SECTION 8

ELECTRIC POWER

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ELECTRIC POWER

8.1 INTRODUCTION

The Electric Power System of the Hope Creek Generating Station (HCGS) is designed to generate and transmit electric power into the Pennsylvania-New Jersey-Maryland (PJM) power grid.

The offsite power for the plant is fed through the 500-kV system via the 13.8-kV yard ring bus. The 500-kV switchyard is connected to the 500-kV grid by three physically independent lines. There are two physically independent connections from the 500-kV switchyard to a 13.8-kV ring bus. Each connection supplies power to the 13.8-kV ring bus through two 500/14.4-kV station power transformers. The physical and operating arrangement of the breakers in the 500-kV switchyard and 13.8-kV ring bus is designed to minimize the possibility of simultaneous failure of the offsite power supplies. The Onsite AC Electric Power System consists of Class 1E and non-Class 1E power systems.

The 13.8-kV ring bus is the preferred source of auxiliary power during startup, normal operation, shutdown, and post-shutdown. In the event of loss of offsite power (LOP), four independent standby diesel generators (SDGs) provide the standby power for Class 1E loads and selected non-Class 1E loads important to the power generating equipment integrity. A non-Class 1E diesel generator provides power for security system and guardhouse emergency loads.

Onsite Class 1E and non-Class 1E dc systems supply dc power requirements of the plant.

8.1.1 Utility Power Grid and Offsite Power Systems

The generator unit uses a three single phase power transformer arrangement that steps up the voltage from 25 kV to 500 kV, which is then fed to the 500-kV switchyard. Breakers in the switchyard are arranged in a highly reliable breaker and a half design. Grid stability and availability is maximized because PSE&G is a member of the PJM interconnected network. There are three 500-kV sources to the HCGS switchyard, all of which are physically independent sources of offsite power to the HCGS unit. They are:

1. A tie of approximately 2112 feet between the HCGS and Salem switchyards.

2. A tie of approximately 42.9 miles to the New Freedom switching station.

3. A tie of approximately 22.1 miles to the Red Lion switching station.

The maximum winter capacity of each of these lines is 3500 MVA. The maximum summer capacity of each of these lines is 3220 MVA.

The 500-kV switchyard provides preferred power through its interconnections with two sets of two station power transformers, to the 13.8-kV ring bus as shown on Plant Drawing E-0001-0. Station power transformers T1 and T4 each supply two 13.8/4.16-kV and one 13.8/7.2-kV station service transformer. Station power transformers T2 and T3 each supply one 13.8/4.16-kV station service transformer, one 13.8 kV/208-120 V station lighting and power transformer and one 13.8/13.8 kV Island substation transformer. In the event a station power transformer is unavailable, alternate feed is made available to the affected buses.

The offsite power systems and their interconnections are described in Section 8.2.

8.1.2 Onsite Power Systems

The Onsite Power System for the unit consists of two major categories:

1. Class 1E power system - The Class 1E power system supplies Class 1E loads that are necessary for safe and orderly shutdown, for maintaining the plant in a safe shutdown condition, and for mitigating the consequences of an accident. A limited number of non-Class 1E loads important to the power generating equipment integrity are also supplied from the Class 1E power system. These non-Class 1E loads are listed in Table 8.3-1.

   The Class 1E power system consists of four independent channels A, B, C, and D, which provide power to their respective loads. Any combination of three out of four channels of Class 1E loads meets the design basis requirements for mitigation of a design basis accident (DBA).

   Electrical channel separation is shown in Table 8.1-1. Physical separation is discussed in Section 8.1.4.14. The Class 1E power system is shown on Plant Drawings E-0006-1, E-0009-1, E-0011-1, E-0012-1 and E-0018-1.

   The Class 1E ac power system distributes power at 4.16-kV, 480 V, and 208/120 V voltage levels. The Class 1E dc power system distributes power at 125 V and 250 V voltage levels.

   A detailed description of the onsite ac and dc power systems is found in Sections 8.3.1 and 8.3.2, respectively.

2. Non-Class 1E power system - The non-Class 1E ac portion of the Onsite Power System supplies electric power to

nonsafety-related plant auxiliary loads. The non-Class 1E ac system distributes power at the 7.2-kV, 4.16-kV, 480-V, and 208/120 V voltage levels. The non-Class 1E dc system distributes power at 250 V, 125 V, and ±24 V voltage levels.

8.1.2.1 Safety-Related Loads

Loads supplied from the Class 1E ac power system are shown on Plant Drawings E-0006-1, E-0012-1 and E-0018-1. Class 1E loads supplied by the Class 1E dc system are shown in Plant Drawings E-0009-1 and E-0011-1.

8.1.3 Design Bases

The following design bases are applied to the design of the Onsite and Offsite Power Systems:

1. Offsite Power System

    a. Three physically independent 500-kV lines from the grid network supply offsite power through the 500-kV switchyard via the 13.8-kV yard ring bus. These three ties are connected to different sections of the switchyard. The 500-kV bus sections 10X and 20X connect different sections of the 13.8-kV ring bus through two sets of two station power transformers. The physical independence of the connections in the 500-kV switchyard and 13.8-kV ring bus for alternate sources of offsite power minimizes the likelihood of simultaneous failure of these sources.

    b. The loss of the Hope Creek unit or the loss of the most critical unit on the power grid or the MAAC criteria contained in Section 8.2.2 does not result in LOP.

2. Onsite power system

a. The 500-kV system supplies the preferred power for the plant via the 13.8-kV yard ring bus. This supplies both Class 1E and non-Class 1E loads during plant startup, normal operation, shutdown, and post-shutdown.

b. The Onsite Class 1E Power System is divided into four independent channels. Each channel supplies power to its dedicated load group. Any three out of the four load groups A, B, C, and D can shut down the unit safely and maintain the plant in a safe shutdown condition. Each channel consists of independent 4.16-kV, 480 V, and 208/120 V ac and 125 V dc power supplies. There are also two 250 V dc systems, one associated with Channel A and the other with Channel B.

c. The non-Class 1E power includes 7.2-kV, 4.16-kV, 480 V, and 208/120 V ac and 250 V dc, 125 V dc, and ±24 V dc systems.

d. Class 1E and non-Class 1E cables do not share raceways. The non-1E circuits that become associated circuits will be treated as Class 1E circuits for separation and isolation purposes.

e. Associated cables comply with Regulatory Guide 1.75.

f. Criteria for identifying Class 1E equipment, cables, and raceways are described in Section 8.1.4.14.2.

g. Section 8.1.4.14.2 describes the separation criteria established to preserve the independence of redundant Class 1E systems. This section also gives the

criteria for separating Class 1E and non-Class 1E equipment and electrical circuitry.

h. Class 1E electrical equipment and systems are designed with the capability of periodic testing in accordance with Regulatory Guide 1.118.

i. Automatic or manual transfers are not provided between any redundant load groups.

8.1.4 Conformance with Regulatory Guides

Codes and standards applicable to the Onsite Power System are listed in Table 3.2-1. The design of the Onsite Power System complies with the requirements of General Design Criteria 2, 4, 17, 18, and 50 as discussed in Section 3.1. In addition, conformance with General Design Criteria (GDC) 17 and 18 of 10CFR50, Appendix A, is discussed in Sections 8.2.1, 8.3.1.2, and 8.3.2.2 and conformance with GDC 50 is demonstrated by compliance with Regulatory Guide 1.63 as discussed in Sections 1.8.1.63 and 8.1.4.12.

Conformance with Regulatory Guides 1.6, 1.9, 1.22, 1.29, 1.30, 1.32, 1.40, 1.41, 1.47, 1.53, 1.62, 1.63, 1.73, 1.75, 1.81, 1.89, 1.93, 1.100, 1.106, 1.108, 1.118, 1.128, 1.129, and 1.131 is discussed in the following paragraphs.

Conformance with Branch Technical Position (BTP) is discussed in Section 8.1.7.

8.1.4.1 Regulatory Guide 1.6, Independence Between Redundant Standby (Onsite) Power Sources and Between Their Distribution Systems, March 1971

The design of the Standby Power System is in conformance with Regulatory Guide 1.6 as discussed in Section 1.8 and as clarified below.

The Standby Power System consists of four electrically independent channels. Safety-related loads are divided among these four channels so that loss of any one channel does not prevent the safety functions from being performed. Each channel includes standby ac and dc power sources. These power sources feed their dedicated channel power systems. The ac loads of each channel have connections to two independent offsite power supplies and a single independent standby diesel generator (SDG). Connections of these three sources are made at 4.16-kV buses. The incoming feeder breakers and SDG breaker to the 4.16-kV bus of each channel are interlocked so that only one of the power supplies can be connected to the bus at any one time, except during the SDG load test. The SDG is synchronized to one of the offsite power sources during its load test. Only one SDG is tested at a time.

Each SDG is connected exclusively to its dedicated power system channel. As there are no interconnections in the redundant power system, the SDG of one channel can not be paralleled, either manually or automatically, with the SDG of another channel.

No provision exists for either automatic or manual transfer of loads between redundant load groups.

The dc power system for each of the four load groups consists of an independent battery and battery charger/chargers. The battery chargers are fed from their corresponding channel motor control centers. There is no provision for transferring load from one dc power channel to the other.

In addition to the 125 V dc systems, there are two independent 250 V dc power systems for the unit. One system supplies dc power to the High Pressure Coolant Injection (HPCI) System, channel A. The second system supplies dc power to the Reactor Core Isolation Cooling (RCIC) System, channel B. Physical separation of Class 1E equipment is discussed in Section 8.1.4.14.

8.1.4.2 Regulatory Guide 1.9, Selection, Design, and Qualification of Diesel Generator Units Used as Standby (Onsite) Electric Power Systems at Nuclear Power Plants, December 1979

The design of the diesel generator used as a standby electric power source for HCGS is in compliance with Regulatory Guide 1.9, Revision 2. Exceptions and clarifications are noted in Section 1.8.

8.1.4.3 Regulatory Guide 1.22, Periodic Testing of Protection System Actuation Functions, February 1972

HCGS complies with Regulatory Guide 1.22 as discussed in Section 1.8.

8.1.4.4 Regulatory Guide 1.29, Seismic Design Classification, September 1978

The structures housing electrical equipment, systems, and components of this plant are in compliance with the requirements of Regulatory Guide 1.29, Revision 3, as clarified in Section 1.8.

8.1.4.5 Regulatory Guide 1.30, Quality Assurance Requirements for the Installation, Inspection, and Testing of Instrumentation and Electrical Equipment, August 1972

HCGS complies with Regulatory Guide 1.30 as discussed in Section 1.8.

The guidelines of ANSI Standard N45.2.4-1972 (IEEE 336-1971), as endorsed by this Regulatory Guide, have been met by the quality assurance (QA) program for the installation of safety-related items as referenced in the constructor's QA procedures.

8.1.4.6 Regulatory Guide 1.32, Criteria for Safety-Related Electric Power Systems for Nuclear Power Plants, February 1977

HCGS complies with Regulatory Guide 1.32. Clarifications and exceptions are noted in Section 1.8.

All safety-related electric systems are in compliance with Regulatory Guide 1.32, Revision 2, except as it refers to Regulatory Guides 1.9 and 1.75, which are discussed in Section 1.8.

Sections 8.2, 8.3.1, and 8.3.2 discuss offsite, and onsite ac and dc power systems, respectively, in the context of Regulatory Guide 1.32.

IEEE 308-1974, IEEE Standard Criteria for Class 1E Power Systems for Nuclear Power Generating Stations, is endorsed by Regulatory Guide 1.32, Revision 2, with certain qualifications discussed in the following paragraphs.

Controls and indicators for the Class 1E 4.16-kV bus supply breakers are provided in the control room and on the switchgear. Controls and indicators for the standby ac power supplies are also provided in the main control room, remote SDG control panel, and local SDG control panel. Control and indication for the standby power system is described in Section 8.1.5.

The HCGS design includes control and indication provisions for switching Class 1E buses between the preferred (offsite) and standby power in and outside the main control room. The control and indication locations outside the main control room are the 4.16 kV switchgear for offsite power supply circuit breakers, and the 4.16 kV switchgear and standby diesel generators (SDG) remote control panel. This is shown on single meter and relay diagram (Plant Drawing E-0006-1) and single line synchronizing diagram (Plant Drawing E-0007-1).

The design, operating, and maintenance documents related to Class 1E equipment are distinctly identified by marking or labeling those documents either "Q" or "nuclear safety-related." The numbering system of specifications and vendor-supplied drawings has a "Q" designation.

Class 1E equipment is qualified by analysis, and by successful use under required conditions or by actual testing to demonstrate its ability to perform its functions during applicable design basis accidents (DBAs).

The surveillance requirements of IEEE 308-1974 are met in design, installation, and operation of Class 1E equipment as follows:

1. Preoperational equipment tests and inspections are performed with all components installed and all meters and protective devices calibrated and adjusted. They demonstrate that:

    a. Components are correct and are properly mounted.

    b. Connections are correct, and circuits are continuous.

    c. Components are operational.

    d. Redundant elements can be tested independently of each other.

2. Preoperational system tests are performed in accordance with requirements described in Section 14, with all components installed. These tests demonstrate that the equipment operates within design limits and that the system is operational and meets its performance specification. These tests demonstrate that:

    a. The Class 1E loads can operate on the preferred power supply.

b. The loss of preferred supply can be detected.

c. The SDGs can be started and can accept the design loads in the sequence and time duration shown in Table 8.3-1 and Diesel Generator Sizing Calculation E-9(Q).

d. The redundant Class 1E sources and their associated load groups are each independent of all other sources.

e. Transfer between preferred and standby power supplies can be accomplished.

f. The batteries of the dc power supply can meet the design requirements of their connected load without the chargers in operation.

g. Each battery charger has sufficient capacity to meet the largest combined demands of the various continuous steady-state loads plus the charging capacity to restore the battery from the design minimum charge (design duty cycle) state to the fully charged state within 12 hours.

3. Periodic equipment tests are performed at scheduled intervals in accordance with the requirements of Section 16. These tests are performed to:

   a. Detect within prescribed limits the deterioration of the equipment toward an unacceptable condition.

   b. Demonstrate that standby power equipment and other components that are not exercised during normal operation of the station are operable.

4. Periodic system tests shall be performed using written procedures which will be designed to demonstrate system

performance. The frequency of testing shall be governed by the frequencies specified in the Technical Specifications. The HCGS Technical Specifications will also include the appropriate periodic system tests as required by Section 6.4 of IEEE Standard 308-1974 in order to demonstrate:

a. The Class 1E loads can operate on the preferred power supply.

b. The loss of the preferred power supply can be detected.

c. The standby power supply can be started and can accept design load within the design basis time.

d. The standby power supply is independent of the preferred power supply.

As HCGS is a single unit generating plant, multiunit station considerations do not apply. Battery testing is described in Chapter 16.

8.1.4.7 Regulatory Guide 1.40, Qualification Tests of Continuous Duty Motors Installed Inside the Containment of Water Cooled Nuclear Power Plants, March 1973

HCGS complies with Regulatory Guide 1.40 as discussed in Section 1.8.

8.1.4.8 Regulatory Guide 1.41, Preoperational Testing of Redundant Onsite Electric Power Systems to Verify Proper Load Group Assignments, March 1973

Preoperational testing is described in detail in Section 14 and is in conformance with Regulatory Guide 1.41, as discussed in Section 1.8.

The Onsite Class 1E Electric Power System, designed in accordance with Regulatory Guides 1.6 and 1.32, is tested as part of the preoperational testing program. These tests are performed in accordance with the requirements outlined in Section 14 and verify the independence between the redundant onsite power systems and their loads.

The Onsite Class 1E Electric Power System is tested functionally, one channel at a time in accordance with Regulatory Guide 1.41.

Functional performance of the loads is checked. Each test is designed to achieve a stable operating condition that permits detection of adverse conditions that could result from improper assignment of loads. Section 14 discusses the procedure for the tests listed above.

8.1.4.9 Regulatory Guide 1.47, Bypassed and Inoperable Status Indication for Nuclear Power Plant Safety Systems, May 1973

Figure 8.1-1 (Section EB of unit operators console) shows the control of the following circuit breakers for each of the four 4.16 kV Class 1E switchgear buses:

1. Two incoming feeders from offsite power supply sources

2. One standby diesel generator, the onsite power supply source

3. Two feeders from the bus to the Class 1E unit substation transformers.

Drawings E-3060, E-3061, E-3080 and E-3400 (these drawings were submitted under separate cover in compliance with Regulatory Guide 1.70, Revision 3, Section 1.7) show that off-normal conditions both deliberately induced or inadvertent are indicated and alarmed in the main control room.

The control for each of these circuit breakers has a circuit breaker malfunction detector (CBMD) circuitry located in HCGS logic cabinet. The CBMD provides input for (i) circuit breaker 'INOP' light at the individual control module located in EB Section of unit operators console and (ii) system alarm at the main annunciator. The following inputs are provided for the CBMD:

1. Loss of 125 V dc control power for the circuit breaker.

2. Loss of trip coil continuity when the circuit breaker is closed.

3. The circuit breaker not in the operating position.

4. The test control switch for the circuit breaker at switchgear in Pull-to-Lock position.

5. Control selector switch not in normal position.

6. The circuit breaker closing springs not charged.

Upon the occurrence of conditions that may render a circuit breaker inoperable, the 'INOP' light at the circuit breaker's control module starts cycling on-off and is accompanied by an alarm at the main annunciator. The main annunciator has the following system alarm windows:

1. 4.16 kV incoming breaker malfunction

2. 4.16 kV feeders to unit substation XFMRS breaker malfunction

3. Diesel generator breaker malfunction

4. 4.16 kV Class 1E incoming breaker emergency takeover.

CRT aids the operator in identifying the Class 1E bus that has an off-normal condition.

The 'INOP' light at the control module also aids the operator in identifying the bus and the circuit breaker having the off-normal condition.

The description above shows that the operator is always cognizant of any off-normal condition that can render any Class 1E circuit breaker of the power distribution system inoperable.

The indicator circuits of the power system of each channel are physically and electrically separated. The annunciator circuits are physically and electrically isolated from safety circuits so that no credible failure of the annunciator circuits will degrade the safety circuit. The only means of cancelling the indications is by correcting the off-normal condition that caused the alarm and
indication.

The indication lights and their annunciators can be tested during plant operation one section at a time.

Compliance of standby diesel generator with Regulatory Guide 1.47 is described in Sections 1.8.1.47 and 7.5.1.3.2.

8.1.4.10 Regulatory Guide 1.53, Application of the Single Failure Criterion to Nuclear Power Plant Protection Systems, June 1973

The Electric Power System is designed to comply with Regulatory Guide 1.53 as discussed in Section 1.8. All four Class 1E power system channels are designed and located in accordance with the separation criteria for the plant. Routing of cables and location of equipment is designed so that a failure of any kind in any channel cannot propagate to any other redundant channel. Consistent with the single failure criterion, only one failure is assumed to occur in the system following a DBA.

HCGS also complies with the revised Sections 5.2 through 5.5 of IEEE 379-1977 with respect to electric power systems as described below:

Section 5.2 Nondetectable Failures

The Class 1E electric power system is designed to meet single failure criterion whereby one channel can be assumed to be lost without affecting the remaining channels. The single failure is assumed to be resulting from any cause whether it be a detectable or nondetectable failure.

Section 5.3 Cascaded Failures

Cascaded failures are considered as a single failure in the HCGS design of the Class 1E electric power system. The Class 1E equipment is qualified for Design Basis Events to preclude common mode failures from the effects of accident environments, abnormal environmental conditions such as temperature and humidity and seismic events when necessary.

Section 5.4 Design Basis Events and Single Failures

Because the Class 1E equipment is qualified for Design Basis Events (DBE) when necessary because of its function and location, the Class 1E system components, modules, or channels remain unimpaired during and following DBE.

Section 5.5 Common Mode Failures

The potential for common mode failures in Class 1E equipment is minimized in HCGS because only qualified Class 1E equipment is used and periodic testing and maintenance of the equipment are performed throughout the equipment life.

8.1.4.11 Regulatory Guide 1.62, Manual Initiation of Protective Actions, October 1973

HCGS complies with Regulatory Guide 1.62 as discussed in Section 1.8.

8.1.4.12 Regulatory Guide 1.63, Electric Penetration Assemblies in Containment Structures for Light-Water-Cooled Nuclear Power Plants, July 1978

Design of HCGS penetration assembly systems is in compliance with Regulatory Guide 1.63 with the exceptions indicated in 7, 8 and 9 below.

The types of circuits that go through penetration assemblies are as follows:

1. Power feeders for medium voltage 3.92-kV motors
2. Power feeders for 480 V ac motors
3. 480 V ac and 208 V ac miscellaneous power feeders
4. 120 V ac control circuits
5. 125 V dc control circuits
6. 120 V ac lighting circuits
7. Motor differential relay current transformer circuits
8. Low energy instrumentation circuits
9. Communication circuits.

The following system features are provided to ensure compliance with the Regulatory Guide position on single random failures of circuit overload protection devices:

1. Medium voltage penetration assemblies: The only medium voltage circuits routed through the penetration are the 3.92 kV circuits for the two reactor recirculation pump motors. Each motor is supplied from a variable frequency

motor generator set. The maximum fault current available for a fault inside the containment is limited by the generator contribution and the circuit resistance. Primary and backup protection for the 1000 kcmil penetration is provided by two Class 1E circuit breakers in series as shown in Plant Drawing E-0004-1. Each circuit breaker is provided with an overcurrent relay. These relays are set to trip their respective circuit breakers. Figure 8.3-17, Sheet 11 shows that the time current capability of the 1000 kcmil penetration is greater than any maximum short circuit current vs. time condition that could occur.

2. 480 V ac motor feeder circuits: The 480 V ac loads inside the containment consist of Class 1E and non-Class 1E motor operated valves and non-Class 1E continuous-duty motors. All these loads are supplied from 480 V motor control centers (MCCs).

The magnetic only circuit breaker used in the combination starter for the motor provides primary protection for penetration conductors. A thermal magnetic breaker in series with the starter breaker provides backup protection for these penetration conductors. These primary and backup breakers used for the protection of penetration conductors are both located in the same cubicle of the MCC. The primary breaker is set to provide only short circuit protection. It does not provide locked rotor protection, which is provided by overload relays in the MCCs for non-Class 1E motor-operated valves and continuous duty motors.

Location of the primary and backup protective devices in the same cubicle of a motor control center for a 480 V feeder for loads inside the primary containment is justified as follows:

a. Both the primary and backup protective devices are qualified for HCGS seismic and environmental parameters for any design basis event as described in Sections 3.10 and 3.11.

b. Both the primary and backup circuit breakers are molded case type. These circuit breakers trip directly in response to an overcurrent condition and do not require external control power supply for tripping function.

c. There is no credible single event that will cause both the primary and backup protective circuit breakers to fail in the close position.

For non-Class 1E 480 V circuits that penetrate into containment, the non-Class 1E circuit breakers are identical in design and construction to that of Class 1E circuit breakers, thereby assuring high reliability.

With the three provisions described above, the configuration of the primary and backup protective devices located in the same cubicle, meets the intent of IEEE -279-1971.

For Class 1E motor operated valves (MOVs), the overload relay is bypassed for emergency plant operation to increase the availability of these valves in accordance with Regulatory Guide 1.106. For these Class 1E MOVs, the backup breakers are selected to allow for sustained locked rotor current and penetration conductors are selected to ensure that the thermal limits of the penetration are not exceeded during this condition.

The thermal magnetic backup breaker has a nonadjustable trip setting, which is rated on the following basis:

a. The time current characteristic curve remains under the thermal damage curve of the penetration conductor over the range of postulated temperatures so that the breaker trips on overcurrent before the thermal limit of the penetration conductor is reached.

b. The breaker allows locked rotor current of non-Class 1E motors for at least 10 seconds and 1000 seconds for Class 1E motors. These breaker settings prevent nuisance tripping of non-Class 1E motors during starting and allows ample time for the motors to start.

3. 480 V and 208 V miscellaneous feeders: Non-Class 1E 480 V MCCs provide power for hoists, reactor recirculation pump motor space heaters, and welding outlets in the drywell. The primary and backup protections for these feeders are provided by two thermal magnetic breakers in series. Both the breakers have the same ratings and are located in the same cubicle of the MCC. The ratings of both the breakers are selected so that on overcurrent, the breakers trip before the thermal limit of associated penetration conductor is reached.

   208 V ac miscellaneous feeders from a 208/120-V ac power panel provide power for Source Range Monitoring (SRM) and Intermediate Range Monitoring (IRM) Systems. The primary protection for the 208 V ac circuit is provided by fuses in each circuit conductor. These fuses are located in GE control panels. The main 20 ampere thermal magnetic breaker, located in the power panel, provides the backup protection for these circuits. The time current

characteristics of both the fuses and circuit breakers are selected so that both the devices trip before the thermal limit of the associated penetration conductor is reached.

4. 120 V ac control circuits: 120 V ac circuits are powered from 480/120 V ac control transformers located in the MCC cubicles. Two fuses, with the same rating in series for each circuit, located in the associated cubicles of MCCs, provide both the primary and backup protection. For a fault, the fuses blow before the thermal limit of the associated penetration conductor is reached.

   120 V ac control circuits fed from uninterruptible power supply (UPS) distribution panels are provided with two fuses in series for each circuit. Primary protection is provided by the fuses located in GE control panels. Backup protection is provided by the main fuse with a rating higher than the primary fuse located in the UPS panel. For a fault, the fuses blow before the thermal limit of the penetration conductor is reached.

5. 125 V dc control circuits: Each circuit powered from the 125 V dc control bus in the switchgear is provided with two fuses of the same rating located in the associated switchgear cubicle. These two fuses wired in series provide both primary and backup protection for the associated penetration conductor.

   Each circuit powered from the control bus in the GE control panels is provided with a fuse in that panel to ensure primary protection for the penetration conductor. Backup protection is provided by the feeder breaker supplying the control bus.

In both cases above, either the primary or backup protection is capable of clearing the fault before the thermal limit of the associated penetration conductor is reached.

6. 120 V ac lighting circuits: All lighting circuits going through the penetrations are 120 V ac. Each circuit is provided with two thermal magnetic breakers in series. The primary protection for the penetration conductor is provided by breakers located in breaker panels. Breakers located in the lighting panels wired in series circuit with breaker panels provide the backup protection for the penetration conductor.

   Both the primary and backup protection are capable of clearing the fault before the thermal limit of the penetration conductor is reached.

7. Motor differential relay current transformer circuits: The only circuits in this category are the current transformer circuits for differential protection of the reactor recirculation pump motors. No protection is necessary for the penetration conductors associated with these current transformer leads because the maximum possible relay current for a sustained fault in the medium voltage cable is only 37 amperes. The ampacity of the penetration conductor is 41 amperes. Furthermore, the relay current decays to 1.7 amperes after 80 seconds because of the fault current decrement. These current transformer circuit cables are designated control cables and are routed in separate raceways from power cables. This eliminates the possibility of a short circuit between power and control cables. The differential relay fails safe for shorts or opens in the current transformer circuits. If the differential leads were to short while carrying their normal load of 3.17 amperes, the

differential relay would operate and trip the generator drive motor in 144 milliseconds and the 3.17 amperes load would drop down to 1.7 amperes in 80 seconds. The penetration is rated for 41 amperes continuously.

8. Instrumentation circuits: Instrument circuits are all low energy circuits carrying only a few milliamperes. Also, these circuits are routed in separate raceways from power cables to eliminate the possibility of a short between power and instrument circuits. The short circuit current in the instrument circuits can not exceed the ampacity of penetration conductors under any faulted condition. In addition, the instrumentation circuits are protected from overloads by primary overcurrent protective devices which are integral with their power supply and by backup overcurrent protective devices located upstream of the power supplies.

   The only penetrations with instrument class circuits that are protected by a single circuit breaker or fuse are as follows:

   a. Vibration Monitoring

      (1) Circuit breaker is 7 amperes.

      (2) Maximum short circuit current is 0.8 amperes.

      (3) Penetration is No. 16 AWG wire with a continuous rating of 15 amperes.

      (4) These penetrations have a continuous rating in excess of 18 times the maximum short circuit current they may be expected to experience.

   b. Neutron Monitoring System

(1) Circuit protected by a 1/4 ampere fuse.

(2) Maximum short circuit current is 0.2 amperes.

(3) Penetration is No. 16 AWG wire with a continuous rating of 15 amperes.

(4) These penetrations have a continuous rating in excess of 75 times the maximum short circuit current they may be expected to experience.

c. Acoustical Monitoring System

(1) Circuit protected by a 2.5 ampere fuse.

(2) Maximum short circuit current <0.1 ampere. (The 330KΩ resistor would limit the short circuit to 0.1 ampere even if the rest of the circuit impedance was zero.)

(3) Penetration is No. 16 AWG wire with a continuous rating of 15 amperes.

(4) These penetrations have a continuous rating in excess of 150 times the maximum short circuit current they may be expected to experience.

d. Thermocouple Circuits

(1) Thermocouples cannot generate any conceivable short circuit challenge to a penetration.

9. Communication circuits - Communication circuits consist of 120 V ac power and signal circuits. Each power circuit has two fuses in series. One located in the distribution panel provides the primary protection, and another located

in a terminal box near the penetration provides backup protection for the associated penetration conductors. Both of these are capable of clearing the fault before the penetration conductor reaches its thermal limit.

The P.A. voice circuits carry millivolt signals only when they are actually transmitting a voice communication. The system cannot generate any conceivable short circuit challenge to a penetration.

In addition, the penetration assemblies are designed to withstand, without loss of mechanical integrity, the maximum short circuit current vs. time conditions that could occur, given single random failures of circuit overload protection devices. Time current characteristic curves, based on tests, of the penetration conductors have been established by the penetration supplier; these curves show the maximum duration of symmetrical short circuit current. Based on these curves the primary and backup protective devices are selected to ensure that the mechanical integrity of the penetrations is maintained. Coordinated fault current versus time curves for representative penetration conductors and the protective devices are shown in Figure 8.3-17, Sheets 1 to 22.

