RELATED CORRESPONDENCE

The Light

COMPANY Houston Lighting & Power P.O. Box 1700 Houston, Texas 77001 (713) 228-9211

DOCKETED

December 16, 1985 DEC 23 F2:27 ST-HL-AE-1490 File No.: G9.17

Mr. Vincent S. Noonan, Project Director BRANCH PWR Project Directorate #5 U. S. Nuclear Regulatory Commission Washington, DC 20555

South Texas Project Units 1 and 2 Docket Nos. STN 50-498, STN 50-499 Responses to DSER/FSAR Items On Chapter 8

Dear Mr. Noonan:

The enclosed provides STP's response to Draft Safety Evaluation Report (DSER) or Final Safety Analysis Report (FSAR) items. Additional changes to Chapter 8 are included.

The item number listed below corresponds to one of those assigned on STP's internal list of items for completion which includes open and confirmatory DSER items, STP FSAR open items and open NRC questions. This list was given to your Mr. N. Prasad Kadambi on October 8, 1985 by our Mr. M. E. Powell.

The attachment includes mark-ups of FSAR pages which will be incorporated in a future FSAR amendment unless otherwise noted below.

The items which are attached to this letter are:

Attachment Item No.*

Subject

D 8.3-6

Loads on Emergency Buses Note: See Section 8.3.1.2.10.5 on page 8.3-22.

*Legend D - DSER Open Item F - FSAR Open Item

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C - DSER Confirmatory Item

Q - FSAR Question Response Item

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Houston Lighting & Power Company

ST-HL-AE-1490 File No.: G9.17 Page 2

If you should have any questions on this matter, please contact Mr. M. E. Powell at (713) 993-1328.

Very truly yours, Wi serburg Manager, Nuclear Licensing

REP/yd

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Attachments: See above

Houston Lighting & Power Company

cc:

Hugh L. Thompson, Jr., Director Division of PWR Licensing - A Office of Nuclear Reactor Regulation U.S. Nuclear Regulatory Commission Washington, DC 20555

Robert D. Martin Regional Administrator, Region IV Nuclear Regulatory Commission 611 Ryan Plaza Drive, Suite 1000 Arlington, TX 76011

N. Prasad Kadambi, Project Manager U.S. Nuclear Regulatory Commission 7920 Norfolk Avenue Bethesda, MD 20814

Claude E. Johnson Senior Resident Inspector/STP c/o U.S. Nuclear Regulatory Commission P.O. Box 910 Bay City, TX 77414

M.D. Schwarz, Jr., Esquire Baker & Botts One Shell Plaza Houston, TX 77002

J.R. Newman, Esquire Newman & Holtzinger, P.C. 1615 L Street, N.W. Washington, DC 20036

Director, Office of Inspection and Enforcement U.S. Nuclear Regulatory Commission Washington, DC 20555

T.V. Shockley/R.L. Range Central Power & Light Company P.O. Box 2121 Corpus Christi, TX 78403

H.L. Peterson/G. Pokorny City of Austin P.O. Box 1088 Austin, TX 78767

J.B. Poston/A. vonRosenberg City Public Service Board P.O. Box 1771 San Antonio, TX 78296 ST-HL-AE-1490 File No.: G9.17 Page 3

Brian E. Berwick, EsquireAssistant Attorney General for the State of TexasP.O. Box 12548, Capitol StationAustin, TX 78711

Lanny A. Sinkin Christic Institute 1324 North Capitol Street Washington, D.C. 20002

Oreste R. Pirfo, Esquire Hearing Attorney Office of the Executive Legal Director U.S. Nuclear Regulatory Commission Washington, DC 20555

Charles Bechhoefer, Esquire Chairman, Atomic Safety & Licensing Board U.S. Nuclear Regulatory Commission Washington, DC 20555

Dr. James C. Lamb, III 313 Woodhaven Road Chapel Hill, NC 27514

Judge Frederick J. Shon Atomic Safety and Licensing Board U.S. Nuclear Regulatory Commission Washington, DC 20555

Mr. Ray Goldstein, Esquire 1001 Vaughn Building 807 Brazos Austin, TX 78701

Citizens for Equitable Utilities, Inc. c/o Ms. Peggy Buchorn Route 1, Box 1684 Brazoria, TX 77422

Docketing & Service Section Office of the Secretary U.S. Nuclear Regulatory Commission Washington, DC 20555 (3 Copies)

Advisory Committee on Reactor Safeguards U.S. Nuclear Regulatory Commission 1717 H Street Washington, DC 20555

Revised 12/3/85

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1 OF 60

date of commercial operation of both the connection and the terminal facilities is December, 1905. June, 1989).

8.1.2 Onsite Electrical System

The Onsite Electrical System of each unit consists of the unit auxiliary transformer, four 13.8 kV auxiliary buses, three 13.8 kV standby buses, five 13.8/4.16 kV auxiliary transformers, two balance-of-plant (BOP) 4.16 kV [36] auxiliary buses, and three Engineered Safety Feature (ESF) 4.16 kV auxiliary [12] buses. The three ESF 4.16 kV auxiliary buses feed the redundant Class 1E ac [36] power loads.

During normal operation, each unit's ac electrical power is supplied by its unit auxiliary transformer, with the exception of 4.16 kV ESF buses ElB and 36 ElC, which are supplied by the standby transformer.

Power from the utility grid and (the offsite electrical system) is made available to the onsite electrical system through the respective unit auxiliary 36 Ord/ transformer or the two plant standby transformers (no. 1 and no. 2) and the 138 kV emergency transformer (See Figure 8.2-1). Onsite standby power is provided by three standby diesel generators (DGs) for each unit. These operate at 4.16 kV. (Two BOP buses per unit are served from separate 480 V and 43 4160 V DGs. One BOP bus common to both units is served from a 480 V lighting DG. One standby DG is tied to one Class IE A bus per unit. The three standby DGs and their associated Class 1E AC Power Systems make up three independent systems which provide ac power to the three independent ESF load trains designated as Train A, Train B, and Train C. Each train of the Class 1E 🕊 Power System is provided with an independent Class 1E 125 ydc system. Train A serves an additional Class 1E 125 ydc distribution system which supplies power to the fourth Reactor Protection System (RPS) channel. Each Class 1E 125 ydc system is designed to carry all of its required loads during design basis events. The non-Class 1E bg loads are supplied by 48 ydc, 125 ydc, and | 12 250 ydc systems supplied by the respective batteries. In addition, the plant computer is served by its own 250 ydc battery system. These non-Class IE DC 112 systems are served from non-Class 1E 480 V motor control centers.

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

8.1.3 Offsite Electrical System

The Offsite Electrical System consists of the respective unit auxiliary transe formers, (29-13.8/13.8 kV), two standby transformers, (362.25-13.8/13.8 kV)e the two main generators, two pairs of main power transformers (362.25-25 kV)e the 345 kV lines connecting the main power transformers and the standby transformers to the switchyard, the 345 kV switchyard, and the eight 345 kV transformers to the switchyard, the 345 kV switchyard to the STP owners' interconnecting grids, and the 138 kV line from CPL's Elessing Substation to the 138 kV emergency transformer. The eight 345 kV transmission circuits connect the | 28 STP 345 kV switchyard to the STP owner's grids as follows:

1. STP to Hill Country (CPS)

ATTACHMENT ST.HL-AE. 1490

PAGE 2- OF 60

sufficient capacity to provide power to one ESF bus of each unit. Each unit auxiliary transformer is individually connected to the 345 kV switchyard by a separate and independent overhead ties through the main transformers. These 345 kV ties are connected at separate positions on the breaker and-a-half 345 kV switchyard. These transformers have the capacity for startup, full-load operation and safe shutdown. Each unit auxiliary transformer has the capacity for the safe shutdown loads of all three of its ESF buses. and BOP loader

Bop loads and

The switchyard station service is supplied by two 4.16 kV non-Class 1E feeders (one from each unit) via itselocal 480 V load center and is provided with two 12 independent 125 ydc systems. This redundancy in power supplies assures they protective devices have a power source to maintain the reliability of the offsite supply.

The eight 345 kV transmission circuits connecting the owners' grids to the STP switchyard and the connection from the 345 kV switchyard at the STP to the 28 southern terminal facilities of the HVDC interconnection system are routed so that loss of any independent right-of-way or outage of any two circuits does. not alter the operation of the plant during either full generation output or total plant shutdown may necessitate some reduction in generation output but doe not significantly reduce the capability of the offsite supply of power.

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

A listing of safety systems and loads is given in Table 8.1-1 and Table 8.3-3 36 respectively. These tables indicate the redundant loads associated with Train A, Train B, and Train C safety features. Safety functions and power requirements (ac or dc) of these loads are listed for the various plant conditions.

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

- 1. Each redundants safety-related electrical load group (Train A, B, or C) is provided with an onsite standby power source, electrical buses, distribution cables, controls, relays, and other electrical devices separate from the other load groups.
- Each onsite standby source has sufficient capacity to provide power to 2. its associated auxiliary power system to shut down and maintain the unit in a safe condition or to mitigate the consequences of a DBA in the event of a loss of the offsite power sources.
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Redundant parts of the system are physically independent to the extent 3. that a single event, including a single electrical failure, does not cause loss of power to redundant loads groups.

safety-related loads are

4. In the event of the loss of all offsite power, the system is connected to 36 the onsite standby power sources automatically and in sufficient time to safely shut down the unit or limit the consequences of a Design Basis Ac-36 cident (DBA) to within applicable regulatory limits. In case any standbye DG fails to start, that particular ESF transformer can be connected man e welly to the 138 kV emergency transformere

ATTACHMENT ST.HL.AE. 1490 PAGE 3 OF GO

- The Class 1E Electrical System (4.16 kV ESF buses, associated DGs and 480 yac, 120/208 yac and 125 ydc power and control systems) is installed in Seismic Category I structures.
- 6. The Class IE Electrical System is designed to withstand the effects of design basis natural phenomena, assuming encutemeous single active failure, without loss of onsite power to those safety-related electrical components required to shut down the plant and maintain it in a safe condition or to mitigate the consequences of postulated accidents.
- 7. The three offsite ac power sources (two standby transformers and the respective unit auxiliary) are capable of supplying power to each Class lE electrical system bus. transformers
- One standby DG set and one independent 125 ydc system are provided for each Class 1E load group. (An additional 125 ydc system for the fourth RPS channel is provided using Train A as the KQ power supply.)
- Physical separation and electrical isolation are provided to maintain independence of all redundant Class IE circuits and equipment.
- Manual initiation of each protective action at the system level is provided in the main control room.
- 11. Inoperability and bypassed status indication for the safety-related systems are provided at the ESF system level in the main control room. (Refer to Section 7.5.4).
 and component level

The applicable criteria and codes, such as Regulatory Guides and IEEE standards, concerned with power requirements of the safety-related electrical loads are met by these systems. (See Table 8.1-2). 36

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AGE 4 OF 60

TABLE 8.1-2

LISTING OF APPLICABLE CRITERIA

8.1-8

Amendment 49

	Criteria	Title	Conformance Discussed In		1
۱.	Regulatory Guides*				
,	Institute of Electrical			36	
1.1	Floring Frances St	anderde			2
	Not Otherwise Incorporat	ed by			040.1
	RC Reference:				
				104	
	IFFE Std. 420-1973	IEEE Trial-Use Guide for Class IE Control Switchboards for Nuclear Power Cenersting Stations	8.3.1.3	44	
	IFEE Std. 485-1978	IEEE Recommended Practice for Sizing Large Lead Storage Batteries for Generaling Stations and Substations	8.3.7.1.1	49	Q430.10
				1 16	
3.	Branch Technical Positio	ns		49	
	RTP ICSB 8 (PSB)	Ose of Diesel Generator Sets for Peaking	8.3.1.1.4	36	29
	BTP ICSB 11 (PSB)	Stability of Offsite Power Systems	8.2.2.1		Q4 30. 04N
	RTP ICSR 18 (PSR)	Application of the Single Failure Criterion	6.3.1 6.3.2.2.		1
		to Manually-Controlled Electrically Operat-	6.3.5.5, 7.6.3,		
		ed Valves	7.6.7 See Figures	49	
			7.6.3 and 7.6-10	04 30.	
				107N	1
	BTP ICSB 21	Guidance for Application of RG 1.47	7.1.2.6		
	BTP PSBI	Adequacy of Station Electric Distribution System Voltages	8.3.1.1.4.6		
	RTP PSBF2	Criteria for Alarma and Indications Associ- ated with Diesel Generator Unit Bypassed and Inoperable Status	8.3.1.1.4.7		

*See Table 3.12-1 for revision and STP position on the following Regulatory Guides:	.49
1.6, 1.9 (IEEE 387-1977), 1.22, 1.29, 1.30 (IEEE 336-1971), 1.32 (IEEE 308-1974), 1.40 (IEEE 334-1971),	Q4 30. 107N
1.41, 1.47 (IEEE 2/9-19/1), 1.53 (IEEE 3/9-19/2), 1.62 (IEEE 2/9-19/1), 1.63 (IEEE 31/-19/6), 1.73 (IEEE 382-1972), 1.75 (IEEE 384-1974), 1.81, 1.89 (IEEE 373-1974), 1.93, 1.100 (IEEE	Q430.108N
344-1975), 1.106, 1.108, 1.118 (IEEE 338-1977) 1.128 (IEEE 484-1975), 1.129 (IEEE 450-1975), and 1.131 (IEEE 383-1974)	104 10.

