming coincident loss of preferred power.	a.	Failure of the associated DG (diesel generator) to start.	a.	Failure of the DG to start results in the loss of one complete safety related division. The redundant DG starts and supplies the redundant safety related loads. The reliability of the DG to start has been enhanced considerably by the following design features: Starting Signal: Engineered Safety Features actuation signal or undervoltage relays on 4.16 kV bus. Starting System: Four air starting systems for each DG unit.
		b.	Failure of the DG to develop voltage.	b.	The consequences are identical to Item a. A dual static excitation system is used to improve reliability and to ensure fast voltage buildup.
		c.	Failure of DG ACB to autoclose	c.	Consequences are identical to Item a.
		d.	Bus fault on Bus 2A3 or 2B3.	d.	A bus fault prevents loading of the bus. The redundant bus provides the power to the redundant safety related loads.
		e.	Loss of associated dc control power source.	e.	DC control power to the two redundant 4.16 kV safety related systems is supplied from two redundant batteries. Loss of control power to any one system does not prevent the redundant system from performing the safety function.
		f.	Failure of a feeder breaker to trip on feeder fault.	f.	A fault on a feeder cable, if not cleared by the feeder breaker, leads to tripping of the bus. Under this condition, the redundant 4.16 kV bus supplies the redundant safety related loads. The safety related system is designed to operate without isolating any component on a single ground fault. As multiple faults are relatively few in number, reliability of complete safety functions is greatly increased.

TABLE 8.3-6 (Cont'd)

	FAILURE		CAUSE	CONSEQUENCES AND COMMENTS
2.	4.16 kv load (power center, motor, etc)	a.	Failure of power center feeder. ACB to close.	Any of the events a, b or c results in a loss of the affected actuated component. The redundant load on the redundant bus performs the safety function.
		b.	Stalled motor	
		c.	Feeder cable fault	

TABLE 8.3-7

480 VOLT SAFETY RELATED SYSTEM - FAILURE MODES AND EFFECTS ANALYSIS

	FAILURE		CAUSE	CONSEQUENCES AND COMMENTS
1.	480V power to bus 2A2, 2B2, 2A5, 2B5 or 2AB	a.	Failure of associated power center transformer.	Any of the five events a, b, c, d or e causes the loss of 480V safety related loads on one channel The redundant 480V load center bus supplies the redundant safety related loads.
		b.	4.16 kV cable fault.	
		c.	Power center bus fault.	
		d.	Failure of any load breaker to clear a fault.	
		e.	Loss of dc control power source.	
2.	480V MCC feeders	a.	Feeder cable fault.	Any of the events a, b, or c results in the loss of 480V power to the safety related loads connected to the affected MCC. The redundant loads connected to the redundant MCC performs the safety function.
		b.	MCC bus fault.	
		c.	Failure of any MCC load feeder breaker to clear a fault.	
3.	480V loads	a.	Feeder cable fault.	The result is the loss of the affected actuated component. The redundant component on the other division performs the safety function.
		b.	Stalled motor.	

TABLE 8.3-8

208Y/120V AC SAFETY RELATED SYSTEM - FAILURE MODES AND EFFECTS ANALYSIS

	FAILURE		CAUSE		CONSEQUENCES AND COMMENTS
1.	Power to bus	a.	Failure of associated transformer		a, b, c, d; Any of these events results in the loss of power to the 208 or 120V loads of one division. The unaffected bus supplies the redundant safety related loads.
		b.	Cable fault.		
		c.	Failure of any load breaker to clear a fault.		
		d.	Bus fault.		
2.	Any distribution feeder	a.	Cable fault.	a.	This results in loss of power to the loads. The redundant loads on the unaffected division are adequate to insure safety

TABLE 8.3-9

120 V INSTRUMENT POWER SUPPLY SAFETY RELATED SYSTEM – FAILURE MODES AND EFFECTS ANALYSIS

	FAILURE		CAUSE	CONSEQUENCES AND COMMENTS
1.	120 V ac power to buses 2MA, 2MB, 2MC and 2MD	a.	Bus fault	a,b,c,d. The result is the loss of 120 volt uninterruptible ac power supply to one of the four channels of the protection system. As a two out of four criterion is used in all logic circuits, the remaining three channels ensure safe, but not false, shutdown. The 120 V ac system is designed as an ungrounded system. The reliability of any channel is consequently greatly enhanced.
		b.	Cable fault	
		c.	Failure of a distribution breaker to clear a fault	
		d.	Failure in inverter	
2.	Any distribution feeder	a.	Cable fault	a. This results in the loss of power to the connected loads. The redundant loads in the remaining three channels are adequate to ensure safety.
3.	Loss of 480 V ac power to battery charger.	a.	MCC bus fault	a,b. The inverter is supplied by the battery without interruption of output power within the battery rating.
		b.	Cable fault	