The test report that substantiates the capability of the electrical penetration to withstand fault current without seal failure for worst case environmental conditions has been submitted under a separate cover.

The testing of penetration over current protective devices has been incorporated in the HCGS Technical Specifications.

8.1.4.13 Regulatory Guide 1.73, Qualification Tests of Electric Valve Operators Installed Inside the Containment of Nuclear Power Plants, January 1974

HCGS complies with Regulatory Guide 1.73 as discussed in Section 1.8.

8.1.4.14 Regulatory Guide 1.75, Physical Independence of Electric Systems, September 1978

HCGS complies with Regulatory Guide 1.75. Clarifications and exceptions are noted in Section 1.8.

8.1.4.14.1 General Separation Criteria

Electrical equipment and wiring for the Engineered Safety Feature Systems (ESF), Reactor Protection System (RPS), and Neutron Monitoring System (NMS) are segregated into separated channels/divisions as shown in Table 8.1-1, so that under DBAs no single credible event is capable of disabling sufficient equipment to prevent reactor shutdown, decay heat removal from the core, or mitigation of accidents. The ESF systems, RPS, and NMS are separated electrically and physically from one another, and each is further separated into four channels. The degree of separation provided is commensurate with the potential hazards in a given area.

The Class 1E cable system is designed with four redundant channels, A, B, C, and D. Each of these four channels is separated from its redundant counterpart. Each of the RPS channels, W, X, Y and Z, is run in separate conduits and is separated from other Class 1E channels. Additionally, each of the neutron monitoring channels, R, S, T and U, is run in separate conduits and is separated from other Class 1E channels.

All of the above channelized systems are separated from non-Class 1E circuits.

Equipment and circuits requiring separation are identified on documents and drawings in a distinctive manner.

8.1.4.14.1.1 Methods of Separation

Separation of circuits and equipment is achieved by separate safety class structures, distance, barriers, or combinations thereof.

8.1.4.14.1.2 Compatibility with Mechanical Systems

The separation of Class 1E circuits and equipment ensures that the required independence is not compromised by the failure of mechanical systems served by the Class 1E systems. For example, Class 1E circuits are routed and/or protected so that the failure of related mechanical equipment of one redundant system cannot disable Class 1E circuits or equipment essential to the operation of the other redundant system(s). This is further discussed under specific separation criteria, in Section 8.1.4.14.2.

8.1.4.14.1.3 Associated Circuits

Associated circuits, which are non-Class 1E circuits that share raceways, enclosures, or power supplies with Class 1E systems or are not physically separated from Class 1E circuits, meet identification and separation requirements of Class 1E circuits with which they are associated up to an isolation device. Beyond the isolation device, these circuits are treated as non-Class 1E.

Non-Class 1E circuits or equipment may be connected to Class 1E equipment or circuits by the use of approved qualified isolation devices to assure that in the event of failure of the non-Class 1E equipment, the Class 1E equipment will continue to perform its function. If non-Class 1E equipment becomes associated with Class 1E equipment and an approved isolation device is not available, the non-Class 1E equipment will be treated as Class 1E and will be qualified as such.

There are cases where Class 1E unit substations feed non-Class 1E loads. The breaker feeding such a load is Class 1E and is tripped under a LOCA condition. The feeder from the breaker to the load is a non-Class 1E cable, which is wrapped with Siltemp material inside the unit substation. This approach is in accordance with Position C.1 of Regulatory Guide 1.75, Revision 2.

There are cases where Class 1E AC power feeds non-Class 1E loads. In these cases two redundant Class 1E fuses are installed as isolation devices. Isolation devices actuated only by a fault current are coordinated such that upstream circuit protection devices are not affected by a non-Class 1E fault. This approach is in accordance with Position C.1 of Regulatory Guide 1.75, Revision 3.

8.1.4.14.1.3.1 Non-Class 1E Loads Connected to Class 1E Busses

Figure 8.1-2 shows the two configurations that employ a circuit breaker tripped by a LOCA signal as an isolation device. The two configurations are:

1. A Class 1E unit substation supplies a non-Class 1E motor control center (MCC) or a motor load through Class 1E circuit breaker B.

2. A Class 1E motor control center supplies through Class 1E circuit breaker D, a non-Class 1E distribution panel.

The Class 1E circuit breakers B and D are qualified to operate for HCGS seismic and environmental parameters for all design basis events. These circuit breakers will trip to isolate their respective Class 1E power supply buses from the non-Class 1E loads in the event the non-Class 1E loads fail. This applies whether the plant is supplied from an offsite source or an onsite source. The Class 1E onsite ac sources and the offsite power sources and their distribution system are of sufficient capacity and capability to supply power to both Class 1E and non-Class 1E loads during all plant conditions. In the event of a LOCA the non-Class 1E loads are automatically tripped from the Class 1E buses. In addition, cables from the Class 1E buses to the non-Class 1E loads are routed in rigid steel conduits or trays. Where tray routing is used, non-Class 1E cables associated with another Class 1E channel are not run together in the same tray. An operation design change control program will be in effect at HCGS to assure that future additions/modifications will comply with this requirement. Additionally, the pertinent design documents will be provided with notation to reflect this requirement. Thus, the failure of the non-Class 1E loads supplied from Class 1E power supply buses will not prevent any of the four channels of Class 1E power supplies from performing its safety function.

8.1.4.14.1.3.2 Compliance with Guidelines of Section 7.1.2.1 of IEEE 384-1981

Protective device coordination studies for devices shown in Figure 8.1-2 have shown that the time overcurrent trip characteristics of circuit breakers A, B, C, and D are such that:

1. Circuit breaker B will trip to clear a fault current prior to initiation of a trip of circuit breaker A.

2. Circuit breaker D will trip to clear a fault current prior to initiation of a trip of circuit breaker C.

Both the onsite and offsite powers supply sources are separately capable of supplying the necessary fault current for sufficient time to ensure the proper protective device coordination without loss of function of Class 1E loads. Periodic testing of the breaker time overcurrent trip characteristics will be performed to demonstrate that the circuit breaker trip function remains within required limits. Table 8.1-2 identifies the non-Class 1E loads that are supplied through circuit breakers B and D of Figure 8.1-2.

8.1.4.14.1.3.3 Failure of the Non-Class 1E DC System that Supplies Control Power to the Subject Non-Class 1E Loads

For configuration (a) (described above) the circuit breaker B supplying a Non-Class 1E MCC or a motor load is controlled by Class 1E 125 V dc control power supply. For a non-Class 1E motor load, a non-Class 1E circuit breaker is provided downstream of circuit breaker B. This non-Class 1E circuit breaker is controlled by a non-Class 1E 125 V dc control power. Hope Creek's 480VAC switchgear circuit breakers are direct acting trip devices and do not require external control power supply for tripping for electrical fault conditions. Therefore, the failure of the dc control power supply does not prevent the circuit breaker from tripping in response to the failure of non-Class 1E motor load.

8.1.4.14.1.3.4 Analysis for Supplying Non-Class 1E From Class 1E DC Systems

Plant Drawing E-0012-1 shows non-Class 1E public address system distribution panel 10J496 supplied from a Class 1E dc power bus 10D410 through a Class 1E inverter in UPS unit 10D496. The inverter is an acceptable isolation device per IEEE-384-1981, Section 7.1.2.3. Therefore, a failure in the non-Class 1E distribution panel 10J496 will not degrade Class 1E dc system bus 10D410.

The HCGS UPS system has been tested to demonstrate the adequacy of an inverter being applied as an isolation device. The test demonstrated that voltage, current, and frequency on the Class 1E side of the UPS are not degraded below acceptable levels when a maximum credible voltage or current transient is applied on the non-Class 1E side of the UPS system. The tests performed simulated all operating modes for which the HCGS UPS system is designed. the tests included the following types of faults at the UPS output location:

1. Phase to ground
2. Neutral to ground
3. Phase to neutral without ground

The test plan and the test results were submitted separately for the staff's review by letters from R. L. Mittl, PSE&G, to A. Schwencer, NRC, dated October 3, 1984, and March 7, 1985, respectively.

An analysis has been performed to support the values used for the acceptance criteria for voltages. This analysis shows that the voltages specified will not cause misoperation or loss of any electrical equipment connected to the supply buses.

The results of this analysis for the ac systems are stated in Section 8.3.1.2.1. The results of the dc analysis are contained in Section 8.3.2. These results indicate that the 125 volt dc system

has an acceptable operating capability with battery voltage variations of 32 volts (140 volts dc to 108 volts dc). The test acceptance criterion limits the UPS input voltage variation to 105-140 volts.

In addition, the acceptance values for the test currents are well below the level that would cause the infeed breakers to the UPS supply buses to trip. These values are as follows:

Circuit	Acceptance Current	Infeed breaker Setting
Normal 480 V ac Supply	0-55 amperes continuous with a maximum peak not to exceed 132 amperes and no value above 55 amperes shall persist for longer than 10 mS	600 amperes pick-up
Backup 480 V ac Supply	0-78 amperes continuous with a maximum peak not to exceed 500 amperes and no value above 78 amperes shall persist for longer than 10 mS	600 amperes pick-up
Alternate 125 V dc Supply	The UPS input voltage variation of 105-140 volts will hold for the following cases: (1) With the UPS energized but without load the input current should not exceed 56 amperes (2) With the UPS input current at 56 amperes the input current should not exceed the range of 0-56 amperes	2000 ampere fuse

Circuit	Acceptance Current	Infeed breaker Setting
	(3) With the UPS input current at 158 amperes the input current should not exceed the range of 0-158 amperes	
	(4) With the UPS output faulted the input current should not exceed 364 amperes	

The following is justification that the above acceptance current values do not adversely effect the Class 1E buses. The 480 V ac backup feed is supplied from a 480 volt Class 1E motor control center which in turn is supplied from a 480 volt Class 1E unit substation. The infeed breaker to the MCC has a 600 ampere pick-up setting for its time delay trip setpoint. This allows the largest motor loads on the MCC, in combination with the maximum acceptable current spike of the UPS acceptance values (500 amperes for not longer than 10 mS), to persist for 25 seconds. Since the 500 ampere spike is completed in 10 mS, the largest motor loads then have 55 seconds to accelerate. This is 48 seconds longer than the time delay for the primary protective device for the largest motor and, therefore, it is not possible for any of the Class 1E loads to be disabled. The inrush current of the normal ac feed is 132 amperes for 10 mS which is less than the 480 V ac backup supply. The normal 480 V supply breaker is the same type and size as the 480 V backup supply breaker. Therefore the Class 1E loads on the MCC's from the normal and backup 480 V ac supply are not affected by any short circuits on the output of the inverter.

The alternate 125 V dc supply full load amperes are already included in the 125 volt battery profiles. The impedance of the conductors from the battery to the

125 V dc bus is such that the voltage drop for the specified load profiles does not cause the 125 volt bus to drop below an acceptable limit.

The testing demonstrated the adequacy of the UPS as an isolation device in accordance with the test plan. The hot short test which was originally required by the test plan was not performed because of implemented design changes to ensure that all of the inverters' output cables are not routed in raceways containing any 480 V ac service level cables. Therefore, the UPS output cables will not be subject to any hot short (460 V ac) condition. In addition, Section IA of the test report submitted to the NRC on March 7, 1985 includes the justification for not performing a 200 percent overload test. This justification is based on the design limitation of the inverter to support an overload. An overload above the inverter's current limit setting will cause the static switch to transfer the load to the backup 480 V ac source.

8.1.4.14.2 Specific Separation Criteria: Cables and Raceways

For cables and raceways, the following specific separation criteria apply:

1. Minimum separation distances for limited hazard areas, such as cable spreading area, control equipment room, relay room, and control room are based on open ventilated trays.

2. Cable splices in raceways are not permitted. However, splicing is permitted for terminating cables to the pigtails of primary containment penetration assemblies. These splices are made in terminal boxes located next to the penetration assemblies.

3. Cables and raceways used in the HCGS design have flame retardant properties. Hazards in the above mentioned areas are limited to failures or faults internal to the electric equipment or cables.

To aid in identification prior to installation, raceways are marked with distinct permanent identification markers in accordance with raceway layout drawings and raceway schedules. Distance between the two adjacent markers is not to exceed 15 feet. These raceways are also identified where they pass through walls, floors, and enclosed areas.

Presently, color coding for raceway systems markers is as follows:

1.	Channel N and P (Fire Protection)	BLACK
2.	Channels A (Class 1E), W [Reactor Protection System (RPS)], and R [Neutron Monitoring System (NMS)]	GREEN
3.	Channels B (Class 1E), X (RPS), and S (NMS)	PURPLE
4.	Channels C (Class 1E), Y (RPS), and T (NMS)	BLUE
5.	Channels D (Class 1E), Z (RPS), and U (NMS)	ORANGE

Cable markers provide permanent identification for individual cables. They are applied at each end of the cable giving the cable number, equipment to and from destinations, and separation group color coding.

Class 1E cables are distinctly identifiable as safety related cables in addition to the permanent markers at two ends. The spacing between identification points is not to exceed 5 feet.

The present method of using color coding schemes to identify the cables and raceways facilitates initial verification that the installation conforms to separation criteria. This scheme precludes

the need to consult any reference material to distinguish between redundant Class 1E and between Class 1E and non-Class 1E systems.

8.1.4.14.3 Differing Hazard Condition by Area

The following three areas with differing hazard conditions are considered in HCGS:

1. Cable spreading area, control equipment room, relay room, and main control room

2. Limited hazard areas

3. Hazardous areas.

8.1.4.14.3.1 Cable Spreading Area, Control Equipment Room and Mezzanine, and Main Control Room

The cable spreading area, control equipment room and mezzanine, and main control room do not contain high energy equipment such as switchgear, transformer, rotating equipment, or potential sources of missiles or pipe whip, and are not used for storing flammable materials. Power supply circuits are limited to those serving these areas and their instrument systems. These 208/120 V power cables are installed in conduits. Conduits containing redundant cables are separated by a minimum of 1 inch. Conduit couplings, clamps, locknuts, bushings, etc, shall not be considered in determining the required separation distances. For conduits carrying redundant neutron monitoring cables, boxes also shall not be considered in determining the required separation. Redundant cable trays are separated by at least 18 inches vertically and 12 inches horizontally. The configurations, for which the redundant raceways can not be separated by distances specified above, will either be analyzed or tested to demonstrate the compliance with the intent of Regulatory Guide 1.75 as discussed in this section and Section 1.8.1.75. Separation distance requirements between Class 1E and

non-Class 1E raceways are the same as for the separation among redundant channels.

IEEE 384-1974 requires a minimum vertical separation of 3 feet between trays. The HCGS minimum vertical separation distance is 18 inches. The following analysis provides the justification for the lesser separation distance:

1. All cables are flame retardant and meet or exceed the flame test specified in IEEE 383-1974 as demonstrated by tests. Cable test reports are on file and available for audit.

2. As indicated in the above paragraph, high energy equipment and potential sources of missiles or pipe whip are excluded from the areas. Power circuits in the areas are installed in conduits that qualify as barriers; the maximum potential of the power circuits is limited to 208/120 volts ac or 125 volts dc. There are no power cables of higher potential serving equipment in the areas except for lighting branch and feeder cables, which are either enclosed in conduit or of a metal clad construction.

3. The cable tray test report performed for Salem showed that a fire in a cable tray located 12 inches directly below another tray did not propagate to the upper cable tray. The test configuration and cables were representative of the HCGS design and installation except that the test configuration used a 12-inch vertical separation. The Salem test report, "Basis for Cable System Design Power Generating Stations", dated July 16, 1971, has been submitted under separate cover (letter from R. L. Mittl, PSE&G, to A. Schwencer, NRC, dated August 15, 1984).

4. To supplement the cable tray test performed for Salem, as discussed in Paragraph 3. above, additional testing was performed in February 1985 to demonstrate that the HCGS minimum 18-inch vertical separation distance is adequate for hazards caused by failures or faults internal to the electric cables. This test was performed in accordance with test plan submitted to NRC (PSE&G, R. L. Mittl, to NRC, A. Schwencer, dated September 28, 1984) except that 12-inch vertical separation between open top cable trays was used instead of the test plan requirement for 18 inches. The test successfully demonstrated that a faulted cable in the top center of the bottom tray did not affect the performance and insulation integrity of cables in the bottom center of the upper tray. Both trays contained sufficient quantities of HCGS control and instrumentation cables to represent a worst case cable tray fill of 50 percent by area; in addition, the faulted cable used, No. 2 AWG, represented the largest size of cable in the HCGS trays used in the cable spreading area and control equipment room and mezzanine. The test results showed that the unfaulted cables were undamaged, and post-test measurements remained within the acceptance criteria established by the test plan, i.e., insulation resistance, high potential, cable continuity, and cable temperature. The test report, Wyle Test Report No. 17730-01, has been submitted to the NRC by letter dated April 4, 1985 (PSE&G, R. L. Mittl, to NRC, A. Schwencer).

   Based on the above analysis and tests, the HCGS minimum vertical separation distance of 18 inches between redundant open ventilated trays is justified. The testing showed that a 12-inch vertical separation distance between redundant open top trays is acceptable. Therefore, in cases where the HCGS tray installation has a vertical separation distance of 12 inches or more, these cases are considered acceptable provided that all cables within the

open ventilated trays are smaller than No. 2 AWG. If the foregoing is not met, then cable tray covers will be installed.

Strict administrative control of operations and maintenance activities is developed to control and limit the introduction of potential hazards into these areas.

8.1.4.14.3.2 Limited Hazard Areas

Limited hazard areas are the general plant areas from which potential nonelectrical hazards such as missiles, pipe whip, and exposure fires are excluded. The hazards in this area are limited to failures or faults internal to the electrical equipment or cables. These areas include Elevations 77, 102, 124, 130, and 137 feet in the Auxiliary Building wing areas and elevation 87 feet in the radwaste area. Minimum separation in these areas is as follows:

1. Conduits containing redundant cables are separated by a minimum of 1 inch, unless consideration of hazards indicates greater separation is required. Conduit couplings, clamps, locknuts, bushings, etc, shall not be considered in determining the required separation distances. For conduits carrying redundant neutron monitoring cables, boxes also shall not be considered in determining the required separation.

2. In case of open ventilated trays, redundant trays are separated by 3 feet horizontally and 5 feet vertically, respectively. If the redundant trays cannot be separated by the distances specified above, solid covers for trays are provided as designated in Section 6.1.4 of IEEE 384-1981. The use of solid covers has been justified by test performed in conjunction with other cable tray testing described in Section 8.1.4.14.3.1d. The HCGS test configuration simulated that shown on Figure 7 of IEEE

384-1981 except that 3/4-inch vertical separation between the covered tray was used. This test was performed with HCGS trays, tray covers, and cables. The tray covers were fastened with actual HCGS hardware to simulate HCGS installation, including gaps between the cover and the tray surface where tray supports are located. The test acceptance criteria were the same as those in the test plan submitted to the NRC, discussed in Section 8.1.4.14.3.1(4). The test results showed that the HCGS cable tray covers act as an effective barrier such that no damage, loss of performance, or degradation of insulation integrity of cables in the top tray results from a faulted cable in the bottom tray. The faulted cable size was No. 2 AWG to represent the largest size cable in cable trays located in limited hazard areas. The test results are included in the Wyle Test Report No. 17730-01.

Separation requirements between Class 1E and non-Class 1E circuits are the same as those required between redundant circuits.

8.1.4.14.3.3 Hazardous Areas

These are areas where one or more of hazards such as pipe break, flooding, missile, and fire can be postulated.

Routing of redundant Class 1E circuits or the locating of redundant Class 1E equipment in hazardous areas is avoided. The preferred separation between redundant Class 1E circuits or equipment in these areas is by a wall, floor, or barrier that is structurally adequate to shield redundant raceways from potential hazards in the area.

Where neither compartmentalization nor the construction of barriers is possible, an analysis is performed to demonstrate that no missile, fire, jet stream impingement, or pipe whip hazard disables redundant equipment, conduits, or trays. In no case, regardless of the distance of physical separation, are redundant equipment cable

trays located in the direct line of sight of the same potential missile source.

The plant design for fire protection separation of electrical cables and equipment is reviewed against 10CFR50, Appendix R, which is discussed in Section 9.5.1.

A separation analysis has been performed which addresses protection of all Class 1E electrical equipment from external hazards generated by a non -safety system or component. It has been concluded that in certain areas, a break in a fire protection system could affect some Class 1E electrical equipment. HCGS has committed to protect all Class 1E equipment from this hazard. In addition, the flooding hazard in the main steam tunnel which results from a feedwater line break could cause the failure of some Class 1E motor operated valves and some Class 1E temperature elements. These devices are protected from short circuit damage by Class 1E overcurrent protective devices located in hazard free areas. These primary overcurrent protective devices are backed up by additional Class 1E overcurrent protective devices also located in hazard free areas. HCGS has completed an analysis to verify that after the backup isolation device clears the flooded devices, the plant can be safely shut down with the worst case single failure in a redundant train (See letter from R. L. Mittl to W. Butler dated May 24, 1985). Other external hazards were also analyzed and it is concluded that no other Class 1E electrical equipment can be damaged by external hazard originating from a non-safety system or component.

8.1.4.14.4 Power supply

Separation of the power supplies is achieved as described below:

1. Standby diesel generators (SDGs) - SDGs are housed in separate compartments within a Seismic Category I structure. The auxiliaries and local controls of each unit are housed in compartments dedicated to their applicable channels.

2. DC system - Redundant Class 1E batteries are located in separate compartments within a Seismic Category I structure. Each battery room is exhausted by an individual ventilation duct to a common exhaust plenum. 250-V, Class 1E batteries for channels A and B are served by a common ventilation exhaust system with redundant exhaust fans but not with independent ductwork. Battery chargers for redundant load groups are also physically separated by compartmentalization.

3. AC distribution system - All redundant Class 1E switchgear, MCCs, and distribution panels are physically separated in accordance with Section 8.1.4.14.3.3.

8.1.4.14.5 Containment Penetrations

Redundant Class 1E electrical penetrations are widely dispersed along the circumference of the primary containment to provide the maximum practical physical separation. The minimum separation of redundant penetrations is 5 feet vertically and 3 feet horizontally. The adequacy of the penetration separation is analyzed with respect to actual hazards inside and outside the primary containment as design work proceeds. Non-Class 1E circuits are not routed in penetrations containing Class 1E circuits. The RPS cables are routed in penetrations used for Class 1E circuits, but are separated from Class 1E cables. These RPS cables are run in conduits up to the terminal box. The conduit carrying the RPS cables terminates inside a terminal box dedicated to RPS circuits. This box is located inside the main terminal box on the penetration assembly. Conductors run through the penetration assembly into the dedicated terminal boxes inside and outside the containment.

8.1.4.14.6 Separation Requirements for Control Boards, Control Panels, and Instrumentation Cabinets

Local control boards are located so that a postulated hazard does not cause failure of redundant Class 1E functions. Separation of

redundant Class 1E equipment and circuits may be achieved by locating them on separate control boards, physically separated in accordance with the requirements described for cable tray separation in Sections 8.1.4.14.

Where operational considerations dictate that redundant Class 1E devices and circuits be located in one section of a panel, the following requirements are met:

1. Internal separation - The minimum internal separation distance between redundant Class 1E equipment and circuits is established by analysis of the proposed installation, plus determination of its flame retardant characteristics. Where materials are flame retardant and analysis is not performed, the minimum separation is 6 inches. In the event the above separation distances cannot be maintained, a flame retardant barrier is installed between redundant Class 1E equipment and wiring. When a panel consists of two or more redundant devices and circuits, the following applies:

   a. Physical isolation is as follows:

      (1) Floor to panel fireproof barriers are provided between adjacent sections (bays) of the panel containing circuits of different channels.

      (2) Penetration of separation barriers within a subdivided panel is sealed or otherwise treated to prevent fire propagation.

   b. The electrical isolation of instrumentation and control is achieved through the use of Class 1E isolation devices applied to interconnections of:

      (1) Class 1E and non-Class 1E circuits

(2) Associated circuits and non-Class 1E circuits

(3) Class 1E logic circuits of redundant divisions.

2. External separation - The minimum separation between redundant cables routed to one piece of equipment containing redundant counterparts is described below.

   Wherever possible, the trays carrying redundant cables approach the common panel from opposite directions to maintain maximum separation. At the point where these trays breach the separation distance requirements for redundant cable tray systems, the redundant cables are routed in conduits to the common panel. At the entrance into the common panel, the conduits are placed as far apart as possible. Inside the panel, the requirements of Section 8.1.4.14.6 apply.

8.1.4.14.7 Sensors and Sensor to Process Connections

Redundant Class 1E sensors and their connections to the process system are sufficiently separated so that the functional capability of the protection system is maintained despite any single DBA or result therefrom, including secondary effects of design basis events, such as pipe whip, steam release, radiation, missiles, or flooding.

Where practicable, redundant Class 1E sensors and process connecting lines are brought together at widely divergent points, using large components such as process vessels or pipes as protection barriers. Where necessary, additional barriers protect against damage from a credible common cause.

8.1.4.15 Regulatory Guide 1.81, Shared Emergency and Shutdown Electric Systems for Multiunit Nuclear Power Plants, January 1975

HCGS is a single unit plant. Therefore, Regulatory Guide 1.81 is not applicable to this plant.

8.1.4.16 Regulatory Guide 1.89, Qualification of Class 1E Equipment for Nuclear Power Plants, November 1974

See Section 1.8 for discussion of compliance.

8.1.4.17 Regulatory Guide 1.93, Availability of Electric Power Sources, December 1974

HCGS complies with Regulatory Guide 1.93 as discussed in Section 1.8.

8.1.4.18 Regulatory Guide 1.100, Seismic Qualification of Electric Equipment for Nuclear Power Plants, August 1977

HCGS complies with Regulatory Guide 1.100 as discussed in Section 1.8.

8.1.4.19 Regulatory Guide 1.106, Thermal Overload Protection for Electric Motors on Motor-Operated Valves, March 1977

Design of electrical circuits for MOVs for HCGS complies with Regulatory Guide 1.106, Revision 1, as discussed in Section 1.8.

8.1.4.20 Regulatory Guide 1.108, Periodic Testing of Diesel Generator Units Used as Onsite Electric Power Systems at Nuclear Power Plants, August 1977

HCGS complies with Regulatory Guide 1.108 as discussed in Section 1.8.

8.1.4.21 Regulatory Guide 1.118, Periodic Testing of Electric Power and Protection Systems, June 1978

HCGS complies with Regulatory Guide 1.118 as discussed in Section 1.8.

The design of the electrical power system permits its periodic testing during the normal plant operation. Redundant power channels can be tested one at a time. 4.16-kV and 480 V unit substation breakers have a test position. All the signals that are required to open or close the breaker automatically can be simulated. Proper operation of the breakers in response to these signals can be verified. Relays on the switchgear are accessible and installed in such a way that their calibration can be verified in place.

For the loads that are supplied from MCCs, testing of the electrical apparatus is performed in conjunction with testing of mechanical, control, and instrumentation systems.

The preoperational testing program is described in Section 14.

8.1.4.22 Regulatory Guide 1.128, Installation Design and Installation of Large Lead Storage Batteries for Nuclear Power Plants, October 1978

The design of HCGS lead storage battery systems complies with Regulatory Guide 1.128, as discussed in Section 1.8 and clarified below.

The ventilation exhaust duct is located just below the battery room ceiling to limit hydrogen concentration to less than 2 percent by volume within the battery area.

The HCGS battery room ventilation system is designed to meet IEEE 484-1975, Section 4.1.4, requirements. Even though the ventilation exhaust duct is located just below the ceiling, there is sufficient air mixing within the battery area furnished by the battery room

HVAC supply system to limit hydrogen accumulation. In addition, the battery room exhaust system is comprised of two 100 percent capacity fans, as discussed in Section 9.4, so that ventilation is continuously maintained. Ventilation is continuously maintained in the safety-related battery rooms during all modes of plant operation.

8.1.4.23 Regulatory Guide 1.129, Maintenance, Testing, and Replacement of Large Lead Storage Batteries for Nuclear Power Plants, February 1978

HCGS complies with Regulatory Guide 1.129 as discussed in Section 1.8.

8.1.4.24 Regulatory Guide 1.131, Qualification Tests of Electric Cables, Field Splices, and Connections for Light-Water-Cooled Nuclear Power Plants, August 1977

HCGS complies with Regulatory Guide 1.131 as discussed in Section 1.8.

8.1.5 Conformance with IEEE 387-1977 - IEEE Standard Criteria for Diesel Generator Units Applied as Standby Power Supplies for Nuclear Power Generating Stations

Design of standby diesel generators (SDGs) and their auxiliary equipment complies with IEEE 387-1977 as discussed in Section 8.3.1.1.3.

8.1.6 SRP Rule Review

Regulatory Guide 1.75 is listed in Table 8-1 of SRP 8.1 as acceptance criteria for physical independence of electric systems and as such as indicated to apply also to SRP Sections 8.3.1 and 8.3.2. For specific tray separation requirements, Regulatory Guide 1.75 refers to IEEE 384, which requires a minimum vertical

separation distance of 3 feet between redundant Class 1E cable trays in the cable spreading room.

The HCGS separation criteria, however, allows a minimum 18-inch vertical separation between redundant cable trays in the cable spreading room. The reason for this difference is that regulatory guidelines for the physical separation of redundant cable trays were not available during the conceptual design stage of the HCGS. As the station design progressed, the number of cables requiring routing through the cable spreading room increased considerably as a result of revisions to Regulatory Guides and standards. The increase in cable volume could not be accommodated with a vertical separation of 3 feet between redundant cable trays. To protect against the effect of fires and meet the general intent of Regulatory Guide 1.75, fire suppression systems are installed in the cable spreading room.

