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8.0 ELECTRIC POWER

8.1 INTRODUCTION

The Cleveland Electric Illuminating Company (CEI) is one of the five members of the Central Area Power Coordination Group (CAPCO), and serves as the agent for CAPCO on this project. The other member companies are Duquesne Light Company, Ohio Edison Company, Pennsylvania Power Company and Toledo Edison Company.

The CAPCO service area covers approximately 14,000 square miles in Ohio and Pennsylvania. The present (May 15, 1979) total capacity of the CAPCO companies is approximately 15,448 MWe net demonstrated capacity (NDC), with 8,481 MWe under construction or committed (including the Perry units). The CAPCO group transmission voltages are 69 kV, 138 kV, and 345 kV, with interconnecting ties to neighboring utilities at 138 kV and 345 kV.

The CEI portion of the CAPCO service area encompasses approximately 1,700 square miles in northeastern Ohio. The May 15, 1979, total capacity of the CEI system is 4755 MWe (NDC). Presently, CEI has three transmission voltages: 69 kV, 138 kV and 345 kV. The CEI transmission system is interconnected with Pennsylvania Electric Company (at 345 kV), Ohio Edison Company (at 138 kV and 345 kV), and Ohio Power Company (at 345 kV), as shown in Figure 8.1-1. The CAPCO service area is part of the East Central Area Reliability (ECAR) system, as shown in Figure 8.1-2.

The Perry Nuclear Power Plant consists of two 1205 MWe (net) units which generate power at 22 kV. The power from each unit is fed via an isolated phase bus to the unit's main transformers, stepped up to 345 kV and delivered to the adjacent 345 kV switchyard. The physical arrangement is further explained in Section 8.2.1.2.

The 345 kV switchyard includes five transmission circuit terminals. The switchyard is arranged in a breaker-and-a-half configuration and serves as the interface between the preferred sources (Unit 1 and Unit 2 startup transformers) and the offsite transmission network. The transmission system, switchyard, and plant interfaces are further discussed in Section 8.2.1.

The loads connected to the Class 1E buses are normally supplied from the preferred offsite power system. On complete loss of offsite power, the engineered safety features loads are automatically transferred to the standby diesel generators.

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

8.1.1 SAFETY LOADS

The engineered safety feature power systems consist of three independent load groups per unit. They are designated as Division 1, 2, and 3. Each group consists of 4160 volt, 480 volt, 120 volt a-c, and 125 volt d-c systems. The redundant engineered safety feature systems in Divisions 1, 2, and 3, required for safety functions, are listed in Table 8.1-1 as an introduction, and detailed as part of Table 8.3-1 for the a-c loads and Table 8.3-7 for d-c loads.

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

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

8.1.2 REFERENCES FOR SECTION 8.1

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

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

TABLE 8.1-1

REDUNDANT ENGINEERED SAFETY FEATURE SYSTEMS

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

TABLE 8.1-2

DESIGN BASES FOR CLASS 1E POWER SYSTEM

Publication	Discussion
10 CFR 50 Appendix A General Design Criteria 17	Offsite and onsite electric power systems are provided to ensure integrity of electric power service to Class 1E systems while withstanding a single failure.
10 CFR 50 Appendix A General Design Criteria 18	Electric power system components and systems are designed to permit periodic functional testing to ensure integrity of systems and operability of components.
IEEE Std. 279-1971	Protection systems are designed in accordance with IEEE Std. 279-1971.
IEEE Std. 308-1974	The design of the Class 1E Power System is in accordance with IEEE Std. 308-1974, as modified by Regulatory Guide 1.32.
IEEE Std. 317-1976	Electrical penetration assemblies are designed and applied in accordance with IEEE Std. 317-1976, as modified by Regulatory Guide 1.63.
IEEE Std. 323-1971	All Class 1E equipment is qualified in accordance with IEEE Std. 323-1971. Section 3.11 presents the details of the qualification program and describes further compliance to IEEE Std. 323-1974 (as modified by Regulatory Guide 1.89) for certain components and equipment.
IEEE Std. 334-1971	Inside containment Class 1E motors are type tested in accordance with IEEE Std. 334-1971, as modified by Regulatory Guide 1.40. All Class 1E motors are qualified in accordance with IEEE Std. 323-1971.
IEEE Std. 336-1971	Methods for installation, inspection and testing of instrumentation and electric equipment are in accordance with IEEE Std. 336-1971.
IEEE Std. 338-1977	Periodic testing of electric power and protection systems is in accordance with IEEE Std. 338-1977, as modified by Regulatory Guide 1.118 and described in the technical specifications.

TABLE 8.1-2 (Continued)

Publication	Discussion
IEEE Std. 344-1971	All Class 1E electric equipment is seismically qualified in accordance with IEEE Std. 344-1971. Section 3.10 presents the details of the seismic qualification program and describes further compliance to IEEE Std. 344-1975 (as modified by Regulatory Guide 1.100) for certain components and equipment.
IEEE Std. 379-1977	Single failure criteria is applied to Class 1E systems in accordance with IEEE Std. 379-1977.
IEEE Std. 382-1972	Qualification of electric valve operators is in accordance with IEEE Std. 382-1972, as modified by Regulatory Guide 1.73.
IEEE Std. 383-1974	Cables, field splices and connections are type tested in accordance with IEEE Std. 383-1974.
IEEE Std. 384-1974	Separation criteria for Class 1E equipment and circuits is in accordance with IEEE Std. 384-1974, as modified by the discussion under Regulatory Guide 1.75.
IEEE Std. 387-1977	Application of standby diesel generators to the Class 1E power system is in accordance with IEEE Std. 387-1977. Type testing modifications for the HPCS diesel generator units are described in G.E. Topical Report NEDO-10905-2.[2]
IEEE Std. 415-1976	Preoperational test programs for the Class 1E power system are in accordance with the guidelines in IEEE Std. 415-1976 as described in Chapter 14.
IEEE Std. 450-1975	Maintenance, testing and replacement of Class 1E storage batteries are in accordance with IEEE Std. 450-1975, except in the areas of general inspections, corrective actions, and other operational criteria affecting plant technical specifications. The plant technical specifications will reflect current industry practice, which is being developed by IEEE in a revision of IEEE Std. 450-1975.

TABLE 8.1-2 (Continued)

Publication	Discussion
IEEE Std. 484-1975	Class 1E batteries are designed and installed in accordance with IEEE Std. 484-1975.
Regulatory Guide 1.6	The independence among standby power sources and among their distribution systems is in accordance with Regulatory Guide 1.6. HPCS system conformance to Regulation Guide 1.6 is discussed in Section 8.3.1.2.3.4.
Regulatory Guide 1.9	The standby diesel generators are selected in accordance with Regulatory Guide 1.9. The detailed design and testing criteria for the HPCS diesel generators is described in G.E. Topical Report NEDO-10905-2, and Section 8.3.1.2.3.5.
Regulatory Guide 1.22	The protective systems and components important to safety are designed to allow periodic testing in accordance with Regulatory Guide 1.22.
Regulatory Guide 1.29	The seismic design classification of electric equipment and components important to safety is in accordance with Regulatory Guide 1.29.
Regulatory Guide 1.30	Instrumentation and electric equipment are installed, inspected and tested in accordance with Regulatory Guide 1.30.
Regulatory Guide 1.32	The design of the Class 1E power system is in accordance with IEEE Std. 308-1974, as modified by Regulatory Guide 1.32.
Regulatory Guide 1.40	Inside containment Class 1E motors are type tested in accordance with IEEE Std. 334-1971, as modified by Regulatory Guide 1.40.
Regulatory Guide 1.41	Preoperational testing of the Class 1E power system is in accordance with Regulatory Guide 1.41.
Regulatory Guide 1.47	Bypass and inoperable status indication is provided in the plant control room in accordance with Regulatory Guide 1.47.
Regulatory Guide 1.53	Single failure criteria is applied to protection systems in accordance with Regulatory Guide 1.53.

TABLE 8.1-2 (Continued)

Publication	Discussion
Regulatory Guide 1.63	Electrical penetration assemblies are designed and applied in accordance with IEEE Std. 317-1976, as modified by Regulatory Guide 1.63.
Regulatory Guide 1.68	Preoperational and initial startup test programs are in accordance with Regulatory Guide 1.68, as discussed in Chapter 14.
Regulatory Guide 1.73	Qualification of electric valve operators is in accordance with IEEE Std. 382-1972, as modified by Regulatory Guide 1.73.
Regulatory Guide 1.75	Separation criteria for Class 1E equipment and circuits is in accordance with IEEE Std. 384-1974, as modified by Regulatory Guide 1.75, with the following design alternatives: a. Interrupting devices actuated only by fault current are not considered to be isolation devices, unless acceptable coordination can be verified by test. b. Associated circuits installed in accordance with Section 4.5(1) of IEEE Std. 384-1974 will be subject to the requirements of Class 1E circuits for cable derating, environmental qualification, flame retardance, splicing restrictions, and raceway fill, unless it is demonstrated that the Class 1E circuits are not degraded below an acceptable level by the absence of such reqirements. c. Non-Class 1E instrumentation circuits may not be separated from associated circuits, provided they are not routed in the same raceway as power and control cables, or are not routed with associated cables of the redundant division.

TABLE 8.1-2 (Continued)

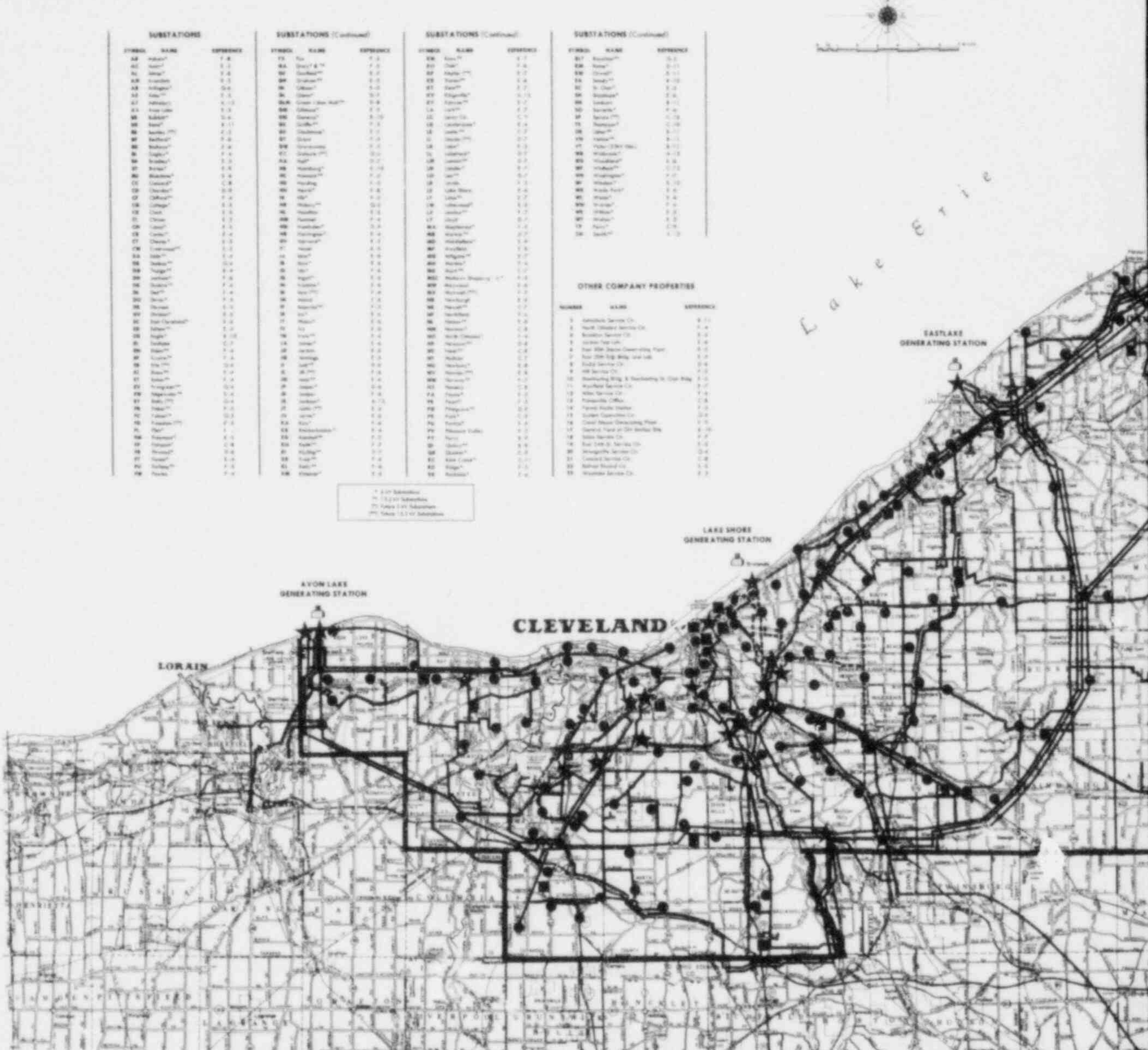
Publication	Discussion
	d. A confined space, such as a cable tunnel, that is effectively unventilated may be used when justified as adequate separation of redundant circuits. e. The method of identification, as discussed in IEEE Std. 384-1974, Section 5.1.2, will be simple and preclude the need to frequently consult reference material to distinguish between Class 1E and non-Class 1E circuits, between non-Class 1E circuits associated with different redundant Class 1E systems, and between redundant Class 1E systems. f. Position C.11 is implemented as follows: "...and should preclude the need to frequently consult reference..."
Regulatory Guide 1.81	The recommendations in Regulatory Guide 1.81 are followed for the Class 1E power systems. Each unit has separate, independent electric systems capable of supplying ESF and safe shutdown loads, assuming a single failure and loss of offsite power.
Regulatory Guide 1.89	All Class 1E equipment is qualified in accordance with IEEE Std. 323-1971. Section 3.11 presents the details of the qualification program and describes further compliance to IEEE Std. 323-1974 (as modified by Regulatory Guide 1.89) for certain components and equipment.
Regulatory Guide 1.93	The requirements of Regulatory Guide 1.93 for Limiting Conditions for Operation are addressed in the technical specifications.
Regulatory Guide 1.100	All Class 1E electric equipment is seismically qualified in accordance with IEEE Std. 344-1971. Section 3.10 presents the details of the seismic qualification program and describes further compliance to IEEE Std. 344-1975 (as modified by Regulatory Guide 1.100) for certain components and equipment.

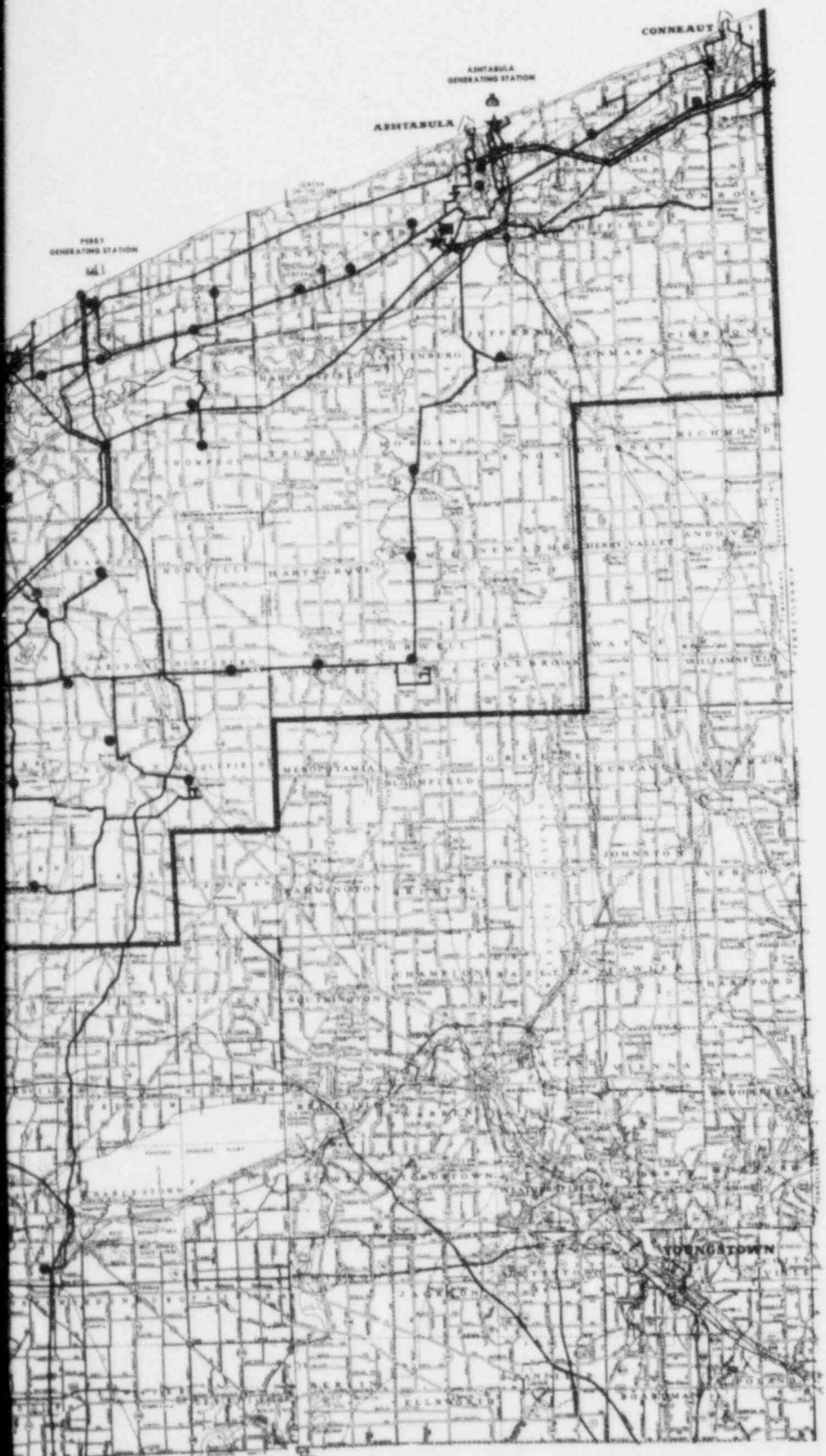
TABLE 8.1-2 (Continued)

Publication	Discussion
Regulatory Guide 1.106	The Class 1E power system does not include thermal overload relays to protect motor operated valves; therefore, this Regulatory Guide is not applicable to the design.
Regulatory Guide 1.108	The guidelines presented in Regulatory Guide 1.108 are used in establishing preoperational and periodic test procedures for the standby and HPCS diesel generators, with the exception that "first out" annunciation is not used. The basis for this is individual protective trip alarms, which give the operator adequate information for correct action.
Regulatory Guide 1.118	Periodic testing of electric power and protection systems is in accordance with IEEE Std. 338-1977, as modified by Regulatory Guide 1.118.
Regulatory Guide 1.120	Refer to Section 9.5.1 for details.
Regulatory Guide 1.128	Class 1E batteries are designed and installed in accordance with IEEE Std. 484-1975, as modified by Regulatory Guide 1.128, except that a hydrogen survey will not be performed. Calculations indicate that the maximum hydrogen concentration in the battery area will be less than 0.001%.
Regulatory Guide 1.129	Class 1E batteries are maintained and tested in accordance with IEEE 450-1975, as modified by Regulatory Guide 1.129, except as indicated in the discussion under IEEE 450-1975.
Branch Technical Position ICSB 2	Standby diesel generators are type qualified in accordance with ICSB 2. The HPCS diesel generators are type qualified as described in Section 8.3.
Branch Technical Position ICSB 6	Capacity testing of Class 1E batteries is in accordance with ICSB 6.
Branch Technical Position ICSB 8	As required by ICSB 8, onsite diesel generators will not be used for peaking service.

TABLE 8.1-2 (Continued)

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


SUBSTATIONS
SUBSTATIONS (Continued)
OTHER COMPANY PROPERTIES
Lake Erie
EASTLAKE
GENERATING STATION
LAKE SHORE
GENERATING STATION
AVON LAKE
GENERATING STATION
CLEVELAND
LORAIN
AKRON
THE CLEVELAND ELECTRIC
ILLUMINATING COMPANY
TRANSMISSION SYSTEM MAP



PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC
ILLUMINATING COMPANY

Cleveland Electric Illuminating Company Transmission System

Figure 8.1-1


Lake Huron
Lake Michigan
Lake Erie
MICHIGAN
INDIANA
OHIO
KENTUCKY
W. VIRGINIA

ECAR

PRINCIPAL POWER SUPPLY FACILITIES
EXISTING AND AUTHORIZED-JANUARY 1979

ELECTRIC TRANSMISSION LINES

EXISTING		AUTHORIZED
▬▬▬	765 KV	▬ ▬ ▬
───	500 KV	- - - -
───	345 KV	- - - -
	230 KV	
───	100-161 KV	- - - -
───	69 KV	- - - -

∘ TRANSMISSION STATIONS

BOUNDARY OF ECAR

ELECTRIC GENERATING PLANTS

- FOSSIL FUEL
- NUCLEAR
- HYDRO
- PUMPED STORAGE

0 25 50 75 100 MILES

EAST CENTRAL AREA RELIABILITY COORDINATION AGREEMENT POWER SYSTEMS

PNPP

PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

Eastern Central Area Reliability System (ECAR)

Figure 8.1-2

8.2 OFFSITE POWER SYSTEM

8.2.1 DESCRIPTION

8.2.1.1 Transmission System

The Perry Nuclear Power Plant is integrated into the Cleveland Electric Illuminating Company/CAPCO transmission network through the transmssion switchyard at the Perry site. The Cleveland Electric Illuminating Company/CAPCO system supplies the offsite a-c power for the starting, normal operation, and safe shutdown of both Perry units. Offsite power is available to the plant onsite electrical system from the 345 kV switchyard, as further discussed in Section 8.2.1.2.

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

a. S-5-PY-IN: 55.2 miles to the Inland 345 kV Substation

b. S-6-PY-HD: 55.1 miles to the Harding 345 kV Substation

c. S-8-PY-EL: 20.6 miles to the Eastlake Plant

d. S-24-PY-OEH: 51.5 miles to the Hanna (Ohio Edison Co.) Substation

e. S-29-PY-AT-ERW: 44.1 miles via CEI's Ashtabula Plant to the Erie West (Pennsylvania Electric Co.) Substation

Offsite power is available to the 345 kV switchyard from the Eastlake Plant 345 kV Substation, the Ashtabula Plant 345 kV Substation, the Erie West (PENELEC) 345 kV Substation, the Inland 345 kV Substation, and the Harding 345 kV Substation via the four 345 kV circuits connecting these stations to the switchyard when the first generating unit is operational. When the second generating unit is operational, offsite power will also be available to the switchyard from the Hanna 345 kV Substation.

Specific design features of the transmission system are as follows:

a. The 345 kV transmission lines, their associated structures, and interconnections between the switchyard and the system, are designed to withstand the loading conditions for climatic conditions prevalent in the area in regard to wind, temperature, lightning, flood, and ice loading, so as to minimize failure.

b. The 345 kV transmission circuits to Eastlake, Ashtabula and Inland/ Harding occupy separate right-of-way corridors, except within the vicinity of the plant. The circuits to Inland/Harding occupy a corridor with existing transmission lines for approximately 30.7 miles of the length. The tie to Ohio Edison, added with the second unit, is installed on the same right-of-way as the Inland/Harding line for approximately 6.3 miles of its length.

c. The Inland/Harding circuits and the Hanna line cross over two double circuit 138 kV lines at a point approximately eight miles south of the switchyard.

d. The Inland/Harding circuits cross over one 345 kV circuit and two double circuit 138 kV lines in Macedonia and Oakwood, Ohio, respectively, and one double circuit 138 kV line in Cleveland.

e. The 345 kV system is protected from lightning and switching surges by lightning protection equipment and overhead electrostatic shield wires.

The Eastlake Plant, Ashtabula Plant, Inland, Harding and Hanna 345 kV Substations are part of the Cleveland Electric Illuminating Company/CAPCO grid system as described in Section 8.1. The Erie-West 345 kV Substation is part of the Pennsylvania Electric Company (PENELEC) System, which in turn, is part of the Pennsylvania-New Jersey-Maryland (PJM) Power Pool. The transmission line layout in the plant vicinity is shown in Figure 8.2-1. The interconnection of the plant with neighboring transmission systems is shown on Figures 8.1-1 and 8.1-2.

The design and construction of the transmission lines is consistent with the established practices of the Cleveland Electric Illuminating Company. Experience has shown that these practices result in minimum line outages, as described in Section 8.2.2.1.

8.2.1.2 Preferred Power System

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

8.2.1.2.1 Transmission Station

The 345 kV transmission station is a breaker-and-a-half configuration, as shown on the main connection diagram, Figure 8.2-2. Each unit's startup transformer is directly connected to a 345 kV main bus. The two full capacity main buses are on opposite sides of the transmission station and are physically independent, as shown in Figure 8.2-3.

Specific design features of the transmission station are as follows:

a. 345 kV circuit breakers are rated 3000 A, 50,000 AIC, with an SF_6 insulation system. Breakers are independent-pole tripping (mechanical and electrical) and gang closing. There are two trip coils per pole for primary and backup relaying.

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

c. AC auxiliary power is provided from the 4 kV non-Class 1E plant power system with a backup power supply that is connectable (through a Class 1E isolation device) to the Division 2 Class 1E standby diesel generator. This will

ensure a-c power to the transmission station for critical functions (battery chargers, breaker heaters, etc.) during extended outage non-accident conditions.

d. A data acquisition and control (DAC) system provides information and breaker control to system dispatchers in the CEI System Operations Center (SOC) in Brecksville, Ohio. Two separate DAC systems are provided for the transmission station, one for each of the preferred sources' associated breakers. For the generator-associated breakers (S-610, S-611, S-620 and S-622), DAC control for the dispatcher is not provided. These breakers are only controlled from the plant control room.

e. Physical design criteria for station and structures include:

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

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

   3. Ice loading at 50 percent of weight of steel and equipment.

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

   5. Grounding in accordance with IEEE Standard 80.

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

8.2.1.2.2 Interface with Class 1E System

The interfaces between the transmission station and Class 1E power system consist of 345 kV transmission circuits, disconnect switches, startup transformers, circuits in cable tray and underground duct banks, interbus transformers, and 5

and 15 kV switchgear. The overview of this interface is shown on Figure 8.2-3. The one line diagrams are shown in Figures 8.3-1 and 8.3-2.

Several additional paths from the transmission system to the Class 1E system are available as alternate offsite power sources if loss of a startup transformer occurs. For example, for Unit 1, this includes feeding 15 kV bus L10 from buses L11 or L12, via the unit auxiliary transformer. A motor-operated disconnect switch is provided to facilitate the availability of this path within the time required for operator action. Each operating contingency is reviewed with respect to Regulatory Guide 1.93. In all cases, there are at least two separate paths, with sufficient capacity provided from the transmission network to the standby power distribution system, available in sufficient time, in accordance with General Design Criterion 17.

8.2.1.2.3 Surveillance

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

8.2.2 ANALYSIS

8.2.2.1 Availability

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

a. The 345 kV switchyard is directly connected to two independent generating stations (Eastlake Plant to the west and Ashtabula Plant to the east), the remaining CEI/CAPCO network (to the south), and the Pennsylvania-New Jersey-Maryland (PJM) network (to the east). The Eastlake Plant contains six generators with a combined net demonstrated capability (NDC) of 1336 MWe. The Ashtabula Plant contains nine generators with a combined NDC of 647 MWe. Thus, the loss of any single generating unit will have a negligible impact on the availability of the preferred source.

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

c. Within the plant vicinity, the 345 kV transmission lines approach the switchyard on a common right-of-way corridor for approximately 1.1 miles. The structures are set far enough apart to avoid the possibility of structural collapse of one line, causing an outage of all lines. Collapse of a structure will not preclude the ability of the preferred source to supply power to the onsite electrical distribution system.

d. Beyond the plant boundary, the 345 kV transmission circuits (except Inland/Harding) are supported on independent structures. The Inland/Harding circuits are supported on double circuit structures. Both the

Inland and Harding circuits may be interrupted with either one or two units operating, and the remaining circuits will be capable of carrying the load.

e. The switchyard components are arranged to ensure that no single event results in the simultaneous loss of both a unit and the associated preferred source or both preferred sources. The provisions incorporated in the switchyard design permit the following:

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

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

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

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

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

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

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

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

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

10. Short circuit failure of breaker S-660-PY-TIE will result in the loss of S-24-PY-OEH and S-6-PY-HD until the point of fault is isolated by disconnect switches.

11. Short circuit failure of breaker S-662-PY-TIE will result in loss of the startup transformer No. 1 and the S-24-PY-OEH until the point of fault is isolated by disconnect switches.

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

13. Short circuit failure of breaker S-620-PY-TIE before Unit 2 is operational will result in the loss of S-29-PY-AT-ERW and the startup transformer No. 1 until the point of the fault is isolated by discount switches. After Unit 2 is operational, the same short circuit failure will result in the loss of Unit 2 and S-29-PY-AT-ERW until the point of fault is isolated by disconnect switches.

14. Short circuit failure of breaker S-622-PY-TIE after Unit 2 is operational will result in the loss of Uni 2 and the startup transformer No. 1 until the point of fault is isolated by disconnect switches.

f. The switchyard design incorporates primary and backup relaying, separate d-c systems, and separate DAC information systems, all arranged such that the loss of one preferred system circuit will not result in loss of the redundant counterpart, or the loss of any standby power system sources.

The latest available statistics from ECAR pertaining to the reliability of 345 kV circuits are contained in "ECAR Summary Report of Transmission Line Outages 1973-1974." This report is a compilation of transmission line outages for the ECAR member companies. It covers 1973-1974 and includes a 1970-1974 five-year summary. The average availabilities of the 345 kV transmission lines in ECAR in 1973 and 1974 were 98.61 percent and 98.91 percent, respectively. The 1970-1974 five-year average availability was 99.04 percent. Based on the above data and considering the design features described earlier, the availability of the preferred power system to supply power to the onsite distribution system is expected to be substantial.

8.2.2.2 Stability

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

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

The most critical stability test for Perry was the loss of the Perry-Inland circuit (S-5-PY-IN) with one phase of a center breaker failing to open at Perry. This case produced the largest Perry unit maximum internal voltage angle swing. For this case, a permanent three-phase fault was simulated on S-5-PY-IN at Perry with one phase of breaker S-650-PY-TIE failing to open. The following switching sequence was assumed: (Note: this case was run to 1.5 seconds)

a. Fault cleared at Inland at 0.08 seconds (4.8 cycles).

b. Fault cleared at Perry and Hanna (Ohio Edison) at 0.20 seconds (12.0 cycles).

c. Perry and Inland breakers reclose into the fault at 0.47 seconds (28.2 cycles).

d. Fault cleared at Perry and Inland at 0.55 seconds (33.0 cycles).

The initial angle of the Perry units was 49°. The maximum internal voltage departure, which was on the first swing, was 63° at 0.37 seconds. The non-faulted lines in the area were monitored both for watt and var flows. The level of flows experienced preclude any hazard of line trippings. For this case, the Perry generating units and the entire system proved stable and free of cascading.

ECAR has established certain criteria for evaluating the reliability of electrical power systems of its member companies. These criteria were reviewed with respect to the Perry design. Of the eight criteria listed by ECAR, seven were considered applicable to the CAPCO system and were tested.

One ECAR Criterion, Number 6 test (sudden outage of all transmission lines on the same right-of-way), was considered to be the worst test case. This involved the sudden loss of the Perry-Hanna (OE), Perry-Harding and Perry-Inland 345 kV circuits. This outage removed three of the five 345 kV circuits exiting Perry. In this case and for every case tested, the results met the ECAR Criteria or Evaluation and Simulated Testing of the ECAR Bulk Power Supply Systems.

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

8.2.2.3 Capacity

Each of the circuits from the transmission network to the onsite electric distribution system has the capacity and capability to supply the loads during normal and abnormal operating conditions, accident conditions, or plant shutdown

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

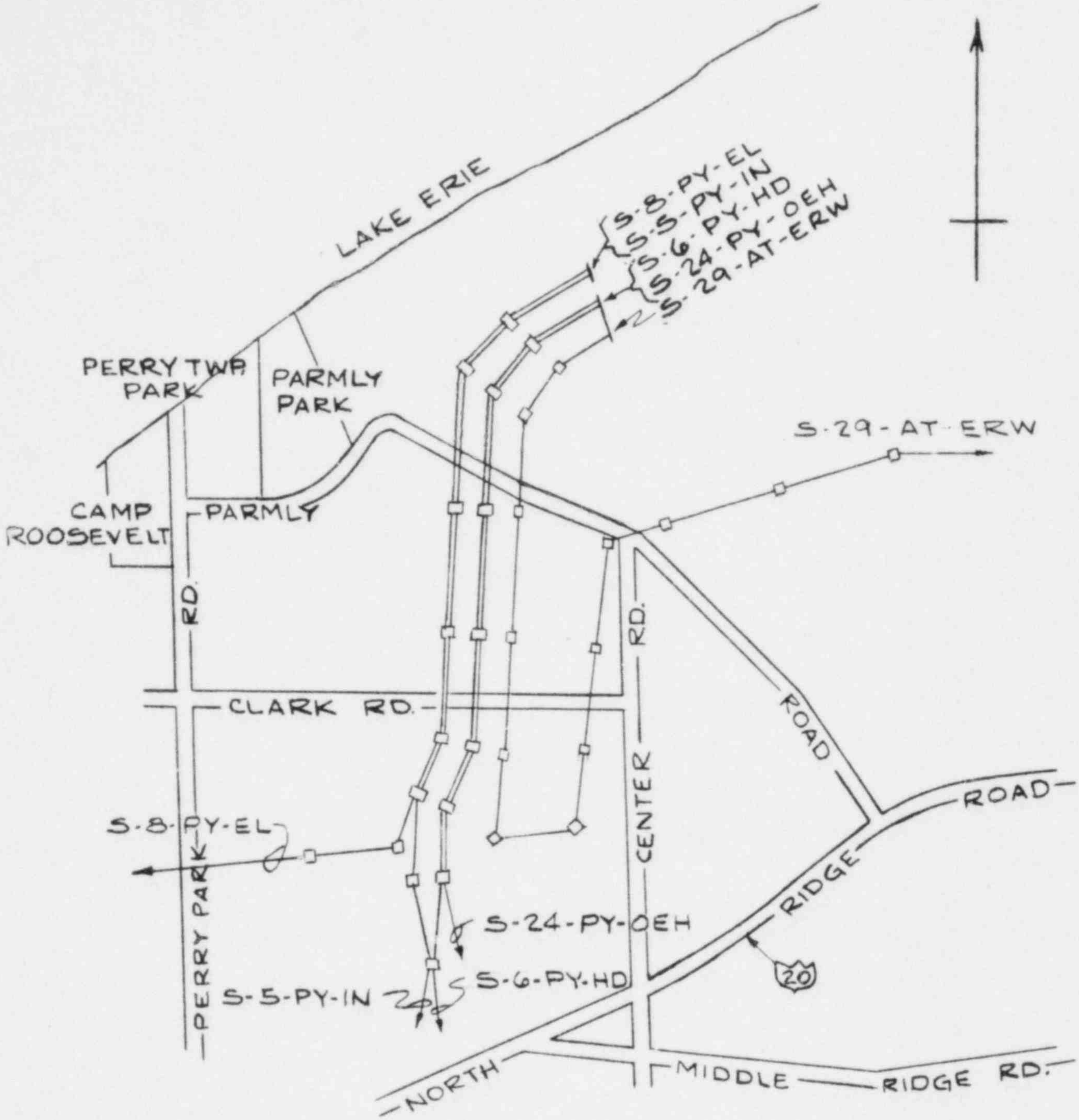
8.2.3 REFERENCE FOR SECTION 8.2

1. Institute of Electrical and Electronics Engineers, "Guide for Safety in AC Substation Grounding," IEEE Std. 80.

TABLE 8.2-1

PREFERRED POWER SYSTEM SURVEILLANCE
METHODS IN PLANT CONTROL ROOM

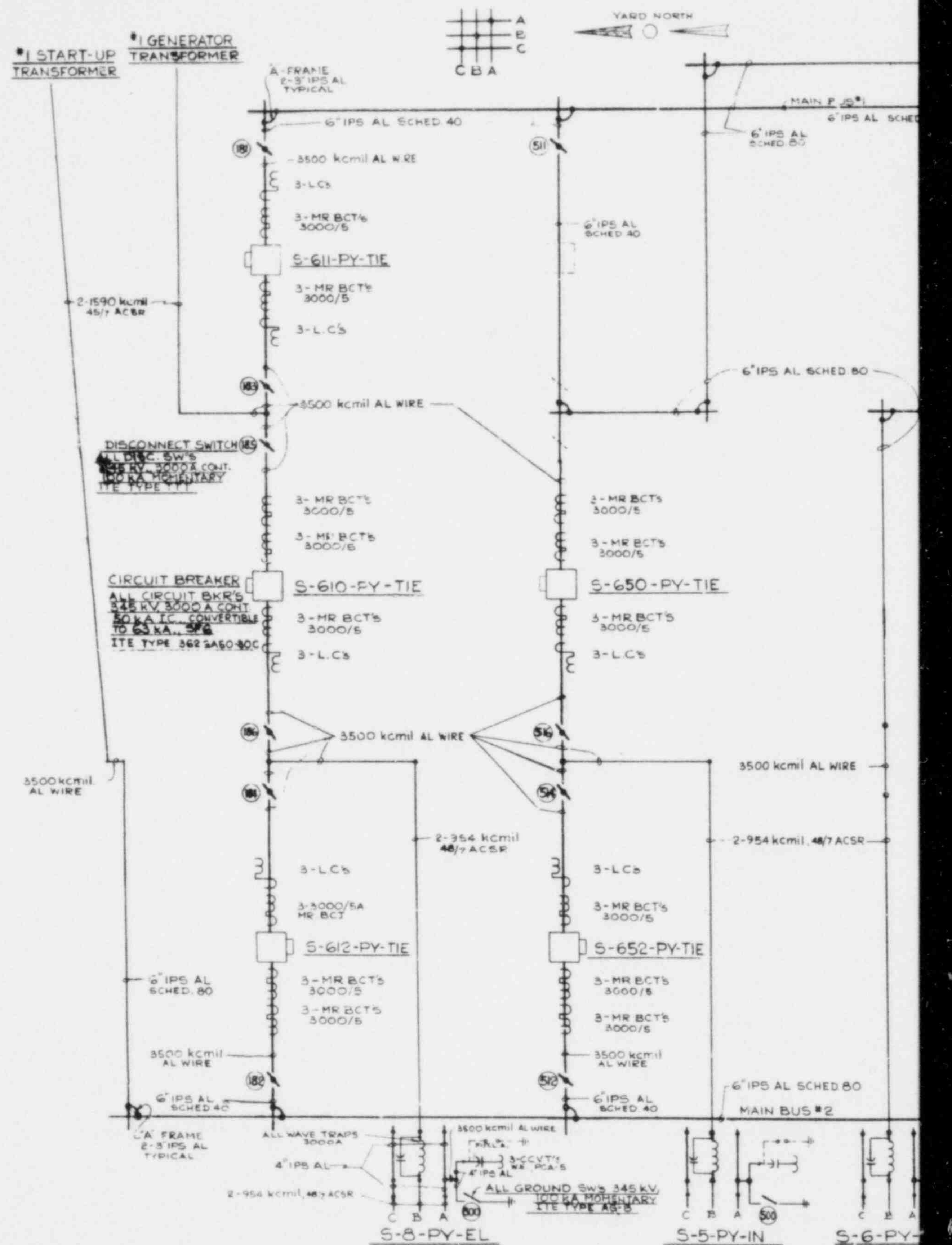
	Indicating Lights							
Equipment	Breaker Position	Breaker Operation	Potential	Annunciator	SER	Meter	Computer	Reference
345kV Transmission Substation Breakers:								
S-611		X						
S-610		X						
S-612	X							
S-650	X							
S-652	X							
S-661	X							
S-660	X							
S-662	X							
S-621	X							
S-620		X						
S-622		X						
Transmission Substation Trouble				X				
345kV Bus No. 1 and No. 2								
Differential Relaying					X			
Voltage			X			X		
Startup Transformer 100 PY-B, 200 PY-B								
Relaying					X			
Trouble				X				
Amperes						X		
345kV Disconnect Switch	X							
15kV Bus L10, L20 Volts			X			X		
Low Voltage (27)				X				
L1003		X		X			X	
L1004 - L2001		X		X			X	
L2003		X		X			X	
L2004 - L1001		X		X			X	
Interbus Transformer								
L1010 - EH1101		X		X			X	
L2006 - EH2101		X		X			X	
Amperes						X		
4.16kV Tie Buses TH1, TH2, TH21, TH12			X					
Voltage						X		
4.16kV EH Buses Volts			X			X		R61, B-208-222, Sh. 203
EH1114, EH1115	X			X				
EH1303, EH1302	X			X				
EH1212, EH1213	X			X				



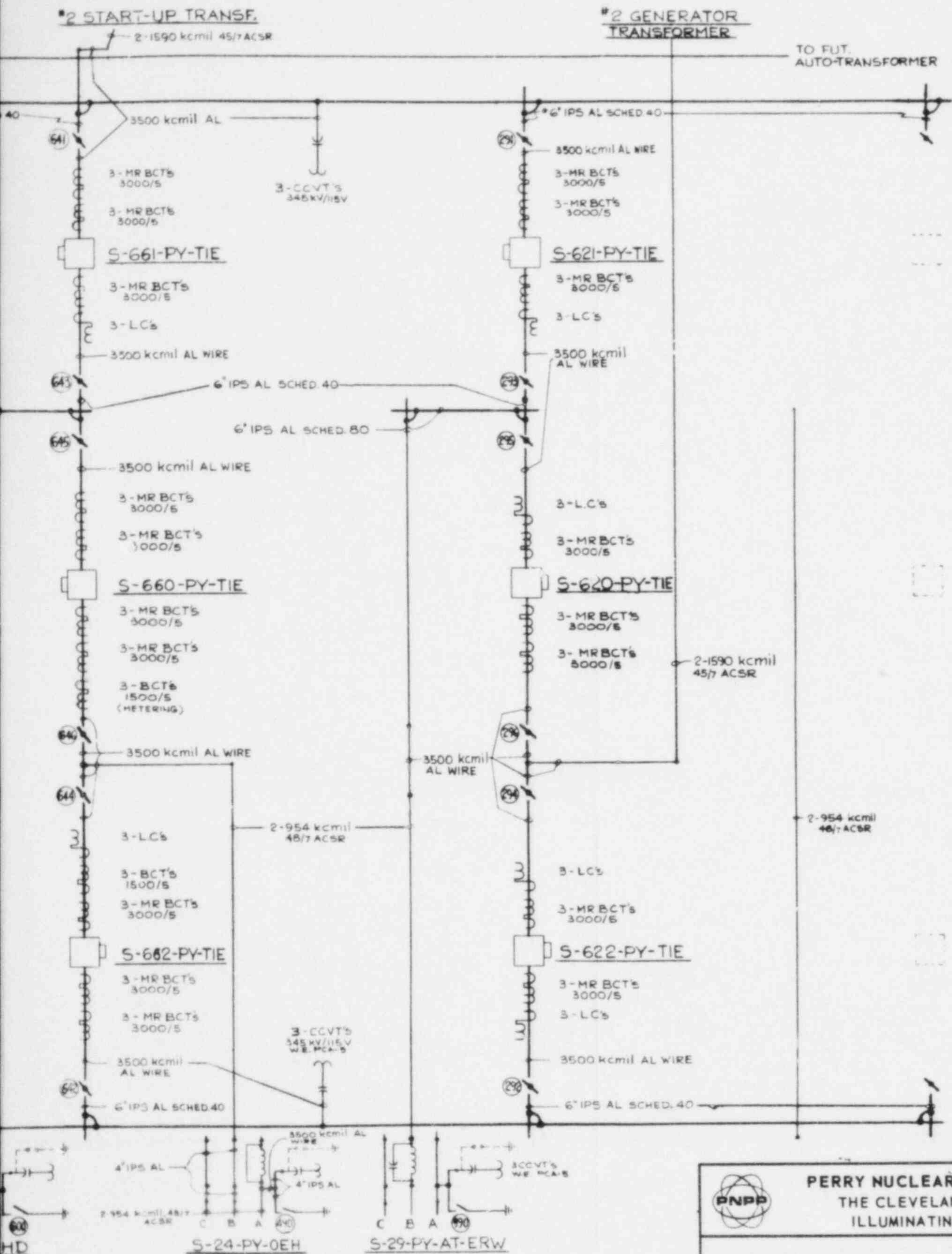
PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC
ILLUMINATING COMPANY