TABLE 8.3-10

125 V DC SAFETY RELATED SYSTEM - FAILURE MODES AND EFFECTS ANALYSIS

	FAILURE		CAUSE		CONSEQUENCES AND COMMENTS
1.	125 V dc power to bus 2A or 2B	a.	Bus fault	a,b,c.	In the event of the loss of one dc bus, the redundant bus supplies control power to the safety related load of corresponding channel.
		b.	Battery fault		
		c.	Failure of load breaker to clear fault.		
2.	125 V dc power to bus 2AB	a.	Bus fault	a,b.	Loss of this bus causes loss of control power to the 4160V switchgear 2AB, and 480V switchgear 2AB thereby rendering loads fed from these buses inoperable. However, since these loads are third service loads designed to replace a corresponding load is the A or B division the effect of a loss of this bus is equivalent to the loss of a single train.
		b.	Failure of load breaker to clear fault.		
3.	Battery Charger	a.	Charger fault	a.	If a faulted charger can be isolated from the bus, the other charger is capable of supplying the connected loads. If it can't be isolated, the 2AB charger cannot be connected to a faulted bus. The associated battery will supply the fault until conductor failure clears the fault. The redundant train then supplies the necessary loads.
		b.	Loss of feeder to charger	b.	The loss of a single charger as a result of losing its feeder cable will still leave one charger connected to the bus and it is capable of supplying the connected loads.
		c.	Loss of MCC supplying a charger	c.	If an MCC (2A5 or 2B5) is lost, both associated chargers will be lost. In this case, the 2AB charger can be aligned to the appropriate bus and its output breaker closed to fully supply the connected loads.
4.	Loss of any dc load breaker	a.	Cable fault	a.	A cable fault trips the feeder breaker and results in lose of power to the connected safety related loads. The redundant loads connected to the redundant dc system ensures safe shutdown.
		b.	Distribution feeder fault not cleared by associated breaker.	b.	An uncleared fault results in loss of all dc on the bus concerned. The redundant loads ensures safe shutdown as in (a).

TABLE 8.3-11

DIESEL GENERATOR INDICATION

	Control Room	Local
Diesel Generator Voltage	*	*
Diesel Generator Current	*	*
Diesel Generator Watts	*	*
Diesel Generator Watt-Hours	*	-
Diesel Generator Frequency	*	*
Diesel Generator Reactive Power	*	*
Diesel Generator Field Voltage	-	*
Diesel Generator Field Current	-	*
Diesel Generator Elapsed Running Time	-	*
Diesel Generator Breaker Position Lights	*	*
Diesel Generator Volt Regulator Position Lights	*	*
Diesel "Off-Run-Ready To Start" Lights	*	*
Diesel Speed Check Lights	-	*
Diesel Governor Position Lights	*	*

TABLE 8.3-12

DIESEL GENERATOR 2A(2B) ALARMS AND ANNUNCIATION

	Control Room	Local
Emergency Diesel Generator Breaker Failure To Close	*	-
Emergency Diesel Generator - One Engine Failure To Start	*	-
Emergency Diesel Generator Lockout	*	-
Emergency Diesel Generator Local Alarm	*	-
Diesel Oil Storage Tank Low Level	*	-
Diesel Oil Day Tank Low Level	*	-
Engine Fuel System Fault	*1	*
Engine Low Lube Oil Temperature (2A1)	*1	*
Engine Low Lube Oil Temperature (2A2)	*1	*
Engine High Crankcase Pressure Trip (2A1)	*1	*
Engine High Crankcase Pressure Trip (2A2)	*1	*
Engine High Jacket Water Temperature (2A2)	*1	*
Engine Low Lube Oil Pressure (2A1)	*1	*
Engine Low Lube Oil Pressure (2A2)	*1	*
Engine Low Water Pressure (2A1)	*1	*
Engine Low Water Pressure (2A2)	*1	*
Engine Low Water Level (2A1)	*1	*
Engine Low Water Level (2A2)	*1	*
Engine Low Lube Oil Sump Level (2A1)	*1	*
Engine Low Lube Oil Sump Level (2A2)	*1	*
Low Air Start Pressure	*1	*
Overspeed Trip	*1	*
Fuel Day Tanks Low-Low Level	*1	*
Fuel Day Tanks High-High Level	*1	*
Unit Trip/Lockout	*1	*
Start dc Failure	*1	*
One Engine Failure to Start	*1	*
Fuel Storage Tank 2A Low Level	*1	*
Generator Ground	*1	*
Generator Overcurrent Trip	*1	*
Generator Reverse Power Trip	*1	*
Generator Loss of Excitation Trip	*1	*
Generator Differential Trip	*1	*
Potential Transformer Fuse Failure	*1	*
Lockout Relay Failure	*1	*

Notes:

1. All local annunciation/alarm are annunciated in the control room as Emergency Diesel Generator Local Alarm.

TABLE 8.3-13
COMPONENT ISOLATION LIST - RG 1.63

COMPONENT	ISOLATION MODE*(Ascending Power Level)
V3614 (2A2 SIT Outlet)	Isolate prior to Mode 2
Space heater for V3614	Isolate prior to Mode 4**
V3624 (2A1 SIT Outlet)	Isolate prior to Mode 2
Space Heater for V3624	Isolate prior to Mode 4**
V3634 (2B1 SIT Outlet)	Isolate prior to Mode 2
Space heater for V3634	Isolate prior to Mode 4**
V3644 (2B2 SIT Outlet)	Isolate prior to Mode 2
Space heater for V3644	Isolate prior to Mode 4**
V3480 ("A" SDC Hot Leg Suction)	Isolate prior to Mode 2
Space heater for V3480	Isolate prior to Mode 4**
V3481 ("A" SDC Hot Leg Suction)	Isolate prior to Mode 2
Space heater for V3481	Isolate prior to Mode 4**
V3652 ("B" SDC Hot Leg Suction)	Isolate prior to Mode 2
Space heater for V3652	Isolate prior to Mode 4**
V3545: (SDC Cross-Conn)	Isolate prior to Mode 2
Space heater for V3545	Isolate prior to Mode 4**
HVE-22: (Containment Elevator Fan)	Isolate prior to Mode 4
Fuel Transfer Equipment	Isolate prior to Mode 4
Refueling Machine Junction Box	Isolate prior to Mode 4
V3651 "B" SDC Hot Leg Suction	Isolate prior to Mode 2
Space heater for V3651	Isolate prior to Mode 4**
Space heater for V1476 (PORV Block valve)	Isolate prior to Mode 4**

TABLE 8.3-13 (Cont'd)

COMPONENT ISOLATION LIST - RG 1.63

COMPONENT	ISOLATION MODE
Space heater for V1477 (PORV Block valve)	Isolate prior to Mode 4**
Reactor Bldg. Maint. Hatch Hoist Bkr 2-41381	Isolate prior to Mode 4
Reactor Bldg. Jib Crane Recpt	Isolate prior to Mode 4
Pwr Recp 257, 261, 265, 271	Isolate prior to Mode 4
Pwr Recp 227, 232, 258, 262, 266	Isolate prior to Mode 4
Pwr Recp 259, 263, 267, 270	Isolate prior to Mode 4
Pwr Recp 260, 264, 268, 269	Isolate prior to Mode 4
Reactor Bldg Telescoping Crane	Isolate prior to Mode 4
Reactor Bldg Elevator Starter	Isolate prior to Mode 4
RCP Polar Crane	Isolate prior to Mode 2

* Technical Specification identify power modes

** Cables to MOV space heaters have been disconnected at their 120 VAC power panels. Cables remain in place for possible connection in the future.