Also, in the unlikely event of a fire in the cable spreading room damaging redundant cables required for safe shutdown, the plant can be brought to a safe shutdown condition from the remote shutdown station not affected by the fire.

Section II of SRP 8.1 refers to Table 8-1 for acceptable criteria in the design of electric power systems. Position C.15 of Regulatory Guide 1.75, as referenced in Table 8-1, requires that where ventilation is needed, separate safety class structures for redundant Class 1E batteries should be served by independent ventilation systems.

In the design of the ventilation system for the battery rooms at elevations 54 feet and 163 feet, a common duct is used between the battery rooms and the exhaust fans. Independence is provided with the use of individual exhaust ducts from each room, separate fire dampers, and low flow alarm. All equipment ductwork, and hangers are qualified for Seismic Category I. These systems are provided with two 100 percent redundant fans powered by redundant Class 1E

power systems. This design will enable individual battery rooms to operate simultaneously with the operation of one redundant exhaust fan.

8.1.7 Conformance With Branch Technical Positions (BTP)

Conformance with applicable Branch Technical Positions ICSB (PSB)-4, 8, 11, 18 and 21, PSB-1 and PSB-2 is discussed below.

8.1.7.1 Branch Technical Position ICSB (PSB)-4, Requirements on Motor Operated Valves in the ECCS Accumulator lines

This BTP is not applicable to HCGS because HCGS is a BWR plant which does not have safety injection tanks in the ECCS.

8.1.7.2 Branch Technical Position ICSB (PSB)-8, Use of Diesel Generator Sets for Peaking

HCGS is in compliance with this BTP. The diesel generators sets are not used for peaking service.

8.1.7.3 Branch Technical Position ICSB (PSB)-11, Stability of Offsite Power Systems

The grid stability analysis provided in Section 8.2.2 includes study of the loss of the largest operating unit in conformance with this BTP.

8.1.7.4 Branch Technical Position ICSB (PSB)-18, Application of the Single Failure Criterion to Manually Controlled Electrically Operated Valves

Section 6.3.3.3 provides an evaluation of the effect of loss of electric power to manually controlled electrically operated valves on ECCS performance. Section 6.3.2.8 discusses the administrative controls and indication features available for manually controlled valves in the ECCS.

There are no electrically operated valves at HCGS that are deliberately disconnected from their power supplies to meet the single failure requirement for ECGS as referred to in BTP ICSB 18 (PSB).

8.1.7.5 Branch Technical Position ICSB (PSB)-21, Guidance for Application of Regulatory Guide 1.47

The Class 1E electric power system is designed to comply with this BTP and Regulatory Guide 1.47. Sections 1.8 and 8.1.4.9 discuss compliance with Regulatory Guide 1.47 and Section 7.5.1.3.2 describes the Bypassed and Inoperable Status Indication System (BISIS). Monitoring of electric power availability to safety-related systems is part of the BISIS design basis.

8.1.7.6 Branch Technical Position PSB-1, Adequacy of Station Electric Distribution System Voltages

A second level of undervoltage protection is provided on the 4.16-kV distribution system as discussed in Section 8.3.1.1.2.10. The selection of undervoltage and time delay setpoints are based on the voltage analysis presented in Section 8.3.1.2.1.

The analytical results obtained in the voltage analysis will be verified by tests performed during the preoperational testing program as described in Section 14.

The Technical Specifications will include requirements and parameters for testing and calibrating of the undervoltage protection devices.

8.1.7.7 Branch Technical Position PSB-2, Criteria for Alarms and Indications Associated with Diesel Generator Unit Bypassed and Inoperable Status

The Standby Diesel Generator (SDG) system is designed to comply with this BTP and Regulatory Guide 1.47. Sections 1.8 and 8.1.4.9

discuss compliance with Regulatory Guide 1.47. Section 7.5.1.3.2 indicates that the SDG system is part of the Bypassed and Inoperable Status Indication System and Section 8.3.1.6 provides additional discussion on this BTP.

TABLE 8.1-1

CLASS 1E SEPARATION CHANNELS
(SENSORS ENERGIZE TO OPERATE)

Channel A	Channel B	Channel C	Channel D
A and E sensors	B and F sensors	C and G sensors	D and H sensors
A SDG	B SDG	C SDG	D SDG
High Pressure Coolant Injection (HPCI) System	Reactor Core Isolation Cooling (RCIC) System	-	-
HPCI sensors A and E	RCIC sensors B and F	HPCI sensors C and G	RCIC sensors D and H
HPCI outboard valve	RCIC outboard valve	HPCI inboard valve	RCIC inboard valve
-	Automatic Depressurization System (ADS)	-	ADS
Residual heat removal (RHR) A	RHR B	RHR C	RHR D
Core spray A	Core spray B	Core spray C	Core spray D
Service water A	Service water B	Service water C	Service water D
Safety Aux Cooling System A	Safety Aux Cooling System B	Safety Aux Cooling System C	Safety Aux Cooling System D
A 250 V dc power	B 250 V dc power	-	-
A ac and dc power	B ac and dc power	C ac and dc power	D ac and dc power

TABLE 8.1-2

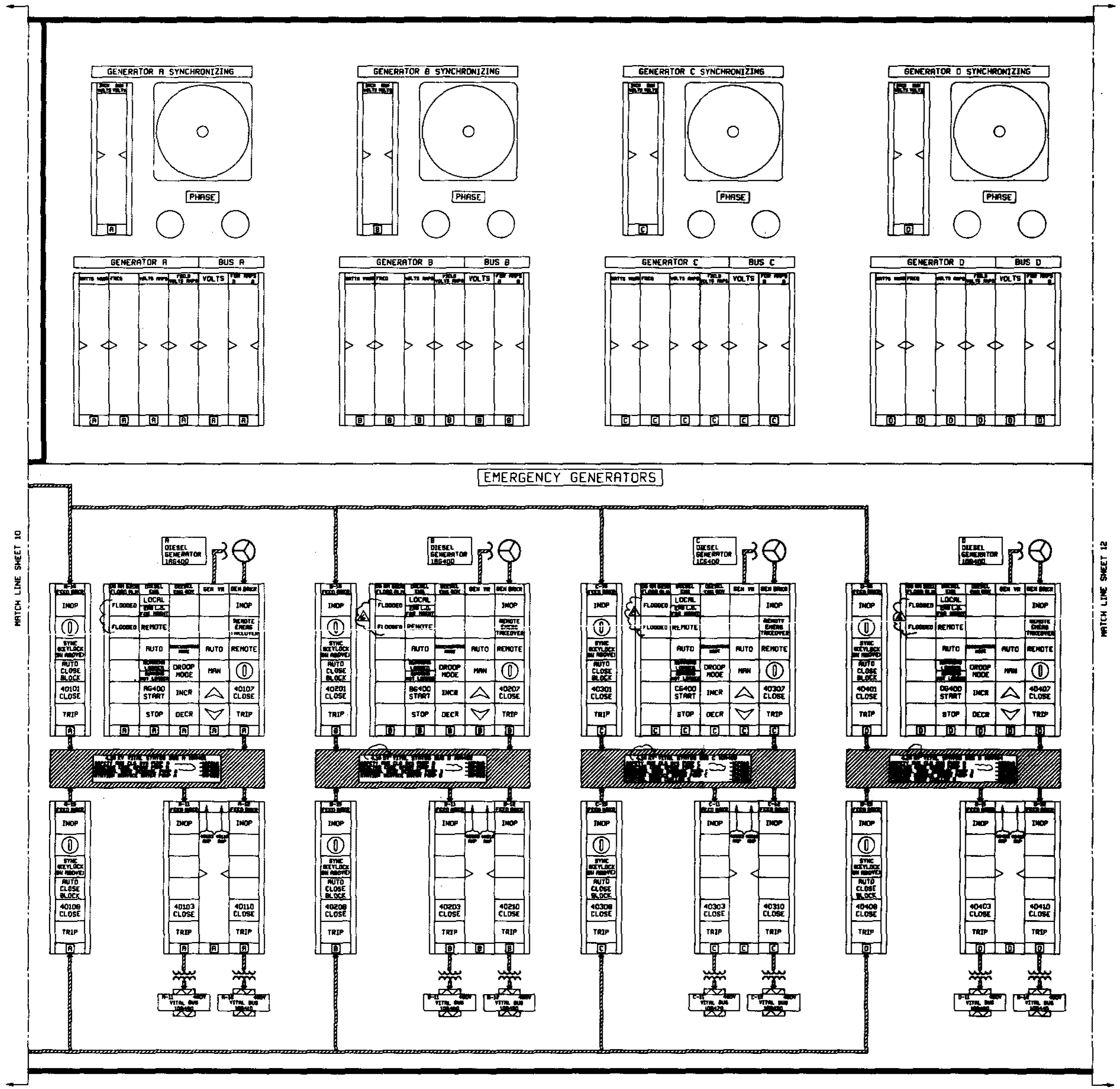
NON-CLASS 1E LOADS CONNECTED TO CLASS 1E BUSES
THROUGH CIRCUIT BREAKERS TRIPPED BY LOCA SIGNAL

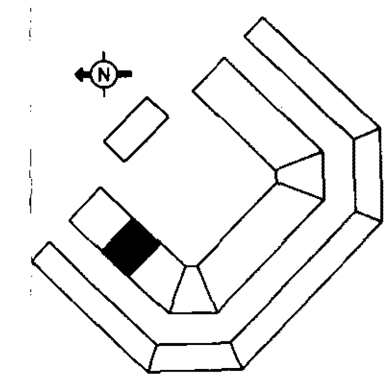
Load No.	Non-Class 1E Load Description	Class 1E Bus	Class 1E Circuit Breaker No.
1	Reactor Auxiliaries Cooling System Pump 1AP209	10B410	52-41011
2	Radwaste and Service Area MCC 10B313	10B410	52-41014
3	Reactor Building Supply Air Handling Unit 1BVH300	10B410	52-41024
4	Reactor Auxiliaries Cooling System Pump 1BP209	10B420	52-42011
5	Radwaste and Service Area MCC 10B323	10B420	52-42014
6	Reactor Building Exhaust Fan 1BV301	10B420	52-42024
7	Reactor Building Supply Air Handling Unit 1CVH300	10B430	52-43024
8	Control Rod Drive Pump 1AP207	10B430	52-43014
9	Control Rod Drive Pump 1BP207	10B440	52-44014
10	Reactor Building Supply Air Handling Unit 1AVH300	10B440	52-44024

TABLE 8.1-2 (Cont)

Load No.	Non-Class 1E Load Description	Class 1E Bus	Class 1E Circuit Breaker No.
11	Radwaste Area Supply Fan OBV316	10B440	52-44034
12	Reactor Area MCC 10B252	10B450	52-45011
13	Radwaste Area Exhaust Fan OAV305	10B450	52-45014
14	Emergency Instrument Air Compressor 10K100	10B450	52-45024
15	Reactor Building Exhaust Fan 1CV301	10B450	52-45034
16	Reactor Area MCC 10B262	10B460	52-46011
17	Radwaste Area Exhaust Fan OBV305	10B460	52-46014
18	Reactor Area MCC 10B272	10B470	52-47011
19	Radwaste Area Exhaust Fan OCV305	10B470	52-47014
20	Radwaste Area Supply Fan OAV316	10B470	52-47024
21	Technical Support Center MCC 00B474	10B470	52-47031

Load No.	Non-Class 1E Load Description	Class 1E Bus	Class 1E Circuit Breaker No.
22	Reactor Area MCC 10B282	10B480	52-48011
23	Reactor Building Exhaust Fan 1AV301	10B480	52-48024
24	Public Address System Inverter 10D496	10B451	52-451023
25	Security System Inverter OAD495	10B471	52-471023
26	Process Computer Inverter 10D485	10B441	52-441043





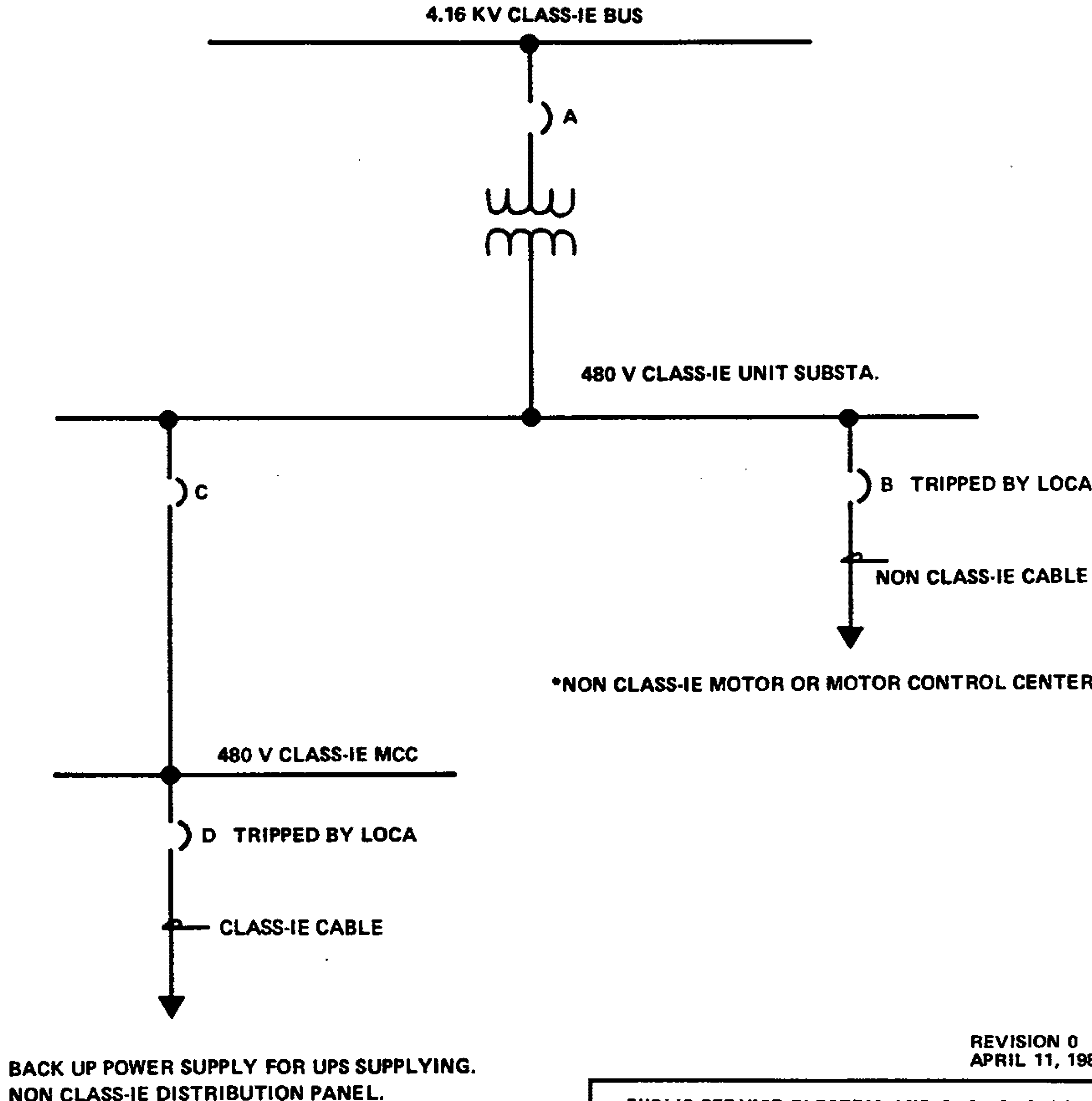
REVISION 0
APRIL 11, 1988

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

PANEL ARRANGEMENT
10C651 – UNIT OPERATORS
CONSOLE LEGENDS

UPDATED FSAR **FIGURE 8.1-1**

*FOR MOTOR LOADS, IN ADDITION TO CIRCUIT BREAKER B, THERE IS NON CLASS-IE CIRCUIT BREAKER DOWNSTREAM OF BREAKER B.



REVISION 0
APRIL 11, 1988

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

ISOLATION BETWEEN CLASS-IE POWER SUPPLIES AND NON CLASS-IE LOADS–TRIPPING CIRCUIT BREAKER

UPDATED FSAR

FIGURE 8.1-2

8.2 OFFSITE POWER SYSTEMS

8.2.1 Description

8.2.1.1 Transmission Systems

The Bulk Power Transmission System at Hope Creek Generating Station (HCGS) operates nominally at 500-kV. The station supplies power to the 500-V system through three single phase power transformers. These transformers step the voltage up from 24 to 500 kV. The offsite power for the plant is fed through the 500-kV system via the 13.8-kV yard.

Plant Drawing 205415 shows the 500/13.8-kV yard and the 500-kV transmission lines in the vicinity of the plant. All HCGS lines are on separate towers and terminate at widely separated switching stations. The 13.8-kV and 500-kV sections of the yard are physically tied together through two sets of two station power transformers, T1, T2, T3, and T4, located in the 13.8-kV yard.

[redacted]

[redacted]

Transmission lines meet or exceed design requirements set forth by the National Electrical Safety Code and agree with Lower Delaware Valley 500-kV Transmission Design Criteria. Lines meet the Army Corps of Engineers requirements for clearance over flood levels. All bulk power transmission lines are designed to withstand 100 mph wind loads on bare conductors. The transmission network provided for the Hope Creek plant complies with General Design Criteria (GDC) 17 and 18 of Appendix A to 10CFRPart 50.

8.2.1.2 Transmission Interconnection

PSE & G belongs to the Pennsylvania-New Jersey-Maryland Interconnection (PJM). This power pooling arrangement facilitates, through the coordinated planning and operation of its eleven members

in five stats and the District of Columbia, economical and reliable exchanges of power, both within PJM and with adjacent nonmember utilities and power pools under a wide range of normal and emergency conditions. Direct bulk power ties connect PSE&G, Pennsylvania Power and Light, Philadelphia Electric, Jersey Central Power and Light, Atlantic City Electric, and Delmarva Power and Light. PSE&G also has bulk power ties to the neighboring non-PJM companies of Consolidated Edison, and Orange and Rockland.

[redacted]

[redacted]

[redacted]

This configuration of the offsite power system, with provisions for periodic testing, is in full conformance with NRC GDC 17 and 18 of Appendix A to 10CFRPart 50, which is further discussed in Section 8.3.1.2.1.

HCGS complies with Regulatory Guide 1.32. Clarifications and exception are noted in Section 1.8.

[redacted]

8.2.1.4.1 13.8-kV Supply

Station power is supplied from the 13.8-kV switchyard via multiple runs of 15-kV, 2000-kcmil power cable in polyvinyl chloride (PVC) conduit. The PVC conduit runs are encased in concrete and run underground from the 13.8-kV feeder positions to in-plant station service transformers. These duct banks are routed to minimize the possibilities of simultaneous failure under operating, postulated accident, and environmental conditions.

8.2.1.5 System Monitoring

PSE&G transmission lines and rights of way are patrolled at least five times each year to ensure that the physical and electrical integrity of transmission line supports, hardware, insulators, and conductors are acceptable for safe and reliable service. This

periodic transmission line patrol is conducted by helicopter and ground patrols. Climbing inspections of structures are performed at least every 3 years depending on the age of the line.

Monitoring of the offsite power sources in the plant control room is provided for by a hard wired, console mounted, mimic bus arrangement that shows the status of station power, and station service transformers. Potential indication of the 500/13.8 kV systems and status indication of the transformer secondary and bus tie disconnect switches are provided by the plant computer systems. Control and status indications of all 500-kV and 13.8-kV breakers are also shown. Annunciation accompanies status changes of circuit breakers, loss of potential, transformer trouble, fire protection system actuation, carrier equipment failure, and fault recorder failure.

The switchyard fault recorder inputs include phase currents, voltages, and carrier information for all three Hope Creek switchyard offsite power sources. Inputs to the plant fault recorder include the following:

1. Voltage and current information on the generator and main transformer

2. Voltage information on the 13.8-kV bus sections 1, 5, 6, and 10

3. Voltage information on the station service transformers

4. Voltage information on all 7.2-kV and 4.16-kV buses.

The Plant Computer System displays additional offsite power system information for the operator on CRTs. Each display is a mimic bus arrangement similar to the hard wired mimic bus and includes the status of switchyard power circuit breakers (PCBs).

The main generator output leads to the 500-kV switchyard are monitored in the control room. A mimic bus arrangement provides control and status indication of the synchronizing PCB. Potential indication and monitoring of current, watts, volt amperes reactive (VARs), watt hours, and voltage are provided. Annunciation accompanies an abnormal change in the status of the synchronizing PCB and failure of the supervisory system.

[redacted]

8.2.2 Analysis

The PSE&G bulk and power system is planned in accordance with Mid-Atlantic Area Council (MAAC) Reliability Principles and Standards. MAAC is one of ten regional reliability councils of the North American Electric Reliability Council (NERC). These Reliability Principles and Standards ensure that the planning for the expansion of the system is conducted in a logical and consistent manner to provide safe, adequate, and proper service to the customers. The primary objective of MAAC is to continually review all planning in conjunction with additions or revisions to generating plant or bulk power transmission facilities, in order to ensure that they conform to accepted standards of reliability.

The addition of HCGS and associated bulk system transmission facilities were planned and tested using system simulation for both computer power flow and transient stability studies. These studies tested the compliance of the planned systems with the MAAC Reliability Principles and Standards.

The power flow portion of the analysis consisted of testing the planned system under normal and emergency conditions. The transmission system was tested under normal conditions in order to assess the transmission network element loadings with the addition of the Hope Creek project. Testing included simulation of heavy power transfer conditions followed by single and multiple transmission facility outages.

Under all power flow conditions tested, the station and its transmission arrangements satisfy the MAAC Reliability Principles and Standards.

The stability analysis was conducted for the system configuration using the PSS/E Load Flow and Dynamic Stability program provided by Power Technologies Incorporated.

Breaker 62X is added to the switchyard based on the PJM Impact Study, Q Positions, pages 17 through 19.

The types of faults tested in accordance with the MAAC Criteria, Section IV, were:

1. Three phase faults with normal clearing time

2. Single phase to ground faults with delayed clearing.

The analysis established that the critical fault condition was a three phase fault on the Hope Creek to Red Lion 500 kV line at HCGS. The single phase to ground fault case with delayed clearing simulated a stuck breaker condition, such that with independent pole tripping of the breakers, the breaker closest to the fault on the faulted phase failed to open. Therefore, backup or delayed clearing is required to isolate the fault. A transient stability case list is given in Table 8.2-1.

Additionally, analysis of the most severe multiphase fault with delayed clearing (stuck 500 kV Breaker 60X) on the Hope Creek – Red Lion 500 kV line at Hope Creek, shows that Salem No. 1 and 2, and Hope Creek No. 1 Units will lose synchronism and trip. However, the 500 kV system remains transiently stable.

[redacted]

The circuits from the offsite system to the onsite distribution system are of sufficient capacity and capability to supply the station loads during normal or abnormal operating conditions, accident conditions or plant shutdown conditions independent of the onsite standby power sources. The circuits consist of two paths as shown on Plant Drawing E-0001-0. One path is from Station Power Transformers T1 and T3 to the station service transformers as shown. Whereas, the other path begins from Station Power Transformers T2 and T4. In the event that one of the paths is unavailable and/or the offsite system has a degraded voltage condition, automatic transfer of its station distribution buses to the other path is initiated.

On the Class 1E 4 kV buses the transfer circuit has two functions. One is to transfer the bus to the alternate source if the normal source is lost due to transformer fault. The other function is to transfer the bus to the alternate source if the normal source has an undervoltage condition. The transfer circuit is shown in each of the main circuit breaker schematic diagrams. The applicable diagrams were submitted under separate cover in accordance with Regulatory Guide 1.70, Revision 3, Section 1.7 and consist of Drawing Numbers E-0068-0 thru E-0075-0 and Sheets 3 and 4 of E-0106-0 together with other drawings referenced thereon.

There are eight main circuit breakers, two for each bus, and the transfer circuit is typical for each breaker. The transfer circuit(s) is described as follows, using Bus 10A401 as an example:

1. <u>Transformer Fault/Transformer Feeder Fault</u>

   Bus 10A401 is normally supplied from station service transformer 1AX501 through main circuit breaker (1)52-40108. Drawing Number E-0068-0 shows this breaker's schematic diagram. In the event transformer protective relay operation (differential, ground overcurrent or overcurrent relay), lockout relay (3)86TR-AX501 or (3)86TB1-AX501, or feeder differential protection lockout relay (3)86AXR, shown on Drawing Number E-0112-0, will trip breaker (1)52-40108 and close the alternate feeder breaker (1)52-40101, shown on Drawing Number E-0069-0.

2. <u>Undervoltage of Normal Source Voltage</u>

   Undervoltage relays (1)27-40108(A-B) and (1)27-40108(B-C) will pickup auxiliary relays (1)27X-40108(A-B) and (1)27X-40108(B-C) when the normal source voltage is less than 92 percent and greater than 70 percent of rated bus voltage for greater than 20 seconds as shown on Drawing Number E-106-0 Sheet 3. For voltages less than 70 percent of rated the auxiliary relays (1)27X-40108(A-B) will be picked up instantaneously via the 92 percent undervoltage relay (1)27-40108(A-B) and (1)27AXZ-401 contacts 5-6 and (1)27X-40108(B-C) will be picked up instantaneously via the 92 percent undervoltage relay (1)27-40108(B-C) and (1)27AXZ-401 contacts 7-8 as shown on Drawing Number E-106. Contacts 7-8 of the two auxiliary relays are connected in series to provide a trip signal to breaker (1)52-40108 upon relay actuation - shown as wire number 31 in Drawing Number E-0068-0. This bus is now deenergized since the normal source feeder breaker is tripped. Bus undervoltage relays (1)27A1-401(A-B), (1)27A1-401(B-C), (1)27A2-401(A-B) and (1)27A2-401(B-C) will operate auxiliary relays (1)27AX1-401(A-B), (1)27AY1-401(A-B), (1)27AX1-401(B-C), (1)27AY1-401(B-C), (1)27AX2-401(A-B), (1)27AY2-401(A-B), (1)27AX2-401(B-C), and (1)27AY2-401(B-C) - all shown on Sheet 3 of Drawing Number E-0106-0.

   Of the eight auxiliary relays, contacts 9-10 of (1)27AY1-401(A-B), (1)27AY1-401(B-C), (1)27AY2-401(A-B)

and (1)27AY2-401(B-C) are connected in a two-out-of-four, twice arrangement to close the alternate source feeder breaker (1)52-40101 - shown as wire number 52 on Drawing Number E-0069-0.

The transfer circuit will be tested during the preoperational test of Class 1E 4.16 kV ac power system as indicated in Section 14.2.12.1.32. This test will include actual loads on the bus if the loads are ready for preoperational test; otherwise the complete bus transfer test will be performed during the ECCS integrated initiation during loss of offsite power preoperational test described in Section 14.2.12.1.47. The protective relays of the transfer circuit are designed for testing during normal plant operation by use of test plugs or test switches to isolate their actuating function. Actual power source transfer testing from the normal source to the alternate sources as required by GDC 18 will be performed in accordance with surveillance requirement 4.8.1.1.1 of the Standard Technical Specifications. Power source transfer testing is not performed during power operation in order to preclude an undesirable transient which may result due to the interruption of normal ac power to an individual bus should the transfer sequence fail.

Voltage analysis performed indicate that each path is of sufficient capacity and capability to supply all the station loads, Class 1E and non-Class 1E, without exceeding design limits of the station equipment.

8.2.2.1 Outages of Transmission Lines in Vicinity of the Station

To demonstrate the reliability of the transmission line associated with the Hope Creek station, unscheduled outages of existing transmission lines (of similar or identical design) in the geographical area were investigated. Unscheduled outages of these lines for the past 5 years are listed below:

Transmission Lines	1978	1979	1980	1981	1982
Salem - Keeney	0	0	2	1	1
Salem - New Freedom-North	1	0	1	0	0
Salem - New Freedom-South	0	0	0	1	1

Historically, outages in the area have been caused by lightning strikes, fires, and equipment problems.

8.2.2.2 Separation of Offsite Power Supplies Within the Plant

The circuits for the offsite power supply located within the plant are designed to comply with the requirements of GDC 17. Refer to Section 8.3.1.2.1 for a detailed description.

TABLE 8.2-1

SIMULATED HCGS TRANSIENT STABILITY CASE LIST[(1)]

Transient stability analysis performed and incorporated in Engineering Evaluation A-5-EEE-1686 for various grid disturbances indicates that the grid is stable for all faults that meet the (Mid Atlantic Area Committee) MAAC criteria.