Transmission Lines Layout

Figure 8.2-1



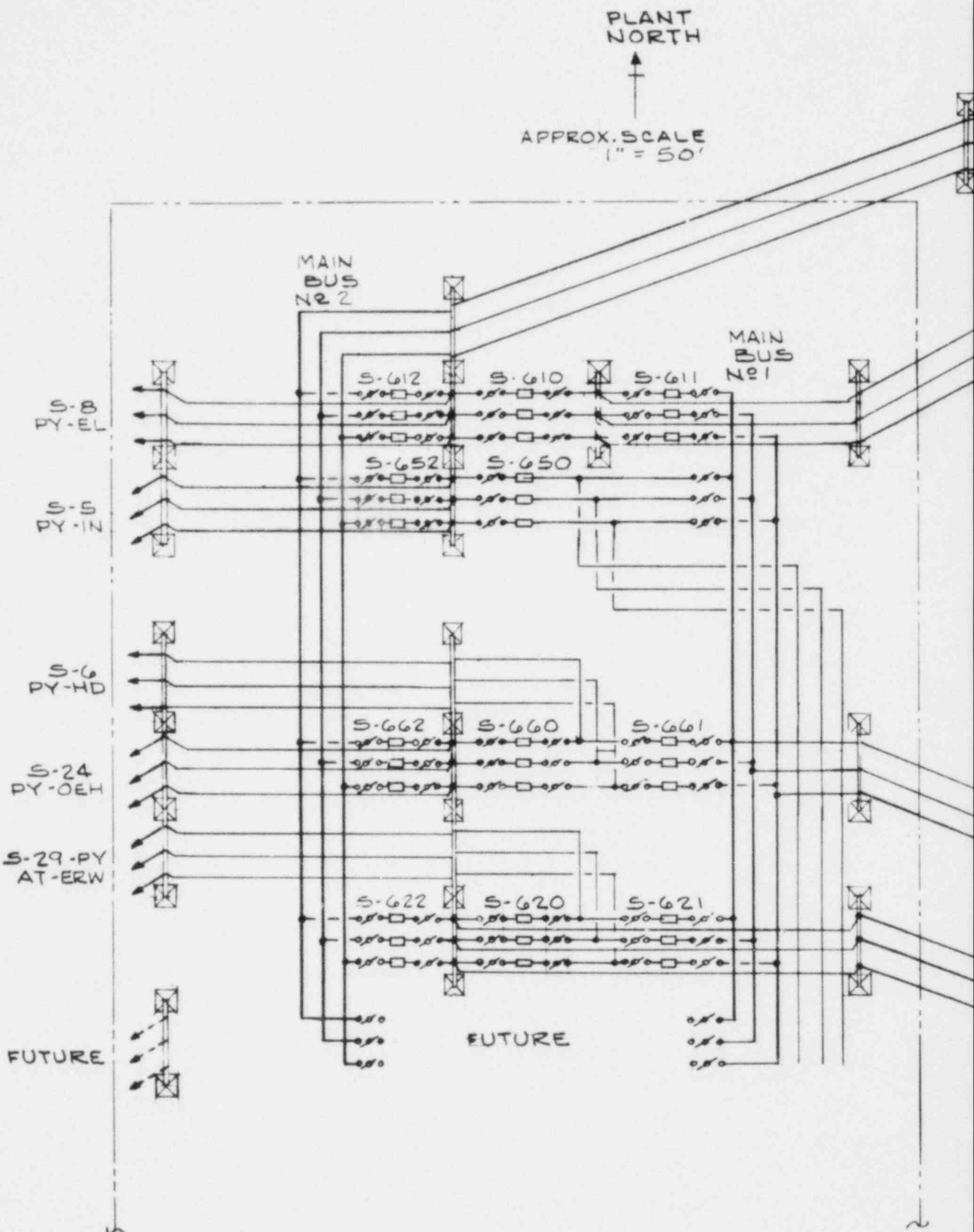
YARD NORTH
#1 START-UP TRANSFORMER
#1 GENERATOR TRANSFORMER
A-FRAME 2-3" IPS AL TYPICAL
6" IPS AL SCHED. 40
3500 kcmil AL WIRE
3-L.C's
3-MR BCT's 3000/5
S-611-PY-TIE
2-1590 kcmil 45/7 ACSR
6" IPS AL SCHED 40
MAIN BUS #1
6" IPS AL SCHED 80
DISCONNECT SWITCH
ALL DISC. SW'S 345 KV, 3000 A CONT. 100 KA MOMENTARY ITE TYPE TTT
CIRCUIT BREAKER
ALL CIRCUIT BKR'S 345 KV, 3000 A CONT. 50 kA I.C., CONVERTIBLE TO 63 kA., SF6 ITE TYPE 362 SA60-30C
S-610-PY-TIE
S-650-PY-TIE
2-954 kcmil 48/7 ACSR
3-3000/5A MR. BCT
S-612-PY-TIE
S-652-PY-TIE
MAIN BUS #2
ALL WAVE TRAPS 3000A
4" IPS AL
3-CCVT's W/ PCA's
ALL GROUND SW's 345 KV, 100 kA MOMENTARY ITE TYPE AS-B
S-8-PY-EL
S-5-PY-IN
S-6-PY-

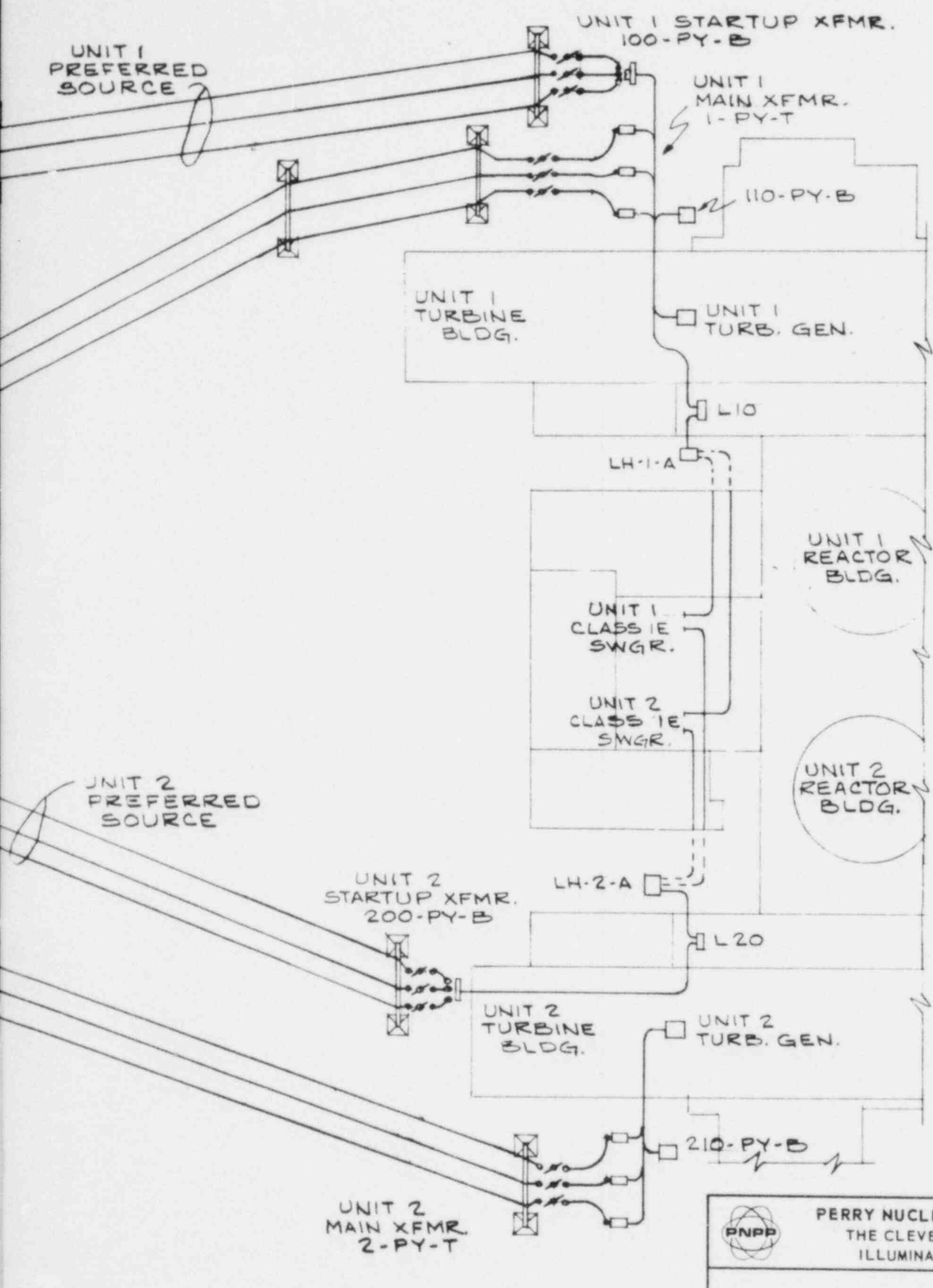


PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

345 kV Transmission Substation
Main Connection Diagram

Figure 8.2-2


PLANT NORTH
APPROX. SCALE 1" = 50'
MAIN BUS № 2
MAIN BUS № 1
S-612
S-610
S-611
S-652
S-650
S-8 PY-EL
S-5 PY-IN
S-6 PY-HD
S-662
S-660
S-661
S-24 PY-OEH
S-29-PY AT-ERW
S-622
S-620
S-621
FUTURE
FUTURE



PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC
ILLUMINATING COMPANY

Preferred Power System Layout

Figure 8.2-3

8.3 ONSITE POWER SYSTEMS

8.3.1 AC POWER SYSTEMS

8.3.1.1 Description

The onsite a-c power system consists of two similar power distribution systems. One system serves each unit and ties between units are minimized. The power distribution system for each unit is comprised of the following three distinct subsystems:

a. Startup and preferred power supply.
b. Non-Class 1E power system (unit auxiliary power system).
c. Class 1E power system (engineered safety features power system).

Figures 8.3-1 and 8.3-2 are the main one line diagrams for the onsite power system.

8.3.1.1.1 Non-Class 1E AC Power System

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

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

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

8.3.1.1.2 Class 1E Power System

The Class 1E power system is illustrated on Figures 8.3-1 and 8.3-2. The system is designed with independent divisions having radial systems through all voltages at 4.16 kV and below. Complete physical and electrical separation is maintained to ensure maximum integrity. Switchgear associated with each division is housed in rooms within the control complex which are completely separate from rooms housing redundant division equipment. The radial configuration permits use of a single, manual switching action to transfer an entire division load at all voltages to an alternate preferred power source with minimum risk of operator error or equipment malfunction.

Class 1E portions of the onsite power system are designed to satisfy the applicable criteria listed in Table 8.1-2.

Engineered safety features loads are assigned to three independent load groups designated as Divisions 1, 2 and 3. Each division consists of a 4.16 kV switchgear assembly, diesel generator standby power supply, 480 volt power center and motor control center, 120 volt a-c and 125 volt d-c distribution panels, battery, battery chargers, and interconnecting cables. Engineered safety features loads are assigned to divisions in such a manner that loss of a single division from any cause does not affect redundant equipment.

8.3.1.1.2.1 Power Supply Feeders

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

8.3.1.1.2.2 Arrangements

The Class 1E a-c system is comprised of three divisions: Divisions 1 and 2 are redundant, while Division 3 supplies power for the high pressure core spray (HPCS) system. Divisions 1 and 2 supply power from the 4.16 kV buses to 480 volt double-ended load centers and 480 volt motor control centers. Division 3 supplies power from the 4.16 kV bus to a 4.16 kV/480 volt transformer which feeds a 480 volt motor control center.

8.3.1.1.2.3 Supplied Loads

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

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

No provision is made for automatic parallel operation of any onsite power supplies with other onsite power supplies. Neither buses nor loads can be interconnected through the onsite supplies nor are there any provisions for interdivisional connections between onsite supplies and buses. All three divisions receive power from the non-Class 1E preferred power supply. A manual transfer to the alternate preferred power supply can be accomplished by closing the alternate preferred supply feeder breaker for each division. Circuit breakers which feed each 4.16 kV Class 1E bus from the preferred power supply and

alternate preferred power supply are interlocked with each other to preclude paralleling of the preferred and alternate preferred power supplies.

8.3.1.1.2.5 Interconnections between Safety Related and Non-Safety Related Buses

Interconnections are made at the 4.16 kV level between Division 1 and a non-Class 1E bus, and between Division 2 and a separate non-Class 1E bus. These non-Class 1E buses ("stub" buses) supply critical non-Class 1E loads, such as the control rod drive pumps and nuclear closed cooling water pumps. Circuit breakers feeding the stub buses are qualified isolation devices, are housed in Class 1E switchgear, are tripped upon receipt of a LOCA signal, and satisfy the recommendations of Regulatory Guide 1.75.

8.3.1.1.2.6 Redundant Bus Separation

Class 1E switchgear, load centers, and motor control centers of each division are located in rooms separate from similar equipment of other divisions.
Figures 8.3-3 through 8.3-5 depict equipment locations.

8.3.1.1.2.7 Equipment Capacities

Equipment capacities are listed in Table 8.3-2.

8.3.1.1.2.8 Automatic Bus Loading and Stripping

The diesel generator for each division is automatically started upon receipt of a LOCA signal and/or an undervoltage signal at the associated division bus. If the diesel generator is started by a LOCA signal only, the diesel generator is not connected to the bus but remains in standby operation, non-Class 1E 4.16 kV buses (stub buses) fed from Division 1 and 2 buses are shed, and LOCA loads are started and fed from offsite power. Class 1E bus feeder breakers are tripped by bus undervoltage which is detected at each division bus by two 3 phase undervoltage relays and specific coincident logic. For Divisions 1 and 2, 4.16 kV load

circuit breakers (except those protecting unit substations) are tripped; Division 3, 4.16 kV load circuit breakers remain closed following a 4.16 kV bus undervoltage signal.

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

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

When a diesel generator is started, the emergency service water pump receives a start signal coincident to the diesel generator start signal since the emergency service water pump supplies diesel generator cooling water. However, pump start is delayed until after closure of the diesel generator circuit breaker (see Table 8.3-1).

8.3.1.1.2.9 Safety Related Equipment Identification

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

Switchgear, motor control centers, unit substations, panels, and racks are equipped with color coded tags to indicate the division with which they are associated. Field cable jackets or armor are color coded with the appropriate division marker color. Either the outer jacket or armor of the cable is continuously colored or striped or colored tags are installed at both ends of the

cable and at a sufficient number of intermediate points to facilitate initial verification that the installation is in conformance with the separation criteria.

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

Independence of Class 1E equipment and circuits is in accordance with IEEE Standard 384[1] as clarified in Table 8.1-2.

8.3.1.1.2.10 Instrumentation and Control Systems

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

8.3.1.1.2.11 Electric Circuit Protection System Network

a. Protective Relay Devices

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

1. Interbus Transformer

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

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

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

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

2. Voltage Relaying

Degraded voltage conditions for the onsite Class 1E power system are detected by an undervoltage protection system on each division. The system consists of two sets of instantaneous voltage relays which actuate solid state timers. The voltage relay and timer set points are determined from an analysis of the voltage requirements of the safety related loads at all distribution levels. The system includes specific coincident logic for each bus. The timer set points are based on the accident analysis and minimization of the effect of short term disturbances.

The overall design adequacy of the undervoltage protection system will be tested as described in Section 8.3.1.1.2.14. Transformer tap settings, the voltage relays and timers will be all adjusted to optimize the voltage at all distribution levels.

The use of the undervoltage protection system in the automatic bus loading and shedding scheme is discussed in Section 8.3.1.1.2.8.

3. Preferred and Alternate Preferred Power Supply Bus Feeder Breakers

Bus feeder overcurrent protection for preferred and alternate preferred power supply bus feeder breakers consists of three single phase time overcurrent electromechanical relays (51) and one ground overcurrent electromechanical relay (51N) for each circuit breaker.

4. Standby Power Sources

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

(a) Generator Differential Protection

Generator differential protection is provided by a solid state differential relay (87G). This device uses dedicated CTs and is the only relay connected to trip the diesel generator in both the test and emergency modes of operation.

(b) Overcurrent Protection

Protection against overcurrent in the event of a system fault is provided by one 3 phase, electromechanical instantaneous overcurrent relay (50).

(c) Voltage Protection

Voltage protection is provided by one 2-unit electromechanical voltage relay (59D). This device blocks closure of the diesel generator breaker until rated voltage is established.

(d) Reverse Power Protection

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

(e) Neutral Overvoltage Protection

Neutral overvoltage protection is provided by an electromechanical neutral overvoltage relay (59NG). This device protects against a stator ground fault.

(f) Field Ground Protection

Field ground fault protection is provided by an electromechanical field ground relay (64F).

5. Class 1E 4.16 kV Load Circuit Feeder Breakers

Load circuit feeder breakers are equipped with a solid state ground fault relay (50G), and three single phase time and instantaneous overcurrent electromechanical relays (50/51) motor feeders, and transformer feeders.

6. Class 1E 480 Volt Unit Substations

(a) Incoming Breakers

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

(b) Feeder Breakers

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

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

7. Class 1E Motor Control Centers

Loads supplied from motor control centers are protected by fused combination motor starters. Dual element class RK-5 fuses are used to provide overload and short circuit protection. Single speed non-reversing motors are protected by thermal overload devices located in the motor starter.

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

8. 120 Volt A-C Distribution Panels

Loads supplied from 120 volt a-c distribution panels are protected by molded case circuit breakers.

9. 125 Volt D-C Distribution Panels

Loads supplied from 125 volt d-c distribution panels are protected by fused disconnects with dual element class RK-5 fuses.

b. Protective Relaying and Protective Device Setting Criteria

1. Class 1E 4160 and 480 Volt Switchgear

Protective devices on the 4160 and 480 volt switchgear are set to meet the following criteria:

(a) The primary downstream protective devices are set to clear the fault in the least amount of time and to protect the end device from damage. These devices have been strategically located in the electrical system to isolate the smallest portion of the system during fault conditions.

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

2. Class 1E Motor Control Centers

Class RK-5 dual element fuses are selected, based on approximately 125 percent of the full rated load current, except for motor operated valves. Motors for valves are fused as follows:

(a) The fuse is selected so that the operating point is at least 300 percent of motor full load current during the normal operating time of the valve.

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

3. 120 Volt A-C Distribution Panels

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

4. 125 Volt D-C Distribution Panels

Class RK-5 dual element fuses are selected, based on interrupting capacities, voltage rating and load current capabilities, typically based on 125 percent of the full rated load current.

8.3.1.1.2.12 Class 1E Protection System Testing During Power Operation

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

a. Protection System Response to an Undervoltage Signal

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

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

b. Standby Power Source Testing

Standby power source testing is discussed in Section 8.3.1.1.2.14.

c. Engineered Safety Features Systems Testing

Testing of ESF systems is discussed in Sections 7.3 and 7.4.

8.3.1.1.2.13 Electrical Systems Shared between Units

No Class 1E a-c power systems are shared between Units 1 and 2. The interunit connections for the Class 1E a-c power system are discussed in Section 8.3.2.1.2.1.

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

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

a. Division 1 and 2 Standby Power Source Testing

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

Testing to verify these responses will be accomplished in two separate, but related, test procedures:

1. The standby diesel generator preoperational test.

2. Emergency core cooling system integrated initiation with preferred source of offsite power available and during a loss of offsite power preoperational test.

Abstracts of the above test procedures are provided in Chapter 14.

Preoperational testing will compare design performance against analytical results. Voltage tap settings of intervening transformers are set to yield optimum voltage levels on the emergency buses for the full load and minimum load conditions expected throughout the anticipated voltage variations of the offsite power source. The adequacy of these tap settings will be verified by actual measurements which will be correlated with predicated analytical results.

Technical specifications and approved test procedures verify the adequate performance of the integrated onsite power system prior to initial reactor power operation.

b. Division 3 Standby Power Source Testing

The Division 3 Class 1E 4.16 kV bus (EH13) and the associated diesel generator will be tested in a manner similar to the testing of Division 1 and 2 equipment. Testing of Division 3 equipment is in accordance with the applicable design bases discussed in Table 8.1-2 and the technical specifications.

8.3.1.1.3 Standby Power Sources

8.3.1.1.3.1 Description

Each division is provided with a diesel engine driven, 4.16 kV, 3 phase, 60 Hz synchronous generator (see Figure 8.3-1). The diesel generator sets are electrically and physically isolated from each other and are located in a Seismic Category I structure adjacent to the control complex. Figure 8.3-3 shows the locations of the standby power sources.

Table 8.3-1 lists loads required for various maximum loading conditions, such as forced shutdown and LOCA. The basis for the power required for each safety related load is the motor nameplate rating. In each case this rating is greater than the horsepower required by the driven equipment.

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

8.3.1.1.3.2 Division 1 and 2 Diesel Generators

a. Sizing Criteria

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

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

Sequencing of large loads at five second intervals ensures that large motors will have attained rated speed and that voltage and frequency will have stabilized before succeeding loads are applied. The decreases in frequency and voltage have been verified by qualification test to be not greater than 5 and 20 percent of nominal, respectively.

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

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

1. Diesel fast start capability.
2. Load carrying capability.
3. Load rejection capability.
4. Margin capability.
5. No load operating capability.

System reliability and qualification testing are discussed further in Section 8.3.1.1.3.2, Item b.11.

b. Design Aspects

1. Start Initiating Circuits

The diesel generators are automatically started upon receipt of a LOCA signal or an undervoltage signal from the associated bus. The diesel generators can also be manually started remotely from the control room or locally at the diesel generators. A mode selector switch located at the diesel generator permits transfer of manual control capability to and from the control room. Figure 8.3-6 presents the logic diagram for Division 1 and 2 diesel generators.

2. Starting Mechanism and System

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

3. Tripping Devices

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

(a) High jacket water temperature.
(b) High engine bearing temperature.
(c) High lubricating oil temperature.
(d) Low turbocharger oil pressure.
(e) Low lubricating oil pressure.
(f) High vibration level.

(g) High crankcase pressure.

(h) Reverse power.

(i) Instantaneous overcurrent.

(j) Generator neutral ground fault.

(k) Generator field ground.

4. Interlocks

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

5. Permissives

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

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

(b) Engine-generator lockout trip must be reset.

(c) Starting air supply pressure must be greater than 150 psig.

6. Load Shedding Circuits

Load shedding circuits are discussed in Section 8.3.1.1.2.8.

7. Testability

The diesel generators can be tested during normal plant operation or during plant shutdown periods. Administrative controls allow testing of only one diesel generator at a time. Prior to performing the test, all operating funrtions are transferred to equipment supplied from the bus not affected by the test.

The standby power system can be tested from either the diesel generator room or the control room.

The diesel generators can be manually synchronized with the preferred or alternate preferred power sources. The diesel generators cannot be synchronized with the alternate preferred power source from the diesel generator rooms.

Circuitry is provided which overrides the test mode in the event of a LOCA or loss of 4.16 kV bus voltage.

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

8. Fuel Oil Storage and Transfer System

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

9. Cooling and Heating Systems

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

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

Safety related control power for the diesel generators is supplied from the division with which each diesel generator is associated. There are no instrumentation and control power source interconnections between divisions. Instrumentation which does not perform a safety function is supplied from a non-Class 1E power supply.

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

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

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

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

(3) Engine-generator lockout trip not reset.

(4) Loss of engine d-c control power.

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

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

(7) Loss of diesel generator circuit breaker d-c control power.

(b) The following electrical protective trips shut down the diesel generator when operating in other than the accident mode and actuate a control room alarm annunciator window (DIESEL GENERATOR PROTECTIVE TRIP):

(1) Reverse power.
(2) Instantaneous overcurrent.
(3) Generator neutral ground fault.
(4) Generator field ground.

The above listed trip functions are bypassed under accident (LOCA) conditions. The bypass circuit can be tested in accordance with NRC Branch Technical Position ICSB 17[3] to ensure that these trip functions are not effective under accident conditions. A bypass test switch located at the diesel generator circuit breaker cubicle is used to remove the protective trips from the lockout relay circuit. After expiration of a time delay, a protective trip is simulated causing actuation of the alarm. Operability of the bypass circuit is verified by the absence of the DIESEL GEN LOCKOUT RELAY TRIP alarm in the control room.

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

(1) Emergency service water to diesel heat exchanger flow low.
(2) Fuel transfer pump 1A filter differential pressure high.
(3) Fuel transfer pump 2A filter differential pressure high.
(4) Engine vibration excessive.
(5) Lubricating oil temperature high.
(6) Starting air pressure low.
(7) Fuel day tank 3A level high/low.
(8) Crankcase pressure high.
(9) Lubricating oil pressure low.
(10) Fuel storage tank 2A level low (7 day level).
(11) Fuel storage tank 2A level low (1 day level).

(12) Engine bearing temperature high.
(13) Turbocharger oil pressure low.
(14) Jacket water temperature high.
(15) Diesel generator trouble.
(16) Diesel generator lockout relay trip.
(17) Diesel generator differential relay trip.
(18) Diesel generator emergency start signal received.
(19) Diesel generator overspeed trip.
(20) Diesel generator failure to start.
(21) Diesel generator control in local.
(22) Diesel generator protective relay trip.

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

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

(1) Any switch not in the auto position.
(2) Jacking device engaged.
(3) Fuel oil booster pump strainer differential pressure high.
(4) Fuel day tank level low.
(5) Fuel transfer pump 2 running.
(6) Lubricating oil filter differential pressure high.
(7) Lubricating oil inlet temperature low.
(8) Jacket water pressure low.
(9) Jacket water inlet temperature low.
(10) Loss of control air.
(11) Fuel transfer pump 1 filter differential pressure high.
(12) Fuel day tank level high.
(13) Lubricating oil inlet temperature high.
(14) Jacket water inlet temperature high.
(15) Generator field ground.
(16) Starting air pressure low.
(17) Fuel transfer pump 2 filter differential pressure high.

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

(19) Fuel pump strainer differential pressure high.

(20) Field flashing 125 volt d-c power loss.

(21) Generator stator temperature high.

(22) Fuel filter differential pressure high.

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

(24) Turbocharger oil left bank pressure low.

(25) Lubricating oil level low.

(26) Lubricating oil outlet temperature low.

(27) Jacket water standpipe level low.

(28) Jacket water outlet temperature low.

(29) Diesel generator failure to start.

(30) Fuel oil pressure low.

(31) . 1 pump/OS drive failure.

(32) Turbocharger oil right bank pressure low.

(33) Lubricating oil pressure low.

(34) Lubricating oil outlet temperature high.

(35) Jacket water outlet temperature high.

(36) Diesel generator emergency start signal received.

(37) Diesel generator differential relay trip.

(38) Diesel generator overspeed trip.

(39) Engine vibration trip.

(40) Crankcase pressure high trip.

(41) Turbocharger oil pressure low trip.

(42) Lubricating oil pressure low trip.

(43) Lubricating oil temperature high trip.

(44) Engine bearing temperature high trip.

(45) Jacket water outlet temperature high trip.

(46) Lube oil strainer differential pressure high trip.

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

(1) Engine governor change.

(2) Breaker close or trip.

(3) Bus potential (light and meter).

(4) Preferred power source circuit breaker position.

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

(6) Alternate preferred power source circuit breaker position.

(7) Interbus transformer circuit breaker position.

(8) Synchronization (synchroscope).

(9) Diesel generator speed (tachometer).

(10) Watts and vars (meters).

(11) Field current and voltage.

(12) Phase current.

(13) Division battery voltage.

(14) D-C bus voltage.

(15) Alternate preferred power source voltage.

(16) Diesel generator voltage.

(17) Out of service status (lights).

(18) Fuel storage tank and day tank levels.

(19) Jacket coolant flow.

(20) Generator regulator change.

(21) Generator phase voltage.

11. Qualification Program

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

(a) Starting Air System

(1) Air Receiver

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

(2) Air Compressor

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

(b) Sequential Loading

Two sequential loading tests were performed. The first was performed with the diesel generator in an initially unloaded condition. The second was performed with the diesel generator operating at an initial load of 3850 kW. Table 8.3-4 presents test data.

(c) Start and Load Acceptance Test

The start and load acceptance test (300 start test) was performed using a prototype diesel generator intended for use at Grand Gulf Nuclear Station. The Grand Gulf standby power supplies are similar in continuous rating (7000 kW) to the Perry Nuclear Power Plant diesel generators. An analysis was performed to justify the difference (generator manufacturer) between the prototype unit and the Perry units.

During the 300 start test the diesel engine was cycled from standby lubricating oil and coolant temperature conditions for 270 starts. The remaining 30 starts were performed with initial oil and coolant temperatures at half load values. Prior to each start oil and coolant were force cooled to "keep warm" temperatures. The engine was then operated until normal lubricating oil and

coolant temperatures were reached. The engine attained synchronous speed under a load of 3500 kW in less than 7 seconds after each start. The test was considered successful and was in accordance with the requirements of IEEE Standard 387.

(d) Load Rejection Test

The diesel generator was loaded to 7000 kW (resistive load) and operated at rated frequency, voltage, and engine temperature. All load was then removed simultaneously, placing the generator in a no load condition. The engine governor successfully maintained the diesel generator within the required speed range during the transient.

(e) Margin Tests

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

(f) Overspeed Test

The diesel generator was started and a 3500 kW load was applied. Engine speed was then increased manually until the overspeed governor tripped the engine. A Visicorder chart indicated maximum speed at time of trip was 115 percent of synchronous speed.

(g) Starting and Loading Test

A starting and loading test was performed to demonstrate the ability of the diesel generator to operate under load without an engine jacket cooling water supply for 1.5 minutes without causing an alarm condition. The diesel generator was started and loaded

to 7700 kW and was operated until temperatures stabilized. It was then shut down and service water pumps were stopped. A sequential load test was then performed with the service water pumps inoperable. The engine operated for 1.5 minutes without service water and without any alarm condition. Table 8.3-6 presents the load sequence used for this test.

(h) Short Time Overload Test

The short time overload test was performed by operating the diesel generator at normal speed under a load of 7700 kW (110 percent of continuous service rating) established by means of water rheostats. The diesel generator was operated under these conditions for two hours without observation of abnormal engine parameters, noise, or vibration.

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

a. Design Bases

The HPCS power system loads consist of the HPCS pump motor and associated 460 volt a-c auxiliaries, such as motor operated valves, engine cooling water pump, and miscellaneous engine auxiliary loads. Figure 8.3-7 is the basic one line diagram of the system. Figure 8.3-8 illustrates the system logic.

The HPCS power system is self-contained, except for access to the preferred source of offsite power through the onsite a-c power distribution system and the system actuation signal source. The system is operable as an isolated system independent of electrical connection to any other system by using the HPCS diesel generator. Class 1E auxiliary equipment, such as standby heaters and battery chargers, are supplied from the same source as the HPCS pump motor. The diesel generator is compatible with power available from the onsite a-c power system.

The HPCS diesel generator is capable of quickly restoring power to the HPCS pump motor in the event that offsite power is unavailable and can provide all power for startup and operation of the HPCS system. The HPCS diesel generator starts automatically upon receipt of a signal from the plant protection system or upon detection of HPCS bus undervoltage. When the preferred power supply is unavailable, the HPCS diesel generator is automatically connected to the HPCS bus.

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

The HPCS diesel generator is provided with a separate fuel day tank and fuel storage tank of sufficient capacity to support operation of the standby power source while supplying maximum post accident HPCS power requirements for a time sufficient to bring the plant to a safe condition. Tank size is discussed in Section 9.5.4.

An automatic start signal to the HPCS diesel generator overrides the test mode. Control is accomplished from either the control room or the HPCS diesel room.

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

b. Design Aspects

1. Start Initiating Circuits

The Division 3 (HPCS) diesel generator is started automatically upon receipt of a LOCA or associated bus undervoltage signal. Manual starting capability is provided in the control room (remote) and at the diesel generator (local). A mode selector switch located at the diesel generator transfers manual start-stop capability from the diesel generator to the control room. Figure 8.3-8 illustrates system logic.

2. Starting Mechanism and System

The starting mechanism and system for the HPCS diesel generator are similar to those described for the Division 1 and 2 diesel generators in Section 8.3.1.1.3.2, Item b.2.

3. Tripping Devices

Tripping devices for the HPCS diesel generator are similar to those described in Section 8.3.1.1.3.2, Item b.3, for the Division 1 and 2 diesel generators.

4. Interlocks

Interlocks associated with the HPCS diesel generator are similar to those described in Section 8.3.1.1.3.2, Item b.4, for Division 1 and 2 diesel generators.

5. Permissives

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

(a) Maintenance-test-auto switch must be in auto position.
(b) Starting air supply pressure must be greater than 150 psig.
(c) Engine-generator lockout relay must be reset.
(d) HPCS diesel generator circuit breaker must be open.

6. Load Shedding Circuits

Load shedding circuits are discussed in Section 8.3.1.1.2.8.

7. Testing

Testing of the HPCS diesel generator is similar to that described in Section 8.3.1.1.3.2, Item b.7, for Division 1 and 2 diesel generators.

8. Fuel Oil Storage System

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

9. Cooling and Heating Systems

Cooling and heating systems associated with the HPCS diesel generator are discussed in Section 9.5.

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

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

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

(a) A single alarm annunciator window in the control room (HPCS DIESEL GENERATOR OUT OF SERVICE) indicates the HPCS diesel generator is not capable of response to an emergency start signal. The following conditions actuate this alarm:

(1) Maintenance-test-auto switch not in the auto position.

(2) Starting air supply pressure low.

(3) Engine-generator lockout trip not reset.

(4) Loss of engine d-c control power.

(5) HPCS diesel generator circuit breaker not in operating position.

(6) Loss of HPCS diesel generator circuit breaker d-c control power.

(b) The following conditions trip the HPCS diesel generator only during a non-accident condition:

(1) Low engine oil pressure.
(2) High jacket water temperature.
(3) Overcranking.
(4) Neutral ground overcurrent.
(5) Overcurrent with voltage restraint.
(6) Reverse power.

The above listed trip-functions are bypassed under an accident (LOCA) condition. The bypass circuit is discussed in Section 8.3.1.1.6.11.

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

(1) Diesel generator trouble.
(2) Emergency service water to diesel heat exchanger flow low.
(3) Fuel transfer pump 1C filter differential pressure high.
(4) Fuel transfer pump [illegible] filter differential pressure high.
(5) HPCS day tank level high/low.
(6) Lubricating oil pressure low.
(7) HPCS fuel storage tank level low (7 day level).
(8) HPCS fuel storage tank level low (1 day level).
(9) Diesel generator lockout relay trip.
(10) Jacket water temperature high.
(11) Diesel generator differential relay trip.
(12) Diesel generator control in local.
(13) Diesel generator overspeed trip.
(14) Starting air pressure low.
(15) Diesel generator failure to start.

(16) Diesel generator emergency start signal received.

(17) Diesel generator protective relay trip.

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

(1) Failure to start/run.

(2) Charger failure.

(3) Control power failure.

(4) High water temperature.

(5) Overspeed.

(6) Low starting air pressure.

(7) High stator temperature.

(8) Low expansion tank water level.

(9) Low fuel level.

(10) Engine tripped.

(11) Low turbocharger lubricating oil pressure.

(12) Low cooling water pressure.

(13) Crankcase pressure high.

(14) Main fuel pump failure.

(15) Reserve fuel pump failure.

(16) Restricted fuel oil filter.

(17) High lubricating oil temperature.

(18) Low lubricating oil temperature.

(19) Low lubricating oil pressure.

(20) Restricted lubricating oil filter.

(e) Local and remote indication for the HPCS diesel generator is similar to that described in Section 8.3.1.1.3.2, Item b.10(e).

11. Qualification Program

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

8.3.1.1.4 Design Criteria

8.3.1.1.4.1 Electric Motors

a. Motor Size

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

b. Minimum Motor Accelerating Voltage

The electric power system is designed so that the minimum voltage that will exist for Class 1E motor circuits is 75 percent of nominal. This minimum may occur during the diesel generator loading sequence. Motors are specified to be capable of starting from rest and accelerating the connected equipment with 75 percent of nominal voltage at the motor terminals.

c. Motor Starting Torque

Motors are specified to produce starting torque well above that required by the driven equipment and to accelerate to full load speed at 75 percent of nominal voltage without injurious motor heating.

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

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

e. Motor Insulation

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

f. Temperature Monitoring Devices in Large Horsepower Motors

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

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

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

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

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

8.3.1.1.4.3 Electric Circuit Protection

Electric circuit protection is discussed in Section 8.3.1.1.2.11.

8.3.1.1.4.4 Grounding Requirements

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

Buried metal parts are steel plates, bare copper wire, steel pilings, and ground rods. Steel plates are 1/2 inch by 4 feet by 4 feet mild steel, buried below the foundation mats of several buildings at the lowest available elevations in the plant. Bare copper wire in sizes 500 MCM and 4/0 AWG is buried in grid fashion within the plant and switchyard and around the perimeter fence. The grid is concentrated in each area according to the fault current available in the area. Steel pilings at the barge slip on Lake Erie add an underwater conductor to the system. Copper clad ground rods are driven throughout the grid to a depth corresponding to a 15 ohm ground resistance and are connected to the grid, with an overall resistance of 1 ohm.

Exposed conductors are bare 500 MCM copper ground loops in each building, insulated reactor instrumentation conductors, and galvanized steel raceways. Bare 500 MCM stranded copper wire is arranged in loops around the interior perimeter of each building along routes of cable tray or building steel. Reactor instrument grounding is insulated from the safety ground system, except at the main connections in the control complex and reactor building. Bolted disconnect points are available in the instrument ground conductors for monitoring. All metallic electrical raceways, including trays, boxes, and conduit, are part of the safety grounding system.

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

8.3.1.1.4.5 Logic and Schematic Diagrams

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

8.3.1.1.5 Reactor Protection System Power System

8.3.1.1.5.1 General

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

Each motor generator set supplies control power for independent trip systems of the nuclear steam supply shutoff system, power range neutron monitoring system, parts of process radiation monitoring system, and reactor protection trip system. The RPS power is classified as nonessential because failure of the power supply causes a reactor scram. However, the power feeds to independent divisions are physically separated and supply redundant logic.

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

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

8.3.1.1.5.2 Components

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

8.3.1.1.5.3 Sources

Power to each of the RPS buses is supplied from two 120 volt a-c sources. The primary source of power is the motor generator sets. The alternate source of 120 volt a-c power is the station non-Class 1E power supply. The two motor generator sets are supplied from separate 480 volt motor control centers fed from non-Class 1E buses. The alternate power switch design and arrangement prevents paralleling of the power sources. Indicating lights are provided in the control room to monitor the status of both the motor generator sets and the instrument buses.

8.3.1.1.5.4 Operating Configuration

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

the alternate power source. A loss of power to one motor generator set results in a single RPS trip system trip. A persistent loss of electrical power to both motor generator sets (one second minimum) results in a scram.

8.3.1.1.6 High Pressure Core Spray System Power System

8.3.1.1.6.1 General

Figure 8.3-7 shows the HPCS power system simplified one line diagram electrical arrangement, power distribution, protective relaying, and instrumentation for the HPCS power system. Figure 8.3-8 shows the functional logic diagrams of the standby power system.

The HPCS power supply system is self-contained, except for the initiation signal source and access to the preferred offsite power supply through the onsite a-c power distribution system. It has a dedicated diesel generator and is operable as an isolated system independent of electrical connection to any other system. Class 1E auxiliary equipment, such as standby heaters and battery charger, are supplied from the same power source as the HPCS motor. Voltage and frequency of the HPCS diesel generator is compatible with that available from the onsite a-c power system.

The HPCS diesel generator has the capability to quickly restore power to the HPCS bus in the event offsite power is unavailable and to provide all required power for the startup and operation of the HPCS system. The HPCS diesel generator starts automatically upon receipt of a signal from the plant protection system or upon HPCS supply bus undervoltage and is automatically connected to the HPCS bus when the preferred power source is not available. Failure of this diesel generator will not negate the capability of other power sources. There is no provision for automatic paralleling of the HPCS diesel generator with auxiliary power or standby power sources. Provision for manual paralleling with normal power sources is made for loading the diesel generator in the test mode. An interlock is provided to avoid accidental paralleling. There is no sharing of the HPCS power system with the other unit.

8.3.1.1.6.2 Equipment Identification

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

8.3.1.1.6.3 HPCS Class 1E Electrical Equipment Capacity

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

The HPCS transformer is sized for the largest combination of continuous loads that it may be required to carry, plus an allowance for intermittent loads.

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

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

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

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

The HPCS motor is initially tested in accordance with NEMA MG-1[6].

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

8.3.1.1.6.4 HPCS 120 Volt A-C Class 1E Instrument Power System

The Class 1E instrument power system consists of a distribution panel fed through transformers connected to Division 3 ESF load centers. There are no bus ties or interconnections between the HPCS distribution panels and other electrical divisions.

All equipment associated with the Class 1E instrument power system is readily accessible for inspection and testing. Service and testing will be done on a routine basis in accordance with the manufacturer's recommendations.

8.3.1.1.6.5 HPCS Class 1E Electric Equipment Considerations

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

a. Physical Separation and Independence

   Equipment of Division 3 is segregated from the equipment of other divisions in accordance with documents, codes, and standards cited in the design basis. In general, electrical equipment and wiring for the safeguards systems are segregated into separate divisions and separated so that no design basis event is capable of disabling sufficient equipment to prevent reactor shutdown, removal of decay heat from the core, or isolation of the containment in the event of a design basis accident.

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

   Motors are sized in accordance with NEMA standards and manufacturers' ratings to be at least large enough to produce the starting, pull-in, and

driving torque calculated to be needed for the particular application, with due consideration for capabilities of the power sources.

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

The selection of motor insulation from alternative types, such as Class F or Class B is a design consideration based predominately upon environment. The choice of any one type of insulation is not, in itself, inherent to safe operation. Class F insulation is used for all ECCS motors.

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

The HPCS transformer is sized and impedance is chosen to facilitate selection of low voltage switchgear, motor control centers, and distribution panels.

High resistance grounding methods have been employed in the HPCS power system because of the importance of detecting small ground faults and the possible need to keep the entire system operable with a ground fault in existence. Ground fault is annunciated in the control room for operator action.

c. HPCS Class 1E Electrical Equipment Circuit Protection

Circuit protection of the HPCS bus is coordinated with the design of the overall protection system for the plant auxiliary electrical system. Simplicity in load grouping is employed to permit use of conventional protective relaying practice for isolation of faults. There is no load shedding or load sequencing in the HPCS power system. Emphasis is given to

preserving the ESF function in situations of power loss and equipment failure. Overload relays for the HPCS motor and diesel generator give alarm indication, only. Major faults are isolated by instantaneous relaying.

Protection of the HPCS diesel generator is described in Section 8.3.1.1.2.11. The HPCS transformer has overload and instantaneous protection relaying. The HPCS motor has both instantaneous and inverse time overcurrent relaying. These give alarm indications only in case of overloads. The stall condition is monitored by a high dropout instantaneous relay in conjunction with the inverse time overcurrent relay. These trip the motor in case of incipient stall. In general, relay settings are coordinated in such a way that interference of service is not communicated to a "higher" level involving equipment other than that immediately affected by the fault or overload. This is achieved by selecting trip levels and time delay settings so that faults are not passed through to circuit breakers ahead in a chain leading to the power supply but are relayed off without opening the latter. Thus, other loads which share a bus are kept on line. However, a faulty trip device or circuit breaker trip is protected against ultimate damage by circuit breakers "ahead" of it through coordinated magnitude and time settings.

d. HPCS Class 1E Electrical Equipment Testing

Means are provided for periodically testing the chain of system elements from sensing devices through driven equipment to assure that Class 1E equipment is functioning in accordance with design requirements. The drawout feature of protective relays allows replacement relays to be installed. The relay that was removed can be bench tested and calibrated.