TABLE 8.1-2 (Continued)

LISTING OF APPLICABLE CRITERIA

	Criteria	Title	Conformance Discussed In
4.	Ceneral Design Criter.a		
Α	CDC 17	Electrical Power Systems	3.1.7.7.8.1 8.7.1.3 8.3.1.2.1 8.3.7.7.1
	GDC 18	Inspection and Testing of Electric Power Systems	3.1.7.7.9.1 8.3.1.2 8.3.7.7.1
	GDC 21	Protection System Reliability and Teatability	3.1.7.7.12.1 8.3.1.7.1 8.3.2.2.1
	GPC 50	Containment Design Basis	3.1
	*A"		
	GDC 2	Design Basis for Protection Against Natural Phenomena	3.1, 7.2.1.1
	GDC 4	Environmental and Missile Design Bases	3.1, 3.11
	GDC 5	Sharing of Structures, Systems, an Components	d 3.1

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ATTACHMENT ST-HL-AE. 1490 PAGE 6 OF 60

8.2 OFFSITE POWER SYSTEM

8.2.1 Description

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

8.2.1.1 Transmission Lines. Eight 345 kV transmission circuits rated from 850 to 1,080 mVA connect the STP 345 kV switchyard to the owner's respective systems, as shown on Figure 8.2-4. These eight 345 kV circuits provide the source of ac power to the 345 kV switchyard. The 345 kV transmission 112 circuits terminate at seven points in the owner's respective systems as fol-28 lows: at Velasco 345 kV Substation (Houston Lighting & Power Company [HL&P] existing); at W. A. Parish 345 kV Substation (HL&P - existing); at Hill Country 345 kV Substation (City of Public Service Board of San Antonio [CPS] existing); at Skyline 345 kV Substation (CPS - existing); at Holman 345 kV Substation (City of Austin [COA]-Lower Colorado River Authority - existing); at Lon Hill 345 kV Substation (Central Power and Light Company [CPL] - exist-28 ing); and at Blessing 345 kV Substation autotransformer (CPL - future-planned completion prior to the fuel load date of STP Unit No. 1). (The Blessing 345 36 kV autotransformer will be connected to CPL's existing Blessing 138 kV Substation). In addition to the eight 345 kV transmission circuits there will be a connection, rated 1,080 mVA, from the 345 kV switchyard at the STP to the 28 southern terminal facilities of a high voltage direct current (HVDC) interconnection system described in Section 2.2.2.1 (the estimated date of commercial operation of both the connection and the terminal facilities is 36 December, 1989). June, 1989

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

The 138 kV emergency standby supply to STP is furnished from a radial line out of CPL's Blessing Substation. The 138 kV grid of CPL is intertied with HL&P at South Lane City Substation by the existing Blessing-South Lane City transmission circuit, Bay City-South Lane City circuit, and the El Campo-South Lane City circuit.

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lightning flashover as derived from the expected number of lightning strokes (the number of lightning strokes is assumed proportional to the number of thunderstorm days per year).

The South Texas Interconnected System grid and transmission system ensures that ac offsite power is available for shutdown of STP Units 1 and 2 and for 36 mitigating the consequences of postulated accidents at either unit.

8.2.1.2 Substation. As indicated on Figures 8.2-2 and 8.2-3, a breakerand-a-half scheme is incorporated in the design of the 345 kV switchyard. The switchyard bus is of a 40 gva fault duty design. These figures also indicate [31 the respective breaker continuous current ratings. The 345 kV circuit breakers in the switchyard are rated according to the following criteria:

- Circuit breaker continuous current ratings are chosen such that no single contingency in the switchyard (e.g., a breaker being out for maintenance) will result in a load exceeding 100 percent of the nameplate continuous current rating of the breaker.
- Interrupting duties are specified such that no fault occurring on the system, operating in steady-state conditions, will exceed the breaker's nameplate interrupting capability.
- Momentary ratings are specified such that no fault occurring on the system, operating in steady-state conditions, will exceed the breaker's nameplate momentary rating.
- Voltage ratings are specified to be greater than the expected operating voltage.

All 345 kV breakers have a maximum symmetrical interrupting capability of 36 40,000 amperes. The Onsite Electrical System is designed for a future maximum switchyard short circuit contribution of 30 GVA.

The north and south buses of the 345 kV switchyard each have connected to it a 36 150 pVar shunt reactor. Each shunt reactor is connected to the bus by a 2,000 ampere circuit switcher.

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

- Any transmission line into the switchyard can be cleared either under normal or fault conditions without affecting any other transmission line or bus.
- 2. Either bus can be cleared under normal or fault conditions without interruption of any transmission line or the other bus.
- 3. Any circuit breaker can be isolated for maintenance or inspection without interruption of any transmission line or bus.
- 4. A fault in a tie breaker or failure of the breaker to trip for a line or generator fault results only in the loss of its two adjacent circuits until it can be isolated by disconnect switches.

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PAGE

8 OF 60

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breakers. Cables are routed from each breaker to the respective trenches in such a fashion as to maintain separation between primary and secondary circuits.

8.2.1.3 Standby Transformers. Each standby transformer has the capacity to supply all ESF buses in both units and two 13.8 kV auxiliary buses. These 36 can be transformers are shared between Units 1 and 2 and aret the two preferred power co sources (the north and south 345 kV buses). Each transformer has two low-volsuppli tage windings rated at 13.8 kV. Each of the low-voltage windings is connected to two 13.8 kV standby buses of one unit and one 13.8 kV standby bus and one auxiliary bus of the other unit. Each transformer is rated at approximatelye 46.5/62/77.5 mVA, oil to air/forced air/forced oil and air (OA/FA/FOA) cooled at 55°C rise, with a 12-percent supplementary rating at 65°C rise. Each low-voltage winding is rated at approximately 23.25/31/38.75 mVA, OA/FA/FOA at 55°C rises with a 12 percent supplementary rating at 65°C rises Figure 8.2-1 is a schematic representation of the physical layout of the pre-36 ferred power supply circuits which connect the standby transformers to the switchyard. As indicated on Figure 8.2-1, both transformers are connected to 345 kV buses 36 in the switchyard by overhead conductors on steel structures. The no. 2 standby transformer is connected to the south bus, and no. 1 to the north bus. The following separation criteria apply to the standby transformers and associated leads in order to maintain their independence from each other and ensure conformance to GDC 17 and Regulatory Guide 1.32. 1. The high-voltage circuits of each standby transformer arecrouted on separate steel structures and terminates on separate buses in the 345 kV switchyard. The north bus is extended so the no. 1 standby transformer 36

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

leads do not cross over the south bus.

affecting

- 3. The no. 1 and no. 2 standby transformers are physically separated from each other to prevent a single accident of one transformer (e.g., fire) from jeopardizing the operation of the other transformer.
- 4. Each transformer's low voltage windings are connected to the associated 13.8 kV switchgear of each unit by cables (15 kV insulated) routed in underground concrete-encased duct banks and manholes and in air by nonsegregated phase bus duct. These cables terminate at the 13.8 kV 46 switchgear of each unit.
- 5. The 138 kV transmission line does not cross any high-voltage lead from the 345 kV switchyard to the plant.
- 6. The 138 kV emergency transformer is physically separated from both the no. 1 and no. 2 standby transformers by a minimum of 800 ft. This will ensure that a single accident in the 138 kV emergency transformer will not jeopardize the standby transformers.

ATTACHMENT T.HL.AE. 1490 OF 60

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The impendances of the standby transformers have been selected to ensure satisfactory startup, acceleration, and operation of all safety-related motors during the most limiting conditions considering the short circuit and voltage requirements. All ESF motors are specified to start and accelerate satisfactorily with 80 percent of the motor's rated voltage applied at their terminals.

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

Normal transfer of the source of power for the 13.8 kV auxiliary buses between the no. 1 and no. 2 standby transformers is initiated by the operator from the 36 control room.

Normal bus transfers are "live bus" transfers, i.e., the incoming source feeder circuit breaker is momentarily paralleled with the outgoing source feeder circuit breaker. This results in transfers without power interruption. 36 auxiliary transformer

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

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

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

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

- 1. The location of the 138 kV steel structures is such that a complete failure of a steel structure associated with the no. 1 or no. 2 standby transformer leads will not jeopardize the integrity of a 138 kV structure or its associated leads.
- 2. The 138 kV emergency transformer low voltage windings are connected to the associated motor operated switches of each unit by cables (15 kV insulated) routed in underground concrete-encased duct banks, manholes and 44 tray, and in air by non-segregated phase bus duct.

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ATTACHMENT ST.HL.AE. 1490 PAGE 10 OF 60

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

- 1. The impedance of the 138 kV emergency transformer is selected to maintain at least 80 percent, eysteme voltage while starting the largest ESF motor with the transformer loaded to its rating minus this motor load. of motor rated
- All ESF motors are specified to start and accelerate satisfactorily with 2. 80 percent of the motor's crated voltage applied at their terminals.

As indicated on Figure 8.2-2 and 8.2-3, the 138 kV emergency transformer is connected to the 138 kV transmission line through a 1,200-ampere circuit switcher. The 138 kV emergency transformer is protected by primary and backup relays and a circuit switcher failure protection system. The primary relay is of the high speed, percentage slope, harmonic restraint, differential overcurrent type (87/ET) to detect transformer internal faults. The backup relay is of the non-directional, inverse time overcurrent, induction unit and instantaneous overcurrent unit type (50/51/ET) to provide overload protection as well as backup protection to the transformer differential and transformer lowside relays. In addition, rate-of-rise pressure protection (63SP/ET) is also provided. These relays are connected in conjunction with an auxiliary relay (86/ET) to initiate tripping and lockout closing of the 138 kV circuit switcher and transformer lowside breakers.

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

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

The 138 kV emergency transformer may be used as a restree of power for one ESF 36 bus of each unit by manual transfer from the control room. The normal balance-of-plant 4.16 kV and 13.8 kV buses are not fed from the 138 kV emergency transformer.

8.2.1.5 Main Generators. The main generators are rated 1,504.8 mVA, 25 kV and provide power to the system grid at various loads to a maximum of 1,312 1,354 MWe each. The main generator data is given in Table 8.2-6. Each main generator is directly connected, through a 25 kV, 36,600- ampere, forced-cooled, iso-,29 0 36 lated phase bus through at disconnect links and main generator circuit breaker. to isolate the main generator from the main and auxiliary transformer bank. 430.05 The main generator's voltage is stepped up to 345 kV and then tied to one bay of the 345 kV switchyard. Each main transformer bank consists of two threephase transformers, 700 mVA each, FOA rated at 55°C temperature rise, with a

to the main transformers and unit auxiliary transformer

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ATTACHMENT ST.HL.AE. 1490 PAGE // OF 60

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8.3 ONSITE POWER SYSTEMS

8.3.1 AC Power Systems

8.3.1.1 Description. The onsite Af Power Systems of Units 1 and 2 each consist of four major subsystems as follows.

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

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

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

4. Onsite Standby Power System (Class 1E)

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

Figure 8.3-1 illustrates the bus arrangements and interconnections of Units 1 and 2. The general arrangement of the electrical equipment is shown on Figures 1.2-4, 1.2-5, 1.2-10, 1.2-26, 1.2-28, and 1.2-29.