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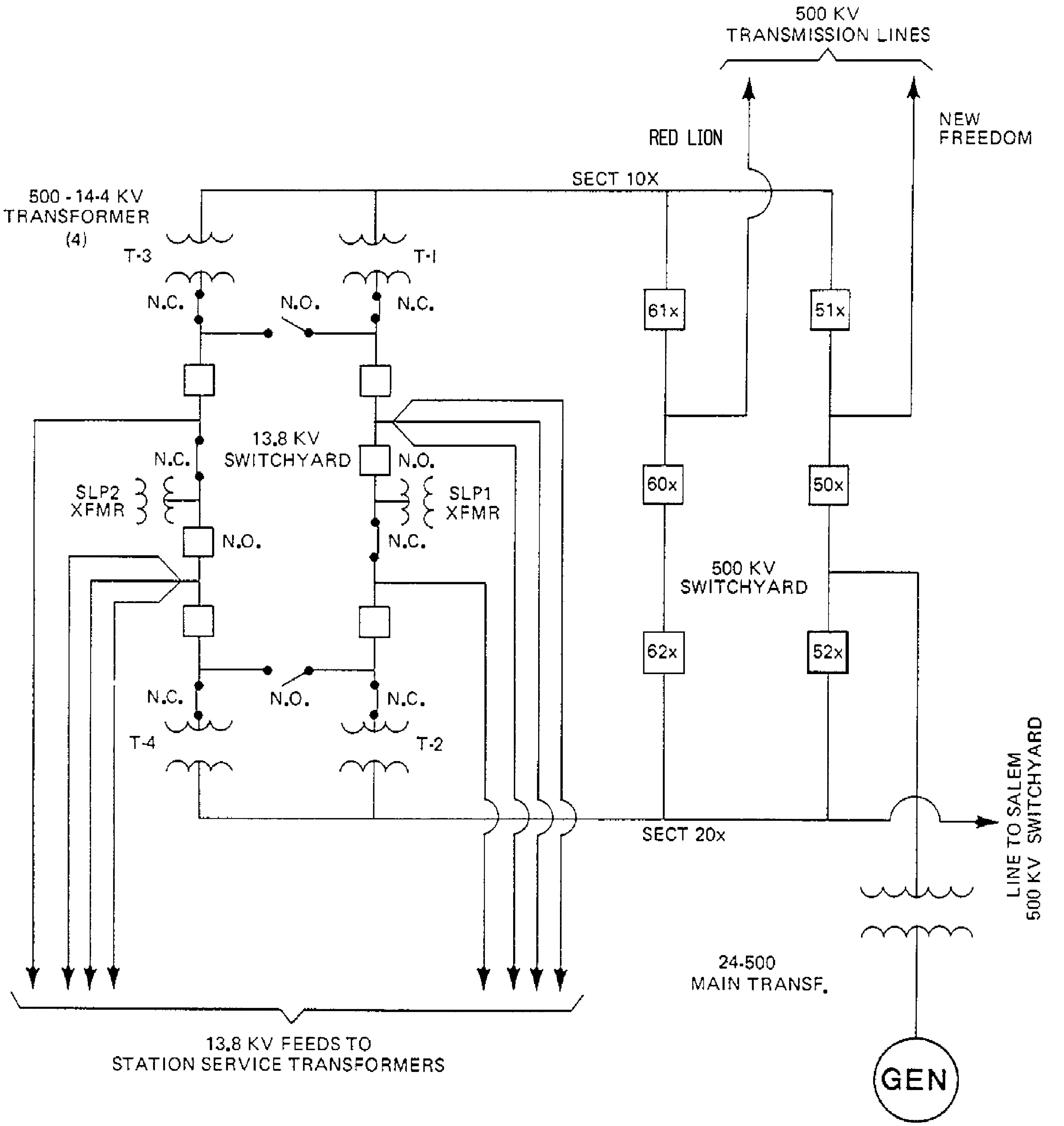
(1) 1987, 50 percent of summer peak load

Figure F8.2-1 intentionally deleted.

Refer to Plant Drawing 205415 in DCRMS



PSEG NUCLEAR, L.L.C. HOPE CREEK GENERATING STATION	
ONE-LINE DIAGRAM	
Updated FSAR	Sheet 1 of 1
Revision 14, July 26, 2005	Fig. 8.2-2

8.3 ONSITE POWER SYSTEMS

The Onsite Power Systems consist of ac and dc power systems.

8.3.1 Ac Power Systems

8.3.1.1 Description

The onsite ac power systems include a Class 1E system and a non-Class 1E system. Plant Drawing E-0001-0 is the single line drawing of both the systems.

The onsite ac power is defined in Section 8.1.2.

8.3.1.1.1 Non-Class 1E AC Power System

The non-Class 1E portion of the Onsite Power System supplies ac power to non-Class 1E loads. A limited number of non-Class 1E loads, important to the power generating equipment integrity, are supplied from the Class 1E distribution system through isolation devices. These non-Class 1E loads are listed in Table 8.3-1.

The offsite power for the plant is fed through the 500-kV system via the 13.8-kV yard ring bus. Two separate buses, 10X and 20X, of the 500-kV switchyard, feed the 13.8-kV ring bus via 500 GND Y/2.88.7-14.4 kV station power transformers, T1, T3 and T2, T4, respectively, as shown on Plant Drawing E-0001-0. Physically independent routing of bus 10X and 20X feeders from sections 1 and 2 of the 500-kV switchyard to the station power transformers T1, T3 and T2, T4, minimizes the likelihood of simultaneous failure of the two 500-kV buses. The 13.8-kV ring bus provides auxiliary power during startup, normal operation, shutdown, and post shutdown operation of the unit. Station power transformers T1 and T4 each feed two 13.8-4.16-kV and one 13.8-7.2-kV station service transformer. Station power transformers T2 and T3 each feed one 13.8-4.16-kV station service transformer, one 13,800-208GNDY/120 V station lighting power transformer, and one 13.8/13.8 kV island

substation transformer. Two 7.2-kV and six 4.16-kV non-Class 1E buses are supplied from the above eight station service transformers. The 7.2-kV buses are 10A110 and 10A120, and the 4.16-kV buses are 10A101, 10A102, 10A103, 10A104, 10A501, and 10A502. The configuration of the non-Class 1E power system is described below for the normal operation of the 13.8-kV ring bus and all the 4.16-kV and 7.2-kV non-Class 1E buses.

1. Station power transformer T1 feeds station service transformers 1BX501, 1BX502, and 1BX503, which are the normal sources of power for buses 10A102, 10A120, and 10A502, respectively, and alternate sources of power for buses 10A101, 10A110, and 10A501, respectively.

2. Station power transformer T4 feeds station service transformers 1AX501, 1AX502, and 1AX503, which are the normal sources of power for buses 10A101, 10A110, and 10A501, respectively, and alternate sources of power for buses 10A102, 10A120, and 10A502, respectively.

3. Station power transformer T2 feeds station service transformer 1CX501, which is the normal source of power for bus 10A104 and the alternate source of power for bus 10A103.

4. Station power transformer T3 feeds station service transformer 1DX501, which is the normal source of power for bus 10A103 and alternate source of power for bus 10A104.

To maintain power continuity at these buses, fast transfer control schemes are provided for each of these buses to transfer these buses from their respective normal sources to alternate sources. Upon the occurrence of an off normal condition (transformer or transformer feeder protective relay actuation) on the normal power supply to a bus, the fast transfer control scheme initiates the automatic tripping of the normal power source feeder breaker and closing of the alternate source feeder breaker on the bus. When

the normal power supply is restored, transfer of the bus from the alternate power supply source to the normal power supply source is manually initiated by the control room operator. These infeed breakers to each bus are interlocked such that only one can be closed at any one time.

The onsite non-Class 1E ac system distributes power at 7.2 kV, 4.16 kV, 480 V, and 208/120 V.

The 7.2-kV system supplies power to large auxiliary loads, such as the motor generator sets for the reactor recirculation pumps, condensate pumps, station air compressors and water chillers. The non-Class 1E 4.16-kV system feeds large auxiliary motor loads, single ended and double ended unit substations. A tie circuit breaker is provided for each of the double ended unit substations. Interlocks are provided so that the tie breaker can be closed only if one of the infeed breakers of the double ended unit substation is open.

The 480 V unit substations feed 480 V motor control centers (MCC), motors of 100 to 250 horsepower rating, and 480 V power panels. MCCs supply power to motors of up to 75 horsepower rating, battery chargers, 480/277 V power distribution panels, and 480 and 208/120 V power distribution panels. Uninterruptible power supply (UPS) panels of 120 V ac supply the security system, public address system, plant computer, etc. As a design enhancement to improve the reliability of certain non-safety related control circuits, 120V AC UPS are provided to the select Control Cabinets considered critical for stable power operation associated with Feedwater Heaters, Service Air, Safety Auxiliary Cooling, Reactor Recirc. System MG Sets and Off-Gas Systems. The distribution panels feed miscellaneous loads such as lighting, space heaters, and unit heaters.

The non-Class 1E equipment ratings are listed below:

1. Transformers

   a. Main stepup transformer: 3-1 ϕ, 466.7 MVA, FOA 65°C, 24.0-500.1 GNDY/288.75 kV; impedance 21.4% $\pm$ 7.5% tolerance, NLTC +7.5 percent to −2.5 percent in 2-1/2 percent steps.

b. Station power transformer: 4-3 ϕ, 42/56/70 MVA each, OA/FOA/FOA, 65°C, 500 GNDY/288.7-14.4 kV, impedance 5.1 percent nominal on 42 MVA base NLTC ±5 percent in 2-1/2 percent step

c. Station service transformers: 2-3 ϕ, 15/20/25 MVA, OA/FOA/FOA 55°C, and 16.8/22.4/28.0 MVA, OA/FOA/FOA 65°C, 13.8-7.2 GNDY/4.16 kV, impedance 5.5 percent on 15 MVA base. HV-LTC= -15 percent to +5 percent

4-3 ϕ, 17.41/23.21/29 MVA, OA/FOA/FOA 55°C and 19.5/26/32.5 MVA, OA/FOA/FOA 65°C, 13.8-4.16 GNDY/2.4 kV, impedance 7.7 percent on 17.41 MVA base. HV-LTC= -15 percent to +5 percent

2-3 ϕ, 14.7/19.6 MVA OA/FA 55°C, 16.5/21.95 MVA OA/FA 65°C, 13.8-4.16 GNDY/2.4 kV, impedance 5.14 percent nominal on 14.7 MVA base, HV-LTC= -15 percent to +5 percent

d. Station lighting and power transformer: 2-3 ϕ, 500 kVA, 13,800-208 V GNDY/120 V

e. Island substation transformer: 2-3 ϕ, 12/16 MVA, OA/FA 65°C, 13.8-13.8 kV Y/7970 V, impedance 5.89 percent (SLP3), 5.94 percent (SLP4) on 12 MVA base at 13.8 kV.

2. Switchgear

a. 7.2-kV switchgear: 1200/2000 A continuous rating, 500 MVA 3 ϕ class, 35,000 A interrupting rating at 8250 V (maximum rated voltage)

b. 4.16-kV switchgear: 1200/2000 A continuous rating 350 MVA 3 ϕ class, 42,400 A interrupting rating at 4760 V (maximum rated voltage)

c. 13.8-kV switchgear: 1200 A continuous rating, 19,300 A short circuit current (symmetrical) rating

3. 480-V unit substations

a. Transformers:

(1) 1000 kVA, 3 ϕ, 4160-480 GNDY/277 V

(2) 1500 kVA, 3 ϕ, 4160-480 GNDY/277 V

b. Bus: 2000 A continuous rating for 1000 kVA unit substations, 3200 A continuous rating for 1500 kVA unit substations

c. Breakers (metal clad): 30,000 A or higher

4. 480 V Motor control centers (MCCs)

a. Horizontal bus: 800 A continuous rating, 42,000 A bracing

b. Vertical bus: 300 A continuous rating, 42,000 A bracing

c. Breakers (molded case); 150 A and 250 A frame sizes, 25,000 A, symmetrical rms interrupting rating

5. 120 V instrument ac distribution panels

1. Buses: 225 A continuous rating, 10,000 A bracing

2. Breakers (molded case): size shown on Plant Drawing E-0012-1, 10,000 A interrupting rating

6. AC and computer distribution panels

   a. Buses: 225 A continuous rating, 10,000 A bracing

   b. Fuses: 10,000 A interrupting rating

8.3.1.1.2 Class 1E AC Power System

The Class 1E power system supplies all Class 1E loads that are needed for safe and orderly shutdown of the reactor, maintaining the plant in a safe shutdown condition, and mitigating the consequences of an accident. In addition to Class 1E loads, the Class 1E system supplies power, through isolation devices, to a limited number of non-Class 1E loads that are important to the integrity of the power generating equipment. Isolation between Class 1E power supply buses and the non-Class 1E loads is achieved by tripping the Class 1E breaker under LOCA condition. This is in accordance with IEEE 384-1981, Paragraph 7.1.2.2. These non-Class 1E loads are listed in Table 8.3-1.

The Class 1E ac power system distributes power at 4.16 kV, 480 V, and 208/120 V. The Class 1E power system is divided into four independent channels. Each power system channel supplies power to loads in its own load group. Each Class 1E 4.16 kV bus is provided with connections to the two offsite power sources. One of these sources is designated as the normal source and the other as the alternate source for the bus. In addition to these two connections to the offsite power, each of the 4.16-kV Class 1E buses is connected to its dedicated standby diesel generator (SDG). These SDGs serve as the standby electric power source for their respective channels in case both the normal and alternate power supplies to a bus are lost.

8.3.1.1.2.1 Power Supply Feeders

Each Class 1E 4.16-kV bus is provided with a normal and an alternate offsite power supply feeder and one SDG feeder.

Each bus is normally energized by the normal power supply. If the normal power is not available at the 4.16 kV bus due to transformer or transformer feeder protective relay actuation, automatic fast transfer to the alternate source takes place as described in Section 8.3.1.1.1. If the normal power supply is lost due to degraded grid conditions (i.e., bus voltage less than 92 percent of rated volts for greater than 20 seconds) or a loss of voltage (i.e., bus voltage less than 70 percent), a slow or dead bus transfer to the alternate source takes place. If both the normal and the alternate power sources are unavailable, the loads on each bus are picked up automatically by the SDG assigned to that bus in a predetermined sequence as shown in Table 8.3-1.

8.3.1.1.2.2 Bus Arrangement

The Class 1E ac power system is divided into four independent power supply channels, A, B, C, and D. Each of these four channels supplies loads in its own load group. All the Class 1E loads are assigned to these channels so that any combination of three out of four load groups has the capability to supply the minimum required safety loads to safely shut down the unit and mitigate the consequences of an accident. The four electrical channels support two mechanical divisions (Divisions I and II).

The distribution system of each channel consists of one 4.16-kV bus, two 480 V unit substations, MCCs and low-voltage distribution panels. The bus arrangements are shown on Plant Drawing E-0001-0.

8.3.1.1.2.3 Loads Supplied From Each Bus

Loads supplied from Class 1E buses are shown on Plant Drawings E-0006-1, E-0009-1, E-0011-1, E-0012-1 and E-0018-1.

8.3.1.1.2.4 Manual and Automatic Interconnections Between Buses, Buses and Loads, and Buses and Supplies

Each Class 1E power supply channel feeds loads in its own load group. No provisions exist for the following:

1. Interconnecting redundant Class 1E buses either manually or automatically

2. Automatic or manual transfer of loads in one group to a redundant load group

3. Interconnecting Class 1E buses to non-Class 1E buses, except where Class 1E unit substations feed non-Class 1E MCCs. These Class 1E unit substation breakers feeding non-Class 1E MCCs are automatically tripped on a LOCA.

The feeders originating from the secondary windings of station service transformers that supply power to both the Class 1E buses and non-Class 1E buses are not considered bus interconnections. The feeders from station service transformers to the Class 1E switchgear buses are considered non-Class 1E. This is in accordance with IEEE 384-1981.

Electrical interlocks are provided so that:

1. Only one of the two offsite power infeed breakers to a bus, either normal or alternate, can be closed at any one time. This prevents the parallel operation of the two offsite power supplies.

2. Only during SDG test can the SDG breaker close while the bus is energized from one of the offsite sources.

When operating on the SDG power supply, during loss of offsite power (LOP), redundant load groups cannot be connected together, since the 4.16-kV circuit breakers controlling the incoming normal and alternate power supplies to the Class 1E buses are interlocked to prevent their automatic closure. This prevents paralleling of the SDGs.

8.3.1.1.2.5 Redundant Bus Separation

The Class 1E switchgear, unit substations, MCCs, and control and power distribution panels for redundant load groups are located in

separate Seismic Category I rooms or are spatially separated by a predetermined safety distance or barrier in the reactor and auxiliary buildings to ensure physical and electrical separation. Electrical equipment separation is discussed in Section 8.1.4.14.

8.3.1.1.2.6 Class 1E Equipment Ratings

1. 4.16-kV switchgear

   a. Bus: 1200 A continuous rating, 350 MVA, 3 phase

   b. Circuit breakers: 1200 A continuous rating,rated short circuit current at rated maximum voltage - 42,400 A.

2. 480 V unit substations

   a. Transformers: 4160-480 GNDY/277 V, 1333 kVA, nominally 9.0 percent impedance, 3 ϕ, AA, 80°C rise, ventilated dry-type.

   b. Circuit breakers: 800 A frame size rms, symmetrical interrupting rating 30,000 A or higher

   c. Bus rating: 2000 A continuous

3. 480 V MCC buses

   a. Continuous current rating

      (1) Main horizontal: 800 A

      (2) Vertical: 300 A

   b. Short circuit withstand capability: 25,000 A rms symmetrical, minimum

c. Circuit breakers (molded case): 480 V, interrupting rating, at least 25,000 A rms symmetrical

d. 120 V ac distribution panels

   a. Buses: 225 A continuous rating, 10,000 A bracing

   b. Breakers: 100 A frame size, 10,000 A interrupting rating.

5. 120 V ac UPS panels

   a. Buses: 225 A continuous rating, 10,000 A bracing

   b. Fuses: 10,000 A interrupting rating.

8.3.1.1.2.7 Automatic Load Shedding and Sequential Loading

Load shedding of the loads off the Class 1E buses is achieved by tripping the 4.16-kV breakers as described below:

1. Upon LOP, undervoltage relays monitoring the voltage on the Class 1E buses, trip all the breakers on their respective buses except the two breakers on each bus, which supply power to 480 V unit substations.

2. Upon the occurrence of a LOCA, the 480 V unit substation breakers feeding the non-Class 1E loads are tripped.

The load shedding of non-Class 1E loads connected to Class 1E unit substation busses occurs upon a loss of offsite power and upon LOCA. During a LOP without LOCA condition, each Class 1E electrical bus has undervoltage relays that energize auxiliary relays which trip the non-Class 1E loads except for MCCs connected to the Class 1E buses and the non-Class 1E Emergency Instrument Air Compressor which is controlled by an integral magnetic starter which opens on loss of power to trip the load. The emergency load sequencer has no electrical interconnection with the load shedding of the non-Class 1E loads.

If offsite power is available and LOCA occurs, then individual LOCA signals will go directly to the Class 1E unit substation breakers feeding the non-Class 1E loads and trip these breakers. Any Class 1E loads that are running during the condition will remain running.

The emergency load sequencer (ELS) has no electrical interconnection with the tripping of the non-Class 1E loads by the LOCA signal and, in addition, has no electrical inter ties with the offsite power sources.

Each channelized ELS consists of two individual solid state sequencers that are housed in a single control panel. These two solid state sequencers are for the LOP sequence and the LOCA sequence. The LOP and LOCA sequencers have two solid state logic timers for each particular sequence powered from redundant internal power supplies. Each of the four channelized ELS has these internal redundant component features.

There are four Class 1E emergency load sequencers, one for each of the four Class 1E power divisions. These four emergency load sequencers are electrically and physically independent of each other. There are no interconnections of electrical cabling between any of the four divisional emergency load sequencers. The individual solid state design circuitry and unique redundant solid state timers and power supplies within each emergency load sequencer minimize the possibility of a sneak circuit or misoperation of an individual ELS. In the event that an ELS did have inadvertent operation as a result of a sneak circuit, only one Class 1E ELS would be impacted since each ELS is electrically and physically independent of each other. There would be three Class 1E ELS available for plant shutdown if any single ELS failed.

There are no credible sneak circuits or common failure modes in the sequencer design that could impact the availability of the

onsite and offsite power sources. The HCGS sequencer design does not degrade the combined reliability of the onsite and offsite power sources.

Sequential loading is shown in Table 8.3-1.

Control power for the ELSs is provided from their respective channel of uninterruptible power supply source.

The inputs and outputs of the four ELSs are electrically and physically separated to meet the requirements of Regulatory Guide 1.75.

During normal plant operation, the ELSs are in a standby condition. Each of the four ELSs is supplied inputs from its corresponding channel that represent:

1. LOCA - Low reactor vessel level and/or high drywell pressure condition.

2. LOP - Undervoltage condition on the ELS's corresponding 4.16 kV Class 1E bus.

3. Standby Diesel Generator (SDG) circuit breaker closed.

4. Remote system reset.

Each ELS provides the following four sets of outputs fanned out to various plant electrical loads within its Class 1E channel system:

1. Sequential start signals to loads required following a LOCA.

2. Sequential starts signals to loads required following a LOP.

3. One set of process start inhibit signals (PSIS) to the LOCA Loads to prevent inadvertent starting of LOCA equipment due to automatic signals while ELS is in operation.

4. One set of PSIS to prevent inadvertent starting of the LOP equipment due to automatic signals while the ELS is in operation.

The ELSs respond to the receipt of LOCA and/or LOP signals in the following manner:

1. LOP ONLY

The LOP input to the sequencer resets the logic to prevent starting of the ELS timer until the SDG circuit breaker closes. Upon the closing of the SDG circuit breaker, the ELS timer starts applying the LOP loads in the predetermined sequence. The 'LOP Loads' refers to the loads that are required to shutdown the reactor safely under an LOP event. The LOP sequencer is manually reset after the end of the LOP sequence.

2. LOCA ONLY

The LOCA signal sheds a non-Class 1E loads (independent of ELS) and initiates the ELS logic to start applying the LOCA loads in the predetermined sequence. The LOCA loads here refer to the loads that are required to shutdown the reactor safely under LOCA condition. The LOCA sequence is manually reset after the end of LOCA sequence.

3. LOCA DURING LOP SEQUENCING

The LOCA signal sheds non-Class 1E loads (independent of ELS), and overrides the LOP sequencer and starts the LOCA sequencer to apply LOCA loads in the predetermined sequence.

4. LOP DURING LOCA SEQUENCING

The LOCA sequencer stops and resets. When the power is restored to the 4.16 kV Class 1E bus associated with the ELS, the LOCA signal overrides the LOP timer initiated signal. The LOCA sequencer restarts applying LOCA loads.

5. LOCA AFTER LOP SEQUENCING COMPLETED

The LOCA signal sheds the non-Class 1E loads (independent of ELS) and starts the LOCA sequencer to apply LOCA loads in a predetermined sequence.

6. LOP AFTER LOCA SEQUENCING COMPLETED

If a LOCA signal is still present when the SDG circuit breaker is closed, the LOCA signal overrides the LOP sequencer and starts the LOCA sequencer to apply LOCA loads in the predetermined sequence.

For scenarios '1' through '6' above, the PSIS signals are present to prevent the inadvertent starting of equipment before its predetermined sequenced time.

The load shedding of non-Class 1E loads connected to Class 1E buses occurs upon a loss of offsite power and upon LOCA. During the LOP without LOCA condition, each Class 1E electrical bus has undervoltage relays that energize auxiliary relays which trip the non-Class 1E loads connected to the Class 1E buses except for non-Class 1E Emergency Instrument Air Compressor which is controlled by an integral magnetic starter which opens on loss of power to trip the load. The emergency load sequencer has no electrical interconnection with the load shedding of the non-Class 1E loads.

If offsite power is available and LOCA occurs, then individual LOCA signals will go directly to the Class 1E unit substation breakers feeding the non-Class 1E loads and trip these breakers. Any Class 1E loads that are running during the condition will remain running.

The emergency load sequencer has no electrical interconnection with the tripping of the non-Class 1E loads by the LOCA signal and in addition, has no electrical interties with the offsite power sources.

Provisions exist at each of the sequencer cabinets to test the ELSs for 1 through 6 scenarios described above. An alarm is provided in the main control room to indicate that an ELS is being tested. If an actual LOP or LOCA occurs during the testing of an ELS, the sequencer resets automatically and responds to LOP and/or LOCA event.

The ELS system reliability analysis has been provided under a separate cover (See letter; R. L. Mittl (PSE&G) to A. Schwencer (NRC), "DSER Open Item Status," dated August 1, 1984). The ELS system reliability is enhanced by the use of two redundant microprocessors in each of the four ELS systems.

8.3.1.1.2.8 Physical Identification of Safety-Related Equipment

Section 8.1.4.14 provides information regarding the physical identification of safety-related cables and raceways.

Color coded nameplates are provided for all Class 1E equipment. Each separation group has its own color. The color codes assigned to identify electrical switchgear, MCCs, control panels, etc, are the same as the color codes assigned for raceway systems described in Section 8.1.4.14.

In case of multiple cubicle switchgear or multiple bay panels of the same separation group, only the main nameplate is color-coded.

Design drawings provide distinct identification of Class 1E equipment. The applicable separation group is also identified.

Operating and maintenance documents pertaining to Class 1E equipment are distinctly identified as either "Q" or "nuclear safety-related".

8.3.1.1.2.9 Instrumentation and Control Systems for the Applicable Power Systems with the Supply Power Identified

Power for the four channels of Class 1E instrumentation and control circuits is supplied by the respective channel of the Class 1E instrumentation and control power distribution panels. The power supplies for instrumentation and control circuits are described below:

1. Instrumentation - Four independent Class 1E 208/120 V ac power supplies are provided to supply instruments in their respective channels. The four channel arrangement provides a separate electric power supply to each of the four channels that are electrically and physically separated from the other channels. Each power supply consists of a 480-208Y/120 transformer and a distribution panel. The 480 V power supply is provided from the MCC of the corresponding Class 1E channel. In addition to the above supplies, each channel has 120 V ac uninterruptible power supplies associated with it. UPS panels feed loads such as diesel generator control panels, remote shutdown panel, and 4.16 kV switchgear in their corresponding channel loads.

2. Control circuits - Control power for the Class 1E 4.16-kV and 480 V unit substation switchgear is provided from the 125 V dc distribution panel of the corresponding channel.

Each MCC cubicle derives its 120 V ac control power from a control power transformer located within the cubicle.

8.3.1.1.2.10 Electric Circuit Protection Systems

Protective relay schemes and trip devices on the primary and backup circuit breakers are provided throughout the power system in order to:

1. Isolate faulted equipment and/or circuits from unfaulted equipment and/or circuits

2. Prevent damage to equipment

3. Protect personnel

4. Minimize system disturbances

5. Maintain power continuity of power supply in the unaffected part of the system.

The short circuit protective system is analyzed to ensure that the various adjustable devices are applied within their ratings and set to be coordinated with each other to attain selectivity necessary to isolate a faulted area quickly with a minimum of disturbance to the rest of the system. Major types of protection measures employed include the following:

1. Differential relaying - Differential relaying schemes are provided for the main generator, main generator main transformer, station power transformers, station service transformers, island substation transformers, 4.16-kV buses, SDGs, motors above 3000 horsepower rating, and 4.16- and 7.2-kV buses. These schemes provide high-speed disconnection by opening appropriate breakers to prevent severe damage in case of faults occurring within the bounds of the areas served by these relays.

2. Overcurrent relaying - Each Class 1E 4.16-kV bus incoming feeder circuit breaker is equipped with three (one per phase) very inverse time overcurrent relays, one high dropout instantaneous overcurrent relay, and one extremely inverse time bus ground overcurrent relay. These relays sense and protect the bus from overcurrent conditions and provide backup for feeder circuit breaker relays.

For all 4.16-kV Class 1E motors except control room water chillers, time overcurrent unit is set at 115 percent to 125 percent of the motor full load current to alarm, and high dropout instantaneous overcurrent unit is set at 175 percent of motor full load current. Operation of both these units of the relay is required to trip the circuit breaker. For control room water chillers, the corresponding settings for the above two units are 105 percent and 131 percent, respectively. Normal dropout instantaneous overcurrent unit is set at 1200 percent of full load current to trip the circuit breaker for all motors. The combination of the three units of the motor feeder overcurrent relay provide overload, locked-rotor, and short circuit protection for the motor.

Each of the 4.16-kV Class 1E breakers feeding the 480 V unit substations have three overcurrent relays each with time-current and instantaneous elements. These provide overload and short circuit protection.

Ground fault protection is provided for each of the outgoing 4.16-kV Class 1E feeders. When a 4.16-kV Class 1E bus is supplied from an offsite power source, operation of a ground fault relay trips its associated breaker. When a bus is supplied from the SDG, ground fault is only alarmed.

Each 4.16-kV Class 1E bus is equipped with undervoltage relays for initiating the automatic transfer from the normal to the alternate offsite power source, shedding the loads off the 4.16-kV bus, and starting the corresponding SDG when both the offsite sources are not available at that bus. Each Class 1E incoming bus feeder is

equipped with undervoltage relays that blocks automatic transfer to its associated breaker, if its voltage is less than 92 percent of the normal bus voltage.

Each unit substation breaker in the 480 V unit substation is equipped with integral, solid state, adjustable, direct acting trip devices providing instantaneous and/or inverse time overcurrent protection. Class 1E motor feeders are equipped with long time delay (LTD), instantaneous (Inst), ground tripping, and time delay undervoltage trip devices. Nonmotor feeder breakers are provided with LTD, short time delay (STD), and ground tripping devices.

Molded case circuit breakers provide inverse time overcurrent and/or instantaneous short circuit protection for all connected loads in the 480-V MCC. For motor circuits, the molded case circuit breakers are equipped with an adjustable instantaneous magnetic trip function only. Motor thermal overload protection is provided by thermal overload relays mounted in the starter. The molded case breakers for nonmotor feeder circuits provide thermal inverse time overcurrent protection and instantaneous short circuit protection.

The thermal overload contact of various safety-related, motor operated valves (MOVs) is connected in series with the starter seal-in contact for manual operation. This overload contact is bypassed either by a signal that requires automatic operation of the MOV or by a contact of the control pushbutton as long as it is pressed. The thermal overload protection device for various other safety-related MOVs is bypassed continuously and can be temporarily placed in force when the valve motors are undergoing periodic or past maintenance testing. In addition, those thermal overload protection devices that are normally in force during plant operation are bypassed under accident conditions. This thermal overload protection design meets the requirements of Regulatory Guide 1.106, Position C.1. The motor starter circuitry for a limited number of safety-related MOV's has no integral bypass device. For these cases the trip setpoint of the thermal overload protection device is

established high enough such that the safety-related action of the MOV is completed. This thermal overload protection design meets the requirements of Regulatory Guide 1.106, Position C.2.