Refer to Dwg.
2998-G-272

FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

MAIN ONE-LINE
WIRING DIAGRAM
FIGURE 8.3-1

Refer to Dwg.
2998-G-272A

FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

COMBINED MAIN & AUXILIARY
ONE-LINE DIAGRAM
FIGURE 8.3-1a

Refer to Dwg.
2998-G-274 Sh. 1

FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

AUXILIARY ONE-LINE DIAGRAM
SHEET 1 OF 2

FIGURE 8.3-2a

Refer to Dwg.
2998-G-274 SH 2

FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

AUXILIARY ONE-LINE DIAGRAM
SHEET 2 OF 2

FIGURE 8.3-2b

Refer to Dwg.
2998-G-332

FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

480V MISCELLANEOUS, 125V DC
AND VITAL AC ONE LINE
SHEET 1 0F 2

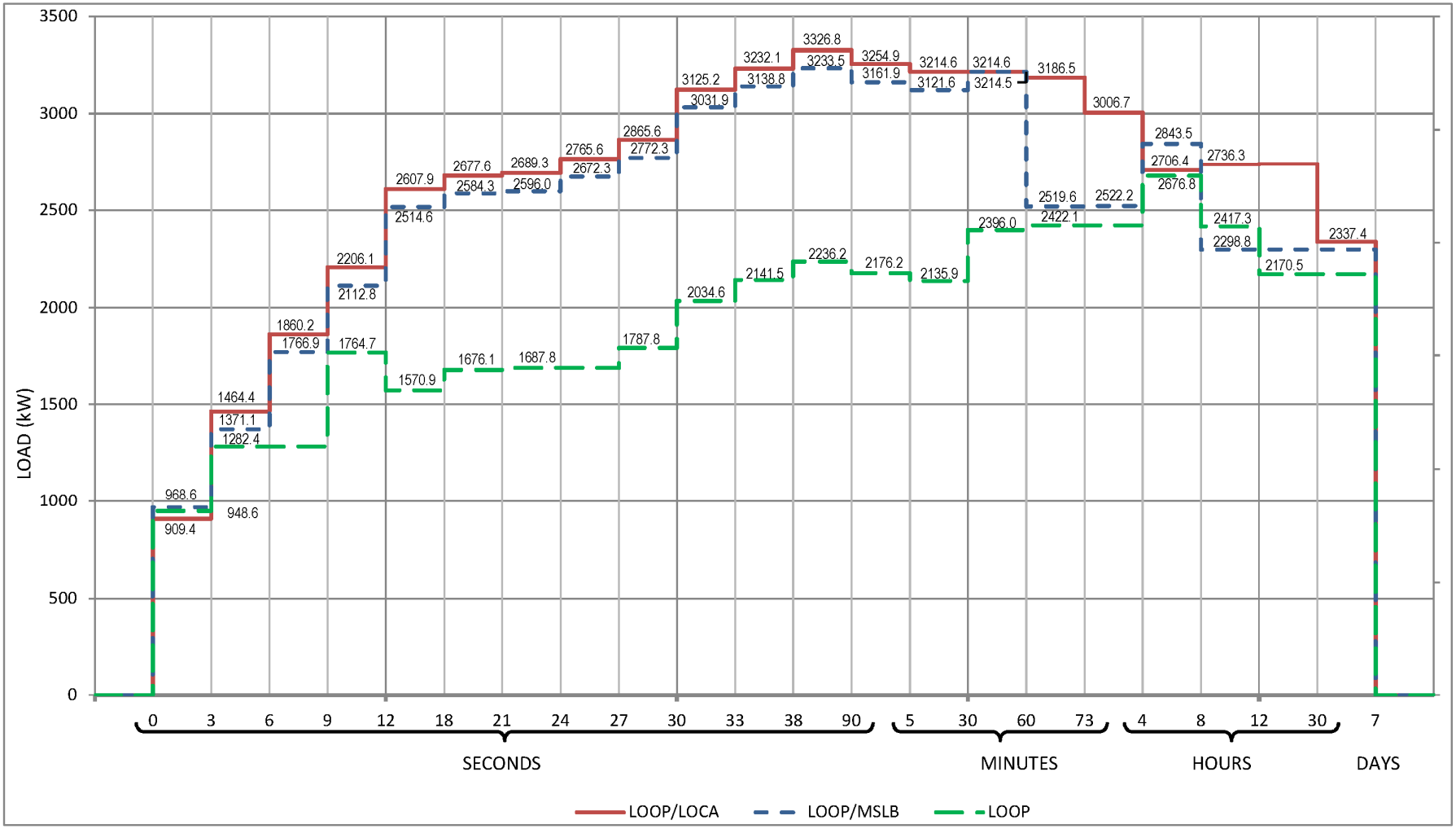
FIGURE 8.3-3

Refer to Dwg.
2998-G-332 SH 2

FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

480V MISCELLANEOUS, 125V DC
AND VITAL AC ONE LINE
SHEET 2 0F 2

FIGURE 8.3-3a



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

DIESEL GENERATOR LOAD PROFILE FOR SAFE SHUTDOWN, LOSS OF COOLANT ACCIDENT CONDITION, AND MAIN STEAM LINE BREAK

FIGURE 8.3-4

EC 283 221

Refer to Drawing
2998-B-271 SH 5-3

FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

ELECTRICAL GENERAL INSTALLATION NOTES

FIGURE 8.3-5a

Refer to Drawing
2998-B-271 SH 5-4

FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

ELECTRICAL GENERAL INSTALLATION NOTES

FIGURE 8.3-5b

Refer to Drawing
2998-B-271 SH 5-5

FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

ELECTRICAL GENERAL INSTALLATION NOTES

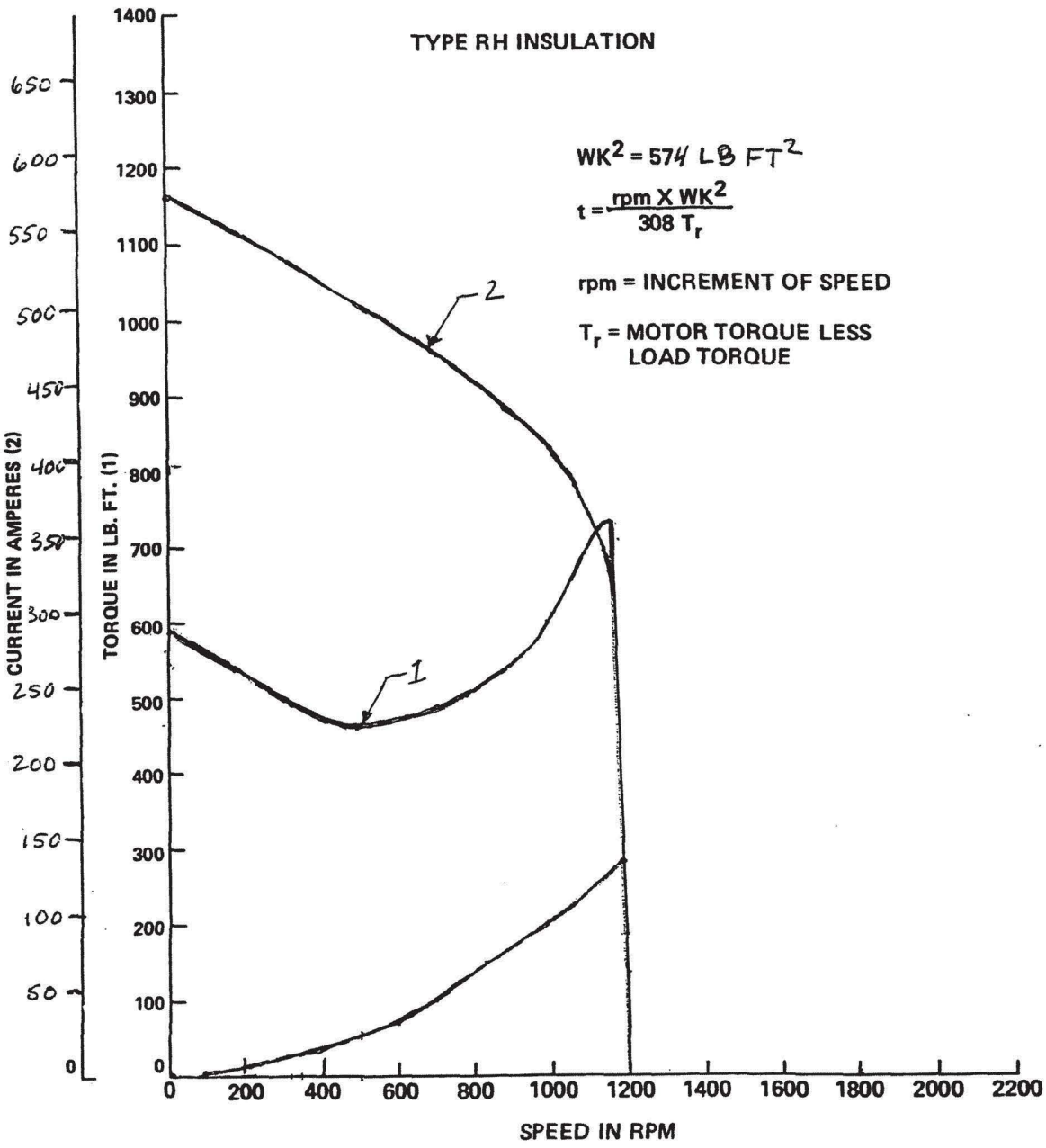
FIGURE 8.3-5c

Refer to Drawing 2998-B-327
Sheet 1000

Amendment No. 18 (01/08)

FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

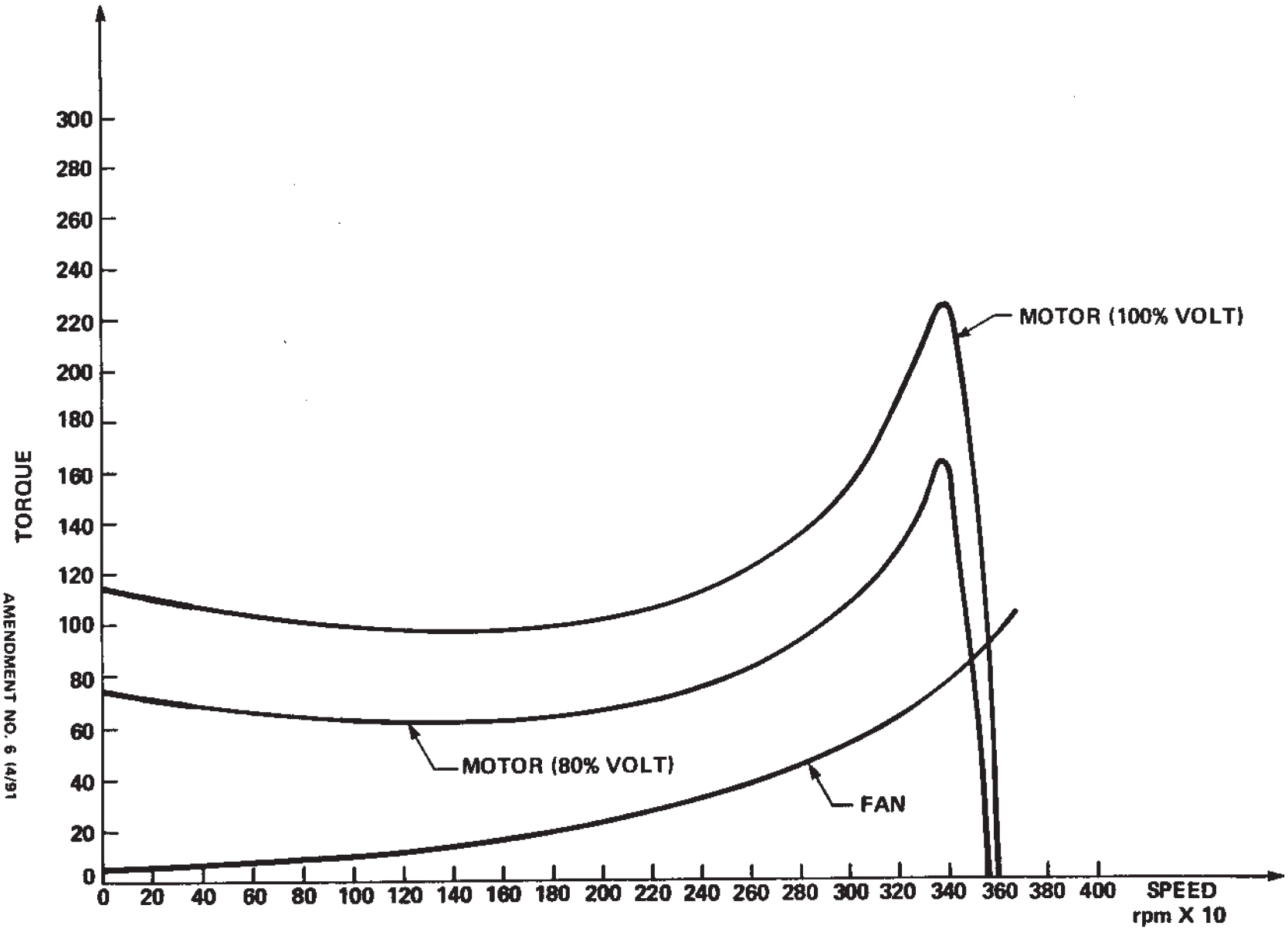
CONTROL WIRING DIAGRAM 125V DC
BUS TRANSFER CONTROL
FIGURE 8.3-6



AMENDMENT NO. 16 (02/05)

FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

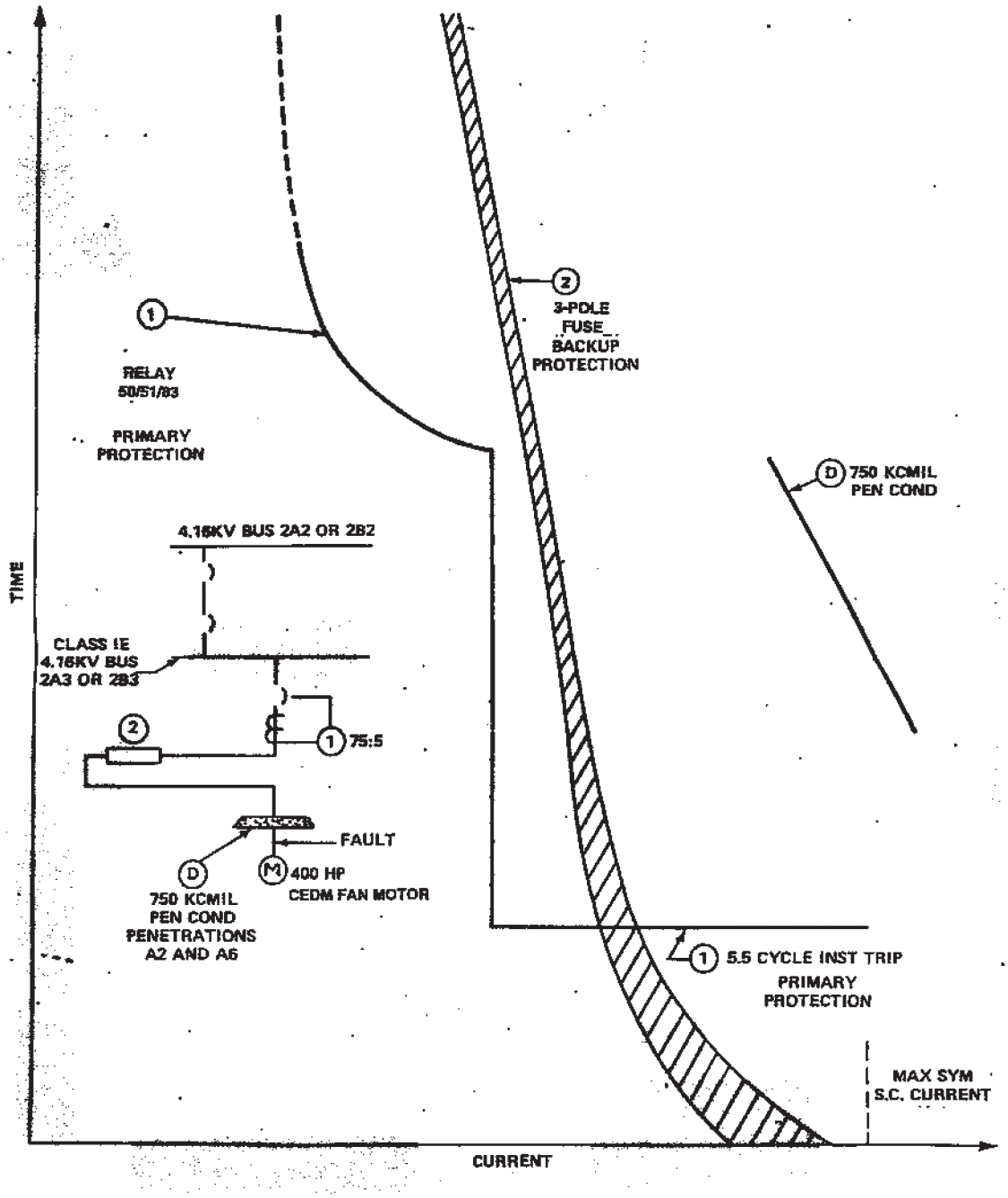
CONTAINMENT FAN COOLERS
TORQUE AND CURRENT VS SPEED
AT 80% VOLTS
FIGURE 8.3-7



AMENDMENT NO. 6 14/91

FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