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

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

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

8.3.1.1.1 <u>Main Auxiliary Power Distribution</u>: During normal plant operation, auxiliary loads are energized from the main generator through the closed main generator breaker and the three-winding unit auxiliary transformer which is connected to the isolated phase bus of the main generator. Each unit auxiliary transformer, is rated 25 kV/13.8 kV/13.8 kV, 84/112 mVA, oil-to-air (OA)/ forced oil and air (FOA), 65°C, three phase, 60 Hz. Each transformer 36 secondary winding is rated 42/56 mVA₂. OA/forced air (FAX)

nas an automatic load tap changer and

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

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

offs pewer sources through

ATTACHMENT ST.HL-AE. 1490 PAGE 12 OF 60

143

1000/1333 KVA, AA/FA, or 1200/1600 KVA, AA/FA, or oil

1200 KVA,

filled rated 500 or

36

36

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

Non-Class IE Motors

Motors rated 1500 hp and above are rated 13.2 kV; motors rated 300 to 1250 hp are rated 4 kV; and motors rated 3/4 hp to 250 hp are rated 460 V.

Two feeders from the 13.8 kV auxiliary buses supply power to two auxiliary transformers serving non-Class 1E equipment. These transformers are of the oil-filled type, rated 13.8 kV/4.16 kV, 5,000/6,250/7000 kVA, OA/FA, 55°C/FM OA/FA/FA, 65°C, three phase, 60 Hz. Switchgear distributing power from these transformers is standard, indoor, metal-clad, 5 kV class switchgear in a double-ended arrangement. Circuit breakers are of the magnetic, air-interruption type with interrupting rating of 250 mVA. The continuous current rating of all breakers in this double-ended arrangement is 1,200 amperes. 36

Other feeders from the 13.8 kV auxiliary buses are connected to low-voltage transformers supplying power through single and double-ended 480 V switchgear [36 sections to non-Class IE loads. These transformers are of the dry type rated 13.8 kV/480 V, 1,000 kVA or 1,200 kVA, air-to-air (AA) FA or 500 kVA (OAP, [36] three phase, 60 Hz. The switchgear sections consist of standard, indoor, metal-enclosed, 600 V class switchgear. All circuit breakers are of the magnetic, air-interruption type with interrupting ratings consistent with the short-circuit duty at the point of application. All circuit breakers are electrically operated with 125 vdc control power. Feeders from the 480 V load center buses energize non-Class IE motors and motor control centers (MCCs) from which non-Class IE small motors and miscellaneous loads are furnished power.

Normally opent bus tie breakers between the bust sections of the double-ended switchgear sections are provided to allow power to selective loads on both bust sections under administrative control. should one of the power sources to the switchgear be disabled. These breakers can be closed during maintenance periods.

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

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

During startup and normal plant operation the 13.8 kV standby buses are supplied power from the unit auxiliary and standby transformers. Standby 13.8 kV Bus 1F is supplied power from the X-winding of the unit auxiliary transformer through 13.8 kV auxiliary Bus 1R with the bus tie breaker closed. Standby 13.8 kV Buses 1G and 1H are supplied power from the Y and X windings, respect tively, of the standby transformers(see Figure 8.3-1).

8.3-2

and unit auxiliary

ATTACHMENT ST. HL. AE. 1490 PAGE 130F 60

or from either of the

By means of manual transfer, the 13.8 kV standby buses can be supplied from the respective unit auxiliary transformer or the standby transformers. Normal connections and possible interconnection from the 13.8 kV standby buses to the unit auxiliary transformers are shown on Table 8.3-1. Normally, standby transformer No. 1 and 2 supply only Unit 1 and 2, respectively. Normal connections and possible interconnection from the 13.8 kV standby buses to the standby transformers are shown in Table 8.3-2.

Power is supplied from 13.8 kV standby buses 1F, 1G, and 1H to 4.16 kV ESF Buses ElA, ElB, and ElC, respectively, through the associated auxiliary ESF transformers.

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

Each auxiliary ESF transformer supplying the ESF buses is rated 13.8 kV/4.16 36 kV, 5,000/6,250/7,000 kVA, 0A/FA at 55°C, FA at 65°C three phase, 60 Hz. Each transformer is connected by cable to Class 1E, 5 kV class, metal-clad switch-gear.

8.3.1.1.3 Additional Source ESF Power Distribution: Another offsite 36 power source, the 138 kV emergency transformer, is capable of supplying power concurrently to one ESF bus of each unit. The 138 kV emergency transformer is a three-winding transformer rated 138 kV/13.8 kV/13.8 kV, 12/16/20 mVA, (22.5) mVA, OA/FOA/FOA, 55°C (65°C) three-phase, 60 Hz. Each secondary winding is 13 rated 9/12/15 (16.875) mVA, 55°C (65°C). Each of the secondary windings of this transformer is connected to a separate, outdoor-type, 13.8 kV air-circuit breaker. These air-circuit breakers make it possible to supply power to the 36 Unit 1 or Unit 2 13.8 kV emergency buses(11). These are interlocked with the normal supply to prevent both supplies from being tied together. Switchgear constituting the 13.8 kV emergency buses of Units 1 and 2 is of the same type and rating as switchgear constituting the auxiliary buses. The switchgear breakers have a continuous current rating of 1,200 amperes. Each of these breakers can supply power to one of the ESF buses, via the associated auxiliary ESF transformer, when the standby transformers are not available and 36 the standby Diesel-Generators (DGs) fail to start. Switching and control of this switchgear are nonautomatic and by operator action only.

8.3.1.1.4 Onsite Standby Power Supply and ESF Power Distribution: The Onsite Standby Power Supply Systems of Units 1 and 2 each consist of three independent, physically separated, standby DGs supplying power to three associated load groups designated Train A, Train B, and Train C. Each load group consists of a 4.16 kV ESF bus and the electrical loads connected to that bus. The Onsite Standby Power Supply Systems of Units 1 and 2 operate independently of each other. Each standby DG and load group of a particular unit is also physically separated and electrically independent from the other two standby DGs and their load groups. Qualification of all Class 1E electrical equipment which is a part of the Onsite Standby Power Supply and ESF Power Distribution System is discussed in Sections 3.10 and 3.11.

Each standby DG is located in a separate room of the Diesel-Generato: Building, which is a seismic Category I structure (described in Section 3.8.4).

Each train (i.e., Load Group) is independent but is not totally redundant; two trains are necessary to mitigate the consequences of a design basis accident.

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

1. The respective unit auxiliary transformer

2. No. 1 standby transformer

3. No.2 standby transformer

4. Standby DG

5. 138 kV emergency transformer

When weither standby transformer nor the respective unit auxiliary transformer (is available, the standby DGs supply the power required by the ESF loads to (safely shut down the reactor. The 138 kV emergency transformer provides an (additional means for supplying power to these systems if for any reason the(above power sources are unavailable. This power sources is immediately available; however, its use is operator controlled.

in the event of loss of offsite power or safet.

ATTACHMENT ST.HL.AE. 1490

PAGE 14 OF 60

Each standby DG is automatically started; as described in Section 8.3.1.1.4.4, [36 and the required Class IE loads connected to that ESF bus are automatically connected in a predetermined time sequence. after the standby DC is ready to accept load. Each standby DG is ready to accept load within 10 seconds after the start signal.

The standby DGs are not used for peaking and therefore the design complies with BTP ICSB-8.

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

8.3.1.1.4.1 <u>ESF Buses</u> - The three ESF buses are physically and electrically separated from each other to comply with the single-failure criterion. There are no automatic or manual interconnections between **redundante** load groups.

Switchgear constituting the ESF buses is indoor-type, metal-clad, 5 kV switchgear qualified for Class IE service. All circuit breakers are of the magnetic, air-interruption type with an interrupting rating of 250 mVA. The continuous current rating of slk circuit breakers in this switch gear is 1,200 amperes. All circuit breakers are electrically operated with 125 ydc control power.

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

Two feeders from each 4.16 kV ESF bus supply power to a double-ended 480 V switchgear assembly. The transformer sections of this switchgear assembly consist of dry-type transformers rated 4.16 kV/480 V, 1,000/1333 kVA, AA/FA, 36 three phase, 60 Hz with impedence of 4.0 percent ± 7.5 percent tolerance. The switchgear sections consist of indoor, metal-enclosed, 600 V class switchgear.

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

ATTACHMENT ST-HL-AE 1490 PAGE 15 OF 60

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All circuit breakers are of the magnetic, air-interruption type with interrupting ratings consistent with the short-circuit duty at the point of application. All circuit breakers are electrically operated with 125 vdc control power. The bus tie breakers are normally open and are elected to allow power to selected loads on both bus sections under administrative control should once 3 of the power sources to the switchgear be disabled.

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

8.3.1.1.4.1.1 <u>Non-Class lE Loads Connected to Class-lE Power System</u>: The non-Class lE loads that can be powered from the standby Diesel Generators (SBDGs) during loss of offsite power are included in Table 8.3-3 and include:

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

2. Control Rod Drive Mechanism (CRDM) Cooling Fans

3. Reactor Cavity Vent Fans, and

4. Reactor Support Exhaust Fan through qualified isolation devices which are tripped upon A redundant sets of pressurizer heaters are connected to 480 V ESF load centers ELA (Train A) and ELC (Train C) As indicated in Table 8.3-3 these heaters are manually loaded during loss-of-offsite-power (LOOP) when a SI signal is not present. To nected under administrative control 30N

The balance of the non-Class 1E loads indicated above (See detailed listing in Table 8.3-3) are connected to common MCCs. As shown in Figure 8.3-1, these non-Class 1E MCCs, one per train, are connected to Class 1E 480 V MCCs. These MCC breakerst are tripped upon receipt of a SI signal and therefore are classe.

ified as isolation devices (see Section 8.3.1.4.4.14). As indicated on Table 8.3-3, these loads are either sequenced or manually loaded onto the standby DGs during a LOOP when a SI signal is not present. In the event sequencing is initiated by a SI signal, these loads may be manually loaded after resetting the SI signal, under administrative automatically control.

8.3.1.1.4.2 Equipment Capacities and Loading Basis - Each SBDG has a continuous 8,760-hour rating of 5,500 kW. The loads are listed in Table 36 8.3-3. The design and continuous rating selected is consistent with the requirements of Regulatory Guide (RG) 1.9 and IEEE Standard 387-19727. Capacities of individual loads are determined on the basis of motor maneplateration 36 ings. The diesel engine, generator, and accessories are briefly described in the following: 56 brake horsepower 4430.

 The DG set, manufactured by Cooper Energy Services, has the following ratings: 2000-hour at 5935 kW, 168-hour at 6050 kW, and 30-minute at 6050 kW. These ratings are based on a cooling water inlet temperature of 115°F.

through qualified isolation devices which

ST. HL AE. 1490 PAGE 16 OF 60 STP FSAR Each diesel engine is a cold starting, compression-ignition, multi-cylin-2. der type Each engine is a Type KSV-20-T, four-stroke, turbocharged machine. The generator is a synchronous-type, model HS-160 ET, 4160 V, 60 Hz, 3. three phase alternating current machine, manufactured by Electric Product Division of Portec. The generator continuous rating at 80 percent power voltage factor lagging is 6875 kVA. The generator and exciter are capable of and operating at 110 percent of the continuous ratings for a period of 2 hours power out of any 24 hours of operation with no reduction of annual maintenance 29 interval. The generator insulation is designed for the special environ-0430. mental conditions of the nuclear power plant. The generator has non-13N hygroscopic sealed Class F insulation in accordance with NEMA Standard MG1-22.40. 4. The generator excitation system manufactured by Electric Product Division of Portec, is a static-type exciter-regulator having response characteristics and sufficient capacity to provide the generator with the required excitation to allow startup of the loads listed in Table 8.3-3. The ex-1 36 citer voltage rating is consistent with the requirements of the generator field. Regulator sensing voltage is 120 yac, three-phase, 60 Hz, and is taken from the generator output by means of potential transformers. Each engine has two independent air compressor skids each consisting of 5. an air compressor, dryer, air receiver, and all piping and valves. 49 Each engine has an auxiliary skid with standby jacket water circulating pump, lube oil circulating pump, lube oil heaters, and other equipment. The auxiliary skids are located adjacent to the engine and generator skid. Each engine has an engine control panel, a generator control panel, and a high voltage cubicle. All these accessories are furnished by Cooper Energy Service (CES) but 36 much of the equipment is fabricated by subvendors contracted to CES. The DG units are subjected to the qualification program in accordance with RG 1.9 and IEEE 387-1977. 49 ESF motors are sized equal to or greater than the maximum horsepower required 29 by the driven load under normal running and runout condition. All motors are 0430. suitable for running at +10 percent of the nominal voltage rating. The 4.0 kV 15N class motors have a service factor ranging from 1.0 to 1.15, whereas 460 V motors generally have a service factor of 1.15. The 4 kV ESF motors, except those that are hermetically sealed, are provided with resistance temperature 43 detectors (RTDs) in the stator windings and with thermocouples (TCs) in sleeve bearings. The RTDs and TCs are monitored by the plant computer. The effect of any overvoltage at the motor teminal is reviewed.