There are MOVs which are required to achieve Post Fire Remote Shutdown. The thermal overload function for these valves has been permanently disabled. NRC Regulatory Guide 1.106 identified that it can be undesirable for safety-related MOVs to utilize thermal overload devices while performing their safety functions due to the difficulties associated with their use on intermittent duty motors and could interfere with the MOVs ability to perform its safety related function(s). Regulatory Guide 1.106 states that the thermal overload devices should typically be disabled during accident scenarios. Since the use of the thermal overload devices for intermittent duty motors is of limited or no value and overload indication is provided in the Control Room, this function has been deleted. The list of MOVs required to have thermal overload bypass circuitry is contained in UFSAR Table 8.3-11.

8.3.1.1.2.11 Testing of AC System During Power Operation

Testing of the ac system during power operation is discussed in Section 8.1.4.21.

8.3.1.1.3 Standby Power Supply

The standby power supply for each of the four safety-related load groups consists of one SDG complete with its auxiliaries, which include the cooling water, starting air, lubrication, intake and exhaust, and fuel oil systems. The sizing of the SDGs and the loads assigned among them is such that any combination of three out of four of these SDGs is capable of shutting down the plant safely, maintaining the plant in a safe shutdown condition, and mitigating the consequences of accident conditions. Each SDG is rated at 4430 kw for continuous operation and at 4873 kw for 2 hours of short time operation in any 24-hour period. The continuous rating of the SDG is based on the maximum total load required at any one time. Each SDG is connected exclusively to its dedicated 4.16-kV Class 1E bus. Each of the four Class 1E power supply channels feed loads in its own dedicated load group. No provisions exist for parallel operation of the SDG of one channel with the SDG of a redundant channel.

The SDGs are electrically isolated from each other. Physical separation for fire and missile protection is provided between SDGs by housing them in separate rooms of a Seismic Category I structure. Power and control cables for the redundant SDGs and associated switchgear are routed so as to maintain physical separation. Compliance with IEEE 387-1977 is discussed below:

Each SDG is sized in accordance with Position C.1 of Regulatory Guide 1.9, Revision 2.

The four SDGS are completely independent. Their mechanical and electrical systems are designed so that a single failure affects the operation of only one SDG.

Adequate cooling and ventilation equipment is provided to maintain an acceptable environment within the diesel generator rooms during and after any design basis accident (DBA), even without the support from the preferred power supply.

Each SDG is capable of starting, accelerating, and accepting load as described in Section 8.3.1.1.3.10. Design conditions, e.g., vibration, torsional vibration, and overspeed, are in accordance with the requirements of IEEE 387-1977.

Each SDG governor can operate in droop and isochronous modes. The voltage regulator can operate in the paralleled mode during SDG testing. If an underfrequency condition occurs while the SDG is paralleled with the offsite power supply, the associated SDG breaker trips automatically. Each SDG is provided with control systems permitting automatic and manual control. The SDG will not start in response to an automatic start signal when it is under maintenance.

Provision is made for controlling the SDGs from the main control room and from their respective remote or local control panels. This feature is provided to enable the operator to control the SDGs from remote or local control panels in the event that the main control room has to be evacuated.

Controls for the diesel generator and Class 1E circuit breakers are located in both the control room and at remote locations. Electrical independence between the two control locations of the 4.16 kV Class 1E circuit breakers is described below.

Plant Drawing E-0006-1 shows that each of the 4.16 kV Class 1E circuit breakers has control from two locations, the main control room and another location outside the main control room. The various control locations outside the main control room are the 4.16 kV Class 1E switchgear cubicles, remote shutdown panel, and standby diesel generator remote control panels.

Drawings E-0069-0, E-0080-0, E-0084-0, E-6442-0, and E-6443-0 (these drawings were submitted under separate cover in compliance with Regulatory Guide 1.70, Revision 3, Section 1.7) are representative samples of schematic diagrams of 4.16 kV Class 1E circuit breakers with controls from the main control room and another location outside the main control room. Under normal operating conditions these circuit breakers are controlled from the main control room, and the "NORM-EMERG" transfer switch at the control location (switchgear room and remote shutdown panel room) outside the main control room is in "NORM" position. When in the NORM position, the contacts of this switch are arranged to prevent the closing of the circuit breaker from a location outside the main control room. In the event the control of the circuit breaker from the main control room is not available, the NORM-EMERG switch is switched to the EMERG position. When in the EMERG position, the contacts of this switch are arranged to isolate (electrically) the wiring between the main control room and the other control location, both for closing and tripping functions. Separate control power supply fuses are provided for the main control room and the other control location control circuits.

For the conditions of loading described in Section 8.3.1.1.3.10, the SDG maintains its voltage and frequency, following each step of loading to a value not less than 80 percent and 95 percent of nominal, respectively.

During the automatic loading sequence, voltage and frequency are restored to 90 percent and 98 percent of nominal, respectively, in less than 60 percent of each load sequence time interval.

Type qualification tests shall be performed in accordance with Regulatory Guide 1.9, Revision 2, and IEEE 387-1977.

Indicating lights for the following modes for each SDG are provided in the main control room:

1. Start
2. Stop
3. Ready for auto-start
4. Running loaded
5. Running not loaded
6. Engine locked out for maintenance
7. Control in local
8. Control in remote
9. Regulator in auto
10. Regulator in manual
11. Governor in droop mode
12. Governor in isochronous mode.

Electrical metering instruments are provided both in the main control room and at each generator remote control panel for surveillance of the following SDG parameters:

1. Field voltage
2. Field current

3. Voltage

4. Current

5. Frequency

6. Watts

7. Vars.

The following abnormal diesel engine conditions are individually annunciated at remote engine control panel:

1. Annunciator ground

2. Crankcase pressure high

3. Jacket water keep warm temperature high

4. Jacket water keep warm temperature low

5. Jacket water expansion tank level high

6. Jacket water expansion tank filling

7. Lube oil temperature low

8. Lube oil keep warm temperature high

9. Lube oil keep warm temperature low

10. Rocker arm lube oil tank level high

11. Lube oil filter differential pressure high

12. Lube oil strainer differential pressure high

13. Fuel oil filter differential pressure high

14. Fuel oil strainer differential pressure high

15. Engine in local control

16. Fuel oil day tank level high

17. Fuel oil storage tank 1 level low

18. Fuel oil storage tank 1 level Low-Low

19. Fuel oil transfer system not in auto

20. Fuel oil transfer pump 1 malfunction

21. Fuel oil storage tank 2 level low

22. Fuel oil storage tank 2 level Low-Low

23. Engine locked out for maintenance

24. Fuel oil transfer pump 2 malfunction

25. Remote emergency takeover

26. Barring device engaged

27. Loss of ac control power

28. Any control switch not in automatic/off

29. Start failure crankshaft rotating

30. Start failure crankshaft not rotating

31. Combustion air temperature high

32. Jacket water pressure low

33. Jacket water temperature high

34. Jacket water temperature low

35. Jacket water expansion tank level low

36. Rocker arm lube oil pressure low

37. Lube oil temperature high

38. Lube oil makeup tank level low

39. Crankcase lube oil level high

40. Crankcase lube oil level low

41. Lube oil pressure low pretrip

42. Lube oil pressure low shutdown

43. Starting air pressure low

44. Fuel oil pressure low

45. Fuel oil day tank level low

46. Engine overspeed

47. Emergency stop

48. Loss of dc control power.

Alarms 1 through 26 are grouped as low priority alarms, and 27 through 48 are grouped as high priority alarms.

All of the above conditions are alarmed as a common trouble alarm on one window in the main control room for all four SDG engines.

A CRT aids in identifying the SDG engine in trouble and determining which of the following two conditions is causing annunciation in the main control room:

1. Low priority alarm condition as defined above

2. High priority alarm condition as defined above.

The exact cause for any of these alarm conditions is determined from the annunciator at the respective SDG engine remote control panel.

The following abnormal SDG conditions are individually annunciated at remote generator control panel:

1. Generator overvoltage

2. Generator stator temperature high

3. Generator overload

4. Generator reverse power

5. Relaying potential transformer fuse blown

6. Generator underfrequency

7. Generator overcurrent pretrip

8. Generator field ground

9. Generator field overexcitation

10. Generator field current low

11. Generator lockout relays activated

12. Generator circuit breaker failure

13. Generator bearing temperature high

14. Generator neutral overvoltage

15. Metering potential transformer fuse blown

16. Annunciator ground fault

17. Remote emergency takeover

18. Generator overcurrent trip

All of the above generator abnormal conditions for all four SDGS are annunciated at one window in the main control room. A CRT aids in identifying the generator in trouble. The exact cause of trouble is determined from the annunciator at the respective generator remote control panel.

In addition to the above alarm systems, the following information is separately available for each SDG on the CRTs in the main control room.

1. Test switch limit switch closed, and SDG regular lockout relay reset

2. Test switch limit switch closed, and SDG backup lockout relay reset

3. Test switch limit switch closed, and SDG test lockout relay reset

4. Test switch limit switch closed, and SDG breaker failure lockout relay reset

5. SDG regular lockout relay trip

6. SDG breaker failure lockout relay trip

7. SDG backup lockout relay/test lockout relay trip.

Diesel generator circuit breaker malfunctions for all SDGs are annunciated at one window in the main control room. A CRT aids in identifying the generator circuit breaker in trouble. In addition, CRT display is available for generator circuit breaker status, diesel start command, and diesel generator ready to load status.

SDGs are preoperationally tested in accordance with the requirements of Section 14 and periodically tested in accordance with the requirements of Section 16.

There are SDG breaker status indicating lights on the remote shutdown panel.

The following items are discussed in their applicable sections:

1. SDG starting system, Section 9.5.6

2. SDG lubrication system, Section 9.5.7

3. SDG combustion air intake and exhaust system, Section 9.5.8.

Recommendations of NUREG/CR 660 with respect to the following four items will be considered in developing operation and maintenance programs for SDGs:

1. Extended no load operation

2. Training of maintenance personnel

3. Preventive maintenance program

4. Repair and maintenance procedures for a final check prior to an actual start run load test.

The functional aspects of the SDGs are discussed below.

8.3.1.1.3.1 Starting Initiating Circuits

A SDG starts under any one of the following conditions:

1. Unacceptable degradation of voltage at the respective 4.16-kV Class 1E bus with which the SDG is associated. Unacceptable degradation of voltage implies one or both of the following conditions:

   a. Voltage at both the preferred incoming feeder breakers is less than 92 percent of normal voltage

   b. Bus voltage is less than 70 percent of normal and the voltage at both the preferred incoming feeder breakers is less than 92 percent of normal voltage.

2. Receipt of an Emergency Core Cooling System (ECCS) actuation signal from the Core Spray System. This signal is generated by low reactor water level (L1), or high drywell pressure initiation.

3. Manual initiation of the Core Spray System.

4. Manual actuation of switches at the local or remote control panels, and in the main control room.

8.3.1.1.3.2 SDG Starting System

The SDG starting system is described in Section 9.5.6.

8.3.1.1.3.3 SDG Tripping

When a Class 1E bus is energized only by SDG (during LOP and/or LOCA), each diesel engine and the circuit breaker that connects the diesel engine generator to the 4.16-kV Class 1E bus are tripped and locked out by protective devices under the following conditions:

1. Operation of SDG differential relay

2. Operation of the bus differential relay for the bus to which the SDG is connected

3. Engine overspeed

4. Low lube oil pressure

5. SDG overcurrent.

For low lube oil pressure, four independent sensors are provided and connected in a two out of four logic to generate the trip function. The three SDG overcurrent relays are connected in a two out of three logic to generate the trip function. The use of coincidence logic above prevents spurious tripping due to malfunction of one of the sensors for items 4. and 5. above.

The overspeed trip device is a simple and reliable mechanical device for which coincidence logic is not provided.

During the periodic testing of SDGs, the diesel generator breaker is tripped and locked out under the following conditions:

1. SDG tripping conditions as previously discussed in this Section

2. Bus overcurrent lockout relay operation

3. SDG reverse power flow

4. SDG low field current

5. SDG overexcitation

The test lockout relay that accomplishes 2. through 5. above is prevented from tripping on the occurrence of a LOCA or DBA. During the periodic testing of an SDG, the diesel generator breaker is also tripped on underfrequency and SDG feeder ground fault.

8.3.1.1.3.4 Circuit Breaker Interlocks

Electrical interlocks are provided in the control circuitry of the SDG breakers such that they will not automatically close onto an energized or faulted bus. Upon LOP, undervoltage relays on the incoming (offsite) side of the 4.16-kV feeder breakers prevent closure of these incoming breakers. The SDG breaker can be closed onto a bus energized by an offsite power source during SDG testing only by synchronizing with the offsite source. If a bus is energized only from its associated SDG and the offsite power is available, the offsite source breaker is closed only by synchronizing the two sources.

8.3.1.1.3.5 Control Permissives

A selector switch is provided at the diesel engine local control panel to block the automatic start signal when the SDG is out for maintenance or local testing. This condition is alarmed and indicated in the main control room.

The diesel engine can be started from the main control room if the following permissives are met:

1. Selector switch at the local engine control panel is in the "remote" position.

2. Selector switch at the remote engine control panel is in the "normal" position.

3. Pushbutton in the main control room for transferring the engine control to remote panel is released.

The diesel engine can be started from the remote control panel if the following permissives are met:

1. Selector switch at the local engine control panel is in the "remote" position.

2. Main control room pushbutton "remote" is depressed to transfer the engine control to the remote engine control panel.

3. "Normal-emergency takeover" switch at the remote engine control panel is in the "emergency takeover" position.

The SDG is normally in the automatic start position except for during the testing and maintenance period.

Provision exists at the SDG remote control panel and the main control room for manually synchronizing the SDG with the offsite sources.

8.3.1.1.3.6 Load Shedding Circuits

Upon LOP or a sustained undervoltage to a 4.16-kV Class 1E bus, the undervoltage relays on the 4.16-kV bus initiate signals required to:

1. Shed all loads except unit substation feeder breakers

2. Start the SDG

3. Trip and lockout the 4.16-kV feeder breakers that connect the Class 1E bus to the offsite power supplies.

On an undervoltage condition at a unit substation bus, the undervoltage relays on the unit substation bus trip the Class 1E motor feeders fed from the bus.

As the SDG reaches rated voltage and frequency, logic is provided to generate a permissive interlock for the closing of the SDG circuit breaker.

8.3.1.1.3.7 Periodic Testing of SDGs

During preoperational testing of the SDG, it was demonstrated that the voltage drop was never below the design voltage rating and therefore does not impact the diesel generator capability to supply loads.

Periodic testing of SDGs is discussed in the Hope Creek Technical Specifications. In addition, periodic verification of the following diesel generator lockout features is performed to prevent diesel generator starting only when required: a) Engine overspeed, generator differential, and low lube oil pressure (regular lockout relay, (1) 86R), b) backup generator differential and generator overcurrent (backup lockout relay, (1) 86B), and c) generator ground and lockout relays-regular, backup and test, energized (breaker failure lockout relay, (1) 86F).

8.3.1.1.3.8 Fuel Oil Storage and Transfer System

The fuel oil storage and transfer system associated with the SDGs is discussed in Section 9.5.4.

8.3.1.1.3.9 SDG Cooling Water System

The SDG cooling and heating system, including engine keepwarm, is described in Section 9.5.5.

8.3.1.1.3.10 Loading of Standby Diesel Generators

The SDGs are designed to start and attain rated voltage and frequency within 10 seconds of the receipt of the starting signal. The generator, exciter, and voltage regulator are designed to permit the unit to accept the load and to start the motors in the sequence and time requirements shown in Table 8.3-1. When the automatic load sequencing of Class 1E loads is completed, the operator may manually add additional loads as

shown in Table 8.3-1. The application of these additional loads does not exceed the SDG capacity.

Upon the completion of the automatic loading sequence, the operator trips the Class 1E loads that are no longer required to mitigate the consequences of the emergency that initiated the starting and loading of the SDGs. Having tripped the Class 1E loads described above, the operator can apply the non-Class 1E loads manually. The SDG ratings are not exceeded during the automatic application of loads by the sequencer. The manual application of loads is governed by administrative controls to ensure that the SDG continuous rating is not exceeded. The four SDG wattmeters, one for each of the four SDGs, located in the control room, aid the operator to avoid the overloading of the SDGs. No unique one-step loads could push the diesel significantly over 104 percent of its continuous rating.

In the remote event that the operator starts overloading a SDG in excess of 104 percent of its continuous rating, an alarm in the control room is sounded to alert the operator to the SDG overload condition. This condition is detected by an overcurrent relay as shown on Plant Drawing E-0008-1. However, a temporary overload of an SDG up to 110 percent of its related capacity for two hours is within its design capability.

The control room indicators and overload alarms will be used in conjunction with administrative controls for loading SDGs manually.

The Hope Creek diesel generators can accommodate a full load acceptance test per IEEE 387-1977 after a no load operation of the diesel generator.

During pre-operational testing, a full load acceptance test per IEEE 387-1977 will be performed. This test will be conducted in accordance with the diesel generator manufacturer's recommendations. The 24-hour full load test followed by generator load shedding, including a test of the largest single load, will be performed during the ECCS integrated initiation during the loss of offsite power test, described in Section 14.2.12.1.47.

Station operating procedures will be provided to assure that after a cumulative four hours of operation at light load, i.e., less than 20 percent of rated, on any diesel, that diesel will be operated for one hour at a minimum of 50 percent rated load as per the diesel manufacturer's recommendations.

A comprehensive preventive maintenance (PM) program for the SDG incorporates the latest vendor recommendations and the requirements of Chapter 16. One SDG can be taken out of service enabling periodic maintenance and/or rework to be performed. Additionally, a reliability monitoring program will be implemented at HCGS. The HCGS reliability program enhances SDG reliability by:

1. Analyzing machinery history record for recurring problems or failures of the SDG or supporting auxiliary systems or components.

2. Tracking operating experience reports, circulars, letters and notices of failure or problems given to all diesel generators.

3. Use of the NPRDS data base system.

4. Analyzing surveillance testing results.

These functions are an ongoing and continuous responsibility of the Technical Department. Items which may adversely impact the safety function of the diesel engines at the station will receive immediate attention to determine a plan of action. Routine feedback issues are reviewed as received. All material reviewed as part of the feedback program is tracked on a computerized tracking system to ensure material is reviewed and dispositioned. In this manner, the root causes of system or component malfunctions can be more readily identified and corrective actions taken as necessary.

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The supervisor in charge of the work will verify for completeness, and administrative controls will be implemented to ensure the system is restored to its operable condition prior to any start, run, or load test on the SDG.

Calculation E-9(Q) gives the maximum loading conditions of each SDG under DBA conditions when all four diesel generators are in service and if one of the four SDGs is not available. The calculation shows that the maximum loading of any SDG at any time does not exceed its continuous rating when operating at rated frequency. Calculation E-9(Q) also demonstrates that operation at frequencies up to the maximum Technical Specification acceptance criteria does not result in any SDG exceeding its two hour rating during the application of loads by the sequencer nor exceeding its continuous load rating during any other loading conditions in compliance with Regulatory Guide 1.9 as described in Section 8.1.4.2

8.3.1.1.4 Electrical Equipment Layout

Class 1E switchgear, unit substations, MCCs, and distribution panels of redundant channels are located in separate rooms or are spatially separated by a predetermined safety distance or barrier. SDGs and associated equipment are located in separate rooms of the Seismic Category I Auxiliary Building. Each of these rooms is equipped with a separate ventilation system serviced by the corresponding load group.

8.3.1.1.5 Design Criteria for Electrical Equipment

The following design criteria is applied to the Class 1E equipment supplied from the onsite ac power system:

1. Motor horsepower capability is equal to or greater than the maximum horsepower required by the driven load under normal running, runout, or discharge valve, or damper, closed condition.

2. Minimum motor accelerating voltage The electrical system is designed such that the total voltage drop on the Class 1E motor circuits is less than 20 percent of the nominal motor voltage. The Class 1E motors are specified with accelerating capability at 80 percent nominal voltage at their terminals.

3. Motor starting torque - The motor starting torque is capable of starting and accelerating the connected load to normal speed within sufficient time to perform its safety function for all expected operating conditions, including the design minimum terminal voltage of 80 percent of nominal voltage.

4. Minimum motor margin over pump torque through accelerating period The minimum motor torque margin over pump torque through accelerating period is determined by using actual pump torque curve and calculated motor torque curve at 80 percent voltage. The minimum torque margin (accelerating torque) is such that the pump-motor assembly reaches nominal speed within the time for a given service.

   The only time the voltage dips below 80 percent is when the unit substation transformers are energized upon closure of the SDG circuit breakers. This voltage dip is due to the excitation inrush of the unit substation transformers. The inrush lasts approximately six cycles. The first motor load applied is the RHR motor, after closure of the SDG circuit breaker. The circuit breaker for the RHR motor has a closing permissive from the bus undervoltage relays. With the current setting of these relays (set to drop out at 70 percent and pickup at approximately 78 percent), the RHR motor circuit breaker will close when permitted. It takes 4.5 cycles for the RHR motor circuit breaker to close. During this interval the generator has recovered its voltage in excess of 90 percent. This will be verified during the preoperational tests described in Section 14.2.12.1.47.

   During the rest of the load sequencing cycle, if the voltage drops below 90 percent, then the voltage is restored to 90 percent of normal within 60 percent of the time interval between the starting of two consecutive loads.

No motors will be started or operated at voltages less than 80 percent of nominal voltage at the motor terminals.

5. Motor insulation - Insulation systems are selected on the basis of the particular ambient conditions to which the insulation is exposed. For Class 1E motors located within the primary containment, the insulation system is selected to withstand the DBA environment for the time that the equipment is required to operate in that environment.

6. Temperature monitoring devices provided in large horsepower motors Six resistance temperature detectors (RTD) are provided in the motor slots, two per phase, for motors larger than 500 horsepower. In normal operation, the RTD at the hottest location, selected by test, monitors the motor temperature, and a computer alarm alerts the operator on high temperature. One chromel-constantan thermocouple temperature device is provided on each bearing in accordance with ANSI C50.51-1977 to alert the main control room operator of a high bearing temperature condition by computer alarm. For GE supplied core spray and residual heat removal pump motors, stator current is monitored by six copper-constantan (two per phase) thermocouples; one copper-constantan thermocouple is provided in each bearing for monitoring bearing temperature. High temperature conditions in the motor stator and bearings are computer alarmed in the main control room.

7. Interrupting capabilities - The interrupting capabilities of the protective equipment are determined as follows:

   a. Switchgear - Switchgear interrupting capacities are greater than the maximum short circuit current available at the point of application. The magnitude of short-circuit currents in medium-voltage systems is determined in accordance with ANSI C37.010-1972,

Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis. The offsite power system, a single operating SDG, and running motor contributions are considered in determining the fault level.

Medium voltage power circuit breaker interrupting capability ratings are selected in accordance with ANSI C37.06-1971, Preferred Ratings and Related Required Capabilities for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis.

b. Unit substations, MCC, and distribution panels - Unit substation, MCC, and power 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 C37.13-1973, and NEMA AB1. Low voltage power circuit breaker interrupting capacity ratings are selected in accordance with ANSI C37.16-1970. Molded-case circuit breaker interrupting capacities are determined in accordance with NEMA AB1-1975, Molded Case Circuit.

8. Electric circuit protection - Electric circuit protection criteria are discussed in Section 8.3.1.1.2.10.

9. Grounding requirements - Equipment and system grounding are designed in accordance with requirements of National Electric Code - 1981 and IEEE 142-1972, Recommended Practice for Grounding of Industrial and Commercial Power Systems.

10. Thermal overload protection for the MOVs listed in Table 8.3-11 has been modified as recommended by Regulatory Guide 1.106. A description of the modified overload protection is included as part of Table 8.3-11.

8.3.1.1.6 Logic and Schematic Diagrams

Sufficient logic and schematic diagrams are provided in the FSAR to permit an independent evaluation of compliance with safety criteria. These drawings are listed in Section 1.7.

8.3.1.1.7 Cable Derating and Raceway Fill

Cable sizing and raceway fill is in accordance with the requirements of National Electric Code - 1981 and IPCEA P-53-426, P-54-440, and P-46-426. The cables are properly derated for specific application in the location where they are installed.

1. Cable derating - The power and control cable insulation is designed for a conductor temperature of 90°C. The allowable current carrying capacity of the cable is based on not exceeding the insulation design temperature while the surrounding air is at an ambient temperature of 65.5°C for the primary containment, 50°C outside the drywell, 40°C for all other areas, and 20°C for duct banks. The design operating conditions of Class 1E cables are discussed in Section 3.11.

   The power cable ampacities are established in accordance with IPCEA P-53-426, P-54-440, and P-46-426. They are derated based on the type of installation, the conductor and ambient temperatures, the number of cables in a raceway, and the grouping of raceways. The method of calculating these derating factors is determined from the IPCEA publications and other applicable standards.

   For control circuits, which usually carry currents of less than 10 amperes, minimum No. 14 AWG conductors are used, except for the cables supplied by Bailey Metering Company for the control room.

Instrumentation cable insulation is also designed for a conductor temperature of 90°C. The operating currents of these cables are low and do not cause the design temperature to be exceeded at maximum design ambient temperature.

2. Raceway fill - Fill for cable trays carrying 480 V power cables is limited to 23 percent of a 4-inch deep cable tray. Fill for cable trays with cables other than 480 V power cables is limited to 50 percent.

Conduit fill is limited to 53 percent for a single conductor, 31 percent for two conductors, and 40 percent for three or more conductors in a conduit.

In cases where the fill limitations are exceeded, a review is performed for each case to determine the adequacy of the design.

8.3.1.2 <u>Analysis</u>

8.3.1.2.1 General Design Criteria and Regulatory Guide Compliance

Compliance with Regulatory Guides is discussed in Section 1.8. Compliance with General Design Criteria (GDC) 2, 4, 5, and 50 of Appendix A to 10CFR50 is discussed in Section 3.1. Compliance with GDC 17 and 18 is discussed below.

1. GDC 17, Electric Power Systems - Offsite and onsite electric power systems are provided to permit the functioning of structures, systems, and components important to the safety of the plant. With LOP, the onsite power system provides sufficient capacity and capability to ensure that:

   a. Specified acceptable fuel design limits and design conditions of the reactor coolant pressure boundary

(RCPB) are not exceeded as a result of anticipated operational occurrences.

b. The core is cooled and containment integrity and other vital functions are maintained in the event of postulated accidents.

Section 3.2 contains a list of structures, systems, and components important to safety. The loads important to safety are divided to form four load groups. Each load group is supplied from a corresponding channel of the Class 1E electric power system. Each of the four Class 1E electric power supply channels has access to two offsite power sources and an onsite power source. The load groups themselves are redundant in that any combination of three out of four load groups are capable of ensuring items a. and b. above.

The onsite electric power supplies, including the batteries, and the onsite electric distribution system have been designed with sufficient independence, redundancy, and testability features so that postulated single failures affect only a single load group. The remaining redundant load groups remain intact to provide for 1. and 2. above.

Plant Drawing E-0006-1 shows that each of the four 4.16 kV Class 1E switchgear buses is supplied from two offsite (preferred) power sources and one onsite standby diesel generator (SDG). The offsite power to these buses is supplied from station service transformers 1AX501 and 1BX501 by non-segregated phase buses that are enclosed in metallic ducts. The non-segregated phase buses from the station service transformers to the 4.16 kV Class 1E switchgear are designated as non-Class 1E.

Figure 8.3-18 shows the routing of these non-segregated phase bus ducts from station service transformers 1AX501 and 1BX501 to 4.16 kV switchgear.

Station service transformers 1AX501 and 1BX501 are provided with individual water spray systems and are separated from each other by a 1-hour fire barrier. Each transformer has a collection dike and drainage outlet for collecting transformer oil spills and fire suppression system water and draining it to the oily waste drainage system. The drainage outlet for each transformer is designed to drain the entire volume of oil from the transformer plus the maximum flow of water from the automatic water spray system.

The non-segregated phase buses are run outside the turbine building wall up to the point where they enter the building. An extension of the station service transformers' water spray sprinkler system provides additional protection in the area of the common bus support and the limited area of crossover of the two non-segregated buses.

The non-segregated bus ducts are designed and constructed for adverse outdoor weather conditions (rain, ice, etc). The bus ducts are designed per ANSI Standard C37.20-1969/C37.20C-1974, Section 8.2.2.4, Watertight Tests, and, therefore, water from the sprinkler system of one transformer will not endanger the operation of the non-segregated bus of the other transformer.

These design features ensure that a station service transformer fire can not damage the bus duct from the other transformer and cause a loss of both offsite sources of power.

Within the Turbine Building the offsite buses are routed through common areas. Separate supports are provided for the non-segregated phase buses in non-seismic plant areas. In Seismic Class I plant areas Seismic Class I supports are provided for the non-segregated phase buses. The buses are physically separated from each other and their steel duct enclosures minimize, to the extent practical, the likelihood of their simultaneous failure under operating and postulated accident environmental conditions.

Within the standby diesel generator (SDG) rooms the offsite buses are provided with a 3-hour fire barrier at each wall and floor penetrations and one section of an offsite bus in SDG Rooms A and B is wrapped on the outside with a 1-hour fire barrier material, refer to Plant Drawing E-1670-1 for details. The 1-hour fire barrier wrapping is provided in accordance with the criteria established in Branch Technical Position CMEB 9.5-1, Position C.5.b(2). The SDG rooms are provided with an automatic fixed carbon dioxide total flooding system and an early warning smoke detection system as discussed in Section 9.5.1.2.26. An analysis of the offsite buses configuration with the fire protective features provided within these rooms showed that safe shutdown of the plant is not impaired assuming a fire occurs in any of the rooms with the worst single failure.