Startup of onsite power units can be effected by simulation of LOCA signal or loss of power to the plant auxiliary power system. Connection of the HPCS diesel generator to the HPCS bus takes place automatically upon loss of plant auxiliary power to the HPCS bus (HPCS bus low voltage).

8.3.1.1.6.6 HPCS Diesel Generator

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

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

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

8.3.1.1.6.7 HPCS Diesel Generator Starting, Lubricating, and Fuel Oil Systems

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

8.3.1.1.6.8 HPCS Diesel Generator Control Power

Control power for the HPCS diesel generator is supplied from its own 125 volt d-c system which consists of a battery and associated battery charger. The battery charger is designed to carry the largest combination of steady state loads in any

mode of operation in addition to battery charging requirements. The d-c system is discussed in Section 8.3.2.

8.3.1.1.6.9 HPCS Diesel Generator Actuation

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

8.3.1.1.6.10 HPCS Diesel Generator Protective Devices

When the HPCS diesel generator is called upon to operate under accident conditions, only the emergency protective devices are functional. These are the generator differential overcurrent relays and the engine overspeed trip device. These trips are annunciated in the control room. Other normal protective devices, such as neutral ground overcurrent, reverse power, overcurrent voltage restraint, high jacket water temperature, low lubricating oil pressure, and engine overcranking, are used to protect the HPCS diesel generator during operation in parallel with the normal power system during periodic tests. These relays are automatically blocked from the tripping circuits under accident conditions. In addition to these protective relays, a normal time delay overcurrent relay senses a generator overload and causes an alarm in the control room. The generator differential overcurrent relays and overspeed trip device are retained under emergency conditions to protect against major faults which would cause immediate system failure and major damage. All bypassed trip devices actuate alarms in the control room and provide the operator with sufficient information to take appropriate corrective action. Since the HPCS diesel generator is performing a safety related core cooling function under accident conditions, these trip devices cannot be permitted to interrupt HPCS diesel generator operation. The decision to operate the diesel generator under these abnormal conditions is left to the operator.

8.3.1.1.6.11 HPCS Diesel Generator Prototype Qualification Program

A prototype test is performed to establish the adequacy of the HPCS diesel generator to successfully accelerate the HPCS pump and system loads. The test consists of starting an HPCS system in an actual HPCS pump loop test (HPCS system in condensate to condensate test mode) several times within the design time requirement with auxiliary loads. A topical report on HPCS power system unit, NEDO-10905-1[(8)], and subsequent amendments, describe and show theoretical and experimental evidence as to the adequacy of the design. The topical report will be further amended to include the results of the prototype qualification test cited above.

8.3.1.1.6.12 Acceptability Criteria for HPCS Diesel Generator

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

8.3.1.2 Analysis

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

The ESF onsite distribution system has been segregated into three separate and distinct load groups. These load groups are Divisions 1, 2, and 3. This arrangement complies with General Design Criterion (GDC) 17 and the recommendations of Regulatory Guide 1.6, in addition to other design bases described in Table 8.1-2. Each load group is complete with respect to 4.16 kV and 480 volt switchgear, 120 volt a-c and 125 volt d-c equipment, and standby power source. Each load group also has access to the preferred power source and the alternate preferred power source. Control power for operating circuit breakers in a particular division is supplied from the associated 125 volt

battery. These batteries are maintained at a constant voltage and are continuously monitored for voltage variations or undesired ground connections. Each motor and distribution feeder is equipped with protective devices which disconnect the motor or feeder under abnormal or potentially damaging conditions to limit degradation of the Class 1E electric power system. No provision exists for transfer of loads between the segregated load groups or for automatic switching which could parallel separate load groups.

The preferred power source and alternate preferred power source supply circuit breakers are manually operated either from the control room or a remote location. These circuit breakers in each division are interlocked with each other and with the division standby power source supply circuit breaker. Interlock contacts prevent the following:

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

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

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

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

8.3.1.2.2 Compliance with General Design Criterion 18

The Class -E electric system will be tested and inspected periodically to determine that settings and adjustments are within specified design limits. Systems and equipment are designed to allow performance of such testing during normal plant operation.

In addition to test facilities for switchgear, described in Section 8.3.1.1.2.12, inservice testing of protective relaying and instrumentation is accomplished by use of test plugs or test switches associated with these devices. These devices, in addition to the test facilities described, satisfy the intent of GDC 18, the recommendations of Regulatory Guide 1.22 and the applicable design bases of Table 8.1-2.

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

8.3.1.2.3 High Pressure Core Spray Division 3 Compliance

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

8.3.1.2.3.1 Compliance with General Design Criterion 17

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

8.3.1.2.3.2 Compliance with General Design Criterion 18

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

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

8.3.1.2.3.3 Compliance with General Design Criterion 21

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

8.3.1.2.3.4 Conformance with Regulatory Guide 1.6

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

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

a. Position 1 Conformance

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

b. Position 2 Conformance

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

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

c. Position 3 Conformance

There is no automatic or manual connection of the HPCS system d-c load group to any other load group.

d. Position 4 Conformance

Position 4 conformance is as follows:

1. The diesel generators connected to the divisions of load groups are physically and electrically independent of each other. The diesel generator connected to the HPCS division of a load group cannot be automatically paralleled with the diesel generator that is connected to another division of the load group.

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

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

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

e. Position 5 Conformance

To comply with the recommendations of Position 5, the following starting and loading reliability lists are performed:

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

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

3. An acceptable start and load reliability test is defined as follows: A total of 69 valid starting and loading tests with no failure or 128 valid starting and loading tests with a single failure are performed. Failure of the diesel generator to successfully complete this series of tests as prescribed requires a review of system design adequacy, correction of the cause of the failure, and continuation of the tests

until 128 valid tests are achieved without exceeding the one failure. The start and load tests are conducted as follows:

(a) Engine cranking will begin upon receipt of the start signal, and the diesel generator set will accelerate to specified frequency and voltage within the required time interval.

(b) Immediately following step No. 1 (Paragraph (a)) the diesel generator set will accept a single step load consisting of the main HPCS pump motor load (full loaded) or larger motor load (fully loaded) and additional loads (inductive and/or resistive) as required to total at least 100 percent of the continuous rating of the diesel generator.

(c) At least 90 percent of these tests are performed with the diesel generator set initially at "warm standby", based upon jacket water and lubricating oil temperatures at or below values recommended by the engine manufacturer. After load is applied, the diesel generator set will continue to operate until jacket water and lubricating oil temperatures are within ±10°F of the normal engine operating temperatures for the corresponding load.

(d) The other 10 percent of these tests are performed with the engine initially at normal operating temperature equilibrium (defined as jacket water and lubricating oil temperatures within ±10°F of normal operating temperatures as established by the engine manufacturer for the corresponding load).

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

1. Unsuccessful start attempts which can definitely be attributed to operator error, including setting of alignment control switches,

rheostats, potentiometers, or other adjustments that may have been changed inadvertently prior to that particular start test.

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

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

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

8.3.1.2.3.5 Conformance with Regulatory Guide 1.9

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

a. Position 1 Conformance

Table 8.3-1 shows that the continuous rating of the diesel generator is greater than the maximum coincidental steady state loads requiring power at any time. Intermittent loads, such as motor operated valves, are not considered for long term loads.

b. Position 2 Conformance

Table 8.3-1 lists the 2000 hour rating of the HPCS diesel generator, the 90 percent of 30 minute rating, and the maximum coincidental load for conformance with this position.

c. Position 3 Conformance

Load requirements will be verified and test data will be provided following the preoperational tests.

d. Position 4 Conformance

The HPCS diesel generator unit performance, with respect to voltage and frequency limits during the initial loading for a transient, is considered as a justifiable departure from literal conformance to Regulatory Guide 1.9. The HPCS system consists of one large pump and motor combination which represents more than 90 percent of the total load. Consequently, limiting the momentary voltage drop to 25 percent and the momentary frequency drop to 5 percent would not significantly enhance the reliability of HPCS operation. To satisfy these regulatory guide recommendations, a diesel generator approximately two to three times as large as that required to carry the continuous rated load would be necessary. However, all other recommendations, including the frequency and voltage overshoot requirements of Regulatory Guide 1.9, are satisfied. A factory testing program on a production diesel generator has verified the following functions:

1. System fast start capabilities.

2. Load carrying capability.

3. Load rejection capability.

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

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

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

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

8.3.1.2.3.6 Conformance with Regulatory Guide 1.29

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

8.3.1.2.3.7 Conformance with Regulatory Guide 1.32

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

8.3.1.2.3.8 Conformance with Regulatory Guide 1.47

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

8.3.1.2.3.9 Conformance with Regulatory Guide 1.62

Manual controls are provided to permit the operator to select the most suitable power supply for the HPCS bus. An automatic start signal will override the manual test mode. Provision is made for system level manual control of the system from the control room, as well as from an external location. Equipment common to manual and automatic control is limited to a practical minimum.

8.3.1.2.3.10 Conformance with Regulatory Guide 1.75

The HPCS diesel generator and supporting auxiliaries are Division 3 equipment separated from, and independent of, equipment of other divisions. All major components are marked with a Division 3 name tag. See Section 8.3.1.1.2.9 for a discussion of safety related equipment identification.

8.3.1.2.3.11 Conformance with IEEE Standard 279

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

8.3.1.2.3.12 Conformance with IEEE Standard 308

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

The HPCS equipment is uniquely identified by color coding of the components or identification tags as detailed in Section 8.3.1.1.2.9.

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

8.3.1.2.3.13 Conformance with IEEE Standard 344

The HPCS power supply unit components are seismically qualified in accordance with IEEE Standard 344[11]. Refer to Section 3.10.

8.3.1.2.3.14 Conformance with IEEE Standard 387

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

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

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

   1. From the normal standby condition.

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

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

c. Carry the design load for 2000 hours.

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

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

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

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

8.3.1.2.4 Safety Related Equipment in Hostile Environments

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

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

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

8.3.1.3 <u>Physical Identification of Safety Related Equipment</u>

Identification of safety related equipment is addressed in Section 8.3.1.1.2.9.

8.3.1.4 <u>Independence of Redundant Systems</u>

8.3.1.4.1 Physical Separation Requirements for Class 1E Equipment

8.3.1.4.1.1 General Requirements

Electrical equipment and wiring for Class 1E electrical systems are segregated into separate independent divisions, designated Division 1, Divison 2, and Division 3, such that no single credible event is capable of disabling sufficient equipment to prevent reactor shutdown, removal of decay heat from the core, and isolation of containment in the event of an incident. Division separation requirements apply to equipment and wiring systems concerned.

Switchgear, batteries, and similar major electrical equipment for each division are housed in separate rooms within the control complex and are completely separated from redundant division equipment. Figures 8.3-14 through 8.3-18 show routing of principal cables.

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

8.3.1.4.1.2 Cable Routing through Mechanical Damage Zones

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

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

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

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

8.3.1.4.1.3 Cable Routing through Fire Hazard Areas

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

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

8.3.1.4.1.4 Cable Routing in General Plant Areas

In any room, compartment, or area of the plant, except the cable spreading rooms, cable trays of different divisions have a minimum horizontal separation of 3 feet when there is no physical barrier between trays. Where a horizontal separation of 3 feet is unattainable, the trays will be separated by fire resistant materials.

Vertical stacking of cable trays of different divisions is avoided wherever possible. In cases where trays requiring separation must be stacked one above another, a minimum vertical separation of 5 feet is maintained. Where vertical separation of 5 feet cannot be maintained, the trays will be separated by fire resistant materials.

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

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

8.3.1.4.1.5 Cable Routing in Cable Spreading Rooms

The cable spreading rooms are provided to allow the cables required in the control room to converge prior to entering the respective panels or termination cabinets. In the cable spreading rooms, cable trays of different divisions have the maximum practical separation, as illustrated in Figure 8.3-16. Separation and independence criteria are in accordance with IEEE Standard 384 as described in Table 8.1-2.

8.3.1.4.1.6 Separation of Components and Wiring in Panels

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

a. Where two panels containing circuits of different divisions are less than 3 feet apart, there is a steel barrier between the two panels. Panel ends, closed by steel end plates, are acceptable barriers provided that terminal boards and wireways are separated from the end plates by a minimum of 1 inch of air space or a thermal insulating barrier.

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

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

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

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

A separate tray system, consisting of power, control, and instrumentation trays, is used for non-Class 1E circuits. This non-safety related tray system does not connect to any tray containing Class 1E circuits. No Class 1E cables are installed in trays containing non-Class 1E circuits. Associated circuits are installed in trays containing Class 1E circuits.

8.3.1.4.1.8 Special Cable Routing Requirements

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

8.3.1.4.2 Cable Tray Selection

Power and control cable trays are of the galvanized steel, ladder type with nominal 9 inch rung spacing. These trays have 4 or 6 inch side rails with a minimum available loading depth of 3 or 5 inches, respectively.

Instrument cable trays are of the galvanized steel, radio frequency type. These trays are 4 inches deep.

8.3.1.4.3 Cable Derating and Cable Tray Fill

Large power cables (#4 AWG and larger) for Class 1E systems are of interlocked armor construction with copper conductors having ampacities in free air as listed in IPCEA P-46-426[12]. A derating factor of 0.6 is applied to the ampacities of these cables. This derating corresponds to that used for the installation of up to 42 conductors with nonmaintained spacing in a single tray. These cables are installed in a single layer in trays committed exclusively to interlocked armor cable.

Non-armored 600 volt copper conductor cable, #14 AWG to #4 AWG, is derated according to IPCEA P-54-440[13], Table 3, with a theoretical loading depth of 1.5 or 2.5 inches. This loading depth is derived by dividing the area computed by summing the cable diameter squared for all cables by the width of the tray. This value corresponds to 50 percent of the 3 inch or 5 inch usable depth of the tray.

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

8.3.1.4.4 Tray Allocation of Cables by Construction and Voltage Level

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

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

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

8.3.1.4.5 Electrical Penetration Assemblies

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

Any deterioration of the epoxy insulation is monitored by a leakage monitoring system using nitrogen. During normal operation, the nitrogen pressure will be kept at or above 15 psig (the Perry containment accident design pressure). This pressure is maintained in a very small volume between the seals of each penetration module to achieve high sensitivity in leak monitoring. Penetration pressures will be routinely inspected during plant operation to assure prompt detection of leaky penetrations. The manufacturer will ship the penetrations pressurized at the time of shipping with dry nitrogen gas at 15 psig minimum. During storage and installation, the nitrogen pressure will be monitored and maintained.

The electrical penetration assemblies are arranged in divisional groups (see Figures 8.3-19 and 8.3-20) to maintain separation of electrical cables to comply with the single failure criterion. Within each divisional group, separate penetrations are provided for large power cables, small power and control cables, and instrument cables. Individual penetration modules are provided for each of the RPS trip channels.

For those Class 1E and non-Class 1E power circuits which penetrate the containment, the power system is designed such that it will isolate faults while subjected to a single random failure of a protective device without exceeding the penetration rating. The rating is based on established criteria in IEEE Standard 317. The fault isolation is accomplished by backup fusing for all 480 volt loads and backup protective relaying on the 15 kV ATWS circuit breaker for the reactor recirculation pump motor.

8.3.1.4.6 Fire Detection and Protection Equipment

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

8.3.2 DC POWER SYSTEMS

8.3.2.1 Description

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

a. Non-Class 1E 125 volt d-c system A.
b. Non-Class 1E 125 volt d-c system B.
c. Class 1E Division 1, 125 volt d-c system.
d. Class 1E Division 2, 125 volt d-c system.
e. Class 1E Division 3, 125 volt d-c system.

8.3.2.1.1 Non-Class 1E 125 Volt D-C Systems

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

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

8.3.2.1.2.1 General

The Class 1E Division 1 and Division 2, 125 volt d-c systems are two completely redundant systems. Each is capable of supplying required d-c power to associated loads needed for safe shutdown. (No non-Class 1E loads are supplied from a Class 1E d-c system.) Each system includes a 60 cell, 1260 ampere hour battery, a 400 ampere battery charger, and a load center. The Division 1 system also includes a motor control center and a distribution panel. The Division 2 system has two distribution panels. In addition, 400 ampere reserve battery

charger is provided for each division. These battery chargers are located with the equipment associated with Unit 1 but can be connected to the appropriate division of either the Unit 1 or Unit 2 Class 1E 125 volt d-c system by means of the maintenance tie buses. No interdivisional ties are provided between the divisions associated with Unit 1 or Unit 2. Maintenance tie buses connect only the same divisions of the two units (i.e., Unit 1, Division 1 to Unit 2, Division 1).

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

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

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

Batteries, battery chargers and distribution equipment for the Class 1E Division 1 and Division 2, 125 volt d-c systems are located in separate, locked rooms in a Seismic Category I structure (see Figure 8.3-4). This maintains separation between divisions.

Each Class 1E 125 volt d-c system is equipped with a bus undervoltage relay which, upon detection of an undervoltage condition, actuates an alarm in the control room. Two voltage relays are also provided for each d-c bus for purposes of ground fault detection. One of these relays is connected from positive to

ground; the other, from negative to ground. These relays are set so that a ground on either the positive or negative side of the system causes a voltage imbalance across the relay coils, resulting in actuation of a d-c system trouble alarm in the control room.

8.3.2.1.2.2 Capacity

The Class 1E Division 1 and Division 2, 125 volt d-c systems batteries are sized to supply the required d-c loads (see Table 8.3-7) for a minimum of two hours without the final discharge voltage decreasing to less than the design minimum of 1.75 volts/cell. Sizing of the batteries also includes a design margin of 1.15 and an aging factor of 1.25. During normal operation the battery chargers supply the continuous d-c load of the associated divisions while maintaining a float charge on the batteries. The battery chargers are sized to supply the continuous load of both units while simultaneously recharging the battery to a fully charged condition from the design minimum charge of 1.75 volts/cell within 12 hours. Since the maintenance tie buses connect the same safety divisions of each unit, the sources (batteries and battery chargers) are sized to provide d-c power under LOCA conditions in one unit coincident with safe shutdown of the other unit. Switching required to make the reserve battery charger available in the event of failure of the normal division battery charger would be accomplished well within the two hour time limit.

8.3.2.1.2.3 Equipment

a. Batteries and Battery Racks

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

b. Battery Chargers

The solid state battery chargers each have a filtered d-c output for float and equalizing modes. Battery charger input is 3 phase, 480 volt a-c power. Each battery charger is equipped with a d-c voltmeter and ammeter, charger failure relay, high battery voltage relay, and low battery voltage relay. Any battery charger malfunction actuates an alarm in the control room. If the reserve battery charger is in service, the alarm system is designed so that a malfunction actuates an alarm only in the control room of the unit which the reserve battery charger is serving.

c. D-C Load Centers

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

d. D-C Motor Control Centers

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

e. D-C Distribution Panels

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

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

8.3.2.1.3.1 General

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

8.3.2.1.3.2 High Pressure Core Spray D-C Loads

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

8.3.2.1.3.3 Battery and Battery Charger

The 125 volt d-c system for the HPCS power supply has a 60 cell, lead acid battery (100 ampere-hours at 8 hours), one 50 ampere battery charger, one 50 ampere reserve battery charger, and a distribution panel with molded case circuit breakers. Figure 8.3-22 shows the connection of batteries, battery chargers, and distribution panel.

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

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

8.3.2.1.3.4 System Identification

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

8.3.2.1.3.5 Battery Capacity

The ampere-hour capacity and short time rating of the Division 3 battery are in accordance with criteria given in IEEE Standard 308 and applicable design bases listed in Table 8.1-2. The battery has sufficient stored energy to operate required connected essential loads for as long as each may be needed during a loss of the a-c bus supplying the battery chargers under normal or emergency conditions. Capacity is large enough to cope with LOCA conditions or any other emergency shutdown. Each distribution circuit is capable of transmitting sufficient energy to start and operate all required loads in that circuit. The Division 3, 125 volt battery is sized in accordance with the principles set out in IEEE Standard 308.

8.3.2.1.3.6 Charging

The normal battery charger and the reserve battery charger for the Division 3 (HPCS) d-c system are each capable of carrying the normal d-c system load and, at the same time, keeping the battery in a fully charged condition. Sizing of the battery chargers satisfies IEEE Standard 308.

The 480 volt a-c system feeds to the normal and reserve battery chargers are from the HPCS motor control center to maintain functional association. Probability of a system failure resulting in prolonged loss of d-c power is extremely low. Important system components are either self-alarming upon failure or are capable

of being tested during service to detect faults. All abnormal conditions of selected system parameters important to surveillance of the system are annunciated in the control room. Automatic cross connections between the Division 3 (HPCS) 125 volt d-c systems and other d-c systems are not provided.

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

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

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

8.3.2.1.4 Ventilation

Complete details of battery room and d-c equipment room ventilation systems are presented in Section 9.4.1. Each room is provided with an ionization type smoke detector which, upon detection of smoke, actuates an alarm in the control room.

8.3.2.1.5 Maintenance and Test

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

General maintenance and testing procedures will be in accordance with IEEE Standard 450[15], as detailed in the technical specifications.

8.3.2.2 Analysis

8.3.2.2.1 Compliance with General Design Criteria and Regulatory Guides

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

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

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

The battery charger has enough power output capacity for the steady state operation of connected loads required during normal or emergency operation (whichever is larger), while maintaining the associated battery in a fully charged state. Each battery charger supply has enough capacity to restore the battery from the design minimum charge to a fully charged state while supplying normal steady state loads. The normal and reserve battery charger supplies are from ESF motor control centers of the appropriate division. Since the d-c power systems are operated ungrounded, a ground detection feature is provided. Indicators are provided to monitor the status of the battery charger supply. This instrumentation includes indication of output voltages, output current, battery ground status, and main circuit breaker position. Bus undervoltage is annunciated in the control room. Battery chargers are provided with disconnecting means and feedback protection. Periodic tests will be performed to assure the readiness of the system to deliver the power required.

8.3.3 FIRE PROTECTION FOR CABLE SYSTEMS

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

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

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

8.3.4 REFERENCES FOR SECTION 8.3

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

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

3. U.S. Nuclear Regulatory Commission, "Diesel-Generator Protective Trip Circuit Bypasses," Branch Technical Position EICSB17, November 24, 1975.

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

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

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

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

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

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

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

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

12. Insulated Power Cable Engineers Association, "Power Cable Ampacities," IPCEA P-46-426, 1962.

13. Insulated Power Cable Engineers Association, "Ampacities of Cables in Open-Top Cable Trays," IPCEA P-54-440, 1972.

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

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

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

TABLE 8.3-1

CONNECTED, AUTOMATIC AND MANUAL LOADING AND UNLOADING OF ENGINEERED SAFETY FEATURES SWITCHGEAR

					Maximum Operating Requirements Without Offsite Power Available					
					Forced Shutdown			Loss of Coolant Accident		
Equipment Description	Number on Bus	HP Each	Full Load (Amperes)	Inrush Current (Amperes)	(9) Time of Start	Req'd Running Time	Type of Control	(9) Time of Start	Req'd Running Time	Type of Control
Unit 1, Division 1										
Safety Feature Loads										
Low Pressure Core Spray Pump	1	1750	222	1443	-	-	(1)	0 sec	Cont	(3)
Residual Heat Removal Pump A	1	900	115	747	10 min	Cont	(1)	5 sec	Cont	(3)
Emergency Service Water Pump A	1	800	102	618	10 sec	Cont	(2)	10 sec	Cont	(2)
Emergency Closed Cooling Pump A	1	100	112	728	0 sec	Cont	(1)	0 sec	Cont	(3)
Low Pressure Core Spray and Residual Heat Removal A Water Leg Pump	1	5	6.35	46	0 sec	Cont	(1)	0 sec	Cont	(1)
Reactor Core Isolation Cooling Water Leg Pump	1	5	7.5	49	0 sec	Cont	(1)	0 sec	Cont	(1)
Standby Liquid Control Pump A	1	40	48.8	317	-	-	(1)	-	-	(1)
Fuel Pool Cooling and Circulating Water Pump A	1	200	229	1450	0 sec	Cont	(1)	0 sec	Cont	(1)
Diesel Room Supply Fans	2	50	57.5	376	0 sec	Cont	(2)	0 sec	Cont	(2)
Residual Heat Removal A Pump Room Cooling Fan	1	20	25	130	10 min	Cont	(2)	5 sec	Cont	(2)
Low Pressure Core Spray Pump Room Cooling Fan	1	20	25	130	-	-	(1)	0 sec	Cont	(2)
Annulus Exhaust Fan A	1	15	19	105	0 sec	Cont	(2)	0 sec	Cont	(3)
Annulus Exhaust System Heating Coil A	1	15 kW	19	-	0 sec	Cont	(2)	0 sec	Cont	(3)
Control Room Supply Fan A	1	60	77	436	0 sec	Cont	(1)	0 sec	Cont	(3)
Control Complex Chiller A	1	680	94	540	50 sec	Cont	(2)	50 sec	Cont	(2)
Control Complex Chiller A Oil Pump	1	1.5	2.2	13.4	50 sec	Cont	(2)	50 sec	Cont	(2)

TABLE 8.3-1 (Continued)

Equipment Description	Number on Bus	HP Each	Full Load (Amperes)	Inrush Current (Amperes)	Maximum Operating Requirements Without Offsite Power Available — Forced Shutdown: (9) Time of Start	Forced Shutdown: Req'd Running Time	Forced Shutdown: Type of Control	Loss of Coolant Accident: (9) Time of Start	Loss of Coolant Accident: Req'd Running Time	Loss of Coolant Accident: Type of Control
Unit 1, Division 1 (Cont'd)										
Safety Feature Loads (Cont'd)										
Control Complex Chilled Water Pump A	1	100		710	0 sec	Cont	(1)	0 sec	Cont	(1)
Control Room Return Fan A	1	60	77	436	-	-	(1)	-	-	-
Control Room Recirculation Fan A	1	100	116	660	0 sec	Cont	(2)	0 sec	Cont	(3)
Control Room Emergency Recirculation A Electric Heating Coil	1	100 kW	125	-	5 sec	Cont	(1)	5 sec	Cont	(3)
Battery Room Exhaust Fan A	1	10	13.5	80	0 sec	Cont	(2)	0 sec	Cont	(3)
Motor Control Center, Switchgear, and Battery Room Supply Fan A	1	100	116	490	5 sec	Cont	(2)	5 sec	Cont	(2)
Motor Control Center and Switchgear Room Return Fan A	1	100	116	490	5 sec	Cont	(2)	5 sec	Cont	(2)
Emergency Closed Cooling Pump Area Cooling Fan A	1	20	25	130	0 sec	Cont	(2)	0 sec	Cont	(2)
Off-Gas Building Vent Fan A	1	40	50	280	0 sec	Cont	(2)	0 sec	Cont	(2)
Fuel Handling Building Supply Fan A	1	30	38	210	0 sec	Cont	(1)	-	-	(1)
Fuel Handling Building Exhaust Fan A	1	40	50	255	0 sec	Cont	(1)	-	-	(1)
Fuel Handling Building Exhaust Fan A Heating Coil	1	50 kW	63	-	0 sec	Cont	(2)	-	-	(2)
Reactor Core Isolation Cooling Pump Room Cooling Fan	1	5	7	42.7	0 sec	Cont	(2)	0 sec	Cont	(2)
Emergency Service Water Pumphouse Vent Supply Fan A	1	30	38	290	0 sec	Cont	(2)	0 sec	Cont	(2)
Emergency Service Water Pumphouse Intake Screen Wash Pump A	1	50	56	362	0 sec	Cycled(5)	(2)	0 sec	Cont	(3)
Emegency Service Water Pumphouse Traveling Screen A	1	15	19.5	103	0 sec	Cycled(5)	(2)	0 sec	Cont	(2)

TABLE 8.3-1 (Continued)

Equipment Description	Number on Bus	HP Each	Full Load (Amperes)	Inrush Current (Amperes)	Maximum Operating Requirements Without Offsite Power Available: Forced Shutdown: (9) Time of Start	Forced Shutdown: Req'd Running Time	Forced Shutdown: Type of Control	Loss of Coolant Accident: (9) Time of Start	Loss of Coolant Accident: Req'd Running Time	Loss of Coolant Accident: Type of Control
Unit 1, Division 1 (Cont'd)										
Safety Feature Loads (Cont'd)										
Emergency Service Water Screen Wash Pump Discharge Strainer A	1	0.5	1	6.5	0 sec	Cycled(5)	(2)	0 sec	Cont	(3)
Emergency Service Water Suction Sluice Gate A	1	1	1.6	15	0 sec	20 min	(2)	0 sec	20 min	(2)
Diesel Generator Fuel Oil Transfer Pump	1	15	20	130	0 sec	Cycled(6)	(2)	0 sec	Cycled(6)	(2)
Diesel Generator Fuel Oil Transfer Backup Pump	1	15	20	130	0 sec	Cycled(6)	(2)	0 sec	Cycled(6)	(2)
Diesel Generator Jacket Water Keep Warm Pump	1	3	4.1	32	-	-	(2)	-	-	(2)
Diesel Generator Jacket Water Keep Warm Heater	1	75 kW	~4	-	-	-	(2)	-	-	(2)
Diesel Generator Lube Oil Keep Warm Pump	1	15	19	116	-	-	(2)	-	-	(2)
Diesel Generator Lube Oil Keep Warm Heater	1	50 kW	63	-	-	-	(2)	-	-	(2)
Main Steam Isolation Valve Leakage Control Pipe Heaters	4	4 kW	5	-	0 sec	Cont	(2)	0 sec	Cont	(2)
Main Steam Isolation Valve Leakage Control Air Blower	1	4	6.5	42.25	0 sec	Cont	(2)	0 sec	Cont	(2)
125 Volt D-C Battery Charger	1	50 kW	87	-	0 sec	Cont	(4)	0 sec	Cont	(4)
125 Volt D-C Reserve Battery Charger	1	50 kW	87	-	-	-	-	-	-	-
Hydrogen Recombiner A	1	75 kW	95	-	-	-	(1)	18.4 hr	Cont	(1)
Hydrogen Mixing Compressor A	1	60	77	436	-	-	(2)	287 hr	Cont	(2)
Motor Operated Valves	110	1.2(7)	-	-	0 sec	30 sec	-	0 sec	30 sec	-

TABLE 8.3-1 (Continued)

Equipment Description	Number on Bus	HP Each	Full Load (Amperes)	Inrush Current (Amperes)	Maximum Operating Requirements Without Offsite Power Available — Forced Shutdown: (9) Time of Start	Forced Shutdown: Req'd Running Time	Forced Shutdown: Type of Control	Loss of Coolant Accident: (9) Time of Start	Loss of Coolant Accident: Req'd Running Time	Loss of Coolant Accident: Type of Control
Unit 1, Division 1 (Cont'd)										
Nonsafety Feature Loads										
Nuclear Closed Cooling Pump A	1	700	90.5	588	1 min	Cont	(1)	-	-	(1)
Control Rod Drive Pump A	1	400	52	312	-	-	(1)	-	-	(1)

	Time Sequence	Forced Shutdown	Loss of Coolant Accident
Subtotal, kW per Time Sequence	0 sec	1131	2428
	5 sec	162	1008
	10 sec	635	635
	50 sec	566	566
	1 min	559	-
	10 min	746	-
	18.4 hr	-	75
	287 hr	-	60
Net Total Maximum Continuous Load (kW)		3799	4772

Equipment Description	Number on Bus	HP Each	Full Load (Amperes)	Inrush Current (Amperes)	Forced Shutdown: (9) Time of Start	Forced Shutdown: Req'd Running Time	Forced Shutdown: Type of Control	Loss of Coolant Accident: (9) Time of Start	Loss of Coolant Accident: Req'd Running Time	Loss of Coolant Accident: Type of Control
Unit 1, Division 2										
Safety Feature Loads										
Residual Heat Removal Pump B	1	900	115	747	10 min	Cont	(1)	5 sec	Cont	(3)
Residual Heat Removal Pump C	1	900	115	747	-	Cont	(1)	0 sec	Cont	(3)
Emergency Service Water Pump B	1	800	102	618	10 sec	Cont	(2)	10 sec	Cont	(2)
Emergency Closed Cooling Pump B	1	100	112	728	0 sec	Cont	(1)	0 sec	Cont	(3)
Residual Heat Removal B and C Water Leg Pump	1	5	6.35	46	0 sec	Cont	(1)	0 sec	Cont	(1)
Standby Liquid Control Pump B	1	40	48.8	317	-	-	(1)	-	-	(1)
Fuel Pool Cooling and Circulating Water Pump B	1	200	229	1450	0 sec	Cont	(1)	0 sec	Cont	(1)
Diesel Room Supply Fans	2	50	57.5	376	0 sec	Cont	(2)	0 sec	Cont	(2)
Residual Heat Removal B Pump Room Cooling Fan	1	20	25	130	10 min	Cont	(2)	5 sec	Cont	(2)

TABLE 8.3-1 (Continued)

Equipment Description	Number on Bus	HP Each	Full Load (Amperes)	Inrush Current (Amperes)	Maximum Operating Requirements Without Offsite Power Available: Forced Shutdown (9) Time of Start	Forced Shutdown Req'd Running Time	Forced Shutdown Type of Control	Loss of Coolant Accident (9) Time of Start	Loss of Coolant Accident Req'd Running Time	Loss of Coolant Accident Type of Control
Unit 1, Division 2 (Cont'd)										
Safety Feature Loads (Cont'd)										
Residual Heat Removal C Pump Room Cooling Fan	1	20	25	130	-	-	(2)	0 sec	Cont	(2)
Annulus Exhaust Fan B	1	15	19	105	0 sec	Cont	(2)	0 sec	Cont	(3)
Annulus Exhaust System Heating Coil B	1	15 kW	19	-	0 sec	Cont	(2)	0 sec	Cont	(3)
Control Room Supply Fan B	1	60	77	436	0 sec	Cont	(1)	0 sec	Cont	(3)
Control Complex Chiller B	1	680	94	540	50 sec	Cont	(2)	50 sec	Cont	(2)
Control Complex Chiller B Oil Pump	1	1.5	2.2	13.4	50 sec	Cont	(2)	50 sec	Cont	(2)
Control Complex Chilled Water Pump B	1	100	115	710	0 sec	Cont	(1)	0 sec	Cont	(1)
Control Room Return Fan B	1	60	77	436	-	-	(1)	-	-	-
Control Room Recirculation Fan B	1	100	116	660	0 sec	Cont	(2)	0 sec	Cont	(3)
Control Room Emergency Recirculation B Electric Heating Coil	1	100 kW	125	-	5 sec	Cont	(1)	5 sec	Cont	(3)
Battery Room Exhaust Fan B	1	10	13.5	80	0 sec	Cont	(2)	0 sec	Cont	(3)
Motor Control Center, Switchgear, and Battery Room Supply Fan B	1	100	116	490	5 sec	Cont	(2)	5 sec	Cont	(2)
Motor Control Center and Switchgear Room Return Fan B	1	100	116	490	5 sec	Cont	(2)	5 sec	Cont	(2)
Emergency Closed Cooling Pump Area Cooling Fan B	1	20	25	130	0 sec	Cont	(2)	0 sec	Cont	(2)
Off-Gas Building Vent Fan B	1	40	50	280	0 sec	Cont	(2)	0 sec	Cont	(2)
Fuel Handling Building Supply Fan B	1	30	38	210	0 sec	Cont	(1)	-	-	(1)
Fuel Handling Building Exhaust Fan B	1	40	50	255	0 sec	Cont	(1)	-	-	(1)

TABLE 8.3-1 (Continued)

Equipment Description	Number on Bus	HP Each	Full Load (Amperes)	Inrush Current (Amperes)	Maximum Operating Requirements Without Offsite Power Available: Forced Shutdown			Loss of Coolant Accident		
					(9) Time of Start	Req'd Running Time	Type of Control	(9) Time of Start	Req'd Running Time	Type of Control
Unit 1, Division 2 (Cont'd)										
Safety Feature Loads (Cont'd)										
Fuel Handling Building Exhaust Fan B Heating Coil	1	50 kW	63	-	0 sec	Cont	(2)	-	-	(2)
Emergency Service Water Pumphouse Vent Supply Fan B	1	30	38	290	0 sec	Cont	(2)	0 sec	Cont	(2)
Emergency Service Water Pumphouse Intake Screen Wash Pump B	1	50	56	352	0 sec	Cycled[5]	(2)	0 sec	Cont	(3)
Emegency Service Water Pumphouse Traveling Screen B	1	15	19.5	103	0 sec	Cycled[5]	(2)	0 sec	Cont	(2)
Emergency Service Water Screen Wash Pump Discharge Strainer B	1	0.5	1	6.5	0 sec	Cycled[5]	(2)	0 sec	Cont	(3)
Emergency Service Water Suction Sluice Gate B	1	1	1.6	15	10 sec	20 min	(2)	10 sec	20 min	(2)
Diesel Generator Fuel Oil Transfer Pump	1	15	20	130	0 sec	Cycled[6]	(2)	0 sec	Cycled[6]	(2)
Diesel Generator Fuel Oil Transfer Backup Pump	1	15	20	130	0 sec	Cycled[6]	(2)	0 sec	Cycled[6]	(2)
Diesel Generator Jacket Water Keep Warm Pump	1	3	4.1	32	-	-	(2)	-	-	(2)
Diesel Generator Jacket Water Keep Warm Heater	1	75 kW	94	-	-	-	(2)	-	-	(2)
Diesel Generator Lube Oil Keep Warm Pump	1	15	19	116	-	-	(2)	-	-	(2)
Diesel Generator Lube Oil Keep Warm Heater	1	50 kW	63	-	-	-	(2)	-	-	(2)
Main Steam Isolation Valve Leakage Control Air Blower	2	4	6.5	42	0 sec	Cont	(2)	0 sec	Cont	(2)
125 Volt D-C Battery Charger	1	50 kW	87	-	0 sec	Cont	(4)	0 sec	Cont	(4)

TABLE 8.3-1 (Continued)

Equipment Description	Number on Bus	HP Each	Full Load (Amperes)	Inrush Current (Amperes)	Maximum Operating Requirements Without Offsite Power Available: Forced Shutdown (9) Time of Start	Req'd Running Time	Type of Control	Loss of Coolant Accident (9) Time of Start	Req'd Running Time	Type of Control
Unit 1, Division 2 (Cont'd)										
Safety Feature Loads (Cont'd)										
125 Volt D-C Reverse Battery Charger	1	50 kW	87	-	-	-	-	-	-	-
Hydrogen Recombiner B	1	75 kW	95	-	-	-	(1)	18.4 hr	Cont	(1)
Hydrogen Mixing Compressor A	1	60	77	436	-	-	(2)	287 hr	Cont	(2)
Motor Operated Valves	90	1.6(7)	-	-	0 sec	30 sec	-	0 sec	30 sec	-
Nonsafety Feature Loads										
Nuclear Closed Cooling Pump B	1	700	90.5	588	1 min	Cont	(1)	-	-	(1)
Control Rod Drive Pump B	1	400	52	312	-	-	(1)	-	-	(1)
Service Water Pump B	1	1000	129	800	1 min	Cont	(1)	-	-	(1)
Standby Liquid Control Operating Heater	1	10	11	-	(8)	Cont	(2)	-	-	(2)
Hydrogen Main Seal Oil Pump	1	20	28.7	145	(8)	Cont	(1)	-	-	(1)
Hydrogen Recirculating Seal Oil Pump	1	7.5	11.2	63.5	(8)	Cont	(1)	-	-	(1)
Hydrogen Seal Oil Vapor Extractor	1	2	3	21	(8)	Cont	(1)	-	-	(1)
Turbine Turning Gear Motor	1	60	80	435	(8)	Cont	(2)	-	-	(2)
Turbine Turning Gear Piggy Back Motor	1	10	15	98	(8)	Cont	(2)	-	-	(2)
Turbine Bearing Lift Pumps	9	5	8.1	46	(8)	Cont	(1)	-	-	(1)
Turbine Lube Oil Motor Suction Pump	1	50	61.5	363	(8)	Cont	(2)	-	-	(2)
Turbine Turning Gear Oil Pump	1	50	61.5	363	(8)	Cont	(2)	-	-	(2)
Reactor Feedwater Pump Turbine A Turning Gear	1	1.5	2.5	16	(8)	Cont	(2)	-	-	(2)

TABLE 8.3-1 (Continued)

Equipment Description	Number on Bus	HP Each	Full Load (Amperes)	Inrush Current (Amperes)	Maximum Operating Requirements Without Offsite Power Available: Forced Shutdown (9) Time of Start	Forced Shutdown Req'd Running Time	Forced Shutdown Type of Control	Loss of Coolant Accident (9) Time of Start	Loss of Coolant Accident Req'd Running Time	Loss of Coolant Accident Type of Control
Unit 1, Division 2 (Cont'd)										
Nonsafety Feature Loads (Cont'd)										
Reactor Feedwater Pump Turbine B Turning Gear	1	1.5	2.5	16	(8)	Cont	(2)	-	-	(2)
Diesel Generator Starting Air Compressors	4	30	34	217	10 min	Cycled[6]	(2)	-	-	(2)
Diesel Generator Starting Air Aftercoolers	4	1	1.68	15	10 min	Cycled[6]	(2)	-	-	(2)
Reactor Protection System Motor Generator Set A	1	25	38.9	253	(8)	Cont	(1)	-	-	(1)
Reactor Water Cleanup Pump A	1	60	66.8	434	(8)	Cont	(1)	-	-	(1)
Reactor Water Cleanup Pump B	1	60	66.8	434	(8)	Cont	(1)	-	-	(1)
Lower Drywell Cooling Fans	2	60	73.5	435	(8)	Cont	(2)	-	-	(2)
Middle Drywell Cooling Fans	2	60	73.5	435	(8)	Cont	(2)	-	-	(2)
Upper Drywell Cooling Fans	2	60	73.5	435	(8)	Cont	(2)	-	-	(2)
Diesel Driven Fire Pump A Fan	1	7.5	10.4	63.5	(8)	Cont	(2)	-	-	(2)
Off-Gas Building Vent Exhaust Radiation Monitor	1	2	2.5	-	(8)	Cont	(4)	-	-	(4)
125 Volt D-C System A Battery Charger	1	75 kW	133	-	(8)	Cont	(4)	0 sec	Cont	(4)
125 Volt D-C System A Reserve Battery Charger	1	75 kW	133	-	-	-	-	-	-	-
125 Volt D-C System B Battery Charger	1	37.5 kW	67	-	(8)	Cont	(4)	0 sec	Cont	(4)
Essential Lighting	-	84 kW	-	-	(8)	Cont	(4)	0 sec	Cont	(4)
Vital A-C Distribution System Alternate Supply Transformer	1	45 kVA	94	-	(8)	Cont	(4)	0 sec	Cont	(4)

TABLE 8.3-1 (Continued)

Equipment Description	Number on Bus	HP Each	Full Load (Amperes)	Inrush Current (Amperes)	Maximum Operating Requirements Without Offsite Power Available — Forced Shutdown — (9) Time of Start	Forced Shutdown — Req'd Running Time	Forced Shutdown — Type of Control	Loss of Coolant Accident — (9) Time of Start	Loss of Coolant Accident — Req'd Running Time	Loss of Coolant Accident — Type of Control
Unit 1, Division 2 (Cont'd)										
Nonsafety Feature Loads (Cont'd)										
Motor Operated Valves	10	1(7)	-	-	(8)	30 sec	-	-	-	-
		Time Sequence		Forced Shutdown				Loss of Coolant Accident		
Subtotal, kW per Time Sequence		0 sec		1120				1750		
		5 sec		262				1008		
		10 sec		636				636		
		50 sec		566				566		
		1 min		2370				-		
		10 min		870				-		
		18.4 hr		-				75		
		287 hr		-				60		
Net Total Maximum Continuous Load (kW)				5824				4095		
Unit 2, Division 1										
Safety Feature Loads										
Low Pressure Core Spray Pump	1	1750	222	1443	-	-	(1)	0 sec	Cont	(3)
Residual Heat Removal Pump A	1	900	115	747	10 min	Cont	(1)	5 sec	Cont	(3)
Emergency Service Water Pump A	1	800	102	618	10 sec	Cont	(2)	10 sec	Cont	(2)
Emergency Closed Cooling Pump A	1	100	112	728	0 sec	Cont	(1)	0 sec	Cont	(3)
Low Pressure Core Spray and Residual Heat Removal A Water Leg Pump	1	5	6.35	46	0 sec	Cont	(1)	0 sec	Cont	(1)
Standby Liquid Control Pump A	1	40	48.8	317	-	-	(1)	-	-	(1)
Diesel Room Supply Fans	2	50	57.5	376	0 sec	Cont	(2)	0 sec	Cont	(2)
Residual Heat Removal A Pump Room Cooling Fan	1	20	25	130	10 min	Cont	(2)	5 sec	Cont	(2)
Low Pressure Core Spray Pump Room Cooling Fan	1	20	25	130	-	-	(1)	0 sec	Cont	(2)