ATTACHMENT

ATTACHMENT. ST-HL-AE 1490 PAGE 17 OF 60

Motor insulation is selected on the basis of normal and design basis event ambient temperatures and anticipated temperature rise resulting from maximum loading conditions (Section 3.11.4). Class 1E motors are seismically and environmentally qualified as described in Sections 3.10 and 3.11, respectively. Trouble alarms in the control room are provided for ESF motors.

Transformer impedances and standby DG voltage regulator and exciter characteristics are selected to permit starting the largest motor connected to a particular bus, when all other loads connected to the bus are energized, without the voltage at the terminals of all ESF motors falling below 80 percent of the nominal motor voltage rating.

8.3.1.1.4.3 Identification of Class 1E Equipment and Circuits - See Section 8.3.1.3 for identification of Class 1E equipment and circuits and Section 36 8.3.1.4 for separation of Class 1E equipment and circuits.

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

Automatic renergization f the Class IE buses is accomplished by solid state ESF Load Sequencers to start the required Class 1E loads imeprogrammed time increments. which also connect

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

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

A sequencer design demonstration test is performed to verify that no credible 36 common failure modes exist in the sequencer design. The test verifies responses to credible input perturbation and series of events.

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

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1.	Mode I (Safety Injection [SI] Actuation 8.3.1.1.4.4.1.	ion) discussed in Sections 7	······································
2.	Mode II (Loss of Offsite Power [LOOP] 8.3.1.1.4.4.2.]) discussed in Section	36
3.	Mode III (SI Actuations Coincident Wit 8.3.1.1.4.4.3.	th LOOP) discussed in Section	29 Q430. 33N
sequ tane these Engineered	8.3.1.1.4.4.1 Mode I (SI Actuations) encer detects the existence of Mode I ous receipt of any four or more of six SI (ESF): Actuation System (ESFAS); disc Safely Features	ESF Load Sequence Operation: abnormal operation by the si SI actuation signals genera cussed in Section 7.3.1. The Si crated by plant conditions as si	Each mul- ited by I signal is nown on Figure 7.2-1
Upon non- energ shown	detecting a Mode I existence, the ESF existence of a Mode II signal. The ESF gizes the equipment required for this n in Table 8.3-3 and Figure 8.3-4 (Sh	load sequencer logic verifi F load sequencer then automa emergency in programmed step er 2).	es the tically s as
The m 8.3-1	nanual sequences for re-connecting oth 3. and on Figure 8.3-4¢	er loads are also shown in T	able
Addit Syste isoch matic Secti	tionally, the standby DGs are started em. The standby DGs run with their go pronous mode, and their voltage regula mode. All non-critical protection d lon 8.3.1.1.4.6.	automatically by the ESF Act vernors automatically set in tors automatically set in th evices are bypassed as descr ESF loads are fed from the offsite source and	uation 36 the e auto- ibed in
With tor c can r the p	an SI signal present and no loss of p an reset the SI actuations signal from then be manually shut down from the co blant emergency operating procedures)	referred (offsite) power, th the control room, The stan ntrol room or locally. (base After the SI signal has been	e opera- dby DG 36
ted a the sector Simul	squently, if a LOOP occurs, load shedd to described in Section 8.3.1.1.4.4.30 SF load sequencer to enable recognition on 8.3.1.1.4.3.2. This memory is shown on F ated testing and actuation of Mode I	ing and load sequencing are However, the SI signal is men on of a Mode III condition, a igure B.3-4 (sneet 2). is discussed in Section 8.3.	initian horized by 36 s discussed in 1.1.4.7.
Opera the s volta 4.16	8.3.1.1.4.4.2 <u>Mode II (Loss of Offsi</u> <u>tion:</u> The ESF load sequencer detects imultaneous receipt of any two out of ge signals which indicate that the nor kV _p bus has dropped below acceptable 1: ESF	te Power) ESF Load Sequence the existence of Mode II (Lu four undervoltage or degrade rmal preferred source to the imits, or has failed complete	OOP) by ed 36 ESP2 ely.
Upon the E taine	receipt of any two out of four undervo SF load sequencer converts the recogn: d signal.	oltage or degraded voltage st ition of these signals into a	ignals, 36 a main-
Upon for t	detecting the existence of a Mode II, he non-existence of Mode I.	condition the ESF load sequencer will	. checks
The E	(a) Shed all loads on the ESR 4.16 kl formers: However, shedding of the network is accomplished by tripp side of the transformers only. The transformers remain 8.3-8	implement the following: SF Vous. (except the load conter load center transformers dist ping the breakers on the 480 breakers on the primary sid Amendment	1 36 Tribution V secondary Le of the 43

TTACHMENT ST. HL AE. 1490 PAGE 190F 60

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- (b) Start the standby DG with the governor in the isochronous mode and the voltage regulator in the automatic mode. Non-critical protective devices are bypassed as described in Section 8.3.1.1.4.6.
- (c) Trip the 4.16 kV ESF power supply breakers to disconnect the Class IE onsite power system from the offsite source.
- (d) Energize the equipment for this emergency event in programmed steps as shown in Table 8.3-3 and on Figure 8.3-4. (Sneet 2)

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

Simulated testing of Mode II is discussed in Section 8.3.1.1.4.7(2b).

inseri F - Requercer Operation. Møde 12 / 45/ the simultaneous existence of Møde Y and Møde 33:

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

- (a) Shed all loads on the 4.16 kV ESF bus. (except the load conter transe formers) c insert G'
- (b) Start the standby DG with the governor in the isochronous mode and the voltage regulator in the automatic mode.

Note - the standby DG receives a simultaneous emergency startup signal directly from the ESF Actuation System due to an SI actuatione signal. This signal starts the standby DG in the isochronous mode and the voltage regulator in the automatic mode. Under these condie tionse all non-critical protective devices are bypassed as described in Section 8.3.1.1.4.6.

- (c) Trip the 4.16 kV ESF offsite power supply breakers to disconnect the Class 1E onsite power system from the offsite source.
- (d) Energize the equipment for this emergency event in programmed steps as shown in Table 8.3-3 and on Figure 8.3-4. (Sheet 2)

insert "H"-----

insert E"

ATTACHMENT-ST.HL.AE. 1490 PAGE 200F 60

INSERT 'E'

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

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

INSERT 'F'

B. 3. 1. 1. 4. 4. 3 <u>Mode III (SI Actuation + Loss of Offick Power)</u>: Mode III to the existence of both Mode I and Mode II conditions. The ESF load sequencer distinguishes three separate methods of entry into a Mode III condition, as follows:

1. The simultaneous existence of Mode I and Mode II,

- 2. Mode I existing tollowed by mode II,
- 3. Mode I existing followed by Mode I.

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

Q430, 33N INSERT 'C'

However, shedding of the load center transformer distribution network to accomplished by tripping the breakers on the 480 V secondary side of the transformers only. The breakers on the primary side of the transformers remain connected.

INSERT 'H'

B. 3.1.1.4.4.3.2. Mode I Existing Followed by Mode II at Some Later Time. Should an existing Mode I (SI) be followed by a Mode II (LCOP), the ESF load sequencers each autometically implement the following:

(a) Shed all loads on the 4.16 KV ESF bus. However, shedding of the load center transformers distribution network is accomplished by tripping the breakers in the 480 V secondary side of the transformers only. The breakers on the primary (b) Shed certain side of the transformers remain connected. selected loads on the 480V ESF distribution (c) Trip the 4.16 kV ESF power supply breakers to disconnect system, as opplicable for that train (RHR pump the class IE onsite power system from the officite source. RCFC fans, EAB HVAC supply air fan, 480V, essential chiller, (d) Since the standby DG has been previously started by pressurizer heater, spent fuel the SI signal and is running at full speed when the pool cooling pump).) mode II occurs, the sequencer delays the permissive to close the DG breaker, to allow the breakers on the

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ATTACHMENT ST.HL.AE. 1490 PAGE 2/ OF 60 INSERT 'H' continued

ATTACHMENT ST HLAE 1490 PAGE 2.2 OF 60

secondary side of the load center transformers sufficient time to recharge the breaker closing spring mechanism. (2) Energize the equipment for this emergency event in programmed steps as shown in Table 8.3-3 and on Figure 8.3-4 (sheet 2). The load shedding of Itam (b) above removes all loads which are to be sequenced on or are manually loaded large loads. 8.3.1.1.4.4.3.3. Mode I Existing Followed by Mode I at Some Later Time. Should an existing Mode II (LOOP) be followed by Q430. a mode I (SI), the ESF load sequencers then automatically 33N implement the following: (a) Shed all loads on the 4.16 kV ESF bus (except the load center transformers and their associated 480 V distribution system). (b) Shed certain selected loads on the 480 V E3F distribution system, (RHR pump, RCFC Fans, EAB HVAC (c) Energize the equipment for this emergency event coling pur in programmed steps as shown in aTable 9.3-3 and on Figure 8.3-4 (Sheet 2). The load shedding of Itam (b) above removes all loads which are to be sequenced on or are menually loaded large loads.

ATTACHMENT ST-HL-AE-1490 PAGE 23 OF 60

The manual sequences for reconnecting other loads are shown in Table 8.3-3 and Figure 8.3-44	+	29 Q430.
S. wlated testing of Mode III in Section 8.3.1.1.4.7(3)2		33N
8.3.1.1.4.5 <u>Instrumentation and Control</u> - Automatic and manual control of each of the SBDGs and the ESF equipment requiring automatic sequencing is provided. Controls for safety-related equipment are generally provided in the control room as well as at equipment locations. Redundant control circuitry and control power sources are compatible with their associated power circuits		36 2
Instrumentation is provide to manually synchronize each SBDG with the ESF bus and to continuously monitor the status of the safety-related systems. Control power for the SBDG systems is obtained from the associated ESF 125 ydc sys- tems. The status of each SBDG is indicated in the control room, including the following parameters:	5 L B	1
1. Voltage, current, power, and frequency	36	
2. Breaker position of each bus supply and feeder breaker		
3. Cooling water pressure and temperature, lube oil pressure and tempera- ture, starting air pressure, fuel level, and engine rpm		
The bypass or inoperability status of each SBDG is automatically indicated in the control room through the ESF Status Monitoring System described in Section 7.5.4. The conditions alarmed through this system are the following:		49
1. DG not in remote mode		Q430 122N
2. Loss of starting air/starting air system malfunction		
3. Loss of control power		
4. Start circuit inoperable		
5. Emergency stop push button not reset		
6. Overspeed lockout not reset		
7. Generator differential lockout not reset		
Inoperability of the SBDGs may also be manually indicated through the Status Monitoring System. These conditions each have their own alarm windows. The SBDG monitoring complies with the guidelines of Branch Technical Position (BTP) PSB-2.		
These signals to the ESF Status Monitoring System, as well as other annun- ciator and computer alarms for various DG conditions, are shown on Figure 8.3-4 (Sheet 1).		

Amendment 49

ATTACHMENT ST.HL.AE. 1490 PAGE 24 OF 60

AC control power for vital instrumentation and controls is supplied by six 36 solid-state inverter/rectifier systems. The inverter/rectifiers are connected as shown on Figure 8.3-3. The inverter/rectifiers supplying power to instrumentation chanrels I and II are normally energized by 480 yac feeders from separate MCCs connected to different bus sections of the Train A, 480 yec switchgear. The inverters/rectifiers supplying power to channels III and IV 138 are normally energized by 480 yac feeders from MCCs connected to the 480 yac switchgear in Trains B and C, respectively. Upon loss of power from the 480 yac feeds, the inverter/rectifiers are automatically powered from the Class IE 36 BG system. The output of the inverter/rectifier is 118 wac, single phase, 60 each Hz. Vital Kg power from the inverter/rectifier is distributed by the instr-\$ 27. umentation power supply buses, which consist of Class 1E distribution panel boards. Manually operated, mechanically interlocked main circuit breakers in each distribution panel permit energization of the bus either by the corresponding inverter/rectifier or by an alternate 120 vac, single-phase, regu-38 lated, backup source, as shown on Figure 8.3-3.