This analysis considered the following cases:

Case A Diesel Generator A Compartment

A fire in this compartment will disable Diesel Generator 'A'. One of the offsite power bus ducts to the Class 1E system is protected from the effects

of the fire by a 1 hour fire barrier wrap and automatic CO_2 suppression system. The protected bus duct will supply offsite power to the three channels not affected by the fire. The channel associated with the diesel compartment fire will be reconnected after the fire is extinguished. The fire will not cause a turbine or reactor trip so one offsite power feeder to the safety buses will be available. If a single failure to the remaining offsite power feeder is postulated in addition to the effects of the fire, the three remaining diesel generators and the equipment in the associated channels will be available. A single failure that would affect one of the Class 1E dc buses, thereby affecting the whole channel, leaves the remaining three channels powered by offsite power and the associated equipment available.

Any three channels will provide the support to assure one division of safe shutdown equipment is available to perform the required safe shutdown function.

Case B Diesel Generator B Compartment

The evaluation is the same as Case A except Diesel Generator B is disabled.

Case C Diesel Generator C Compartment

A fire in this compartment will disable Diesel Generator C and the offsite power buses to the Class 1E power systems. The diesel generators are then required to power the loads on the Class 1E buses. The worst case single failure in this event would be the loss of the B channel dc bus. This failure would prevent operation of any equipment on Channel B including the battery powered and diesel

generator powered equipment. The equipment powered by Diesel Generator C are also not available because of the loss of the diesel generator to the fire. This leaves the equipment powered by Diesel Generators A and D and batteries A, C, and D available to perform the safe shutdown functions.

Case D Diesel Generator D Compartment

A fire in this compartment will disable Diesel Generator D and the offsite power buses to the Class 1E power systems. The diesel generators will be required to provide power to the Class 1E buses as in Case C. The worst case single failure for this event would be the loss of battery A for reasons similar to Case C. This will leave equipment powered by Diesel Generators B and C and batteries B, C, and D available to perform the safe shutdown functions.

The equipment required to perform the safe shutdown functions for Cases C and D were identified and verified to be available. In each case the required safe shutdown functions can be performed with the available equipment and thereby satisfies the requirements of GDC 17.

The onsite power feeds to the 4.16 kV Class 1E switchgear are routed in rigid steel conduit and tray from the standby diesel generator rooms. Each train of onsite Class 1E power is compartmentalized such that the four trains are separated from each other by 3-hour fire rated concrete walls.

The circuit breakers that connect a 4.16 kV Class 1E switchgear bus to the two offsite power supplies and its associated onsite standby power supply are Class 1E and are qualified to the HCGS seismic and

environmental parameters for any design basis event. These breakers are electrically interlocked to prevent the automatic paralleling of the onsite and offsite power supplies.

The only control interface between the onsite Class 1E and offsite power systems is the station service transformer differential relay current transformer (CT) leads in the Class 1E switchgear. The CT leads are classified as non-Class 1E and are enclosed in armored cable or conduit to comply with Regulatory Guide 1.75.

Each of the four SDGs are located in separate rooms of a Seismic Class I structure. The SDGs and the associated control panels are qualified for HCGS seismic and environmental parameters for all design basis events. The control panels, power, and control cables for all the four SDGs are separated to comply with Regulatory Guide 1.75 requirements.

Each of the four Class 1E 4.16 kV switchgear buses has its own independent protective relaying schemes. The failure of a protective relay in the 13.8 kV and/or 500 kV systems does not impact any of the four onsite power sources.

The control power supplies for both the offsite and onsite Class 1E infeed breakers are from a 125 V dc distribution panel of the same Class 1E channel. Cables of the same Class 1E channel are routed in common raceways but these raceways are separated from their redundant counterpart by two-hour fire rated concrete walls from the switchgear room to the cable spreading room. Within the cable spreading room the redundant Class 1E control raceways are provided with Regulatory Guide 1.75 separation as

well as automatic fire suppression systems. Plant Drawings M-5001, M-5002, M-5003, M-5004 and M-5005 show these features.

Common control room panels, where both onsite and offsite control cables terminate, have separation or barriers provided, in accordance with Regulatory Guide 1.75, to eliminate common mode failures between onsite and offsite breaker control.

Protection against common mode fire induced failure of the onsite power trains is addressed as part of the Hope Creek fire protection analysis in Section 9.5.1, and Appendix 9A.

These design features minimize the probability of losing electric power from any of the required Class 1E electrical power systems as a result of, or coincident with, loss of the power generated by the main generator, loss of the power from the offsite transmission network, or loss of the power from the onsite electric power supplies, as required by GDC 17.

Each 4.16-kV Class 1E bus has access to the two physically independent offsite power sources. Upon LOP, the Class 1E system is automatically isolated from the offsite power system and the onsite non-Class 1E distribution system. The isolation of the offsite and Class 1E onsite power systems is accomplished by tripping of the incoming offsite source breakers to the 4.16-kV Class 1E buses. This tripping is accomplished through the undervoltage relays connected on the source side of these breakers. The tripping of these incoming offsite source breakers to the 4.16-kV Class 1E buses also isolates one power supply channel from redundant power supply channels. The combination of these

factors considered in the design of the electric power system minimizes the probability of losing electric power from the onsite power supplies as a result of the loss of power from the offsite sources or any disturbances of the non-Class 1E ac system.

The voltage analysis performed in accordance with Branch Technical Position PSB-1, Item 3, indicates that the onsite distribution system voltages are adequate to support Class 1E loads within the equipment ratings during LOCA and plant shutdown with the offsite system voltages at anticipated minimum or maximum voltage and with only the offsite source being considered available. The analysis also confirmed that the setting of the undervoltage relays on the source side of the incoming offsite source breakers on the Class 1E 4.16-kV buses will protect Class 1E loads from degraded voltages resulting from sustained low offsite system voltage condition.

This voltage analysis determines the voltages on the 4.16-kV, 480 V Class 1E buses under normal operation and a LOCA at degraded grid conditions. The analysis is performed with the aid of a verified and validated computer program. All four (4) Class 1E Buses (A, B, C, and D) are modeled establishing both steady state and transient voltages over an eighty six (86) second LOCA load sequencing period. At 86 seconds, all motor starting is complete and steady state conditions have been achieved.

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The results of the analysis indicate that the calculated Class 1E 4.16-kV and 480 V bus voltages exceed the electrical design criteria in Section 8.3.1.1.5 with regard to minimum motor accelerating voltage during transient condition and that the equipment rated voltage of ±10 percent is not exceeded during steady state condition such that loads downstream of the 480 V buses are also maintained within their design voltage limits. The voltage analysis included actual bus loadings and allowances for load cables voltage drops.

Finally, the voltage analysis indicates that the minimum acceptable 4.16-kV bus voltage should be 0.92 per unit in order to maintain

acceptable voltages on downstream buses. This minimum voltage can only be attained if the offsite system voltage is at minimum, the station service transformer supplying the 4.16 kV bus cannot maintain this voltage because of failure in its automatic load tap changer and all of the buses are loaded to capacity. To preclude consequences of these unlikely events, the undervoltage relays are set at 0.92 per unit of 4.16-kV with sufficient time delay to assure that automatic bus transfer does not occur on transient undervoltage conditions.

The main generator is automatically isolated from the switchyard following a turbine or reactor trip by tripping the switchyard breaker that connects the main generator to the switchyard. Therefore, its loss does not affect the ability of either the offsite sources or the onsite power supplies to provide power to the Class 1E system.

Transmission system stability studies indicate that the trip of the most critical generating unit in the PJM network does not impair the ability of the system to supply plant station service. This subject is further discussed in Section 8.2.2.

2. GDC 18, Inspection and Testing of Electric Power Systems The Class 1E electric power system is designed to permit:

   a. Periodic testing of the operability and functional performance of onsite power sources; switches; circuit breakers; and associated control circuits, relays, and buses during normal plant operation.

   b. Periodic inspection and testing of wiring, insulation, connections, and relays to assess the

continuity of the systems and the condition of components during equipment shutdown.

c. Testing of the operability of the Class 1E system as a whole during plant shutdown. This includes the full operation sequence that brings the system into operation in response to various signals, and transfer of Class 1E buses between the onsite and offsite power sources. These tests are performed under conditions as close to design as possible.

   Electric power systems are preoperationally tested in accordance with the requirements of Section 14 and periodically tested in accordance with the requirements of Section 16.

8.3.1.2.2 Class 1E Equipment Exposed to Hostile Environment

Section 3.11 furnishes the information on all Class 1E equipment that must operate in a hostile environment, e.g., radiation, temperature, pressure, humidity, during and/or subsequent to a postulated accident, e.g., LOCA, steam line break.

8.3.1.3 Physical Identification of Safety-Related Equipment

Physical identification of safety-related equipment is described in Section 8.3.1.1.2.8.

8.3.1.4 Independence of Redundant Systems

Independence of redundant systems for ensuring the minimum required equipment availability during any design basis event is achieved through physical arrangement and spatial separation. The detailed information describing the criteria and their bases that establish the minimum requirements for preserving the independence of redundant Class 1E electric power systems is contained in

Section 8.1.4.14. Section 1.8 discusses the compliance, clarifications, and exceptions to Regulatory Guide 1.75.

8.3.1.4.1 Administrative Responsibilities and Controls for Ensuring Implementation of Separation Criteria During Design and Installation

The separation group identification described in Section 8.1.4.14 facilitates and ensures the maintenance of separation in the location of equipment, routing of cables, and the termination of cables inside panels. At the time of cable routing assignment during design, persons responsible for cable and raceway scheduling check to make sure that the cables are routed in raceways of the same separation group as that of the cables. Extensive use of computer facilities assists in ensuring separation correctness. Each cable and raceway is identified in the computer program, and the identification includes the applicable separation group designation. Various reports generated by computer program are specifically used to ensure that the cables of a particular separation group are routed through compatible raceways. The routing is also verified by quality control personnel during installation to be consistent with design documents. Color identification of equipment, raceways, and cabling, discussed in Section 8.1.4.14, assists field personnel in this effort.

8.3.1.5 Reactor Protection System Power System

8.3.1.5.1 Scope

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 principal elements of the RPS power system are shown in Vendor Technical Document PN1-C71-1030-0003. The system includes two high-inertia,

alternating current, motor generator sets, and distribution equipment.

Each motor generator set supplies power for independent trip systems of the Nuclear Steam Supply Shutoff System (NSSSS), parts of the process radiation monitoring system, and the reactor protection trip system. The RPS power is classified as non-safety related, because failure of the power supply causes a reactor scram and isolation. However, the power feeds to redundant logics are physically separated by running them in separate conduits. In addition, an electrical protective assembly (EPA), which consists of Class 1E protective circuitry, is provided between the RPS and each of the power sources. The EPA provides redundant protection to the RPS buses by acting to disconnect the RPS from the power source circuits. Figure 8.3-14 shows in block diagram form the EPAs used in the RPS protective circuit.

8.3.1.5.2 Components

Each of the high inertia motor generator sets has a voltage regulator that 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 do not require any manual operation or adjustment during a coastdown or acceleration period. High inertia is provided by a flywheel. The inertia is sufficient to maintain the voltage and frequency of the generated voltage within 5 percent of the rated values for a minimum of one second following a loss of power to the drive motor. An EPA, consisting of Class 1E protective circuitry, is installed between the RPS and each of its power sources. The EPA consists of a circuit breaker with a trip coil driven by logic circuitry that senses line voltage and frequency, and trips open the circuit breaker on conditions of either overvoltage, undervoltage, or underfrequency. Provision is made for setpoint verification, calibration, and adjustment under administrative control. After tripping, the circuit breaker must be reset manually. Trip setpoints are based on providing 120 V, 60 hertz power at the RPS logic cabinets. The protective circuit

functional range is ±10 percent of nominal voltage and -5 percent of nominal frequency.

The RPS electrical protection assemblies provide a protective interface between the RPS MG set and its supplied loads. The ATTU power supply receives 120 ± 10 percent V ac power from the RPS MG set and provides regulated voltage to the analog transmitter/trip units (ATTU). The ATTU power supply is specified to regulate output voltage between 23 and 28 V dc, which is within the operating range of the ATTU (normal 23.5 to 26.5 V dc; adverse 22.0 to 28.0 V dc).

The analog transmitter lead length for 16 AWG signal cable is 3,820 feet, based a power supply output of 22 V dc. Typical cable runs span between 500 and 1000 feet. Verification of the proper installation of the ATTU/transmitter loops is accomplished during preoperational testing.

8.3.1.5.3 Sources

The power to each of the RPS buses is supplied from two 120 V ac sources. The primary source of power is the motor generator sets. The alternate source of 120 V ac power is a non-Class 1E MCC. The two motor generator sets are supplied from separate non-Class 1E 480 V MCCs. The alternate power switch design and arrangement prevents the paralleling of the power sources.

Indicating lights are provided in the main control room to monitor the status of the motor generator sets and the alternate sources.

8.3.1.5.4 Operating Configuration

During normal operation of the RPS power system, the RPS buses are energized by their respective motor generator set. Either motor generator set can be taken out of service by manually operating the power source selector switch that disconnects the motor generator set and connects the respective RPS bus to its alternate power source. Provision is made to prevent connection of

both RPS buses to their respective alternate sources at the same time. A loss of power to either motor generator set is monitored in the main control room. Upon loss of power to the motor generator set, the operator switches the affected RPS bus 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 (1 second minimum) results in a scram.

8.3.2 DC Power Systems

8.3.2.1 Description

The plant dc systems are divided into non-Class 1E and Class 1E systems.

8.3.2.1.1 Non-Class 1E DC systems

The non-Class 1E dc system distributes power at ±24, 125, and 250 V. Each of these systems is supplied from independent batteries and battery chargers. The battery chargers are supplied from non-Class 1E, standby diesel generator (SDG)-backed, motor control centers (MCCs). The non-Class 1E MCCs are supplied from Class 1E unit substations, however, the unit substation feeder breakers to these MCCs are automatically tripped on a LOCA. The non-Class 1E dc systems supply power to non-Class 1E loads such as turbine-generator emergency seal oil pump, emergency bearing lube oil pumps, control for non-Class 1E switchgear, and Neutron Monitoring System (NMS), etc. The non-Class 1E dc systems are separated from Class 1E systems. Plant Drawings E-0009-1, E-0010-0 and E-0011-1 are the single line drawings for non-Class 1E dc systems.

8.3.2.1.2 Class 1E DC System

The Class 1E dc system distributes power at 125 and 250 V as shown on Plant Drawings E-0009-1 and E-0011-1. The Class 1E 125 V dc system is divided into four independent channel systems. Each of these

systems is supplied from batteries and battery chargers of the corresponding load group channel. There are two 250 V dc systems. One is associated with the high pressure coolant injection (HPCI) system and the other is associated with the Reactor Core Isolation Cooling (RCIC) System.

8.3.2.1.2.1 Class 1E DC System Equipment Rating

1. 125 V dc system

   a. Battery

      4 - 60 lead calcium cells, 1885 ampere hour at 8-hour rate

      2 - 60 lead calcium cells, 577 ampere hour at 8-hour rate.

   b. Battery chargers: ac input 480 V, 3 ϕ, 60 hertz, dc output - 200 A continuous rating.

   c. Switchgear

   d. Bus: 1600 A continuous rating, 25,000 A short circuit bracing

   e. Breakers: 800 A frame size, 25,000 A interrupting capacity

2. 250 V dc system

   a. HPCI system battery: 120 lead calcium cells, 825 ampere hour at 8-hour rate

   b. RCIC system battery: 120 lead calcium cells, 330 ampere hour at 8-hour rate.

c. Battery chargers: ac input 480 V, 3 ϕ, 60 hertz, dc output, 50 A continuous rating.

d. MCC

(1) Bus

(a) Main horizontal bus: 600 A continuous rating, 10,000 A short circuit bracing

(b) Vertical bus: 300 A continuous rating, 10,000 A short circuit bracing

(2) Breakers

Molded case breakers: 150 A frame size, 10,000 A interrupting capacity

The Class 1E dc system is designed to operate under a range of voltages which are dependent on the status of the battery charger/battery. Under normal operating condition with the battery charger supplying the operating loads and a float charge to the battery, the dc system voltage will be 132 to 135 V for the 125 V system (264 to 270 V for the 250 V system). While the battery is being equalize charged, the dc system voltage will be 140 V for the 125 V system (280 V for the 250 V system). And when the battery is the sole source for supplying the loads, the dc system voltage which is initially at 132 to 135 V or 264 to 270 V will eventually decrease to 108 or 210 V for the 125 or 250 V nominal system, respectively at the end of the discharge period. The operating voltage can then be defined as 108 or 210 V minimum to 140 or 280 V maximum, depending on whether the system is 125 or 250 V nominal system.

The equipment and components of the power supply portion, i.e., battery, battery charger and switchgear assembly are designed and qualified to operate over this voltage range.

The equipment and components of the load portion are designed and qualified to operate over the applicable voltage range expected at the loads based on system voltages defined above.

8.3.2.1.2.2 Class 1E Batteries

A 125 V battery consists of a set of 60 shock absorbing, clear plastic cells of the lead calcium type. Four of the six batteries are rated at 1885 ampere hour and the remaining two at 577 ampere hour at an 8-hour discharge rate.

Each Class 1E battery bank has sufficient capacity to independently supply the required loads for 4 hours without support from battery chargers. This time interval is sufficient to ensure that the Class 1E instrument ac power supply is uninterrupted during a loss of offsite power, because the battery chargers will be reenergized from Class 1E 480 V motor control centers once the standby diesel generators are started.

The battery capacity is 25 percent greater than required. This margin is consistent with the battery replacement criterion of 80 percent rated capacity given in IEEE 450-1975 and is in addition to design margin allowed for load growth and/or for less than optimum operating condition of the battery.

8.3.2.1.2.3 Class 1E Battery Chargers

The battery chargers are full-wave, silicon controlled rectifiers. The chargers are suitable for float charging their respective lead calcium batteries. The chargers operate from a 480 V 3 phase, 60 hertz power supply. The chargers are supplied from MCCs of the same channel as the battery system channel it supplies.

Battery chargers associated with a battery are capable of supplying the largest combined demand of the various continuous steady-state loads plus charging capacity to restore the battery

from the charge state at the completion of their design duty cycle (design minimum charge) to the fully charged state within 12 hours.

The HC Class 1E 125 VDC Station Battery and Charger Sizing Calculation E-4.1(Q) and the HC Class 1E 250 VDC Station Battery and Charger Sizing Calculation E-5.1(Q) show various transient and steady state battery loads grouped into specific time increments. The listed load levels are not continuous steady state loads for the entire time period listed. The indicated load levels are maximum current levels experienced during that particular time increment, and some are of a shorter duration than the actual time increment in which they appear.

Loads which are not considered as continuous steady state loads are momentary loads such as switchgear control operations, motor operated valve operations, motor starting currents and various inrush currents. Momentary loads are supplied from the battery when such loads exceed the maximum output of the battery charger. In addition, inverters are not considered as continuous steady state loads because they are normally supplied from AC power sources and not from the battery charger.

8.3.2.1.2.4 Class 1E Battery Loads

The loads supplied by each Class 1E battery system, along with its length of operation during a loss of all ac power, are shown in calculations E-4.1(Q) and E-5.1(Q) and Figure 8.3-16.

Loads are divided among different battery systems so that each system serves loads that are identical and redundant, are different from but redundant to plant safety, or are backup equipment to the ac driven equipment.

8.3.2.1.2.5 Separation and Ventilation

For each Class 1E dc system, the battery bank, chargers, and dc switchgear are located in separate compartments of the Seismic Category I Auxiliary Building. The battery compartments are ventilated by a system that is designed to preclude the possibility

of hydrogen accumulation. Section 9.4 describes the ventilation system in the battery rooms. Redundant dc systems are separated to minimize the likelihood of a single hazard causing the loss of more than one channel.

8.3.2.2 Analysis of Compliance with General Design Criteria, Regulatory Guide and IEEE Standards

Compliance with General Design Criteria 2, 4, 5, and 50 is discussed in Section 3.1. Compliance with Regulatory Guides 1.47, 1.63, 1.75, and 1.106 is described in Section 1.8. The following paragraphs analyze the compliance of the Class 1E dc power system with GDC 17 and 18; Regulatory Guides 1.6, 1.32, 1.41, 1.93, 1.128, 1.129; and IEEE 308, 450, and 484.

1. GDC 17, Electric Power Systems - HCGS Class 1E dc systems are designed to comply with GDC 17. The following design factors are included in the design of these systems.

    a. Four separate and independent 125 V dc systems supply control power for each of the Class 1E ac load groups.

    b. Two separate and independent 250 V dc systems supply power to the loads in their own load group.

    c. The ac power for the battery chargers in each of the dc systems is supplied from the MCC of the same channel as that of the battery it is feeding.

    d. Four independent Class 1E dc systems are provided to ensure the availability of the dc power system for maintaining the reactor integrity during postulated accidents.

    e. Each of the four Class-1E, 125 V dc systems, including batteries, chargers, dc switchgear, and

distribution equipment are physically separate and independent.

f. Each of the 250 V dc Class 1E systems, including batteries, chargers, dc switchgear, and distribution equipment are physically separate and independent.

g. Sufficient capacity, capability, independence, redundancy, and testability are provided in the Class 1E dc systems, ensuring the performance of safety functions assuming a single failure.

2. GDC 18, Inspection and Testing of Electric Power Systems. Each of the Class 1E 125 V and 250 V dc systems is designed to permit:

a. Inspection and testing of wiring, insulation, and connections during equipment shutdown to assess the continuity of the system and the condition of its components.

b. Periodic testing of the operability and functional performance of the systems during normal plant operation by isolating the system. Only one system is tested at a time.

The Class 1E dc systems are periodically inspected and tested to assess the condition of the battery cells, charger, and other components in accordance with Section 16. Preoperational testing is discussed in Section 14.

3. Regulatory Guide 1.6, Independence Between Redundant Standby (Onsite) Power Sources and Between Their Distribution Systems, 1971 - Separate Class 1E dc systems supply dc power for each of the four load groups. Assignment of loads among the four dc channels is such

that loss of any one of these Class 1E dc systems does not prevent the minimum safety function from being performed. The Class 1E chargers are supplied from the same load group channel for which the dc system supplies power and control power supplies. Each of the four dc power channels, including the battery bank, charger, and distribution system, is independent of the other dc power channels and the non-Class 1E dc systems. Each battery is exclusively associated with a single 125 V dc or 250 V dc bus. Each battery charger is supplied by a corresponding ac load group only. The battery and the battery charger associated with one channel cannot be interconnected with any other dc power supply channel. No provision exists for transferring loads between redundant dc systems.

Thus sufficient independence and redundancy exists between the Class 1E dc systems to ensure performance of minimum safety functions, assuming a single failure. Spare battery chargers are provided to replace any of the Class 1E chargers of 250 Vdc systems.

4. Regulatory Guide 1.32, Criteria for Safety-Related Electric Power Systems for Nuclear Power Plants, February 1977 - Position C.1.b states that the capacity of the battery charger supply should be based on the largest combined demands of the various continuous steady state loads and the charging capacity to restore the battery from the design minimum charge state to the fully charged state, irrespective of the status of the plant during which these demands occur. For the 125 V dc system, HCGS complies with this position by clarifying uninterruptable

power supply inverter (UPS) operation with respect to DC bus loading. Following a loss of all AC power, the UPS inverters are powered directly from their respective battery. Upon restoration of AC power, the UPS inverters are powered from the same Class 1E AC bus as their associated battery charger. During normal plant operation with AC power available the UPS inverters are powered from either one of their two associated 480 V (MCC) power supplies. As a result, with respect to battery charger calculated design capacity, the UPS inverters are not included as an electrical load on the DC bus. The design continuous steady - state load is defined as only those electrical loads which are supplied solely by the batteries. Based on the above clarification, HCGS complies with Regulatory Guide 1.32, Position C.1.b.

5. Regulatory Guide 1.41, Preoperational Testing of Redundant Onsite Electric Power Systems to Verify Proper Load Group Assignments, March 1973 - The Class 1E dc systems have been designed in accordance with Regulatory Guides 1.6 and 1.32, and testing capabilities are provided in accordance with the guidance of Regulatory Guide 1.41.

   These systems are tested as follows:

   a. Testing of the dc power system, including an acceptance test of battery capacity, is performed before unit operation in accordance with the requirements described in Section 14.

   b. The charger, battery connections, and charger supply are verified for proper assignment of ac load groups.

   c. Class 1E dc systems are functionally tested along with the associated ac load groups by disconnecting and isolating the other ac load groups, its ac power sources, and the associated dc system. Each test

includes simulation of an engineered safety features (ESF) actuation signal, startup of the SDG and the load group under test, sequencing of loads, and the functional performance of the loads. During these tests, the ability of the dc system to perform its intended functions, e.g., control of SDGs and Class 1E ac switchgear, is verified.

d. During the testing of the Class 1E dc system and its associated ac load group, the buses and loads of the dc systems associated with other ac load groups not under test are monitored to verify the absence of voltage, indicating no interconnections of redundant dc systems.

6. Regulatory Guide 1.93, Availability of Electric Power Sources Compliance with Regulatory Guide 1.93 is discussed in Section 1.8.

7. Regulatory Guide 1.128, Installation Design and Installation of Large Lead Storage Batteries for Nuclear Power Plants, October 1978 Compliance with Regulatory Guide 1.128 is discussed in Section 1.8.

8. Regulatory Guide 1.129, Maintenance, Testing, and Replacements of Large Lead Storage Batteries for Nuclear Power Plants, February, 1978 Regulatory Guide 1.129 endorses IEEEE-450-1975, with clarifications. Recommended practices of IEEE-450 for maintenance, testing, and replacement of batteries are followed for the Class 1E batteries and are discussed in Chapter 16.

9. IEEE 308-1974, IEEE Standard Criteria for Class 1E Electric Systems for Nuclear Power Stations The Class 1E dc system provides dc electric power to the Class 1E loads and for control and switching of the Class 1E systems. Physical separation and redundancy is provided

to prevent the occurrence of common mode failures. The design of the Class 1E dc system includes the following:

a. The dc system is separated into four independent channels.

b. The safety actions by each group of loads are independent of the safety actions provided by each group's redundant counterparts.

c. Each dc subsystem includes power supplies that consist of one battery bank, and one or two battery chargers, as required.

d. No interconnections are provided between redundant dc systems.

e. Each Class 1E distribution circuit is capable of transmitting sufficient energy to start and operate all required loads in that circuit. The distribution system is monitored to the extent that it is shown to be ready to perform its intended function. The dc auxiliary devices required to operate equipment of a specific ac load group are supplied from a dc subsystem of the same load group.

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

   Ammeters and voltmeters are installed in the main control room to monitor current and voltage respectively for each of the battery systems. Three common trouble alarms are provided, one each for ±24 V, 125 V, and 250 V dc systems. CRT is used to identify the subsystem in trouble. Local indicators

at dc switchgear, battery charger, and battery monitors indicate the exact cause of trouble, which includes the following:

(1) DC bus undervoltage

(2) DC ground

(3) Battery circuit unavailability

(4) Battery charger output under and overvoltage

(5) Battery charger high voltage shutdown

(6) Deleted

(7) Battery charger ac power failure

(8) DC output circuit breaker open.

Except for the ±24 V dc system, the dc systems are ungrounded; thus, a single fault does not cause immediate loss of the faulted system. The ±24 V dc system is grounded in the Control Room.

Each battery charger has an input ac and output dc circuit breaker for isolation. Each battery charger is designed to prevent the ac supply from becoming a load on the battery due to a power feedback as a result of the loss of ac power to the chargers. Each Class 1E dc system is designed to meet the Seismic Category I requirements, as stated in Section 3.10. The batteries, battery chargers, and other components of the dc power system are housed in the Auxiliary Building, which is a Seismic Category I structure.

The periodic testing and surveillance requirements for the Class 1E batteries are discussed in Section 16.

8.3.2.3 Physical Identification of Safety-Related Equipment

Physical identification of safety-related equipment is discussed in Section 8.3.1.1.2.8.

8.3.3 Fire Protection for Cable Systems

The measures employed for the prevention of and protection against fires in electrical cable systems are described in Section 9.5.1.

Cable derating and cable tray fill are described in Section 8.3.1.1.7. Electrical equipment and cabling is arranged to minimize the propagation of fire from one separation group to another. Section 8.1.4.14 discusses the separation of Class 1E equipment including cable trays. Where the separation distances listed in Section 8.1.4.14 cannot be provided for nonhazard, limited hazard, and hazard areas, a barrier or a combination of barriers with details as shown on Figures 4 through 7 of IEEE 384-1981 will be provided.

8.3.4 SRP Rule Review

Regulatory Guide 1.75 is listed in Table 8-1 of SRP 8.1 as acceptance criteria for physical independence of electric systems and as such is indicated to apply also to SRP Sections 8.3.1 and 8.3.2. For specific tray separation requirements Regulatory Guide 1.75 refers to IEEE 384, which requires a minimum vertical separation distance of 3 feet between redundant Class 1E cable trays in the cable spreading room.

The Hope Creek Generating Station (HCGS) separation criteria, however, allows a minimum 18-inch vertical separation between redundant cable trays in the cable spreading room. The reason for this difference is that regulatory guidelines for the physical separation of redundant cable trays were not available during the conceptual design stage of HCGS. As the station design progressed, the number of cables requiring routing through the

cable spreading room increased considerable as a result of revisions to regulatory guides and standards. The increase in cable volume could not be accommodated with a vertical separation of 3 feet between redundant cables trays. To protect against the effect of fires and meet the general intent of Regulatory Guide 1.75, fire suppression systems are installed in the cable spreading room.

Also, in the unlikely event of a fire in the cable spreading room damaging redundant cables required for safe shutdown, the plant can be brought to a safe shutdown condition from the remote shutdown station, which is not affected by the fire.