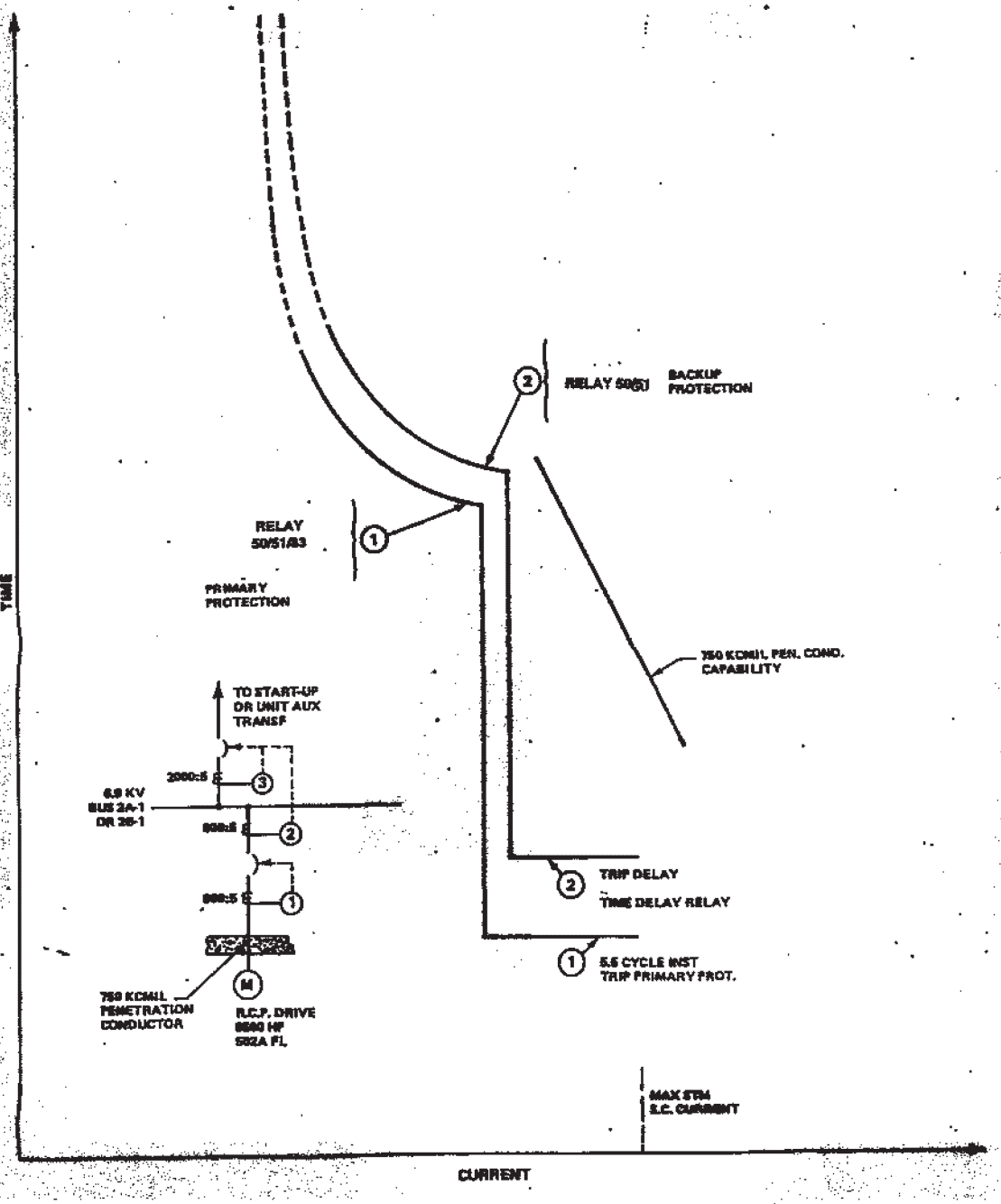
TORQUE VS. SPEED 85%
FIGURE 8.3-8



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

5KV PENETRATION (MVP-A)
PROTECTIVE DEVICE COORDINATION
FIGURE 8.3-9a

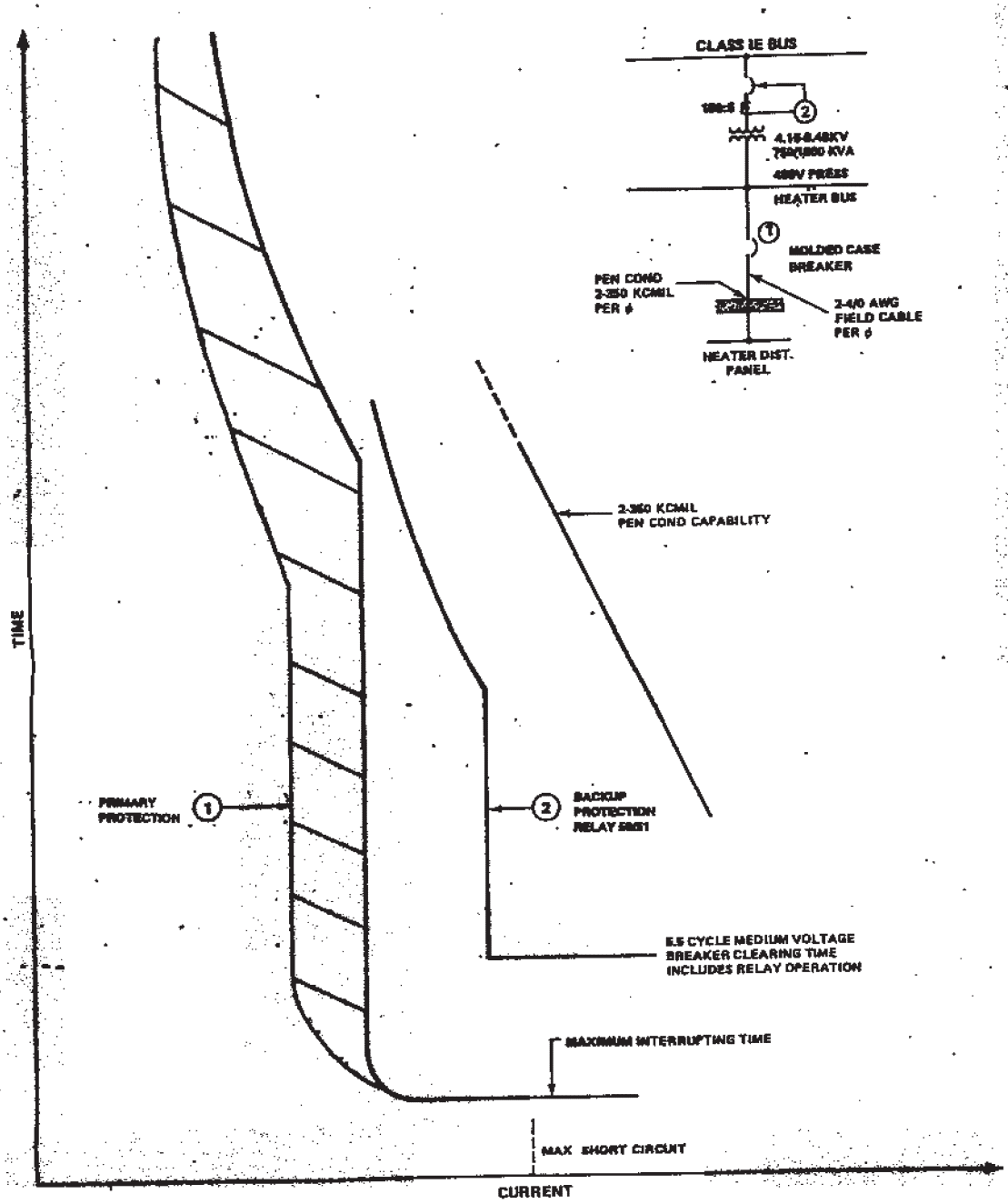