8.3.1.1.4.6 Onsite Standby Power Supply System Protection - The onsite standby power system is provided with protective devices to:

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

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

- 1. Both the 4.16/ESP kV bus supply breakers (normal and standby generator feeds) are tripped and locked out upon the occurrence of a bus fault for that particular bus (Train A, B, or C).
- 2. Each 4.16 kV ESF bus supply breaker and the generator breaker for its corresponding standby DC are interlocked in such a manner that it is not possible for the DG breaker to close automatically unless the 4.16 kV ESF bus supply breaker is open. However the bus normal supply and the DC breaker can be manually closed to provide parallel operation for periodic testing of the DG sets.
- The disconnect switch associated with the auxiliary ESF transformer is interlocked to prevent simultaneous closing: thus avoiding a parallel connection between the standby transformers and the 138 kV emergency transformer.
- 4. In the automatic mode, the standby DG breaker control has permissive interlocks to prevent closing the breaker until the standby DG attains approximately 95 percent of rated frequency and voltage. Whenever the standby DG is tripped or stopped, the DG breaker is automatically opened.

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8.3-11

Amendment 52

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The motor operated disconnect switches on the primary side of the auxiliary ESF transformer are mechanically interlocked to prevent simultaneous closing,

Insert 2

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

ATTACHMENT ST. HL AE 1490 PAGE 26 OF 60

The details of the protection system are as follows:

 4.16 kV ESF System Protection - The bus incoming breaker is tripped by the auxiliary ESF transformer differential relay. In addition, instantaneous directional overcurrent and time overcurrent relays are provided in each phase to protect against reverse current and provide back-up protection to individual load feeders.

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

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

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

- Diesel Generator Protection Each standby DG is provided with the following protection:
 - a. Generator differential
 - b. Reverse power flow
 - c. Loss of field excitation
 - d. Low lube oil pressure (engine and turbocharger)
 - e. Excess vibration
 - f. Turbocharger thrust bearing failure
 - g. Engine overspeed trip
 - h. High jacket water temperature
 - 1. High engine/generator bearing temperature
 - j. Generator overcurrent
 - k. Generator underfrequency
 - 1. Ground fault
 - m. Negative sequence

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

ATTACHMENT ST HL AE 1490 PAGE 27 OF 6 C

- a. Generator differential
- b. Low lube oil pressure (engine and turbo charger)
- C. b. Engine overspeed

4.

Note: Coincident logic is required for low lube oil pressure trip. The bypassed protective functions are elarmed in the control room to elert the operator to take appropriate action.

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

 Each 4.16 kV ESF bus is provided with two levels of undervoltage detection as indicated in Figure 8.3-4, Sheet 5 of 5.

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

480 V ESF System Protection: Each 480 V ESF load center connected to the 4.16 kV ESF buses is protected against bus fault by a supply circuit breaker with a direct acting, solid state trip device having short time and long time trip functions. These breakers also provide backup protection to the individual load feeders. The 480 V feeders to MCCs and static loads are each similarly protected by a circuit breaker with short time and long time trip functions.

Feeders to motors from the 480 V ESF load center breakers are provided with long time and instantaneous trips. The 480 V Class LE system is an ungrounded system and hence a ground fault is sensed at the switchgear bus; it is then alarmed in the control room.

The 480 V ESF MCCs have the combination motor starters which are provided with magnetic, instantaneous trip circuit breakers for short circuit 36 protection. The static loads are provided with thermal magnetic breakers which provide overcurrent and short circuit protection. Motor circuits are provided with thermal overload devices in each of the three phases. The overload elements are set to protect the motor and the feeder cable. For all safety-related motor operated valves, the thermal overload devices are used for alarm only.

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

The 208/120 V system is solidly grounded through the 480-208/120 four wire distribution transformers. The circuit breakers will trip on phase to phase or phase to ground fault. The 220 yec instrument (i.e., vital) bus is ungrounded. 49 Q430. 107N

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

ATTACHMENT ST.HI E. 1490 PAC & OF 60

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

insert "1"

- b. The selected time delay minimizes the ability of short duration disturbances to reduce the availability of the offsite power source...
- c. The allowed time duration of a degraded voltage condition at all distribution system levels does not result in failure of safety systems or components.

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

During pre-requisite testing each protective device will be tested for proper operation to verify the relay settings obtained by the analysis.

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ATTACHMENT ST.HL.AE. 1490 PAGE29 OF 60

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

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

The details of the Containment electrical penetrations protection (RG 1.63) are described in the following. Both safety-related and nonsafety-related electrical penetrations are protected against short-circuit. The protection is provided by source and feeder breakers with coordinated short circuit protection. This protection limits the maximum I't at the penetration to a value far less than that resulting in thermal damage to the penetration seals. Details of the specific protection scheme are provided below:

- 1. The only medium voltage power circuits passing through the electrical penetrations are reactor coolant pump (RCP) motor power feeders. RCP motors are fed from 13.8 kV auxiliary buses 1F, 1G, 1H, and 1J through a feeder breaker. This switchgear is located in the Turbine Generator Building (TGB) which is a non-seismic Category I Building. Protection for the penetration conductors is provia. by coordinated primary and back-up protection using feeder and supply breakers, respectively. The feeder and supply breakers are supplied with 125 vdc control power from separate 125 V battery systems.
- 2. The 480 V power circuits (Class 1E/non-Class 1E) are fed from load centers and MCCs. Protection for the penetration conductors is provided by coordinated primary and backup protection using feeder and supply breakers. respectively: Protection for each circuit is reviewed and when coordinated protection cannot be achieved, a redundant breaker in series is provided with identical tripping characteristics.
- 3. 125 V dc control circuits are protected by double pole fuses and the system is ungrounded. Therefore an overcurrent condition is detected by two devices in series and, if one fails, the other provides the necessary protection.

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- ATTACHMENT ST-HL-AE- 1490 PAGE 30 OF 60
- 4 120 V ac control circuits are low energy circuits and are protected by one fuse. The energy released by short circuits on control cable in general is sufficiently low that backup protective devices are not required. Backup devices are provided where required.

Control circuits will be analyzed and

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

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ATTACHMENT ST.HL.AE. 1490 PAGE31 OF 60

Provi equip Each	8.3.1.1.4.7 <u>Testing of Onsite Standby Power System Equipment</u> - sions are made for periodic testing of the Onsite Standby Power System ment in compliance with RG 1.22, IEEE 338-1977 and BTP PSB 2. SBDG is subjected to standard factory tests and inspections prior to	29 45 Q Q430 430.33N
shipm is su desig RGs1.	ent to the site. In addition, prior to startup of the plant, each SBDG bjected to the field acceptance tests of starting, load acceptance with in load, full load rejection, etc., in accordance with IEEE 387-1977 and 9 and 1.108.	29 Q 430 49 33N
The a shutd start	bility to restart a DG by a "fast start" signal subsequent to normal own of the DG is verified by functional and starting tests prior to -up of the plant.	
	Onsite Standby Power	System
The ol 387-1 verify follow	bjectives and requirements of the above tests are detailed in IEEE 977 and RGs1.9 and 1.108. Periodic testing of the SBDGs is conducted to y theirs availability and capability to perform theirs safety functions as ws: its	29
1.	Tests are performed to verify that each SBDG can be started manually and automatically, synchronized, and loaded to nameplate rating when connect- ed in parallel with the normal power source. Each SBDG is operated under these conditions for one hour which is sufficiently long to demonstrate the ability of the equipment to perform its safety function. A minimum of	Q430. 33N 3€
ESF -	During testing, if an SI actuation signal occurs while the SBDG is paral- leled to the normal power source, the SI actuation signal takes prece- dence, and the SBDG feeder breaker is automatically tripped by a signal directly from the SH Actuation System. The 4.16 kV ESF bus supply break- er remains closed, and the ESF loads are connected to the 4.16 kV ESF bus by the ESF load sequencer per the design, as described in Section 8.3.1.1.4.4.	36
	The SBDG continues to run, its governor is automatically transferred to the isochronous mode, and its voltage regulator is put in the automatic mode, thereby enabling it to respond automatically to an emergency signal without the need for any operator action. Under these conditions, all non-critical protective devices are bypassed, as described in Section 8.3.1.1.4.6.	136
	If a non-critical trip occurs during testing, the SBDG trips. Upon a subsequent SI eccustion signal, the SBDG starts up automatically and runs with its governor in the isochronous mode with the non-critical protective devices bypassed.	36
insert'X"→t	If the offsite power source is lost while in parallel with the SBDC dure ing testing, the SBDC feeder breaker trips automatically on overcurrent. Upon detection of undervoltage on the 4.16 kV ESF bus, Mode 1 is initi ated by the ESF load sequencer, as described in Section 8.3.1 -4.4.22	130
W P	When the local control position is selected at the SBDG local control panel to perform maintenance and testing, a <u>SBDG "Local Position" alarme</u> is annunciated in the main control room. (An audible alarm is also sounde.)	36
	uindow for mode selector switch not in "remote" position is lit	5



Insert X

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

Whether the standby DG had been operating in parallel with the offsite power source or operating but not connected to the bus, upon detection of undervoltage on the 4.16 kV ESF bus, Mode II is initiated by the ESF load sequencer, as described in Section 8.3.1.1.4.4.2. The load sequencing has been arranged such that adequate time is provided between the 480V load center breaker closure (allowing time for closing spring charging) in step 2 and the next significant load required during loss of offsite power (centrifugal charging pumps) in step 4.

STP FSAR starting of the stands DGs during mai 30 standhe An Instated At the Bypass and inoperable Status amunchation An the main control toom! Tests are performed to demonstrate the readiness and the ability of each 2. standby DG+to start automatically in response to a simulated Mode IIIe which is a simultaneous SI actuation signak Mode IX and a toop signale. 30 Mode II, and to reach rated speed and voltage within 10 seconds as follows: for the DG Simulated SI ActuationeSignal (Mode I): to the Standby DCL a. 30 With the ESF Actuation System in test, the standby DG start-up 30 actuation slave relay can be operated directly from the Engineered Safeguards Test Cabinet. The standby DG starts automatically in the isochronous mode. The ESF Actuation System logic is so designed 30 that if an emergency start signal occurs during tosting, thee 290 INSERT automatic actuation circuitry overrides the testinge 430. B 3N on next b. Simulated LOOP (Mode JI): to the Standby DCC page With the ESF load sequencer in test position, the operators are able 36 to actuate any one of the four undervoltage relay signals to the FSF load sequencer from the 4.16 kV ESF bus. The ESF load sequencer is so designed that the signal causes a simulated actuation of Mode II (LOOP) time delay logic and contact closures. Under these test conditions, a low current is passed through the external circuits to 136 verify circuit continuity and integrity. (Subsequent tests external to the ESF load sequencer are made to verify the operability of the 36 external loads in accordance with IEEE 338-1977.) 45 The standby DG starts up automatically in the isochronous mode with 36 the voltage regulator in the automatic mode. The ESF load sequencer emergence actuation logic is so designed that if an actual Mode II (LOOP signal occurred during testing, recognized by the actuation of any two 36 out of four undervoltage relay signals, the testing is overridden, and the ESF load sequencer implements the proper mode of operation as described in Section 8.3.1.1.4.4. Tests are performed to demonstrate the readiness and ability of each 3. standby DGAto start automatically in response to a simulated Mode III and, **B**6 and to reach rated speed and voltage within 10 seconds as follows: ESFIOOD sequencher the DG Simulated signals of Mode I and Mode II, described in 2a and 2b above, 36 are initiated simultaneouslys coincidentally. coincident CThe ESF load sequencer logic is so designed that the simultaneous existence of Mode I and Mode II test signals causes a simulated actuation of 136 Mode III time delay logic and contact closure. Under these conditions, a low current is passed through the external circuits to verify circuit 36 continuity and integrity. (Subsequent tests external to the ESF load sequencers are made to verify the operability of the external loads in 36 accordance with IEEE 338-1977.) The testing performed ensures that the ESF

ATTACHMENT ST.HLAE. 1490 PAGE-33 OF 60

Amendment 45

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load sequencer responds properly to all three entry modes into

Mode III. as described in Section 8.3.1.1.4.4.3.

ACHMEN' AE. 1490 4 OF

The standby DG receives start signals **simultaneously** from both the ESF Actuation System and the ESF load sequencer, and starts automatically in the isochronous mode with the voltage regulator in the automatic mode.

The ESF Actuation System logic and the ESF load sequencer actuation logic is are so designed that if a simultaneous occurrence of an actual SI acutuate energy tion signal and a LOOP occurs during testing, the testing is overridden, and the ESF load sequencer implements the proper mode of operation, as described in Section 8.3.1.1.4.4.