Section II of SRP 8-1 refers to Table 8-1 for acceptable criteria in the design of electric power systems. Position C.15 of Regulatory Guide 1.75, as referenced in Table 8-1, requires that where ventilation is needed, separate safety class structures for redundant Class 1E batteries should be served by independent ventilation systems.

In the design of the ventilation system for the battery rooms at Elevations 54 feet and 163 feet, a common duct is used between the battery rooms and the exhaust fans. Independence is provided with the use of individual exhaust ducts from each room, separate fire dampers, and low flow alarm. All equipment, duct work, and hangers are qualified for Seismic Category I. These systems are provided with two 100 percent redundant fans powered by redundant Class 1E power systems. This design will enable individual battery rooms to operate simultaneously with the operation of one redundant exhaust fan.

Compliance with Branch Technical Position PSB-2 as referenced in Appendix 8A, is described below.

Per item 2.1 of PSB-2, any bypass or deliberately induced inoperability condition that may render a SDG unit unavailable to respond to an automatic or operator initiated emergency start

signal are alarmed in the control room. These conditions are included in Section 8.3.1.1.3. In addition to the alarms described in Section 8.3.1.1.3 the following conditions are separately indicated in the control room on unit operator console 10C651EB:

1. Engine locked out for maintenance

2. Engine control at local SDG control panel

3. Control at a remote location

4. SDG ready for autostart.

Per item 2.2, the high priority alarm, an indication that the SDG may not start automatically, is available at the CRT in the control room. A reflash capability is provided for the SDG alarm conditions. Also, the indications listed in 1. and 4., in the above paragraph, alert the operator as to the availability of the SDG to start automatically.

Item 2.3 does not apply since HCGS is a single unit plant.

Items 2.4 and 2.5 of the branch technical position PSB-2 are discussed in Section 7.5.1.3.2.

TABLE 8.3-1

EMERGENCY LOADS ASSIGNMENT OF CLASS 1E AND SELECTED NON-CLASS 1E LOADS ON STANDBY DIESEL GENERATOR BUSES

Item	Description	Equipment No.	Number Connected To Class 1E Distribution System Diesel Buses A	C	B	D	Loading Sequence[2] Min No.	Time From DBA[13]	Min No.	Time From LOP[13]
	Class 1E Loads									
1.	Reactor core spray pumps	1A,B,C,D-P206	1	1	1	1	3	19 s[6]	-	-
2.	RHR pumps	1A,B,C,D-P202	1	1	1	1	3	13 s[6]	1	11 min
3.	Safety Aux Cooling System Pumps	1A,B,C,D-P210	1	1	1	1	3	45 s	2	45 s
4.	Core spray pump room unit coolers	1A-VH211 thru 1H-VH211	2	2	2	2	3	40 s	-	-
5.	Motor operated valves[4]	-	1	1	1	1	3 (sets)	13 s	3	13 s
6.	Swgr room unit cooler fans	1A,B,C,D-VH401	1	1	1	1	3	65 s	3	65 s
7.	Intake structure supply fans	1A,B,C,D-V503	1	1	1	1	2	13 s[15]	2	13 s[15]
8.	Intake structure traveling screens area fans	OA-V558 OB-V558	1	-	1	-	1	65 s	1	65 s
9.	RHR pump rm unit coolers fans	1A,B,C,D,E,F, G,H-VH210	2	2	2	2	3	40 s	1	11 min
10.	RCIC pump room unit coolers	1A,B-VH208	-	-	2	-	1	65 s	1	65 s
11.	HPCI pump room unit coolers	1A,B-VH209	2	-	-	-	1	65 s	1	65 s
12.	125 V dc battery chargers	1A,B,C,D413 1A,B,C,D-D414 1CD,DD-444	2	3	2	3	8	13 s	8	13 s
13.	Diesel area battery room exhaust fans	1A,B,C,D-V406	1	1	1	1	3	13 s	3	13 s
14.	Diesel fuel oil transfer pumps	1A-P401 thru 1H-P401	2	2	2	2	3	60 min & beyond	3	60 min & beyond

Item	Description	Equipment No.	Number Connected To Class 1E Distribution System Diesel Buses A	C	B	D	Loading Sequence(2) Min No.	Time From DBA(13)	Min No.	Time From LOP(13)
15.	Station service water pumps	1A,B,D,C-P502	1	1	1	1	3	55 s	3	55 s
16.	RB FRVS Recirculation System fans	1A-V213 thru 1F-V213	2	1	2	1	4	19 s 30 s(7)	-	-
17.	Control room supply fans	1A-VH403 1B-VH403	-	1	-	1	1	30 s	1	30 s
18.	208Y/120 V ac XFMRS to power dist panels	10X201,202,203 204 10X411,412,413 414 10X421,422,423, 424 10X501,502,503, 504	4	4	4	4	12	13 s	12	13 s
19.	Deleted									
20.	Intake structure exhaust fans	1A,B,C,D-V504	1	1	1	1	2	13 s(15)	2	13 s(15)
21.	Control room chilled water circulating pumps	1A-P400 1B-P400	-	1	-	1	1	65 s	1	65 s
22.	Control room supply unit heating coils	1A-VH403 1B-VH403	-	1	-	1	1	60 s	1	60 s
23.	Control room water chillers	1A-K400 1B-K400	-	1	-	1	1	110 s(16)	1	110 s(16)
24.	Diesel generator room recirc system fans	1A-V412 thru 1H-V412	2	2	2	2	3	30 s(9)	3	30 s
25.	Primary containment instrument gas compressors	1A-K202 1B-K202	-	1	-	1	1	30 min	1	30 min
26.	Battery chargers, 250 V dc	10D423 10D433	1	-	1	-	2	13 s	2	13 s
27.	Control area battery room exhaust fans	1A-V410 1B-V410	-	1	-	1	1	60 s	1	60 s

TABLE 8.3-1 (Cont)

Item	Description	Equipment No.	Number Connected To Class 1E Distribution System Diesel Buses				Loading Sequence[2]			
			A	C	B	D	Min No.	Time From DBA[13]	Min No.	Time From LOP[13]
28.	(DELETED)									
29.	Traveling screen spray water booster pumps	1A,B,C,D-P507	1	1	1	1	3	55 s	3	55 s
30.	(DELETED)									
31.	Control room supply system return fans	1A-V415 1B-V415	-	1	-	1	1	30 s	1	30 s
32.	Control room emergency filter fans	1A-V400 1B-V400	-	1	-	1	1	30 s	1	30 s
33.	Safety Aux Cooling System unit coolers	1A,B,C,D-VH214	-	2	-	2	2	45 s	2	45 s
34.	Fuel pool cooling pumps	1A-P211 1B-P211	1	-	1	-	1	61 min	1	61 min
35.	Control room emergency filter unit electric heating coils	1A-VH400 1B-VH400	-	1	-	1	1	30 s	1	30 s
36.	Control equipment room air supply fans	1A-VH407 1B-VH407	-	1	-	1	1	70 s	1	70 s
37.	RB FRVS vent sys fans	1A-V206 1B-V206	1	-	1	-	1	19 s	-	-
38.	Containment hydrogen recombiner system	1A-S205 1B-S205	1	-	-	1	1	24 h	-	-
39.	Control equip room supply unit heating coils	1A-VH407 1B-VH407	-	1	-	1	1	70 s	1	70 s
40.	Service water self-cleaning strainers	1A,B,C,D-F509	1	1	1	1	3	55 s	3	55 s
41.	Standby liquid control pumps	1A-P208 1B-P208	1	-	1	-	2	-	2	13 s[14]

Item	Description	Equipment No.	Number Connected To Class 1E Distribution System Diesel Buses A	C	B	D	Loading Sequence(2) Min No.	Time From DBA(13)	Min No.	Time From LOP(13)
42.	Deleted.									
43.	Deleted.									
44.	Deleted.									
45.	Deleted.									
46.	480 V power supply to Class 1E chiller panels	1AC488, 1BC488 1AC491, 1BC491	1	1	1	1	2	13 s	1	13 s
47.	Traveling screens	1A-S501 1B-S501 1C-S501 1D-S501	1	1	1	1	3	55 s	3	55 s
48.	ECCS jockey pumps	1A-P228 1B-P228 1C-P228 1D-P228	1	1	1	1	3	13 s	3	13 s
49.	Motor driven diesel generator fuel oil standby pumps	1A-P402 1B-P402 1C-P402 1D-P402	1	1	1	1	3	13 s	3	13 s
50.	Standby liquid control pump room duct heaters	1A-VE261 1B-VE261	1	-	-	1	1	15 min	1	15 min
51.	480 V power supply to hydrogen & oxygen analyzer panels	1A-C200 1B-C200	1	-	1	-	1	13 s	1	13 s
52.	250 V dc battery room duct heaters	10-VE418	1	-	-	-	1	13 s	1	13 s
53.	125 V dc diesel area battery room duct heaters	1A-VE420 1B-VE420 1C-VE420 1D-VE420	1	1	1	1	3	13 s	1	13 s
54.	HPCI pump room duct heater	10-VE260	1	-	-	-	1	13 s	1	13 s
55.	RCIC pump room duct heater	10-VE259	-	-	1	-	1	13 s	1	13 s

TABLE 8.3-1 (Cont)

Item	Description	Equipment No.	Number Connected To Class 1E Distribution System Diesel Buses A	C	B	D	Loading Sequence[2] Min No.	Time From DBA[13]	Min No.	Time From LOP[13]
56.	250 V dc battery room duct heater	10-VE417	-	-	1	-	1	13 s	1	13 s
57.	Class 1E panel room water chillers	1A-K403 1B-K403	1	-	1	-	1	125 s[16]	1	125 s[16]
58.	Class 1E panel room chilled water pumps	1A-P414 1B-P414	1	-	1	-	1	75 s	1	75 s
59.	Class 1E panel room supply & return air fans	1A-VH408 1B-VH408	1	-	1	-	1	80 s	1	80 s
60.	Class 1E panel room electric heaters	1A-VH408 1B-VH408	1	-	1	-	1	80 s	1	80 s
61.	Battery room, exhaust fans	1A-V416 1B-V416	1	-	1	-	1	60 s	1	60 s
62.	Battery room, duct heaters	1A-VE423 1B-VE423	-	1	-	1	2	13 s	2	13 s
63.	H_2/O_2 analyzer heat tracing panels	1CC-200 1DC-200	-	1	-	1	1	13 s	1	13 s
64.	Deleted.									
65.	Deleted.									
66.	Deleted.									
67.	Deleted.									
68.	Deleted.									
69.	Deleted.									
70.	Deleted.									
	Non-Class 1E Loads									
71.	Turbine generator turning gear oil pump	10-P111	-	-	1	-	1	10 min (11)	1	10 min
72.	Standby liquid control solution operating heater	10-E276	1	-	-	-	1	10 min	1	10 min
73.	Drywell cooling unit fans	1A1-V212 thru 1H1-V212 1A2-V212 thru 1H2-V212	8	-	8	-	-	-	8	13 s
74.	Radwaste exhaust fans	OA-V305 OB-V305 OC-V305	1	1	1	-	-	-	3	14 min

Item	Description	Equipment No.	Number Connected To Class 1E Distribution System Diesel Buses A	C	B	D	Loading Sequence(2) Min No.	Time From DBA(13)	Min No.	Time From LOP(13)
75.	Essential plant lighting		1	1	1	1	2	10 min	2	13 s
76.	CRD water pumps	1A-P207 1B-P207	-	1	-	1	1	11 min	1	16 min
77.	Turbine Building battery room exhaust fans	1A-V138 1B-V138	1	-	1	-	1	10 min	1	13 s
78.	Turbine generator aux Bearing lift pumps total 9 - 5 hp each Turning gear - 60 hp	1A-P110 thru 1J-P110 10G-110	-	-	1	-	1	40 min	1	40 min
79.	Emergency instrument air compressor	10-K100	1	-	-	-	-	-	1	20 min
80.	Radwaste supply fans	0A-V316 0B-V316	-	1	-	1	-	-	2	14 min
81.	Reactor Building supply air handling units	1A-VH300 1B-VH300 1C-VH300	1	1	-	1	-	-	2	19 s
82.	Reactor Building exhaust fans	1A-V301 1B-V301 1C-V301	1	-	1	1	-	-	2	19 s
83.	Radwaste tank vent filter fans	0A-V306 0B-V306	1	-	1	-	1	61 min	1	14 min
84.	Turbine Building battery room supply fans	1A-V137 1B-V137	1	-	1	-	1	10 min	1	13 s
85.	Radwaste tank vent filter heating coils	0A-VH306 0B-VH306	1	-	1	-	1	61 min	1	14 min
86.	Chemical lab exhaust fans	0A-V307 0B-V307	1	-	1	-	1	120 min	1	11 min
87.	Diesel generator starting air compressors	1A-K402 thru 1D-K402	1	1	1	1	3	11 min	3	11 min

TABLE 8.3-1 (Cont)

Item	Description	Equipment No.	Number Connected To Class 1E Distribution System Diesel Buses A	C	B	D	Loading Sequence(2) Min No.	Time From DBA(13)	Min No.	Time From LOP(13)
88.	Reactor Aux Cooling System pumps	1A-P209 1B-P209	1	-	1	-	-	-	1	85 s
89.	125 V dc battery chargers	1A1D473, 1A2D473, 1B1D473,1B2D473	2	-	2	-	1	10 min	2	13 s
90.	125 V dc battery chargers	1A1D474, 1A2D474, 1B1D474,1B2D474	1	1	1	1	4	10 min	4	13 s
91.	250 V dc battery charger	10D143	-	-	1	-	1	10 min	1	13 s
92.	Standby liquid control sol mixing heater	10-E277	-	-	-	1	1	10 min	1	10 min
93.	RFPT auxiliaries Lube oil pumps	1A-1,2P124 1B-1,2P124 1C-1,2P124	1	1	1	-	3	15 min	3	15 min
	Turning gear motors	1A-S100 1B-S100 1C-S100	1	1	1	-	3	15 min	3	15 min
94.	Deleted.									
95.	208 V/120 V ac XFMRS to dist panels	10X205, 10X206 10X207, 10X208 10X419, 10X213	2	2	1	1	3	10 min	3	13 s
96.	Reactor Building floor drain sump pumps	1A-P265 1B-P265 1C-P265 1D-P265	-	2	-	2	2	10 min	2	13 s
97.	Drywell equip drain sump pumps	1A-P267 1B-P267	1	-	1	-	-	-	2	13 s
98.	Drywell floor drain sump pumps	1C-P267 1D-P267	1	-	1	-	-	-	1	13 s

Item	Description	Equipment No.	Number Connected To Class 1E Distribution System Diesel Buses A	C	B	D	Loading Sequence[(2)] Min No.	Time From DBA[(13)]	Min No.	Time From LOP[(13)]
99.	Power supply for unit vent radiation monitoring systems	1AS929, 1BS929	1	-	1	-	1	10 min	1	13 s
100.	Power supply for DLD - radiation monitoring systems	10S935	-	1	-	-	1	10 min	1	13 s
101.	Turbine generator main seal oil pump	10-P173	-	-	1	-	1	55 min	1	55 min
102.	Turbine generator recirc seal oil pump	10-P171	-	-	1	-	1	55 min	1	55 min
103.	Turbine generator seal oil vacuum pump	10-P172	-	-	1	-	1	55 min	1	55 min
104.	Radwaste+ 24 V dc battery room duct heater	00-VE313	1	-	-	-	-	-	1	14 min
105.	Condensate storage tank heat tracing	10-C284	-	1	-	-	1	10 min	1	13 s
106.	TSC supply system fan	0VH314	-	1	-	-	1	15 min	1	15 min
107.	TSC supply system heating coil	0VH314	-	1	-	-	1	15 min	1	15 min
108.	TSC emergency filter fan	00V314	-	1	-	-	1	15 min	1	15 min
109.	TSC emergency filter htg coil	0VH313	-	1	-	-	1	15 min	1	15 min
110.	Steam tunnel unit coolers	1A-V216 1B-V216	-	-	1	1	-	-	1	10 min
111.	Turbine Building battery room supply fan htg coil	10VE132	1	-	-	-	1	10 min	1	13 s
112.	Turbine Building compartment exhaust fans	10V106 10V109	1	-	1	-	-	-	1	10 min or later
113.	Control area 125 V dc battery room duct heater	10-VE419	1	-	-	-	1	10 min	1	13 s

TABLE 8.3-1 (Cont)

Item	Description	Equipment No.	Number Connected To Class 1E Distribution System Diesel Buses A	C	B	D	Loading Sequence (2) Min No.	Time From DBA (13)	Min No.	Time From LOP (13)
114.	Remote shutdown panel rm supply fan	0VH316	1	-	-	-	-	-	1	10 min
115.	Remote shutdown panel rm heating coil	0VH316	1	-	-	-	-	-	1	10 min
116.	Plant leak detection sys heat tracing panel	10C282	-	-	-	1	1	10 min	1	10 min
117.	Unit vent rms heat tracing panel	10C355	1	-	-	-	1	10 min	1	10 min
118.	Post accident sampling sys heat tracing panel	10C203	-	1	-	-	1	10 min	1	10 min
119.	Electric unit heaters	OAVE389, OBVE389, OOVE390	-	3	-	-	3	10 min	3	10 min
120.	TSC electric pan humidifier	OOVH314	-	1	-	-	1	10 min	1	10 min
121.	Wing area exhaust fans	1AV414 1BV414	1	-	-	1	1	-	1	10 min
122.	Wing area supply fans	1AVH304 1BVH304	1	-	-	1	1	-	1	10 min
123.	SPDS UPS	30N401	1	1	-	-	1	-	1	20 min

(1) Each standby diesel generator is rated as follows:
4430 kW - Continuous with 10 percent overload capacity for 2 hours in every 24 hours

(2) Loading sequence is based on availability of three standby diesel generators and their associated electric power distribution systems.

(3) DBA = Design basis accident
LOCA = Loss-of-coolant accident
LOP = Loss of offsite power
DBA = LOCA + LOP

(4) MOV's maximum stroking time will vary from 20 to 70 seconds except for the main steam stop valves, with a stroking time of 120 seconds; and also the SACS cross-connect Inlet & Outlet valves to the Spent Fuel Pool heat exchangers which have a stroke time of 84 seconds.

(5) Deleted.
(6) During a DBA, any two core spray pumps and three RHR pumps can be manually tripped after 10 minutes from the occurrence of LOCA, depending upon the load on each standby diesel generator. Either the A or the B RHR pump must be retained in service after 10 minutes from the occurrence of LOCA.
(7) Buses A and B each have two FRVS recirculating fans connected to them. Buses C and D each have one FRVS recirculating fan connected to them. In the case of a DBA, one fan will start on each of buses A, B, C, and D and the remaining fans and heating coils will start in diesel buses A and B at the times shown in the loading chart.
(8) Deleted.
(9) In case the lead fan fails to start, the lag fan will start automatically at 95 seconds.
(10) Deleted.
(11) Upon the occurrence of a LOCA, non-Class 1E loads are tripped by LOCA signals in 3 seconds by tripping the unit substation circuit breakers feeding the non-Class 1E MCCs and motors. These loads can be reenergized manually at 10 minutes after the occurrence of LOCA.
(12) Deleted.
(13) Times shown are from the occurrence of LOCA or loss of offsite power.
(14) Loads are not sequenced but power is required to be available to the loads in the event of LOP or be available within 25 seconds after an ATWS initiation signal. The time shown (13 sec) is when power is available after LOP.
(15) Loads are not sequenced but are controlled by process signals. For SDG loading purposes, these loads are assumed to start and run after 13 seconds from the DBA/LOCA event.
(16) Time indicated is sequence time required if chillers are off prior to DBA or LOP. If chillers are on prior to DBA or LOP, sequence time required is 160 sec.

TABLE 8.3-2

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TABLE 8.3-3

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TABLE 8.3-4

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TABLE 8.3-5

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TABLE 8.3-6

THIS TABLE INTENTIONALLY DELETED

TABLE 8.3-7a

THIS TABLE INTENTIONALLY DELETED

TABLE 8.3-7b

THIS TABLE INTENTIONALLY DELETED

TABLE 8.3-7c

THIS TABLE INTENTIONALLY DELETED

TABLE 8.3-7d

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TABLE 8.3-8

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TABLE 8.3-9

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TABLE 8.3-10a

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TABLE 8.3-10b

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TABLE 8.3-11

MOTOR OPERATED VALVES - THERMAL OVERLOAD PROTECTION (BYPASSED)

VALVE NUMBER	THERMAL OVERLOAD PROTECTION STATUS	SYSTEM(S) AFFECTED
1AB-HV-F016	2	Main Steam
1AB-HV-F019	2	Main Steam
1AB-HV-F071	3	Main Steam
1AE-HV-F032A	3	Feedwater
1AE-HV-F032B	3	Feedwater
1AE-HV-F039	3	Feedwater
1AE-HV-4144	3	Feedwater
1AN-HV-2600	3	Demineralized Water
0AP-HV-2072	3	Condensate Storage & Transfer
0AP-HV-2073	3	Condensate Storage & Transfer
1AP-HV-F011	1	Condensate Storage & Transfer
1BC-HV-F004A	3	Residual Heat Removal (RHR)
1BC-HV-F004C	3	RHR
1BC-HV-F007A	1	RHR
1BC-HV-F007C	1	RHR
1BC-HV-F007D	1	RHR
1BC-HV-F010A	2	RHR
1BC-HV-F015A	2	RHR
1BC-HV-F016A	3	RHR
1BC-HV-F017A	1	RHR
1BC-HV-F017C	1	RHR
1BC-HV-F017D	1	RHR
1BC-HV-F024A	2	RHR
1BC-HV-F027A	2	RHR
1BC-HV-F047A	3	RHR
1BC-HV-F048A	1	RHR
1BC-HV-F075	3	RHR
1BC-HV-5055A	2	Containment Atmosphere Control
1BC-HV-5055B	2	Containment Atmosphere Control

MOTOR OPERATED VALVES - THERMAL OVERLOAD PROTECTION (BYPASSED)

VALVE NUMBER	THERMAL OVERLOAD PROTECTION STATUS	SYSTEM(S) AFFECTED
1BE-HV-F001A	3	Core Spray
1BE-HV-F001B	3	Core Spray
1BE-HV-F001C	3	Core Spray
1BE-HV-F001D	3	Core Spray
1BE-HV-F004A	1	Core Spray
1BE-HV-F004B	1	Core Spray
1BE-HV-F005A	1	Core Spray
1BE-HV-F005B	1	Core Spray
1BE-HV-F015A	2	Core Spray
1BE-HV-F015B	2	Core Spray
1BE-HV-F031A	1	Core Spray
1BE-HV-F031B	1	Core Spray
1BF-HV-3800A	3	Control Rod Drive
1BF-HV-3800B	3	Control Rod Drive
1BF-HV-4005	3	Control Rod Drive
1BG-HV-F001	2	Reactor Water Cleanup
1BG-HV-F004	2	Reactor Water Cleanup
1BG-HV-F034	3	Reactor Water Cleanup
1BG-HV-F035	3	Reactor Water Cleanup
1BG-HV-3980	3	Reactor Water Cleanup
1BH-HV-F006A	3	Standby Liquid Control
1BH-HV-F006B	3	Standby Liquid Control
1BJ-HV-F004	1	High Pressure Coolant Injection (HPCI)
1BJ-HV-F006	1	HPCI
1BJ-HV-F007	1	HPCI
1BJ-HV-F008	2	HPCI
1BJ-HV-F012	1	HPCI
1BJ-HV-F042	1	HPCI
1BJ-HV-F059	1	HPCI
1BJ-HV-4803	3	HPCI
1BJ-HV-4804	3	HPCI
1BJ-HV-4865	3	HPCI
1BJ-HV-4866	3	HPCI
1BJ-HV-8278	1	HPCI
OBN-HV-2069	3	Refueling Water Transfer
1EA-HV-F073	3	Station Service Water
1EA-HV-2197A	3	Station Service Water

MOTOR OPERATED VALVES - THERMAL OVERLOAD PROTECTION (BYPASSED)

VALVE NUMBER	THERMAL OVERLOAD PROTECTION STATUS	SYSTEM(S) AFFECTED
1EA-HV-2197C	3	Station Service Water
1EA-HV-2198A	2	Station Service Water
1EA-HV-2198C	2	Station Service Water
1EA-HV-2203	3	Station Service Water
1EA-HV-2207	3	Station Service Water
1EA-HV-2234	3	Station Service Water
1EA-HV-2236	3	Station Service Water
1EA-HV-2238	3	Station Service Water
1EA-HV-2346	3	Station Service Water
1EA-HV-2355A	2	Station Service Water
1EA-HV-2356A	3	Station Service Water
1EA-HV-2356B	3	Station Service Water
1EA-HV-2357A	3	Station Service Water
1EA-HV-2371A	2	Station Service Water
1EC-HV-4647	3	Fuel Pool Cooling
1EC-HV-4648	3	Fuel Pool Cooling
1EC-HV-4689A	3	Fuel Pool Cooling
1EC-HV-4689B	3	Fuel Pool Cooling
1ED-HV-2553	2	Reactor Auxiliaries Cooling
1ED-HV-2554	2	Reactor Auxiliaries Cooling
1ED-HV-2555	2	Reactor Auxiliaries Cooling
1ED-HV-2556	2	Reactor Auxiliaries Cooling
1ED-HV-2598	3	Reactor Auxiliaries Cooling
1ED-HV-2599	3	Reactor Auxiliaries Cooling
1EE-HV-4652	2	Torus Water Cleanup
1EE-HV-4679	2	Torus Water Cleanup
1EE-HV-4680	2	Torus Water Cleanup
1EE-HV-4681	2	Torus Water Cleanup
1EG-HV-2314A	3	Safety Auxiliaries Cooling
1EG-HV-2314B	3	Safety Auxiliaries Cooling
1EG-HV-2317A	3	Safety Auxiliaries Cooling
1EG-HV-2317B	3	Safety Auxiliaries Cooling
1EG-HV-2320A	3	Safety Auxiliaries Cooling
1EG-HV-2320B	3	Safety Auxiliaries Cooling
1EG-HV-2321A	2	Safety Auxiliaries Cooling
1EG-HV-2321B	2	Safety Auxiliaries Cooling
1EG-HV-2446	3	Safety Auxiliaries Cooling
1EG-HV-2447	3	Safety Auxiliaries Cooling
1EG-HV-2452A	3	Safety Auxiliaries Cooling

MOTOR OPERATED VALVES - THERMAL OVERLOAD PROTECTION (BYPASSED)

VALVE NUMBER	THERMAL OVERLOAD PROTECTION STATUS	SYSTEM(S) AFFECTED
1EG-HV-2452B	3	Safety Auxiliaries Cooling
1EG-HV-2453A	2	Safety Auxiliaries Cooling
1EG-HV-2453B	2	Safety Auxiliaries Cooling
1EG-HV-2491A	3	Safety Auxiliaries Cooling
1EG-HV-2494A	3	Safety Auxiliaries Cooling
1EG-HV-2496C	3	Safety Auxiliaries Cooling
1EG-HV-2512A	3	Safety Auxiliaries Cooling
1EG-HV-7921A	3	Safety Auxiliaries Cooling
1EG-HV-7921B	3	Safety Auxiliaries Cooling
1EG-HV-7922A	3	Safety Auxiliaries Cooling
1EG-HV-7922B	3	Safety Auxiliaries Cooling
1EP-HV-2225A	3	Station Service Water
1EP-HV-2225B	3	Station Service Water
1EP-HV-2225C	3	Station Service Water
1EP-HV-2225D	3	Station Service Water
1FC-HV-F076	2	Reactor Core Isolation Cooling (RCIC)
1FD-HV-F001	1	High Pressure Coolant Injection (HPCI)
1FD-HV-F002	2	HPCI
1FD-HV-F003	2	HPCI
1FD-HV-F071	3	HPCI
1FD-HV-F075	2	HPCI
1FD-HV-F079	2	HPCI
1FD-HV-F100	2	HPCI
1FD-HV-4922	2	HPCI
1GB-HV-9531A1	2	Chilled Water
1GB-HV-9531A2	2	Chilled Water
1GB-HV-9531A3	2	Chilled Water
1GB-HV-9531A4	2	Chilled Water
1GB-HV-9531B1	2	Chilled Water
1GB-HV-9531B2	2	Chilled Water
1GB-HV-9531B3	2	Chilled Water
1GB-HV-9531B4	2	Chilled Water
1GB-HV-9532-1	3	Chilled Water
1GB-HV-9532-2	3	Chilled Water
1GH-HV-5543	3	Radwaste Area Vent
1GS-HV-4955A	2	Containment Atmosphere Control
1GS-HV-4955B	2	Containment Atmosphere Control

TABLE 8.3-11 (Continued)

MOTOR OPERATED VALVES - THERMAL OVERLOAD PROTECTION (BYPASSED)

VALVE NUMBER	THERMAL OVERLOAD PROTECTION STATUS	SYSTEM(S) AFFECTED
1GS-HV-4959A	2	Containment Atmosphere Control
1GS-HV-4959B	2	Containment Atmosphere Control
1GS-HV-4965A	2	Containment Atmosphere Control
1GS-HV-4965B	2	Containment Atmosphere Control
1GS-HV-4966A	2	Containment Atmosphere Control
1GS-HV-4966B	2	Containment Atmosphere Control
1GS-HV-4974	2	Containment Atmosphere Control
1GS-HV-4983A	2	Containment Atmosphere Control
1GS-HV-4983B	2	Containment Atmosphere Control
1GS-HV-4984A	2	Containment Atmosphere Control
1GS-HV-4984B	2	Containment Atmosphere Control
1GS-HV-5019A	2	Containment Atmosphere Control
1GS-HV-5019B	2	Containment Atmosphere Control
1GS-HV-5022A	2	Containment Atmosphere Control
1GS-HV-5022B	2	Containment Atmosphere Control
1GS-HV-5050A	2	Containment Atmosphere Control
1GS-HV-5050B	2	Containment Atmosphere Control
1GS-HV-5052A	2	Containment Atmosphere Control
1GS-HV-5052B	2	Containment Atmosphere Control
1GS-HV-5053A	2	Containment Atmosphere Control
1GS-HV-5053B	2	Containment Atmosphere Control
1GS-HV-5054A	2	Containment Atmosphere Control
1GS-HV-5054B	2	Containment Atmosphere Control
1GS-HV-5057A	2	Containment Atmosphere Control
1GS-HV-5057B	2	Containment Atmosphere Control
1HB-HV-F003	2	Liquid Radwaste
1HB-HV-F004	2	Liquid Radwaste
1HB-HV-F019	2	Liquid Radwaste
1HB-HV-F020	2	Liquid Radwaste
1HB-HV-5262	3	Liquid Radwaste
1HB-HV-5275	3	Liquid Radwaste
1HC-HV-5551	3	Solid Radwaste
1KA-HV-7626	3	Service Compressed Air
1KB-HV-7629	3	Instrument Air (Backup to PCIG System)
1KL-HV-5124A	2	Primary Containment Instrument Gas (PCIG)
1KL-HV-5124B	2	PCIG
1KL-HV-5126A	2	PCIG
1KL-HV-5126B	2	PCIG

TABLE 8.3-11 (Continued)

MOTOR OPERATED VALVES - THERMAL OVERLOAD PROTECTION (BYPASSED)

VALVE NUMBER	THERMAL OVERLOAD PROTECTION STATUS	SYSTEM(S) AFFECTED
1KL-HV-5147	2	PCIG
1KL-HV-5148	2	PCIG
1KL-HV-5152A	2	PCIG
1KL-HV-5152B	2	PCIG
1KL-HV-5160A	3	PCIG
1KL-HV-5160B	3	PCIG
1KL-HV-5162	2	PCIG
1KL-HV-5172A	2	PCIG
1KL-HV-5172B	2	PCIG
1SK-HV-4953	2	Plant Leak Detection
1SK-HV-4957	2	Plant Leak Detection
1SK-HV-4981	2	Plant Leak Detection
1SK-HV-5018	2	Plant Leak Detection

THERMAL OVERLOAD PROTECTION STATUS CODES

1. Normally in force during plant operation and bypassed only under accident conditions.

2. Bypassed continuously and temporarily placed in force only when the MOVs are undergoing periodic or maintenance testing.