TABLE 8.3-1 (Continued)

Equipment Description	Number on Bus	HP Each	Full Load (Amperes)	Inrush Current (Amperes)	Maximum Operating Requirements Without Offsite Power Available: Forced Shutdown: (9) Time of Start	Forced Shutdown: Req'd Running Time	Forced Shutdown: Type of Control	Loss of Coolant Accident: (9) Time of Start	Loss of Coolant Accident: Req'd Running Time	Loss of Coolant Accident: Type of Control
Unit 2, Division 1 (Cont'd)										
Safety Feature Loads (Cont'd)										
Annulus Exhaust Fan A	1	15	19	105	0 sec	Cont	(2)	0 sec	Cont	(3)
Annulus Exhaust System Heating Coil A	1	15 kW	19	-	0 sec	Cont	(2)	0 sec	Cont	(3)
Control Complex Chiller C	1	680	94	540	50 sec	Cont	(2)	50 sec	Cont	(2)
Control Complex Chiller C Oil Pump	1	1.5	2.2	13.4	50 sec	Cont	(2)	50 sec	Cont	(2)
Control Complex Chilled Water Pump C	1	100	115	710	0 sec	Cont	(1)	0 sec	Cont	(1)
Off-Gas Building Vent Fan A	1	40	50	280	0 sec	Cont	(2)	0 sec	Cont	(2)
Fuel Handling Building Exhaust Fan C	1	40	50	255	0 sec	Cont	(1)	-	-	(1)
Fuel Handling Building Exhaust Fan C Heating Coil	1	50 kW	63	-	0 sec	Cont	(2)	-	-	(2)
Reactor Core Isolation Cooling Pump Room Cooling Fan	1	5	7	42.7	0 sec	Cont	(2)	0 sec	Cont	(2)
Emergency Service Water Pumphouse Vent Supply Fan A	1	30	38	290	0 sec	Cont	(2)	0 sec	Cont	(2)
Diesel Generator Fuel Oil Transfer Pump	1	15	20	130	0 sec	Cycled[6]	(2)	0 sec	Cycled[6]	(2)
Diesel Generator Fuel Oil Transfer Backup Pump	1	15	20	130	0 sec	Cycled[6]	(2)	0 sec	Cycled[6]	(2)
Diesel Generator Jacket Water Keep Warm Pump	1	3	4.1	32	-	-	(2)	-	-	(2)
Diesel Generator Jacket Water Keep Warm Heater	1	75 kW	94	-	-	-	(2)	-	-	(2)
Diesel Generator Lube Oil Keep Warm Pump	1	15	19	116	-	-	(2)	-	-	(2)
Diesel Generator Lube Oil Keep Warm Heater	1	50 kW	63	-	-	-	(2)	-	-	(2)

TABLE 8.3-1 (Continued)

Equipment Description	Number on Bus	HP Each	Full Load (Amperes)	Inrush Current (Amperes)	Maximum Operating Requirements Without Offsite Power Available: Forced Shutdown (5) Time of Start	Forced Shutdown Req'd Running Time	Forced Shutdown Type of Control	Loss of Coolant Accident (9) Time of Start	Loss of Coolant Accident Req'd Running Time	Loss of Coolant Accident Type of Control
Unit 2, Division 1 (Cont'd)										
Safety Feature Loads (Cont'd)										
Main Steam Isolation Valve Leakage Control Pipe Heaters	4	4 kW	5	-	0 sec	Cont	(2)	0 sec	Cont	(2)
Main Steam Isolation Valve Leakage Control Air Blower	1	4	6.5	42.25	0 sec	Cont	(2)	0 sec	Cont	(2)
125 Volt D-C Battery Charger	1	50 kW	87	-	0 sec	Cont	(4)	0 sec	Cont	(4)
Hydrogen Recombiner A	1	75 kW	95	-	-	-	(1)	18.4 hr	Cont	(1)
Hydrogen Mixing Compressor A	1	60	77	436	-	-	(2)	287 hr	Cont	(2)
Motor Operated Valves	100	1.2(7)	-	-	0 sec	30 sec	-	0 sec	30 sec	-
Nonsafety Feature Loads										
Nuclear Closed Cooling Pump C	1	700	90.5	588	1 min	Cont	(1)	-	-	(1)
Control Rod Drive Pump A	1	400	52	312	-	-	(1)	-	-	(1)

	Time Sequence	Forced Shutdown	Loss of Coolant Accident
Subtotal, kW per Time Sequence	0 sec	689	2016
	5 sec	-	746
	10 sec	635	635
	50 sec	566	566
	1 min	559	-
	10 min	746	-
	18.4 hr	-	75
	287 hr	-	60
Net Total Maximum Continuous Load (kW)		3195	4098

Equipment Description	Number on Bus	HP Each	Full Load (Amperes)	Inrush Current (Amperes)	Forced Shutdown (5) Time of Start	Forced Shutdown Req'd Running Time	Forced Shutdown Type of Control	Loss of Coolant Accident (9) Time of Start	Loss of Coolant Accident Req'd Running Time	Loss of Coolant Accident Type of Control
Unit 2, Division 2										
Safety Feature Loads										
Residual Heat Removal Pump B	1	900	115	747	10 min	Cont	(1)	5 sec	Cont	(3)
Residual Heat Removal Pump C	1	900	115	747	-	Cont	(1)	0 sec	Cont	(3)

TABLE 8.3-1 (Continued)

Equipment Description	Number on Bus	HP Each	Full Load (Amperes)	Inrush Current (Amperes)	Maximum Operating Requirements Without Offsite Power Available: Forced Shutdown (9) Time of Start	Forced Shutdown Req'd Running Time	Forced Shutdown Type of Control	Loss of Coolant Accident (9) Time of Start	Loss of Coolant Accident Req'd Running Time	Loss of Coolant Accident Type of Control
Unit 2, Division 2 (Cont'd)										
Safety Feature Loads (Cont'd)										
Emergency Service Water Pump B	1	800	102	618	10 sec	Cont	(2)	10 sec	Cont	(2)
Emergency Closed Cooling Pump B	1	100	112	728	0 sec	Cont	(1)	0 sec	Cont	(3)
Residual Heat R moval B and C Water Leg Pump	1	5	6.35	46	0 sec	Cont	(1)	0 sec	Cont	(1)
Standby Liquid Control Pump B	1	40	48.8	317	-	-	(1)	-	-	(1)
Diesel Room Supply Fans	2	50	57.5	376	0 sec	Cont	(2)	0 sec	Cont	(2)
Residual Heat Removal B Pump Room Cooling Fan	1	20	25	130	10 min	Cont	(2)	5 sec	Cont	(2)
Residual Heat Removal C Pump Room Cooling Fan	1	20	25	130	-	-	(2)	0 sec	Cont	(2)
Annulus Exhaust Fan B	1	15 kW	19	105	0 sec	Cont	(2)	0 sec	Cont	(3)
Annulus Exhaust System Heating Coil B	1	15	19	-	0 sec	Cont	(2)	0 sec	Cont	(3)
Off-Gas Building Vent Fan B	1	40	50	280	0 sec	Cont	(2)	0 sec	Cont	(2)
Emergency Service Water Pumphouse Vent Supply Fan B	1	30	38	290	0 sec	Cont	(2)	0 sec	Cont	(2)
Diesel Generator Fuel Oil Transfer Pump	1	15	20	130	0 sec	Cycled(6)	(2)	0 sec	Cycled(6)	(2)
Diesel Generator Fuel Oil Transfer Backup Pump	1	15	20	130	0 sec	Cycled(6)	(2)	0 sec	Cycled(6)	(2)
Diesel Generator Jacket Water Keep Warm Pump	1	3	4.1	32	-	-	(2)	-	-	(2)
Diesel Generator Jacket Water Keep Warm Heater	1	75 kW	94	-	-	-	(2)	-	-	(2)
Diesel Generator Lube Oil Keep Warm Pump	1	15	19	116	-	-	(2)	-	-	(2)

TABLE 8.3-1 (Continued)

Equipment Description	Number on Bus	HP Each	Full Load (Amperes)	Inrush Current (Amperes)	Maximum Operating Requirements Without Offsite Power Available: Forced Shutdown (9) Time of Start	Forced Shutdown Req'd Running Time	Forced Shutdown Type of Control	Loss of Coolant Accident (9) Time of Start	Loss of Coolant Accident Req'd Running Time	Loss of Coolant Accident Type of Control
Unit 2, Division 2 (Cont'd)										
Safety Feature Loads (Cont'd)										
Diesel Generator Lube Oil Keep Warm Heater	1	50 kW	63	-	-	-	(2)	-	-	(2)
Main Steam Isolation Valve Leakage Control Air Blower	2	4	6.5	42	0 sec	Cont	(2)	0 sec	Cont	(2)
125 Volt D-C Battery Charger	1	50 kW	87	-	0 sec	Cont	(4)	0 sec	Cont	(4)
Hydrogen Recombiner B	1	75 kW	95	-	-	-	(1)	18.4 hr	Cont	(1)
Hydrogen Mixing Compressor A	1	60	77	436	-	-	(2)	287 hr	Cont	(2)
Motor Operated Valves	70	2.1(7)	-	-	0 sec	30 sec	-	0 sec	30 sec	-
Nonsafety Feature Loads										
Control Rod Drive Pump B	1	400	52	312	-	-	(1)	-	-	(1)
Service Water Pump D	1	1000	129	800	1 min	Cont	(1)	-	-	(1)
Standby Liquid Control Operating Heater	1	10 kW	11	-	(8)	Cont	(2)	-	-	(2)
Hydrogen Main Seal Oil Pump	1	20	28.7	145	(8)	Cont	(1)	-	-	(1)
Hydrogen Recirculating Seal Oil Pump	1	7.5	11.2	63.5	(8)	Cont	(1)	-	-	(1)
Hydrogen Seal Oil Vapor Extractor	1	2	3	21	(8)	Cont	(1)	-	-	(1)
Turbine Turning Gear Motor	1	60	80	435	(8)	Cont	(2)	-	-	(2)
Turbine Turning Gear Piggy Back Motor	1	10	15	98	(8)	Cont	(2)	-	-	(2)
Turbine Bearing Lift Pumps	9	5	8.1	46	(8)	Cont	(1)	-	-	(1)
Turbine Lube Oil Motor Suction Pump	1	50	61.5	363	(8)	Cont	(2)	-	-	(2)
Turbine Turning Gear Oil Pump	1	50	61.5	363	(8)	Cont	(2)	-	-	(2)

TABLE 8.3-1 (Continued)

Equipment Description	Number on Bus	HP Each	Full Load (Amperes)	Inrush Current (Amperes)	Maximum Operating Requirements Without Offsite Power Available: Forced Shutdown: (9) Time of Start	Forced Shutdown: Req'd Running Time	Forced Shutdown: Type of Control	Loss of Coolant Accident: (9) Time of Start	Loss of Coolant Accident: Req'd Running Time	Loss of Coolant Accident: Type of Control
Unit 2, Division 2 (Cont'd)										
Nonsafety Feature Loads (Cont'd)										
Reactor Feedwater Pump Turbine A Turning Gear	1	1.5	2.5	16	(8)	Cont	(2)	-	-	(2)
Reactor Feedwater Pump Turbine B Turning Gear	1	1.5	2.5	16	(8)	Cont	(2)	-	-	(2)
Diesel Generator Starting Air Compressors	4	30	34	217	10 min	Cycled(6)	(2)	-	-	(2)
Diesel Generator Starting Air Aftercoolers	4	1	1.68	15	10 min	Cycled(6)	(2)	-	-	(2)
Reactor Protection System Motor Generator Set A	1	25	38.9	253	(8)	Cont	(1)	-	-	(1)
Reactor Water Cleanup Pump A	1	60	66.8	434	(8)	Cont	(1)	-	-	(1)
Reactor Water Cleanup Pump B	1	60	66.8	434	(8)	Cont	(1)	-	-	(1)
Lower Drywell Cooling Fans	2	60	73.5	435	(8)	Cont	(2)	-	-	(2)
Middle Drywell Cooling Fans	2	60	73.5	435	(8)	Cont	(2)	-	-	(2)
Upper Drywell Cooling Fans	2	60	73.5	435	(8)	Cont	(2)	-	-	(2)
Diesel Driven Fire Pump B Fan	1	7.5	10.4	63.5	(8)	Cont	(2)	-	-	(2)
Off-Gas Building Vent Exhaust Radiation Monitor	1	2	2.5	-	(8)	Cont	(4)	-	-	(4)
125 Volt D-C System A Battery Charger	1	75 kW	133	-	(8)	Cont	(4)	0 sec	Cont	(4)
125 Volt D-C System B Battery Charger	1	37.5 kW	67	-	(8)	Cont	(4)	0 sec	Cont	(4)
Essential Lighting	-	24 kW	-	-	(8)	Cont	(4)	0 sec	Cont	(4)
Vital A-C Distribution System Alternate Supply Transformer	1	45 kVA	94	-	(8)	Cont	(4)	0 sec	Cont	(4)

TABLE 8.3-1 (Continued)

Equipment Description	Number on Bus	HP Each	Full Load (Amperes)	Inrush Current (Amperes)	Maximum Operating Requirements Without Offsite Power Available — Forced Shutdown: (9) Time of Start	Forced Shutdown: Req'd Running Time	Forced Shutdown: Type of Control	Loss of Coolant Accident: (9) Time of Start	Loss of Coolant Accident: Req'd Running Time	Loss of Coolant Accident: Type of Control
Unit 2, Division 2 (Cont'd)										
Nonsafety Feature Loads (Cont'd)										
Motor Operated Valves	10	1(7)	-	-	(8)	30 sec	-	-	-	-

Subtotal, kW per Time Sequence	Time Sequence	Forced Shutdown	Loss of Coolant Accident
	0 sec	522	1450
	5 sec	-	746
	10 sec	635	635
	50 sec	-	-
	1 min	1751	-
	10 min	870	-
	18.4 hr	-	75
	287 hr	-	60
Net Total Maximum Continuous Load (kW)		3778	2966

Equipment Description	Number on Bus	HP Each	Full Load (Amperes)	Inrush Current (Amperes)	Forced Shutdown: (9) Time of Start	Forced Shutdown: Req'd Running Time	Forced Shutdown: Type of Control	Loss of Coolant Accident: (9) Time of Start	Loss of Coolant Accident: Req'd Running Time	Loss of Coolant Accident: Type of Control
Units 1 and 2, Division 3										
High Pressure Core Spray Pump	1	3000	372	2418	0 sec	Cont	(1)	0 sec	Cont	(3)
High Pressure Core Spray Emergency Water Pump	1	75	85.4	543	0 sec	Cont	(2)	0 sec	Cont	(2)
High Pressure Core Spray Water Leg Pump	1	5	6.35	46	0 sec	Cont	(1)	0 sec	Cont	(1)
High Pressure Core Spray Pump Room Cooling Fan	1	20	25	130	0 sec	Cont	(2)	0 sec	Cont	(1)
High Pressure Core Spray Diesel Generator Room Fans	2	50	57.5	376	0 sec	Cont	(2)	0 sec	Cont	(2)
High Pressure Core Spray Diesel Generator Fuel Oil Transfer Pump	1	15	20	130	0 sec	Cycled(6)	(2)	0 sec	Cycled(6)	(2)
High Pressure Core Spray Diesel Generator Fuel Oil Transfer Backup Pump	1	15	20	130	0 sec	Cycled(6)	(2)	0 sec	Cycled(6)	(2)
125 Volt D-C Battery Charger	1	9 kW	12	-	0 sec	Cont	(4)	0 sec	Cont	(4)

TABLE 8.3-1 (Continued)

Equipment Description	Number on Bus	HP Each	Full Load (Amperes)	Inrush Current (Amperes)	Maximum Operating Requirements Without Offsite Power Available: Forced Shutdown			Loss of Coolant Accident		
					(9) Time of Start	Req'd Running Time	Type of Control	(9) Time of Start	Req'd Running Time	Type of Control
Units 1 and 2, Division 3 (Cont'd)										
125 Volt D-C Reserve Battery Charger	1	9 kW	12	-	-	-	-	-	-	-
Motor Operated Valves	8	7.3(7)	-	-	0 sec	30 sec	-	0 sec	30 sec	-

	Forced Shutdown	Loss of Coolant Accident
Net Total Maximum Continuous Load (kW)	2390	2390

NOTES:

1. Type of control - equipment energized manually.
2. Type of control - equipment started automatically with associated pump, diesel, temperature switch, pressure switch, etc.
3. Type of control - equipment started automatically by LOCA signal or high radiation signal.
4. Type of control - equipment continuously energized; requires no manual or automatic operation.
5. Cycled; 15 minutes on, 3 to 5 hours off.
6. Cycled; 10 minutes on, 20 minutes off.
7. Average value.
8. Energized with manual closing of stub bus breaker (stub bus breaker closure at 1 minute).
9. Zero seconds (0 sec) is the time that the 4.16 kV bus voltage is available after the diesel generator breaker closes. The time period from diesel generator breaker to zero seconds includes undervoltage relay and auxiliary relay pickup and dropout items. Load center transformers, which are not load shed, are energized immediately after diesel generator breaker closure.

TABLE 8.3-2

CLASS 1E EQUIPMENT CAPACITIES

Equipment	Capacity
4.16 kV Switchgear	
Buses EH11, EH12	2000 A, continuous rating; 350 MVA, interrupting
Bus EH13	1200 A, continuous rating; 350 MVA, interrupting
Incoming Breakers (preferred source)	1200 A, continuous rating; 350 MVA, interrupting
Feeder Breakers	1200 A, continuous rating; 350 MVA, interrupting
Incoming Breaker (alternate source)	2000 A, continuous rating; 350 MVA, interrupting
480 Volt Unit Load Center Substation	
Transformers	
Divisions 1 and 2	1500/2000 kVA (AA, FA rating) 3 phase, 60 Hz, 4.16 kV/480 volt
Division 3	225 kVA (AA rating, 3 phase, 60 Hz, 4.16 kV/480 volt
Buses, Divisions 1 and 2	3000 A, continuous rating
Feeder Breakers	3000 A, continuous rating; 65,000 A, interrupting
Tie Breakers	1600 A, continuous rating; 50,000 A, interrupting
480 Volt Motor Control Centers	
Horizontal Bus	600 A, continuous rating; 42,000 A, rms symmetrical
Vertical Bus	400 A, continuous rating
Fused Disconnect Switches	Class RK-5 fuses, 200,000 A interrupting; switches rated 30 A to 200 A

TABLE 8.3-2 (Continued)

Equipment	Capacity
Distribution Panels	
480 Volt A-C Panels	600 A, continuous, 50,000 A, rms symmetrical; Class V fuses
120 Volt A-C Panels	Lugs only; mounted in 480 volt motor control center; 10,000 A, rms symmetrical; molded case load breakers
125 Volt D-C Panels	600 A, continuous rating; 50,000 A, rms symmetrical; Class RK-5 fuses, 100,000 A, interrupting

TABLE 8.3-3

SAFETY RELATED EQUIPMENT IDENTIFICATION

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

TABLE 8.3-4

DIESEL GENERATOR SEQUENTIAL LOADING
TEST DATA

Time (sec)	Load	Minimum Voltage	Voltage Recovery Time to 90% of Rated (sec)	Minimum Frequency (Hz)	Frequency Recovery Time to 98% of Rated (sec)	Cumulative Load (kW)
Test 1[(1)]						
7.3	2500 HP 2252 kW	3450	0.4	57.5	0.9	2300
12.3	1000 HP 769 kW	3800	0	59.3	0	3200
17.3	300 HP 156 kW	4100	0	59.8	0	3400
22.3	1000 HP 668 kW	3900	0	59.3	0	4150
Test 2[(2)]						
0	3850 kW	-	-	-	-	3850
10.3	1300 HP 875 kW	3750	0	58.8	0	4850
15.3	1000 HP 575 kW	3800	0	59.0	0	5500
20.3	700 HP 601 kW	3950	0	59.0	0	6100

TABLE 8.3-4 (Continued)

Time (sec)	Load	Minimum Voltage	Voltage Recovery Time to 90% of Rated (sec)	Minimum Frequency (Hz)	Frequency Recovery Time to 98% of Rated (sec)	Cumulative Load (kW)
25.3	500 HP 668 kW	4050	0	59.2	0	6500

NOTES:

1. Test 1 performed from initially unloaded condition.
2. Test 2 performed with base load of 3850 kW retained; all other load shed upon receipt of start signal.

TABLE 8.3-5

DIESEL GENERATOR
MARGIN TEST RESULTS

Test	Time (sec)	Load	Minimum Voltage	Voltage Recovery Time to 90% of Rated (sec)	Minimum Frequency (Hz)	Frequency Recovery Time to 98% of Rated (sec)	Cumulative Load (kW)
1	7.0	2700 HP 2500 kW	3400	0.5	57.4	1.1	2650
2	7.0	2700 HP 2500 kW	3400	0.4	57.3	1.0	2800

TABLE 8.3-6

DIESEL GENERATOR
STARTING AND LOADING TEST
WITHOUT SERVICE WATER

Time (sec)	Load	Minimum Voltage	Voltage Recovery Time to 90% of Rated (sec)	Minimum Frequency (Hz)	Frequency Recovery Time to 98% of Rated (sec)	Cumulative Load (kW)
6.2	2500 HP 2252 kW	3250	0.5	59.7	0	2600
11.2	1000 HP 769 kW	3850	0	59.2	0	3550
16.2	1300 HP 824 kW	*	0	58.8	0	4800

*To be provided later.

TABLE 8.3-7

LOAD REQUIREMENTS, 125 VOLT D-C CLASS 1E BATTERIES

Load Description	Amperes Required after A-C Power Loss Coincident with LOCA				
	0 to 1 Min	1 to 10 Min	10 to 11 Min	11 to 119 Min	119 to 120 Min
Division 1, Unit 1 Battery					
Reactor Core Isolation Cooling Isolation Valves	189	-	-	-	-
Residual Heat Removal Metering and Control	4	4	4	4	4
Recirculation Pump Trip Control Logic	5	5	5	5	5
Reactor Core Isolation Cooling Control	21	5	5	5	5
Automatic Depressurization System Control	10	10	10	10	10
Class 1E to Non-Class 1E Circuit Isolators	3	3	3	3	3
Deluge Valve Control, LOCA Relays, and Miscellaneous Instrumentation	14	14	14	14	14
Analog Loop Instrumentation	10	10	10	10	10
Remote Shutdown Panel	20	20	20	20	20
Diesel Generator Control Panel	5	5	5	5	5
Diesel Generator Start Control	4	2	2	2	2

TABLE 8.3-7 (Continued)

Load Description	Amperes Required after A-C Power Loss Coincident with LOCA				
	0 to 1 Min	1 to 10 Min	10 to 11 Min	11 to 119 Min	119 to 120 Min
Division 1, Unit 1 Battery (Cont'd)					
Diesel Generator Redundant Start Control	4	2	2	2	2
Diesel Generator Field Flash	77	-	-	-	-
Switchgear	235 (1)	8	252 (2)	8	252 (2)
Unit 2 Continuous Load (3)	78	78	78	78	78
Total Amperes per Interval	679	166	410	166	410
Division 2, Unit 1 Battery					
Residual Heat Removal Metering and Solenoid Valves	2	2	2	2	2
Recirculation Pump Trip Control Logic	5	5	5	5	5
Automatic Depressurization System Control	10	10	10	10	10
Class 1E to Non-Class 1E Circuit Isolators	3	3	3	3	3
Deluge Valve Control, LOCA Relays, and Miscellaneous Instrumentation	14	14	14	14	14
Analog Loop Instrumentation	10	10	10	10	10
Diesel Generator Panel	5	5	5	5	5

TABLE 8.3-7 (Continued)

Load Description	Amperes Required after A-C Power Loss Coincident with LOCA				
	0 to 1 Min	1 to 10 Min	10 to 11 Min	11 to 119 Min	119 to 120 Min
Division 2, Unit 1 Battery (Cont'd)					
Diesel Generator Start Control	4	2	2	2	2
Diesel Generator Redundant Start Control	4	2	2	2	2
Diesel Generator Field Flash	77	-	-	-	-
Switchgear	235[1]	8	252[2]	8	252[2]
Unit 2 Continuous Load[3]	54	54	54	54	54
Total Amperes per Interval	423	115	359	115	359
Division 1, Unit 2 Battery					
Reactor Core Isolation Cooling Isolation Valves	189	-	-	-	-
Residual Heat Removal Metering and Control	4	4	4	4	4
Recirculation Pump Trip Control Logic	5	5	5	5	5
Reactor Core Isolation Cooling Control	21	5	5	5	5
Automatic Depressurization System Control	10	10	10	10	10
Deluge Valve Control, LOCA Relays	7	7	7	7	7

TABLE 8.3-7 (Continued)

Load Description	Amperes Required after A-C Power Loss Coincident with LOCA				
	0 to 1 Min	1 to 10 Min	10 to 11 Min	11 to 119 Min	119 to 120 Min
Division 1, Unit 2 Battery (Cont'd)					
Analog Loop Instrumentation	10	10	10	10	10
Remote Shutdown Panel	20	20	20	20	20
Diesel Generator Panel	5	5	5	5	5
Diesel Generator Start Control	4	2	2	2	2
Diesel Generator Redundant Start Control	4	2	2	2	2
Diesel Generator Field Flash	77	-	-	-	-
Switchgear	235(1)	8	252(2)	8	252(2)
Unit 1 Continuous Load(3)	88	88	88	88	88
Total Amperes per Interval	679	166	410	166	410
Division 2, Unit 2 Battery					
Residual Heat Removal Metering and Solenoid Valves	2	2	2	2	2
Recirculation Pump Trip Control Logic	5	5	5	5	5
Automatic Depressurization System Control	10	10	10	10	10

TABLE 8.3-7 (Continued)

Load Description	Amperes Required after A-C Power Loss Coincident with LOCA 0 to 1 Min	1 to 10 Min	10 to 11 Min	11 to 119 Min	119 to 120 Min
Division 2, Unit 2 Battery (Cont'd)					
Class 1E to Non-Class 1E Circuit Isolators	3	3	3	3	3
Deluge Valve Control, LOCA Relays	7	7	7	7	7
Analog Loop Instrumentation	10	10	10	10	10
Diesel Generator Panel	5	5	5	5	5
Diesel Generator Start Control	4	2	2	2	2
Diesel Generator Redundant Start Control	4	2	2	2	2
Diesel Generator Field Flash	77	-	-	-	-
Switchgear	235[1]	8	252[2]	8	252[2]
Unit 1 Continuous Load[3]	61	61	61	61	61
Total Amperes per Interval	423	115	359	115	359

	Amperes Required after A-C Power Loss 0 to 1 Min	1 to 60 Min	60 to 120 Min
Division 3 Battery[4]			
Diesel Engine Control	2	2	2
Generator Auxiliary Control	2	2	2

TABLE 8.3-7 (Continued)

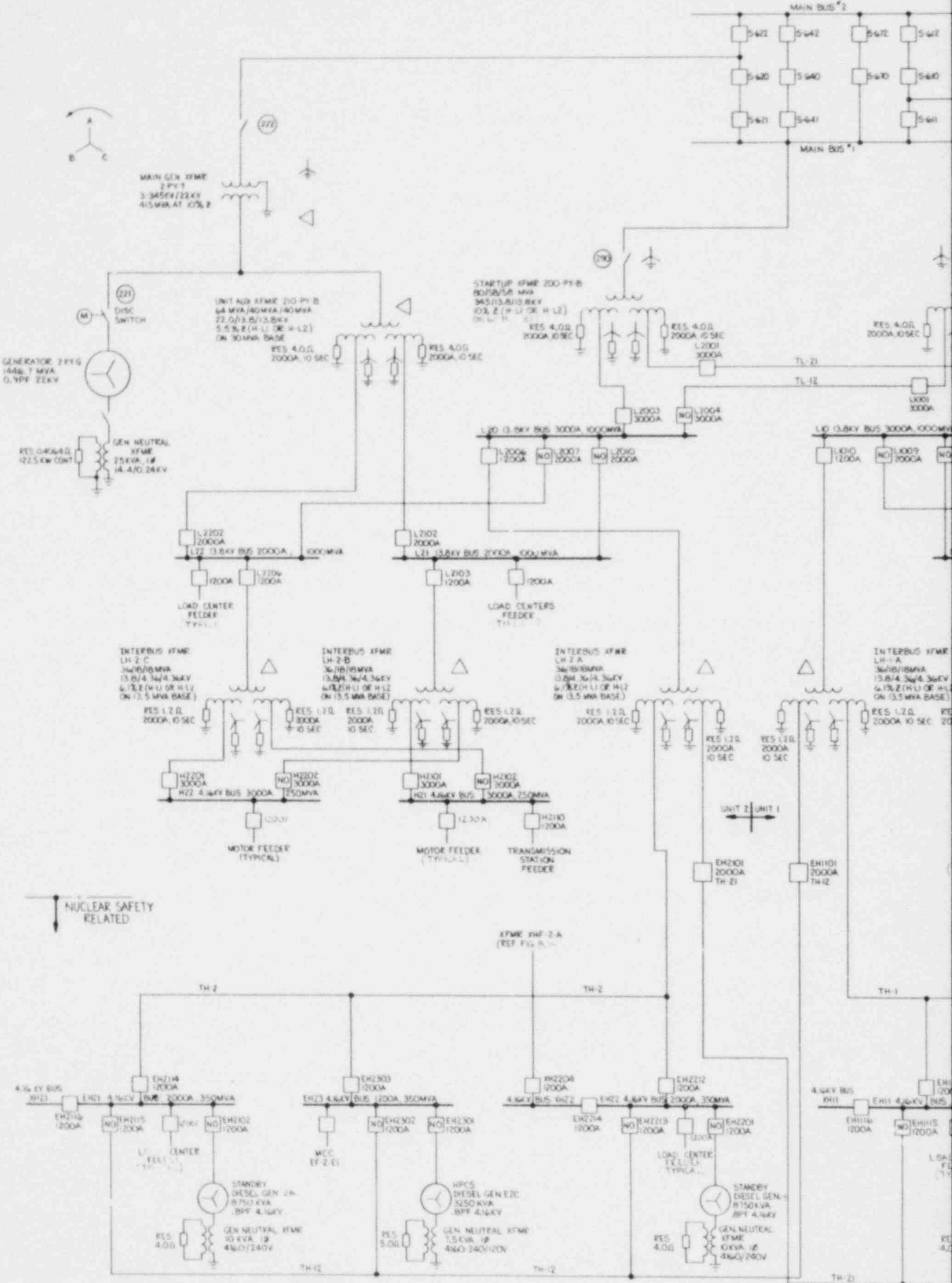
	Amperes Required after A-C Power Loss		
	0 to 1 Min	1 to 60 Min	60 to 120 Min
Division 3 Battery[4] (Cont'd)			
Field Flashing	20	-	-
Solenoid Valves	2	-	-
Relays HPCS Logic Panel	1	1	2
Indicator Lamps Control Room Panel	1	1	2
Switchgear (Breakers Closing)	28	-	-
Diesel Standby Fuel Pump	20	10	10
Total Amperes per Interval	76	16	18

NOTES

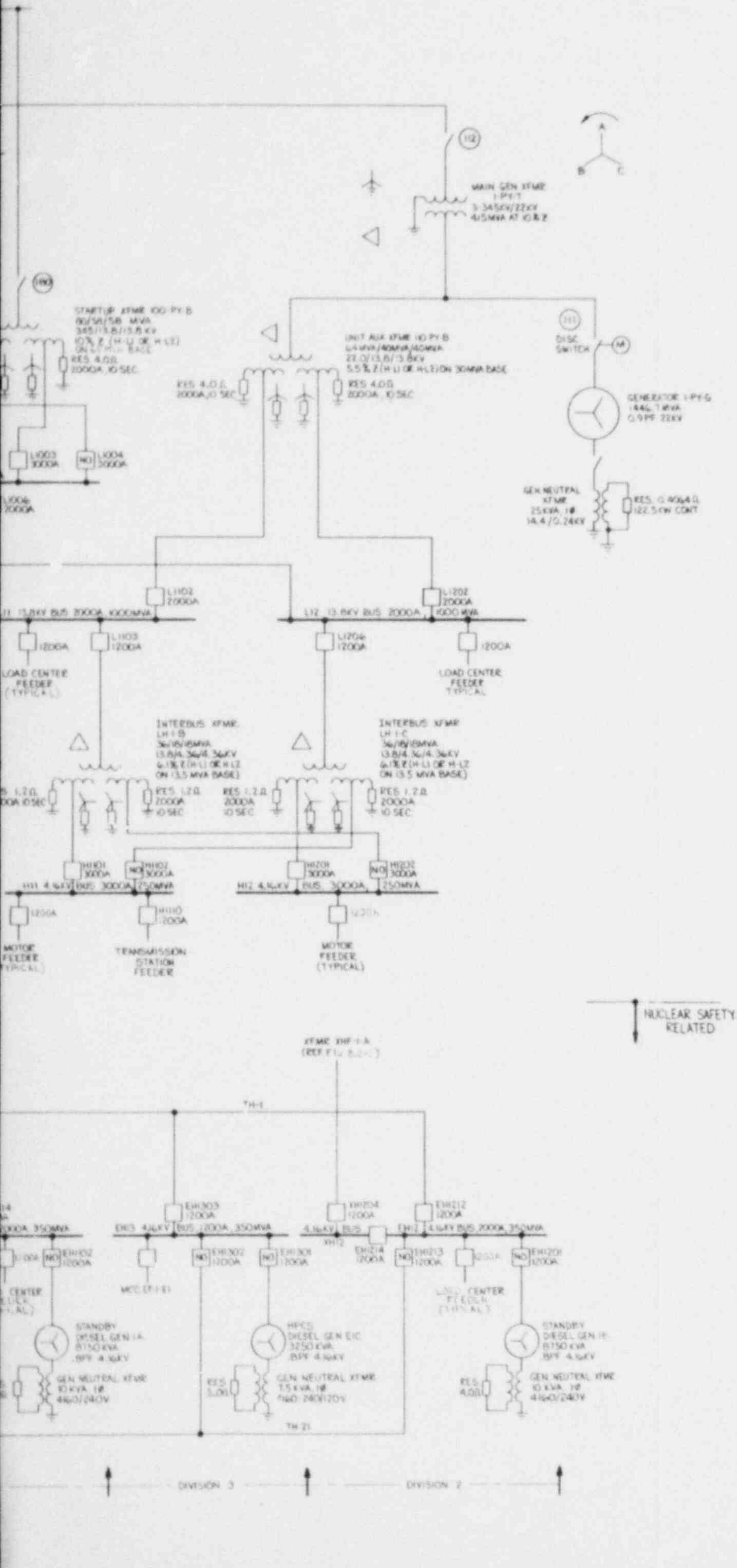
1. Includes initial 4.16 kV bus load shedding and first sequence loading.
2. Includes selective closing or tripping of two 4.16 kV circuit breakers at a time in an attempt to restore normal a-c supply. Also includes selective closing of two 480 volt circuit breakers at a time.
3. Load requirements are based upon the assumption that loss of a-c supply occurs while the maintenance tie circuit breaker is closed and that loss of a-c is confined to one unit.
4. Division 3 battery capacity (for each unit):

   a. 100 ampere - hours at 8 hours

   b. 150 ampere - hours at 1 minute



MAIN BUS #2
MAIN BUS #1
MAIN GEN. XFMR 2PY1 3-345KV/22KV 415MVA AT 10% Z
UNIT AUX. XFMR 210-PY-B 64 MVA/40MVA/40MVA 22.0/13.8/13.8KV 5.5% Z (H-L1 OR H-L2) ON 30MVA BASE
STARTUP XFMR 200-PY-B 80/58/58 MVA 345/13.8/13.8KV
DISC SWITCH
GENERATOR 2PYG 1446.7 MVA 0.9PF 22KV
GEN NEUTRAL XFMR 25KVA, 1Ø 14.4/0.24KV
L20 13.8KV BUS 3000A, 1000MVA
L10 13.8KV BUS 3000A, 1000MVA
L22 13.8KV BUS 2000A, 1000MVA
L21 13.8KV BUS 2000A, 1000MVA
LOAD CENTER FEEDER
LOAD CENTERS FEEDER
INTERBUS XFMR LH-2-C
INTERBUS XFMR LH-2-B
INTERBUS XFMR LH-2-A
INTERBUS XFMR LH-1-A
H22 4.16KV BUS 3000A, 250MVA
H21 4.16KV BUS 3000A, 250MVA
MOTOR FEEDER (TYPICAL)
TRANSMISSION STATION FEEDER
UNIT 2 UNIT 1
NUCLEAR SAFETY RELATED
XFMR XHF-2-A
TH-2
TH-1
TH-12
TH-21
EH21 4.16KV BUS 2000A, 350MVA
EH23 4.16KV BUS 1200A, 350MVA
EH22 4.16KV BUS 2000A, 350MVA
MCC EF-2-E1
STANDBY DIESEL GEN. 2A 8750 KVA .8PF 4.16KV
HPCS DIESEL GEN. E2C 3250 KVA .8PF 4.16KV
STANDBY DIESEL GEN. 8750KVA .8PF 4.16KV
GEN NEUTRAL XFMR 10 KVA 1Ø 4160/240V
GEN NEUTRAL XFMR 7.5KVA 1Ø 4160/240/120V
DIVISION 1
DIVISION 3
DIVISION 2
UNIT 2
UNIT 1



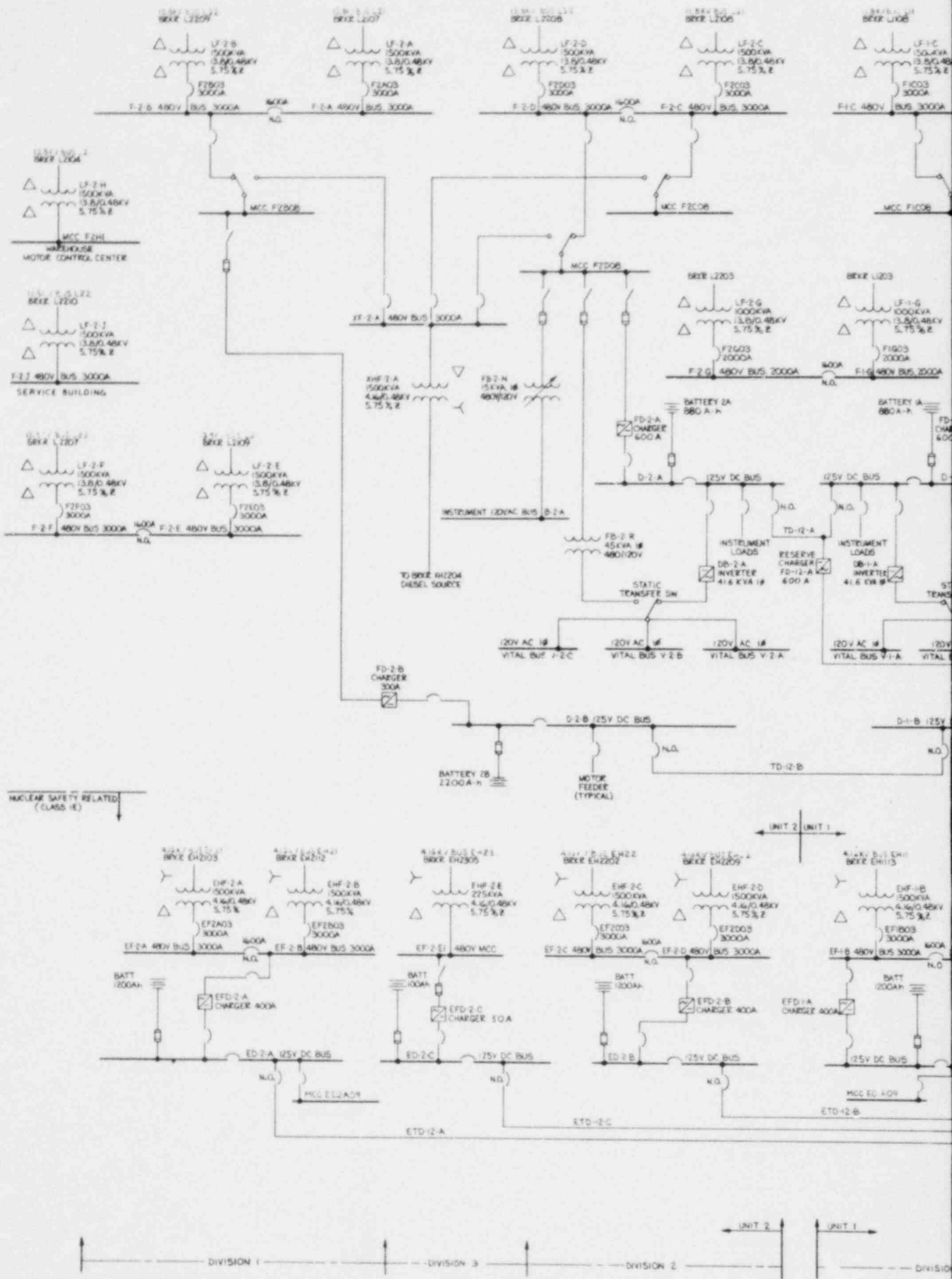
NOTES:

1. MOTOR FEEDS SHOWN ARE TYPICAL ONLY.
2. TRANSFORMER RATINGS ARE SHOWN FOR 55°C TEMPERATURE RISE AND FORCED COOLING.
3. TRANSFORMER IMPEDANCE BASE IS PRIMARY MVA.
4. REF FIG 8.3-2 FOR LOAD CENTERS

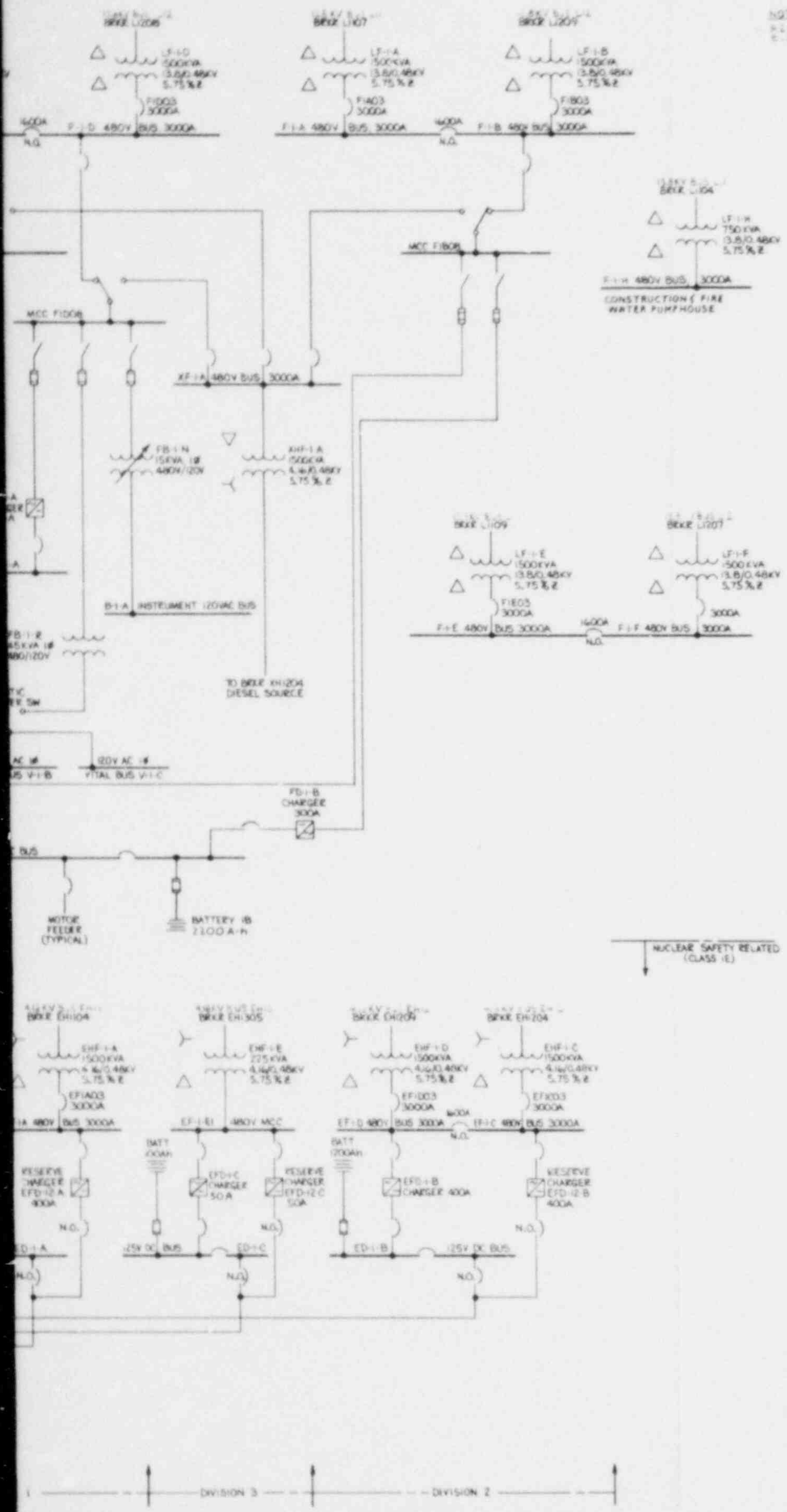
PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