4. Tost & aver performed/ to/ demonstrate/ the readiness and soultty of each ESS Your sequences to respond to a simulated SV actuation signal mode to

"1" to pa 8.3-16 With the ESF load sequencer and the ESF Actuation System in test, the operators are able to send any one out of six individual slave relay actuation signals from the Engineered Safeguards Test Cabinet to the ESF load sequencer.

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

The ESF load sequencer actuation logic is so designed that if an actual energy and Mode I (SIX signal occurred during testing, recognized by the setuations of four or more SI actuation relay signals, the testing is overridden,

and the ESF load sequencer begins the proper mode of operation, as described in Section 8.3.1.1.4.4.

The ESF Actuation System logic is so designed that if an accident occura during the testing, the automatic actuation eircuitry overrides the test ing. At this time, the DG starts automatically in the isochronous model with voltage regulator in the automatic mode in readiness for a LOOPC emergency c

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8.3.1.1.4.8 Optimum Emergency Diesel Generator Readiness - To assure optimum emergency diesel generator readiness and availability on demand, STP is developing a periodic testing program and a preventive maintenance program. The following requirements will be met:

- Plant procedures will include provisions for loading the diesel generators (DG) to a level that will remove gum and varnish buildup accumulated during periods of no load or light load operation.
- Periodic surveillance testing will be performed in accordance with RG 1.108 with the exceptions and interpretations in Section 8.3.1.2.10.
- Diesel generator equipment history records will be maintained and repair records will be reviewed for repeated failures which would warrant further technical investigation.

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ATTACHMENT ST.HL.AE. 1490 PAGE 35 OF 60

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

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

ATTACHMENT ST.HL.AE. 1490 PAGE 34 OF 6 0

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

8.3.1.1.4.9 <u>Diesel Generator Fuel Oil Storage and Transfer System</u> - Each 36 standby DG is provided with a fuel oil storage tank having enough capacity to operate the system with maximum connected load for a duration of at least 7 days.

The fuel oil system design and the factors considered in sizing the fuel oil 36 storage tanks are described in Section 9.5.4. Electrical and mechanical equipment in this system are classified seismic Category I.

8.3.1.1.4.10 Diesel Generator Cooling and Heating System - The DG jacket water cooling system is described in Section 9.5.5.

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

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

eliminate

Class IE equipment is separated as much as practicable from non-Class IE equipment to minimize the potential for degradation of the Class IE equipment by non-Class IE equipment. Separation between redundant Class IE electrical equipment is primarily provided by physical separation as indicated by Figures 1.2-4, 1.2-5 (sheet 1), 1.2-10, 1.2-26, 1.2-28, and 1.2-29. failure or matfunction of

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

 The main transformers and the unit auxiliary transformer of each unit are located outdoors and are separated from each other by fire walls provided between the transformers.units to confine a fire in any unit:

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

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

Each

All of the above transformers except the 138 kV emergency transformer aret is protected by a water deluge fire protection system.

The main generator breaker is located outside the TGB.

A sump is provided under each oil-filled transformer to contain the transformer oil in the event of rupture of the transformer tank. This 36 These sumps drains to an oil separator pit for water removal.

Amendment 45

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ATTACHMENT ST-HL-AE- 1490 PAGE 37 OF 60

lightning

Each outdoor transformer is protected against lighting and switching surges.

2. Class IE electrical equipment is located in a structures or buildings which

have has at seismic Category I classification. These buildings or structures are so designed as to protect the Class IE electrical systems from such postulated events as floods, hurricanes, and other natural events, as outlined in Sections 3.3, 3.4, and 3.5.

In general major Class IE electrical power distribution equipment located 36 in the Mechanical-Electrical Auxiliaries Building (MEAB) is arranged so that each train of the three-train ESF System is located on a different floor elevation. Separate rooms or compartments are also provided within each elevation to enhance the physical and electrical independence of 36 each redundant train.

The standby DGs are each located in a separate room of the Diesel-Generator Building (DGB). The associated Class IE electrical equipment located within each standby DG room is so located and protected within the room as to minimize the possibility of damage due to internally generated

ATTACHMENT ST. HL. AE. 1490 PAGE 38 OF 60

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missiles, pipe ruptures, fires, etc. However, occurrence of any of these events does not affect the ability of the remaining trains of the ESF system to perform their safety function, since no two trains of Class IE equipment or cables are located in or routed through any of the other standby DG rooms. Independent air intake and discharge air ducts for each DG room are furnished. Sufficient separation and isolation of air intake and exhaust gas ducts are provided to prevent dilution of the oxygen content to the diesel engines by the Air Exhaust System, as described in Section 9.5.8.

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

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

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

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

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

There are 27 electrices penetrations located between Elevations 19'-0" and 37'-3" inside the Containment and between Elevations 10'-0" and 35'-0" outside the Containment).

These groups of electrice penetrations have been assigned to Train A, instrumentation channels I and II, and other miscellaneous related to eircuits of the above. (For all penetration locations and assignmenter refer to Table 8.3-12 and Figure 8.3-14.)e

There are 18 electrical penetrations located between elevations 37'-3" and 52'-0" inside the Containment and between (Elevations 35'-0" and 60'-0" outside the Containment). These groups of electrical penetrations have been assigned to Train B, instrumentation channel III and all other miscellaneous related, circuits of the above. (For penetration locations and assignments) refer to Table 8.3-12 and Figure 8.3-14.2

circuits to

There are 24 electrices penetrations located above Elevation 68'-0" inside the Containment (above Elevation 60'-0" outside the Containment). These groups of electrices penetrations have been assigned to Train C, instrumentation channel IV, and miscellaneous circuits related to the above. (For penetration locations and assignments refer to Table 8.3-12 and Figure 8.3-14.)

ATTACHMENT ST.HL.AE. 1490 PAGE 390F 60

Design and qualification testing of electrices penetrations is in accordance with IEEE Standard 317-1976 and RG 1.63. Note, however, that 36 electrices penetrations being purchased for the Containment personnel airlock are to be qualified to IEEE 317-1976, which is endorsed by RG 1.63, Rev. 2.

Protection of the electrical penetrations is provided to preclude a single 29 51 failure from causing excessive currents in the penetration conductors which 2430. 0430. vould degrade the penetration seals. 130N

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

8.3.1.2 <u>Analysis</u>. The following summary describes how the AQ Power Systems comply with the requirements of NRC General Design Criteria (GDC), NRC RGs, and IEEE Standards.

8.3.1.2.1 Compliance with GDC 17, 18, and 21 and RG 1.93: Sections 8.3.1.1.2, and 8.3.1.1.4 describe the normal power distribution system of each 43 unit, with provision for connection to the respective unit auxiliary transformer and the standby transformers, and the onsite standby sources of each 36 unit. This arrangement affords sufficient flexibility and redundancy to ensure the availability of power to the ESF loads in the event of the occurrenced 49 ex a design basis event. Standby DGs reestablish power to the ESF buses within 10 seconds. The offsite power sources comply with GDC 17 and RG 1.93.

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

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

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

Amendment 52

ATTACHMENT ST.HL.AE. 1490 PAGE 40 OF 6 0

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

8.3.1.2.3 <u>Compliance With RG 1.9</u>: Each SBDG is rated on the basis of the sum of the nameplate ratings of the ESF loads it energizes during an accident. During step loading of the SBDG, possible voltage dips and frequency deviations due to the application of large motor loads may occur. These deviations do not exceed 20 percent of the nominal voltage and 5 percent of the nominal frequency. Recovery from such variations is within the RG 1.9 position (i.e., voltage restored to within 10 percent of nominal and frequency within 2 percent of nominal within 60 percent of each load sequence time interval). The DG protective trips are tagged by the ERF computer with a time, but time resolution provided may not be sufficient to identify the first trip as depicted by Rev. 2 of RG 1.9.

8.3.1.2.4 <u>Compliance With IEEE 279-1971 and RG 1.32</u>: Class lE systems and equipment comply with the requirements of IEEE 279-1971 (as amended by RGs 1.47 and 1.62 and RG 1.32) by virtue of the separation, redundancy, and independence provided in the various systems and the location of equipment in seismic Category I buildings and structures. Surveillance of Class lE Systems will be described in the Technical Specifications.

8.3.1.2.5 <u>Failure Mode Analysis</u>: Application of the single-failure criterion to safety-related systems is used to analyze failures of components and 4 causes and effects of failures in systems. Tabulations of failure modes and effects are shown in Tables 8.3-9 and 8.3-13.

8.3.1.2.6 Effects of Hostile Environments on Electrical Equipment: Class | 49 1E electrical equipment is designed to withstand the effects of the environ- | 36 ment existing at the equipment locations. All equipment located inside the Containment and required to operate during and after a design basis event is | 49 identified in Table 3.11-3.

8.3.1.2.7 <u>Compliance with RG 1.75</u>: The design and layout of the electric system is in accordance with the intent of RG 1.75. As noted in Sections 36 8.3.1.3, and 8.3.1.4. For NSSS scope systems the position on RG 1.75 is desc. 36 cribed in Section 7.1.2.2, 7.4.II.F.2.3.

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

8.3.1.2.9 Conformance With Appropriate Quality Assurance Standards: Conformance to RG 1.30 is as stated in Table 3.12-1 and Chapter 17.

8.3.1.2.10 Compliance With RG 1.108: Compliance with rhe intente of RG 45 1.108 are met with the following interpretations and exceptions: Q430.

<u>Starting air system</u>: System boundary starts at air receivers (isolation 36 valve downstream of the air dryer). Air compressors and dryers are not included since the engine can be started five times from air stored in 100 49 102N percent redundant (2 full capacity) receivers for each engine.

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- 2. Fuel Oil System: Fuel oil system boundary starts from the diesel fuel oil tanks and this is not part of the DG system for test purposes.
- Cooling Water System: The Essential Cooling Water (ECW) System cools the 3. engine jacket water, lube oil, turbocharger discharge and intake air, and governor oil cooler. The ECW system is not part of the diesel generator unit.
- 4. Position on Paragraph C.2.e.7: Tests to verify correction will be conducted after the affected DG is declared "ready for service." The diesel and the associated systems may be operated as necessary to perform troubleshooting and verify correction of specific problems, prior to such declaration, without these operations counting as a test, for the purposes of complying with this Regulatory Guide.
- 5. Position on Paragraph C.2.a.(3): STP takes a partial exception to the periodic operational load testing of the standby diesel generators. STP will not perform the two hour run at the two hour rating during normal plant operation, as specified in position C.2.a.3 of this Guide. This test requirement is viewed as imposing unnecessary stresses on the machiner. since the maximum load required for the design basis accident loadinge sequence operation does not exceed the rating of the diesel generatore. The type qualification test performed on an STF diesel generator proved that the STP diesel generator can operate for two hours at the two hour rating. The two hour test at the short time rating will be performede. 49 under the preoperational program as described in Section 14.2.12.2 (81)4. Q430. The results of this preoperational test will further demonstrate that the 130N diesel generator and its subsystems will not exceed their respective dec. sign ratings under similar conditioner. ->inser+ "A"

STP will run the diesel generator for 22 consecutive hours at the continuous rating of the diesel generator.

6. Position on Paragraph C.2.d: In addition to the above stated exceptions, the increased frequency of diesel testing in section C.2.d is excessive and may cause premature engine degradation. It is STP's intent to base the increase in testing frequency on the last 20 valid tests instead of the last 100 valid tests. This will reduce the RG 1.108 established reliability goal of .99 by four percentage points to .95, and will significantly reduce the rate of engine wear. The reliability goal of .95 is consistent with Generic Letter 84-15.

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

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

8.3.1.2.12 Compliance With RG 1.106: Thermal overload units on safetyrelated motor operated valves are used to provide alarm only under all

Q430. 130N

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Amendment 52

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ATTACHMENT ST. HL. AE. 1490

PAGE 41 OF 60

ATTACHMENT ST.HL.AE. 1490 PAGE 42.0F60

Insert A:

STP will perform the two hour run at the 2000 hour rating in accordance with the Technical Specifications. No transient condition or anticipated future load conditions will exceed the 2000 hour rating of the DG.

ATTACHMENT ST.HL.AE. 1490 PAGE 43 OF 60

conditions. Activation of these thermal overload units is alarmed in the control room. Overloads which are not used for tripping is not covered by RGC.

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

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

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

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

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

cables of

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

1. Physically Separate Areas

2. Separation by Distance

3. Separation by Barriers

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

Separation Group A

A Class IE instrumentation control or power cable, raceway or equipment related to ESF Train A, BQ Subsystem I, vital AQ instrumentation and control channel I or PAN T

Post Accident Monitoring (PAM) Channel 1.