Amendment No. 11, (5/87)



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

16KV PENETRATION (MVP-6)
PROTECTIVE DEVICE COORDINATION
FIGURE 8.3-9b

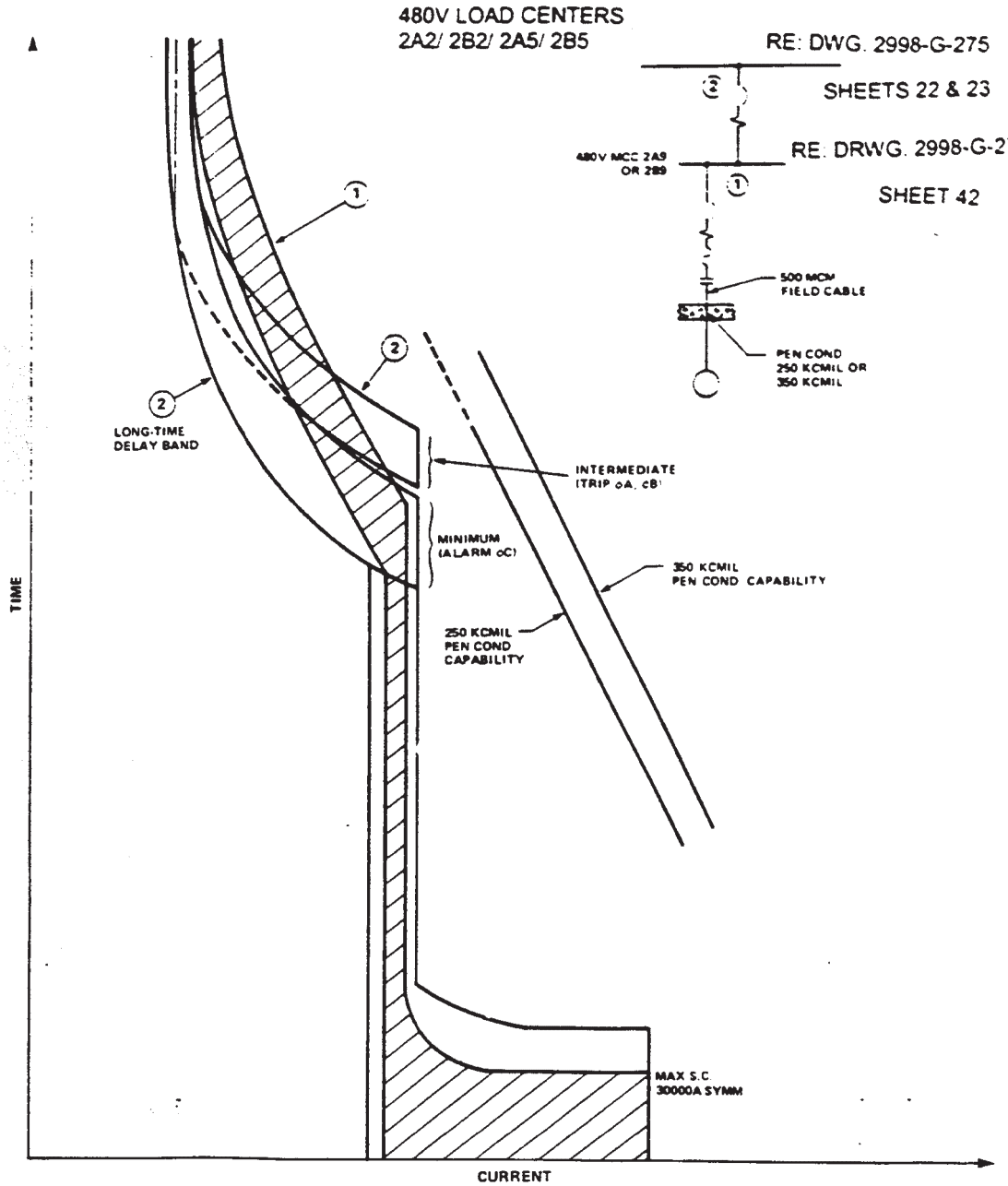
Amendment No. 11, (9/87)