Main One Line Diagram,
13.8 kV and 4.16 kV

Figure 8.3-1



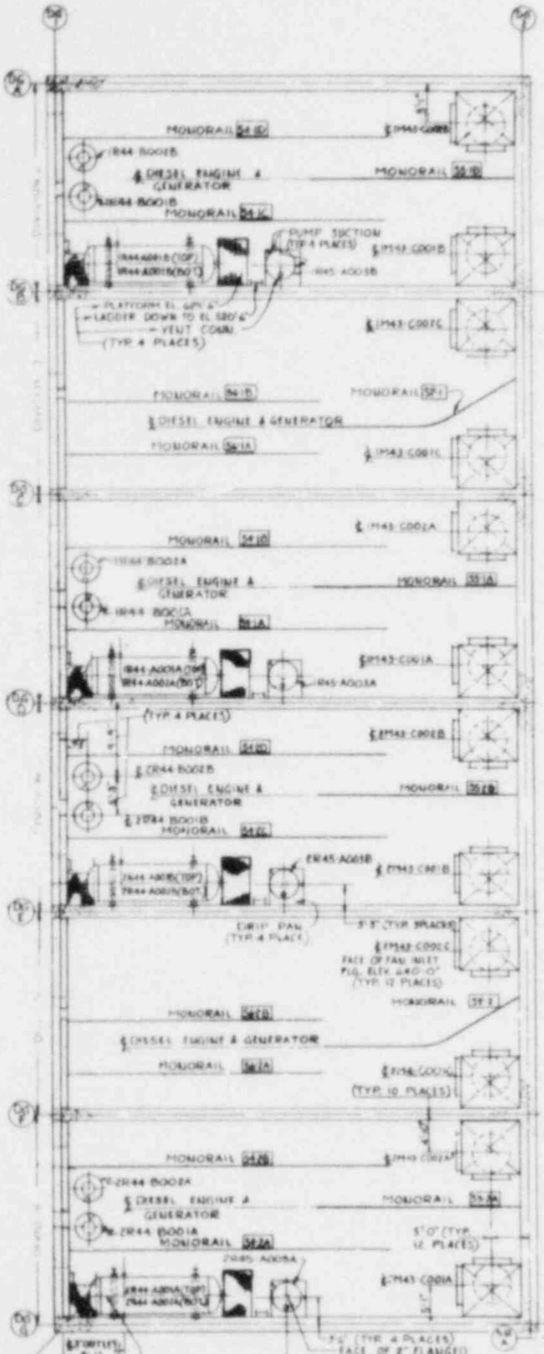
BRKR L2209
LF-2-B 1500KVA 13.8/0.48KV 5.75% Z
F2B03 3000A
F-2-B 480V BUS 3000A
1600A N.O.
BRKR L2207
LF-2-A 1500KVA 13.8/0.48KV 5.75% Z
F2A03 3000A
F-2-A 480V BUS 3000A
BRKR L2208
LF-2-D 1500KVA 13.8/0.48KV 5.75% Z
F2D03 3000A
F-2-D 480V BUS 3000A
1600A N.O.
BRKR L2106
LF-2-C 1500KVA 13.8/0.48KV 5.75% Z
F2C03 3000A
F-2-C 480V BUS 3000A
BRKR L1108
LF-1-C 1500KVA 13.8/0.48KV 5.75% Z
F1C03 3000A
F-1-C 480V BUS 3000A
BRKR L2204
LF-2-H 1500KVA 13.8/0.48KV 5.75% Z
MCC F2H1
WAREHOUSE MOTOR CONTROL CENTER
MCC F2B08
MCC F2C08
MCC F1C08
MCC F2D08
BRKR L2210
LF-2-J 1500KVA 13.8/0.48KV 5.75% Z
F-2-J 480V BUS 3000A
SERVICE BUILDING
XF-2-A 480V BUS 3000A
BRKR L2203
LF-2-G 1000KVA 13.8/0.48KV 5.75% Z
F2G03 2000A
F-2-G 480V BUS 2000A
BRKR L1203
LF-1-G 1000KVA 13.8/0.48KV 5.75% Z
F1G03 2000A
F-1-G 480V BUS 2000A
1600A N.O.
XHF-2-A 1500KVA 4.16/0.48KV 5.75% Z
FB-2-N 15KVA 1Ø 480/120V
BATTERY 2A 880 A-h
FD-2-A CHARGER 600 A
BATTERY 1A 880 A-h
BRKR L2207
LF-2-F 1500KVA 13.8/0.48KV 5.75% Z
F2F03 3000A
F-2-F 480V BUS 3000A
1600A N.O.
BRKR L2109
LF-2-E 1500KVA 13.8/0.48KV 5.75% Z
F2E03 3000A
F-2-E 480V BUS 3000A
D-2-A 125V DC BUS
125V DC BUS
N.O.
INSTRUMENT 120VAC BUS B-2-A
TD-12-A
FB-2-R 45KVA 1Ø 480/120V
INSTRUMENT LOADS
DB-2-A INVERTER 41.6 KVA 1Ø
RESERVE CHARGER FD-12-A 600 A
DB-1-A INVERTER 41.6 KVA 1Ø
TO BRKR EH2204 DIESEL SOURCE
STATIC TRANSFER SW
120V AC 1Ø VITAL BUS V-2-C
120V AC 1Ø VITAL BUS V-2-B
120V AC 1Ø VITAL BUS V-2-A
120V AC 1Ø VITAL BUS V-1-A
FD-2-B CHARGER 300A
D-2-B 125V DC BUS
D-1-B 125V
N.O.
TD-12-B
BATTERY 2B 2200 A-h
MOTOR FEEDER (TYPICAL)
NUCLEAR SAFETY RELATED (CLASS IE)
UNIT 2 UNIT 1
BRKR EH2103
EHF-2-A 1500KVA 4.16/0.48KV 5.75%
EF2A03 3000A
EF-2-A 480V BUS 3000A
1600A N.O.
BRKR EH2112
EHF-2-B 1500KVA 4.16/0.48KV 5.75%
EF2B03 3000A
EF-2-B 480V BUS 3000A
BRKR EH2305
FHF-2-E 225KVA 4.16/0.48KV 5.75% Z
EF-2-E1 480V MCC
BRKR EH2202
EHF-2-C 1500KVA 4.16/0.48KV 5.75% Z
EF2C03 3000A
EF-2-C 480V BUS 3000A
BRKR EH2209
EHF-2-D 1500KVA 4.16/0.48KV 5.75% Z
EF2D03 3000A
EF-2-D 480V BUS 3000A
BRKR EH1113
EHF-1-B 1500KVA 4.16/0.48KV 5.75% Z
EF1B03 3000A
EF-1-B 480V BUS 3000A
1600A N.O.
BATT 1200Ah
EFD-2-A CHARGER 400A
BATT 100Ah
EFD-2-C CHARGER 50A
BATT 1200Ah
EFD-2-B CHARGER 400A
EFD-1-A CHARGER 400A
BATT 1200Ah
ED-2-A 125V DC BUS
ED-2-C 125V DC BUS
ED-2-B 125V DC BUS
125V DC BUS
N.O.
MCC ED2A09
MCC ED-A09
ETD-12-A
ETD-12-C
ETD-12-B
DIVISION 1
DIVISION 3
DIVISION 2
UNIT 2
UNIT 1
DIVISION



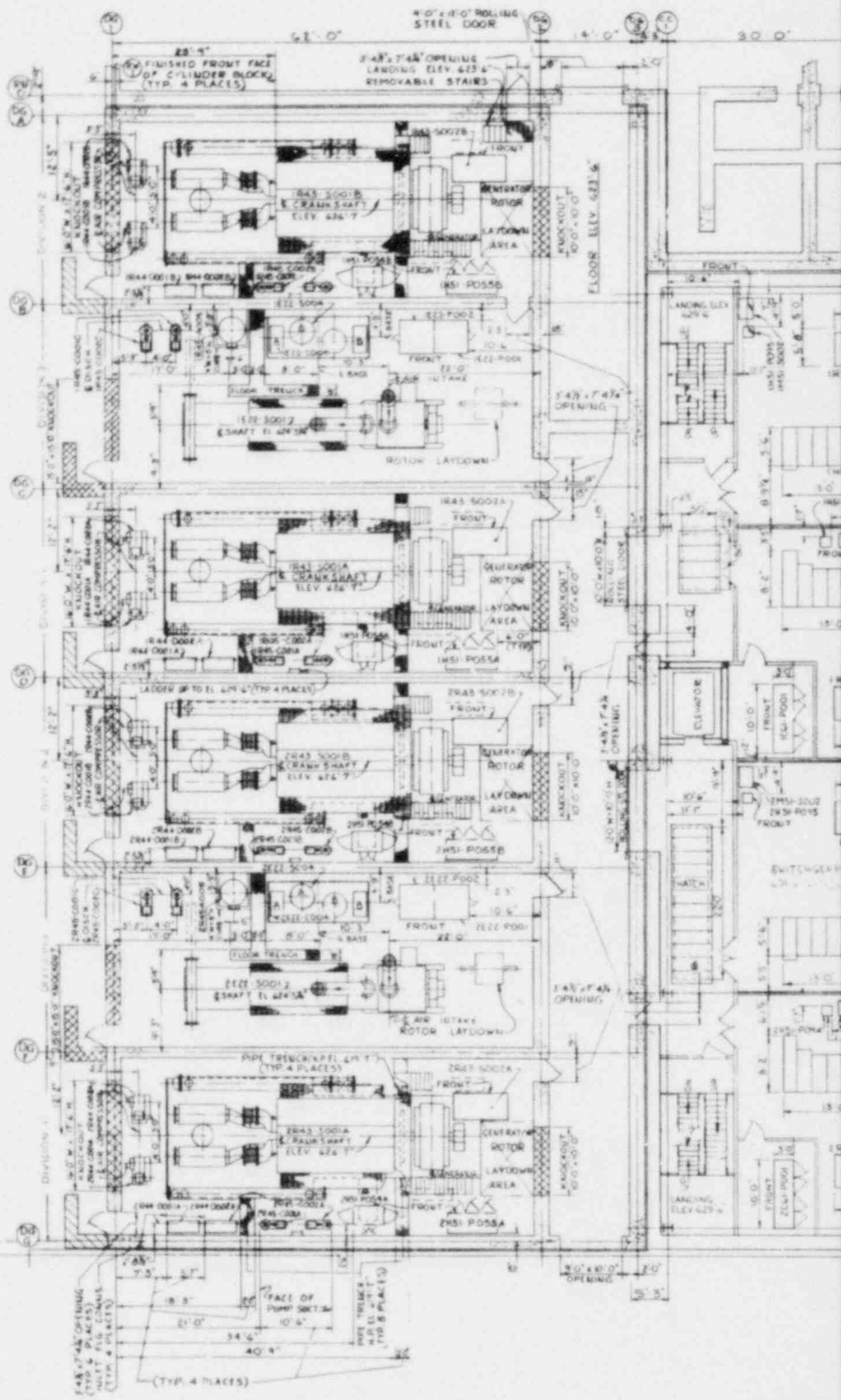
PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

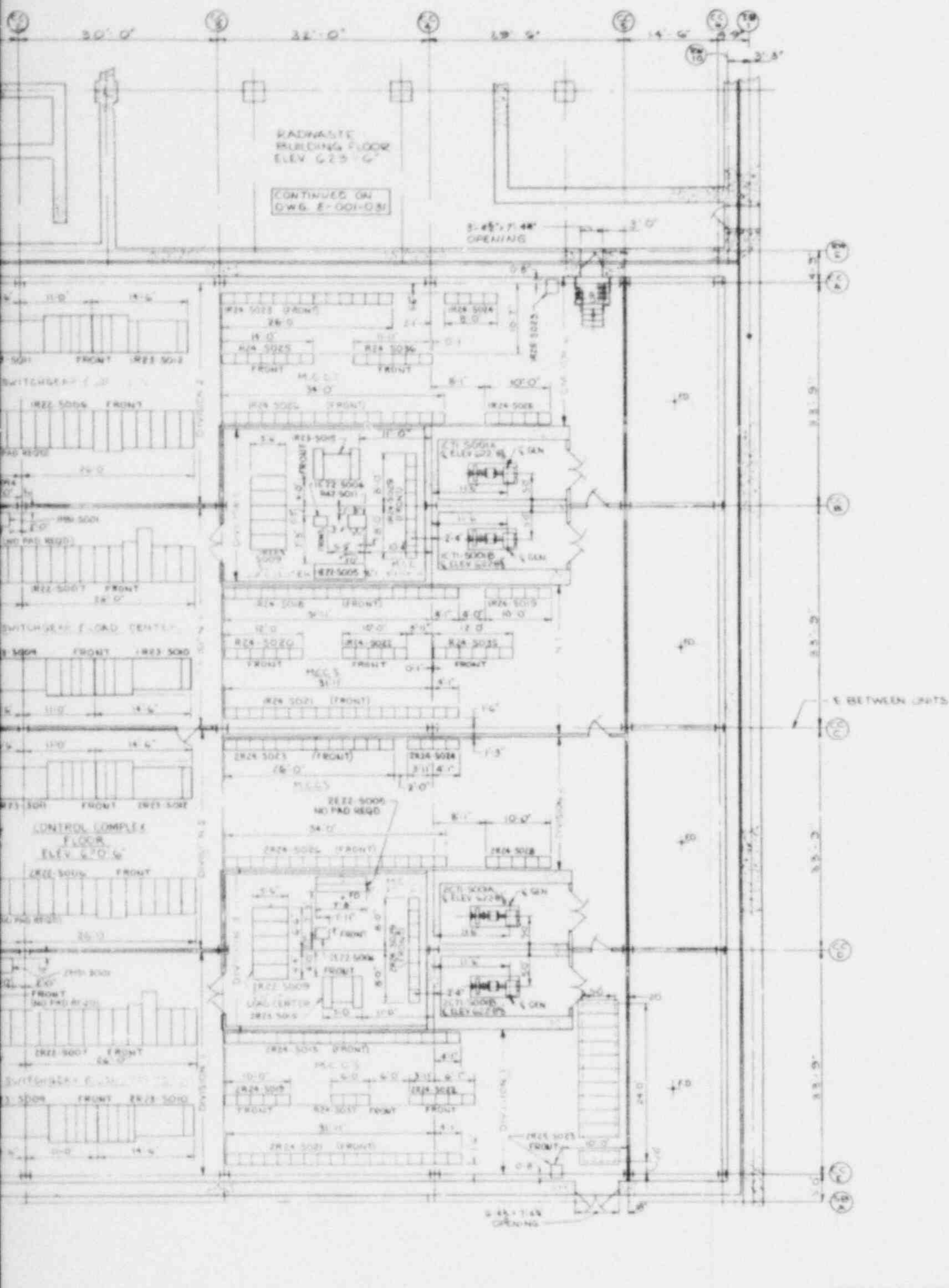
Main One Line Diagram, 480V and Under

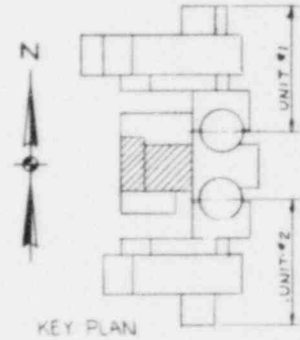
Figure 8.3-2



AUXILIARY PLAN
DIESEL GENERATOR AUXILIARY
EQUIPMENT SUPPORTED FROM
WALLS OR CEILING





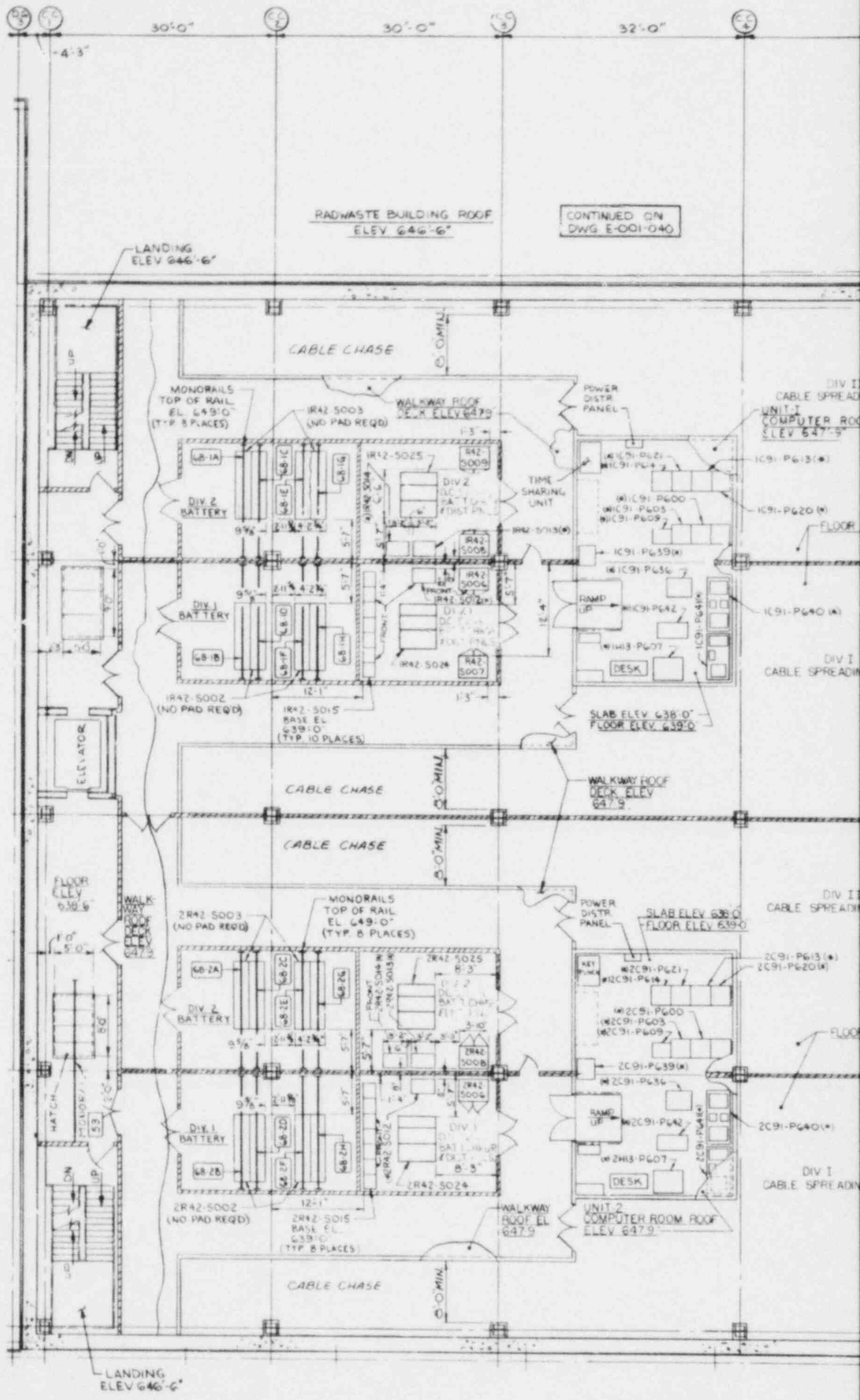


KEY PLAN

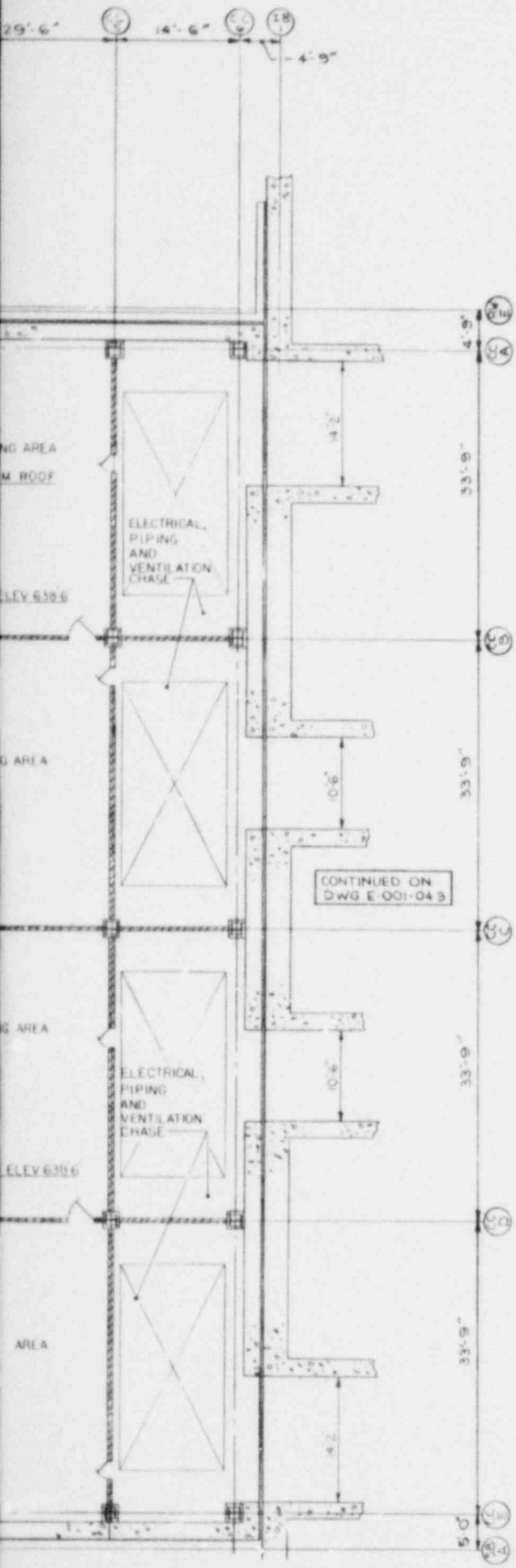
PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

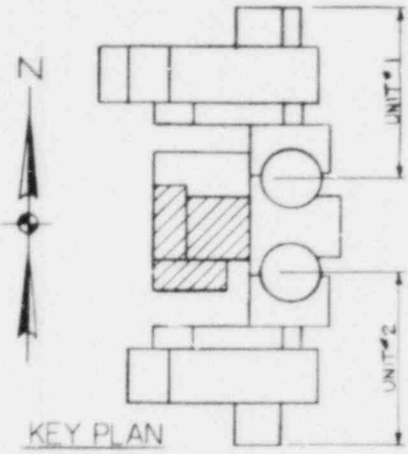
Control Complex and Diesel Generator Bldg. Equipment Layout Above El. 620'-6", Units 1 & 2

Figure 8.3-3



30'-0"
30'-0"
32'-0"
4'-3"
RADWASTE BUILDING ROOF
ELEV 646'-6"
CONTINUED ON
DWG E-001-040
LANDING
ELEV 646'-6"
CABLE CHASE
MONORAILS
TOP OF RAIL
EL. 649'-0"
(TYP. 8 PLACES)
1R42-S003
(NO PAD REQD)
WALKWAY ROOF
DECK ELEV 647'-9"
POWER
DISTR.
PANEL
DIV II
CABLE SPREADING
UNIT-1
COMPUTER ROOM
ELEV 647'-9"
DIV 2
BATTERY
DIV 1
BATTERY
TIME
SHARING
UNIT
1R42-S025
1R42-S002
(NO PAD REQD)
1R42-S015
BASE EL.
639'-0"
(TYP. 10 PLACES)
1R42-S024
RAMP
UP
DESK
SLAB ELEV 638'-0"
FLOOR ELEV 639'-0"
DIV I
CABLE SPREADING
ELEVATOR
WALKWAY ROOF
DECK ELEV
647'-9"
FLOOR
ELEV
638'-6"
WALK
WAY
ROOF
DECK
ELEV
647'-9"
2R42-S003
(NO PAD REQD)
SLAB ELEV 638'-0"
FLOOR ELEV 639'-0"
2R42-S025
2R42-S024
2R42-S002
(NO PAD REQD)
2R42-S015
BASE EL.
639'-0"
(TYP. 8 PLACES)
HATCH
WALKWAY
ROOF EL
647'-9"
UNIT 2
COMPUTER ROOM ROOF
ELEV 647'-9"
KEY
PUNCH
LANDING
ELEV 646'-6"



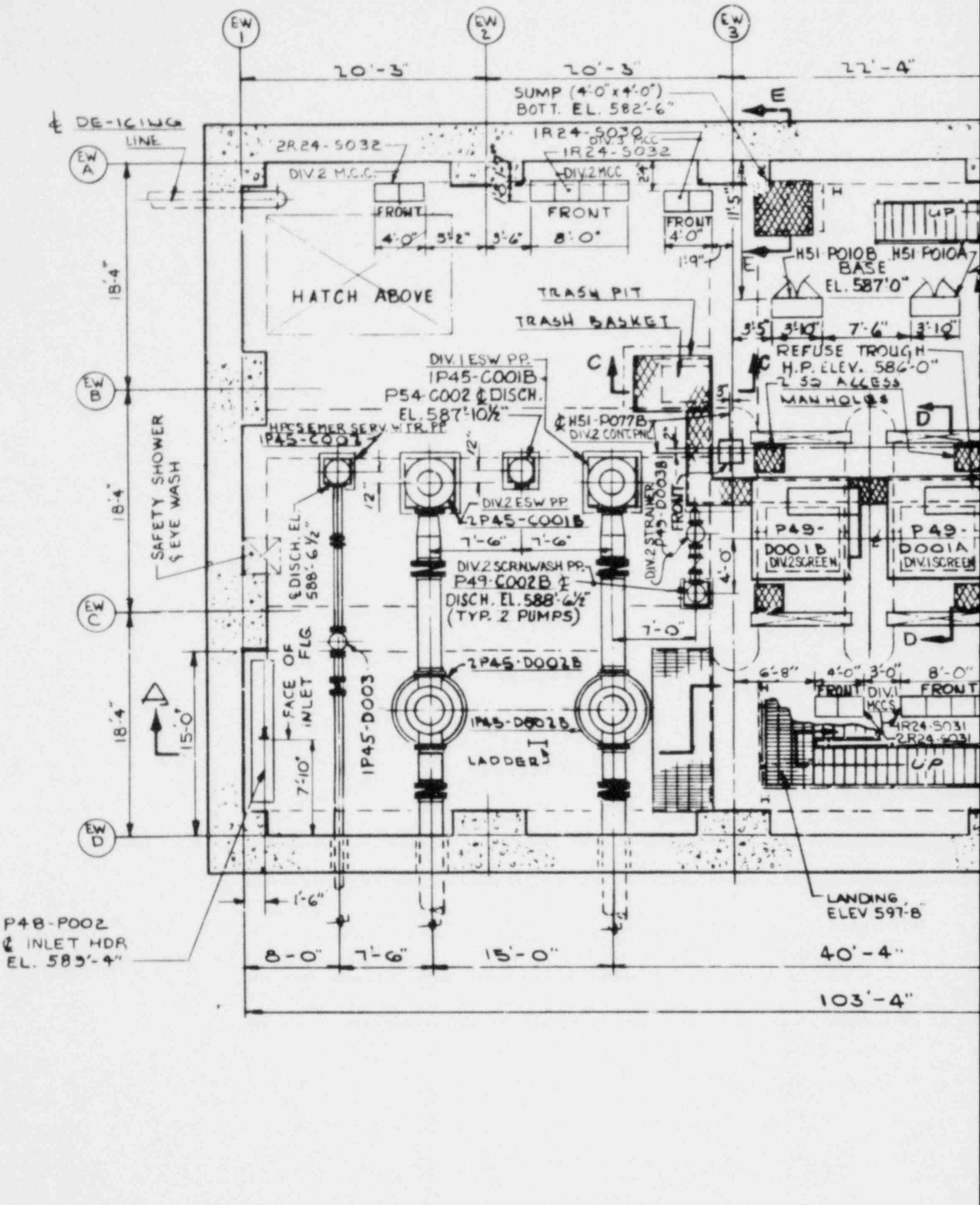


KEY PLAN

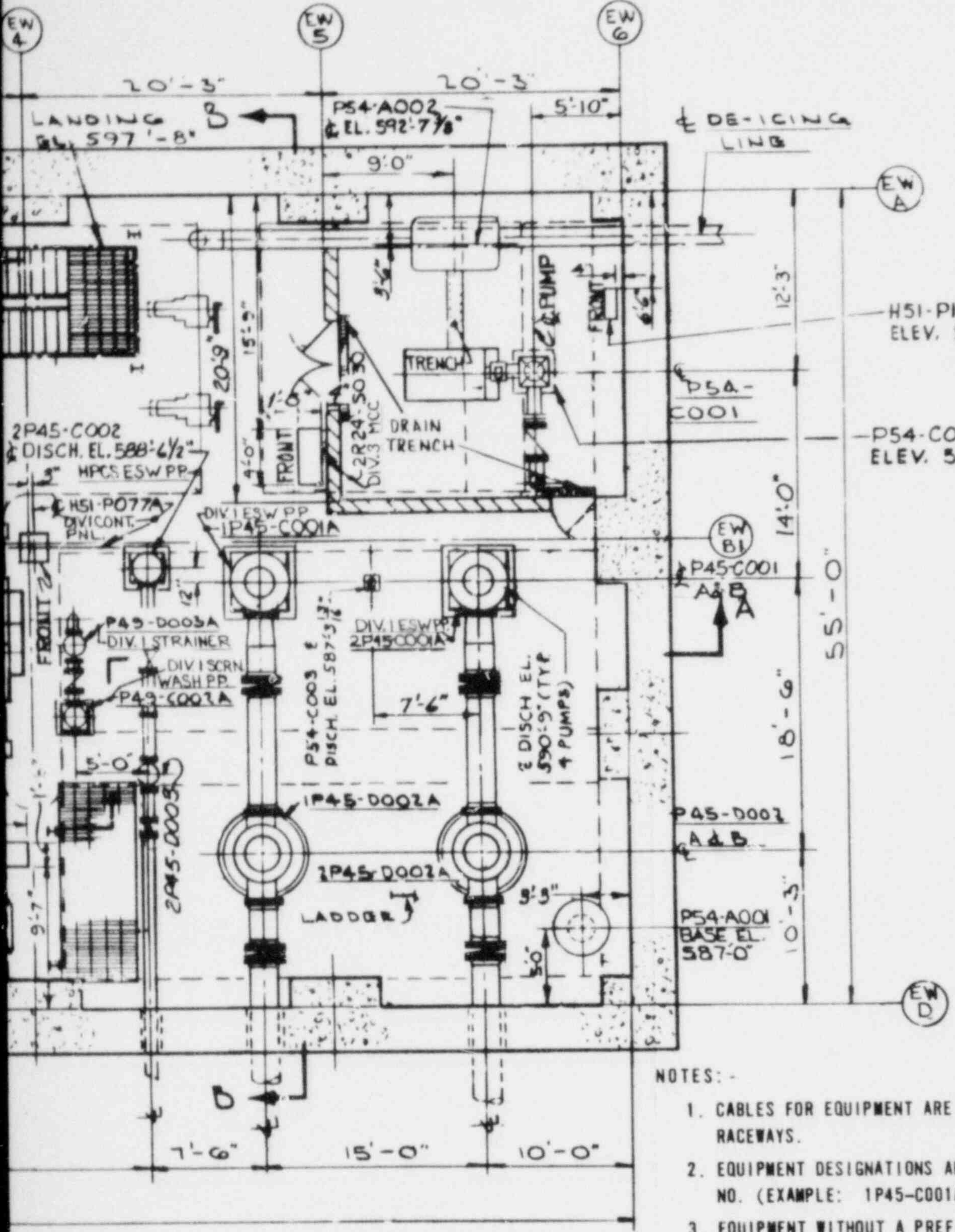
PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC
ILLUMINATING COMPANY

Control Complex Equipment Layout
Above El. 628'-6", Units 1 & 2

Figure 8.3-4



EW 1
EW 2
EW 3
20'-3"
20'-3"
22'-4"
SUMP (4'-0" x 4'-0")
BOTT. EL. 582'-6"
E
℄ DE-ICING LINE
EW A
2R24-S032
DIV.2 M.C.C.
1R24-S030
DIV.3 MCC
1R24-S032
DIV.2 MCC
FRONT
FRONT
FRONT
4'-0"
5'-2"
3'-6"
8'-0"
4'-0"
11'-5"
1'-9"
H51-P010B BASE
H51-P010A
EL. 587'0"
HATCH ABOVE
TRASH PIT
TRASH BASKET
18'-4"
3'-5"
3'-10"
7'-6"
3'-10"
REFUSE TROUGH
H.P. ELEV. 586'-0"
2 SQ ACCESS MANHOLES
EW B
DIV.1 ESW PP.
1P45-C001B
P54-C002 ℄ DISCH.
EL. 587'-10½"
C
℄ H51-P077B
DIV.2 CONT.PNL.
D
HPCS EMER SERV. WTR. PP
1P45-C002
12"
12"
SAFETY SHOWER & EYE WASH
18'-4"
DIV.2 ESW PP
2P45-C001B
7'-6"
7'-6"
℄ DISCH. EL. 588'-6½"
DIV.2 STRAINER
P45-D003B
FRONT
P49-D001B
DIV.2 SCREEN
P49-D001A
DIV.1 SCREEN
DIV.2 SCRN.WASH PP.
P49-C002B ℄
DISCH. EL. 588'-6½"
(TYP. 2 PUMPS)
4'-0"
EW C
7'-0"
D
FACE OF INLET FLG
2P45-D002B
6'-8"
4'-0"
3'-0"
8'-0"
FRONT
DIV.1 MCCS
FRONT
1P45-D003
1P45-D002B
1R24-S031
2R24-S031
18'-4"
15'-0"
7'-10"
LADDER
UP
EW D
LANDING
ELEV 597'-8"
1'-6"
P48-P002
℄ INLET HDR
EL. 589'-4"
8'-0"
7'-6"
15'-0"
40'-4"
103'-4"



NOTES:-

1. CABLES FOR EQUIPMENT ARE ROUTED VIA EMBEDDED RACEWAYS.
2. EQUIPMENT DESIGNATIONS ARE PREFIXED BY UNIT NO. (EXAMPLE: 1P45-C001A AND 2P45-C002).
3. EQUIPMENT WITHOUT A PREFIX IS SHARED BY BOTH UNITS.

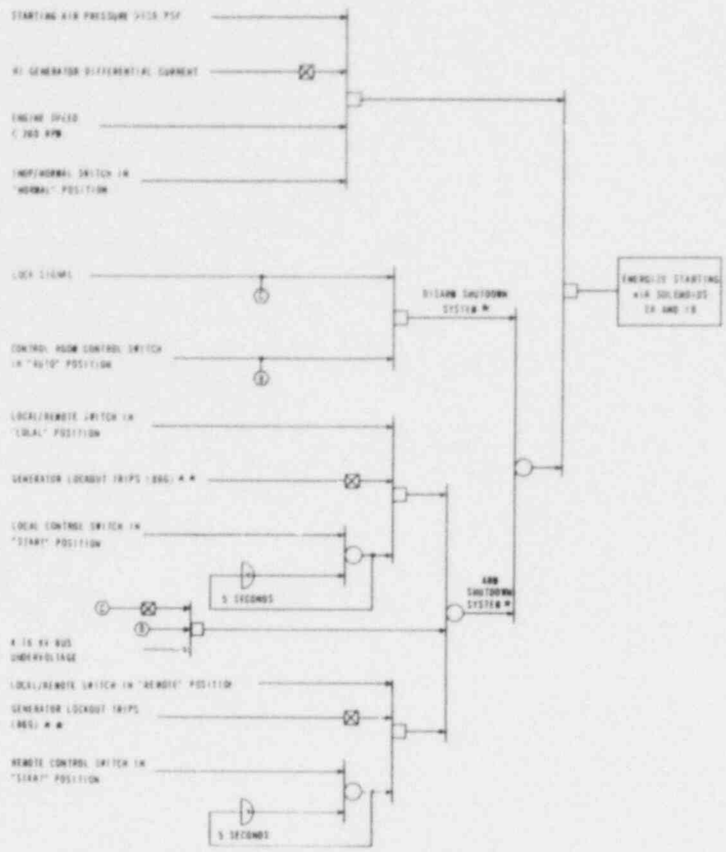
PNPP

PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

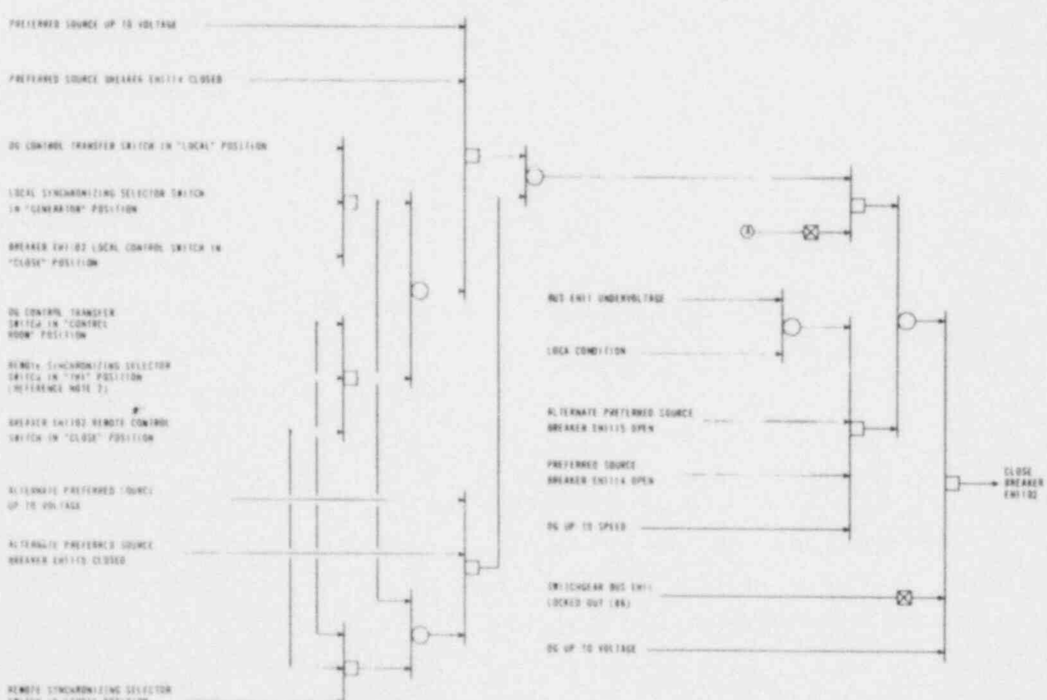
Emergency Service Water Pumphouse Equipment Layout Above El. 586'-6"

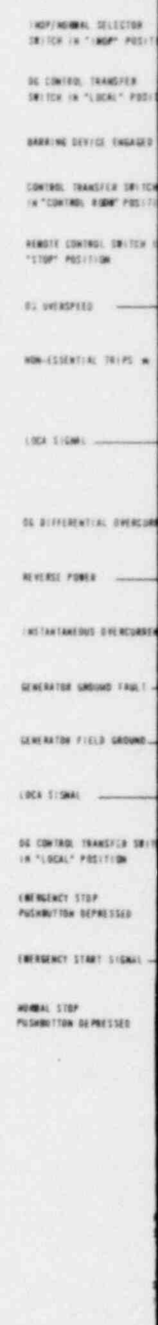
Figure 8.3-5

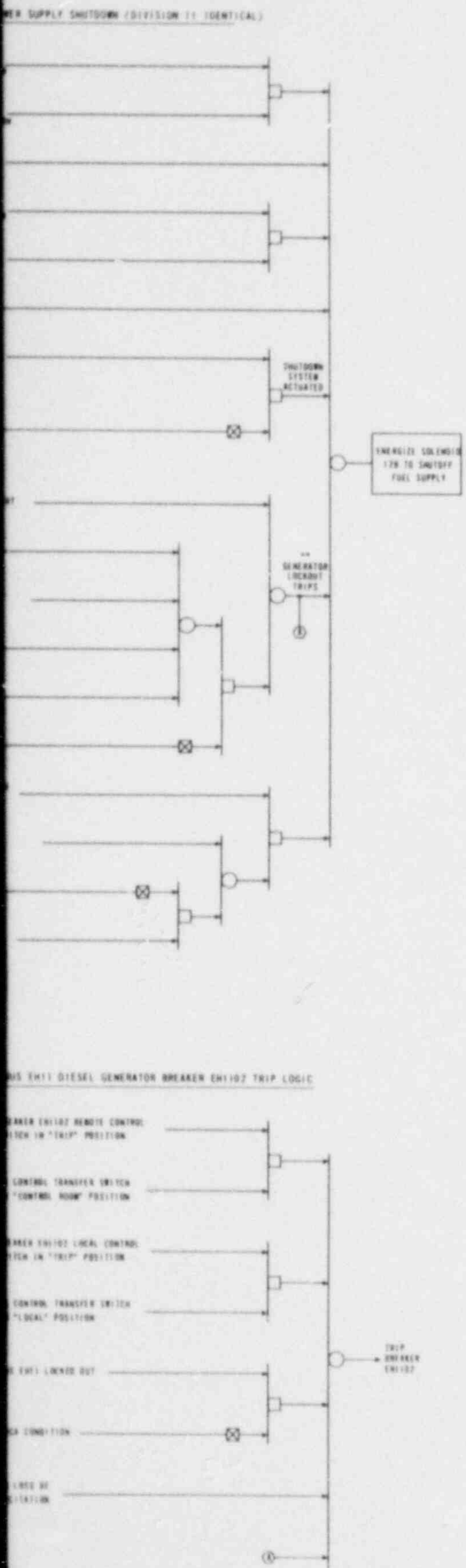
DIVISION I STANDBY POWER SUPPLY START-UP (DIVISION II IDENTICAL - BACKUP START CONTROL IDENTICAL)



BUS EH11 DIESEL GENERATOR BREAKER EH1102 CLOSE LOGIC







CONTROL ROOM ALARMS

EMERGENCY SERVICE WATER TO DIESEL HEAT EXCHANGER LOW FLOW
FUEL TRANSFER PUMP 1A FILTER DIFFERENTIAL PRESSURE HIGH
ENGINE VIBRATION EXCESSIVE
LUBE OIL TEMPERATURE HIGH
STARTING AIR PRESSURE LOW
FUEL DAY TANK 1A LEVEL HIGH/LOW
FUEL TRANSFER PUMP 2A FILTER DIFFERENTIAL PRESSURE HIGH
CRANKCASE PRESSURE HIGH
LUBE OIL PRESSURE LOW
DIESEL GENERATOR PROTECTIVE RELAY TRIP
FUEL STORAGE TANK 2A LEVEL LOW (7 DAY LEVEL)
ENGINE BEARINGS TEMPERATURE HIGH
TURBO OIL PRESSURE LOW
DIESEL GENERATOR CONTROL IN LOCAL
FUEL STORAGE TANK 2A LEVEL LOW (1 DAY LEVEL)
JACKET WATER TEMPERATURE HIGH
DIESEL GENERATOR TROUBLE 1H51-P954A
DIESEL GENERATOR LOCKOUT RELAY TRIP
DIESEL GENERATOR DIFFERENTIAL RELAY TRIP
BUS EH11 (4.16 KV) UNDERVOLTAGE
BUS EH11 (4.16 KV) UNDERVOLTAGE
BUS EH11 (4.16 KV) BREAKER TRIP
BUS EH11 (4.16 KV) BREAKER TRIP
DIESEL GENERATOR EMERGENCY START SIGNAL RECEIVED
DIESEL GENERATOR OVERSPEED TRIP
DIESEL GENERATOR FAILURE TO START
DIESEL GENERATOR OUT OF SERVICE