Amendment 52

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ATTACHMENT ST. HL.AE. 1490 PAGE 44 OF 6 C STP FSAR Separation Group B A Class 1E instrumentation, control or power cable, raceway, or equipment related to ESF Train B, Bg Subsystem III, or vital Ag instrumentation and control channel III. 36 Separation Group C Q430. 19N A Class 1E instrumentation, control or power cable, raceway, or equipment re-040.4 lated to ESF Train C, DC Subsystem IV, vital K instrumentation and control channel IV or PAM, 2. channel Separation Group D A Class 1E instrumentation, control or power cable, raceway, or equipment related to Bg Subsystem II, or vital Kg instrumentation and control channel II. Separation Group R Reactor trip and ESF actuation train "R" as identified by Westinghouse. All cables are equivalent to Separation Group A and can be installed in the Group A raceway system with the exception of the interconnecting cables between logic cabinet R and the output actuation cabinets, Additionally, the 48 V undervoltage trip signals, should also be routed in separate conduited. These are to be installed in dedicated steel conduits. and (2) from the SSPS to the reactor 49 Separation Group S trip switchgear, Reactor trip and ESF actuation train "S" as identified by Westinghouse. cables are equivalent to Separation Group B and can be installed in the Group B raceway system with the exception of the interconnecting cables between logic cabinet S and the output acutation cabinets, Additionally the 48 V undervoltage trip signals, should also be routed in separate conduitse. These are to be installed in dedicated steel conduits. from the SSPS to the reactor trip and try Separation Group N (Designated M for the reservoir makeup pump facility) All non-Class 1E cables, raceways and equipment. 8.3.1.4.2 Separation Color Codes and Measurements: Separation groups A through D and R. S. N and M shall be color coded as follows: (Protection channels and DC subsystems of a separation group use same color) Red (red may be replaced by violet for cables and equipment tags) Group A: Blue (blue may be replaced by brown for cables and equipment Group B: tags)

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

Group D: White

8.3-24

Amendment 49

ATTACHMENT
ST. HL AE. 1490
PAGE 450F 60

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STP FSAR

Group R: Orange

Group S: Green

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

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

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

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

Raceways

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

- 1. 13.8 kV elasse circuits
- 4.16 kV closse circuits 2
- 3. 600 V power circuits
- Control circuits
- 5. Instrumentation circuits

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

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

redundant

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

8.3.1.4.4.1 Cable Spreading Areas Tray Separation: Cable spreading areas consist of the control room, the relay room and the cable spreading rooms on Elevations 21'-0", 60'-0", and 74'-9", encopting the cable chased

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

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

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

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

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

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

Solid

ATTACHMENT ST. HL. AE. 1490

PAGE 46 OF 60

8.3.1.4.4.4.3 Class 1E Conduit to Solid Bottom and/or Top Tray Separation - The minimum separation distance between Class 1E conduit and solid bottom and/or top of a tray is 1 in.

solid

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

or cables in free air

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Lithin

18:31.4.4.5 Exceptions to Area Separation Requirements - Where terminstion strangements or plant arrangements preclude mainteining the minimum separation distances a barrier is placed between trays, or the circuits may be analyzed.

8.3.1.4.4.66 Separation Within Enclosures - Field cables entering an enclosure maintain a 6-inch minimum separation between redundant safety-related group cables and between safety-related and nonsafety-related group cables. Where a 6-inch physical separation cannot be maintained, one of the following alternatives is provided:

- 1. Power
- MA. Each Class 1E separation group is installed in a totally enclosed metallic raceway. Minimum spacing between enclosed raceways is 1-inch or equivalent in thermal insulation material. The raceway is installed over the entire length of the cables or cable conductors from/to the point where a 6-inch minimum separation distance can be established (e.g., from the point of entry into the cabinet to the point of termination of the cable conductor).
- 34 b. A metal barrier is erected between the cabling, terminal blocks, or components of the redundant separation groups. A minimum separation of 1-inch or equivalent in thermal insulating material is maintained between the barrier and the cable, terminal blocks, or components. The barrier is extended a sufficient distance beyond the outer edge of the separation group cable or cable bundle such as to allow a minimum of 6 inches of air space between cables of redundant separation groups.
- Q.C. In case of less than a 6-inch separation between non-Class LE cables and Class LE cables, non-Class LE cables are placed in totally enclosed metallic raceway and a minimum separation of 1 inch or equivalent in thermal insulating material is maintained between totally enclosed raceways and Class LE cables. The inch anspace cannot be provided within the enclosure, a metallic raceway in a provided within the enclosure, a metallic raceway is a separation of the provided within the enclosure, a metallic raceway is a separation of the provided within the enclosure, a metallic raceway is a separation of the provided within the enclosure, a metallic raceway is a separation of the provided within the enclosure, a metallic raceway is a separation of the provided within the enclosure, a metallic raceway is a separation of the provided within the enclosure, a metallic raceway is a separation of the provided within the enclosure, a metallic raceway is a separation of the provided within the enclosure. A metallic raceway is a separation of the provided within the enclosure. A metallic raceway is a separation of the provided within the enclosure. A metallic raceway is a separation of the provided within the enclosure. A metallic raceway is a separation of the provided within the enclosure. A metallic raceway is a separation of the provided within the enclosure. A metallic raceway is a separation of the provided within the enclosure. A metallic raceway is a separation of the provided within the enclosure. A metallic raceway is a separation of the provided within the enclosure. A metallic raceway is a separation of the provided within the enclosure. A metallic raceway is a separation of the provided within the enclosure. A metallic raceway is a separation of the provided within the separation of

considered totally enclosed raceways:

Rigid steel conduit

Aluminum sheathed cable and copper sheathed cable

Flexible metal conduit (scamless). Liquidtant fixibe metal conduct Flexibe metallic trians with solid steel covers installed at top

and bottom of tray

Solid bottom tray with solid steel covers

8.3.1.4.4.8 Separation Criteria for Pipe Failure Hazard Areas - Separation of conduit and cable trays from pipe failure hazards in all areas is accomplished by the use of barriers, restraints, separation distance, or the appropriate combination thereof. Where it is not possible to prevent damage 36 Q430. 19N

Q40.4

Q430. 126N

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Q430. 126N

ATTACHMENT 90 ST.HLAE 149 PAGE 4 9 OF 60

Insert "A"

- Control and Instrumentation Cables.
 - a. Each Class LE separation group is installed in a totally enclosed metallic raceways. The raceway is installed over the entire length of the cables or cable conductors from/to the point where a 6-inch minimum separation distance can be established (e.g., from the point of entry into the cabinet to the point of termination of the cable conductor).
 - b. A metal barrier is erected between the cabling, terminal blocks, or components of the redundant separation groups. The barrier is extended a sufficient distance beyond the outer edge of the separation group cable or cable bundle such as to allow a minimum of 6 inches of air space between cables of redundant separation groups.
 - c. In case of less than a 6 inch separation between non-Class lE cables and Class lE cables, non-Class lE cables are placed in totally enclosed metallic raceway. Minimum separation may also be established by analysis in accordance with IEEE 384-1974.

ATTACHMENT ST. HLAE 1490 PAGE 490F 60

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Q430.14 Q40.4

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0430.

125%

Q430. 125%

to a Class 1E raceway in the event of a pipe failure, an analysis is performed to assure that safe shutdown capability is maintained. The protective mechanisms provided for pipe failure are further discussed in Sections 3.6.1.3.2 and 3.6.2.4.

8.3.1.4.4.9 Separation Criteria for Missile Hazard Areas - Separation of conduit and cable trays from missile hazards in all areas is accomplished where possible by the use of barriers, orientation, separation distance, or the appropriate combination thereof. Where this separation is not practical the routing of Class is conduit and trays through the area conforms to the following requirements c

And the failure causing the missile does not require propective action. Olass 12 conduit and trays routed through the area are limited to a single division.

Where the failure of the missile source involved requires provective action, Class IE conduit and trays are not routed through the area except for those which must terminate at devices of loads within the area.

2/

(or flooding is accomplished where possible by the use of barriers, or intation, separation, distance, or the appropriate combination thereof. Where it is not possible to prevent damage to a class it roceway in the event of a missile hazard or flooding, an analysis is performed to assure that safe shutdown capability is maintained.

ATTACHMENT ST. HLAE 1490 PAGE SO OF 60

. Where the safety related missile source is assignable to a single divisione but this failure requires no protective action, Class 1E conduit and proves routed through the area are limited to the same division as the missiled -DOUTCOL

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

Separate ducts are provided for each redundant Class IE separation group: howseveral ever, since the ducts are enclosed in reinforced concrete, the duct enclosure for all separation groups may be common. Instrumentation cable and cables of different voltage levels are routed within manholes in a manner that maintains a separation commensurate with that outlined for general plant areas. and located at

electric 8.3.1.4.4.11 (Electrices Penetration Area - Containment penetrations are physically separated one different floor elevations of the Containment wall. and Electrical Auxiliary Buildinge. The vertical and horizontal separation distances between redundant separation groups are not less than the minimum acceptable separation distances of 3 ft horizontally and 5 ft vertically for general plant areas.

Electrice penetrations and piping penetrations are located in different quadrants of the Containment circumference. There are no possible missile sources inside or outside the Containment electrical penetration areas. In addition, all nonconducting, nonmetallic materials are flame retardant.

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

8.3.1.4.4.12 Raceway Supports - Gable tray supports - conduit supports ande cable duces for Class IE circuits are designed to comply with Seismic Category Raceway requirements. + Cable trave supports for non-Class 1E review which are located in areas which contain safety-related or Class IE equipment are alex. designed to comply with Seismic Category 1 requirements (raceways -insert"B

8.3.1.4.4.13 Cable Routing and Cable - Cables going to the control room and belonging to seseparation groups \$A and DY, and (B and CY are generally routed through separate cable chases and cable spreading rooms within the Electrical Auxiliary Building. Separation group A and D cables enter the lower cable spreading room while separation groups B and C cables enter the upper cable spreading room.

Non-Class JE cables are not routed through Class IE raceways.

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

The fire barriers used to achieve required separation in lieu of spatial separation are rated for 3 hours unless, otherwise demonstrated adequate. a lesser rating 13

Ampacity rating and group derating factors of cables are in accordance with manufacturers' standards which comply as a minimum, with ICEA P-46-426 for cables in conduit or ducts and with ICEA P-54-440 for cables in trays. Power



... are designed such that they will not fail during a safe-shutdown earthquake to the degree that they will degrade, to an unacceptable level, the ability of safety related, seismic Category I structures, systems and components to perform their required safety function.

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ATTACHMENT ST.HL.AE. 1990 PAGE 320F 60

	troys 2kv	
	Tables rated at 5 kV and 15 kV are installed with 1/4 diameter maintained spacing. in the trays. For power conductors rated at 600 V and below, tray fill is generally limited to 35 percent of the usable cross section of a 5-inch eep tray. In cases where this condition is exceeded, each individual case is eviewed for adequacy of the design. For trays containing only control or instrumentation cables, a 40 percent fill of a 5 inch deep tray limitation is applied in general.	45
	s a minimum, power cables are sized using 100 percent load factor and rated or 90°C conductor temperature. Correction factors for ambient temperature ther than 40°C are incorporated in according with 10°C and 10°C are incorporated in according to 10°C are incorporated.	
	s stated in Section 3.11, cables are qualified in accordance with DC 1 100	
	onduit fill is based on 53 percent fill for one conductor, 31 percent fill or two conductors and 40 percent fill for three conductors or more. Circuits for electrical	
class are	8.3.1.4.4.14 Associated Circuits and Isolation Devices - Equipment there mot qualified as Class IE and does not perform a safety function but which connected to the IE system through isolation devices - These circuits which y BC 1.75 definition are classified as "associated" fare identified as Class	4 3
	ircuit from the isolation device to the equipment is identified as non-Class	3
	th Class IE equipment or circuits. Circuits which share an enclosure or recevered accevary subsequent to the isolation device but which are not connected to lass IE circuits are identified as Class IE. Therefore, associated circuits is re not identified as such but either as Class IE or non-Class IE.	02 1. 10 det
	he following are electified as isolation devices:	inter to
	. Class IE Isolation Transformers.	Or)
	. Class 1E Thermal Magnetic Tript Devices which are tripped on receipt of a SI signal.	1.1144
	Class IE Digital Isolators (See Section 8.3.1.5.1).	
	Class 1E Analog Isolators (See Section 8.3.1.5.2).	1
	Class 1E control switches with 6" separation or barriers between separation groups.	î
	Control circuit fuses (Class IE) which isolate the non-Class IE circuit prior to the operation of the Class IE circuit protective device.	
	Class IE relays with barriers.	
	Redundant Class IE thermal magnetic trip devices in series.	
	Class 1E current transformers.	
	vices which are located in the TGB (a non-seismically designed building) but hich are connected in Class IE circuits are routed in dedicated non-Class IE 43 ligid steel conduit in accordance with Section 8.3.1.4.	
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	and an	

ATTACHMENT 1490 ST-HL-AE-PAGE 530F 60

8.3.1.4.4.15 Administrative Responsibilities and Controls for Assuring Separation Criteria - The cable and raceway channel identification described in Sections 8.3.1.3 and 8.3.1.4.2 facilitates and ensures the maintenance of equipment 36 separation in the routing of cables and the connection of control boards and Q430. panels. At the time of the cable routing assignment during design, those re-19N sponsible for cable and raceway scheduling check to ensure that the separation group designation in the cable number is compatible with a single-line-diagram 040.4 load group designation. Extensive use of computer facilities assists in ensuring separation. Each cable and raceway is identified in the computer program, and the identification includes the applicable separation group designation. Auxiliary programs are made available specifically to ensure that cables of a particular separation group are routed through the appropriate raceways. The routing is also confirmed by quality control personnel during installation to be consistent with the design document. Color identification of equipment, and cabling assist field personnel in this effort.