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

PENETRATION PROTECTION –
PRESSURIZER HEATERS
FIGURE 8.3-9c

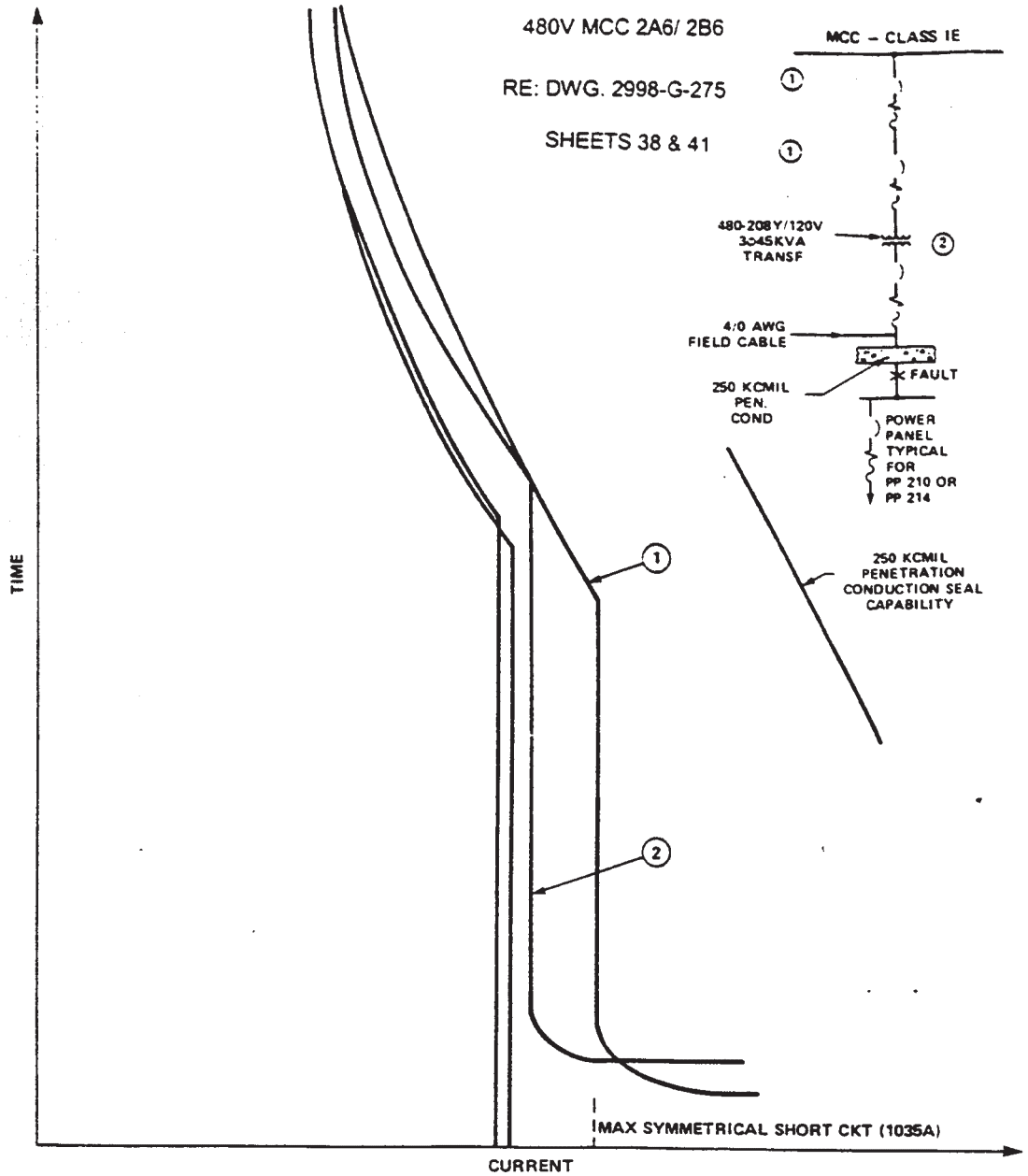
Amendment No. 11 (5/97)



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

PENETRATION PROTECTION – CONTAINMENT COOLING FAN MOTORS
FIGURE 8.3-9d

Amendment No. 13 (05/00)



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

PENETRATION PROTECTION – "NORMAL/EMERGENCY" 200Y/120 VAC SERVICE
FIGURE 8.3-9a

Amendment No. 13 (05/00)