LOCAL ALARMS

JACKING DEVICE ENGAGED
FUEL OIL BOOSTER STRAIN ΔP HIGH
FUEL DAY TANK LEVEL LOW
FUEL TRANSFER PUMP 2 RUNNING
LUBE OIL FILTER ΔP HIGH
LUBE OIL INLET TEMPERATURE LOW
JACKET WATER PRESSURE LOW
JACKET WATER INLET TEMPERATURE LOW
CONTROL AIR PRESSURE LOW
FUEL TRANSFER PUMP 1 FILTER ΔP HIGH
FUEL DAY TANK LEVEL HIGH
LUBE OIL STRAINER ΔP HIGH
LUBE OIL INLET TEMPERATURE HIGH
JACKET WATER INLET TEMPERATURE HIGH
GENERATOR FIELD GROUND
STARTING AIR PRESSURE LOW
FUEL TRANSFER PUMP 2 FILTER ΔP HIGH
FUEL STORAGE TANK LEVEL LOW (7 DAYS)
FUEL PUMP STRAINER ΔP HIGH
FIELD FLASH 125V DC POWER LOSS
GENERATOR STATOR TEMPERATURE HIGH
FUEL FILTER ΔP HIGH
FUEL STORAGE TANK LEVEL LOW (1 DAY)
TURBO OIL LEFT BANK PRESSURE LOW
LUBE OIL LOW LEVEL
LUBE OIL OUTLET TEMPERATURE LOW
JACKET WATER STANDPIPE LEVEL LOW
JACKET WATER OUT TEMPERATURE LOW
DIESEL GENERATOR FAILURE TO START
FUEL OIL PRESSURE LOW
FUEL PUMP/OVERSPEED DRIVE FAILURE
TURBO OIL RIGHT BANK PRESSURE LOW
LUBE OIL PRESSURE LOW
LUBE OIL OUTLET TEMPERATURE HIGH
JACKET WATER OUTLET TEMPERATURE HIGH
DIESEL GENERATOR EMERGENCY START SIGNAL RECEIVED

SHUTDOWN SYSTEM ESSENTIAL TRIP PERMISSIVES:
DIESEL GENERATOR DIFFERENTIAL RELAY TRIP
DIESEL GENERATOR OVERSPEED TRIP

SHUTDOWN SYSTEM NON-ESSENTIAL TRIP PERMISSIVES:
ENGINE VIBRATION TRIP
CRANKCASE PRESSURE HIGH TRIP
TURBO OIL PRESSURE LOW TRIP
LUBE OIL PRESSURE LOW TRIP
LUBE OIL TEMPERATURE HIGH TRIP
ENGINE BEARING TEMPERATURE HIGH TRIP
JACKET WATER OUTLET TEMPERATURE HIGH TRIP

ANY SWITCH NOT IN AUTO

NOTES:

1. BREAKER CLOSE AND TRIP LOGIC FOR REDUNDANT BUS EH12 IS IDENTICAL TO THE LOGIC FOR BUS EH11. THE CORRESPONDING BREAKERS ON BUS EH12 ARE AS FOLLOWS:
   - BREAKER EH1201 - DIESEL GENERATOR BREAKER
   - BREAKER EH1212 - PREFERRED SUPPLY BREAKER
   - BREAKER EH1213 - ALTERNATE PREFERRED SUPPLY BREAKER
   - BREAKER EH1214 - STUB BUS TIE BREAKER
2. TH1 IS THE CABLE BUS CONNECTING THE UNIT 1 CLASS 1E 4 KV BUSES TO NORMAL OFF-SITE POWER VIA UNIT 1 INTERBUS TRANSFORMER LH-1-A
3. TH21 IS THE CABLE BUS CONNECTING THE UNIT 1 CLASS 1E 4 KV BUSES TO OFF-SITE POWER VIA UNIT 2 INTERBUS TRANSFORMER LH-2-A
4. TH12 IS THE CABLE BUS CONNECTING THE UNIT 2 CLASS 1E 4 KV BUSES TO OFF-SITE POWER VIA UNIT 2 INTERBUS TRANSFORMER LH-1-A

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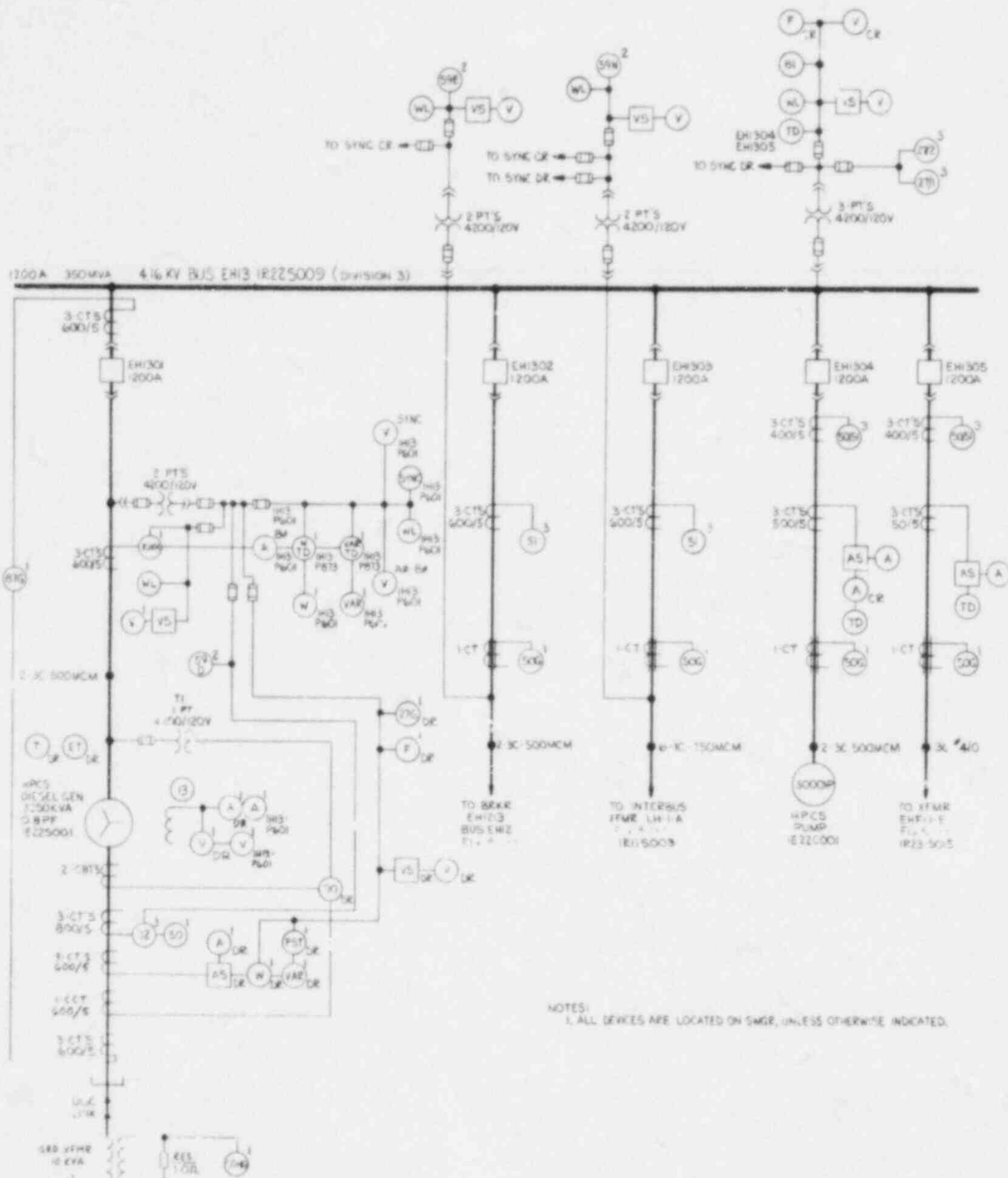
PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

Diesel and Diesel Breaker Logic Diagrams, Division 1 (Division 2), Unit 1

Figure 8.3-6

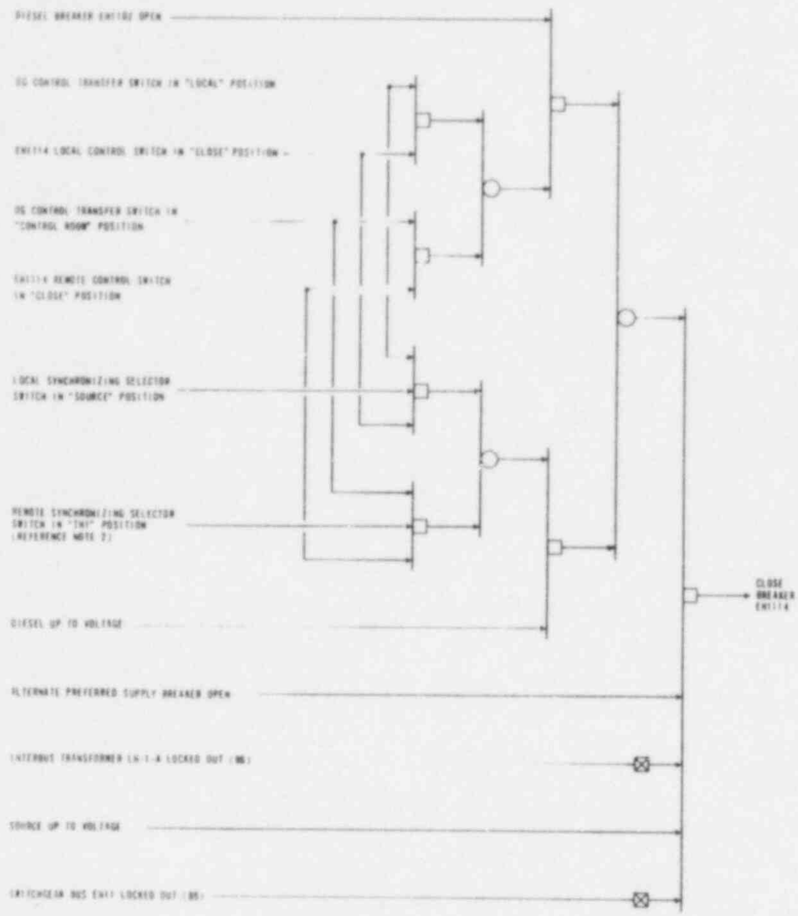


PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

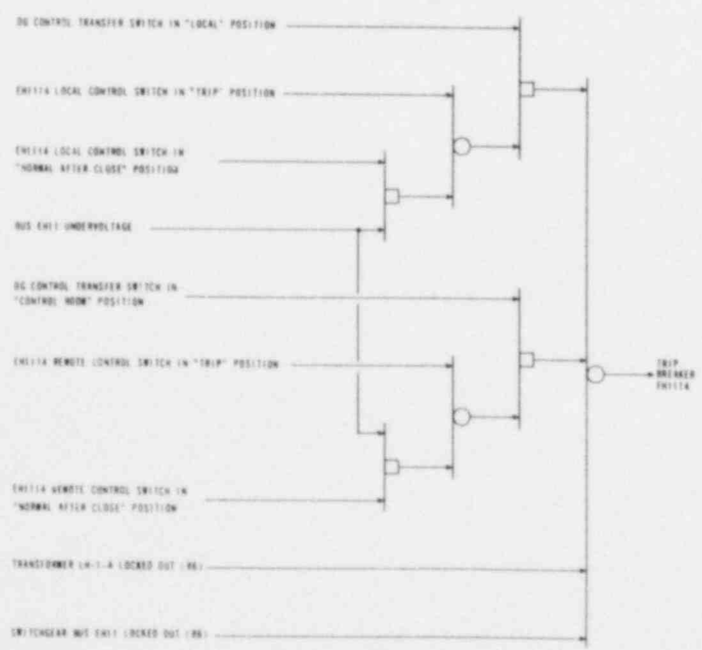
One Line Meter and Relay Diagram
Class 1E, 4.16 kV, Division 3,
Unit 1

Figure 8.3-7

BUS EH11 PREFERRED SUPPLY BREAKER EH1114 CLOSE LOGIC

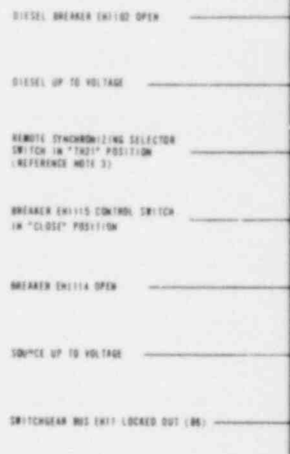


BUS EH11 PREFERRED SUPPLY BREAKER EH1114 TRIP LOGIC

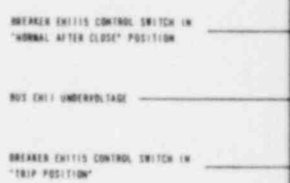


BUS EH11 ALTERNATE PREFERRED SUPPLY BRE

BREAKER CLOSE LOGIC

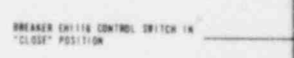


BREAKER TRIP LOGIC

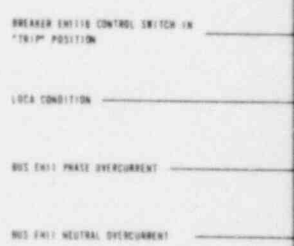


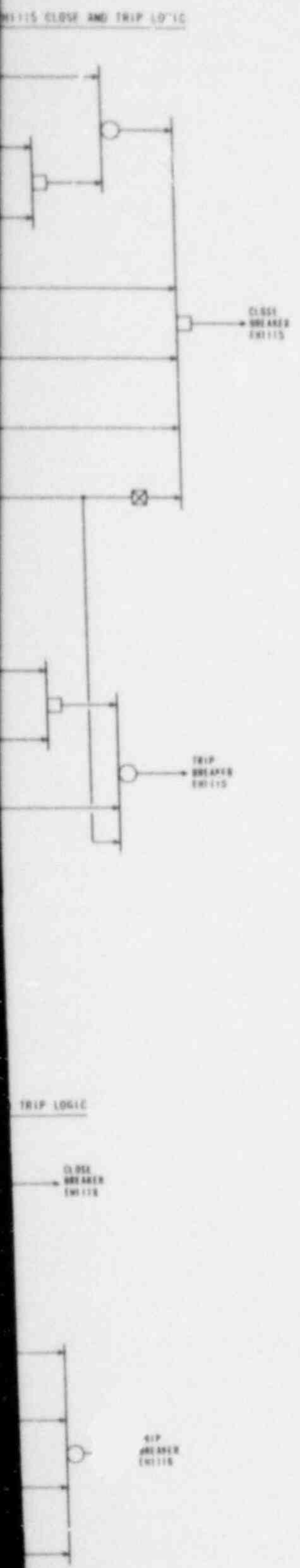
BUS EH11 STUB BUS TIE BREAKER EH1116 CLOSE A

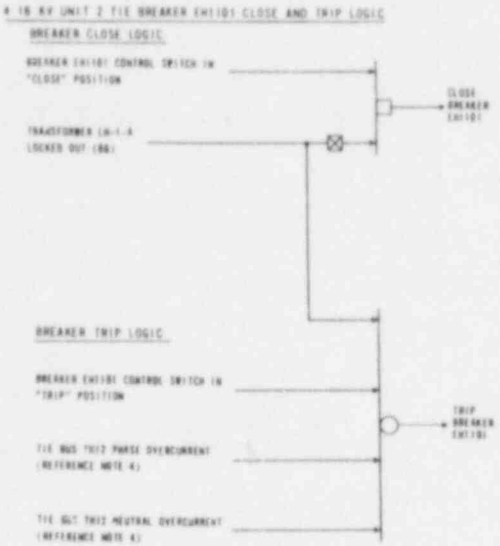
BREAKER CLOSE LOGIC



BREAKER TRIP LOGIC







NOTES:

1. BREAKER CLOSE AND TRIP LOGIC FOR REDUNDANT BUS EH12 IS IDENTICAL TO THE LOGIC FOR BUS EH11. THE CORRESPONDING BREAKERS ON BUS EH12 ARE AS FOLLOWS:
   - BREAKER EH1201 - DIESEL GENERATOR BREAKER
   - BREAKER EH1212 - PREFERRED SUPPLY BREAKER
   - BREAKER EH1213 - ALTERNATE PREFERRED SUPPLY BREAKER
   - BREAKER EH1214 - STUB BUS TIE BREAKER
2. TH1 IS THE CABLE BUS CONNECTING THE UNIT 1 CLASS 1E 4 [illegible] TO NORMAL OFF-SITE POWER VIA UNIT 1 INTERBUS TRANSFORMER LH-1-A
3. TH21 IS THE CABLE BUS CONNECTING THE UNIT 1 CLASS 1E 4 KV BUSES TO OFF-SITE POWER VIA UNIT 2 INTERBUS TRANSFORMER LH-2-A
4. TH12 IS THE CABLE BUS CONNECTING THE UNIT 2 CLASS 1E 4 KV BUSES TO OFF-SITE POWER VIA UNIT 2 INTERBUS TRANSFORMER LH-1-A

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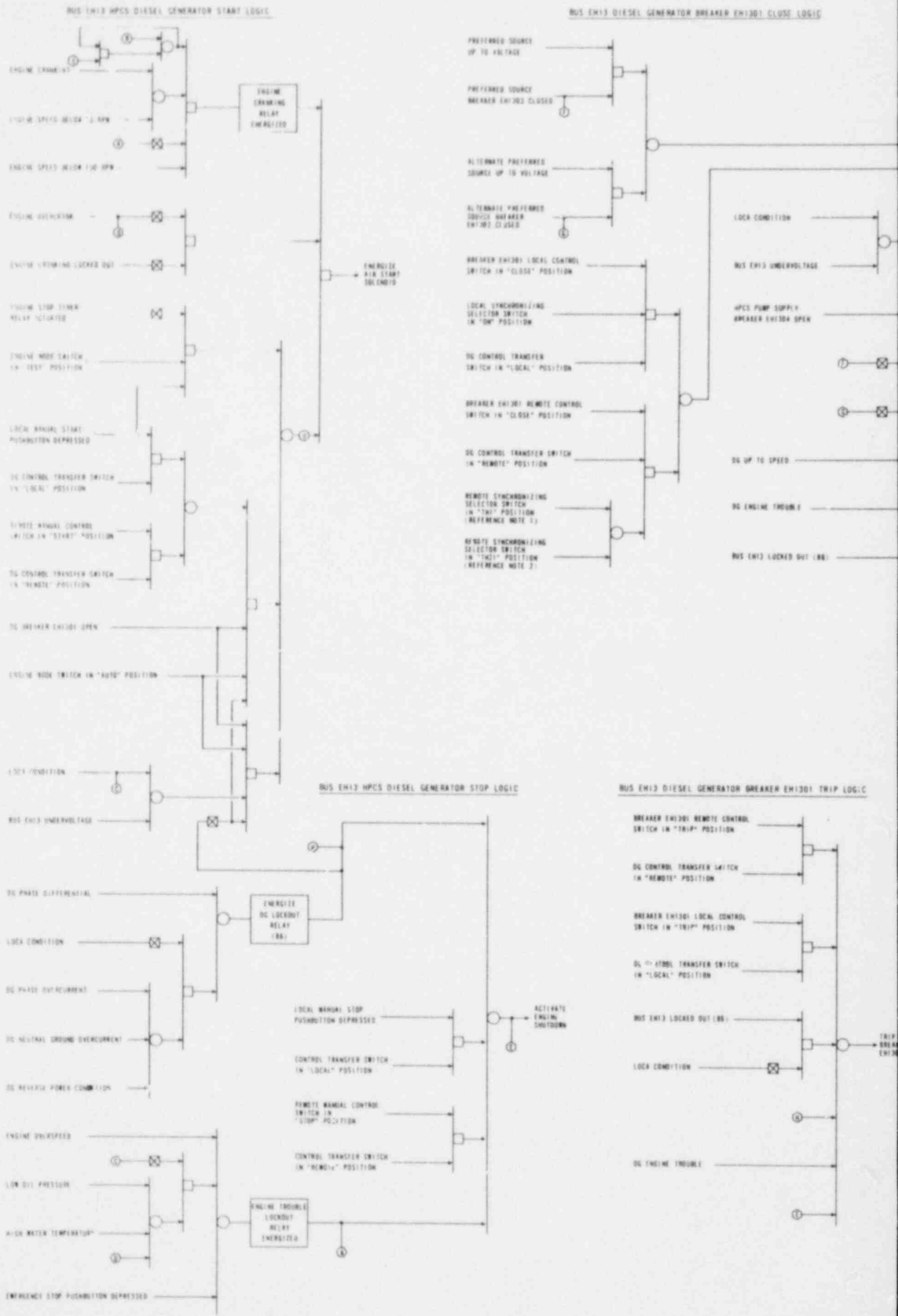
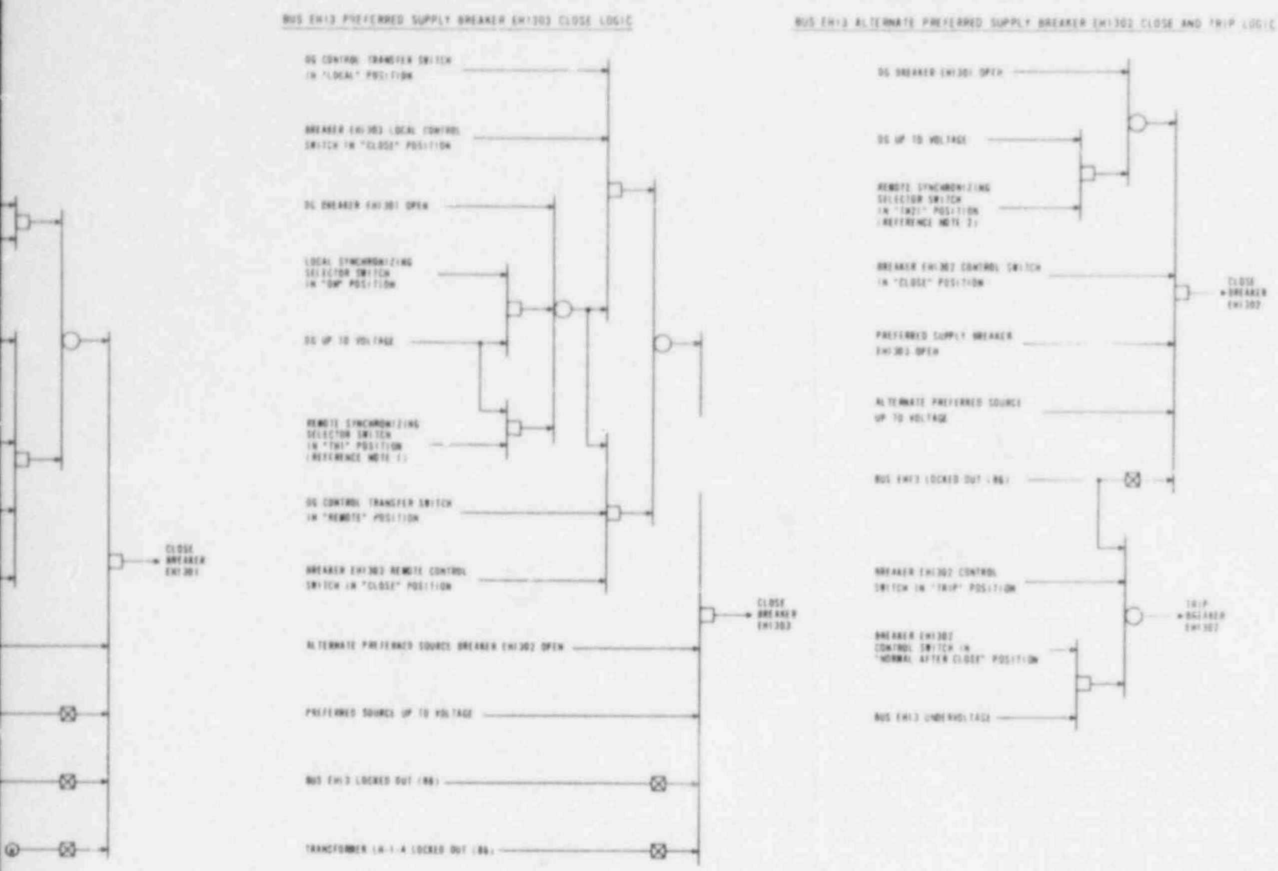
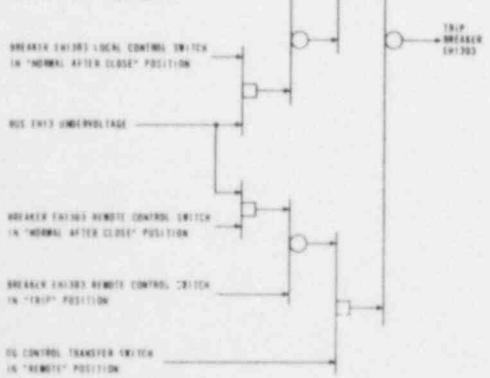
PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

HPCS Diesel, Diesel Breakers, Alternate Preferred Supply Breakers Logic Diagram, Division 3, Unit 1

Figure 8.3-8


BUS EH13 HPCS DIESEL GENERATOR START LOGIC
ENGINE CRANKING RELAY ENERGIZED
ENERGIZE AIR START SOLENOID
ENGINE MODE SWITCH IN "TEST" POSITION
LOCAL MANUAL START PUSHBUTTON DEPRESSED
DG CONTROL TRANSFER SWITCH IN "LOCAL" POSITION
DG CONTROL TRANSFER SWITCH IN "REMOTE" POSITION
DG BREAKER EH1301 OPEN
ENGINE MODE SWITCH IN "AUTO" POSITION
BUS EH13 UNDERVOLTAGE
BUS EH13 DIESEL GENERATOR BREAKER EH1301 CLOSE LOGIC
PREFERRED SOURCE UP TO VOLTAGE
PREFERRED SOURCE BREAKER EH1303 CLOSED
ALTERNATE PREFERRED SOURCE UP TO VOLTAGE
ALTERNATE PREFERRED SOURCE BREAKER EH1302 CLOSED
BREAKER EH1301 LOCAL CONTROL SWITCH IN "CLOSE" POSITION
LOCAL SYNCHRONIZING SELECTOR SWITCH IN "ON" POSITION
DG CONTROL TRANSFER SWITCH IN "LOCAL" POSITION
BREAKER EH1301 REMOTE CONTROL SWITCH IN "CLOSE" POSITION
DG CONTROL TRANSFER SWITCH IN "REMOTE" POSITION
REMOTE SYNCHRONIZING SELECTOR SWITCH IN "TH1" POSITION (REFERENCE NOTE 1)
REMOTE SYNCHRONIZING SELECTOR SWITCH IN "TH21" POSITION (REFERENCE NOTE 2)
LOCA CONDITION
BUS EH13 UNDERVOLTAGE
HPCS PUMP SUPPLY BREAKER EH1304 OPEN
DG UP TO SPEED
DG ENGINE TROUBLE
BUS EH13 LOCKED OUT (86)
BUS EH13 HPCS DIESEL GENERATOR STOP LOGIC
DG PHASE DIFFERENTIAL
ENERGIZE DG LOCKOUT RELAY (86)
LOCA CONDITION
DG PHASE OVERCURRENT
DG NEUTRAL GROUND OVERCURRENT
DG REVERSE POWER CONDITION
ENGINE OVERSPEED
LOW OIL PRESSURE
HIGH WATER TEMPERATURE
ENGINE TROUBLE LOCKOUT RELAY ENERGIZED
EMERGENCY STOP PUSHBUTTON DEPRESSED
LOCAL MANUAL STOP PUSHBUTTON DEPRESSED
CONTROL TRANSFER SWITCH IN "LOCAL" POSITION
REMOTE MANUAL CONTROL SWITCH IN "STOP" POSITION
CONTROL TRANSFER SWITCH IN "REMOTE" POSITION
ACTIVATE ENGINE SHUTDOWN
BUS EH13 DIESEL GENERATOR BREAKER EH1301 TRIP LOGIC
BREAKER EH1301 REMOTE CONTROL SWITCH IN "TRIP" POSITION
DG CONTROL TRANSFER SWITCH IN "REMOTE" POSITION
BREAKER EH1301 LOCAL CONTROL SWITCH IN "TRIP" POSITION
IN "LOCAL" POSITION
BUS EH13 LOCKED OUT (86)
LOCA CONDITION
DG ENGINE TROUBLE





CONTROL ROOM ALARMS

DIESEL HEAT EXCHANGER FLOW LOW
FUEL TRANSFER PUMP 1C FILTER DIFFERENTIAL PRESSURE HIGH
HPCS DAY TANK LEVEL HIGH/LOW
FUEL TRANSFER PUMP 2C FILTER DIFFERENTIAL PRESSURE HIGH
LUBE OIL PRESSURE LOW
HPCS FUEL STORAGE TANK LEVEL LOW (7 DAY LEVEL)
HPCS FUEL STORAGE TANK LEVEL LOW (1 DAY LEVEL)
JACKET WATER TEMPERATURE HIGH
DIESEL GENERATOR CONTROL IN LOCAL
STARTING AIR PRESSURE LOW
DIESEL GENERATOR EMERGENCY START SIGNAL RECEIVED
DIESEL GENERATOR FAILURE TO START
BUS EH13 (4.16 KV) UNDERVOLTAGE
BUS EH13 (4.16 KV) BREAKER TRIP
DIESEL GENERATOR PROTECTIVE RELAY TRIP
DIESEL GENERATOR TROUBLE
DIESEL GENERATOR LOCKOUT RELAY TRIP
DIESEL GENERATOR DIFFERENTIAL RELAY TRIP
DIESEL GENERATOR OVERSPEED TRIP

LOCAL ALARMS

FAIL TO START/RUN
CHARGER FAILURE
CONTROL POWER FAILURE
HIGH WATER TEMPERATURE
OVERSPEED
LOW STARTING AIR PRESSURE
HIGH STATOR TEMPERATURE
LOW EXPANSION TANK WATER LEVEL
LOW FUEL LEVEL
ENGINE TRIPPED
LOW TURBO LUBE OIL PRESSURE
LOW COOLING WATER PRESSURE
CRANKCASE PRESSURE HIGH
MAIN FUEL PUMP FAILURE
RESERVE FUEL PUMP FAILURE
RESTRICTED FUEL OIL FILTER
HIGH LUBE OIL TEMPERATURE
LOW LUBE OIL TEMPERATURE
LOW LUBE OIL PRESSURE
RESTRICTED LUBE OIL FILTER

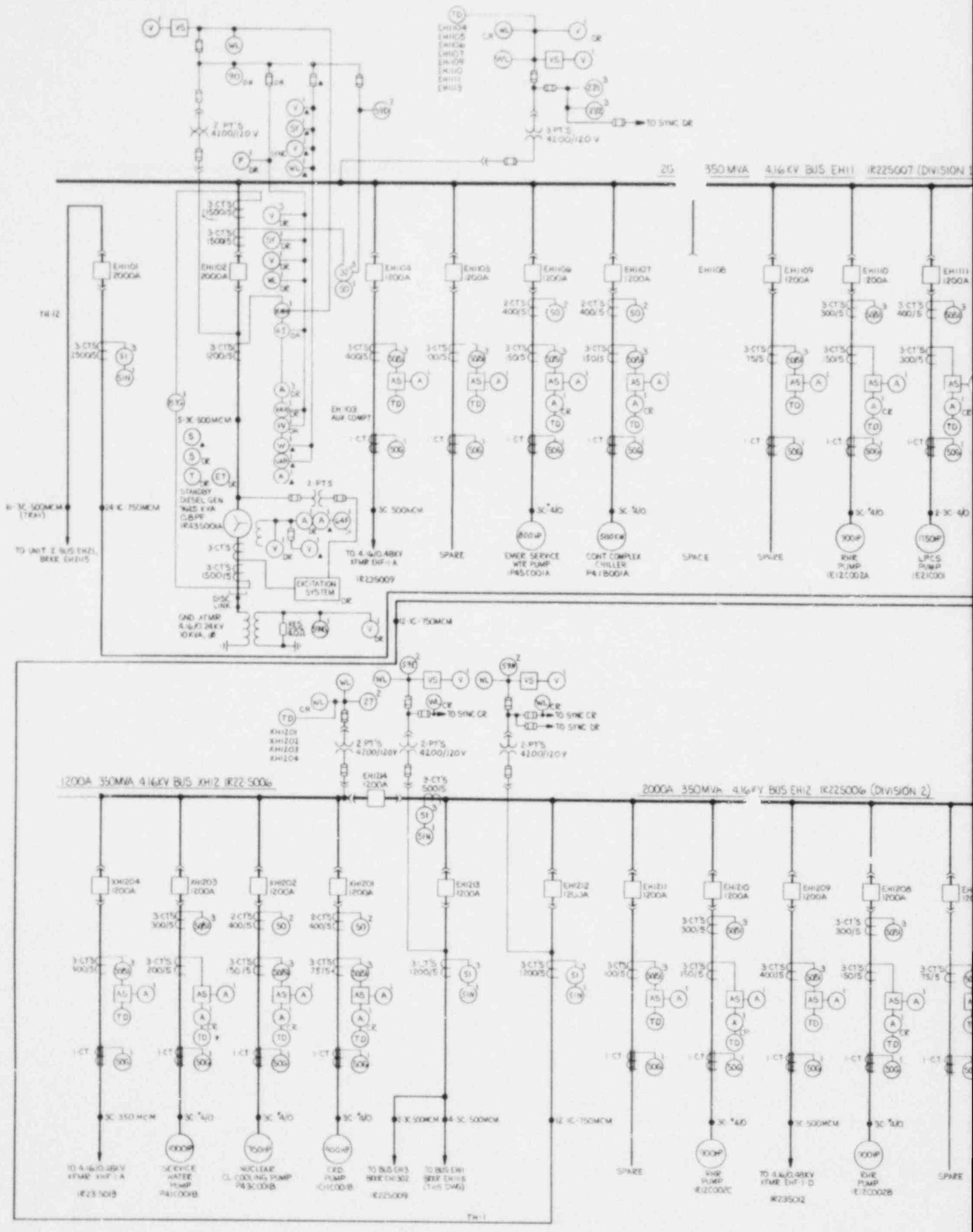
NOTES:

1. TH1 IS THE CABLE BUS CONNECTING THE UNIT 1 CLASS 1E 4 KV BUSES TO NORMAL OFF-SITE POWER VIA UNIT 1 INTERBUS TRANSFORMER LH-1-A
2. TH21 IS THE CABLE BUS CONNECTING THE UNIT 1 CLASS 1E 4 KV BUSES TO OFF-SITE POWER VIA UNIT 2 INTERBUS TRANSFORMER LH-2-A

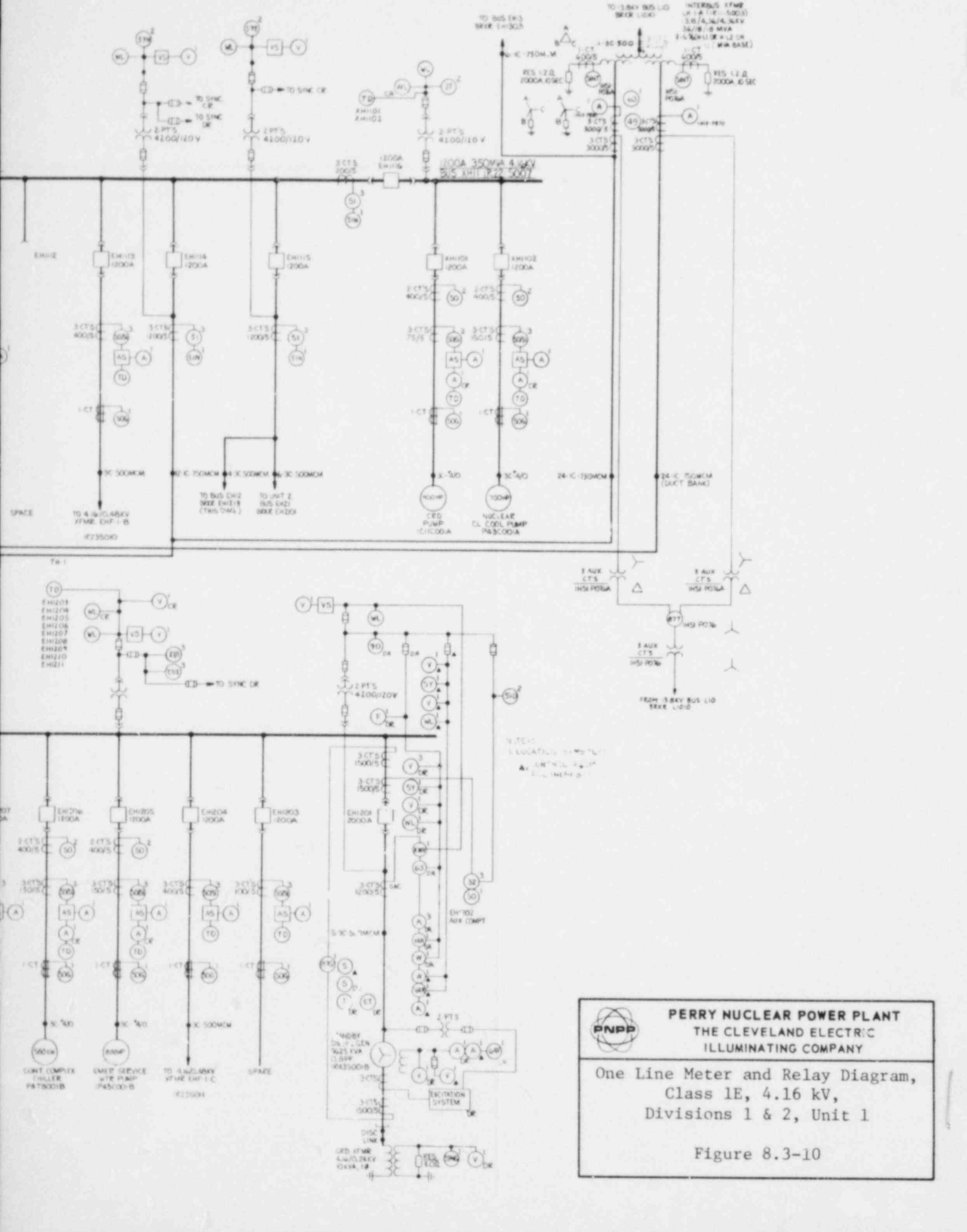
PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

Preferred, Alternate Preferred and Stub Bus Logic Diagram, Division 1, Unit 1

Figure 8.3-9



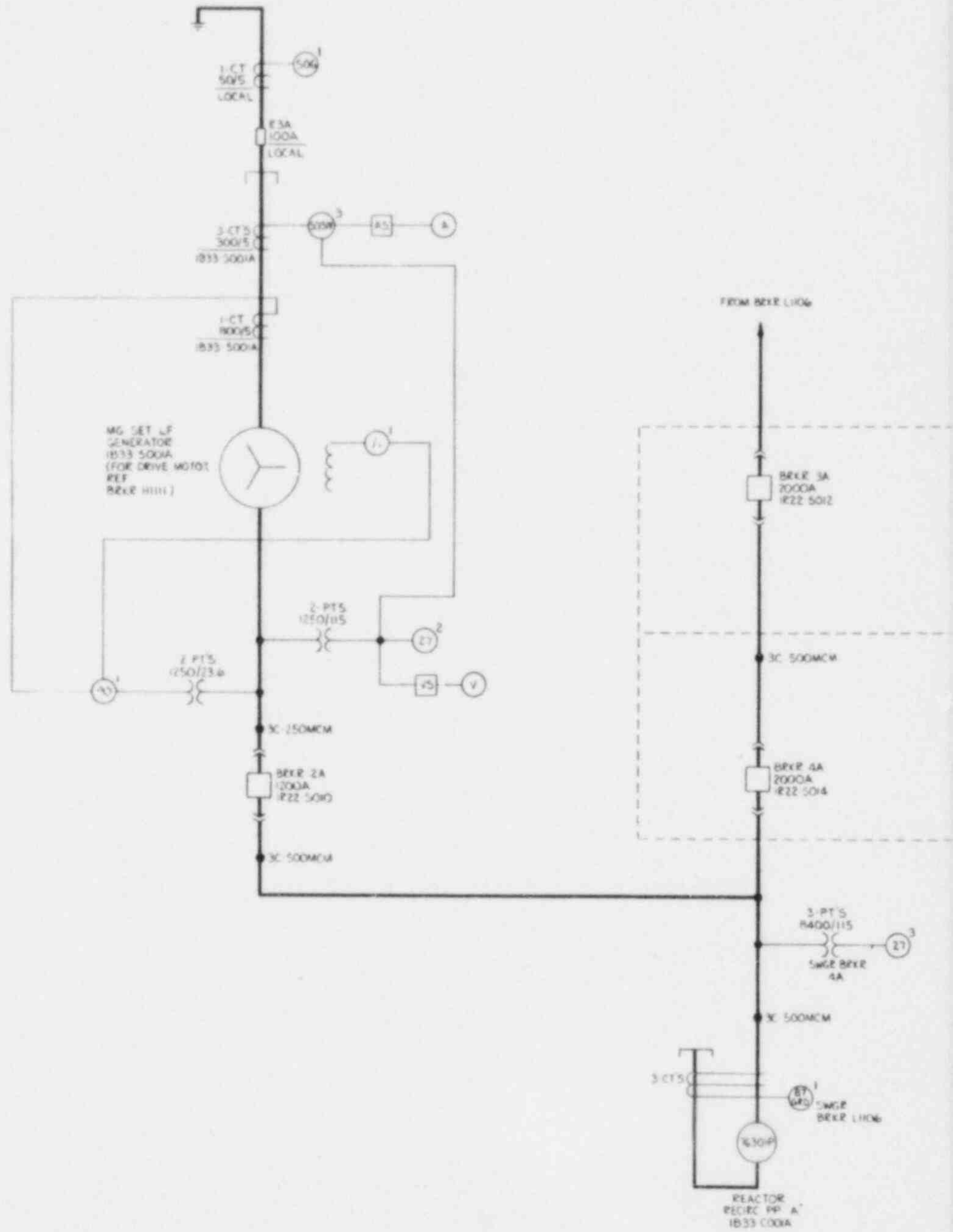
2G 350 MVA 4.16 KV BUS EH11 1R22S007 (DIVISION 1
2 PT'S 4200/120 V
3 PT'S 4200/120 V
TO SYNC CR
EH1101 2000A
EH1102 2000A
EH1104 1200A
EH1105 1200A
EH1106 1200A
EH1107 1200A
EH1108
EH1109 1200A
EH1110 1200A
EH1111 1200A
5-3C 500MCM
STANDBY DIESEL GEN 7465 KVA 0.8PF 1R43S001A
EXCITATION SYSTEM
DISC LINK
GND XFMR 4.16/0.24 KV 10 KVA, 1Ø
12-1C-750MCM
6-3C 500MCM (TRAY)
24-1C-750MCM
TO UNIT 2 BUS EH21, BRKR EH2115
EH 103 AUX COMPT
TO 4.16/0.48KV XFMR EHF-1-A
1R23S009
SPARE
EMER SERVICE WTR PUMP 1P45C001A
CONT COMPLEX CHILLER P47B001A
SPACE
SPARE
RHR PUMP 1E12C002A
LPCS PUMP 1E21C001
1200A 350MVA 4.16KV BUS XH12 1R22-S006
2000A 350MVA 4.16KV BUS EH12 1R22S006 (DIVISION 2)
EH1214 1200A
XH1204 1200A
XH1203 1200A
XH1202 1200A
XH1201 1200A
EH1213 1200A
EH1212 1200A
EH1211 1200A
EH1210 1200A
EH1209 1200A
EH1208 1200A
TO 4.16/0.48KV XFMR XHF-1-A
1R23-S018
SERVICE WATER PUMP P41C001B
NUCLEAR CL COOLING PUMP P43C001B
CRD PUMP 1C11C001B
TO BUS EH13 BRKR EH1302
1R22S009
TO BUS EH11 BRKR EH1115 (THIS DWG)
SPARE
RHR PUMP 1E12C002C
TO 4.16/0.48KV XFMR EHF-1-D
1R23S012
RHR PUMP 1E12C002B
SPARE
TH-1
TH-12



PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

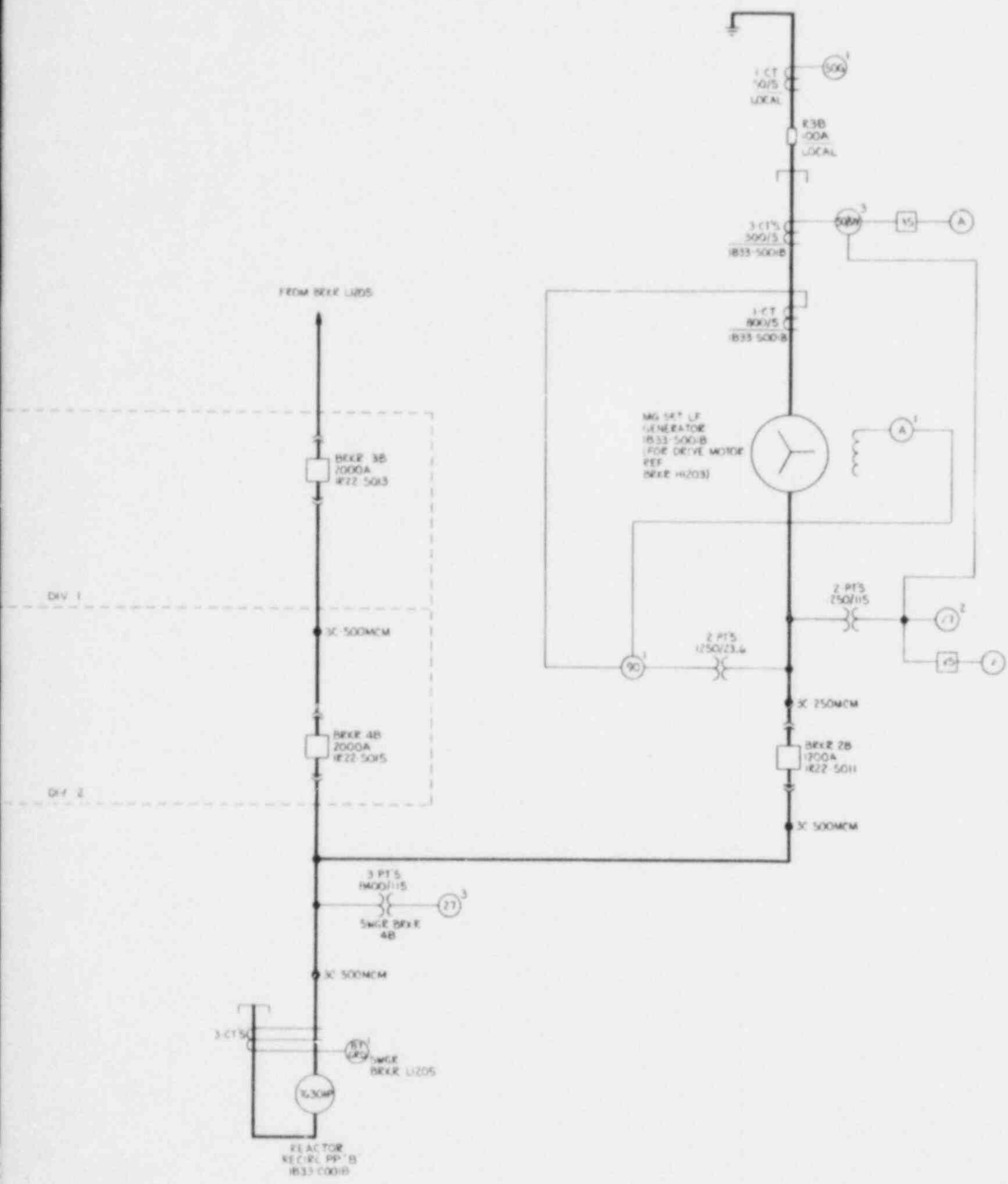
One Line Meter and Relay Diagram, Class 1E, 4.16 kV, Divisions 1 & 2, Unit 1

Figure 8.3-10



NOTES

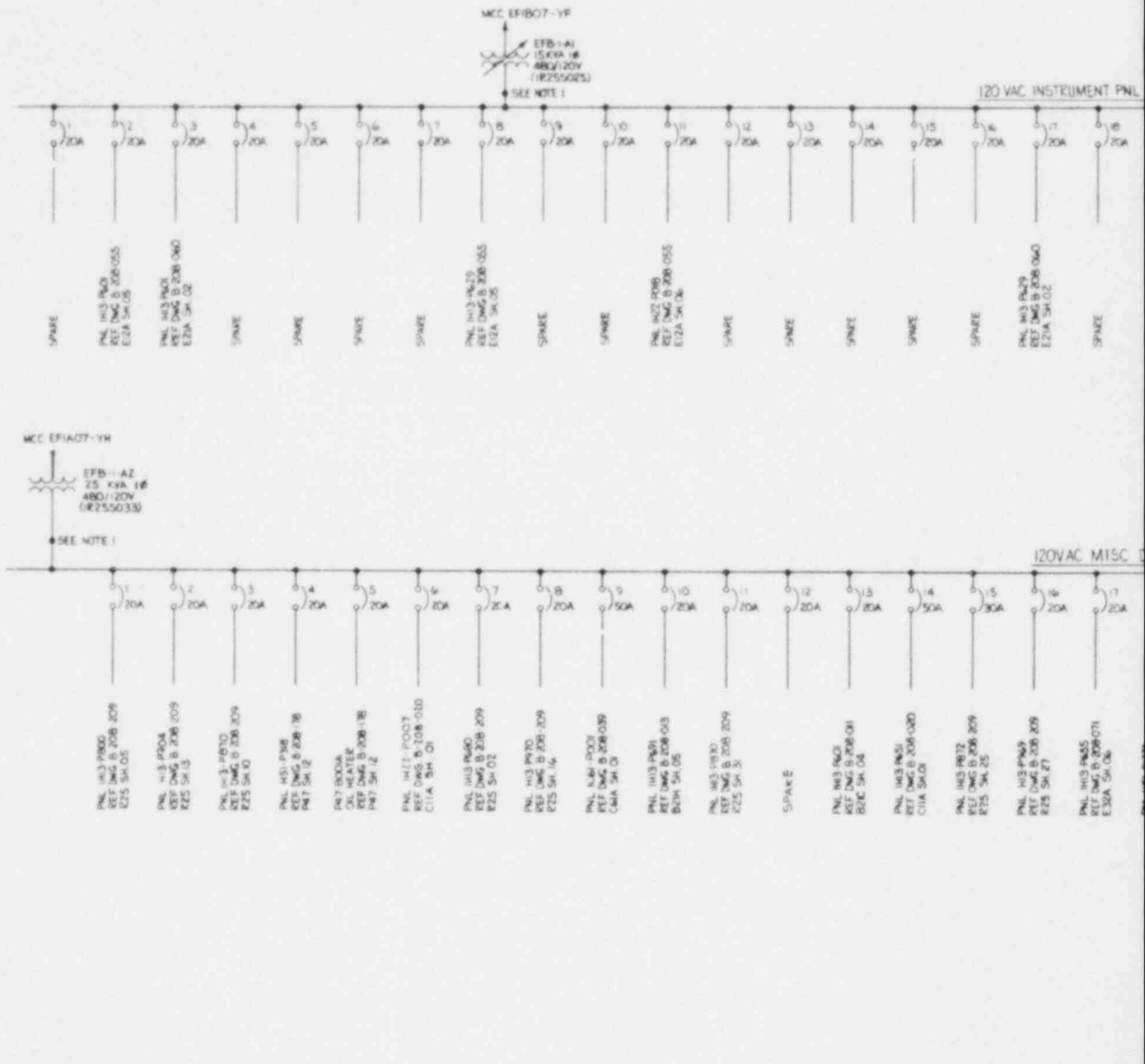
1. DEVICES ARE LOCATED IN PANEL 1B33-P001A FOR RECIRCULATION PUMP "A" AND PANEL 1B33-P001B FOR RECIRCULATION PUMP "B" UNLESS OTHERWISE INDICATED.
2. EQUIPMENT IS NON-DIVISIONAL, UNLESS INDICATED OTHERWISE.



PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC
ILLUMINATING COMPANY

One Line Meter and Relay Diagram, Recirculation Pump Motor Feeders, Unit 1

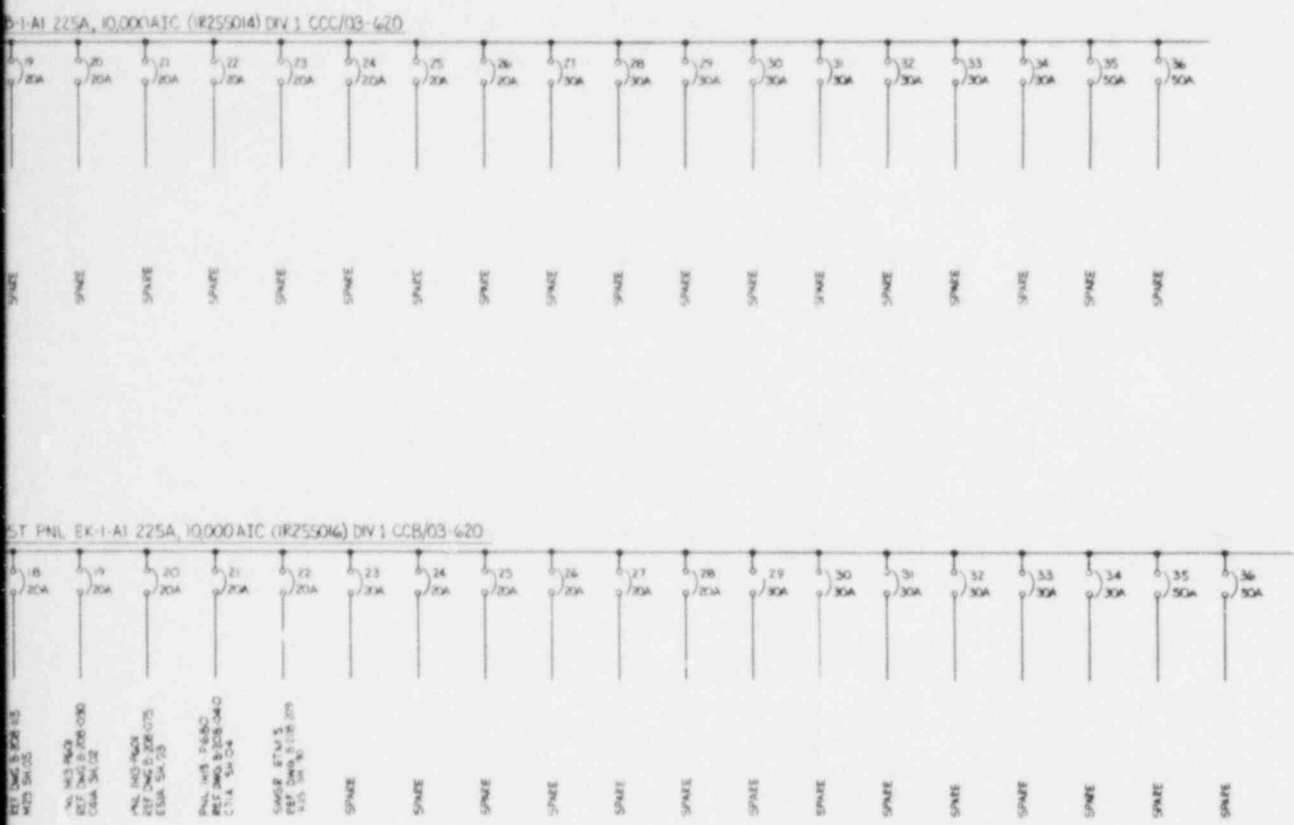
Figure 8.3-11



NOTES

1. EACH DISTRIBUTION PANEL AND TRANSFORMER IS MOUNTED INSIDE THEIR RESPECTIVE MCC. CABLE INSTALLED BY MCC SUPPLIER.
2. NEUTRALS GROUNDED AT TRANSFORMER SECONDARIES:
   A. EFB-1-A1 GROUNDED TO INSTRUMENT GND. BUS.
   B. EFB-1-A2 GROUNDED TO PLANT GND GRID.
3. ALL STRUCTURES GROUNDED TO PLANT GND GRID.
4. FEEDER CABLE SIZES:

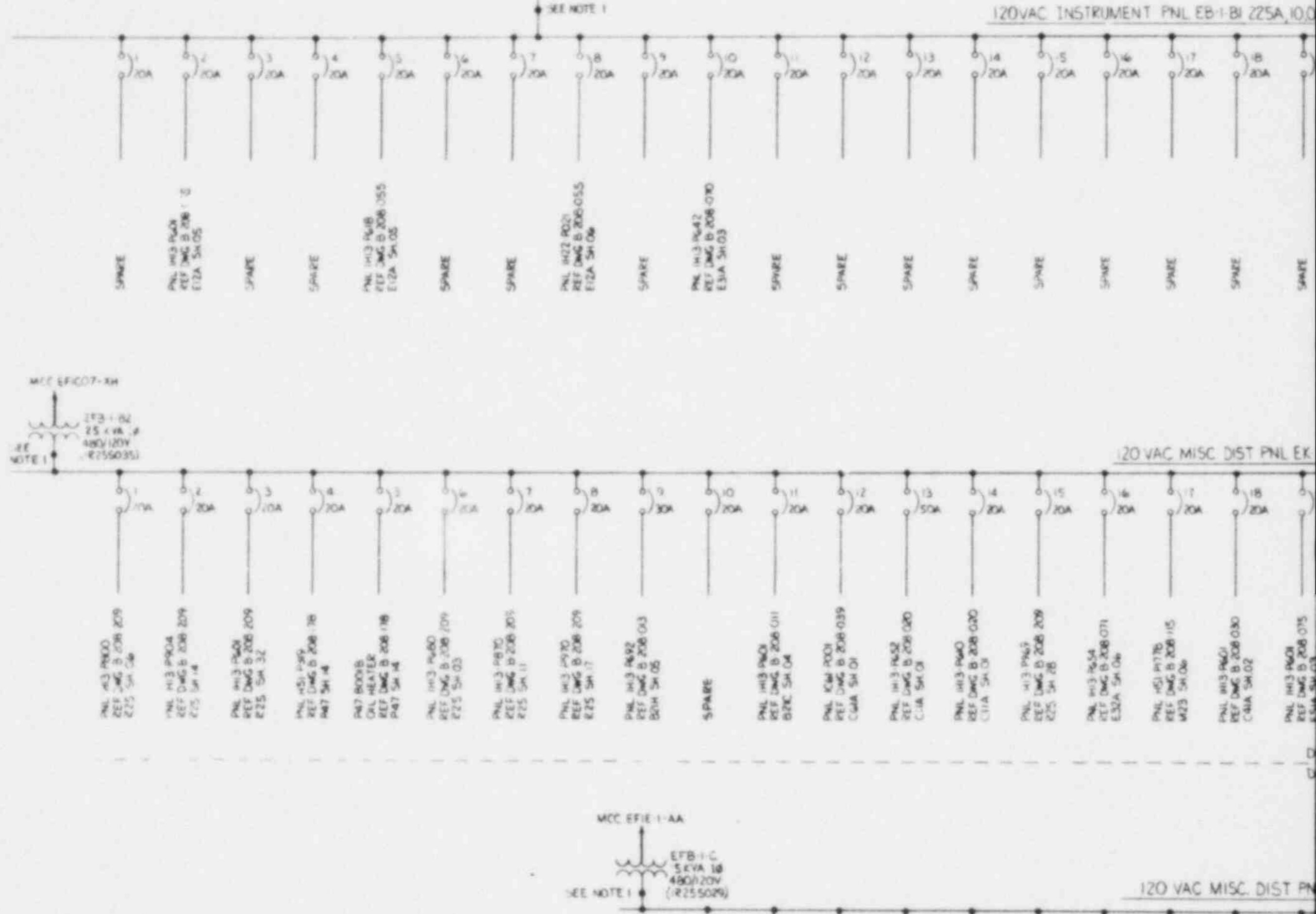
BRKR SIZE	WIRE SIZE IF RUN ENTIRELY IN CONDUIT	WIRE SIZE IF RUN ENTIRELY OR PARTIALLY IN TRAY
20A	#12	#10
30A	#10	#8
50A	#8	#4

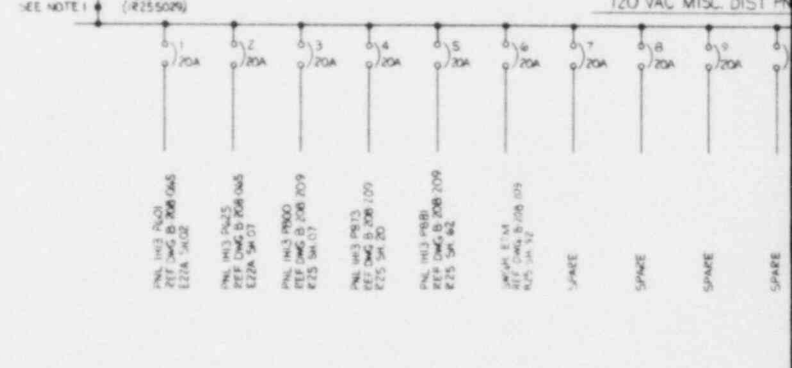


PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC
ILLUMINATING COMPANY

One Line Diagram, Class 1E,
120 Volts A-C,
Division 1, Unit 1

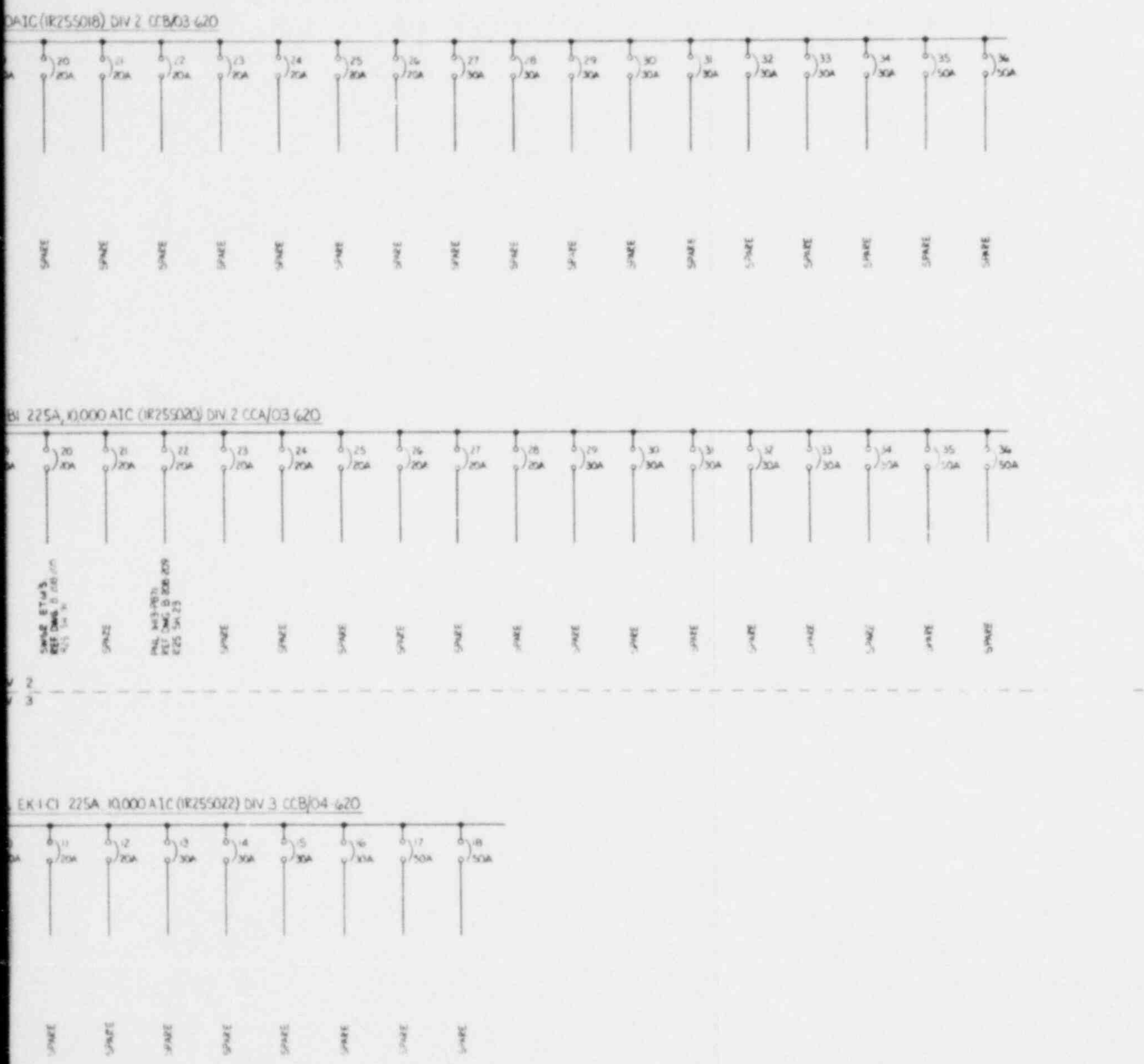
Figure 8.3-12





NOTES:

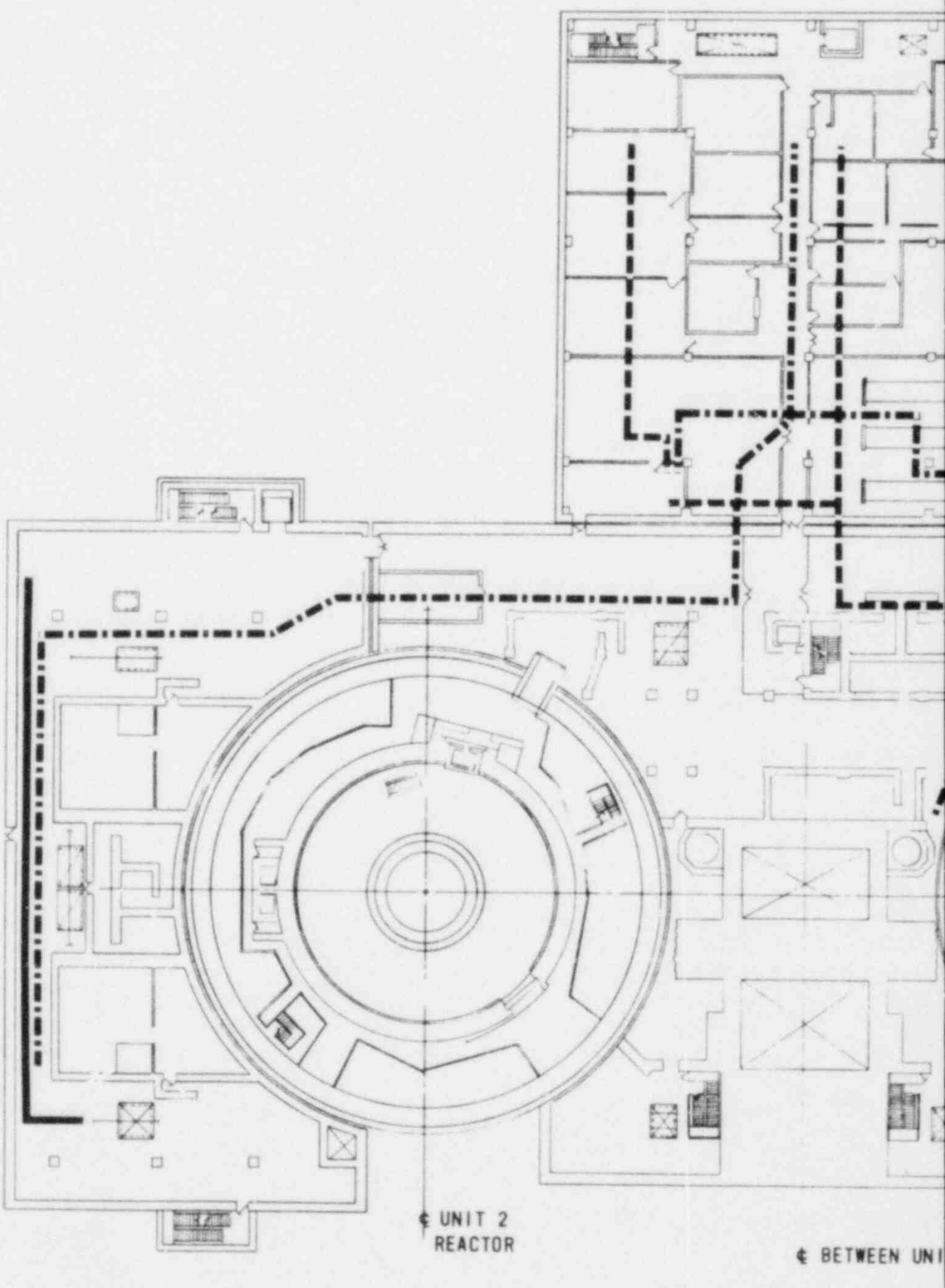
1. EACH DISTRIBUTION PANEL AND TRANSFORMER IS MOUNTED INSIDE THEIR RESPECTIVE MCC. CABLE INSTALLED BY MCC SUPPLIER.
2. NEUTRAL GROUNDED AT TRANSFORMER SECONDARIES:
   A. EFB-1-B1 GROUNDED TO INSTRUMENT GND BUS.
   B. EFB-1-B2, EFB-1-C GROUNDED TO PLANT GND GRID.
3. ALL STRUCTURES GROUNDED TO PLANT GND GRID.
4. FOR FEEDER CABLE SIZES REFER TO DWG [illegible] NOTE 4.



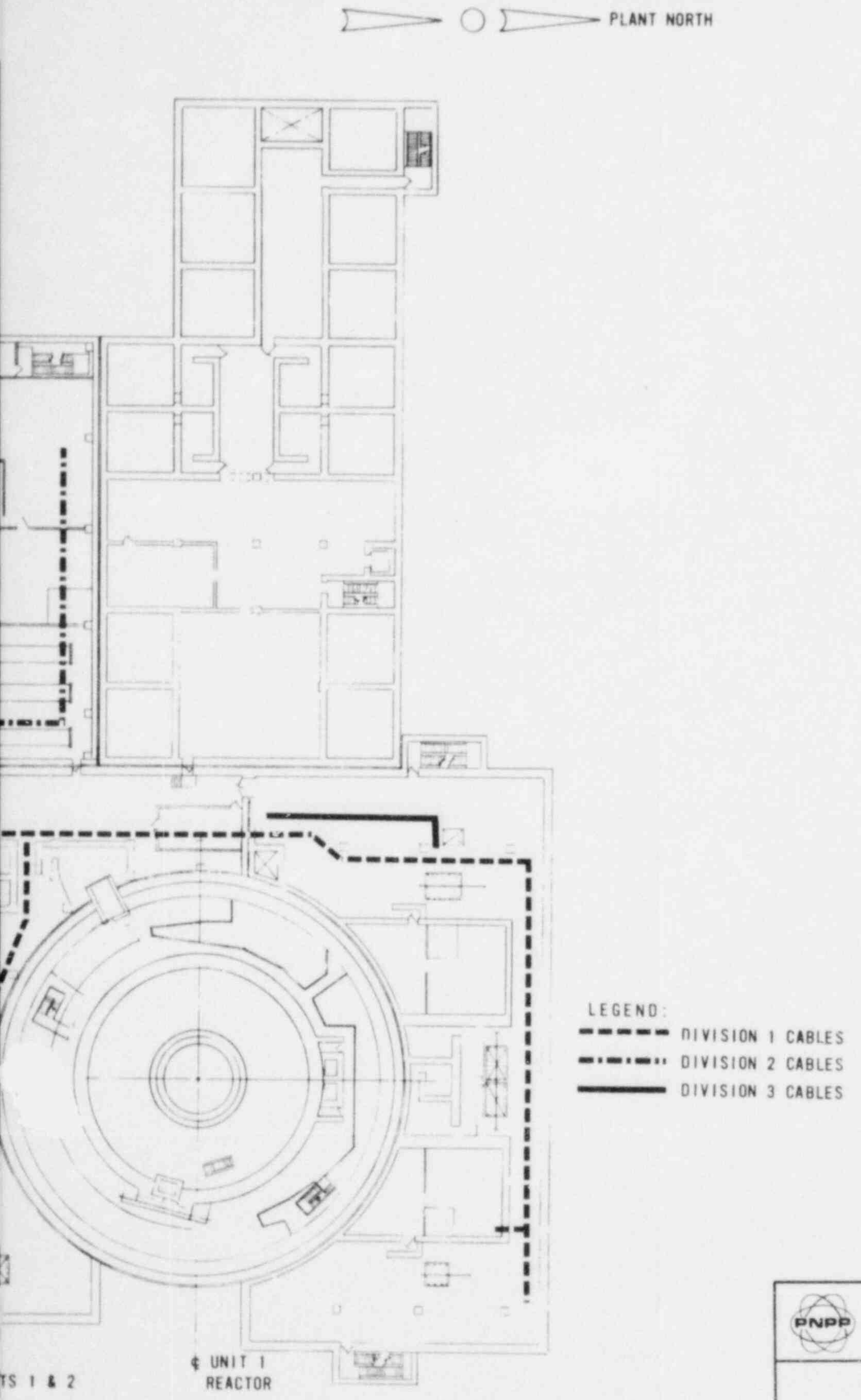
PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC
ILLUMINATING COMPANY

One Line Diagram, Class 1E
120 Volts A-C,
Divisions 2 & 3, Unit 1

Figure 8.3-13



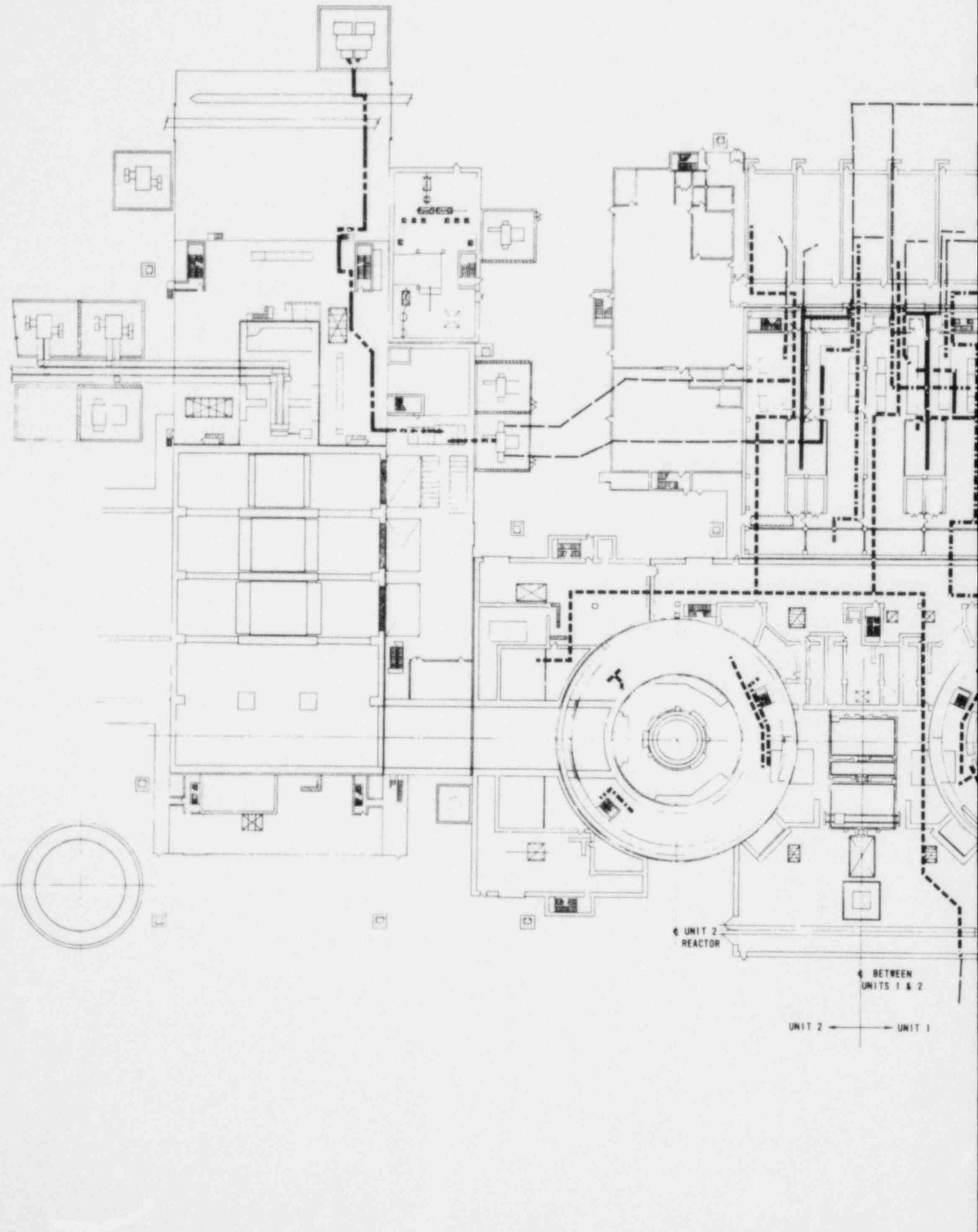
¢ UNIT 2
REACTOR
¢ BETWEEN UNI
UNIT 2
UNIT



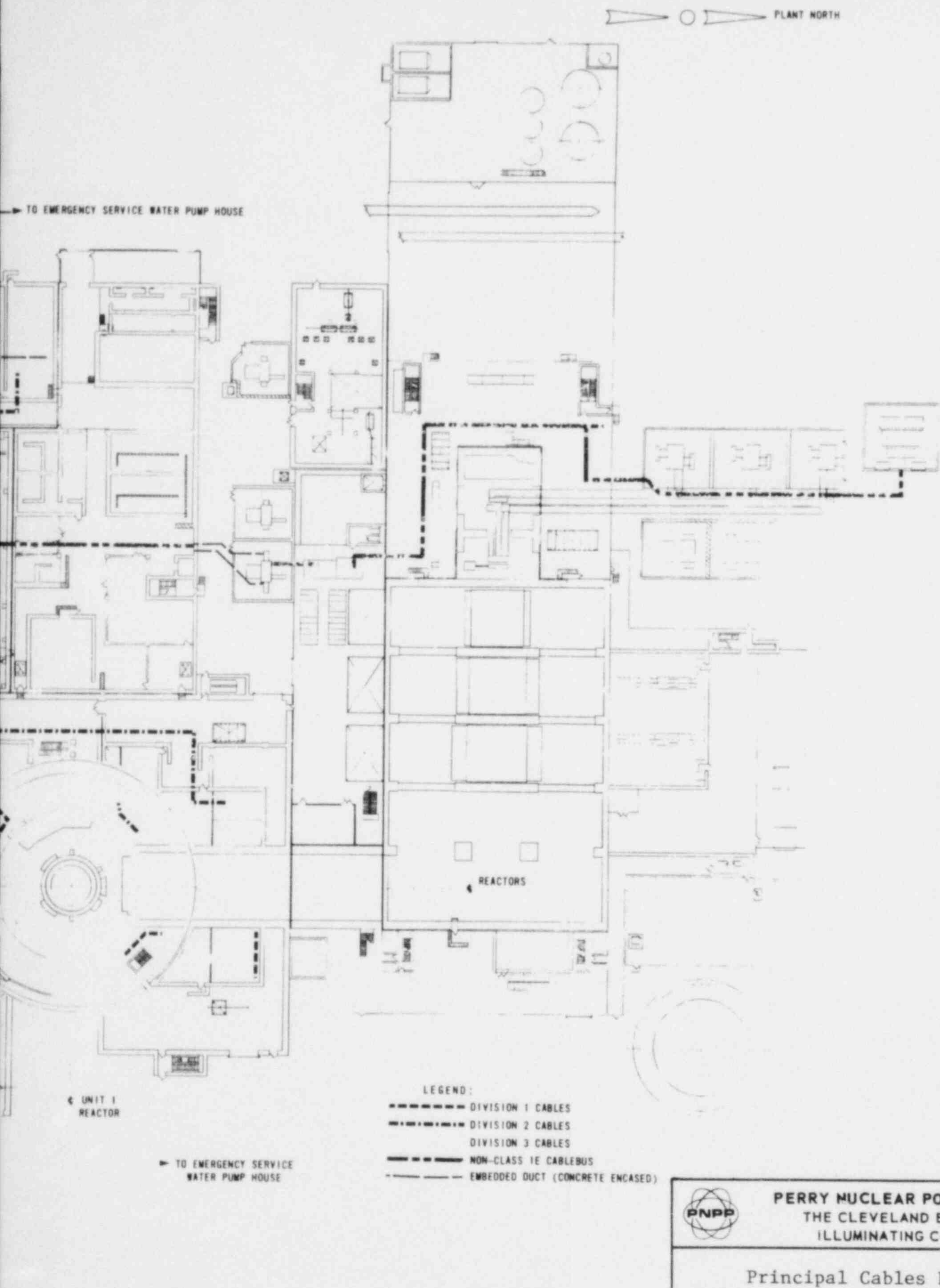
PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC
ILLUMINATING COMPANY

Principal Cable Routes
Above El. 599'-0"

Figure 8.3-14



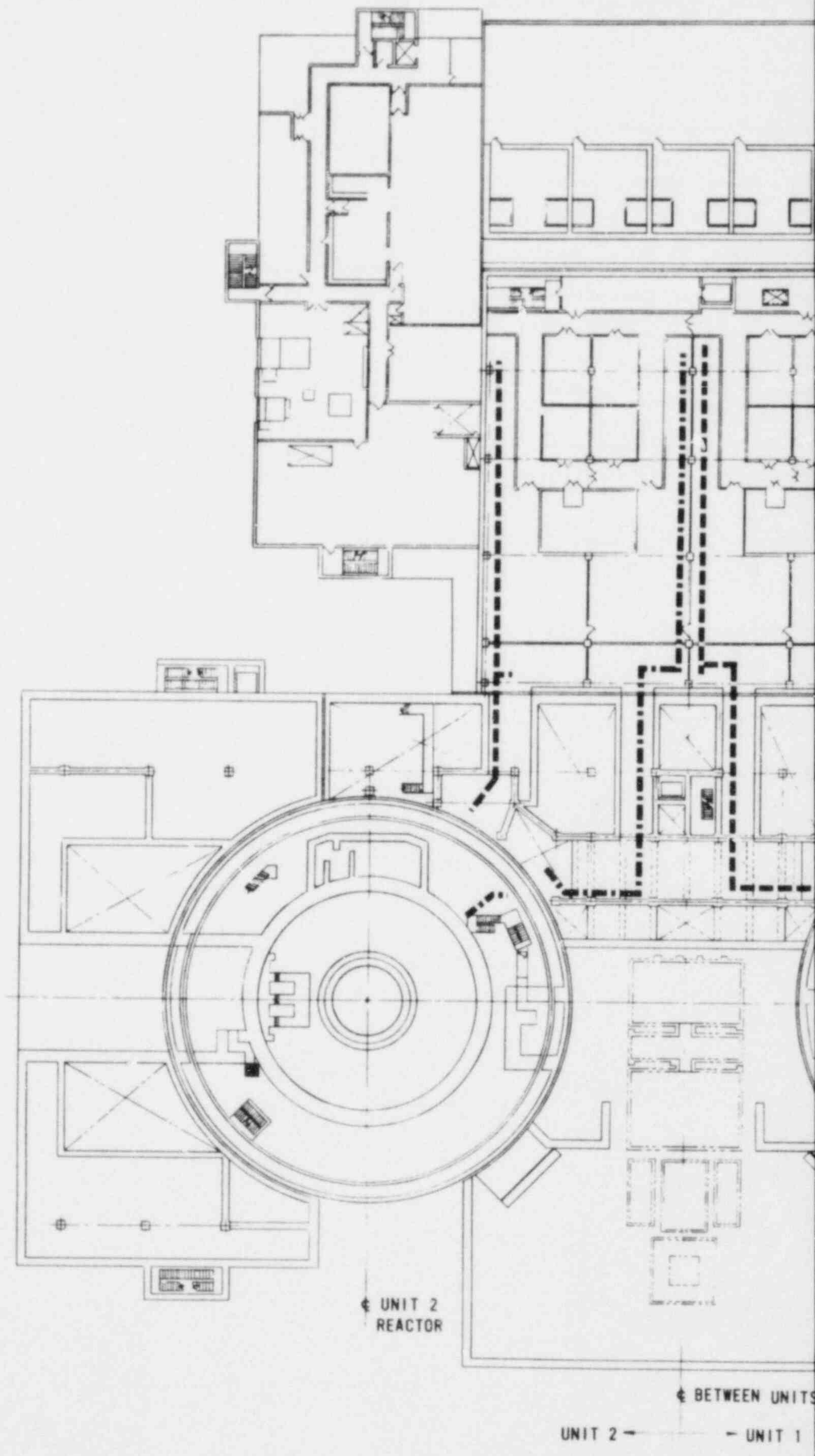
℄ UNIT 2
REACTOR
℄ BETWEEN
UNITS 1 & 2
UNIT 2
UNIT 1



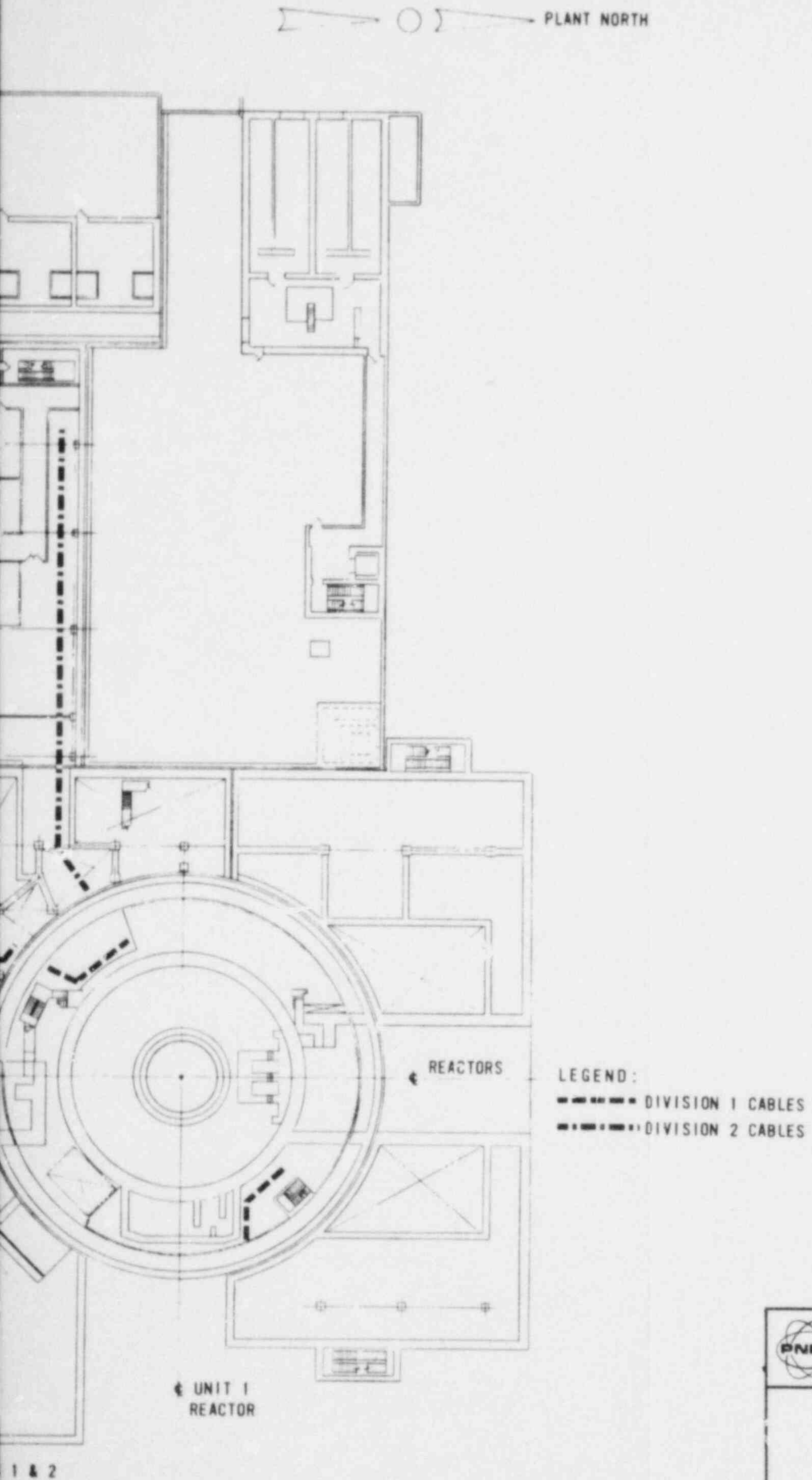
PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