Engineered Safety Signal Isolation System. The Engineered 8.3.1.5 Safety Signal Isolation System provides Class 1E to non-Class 1E and non-Class 1E to Class 1E digital and analog signal isolation while maintaining Class 1E 32 integrity in accordance with RG 1.75. This system uses solid state components to the maximum extent practicable, consistent with interface and reliability requirements. Interchangeability is provided for all similar modules, components, or assemblies. Dissimilar modules, components, and assemblies do not permit interchangeability. To prevent incorrect insertion or interchange, cable connectors, if required, are keyed and identified. The isolation device terminal arrangement provides physical separation in accordance with RG 1.75. when isolation barriers are required, they are in accordance with RG 1.75. 36

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

- Mercury wetted relays are not used.
- Printed circuit board layout provides separate input and output patterns and components.
- coils contact Relay sockets ensure separation of relay pinst and terminal connections.

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

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

8.3.2 DC Power Systems

8.3.2.1 Description. The By Power Systems of Units 1 and 2 consist of 36 four Class 1E 125 ydc battery systems and Balance-of-Plant (BOP) battery eystems ecoposed of one 48 ydc, two 125 ydc, and one 250 ydc battery in each unit 43 including

each

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ATTACHMENT ST. HL. AE. 1490 PAGESYOF 60

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as shown in Figure 8.3-3. There are separate batteries provided with the 36 plant computer, and other data acquisition systems. These batteries do not interface with the rest of the plant pd Power System.

8.3.2.1.1 <u>Class lE Battery Systems</u>: The Class lE 125 ydc Battery Systems of each unit consists of four independent, physically separated buses, each energized by two battery chargers and one battery. Voltage on any seperate bus varies between 105-140 ydc depending on the operating mode of battery charging equipment and system loads. The batteries are sized in accordance 107N with IEEE 485-1978. 135

Emergency power required for plant protection and control is supplied by the batteries without interruption when the power from ac sources is interrupted. Each battery system also supplies power to its associated inverter system. Which converts the dc power to ac power at 118 was, 60 Hr single phase for the vital instrumentation and protection system, The six wital ac buses supply power to instrumentation channels 1, 11, 111, and IV. There are two vital act buses each for channels I and IV, and one vital ac bus each for channels II and IIIE as discussed in Section 8.3.1.1.4.6.

The ampere-hour capacity of each battery is sufficient to provide, for a minimum of 2 hours, the power required by emergency dc controls and the vital ac 43 instrumentation and protection system. Only small dc loads and dc controls 49 29 are supplied from the 125 ydc batteries.

The tro copiaged with each ply the boux 124 yes burey are uses bit the same train to entraped the replacitions CENDECLES 113 shakest yack is regulized hoy shannels II and III And / chatgers for dooh of channels I and IV are required. 6 alt. 36

The four 125 ydc batteries are each located in separate rooms in a seismic Category I building which inhibits the propagation of fire and provides protection against missiles. Battery chargers and distribution panels associated with a given battery are located outside of the battery room. Each battery room is ventilated by the Heating. Ventilating, and Air Conditioning (HVAC) System (Section 9.4.1) through separate intake and embaustefans which are energized from the ESF buses.

The Class 1E DC Power Systems are designed to withstand the effects of tornadoes, fires, and the Safe Shutdown Earthquake (SSE) without loss of function. Flooding of the battery rooms is precluded by the elevation and location of the battery rooms in the Mechanical-Electrical Auxiliaries Building (MEAB).

The environmental and seismic qualification programs of the Class IE battery system are discussed in Sections 3.10 and 3.11. The Class IE Battery System are designed to comply with the requirements of NRC RGs 1.6 and 1.32.

Each of System is provided with an annunciator window having inputs from each of the two chargers and the switchboard. The computer may be used to identify which of the three inputs is being alarmed.

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

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Amendment 49

•	STP FSAR ST.HL.AE. 1490 PAGE 3 DF 60	
+	. Input undervoltage (ac)c	1
12	Output under and overvoltage (dc)	
2.3	te ground & STET	
4	. Output breaker position (alors when open) C	
Ea	the has the following alarm circuits which are connected common to the control room annunciator/computer:	43
1.	. Input breaker position from battery charger (alarm when open)	
2.	Input breaker positions of selected loads (alarm when open) Output breaker positions of selected loads (alarm when open) Battery overcurrent (computer only)	
4.	Battery charger no current/overcurrent (computer only)@	36
4.54	dc bus ground and over/under voltage (combined)	Q430. 35N
th	e control room: Switchboard Jus voltage	
2.	Battery current	
3.	Battery charger current from each charger	
East	ch battery is protected by an air circuit breaker with long-time and short- me protection.	36
Id:	entification of Class 1E dc systems and equipment is discussed in Section 3.1.3.	
lea tai pre	8.3.2.1.2 <u>Class 1E Batteries</u> : Class 1E 125 ydc batteries are 59-cell ad-calcium type, assembled in shock-absorbing, clear plastic, sealed con- iners. Noncombustible spacers are provided between cells and cell clamps to event shifting during seismic events. The battery cells are mounted on ismic Category I, corrosion resistant, steel racks.	36 2
The nom siz the	batteries are suitable for continuous float duty and are maintained in a minally fully charged state by the batterv chargers. The batteries are red to carry their connected ESF loads for two hours without power flow from a chargers in the event of loss of all ac power.	36
The	FSF loads energized from each de bus are shown in Table 8.3-6.	
Upo aut sit sta	on loss of power from the 10 System to the battery chargers, the batteries comatically assume the load without switching. In the event that all off- te ac sources are lost, ac power to the battery chargers is supplied by the andby DGs.	36

Insert 1

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

- Input undervoltage, charger output breaker open position or charger input to switchboard breaker open position for each battery charger. (ERF computer is used to indicate which condition caused the window to light.)
- 2. Battery output breaker open position.

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

ATTACHMENT ST. HL. AE. 1490 PAGE 570F 60

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Each battery is sized to provide a minimum of 1.78 V/cell at the discharge state after 2 hours. 49 8.3.2.1.3 Battery Chargers: Each Class 15 Battery System consists 12 bettery chargers associated with each 125 vde betterye 136 > insert "1 Battery chargers are sized to recharge the battery within 12 hours from the Bysgnarged state (1. B) /gell) to the nominally this shared state when 36 charging carpent was stavilized at the charging voltage 7.31 y/cely. even though specific gravities have not stabilized) while supplying roads indicated, in Table 8.3-6. 49 430.35 The output voltage of each battery charger is adjustable to +10 percent of the 13028 value required for periodic equalizing charging of the battery (i.e., +10 43371 percent of 141 ydc). AC power to the Class 1E battery chargers associated with a given battery is supplied from independent MCCs connected to double-ended sections of switchgear. The switchgear sections are energized from the ESF buses and supplied with power from the standby DGs when offsite sources are unavailable. achieved Independence of the four battery systems is secured by separation of cables and equipment and by prohibiting cross-ties between load groups in different 36 trains. Each battery charger is equipped with a dc voltmeter and ammeter. Protection against power feedback from the battery to the charger and ac source, upon 43 loss of the ac source, is provided. 8.3.2.1.4 Testing: Periodic testing of Class 1E DO Power System equipment is performed in accordance with RG 1.32 to verify its ability to perform its safety function. The batteries and chargers are inspected and tested in accordance with the 36 Technical Specifications. Visual inspection, liquid level, specific gravity, and cell voltage and tem-36 perature checks are performed routinely on the batteries. Additional testing in accordance with RG 1.129 is performed. 36 8.3.2.1.5 Service Equipment: All equipment of the DO Power Systems is located in moventilated, controlled environments outside of the Reactor Con-2 tainment Building. circuits Class 1E pd Power System eables or supporting structures penetrating into the RCB are designed to operate in the post-accident environment for the period of time required to maintain the plant in a safe shutdown conditions following a Design Basis Accident (DBA), as discussed in Section 3.11. 8.3.2.1.6 Non-Class 1E Battery Systems: The non-Class 1E Battery Systems in each unit consist of one 48 ydc distribution panel bus, two 125 ydc distribution panel buses and one 250 ydc distribution panel bus. These buses are energized by two battery chargers and a battery. 8.3-33 Amendment 49

Insert 1

There are two battery chargers associated with each of the four 125Vdc buses. These chargers are connected to their train related ac buses. One charger is required for each of Channels II and III. Two chargers are required for each of Channels I and IV.

The battery charger configurations, as stated above, are sized to restore the battery voltage within 12 hours after being discharged for the batteries' 2 hour duty cycle. The batteries are floated at 2.20V/cell (130 Vdc) and equalized at 2.27(+1%) V/cell (135Vdc).



ATTACHMENT ST.HL.AE. 1490 PAGE 590F 60

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

These non-Class 1E battery systems are entirely independent of the Class 1E batteries and the Class 1E AC Distribution System. There are no interconnections between the two classes of systems. The 250 ydc system generally supplies the large balance-of-plant loads, such as the turbine generator emergency lube oil pump and other similar loads. The 125 ydc systems supply 36 smaller balance-of-plant loads, such as switchgear control power. The 48 ydc system is used exclusively for the plant annunciator and has no interface with the Class 1E BC Power System.

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

8.3.2.2 <u>Analysis</u>. The following summary highlights the compliance of the design of the Class IE pg Power Systems with the NRC GDC, and NRC RGs. 36

Failure modes and effects analysis for the Class IE presented in 36 Table 8.3-8.

8.3.2.2.1 <u>Compliance with GDC 17, 18 and 21</u>: As described in Section 8.3.2.1, the Class 1E DY Power Systems are designed with sufficient flexibility and redundancy to ensure the availability of power to the plant protection and control systems under all postulated design basis events. In addition, when all ac sources are lost, the stored energy in the batteries is sufficient to supply the power needs of critical instrumentation and control systems for a duration sufficiently long to restore the ac power sources. Therefore, the design is in compliance with GDC 17.

Provision for periodic inservice testing of Class 1E by Power System equipment 13 is made in compliance with GDC 18 and 21. This testing verifies the availability and capability of equipment to perform its design functions.

8.3.2.2.2 <u>Compliance with RG 1.6</u>: Figure 8.3-3 and Section 8.3.2.1 de- 136 scribe the separation, redundancy, and independence which exists within the Class IE BC Power System to meet the singlegfailure criterion. 13

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

8.3.2.2.4 <u>Compliance with RG 1.75</u>: The design and layout of the Elec- 3 trical Raceway System and circuits comply with the requirements of RG 1.75, as discussed in Section 8.3.1.4.1.

8.3.2.2.5 <u>Compliance with RGs 1.128 and 1.129</u>: The Class 1E BQ System is in compliance with RG\$ 1.128 and 1.129. Testing is described in Section 8.3.2.1.4. 5.2.2(12) of IEEE 484-1975 endorsed by RG 1.128. The intercell connection resistance will not be greater than ISOXIO⁶ ohmine 3-34, in accordance with NUREG 0452 (July 27, 1981) Section 4.8.2.1.

ATTACHMENT ST.HL.AE. 1490 PAGE 60 OF 60

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

3.12-1.

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

8.3.3 Fire Protection for Cable Systems

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