Principal Cables Routes
Above El. 620'-6"

Figure 8.3-15



℄ UNIT 2
REACTOR
℄ BETWEEN UNITS
UNIT 2
UNIT 1



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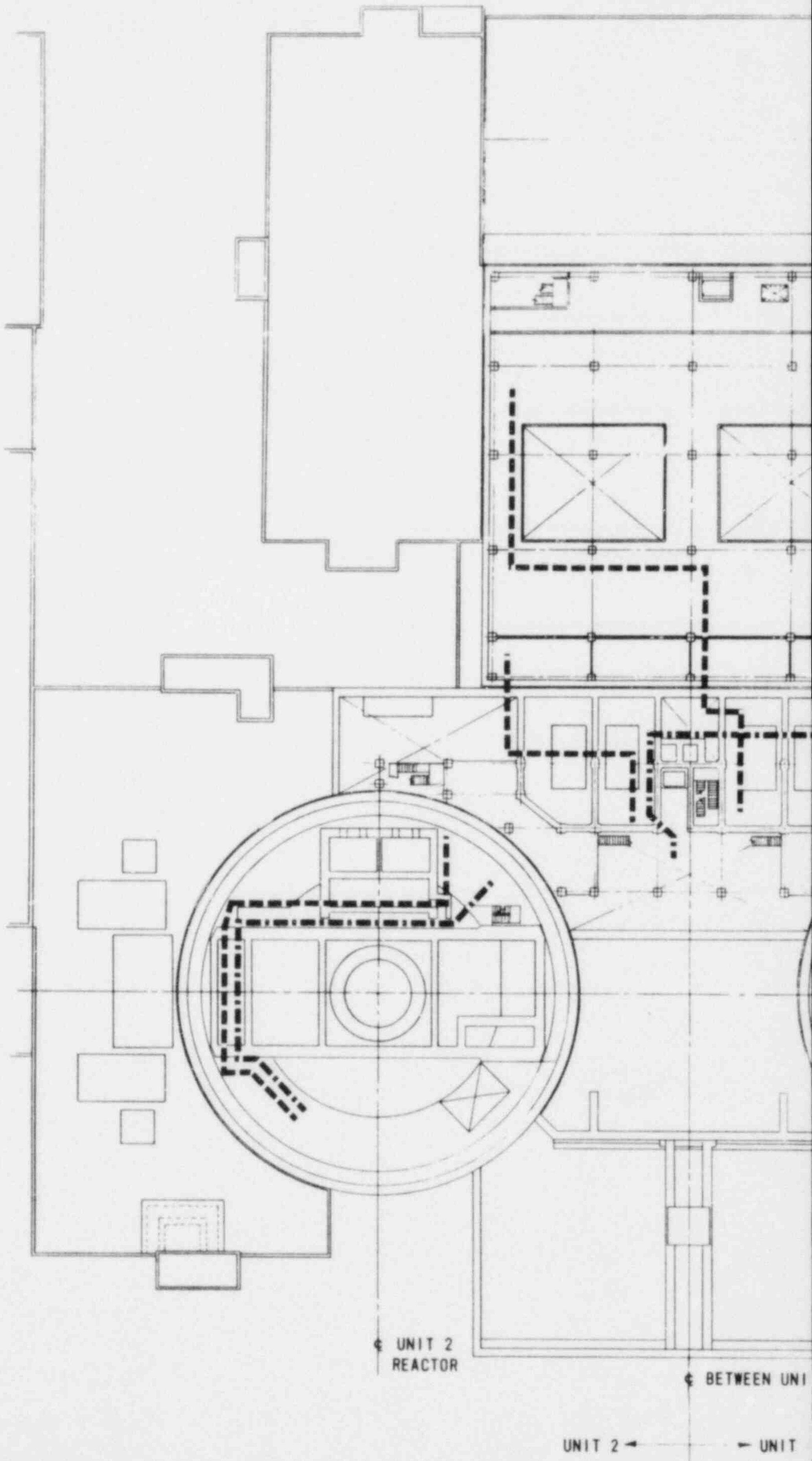
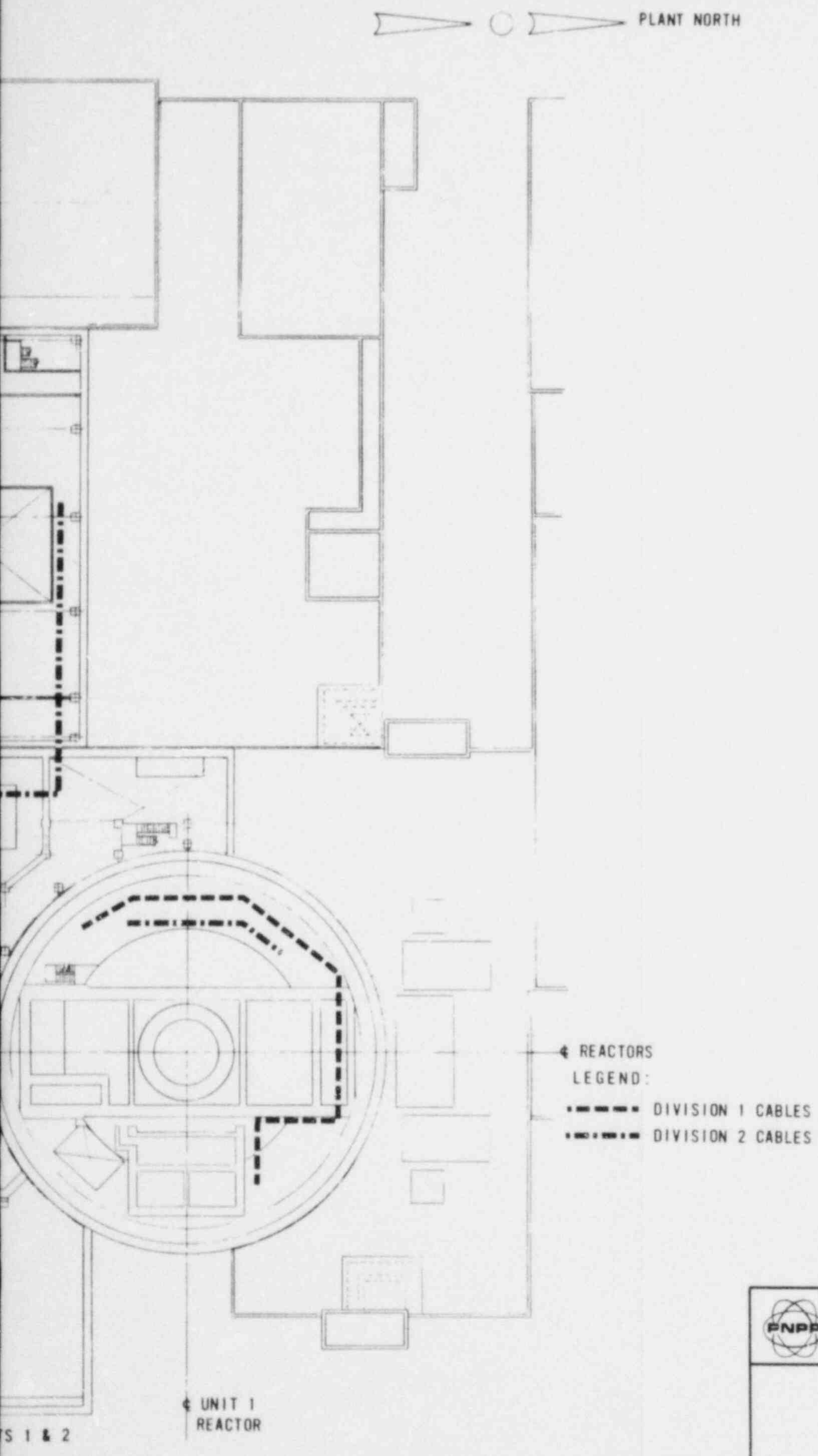
PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC
ILLUMINATING COMPANY

Principal Cables Routes
Above El. 638'-6"

Figure 8.3-16



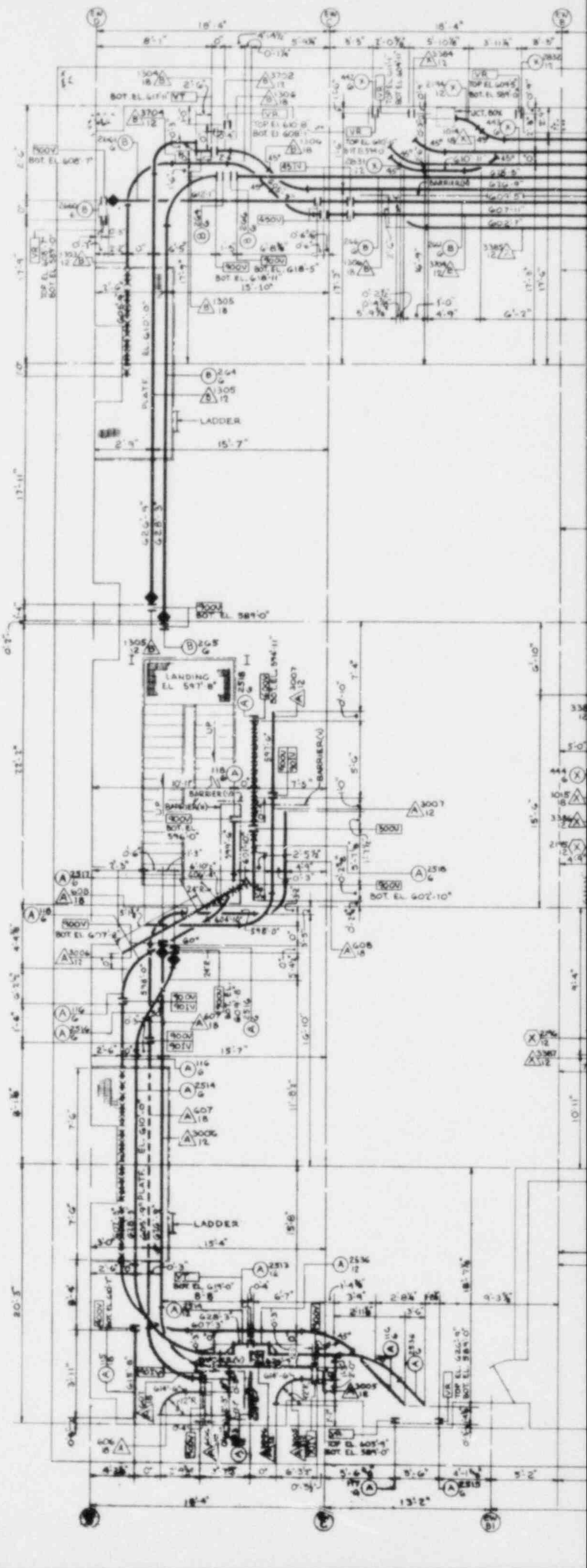
¢ UNIT 2
REACTOR
¢ BETWEEN UNI
UNIT 2
UNIT



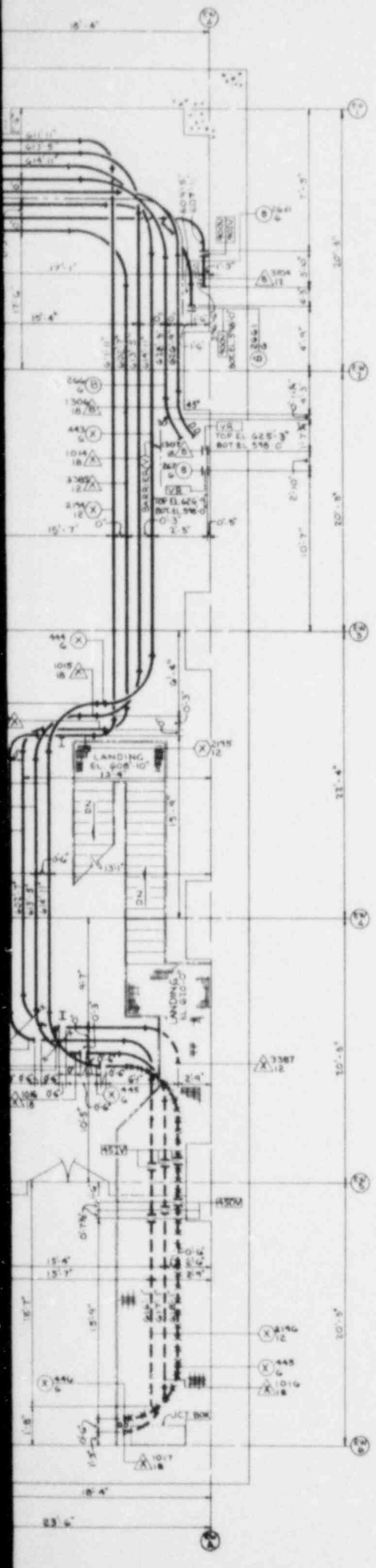
PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC
ILLUMINATING COMPANY

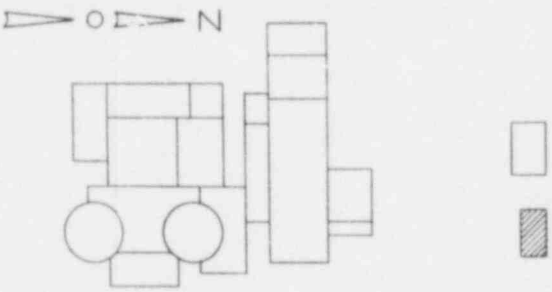
Principal Cables Routes
Above El. 679'-6"

Figure 8.3-17



LADDER
LANDING
EL 597'-8"
LADDER





KEY PLAN

NOTES:

1. X DESIGNATIONS INDICATE NON 1E RACEWAYS.
2. A DESIGNATIONS INDICATE CLASS 1E DIV 1 RACEWAYS.
3. B DESIGNATIONS INDICATE CLASS 1E DIV 2 RACEWAYS.
4. CABLES FOR CLASS 1E DIV 3 CIRCUITS ARE ROUTED VIA EMBEDDED RACEWAYS.

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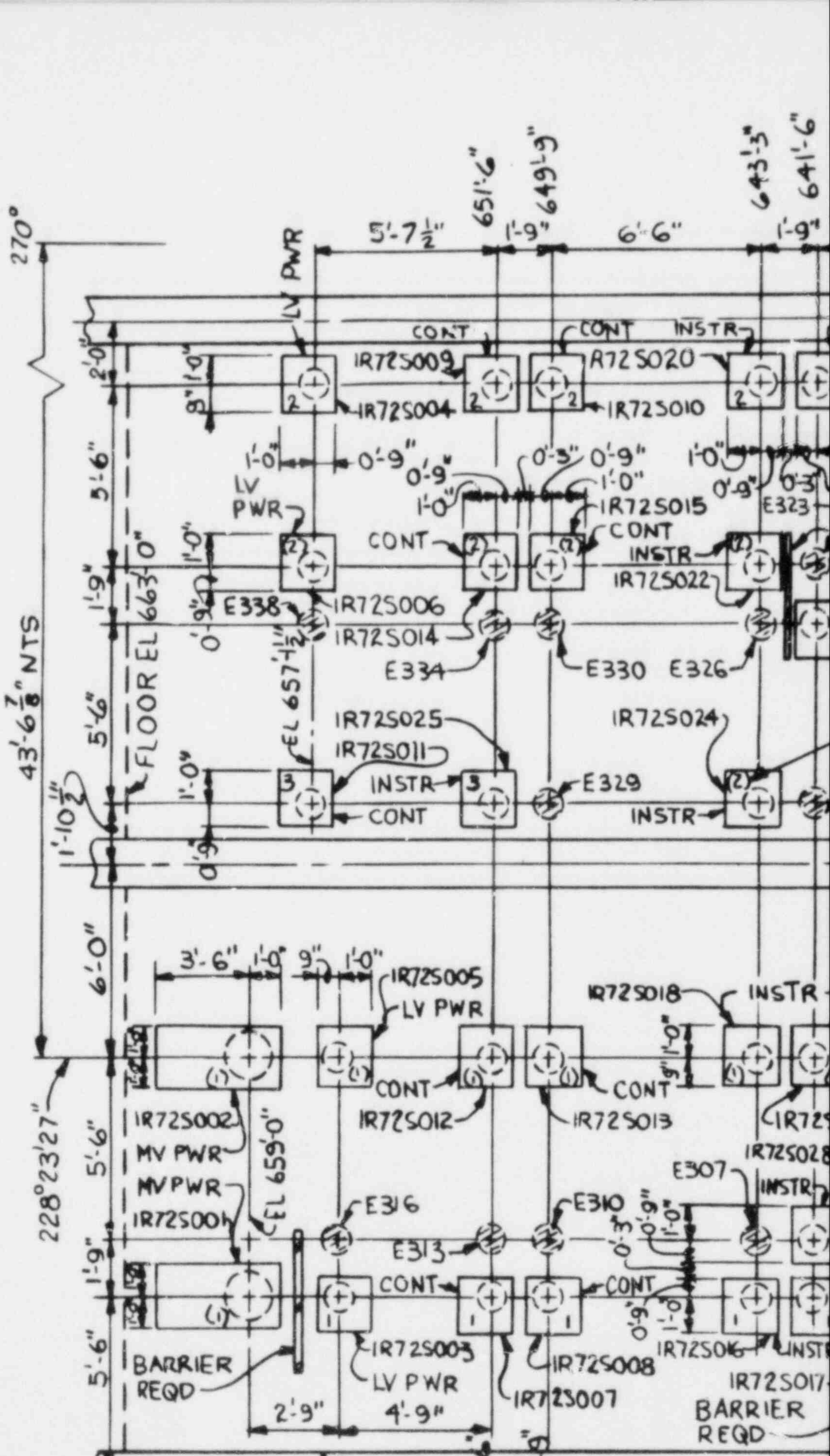
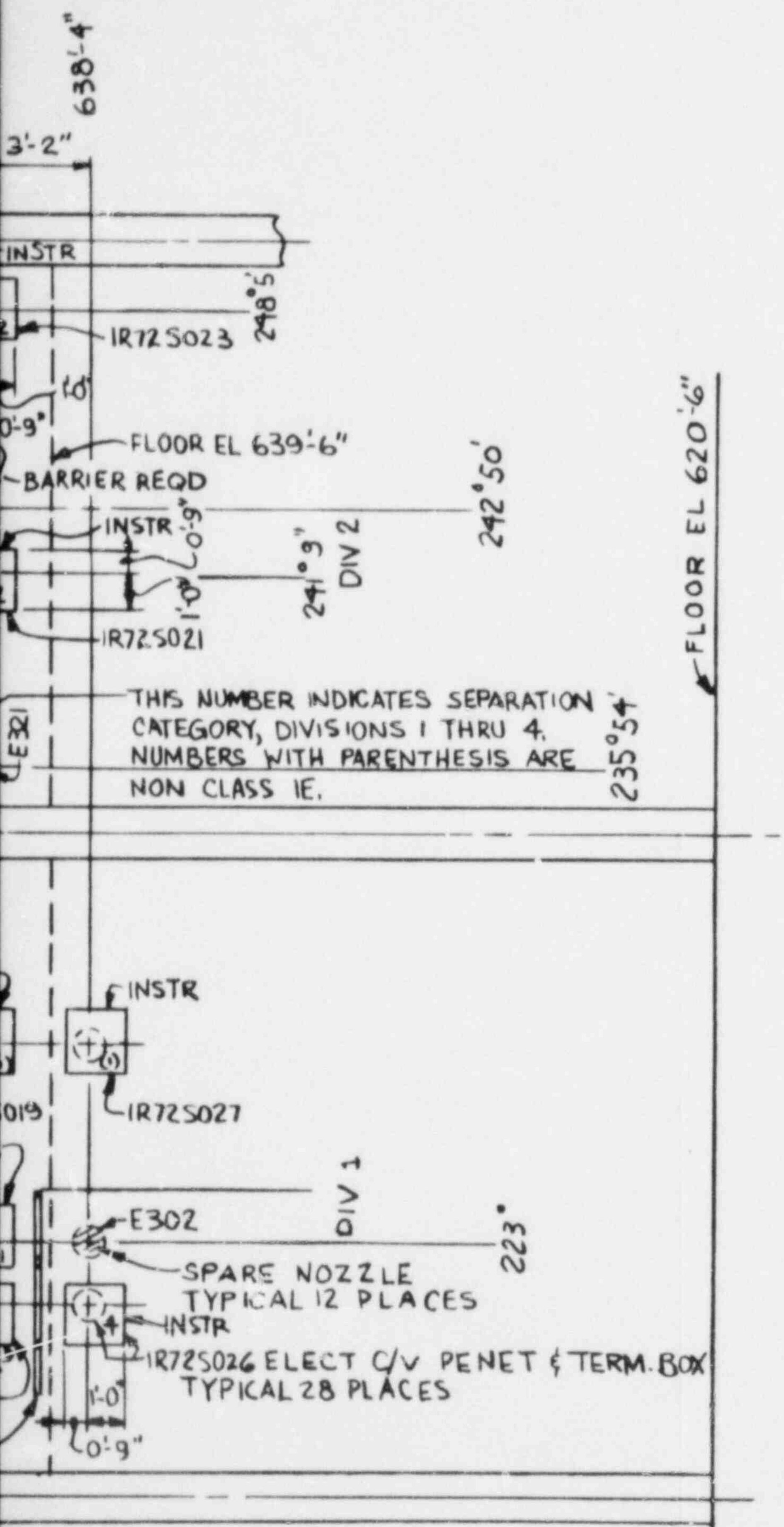
PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

Principal Cables Routes
ESW Pumphouse Above El. 586'-6"

Figure 8.3-18



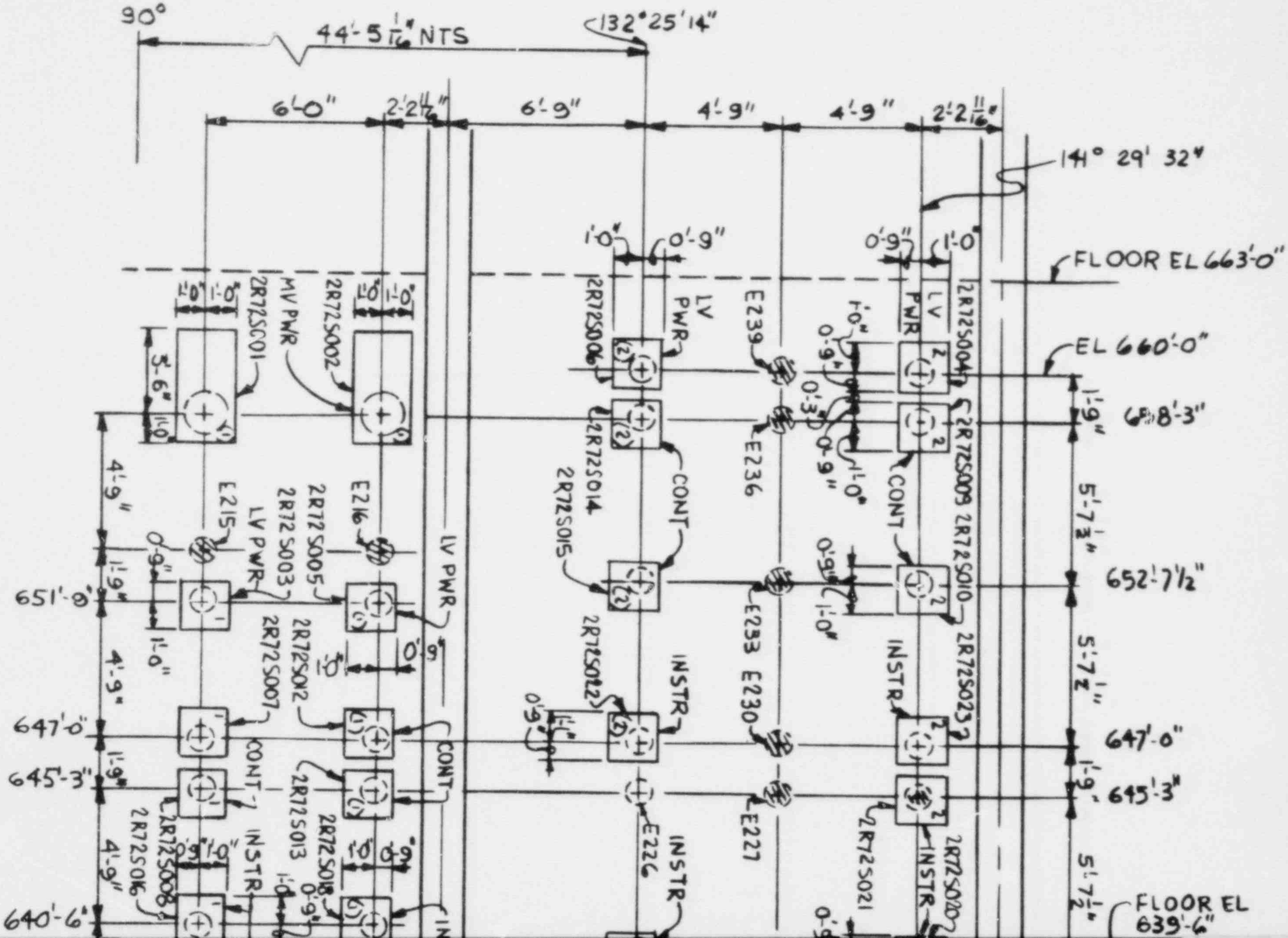
270°
43'-6 7/8" NTS
228°23'27"
FLOOR EL 663'-0"
EL 657'-1 1/2"
EL 659'-0"
5'-7 1/2"
651'-6"
649'-9"
1'-9"
6'-6"
643'-3"
641'-6"
LV PWR
CONT
INSTR
IR72S009
IR72S004
R72S020
IR72S010
IR72S015
IR72S022
IR72S006
IR72S014
E338
E334
E330
E326
E323
IR72S025
IR72S011
IR72S024
E329
IR72S005
IR72S018
IR72S002
MV PWR
IR72S001
IR72S012
IR72S013
IR72S028
E307
E316
E313
E310
IR72S003
IR72S008
IR72S007
IR72S016
IR72S017
BARRIER REQD
2'-9"
4'-9"
3'-6"
1'-0"
9"
5'-6"
6'-0"
2'-0"
1'-10 1/2"
659
656'-3"
651'-6"
649'-9"



PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

Containment Vessel Penetration Locations Protective Enclosure Spatial Layout Viewed from Inside Unit 1 Containment Vessel

Figure 8.3-19



90°
44'-5 1/16" NTS
132°25'14"
14° 29' 32"
FLOOR EL 663'-0"
EL 660'-0"
658'-3"
652'-7 1/2"
647'-0"
645'-3"
FLOOR EL 639'-6"
651'-9"
640'-6"
6'-0"
2'-2 1/4"
6'-9"
4'-9"
2'-2 11/16"
1'-9"
5'-7 1/2"
3'-6"
LV PWR
MV PWR
CONT
INSTR
2R72S001
2R72S002
2R72S003
2R72S004
2R72S005
2R72S006
2R72S007
2R72S008
2R72S009
2R72S010
2R72S012
2R72S013
2R72S014
2R72S015
2R72S016
2R72S018
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E215
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E226
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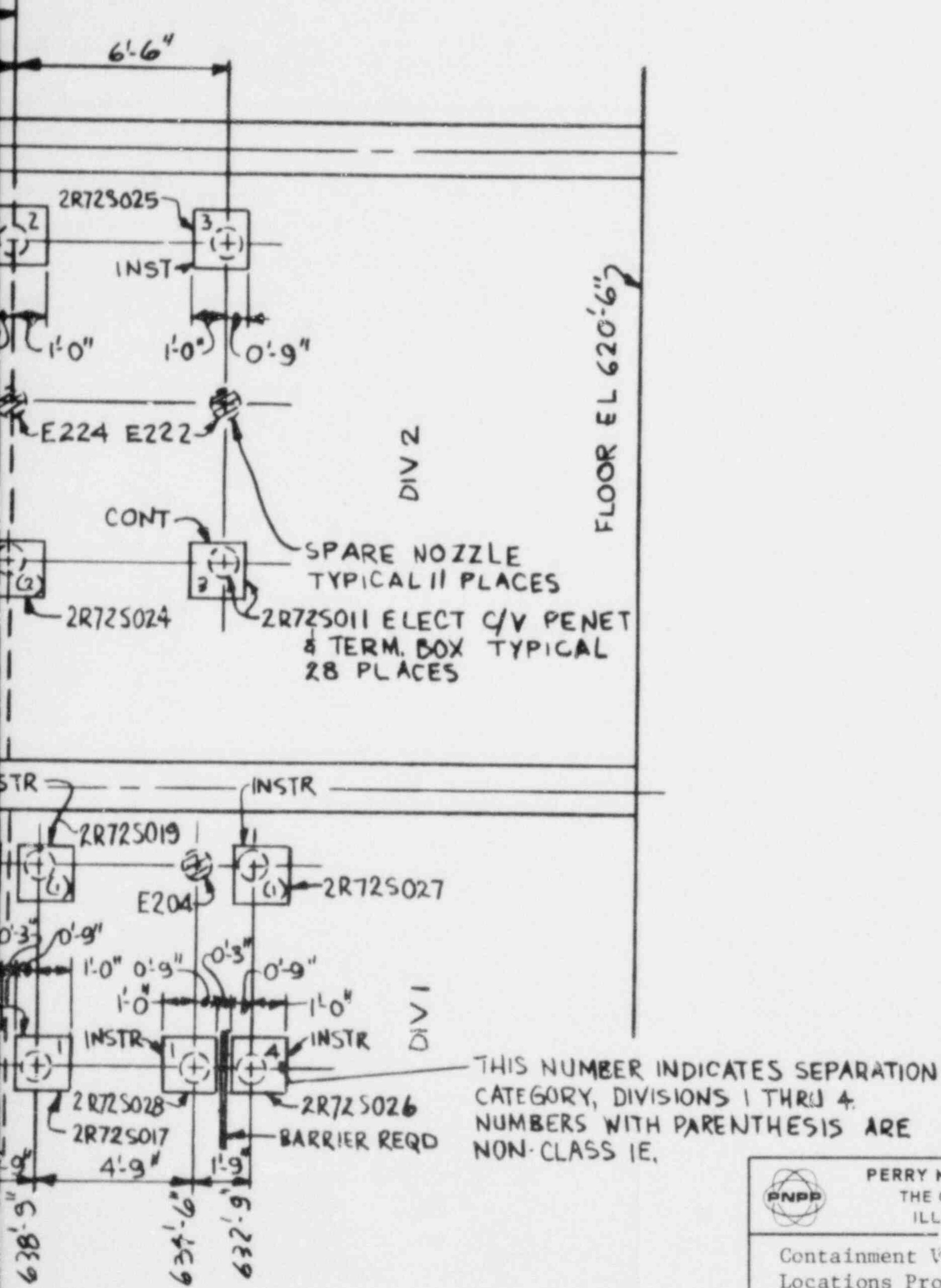
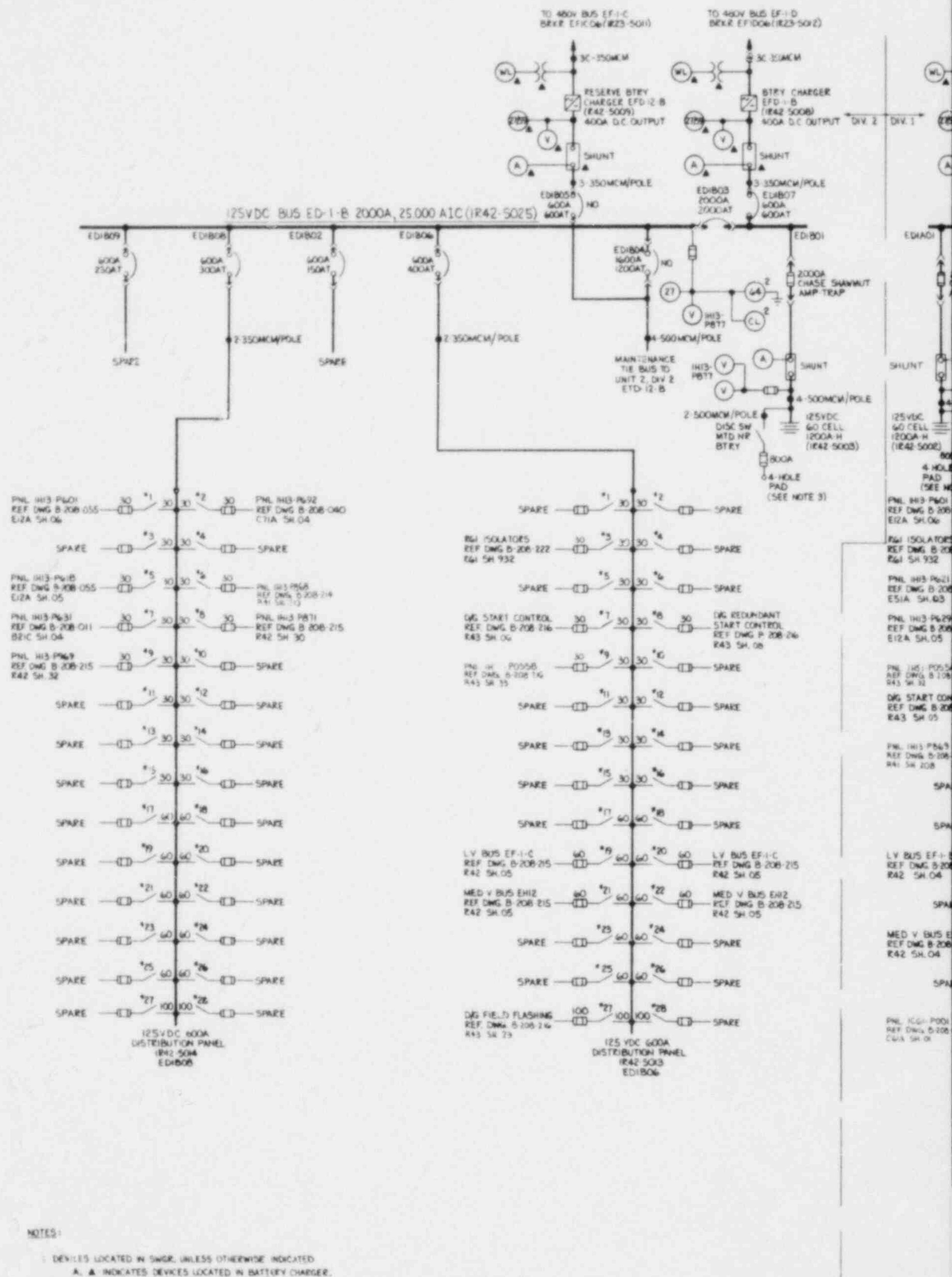
E230
E233
E236
E239



PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC
ILLUMINATING COMPANY

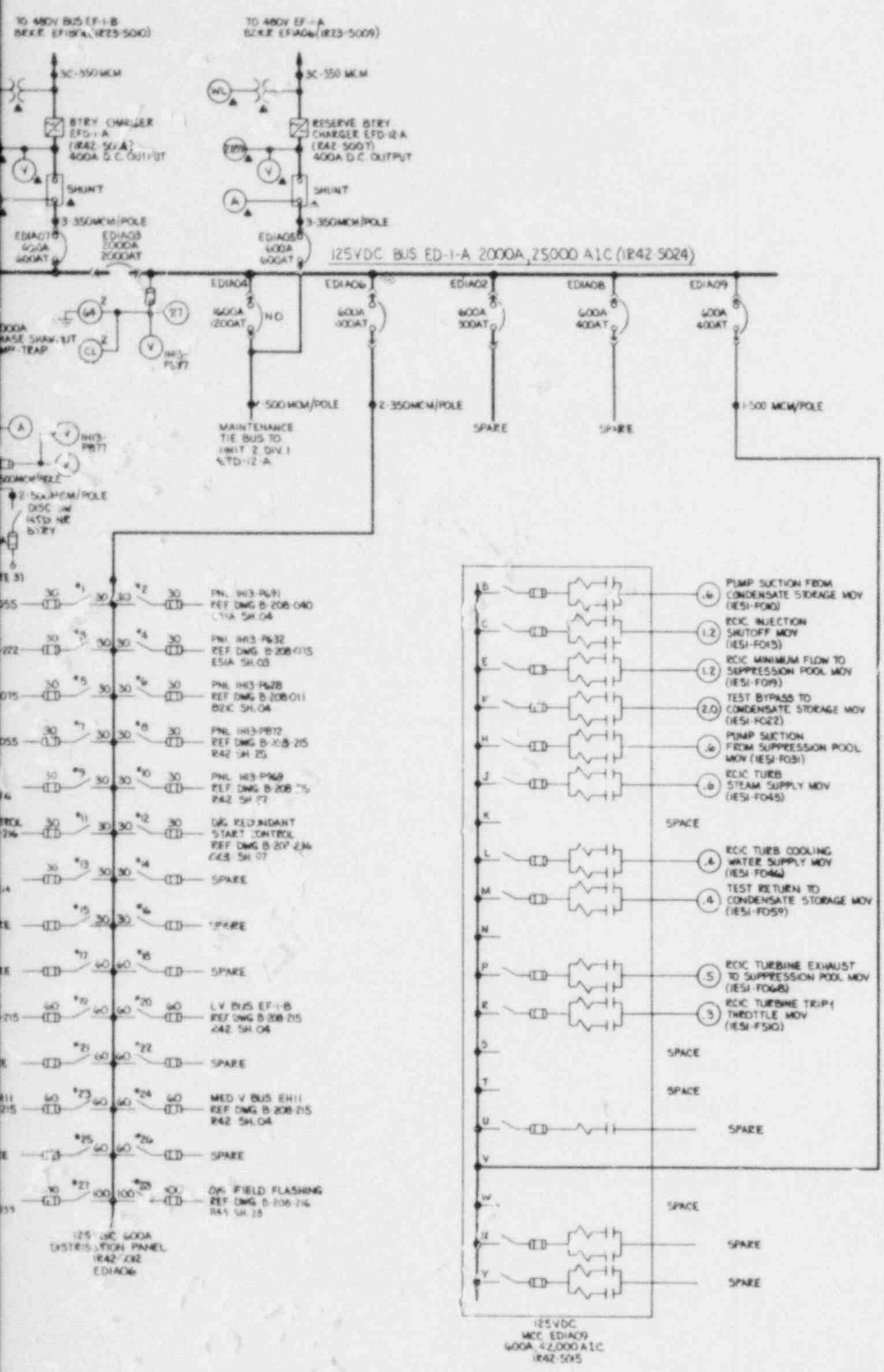
Containment Vessel Penetration Locations Protective Enclosure Spatial Layout Viewed from Inside Unit 2 Containment Vessel

Figure 8.3-20



NOTES:

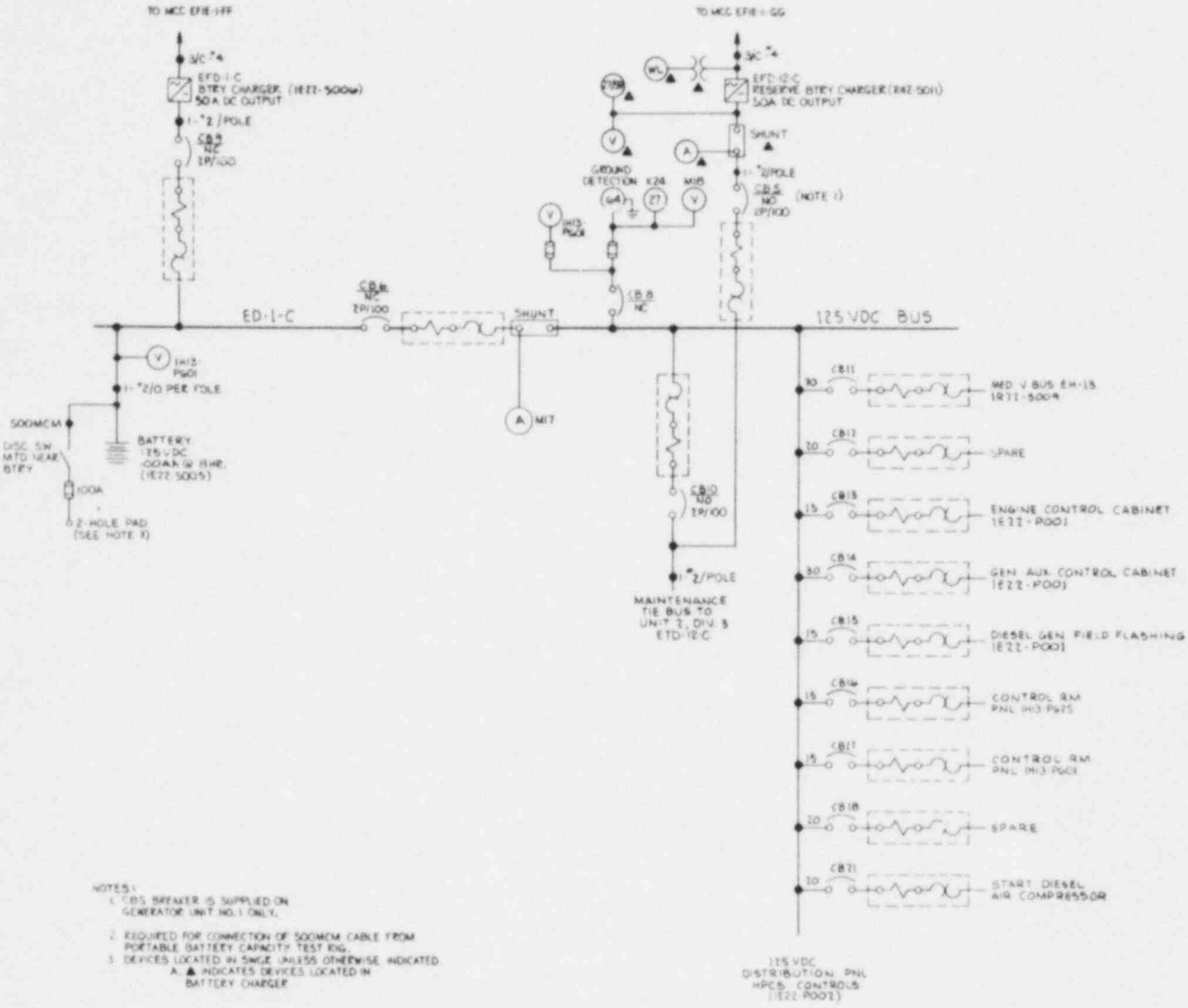
1. DEVICES LOCATED IN SWGR. UNLESS OTHERWISE INDICATED
   A, ▲ INDICATES DEVICES LOCATED IN BATTERY CHARGER.
2. REQUIRED FOR CONNECTION OF 2 500MCM CABLES FROM PORTABLE BATTERY CAPACITY TEST RIG.



PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

One Line Meter and Relay Diagram, Class 1E, 125 Volts D-C, Divisions 1 & 2, Unit 1

Figure 8.3-21



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PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC
ILLUMINATING COMPANY

One Line Meter and Relay Diagram, Class 1E, 125 Volts D-C, Division 3, Unit 1

Figure 8.3-22