3. In force during normal remote manual (momentary push button contact) MOV operation and bypassed during remote manual (push button held depressed) MOV operation.

Figure F8.3-1 intentionally deleted.

Refer to Plant Drawing E-0001-0 in DCRMS

Figure F8.3-2 SH 1-2 intentionally deleted.

Refer to Plant Drawing E-0002-1 for both sheets in DCRMS

Figure F8.3-3 intentionally deleted.

Refer to Plant Drawing E-0003-1 in DCRMS

Figure F8.3-4 intentionally deleted.

Refer to Plant Drawing E-0004-1 in DCRMS

Figure F8.3-5 SH 1-2 intentionally deleted.

Refer to Plant Drawing E-0006-1 for both sheets in DCRMS

Figure F8.3-6 intentionally deleted.

Refer to Plant Drawing E-0007-1 in DCRMS

Figure F8.3-7 intentionally deleted.

Refer to Plant Drawing E-0008-1 in DCRMS

Figure F8.3-8 SH 1-5 intentionally deleted.

Refer to Plant Drawing E-0009-1 for all sheets in DCRMS

Figure F8.3-9 intentionally deleted.

Refer to Plant Drawing E-0010-0 in DCRMS

Figure F8.3-10 SH 1-2 intentionally deleted.

Refer to Plant Drawing E-0011-1 for both sheets in DCRMS

Figure F8.3-11 SH 1-5 intentionally deleted.

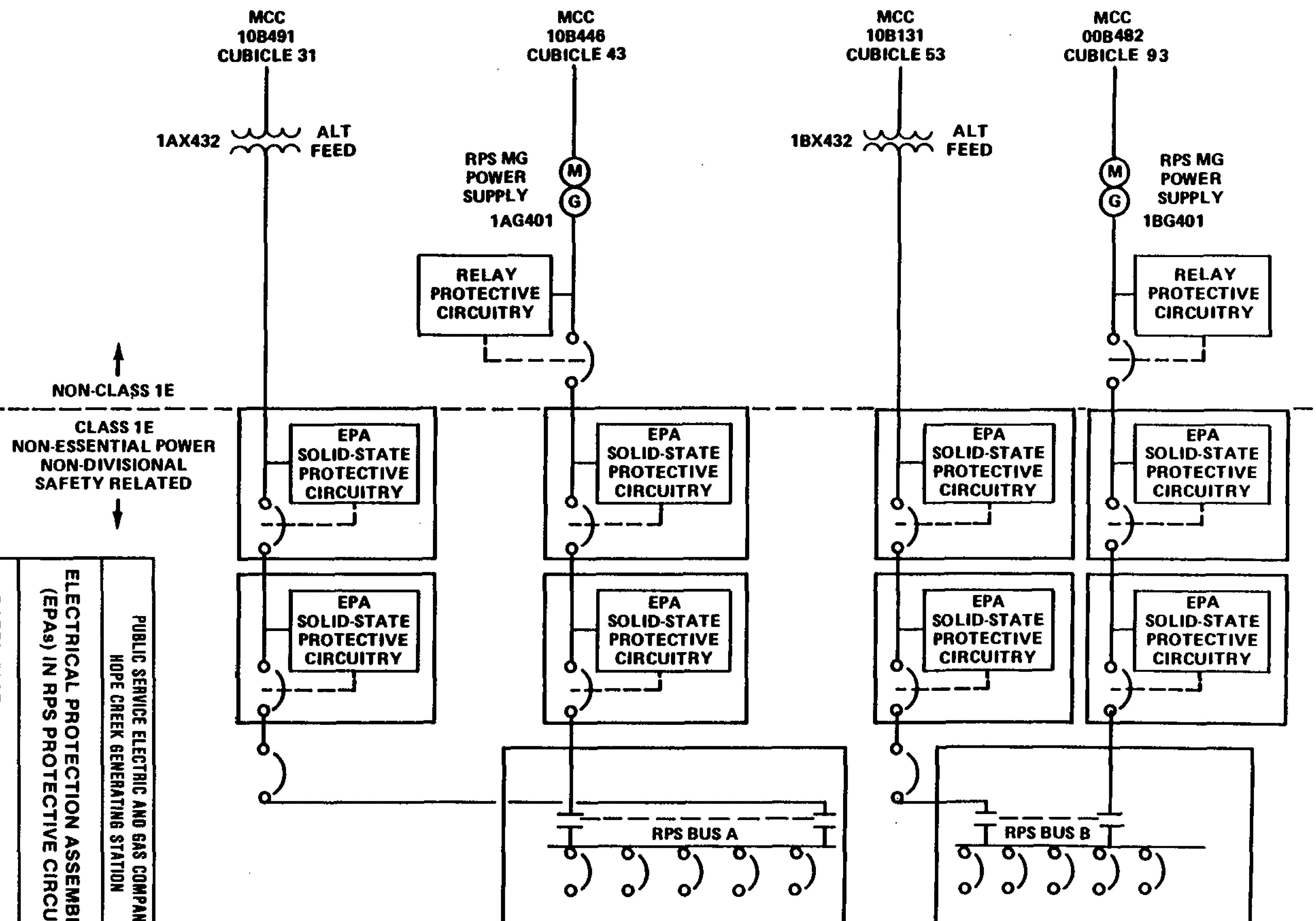
Refer to Plant Drawing E-0012-1 for all sheets in DCRMS

Figure F8.3-12 SH 1-3 intentionally deleted.

Refer to Plant Drawing E-0018-1 for all sheets in DCRMS

Figure F8.3-13 intentionally deleted.

Refer to Vendor Technical Document PN1-C71-1030-0003 in DCRMS



PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK GENERATING STATION

ELECTRICAL PROTECTION ASSEMBLIES (EPAs) IN RPS PROTECTIVE CIRCUIT

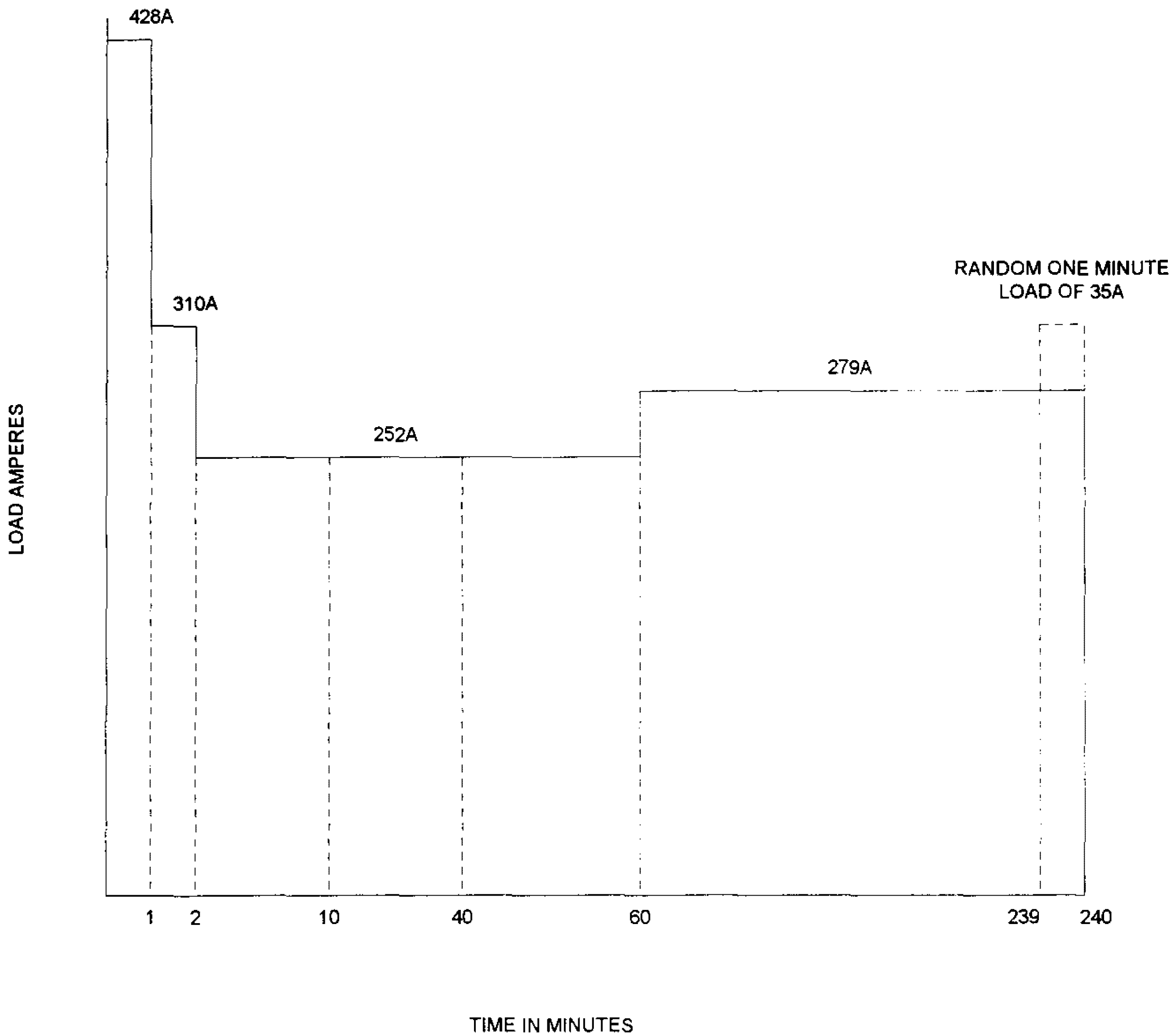
UPDATED FSAR
REVISION 1, APRIL 11, 1989

FIGURE 8.3-14

THIS FIGURE HAS BEEN DELETED.

REVISION 7
DECEMBER 29, 1995

PUBLIC SERVICE ELECTRIC AND GAS COMPANY HOPE CREEK NUCLEAR GENERATING STATION	Updated FSAR Figure 8.3-15



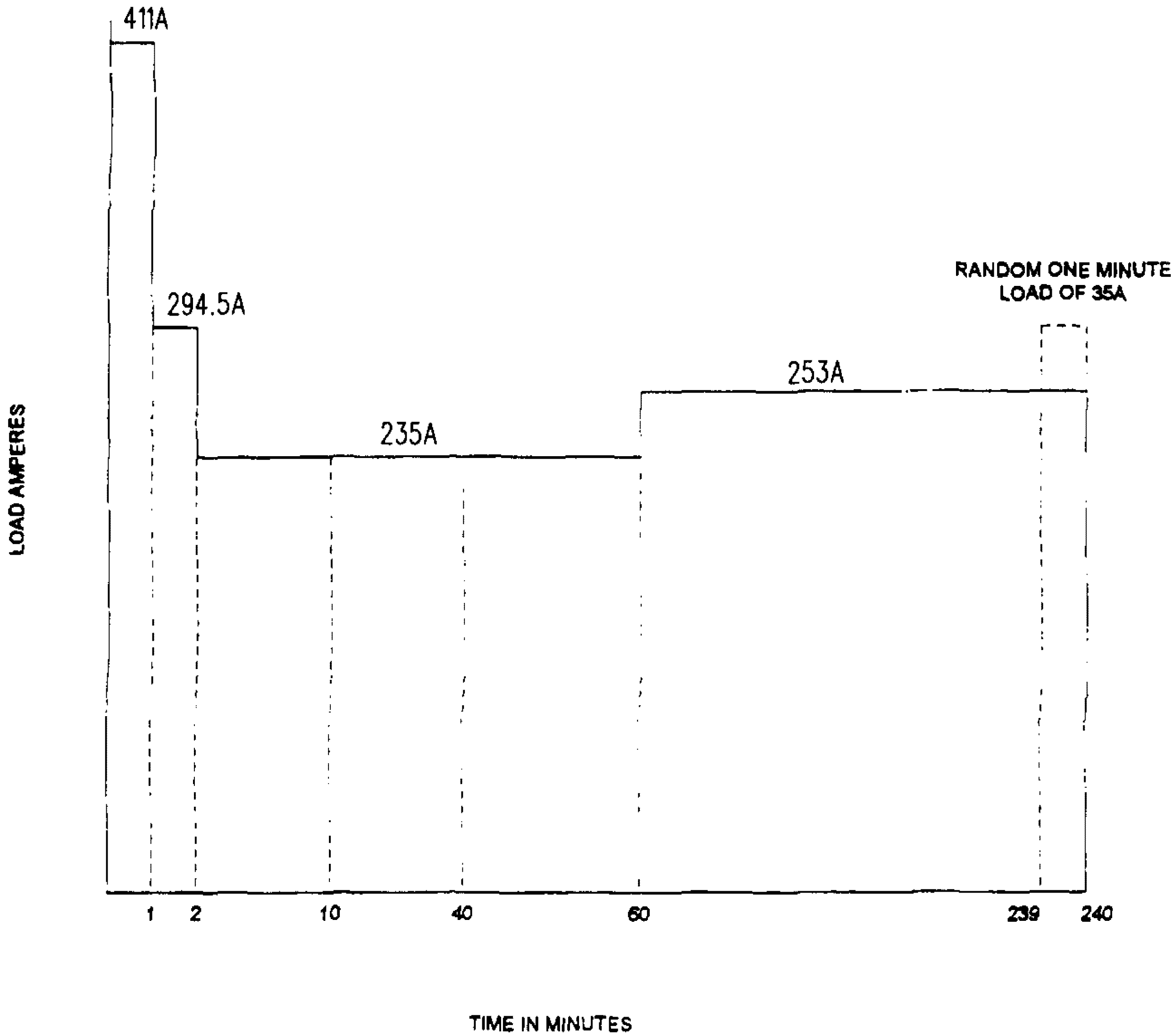
BATTERY 1A D411

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

CLASS 1E 125 VDC BATTERY LOAD PROFILE

Updated FSAR
Revision 9 June 13, 1998

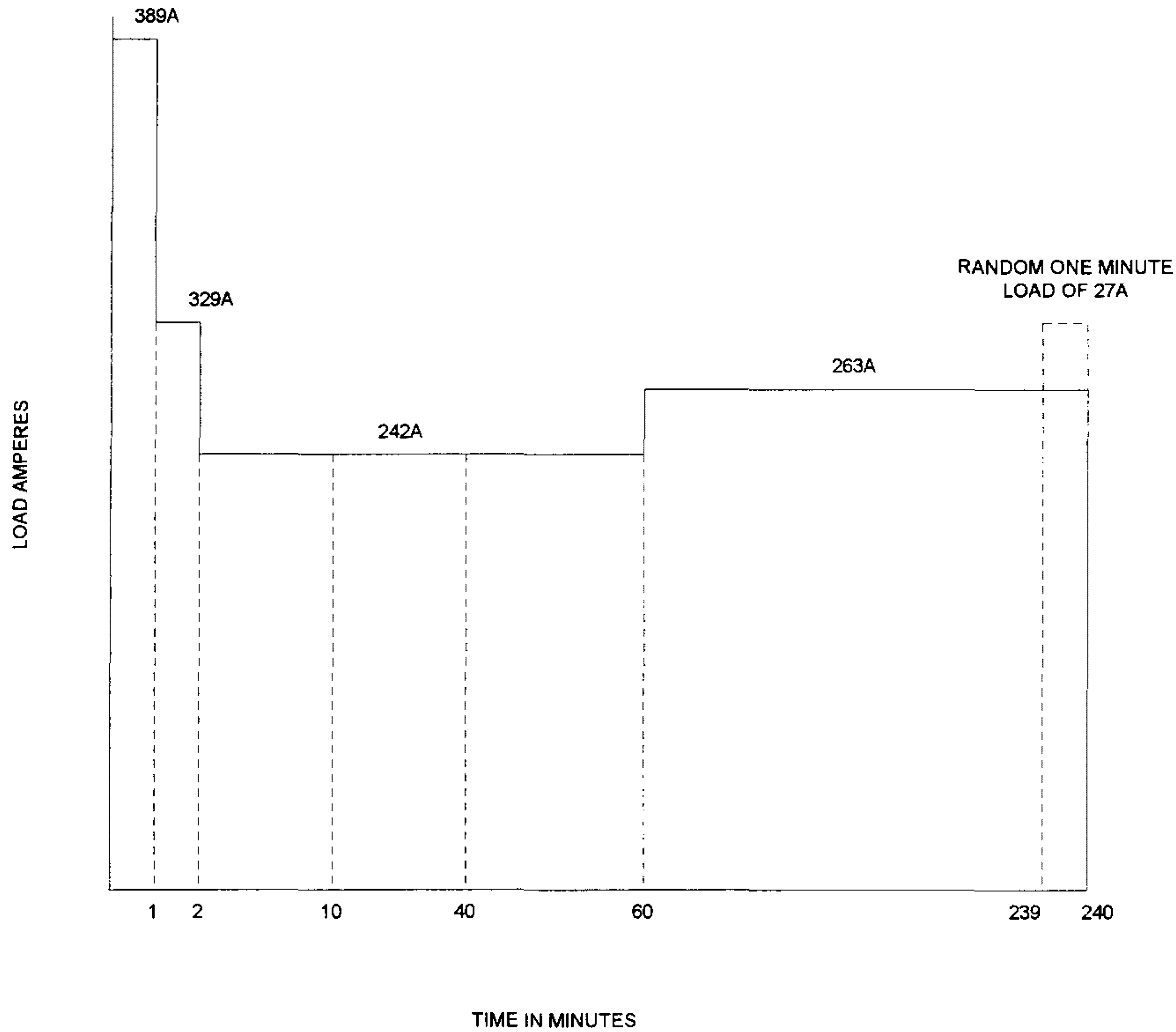
Sheet 1 of 8
Figure 8.3-16



BATTERY 1B D411

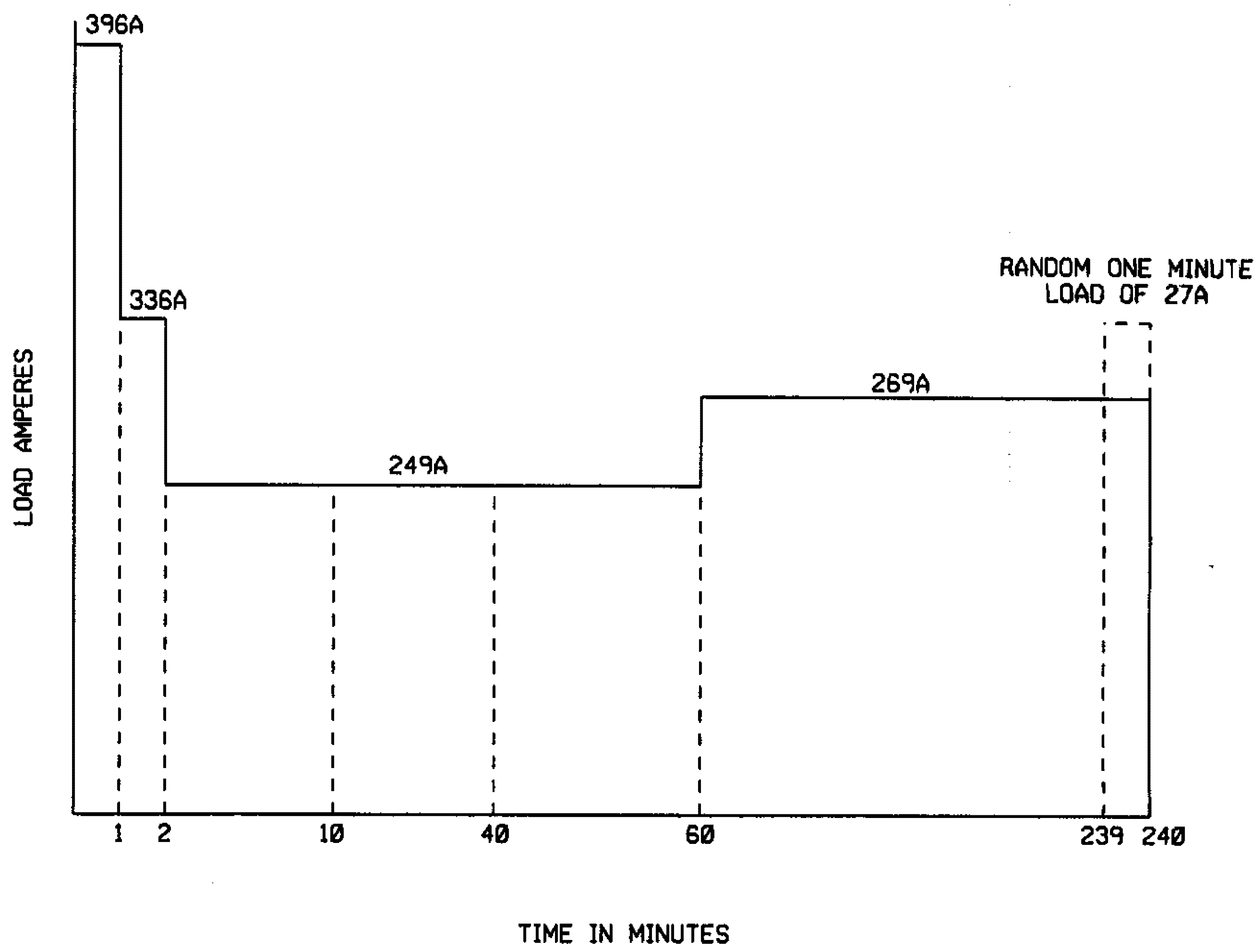
November 24, 2000

PSEG Nuclear, LLC HOPE CREEK NUCLEAR GENERATING STATION	Hope Creek Nuclear Generating Station CLASS 1E 125 VDC BATTERY LOAD PROFILE Updated FSAR - Revision 11 Figure 8.3-16, Sheet 2 of 8



BATTERY 1C D411

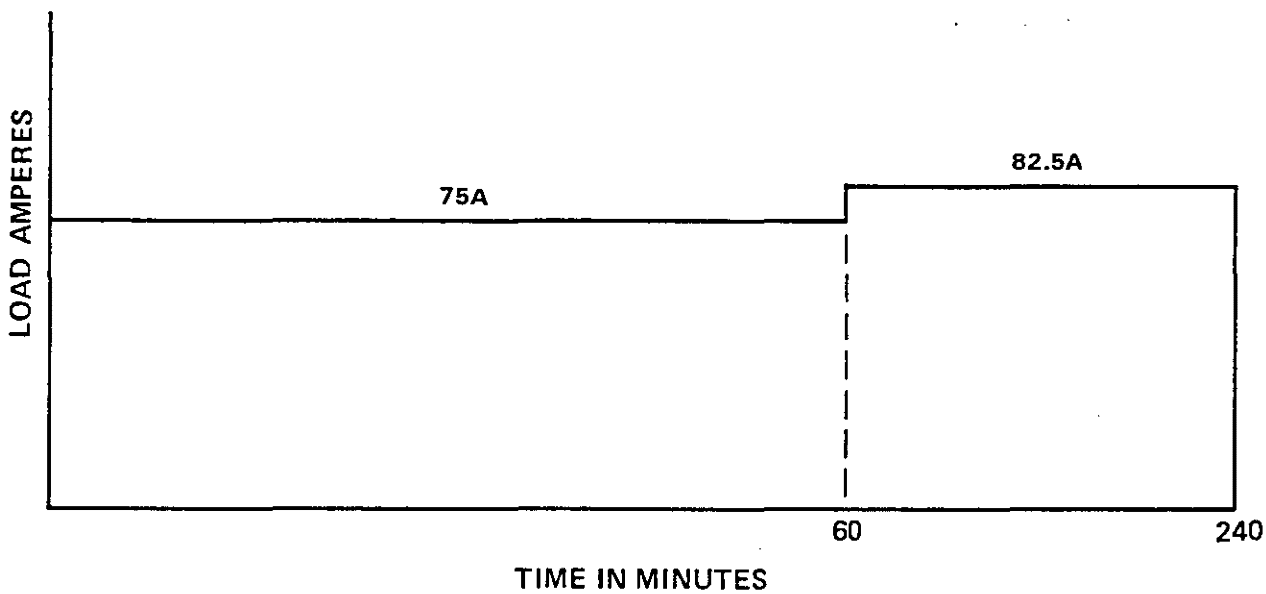
PUBLIC SERVICE ELECTRIC AND GAS COMPANY HOPE CREEK NUCLEAR GENERATING STATION	CLASS 1E 125 VDC BATTERY LOAD PROFILE	
	Updated FSAR Revision 9 June 13,1998	Sheet 3 of 8 Figure 8.3-16



BATTERY 1D D411

Revision 13, Nov 14, 2003

PSEG Nuclear, LLC HOPE CREEK NUCLEAR GENERATING STATION	Hope Creek Nuclear Generating Station CLASS 1E 125 VDC BATTERY LOAD PROFILE Updated FSAR Sheet 4 of 8 Figure 8.3-16



BATTERY 1C D447

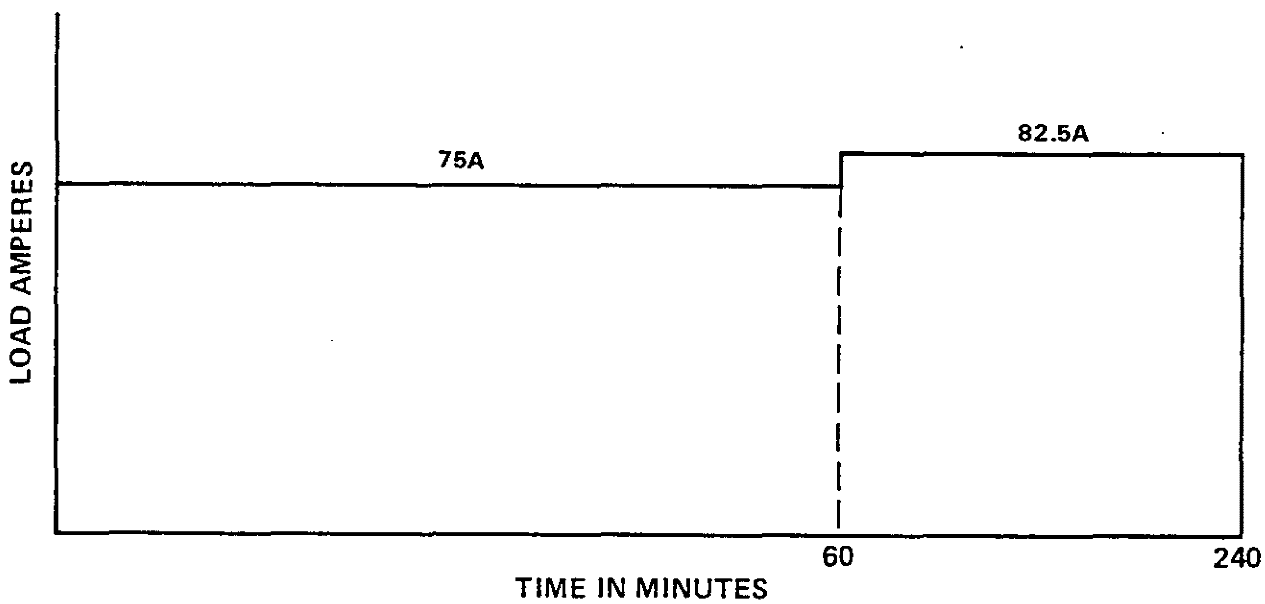
Revision 8
September 25, 1996

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

CLASS IE 125 VDC
BATTERY LOAD PROFILE

UPDATED FSAR

Sheet 5 of 8
FIGURE 8.3-16



BATTERY 1D D447

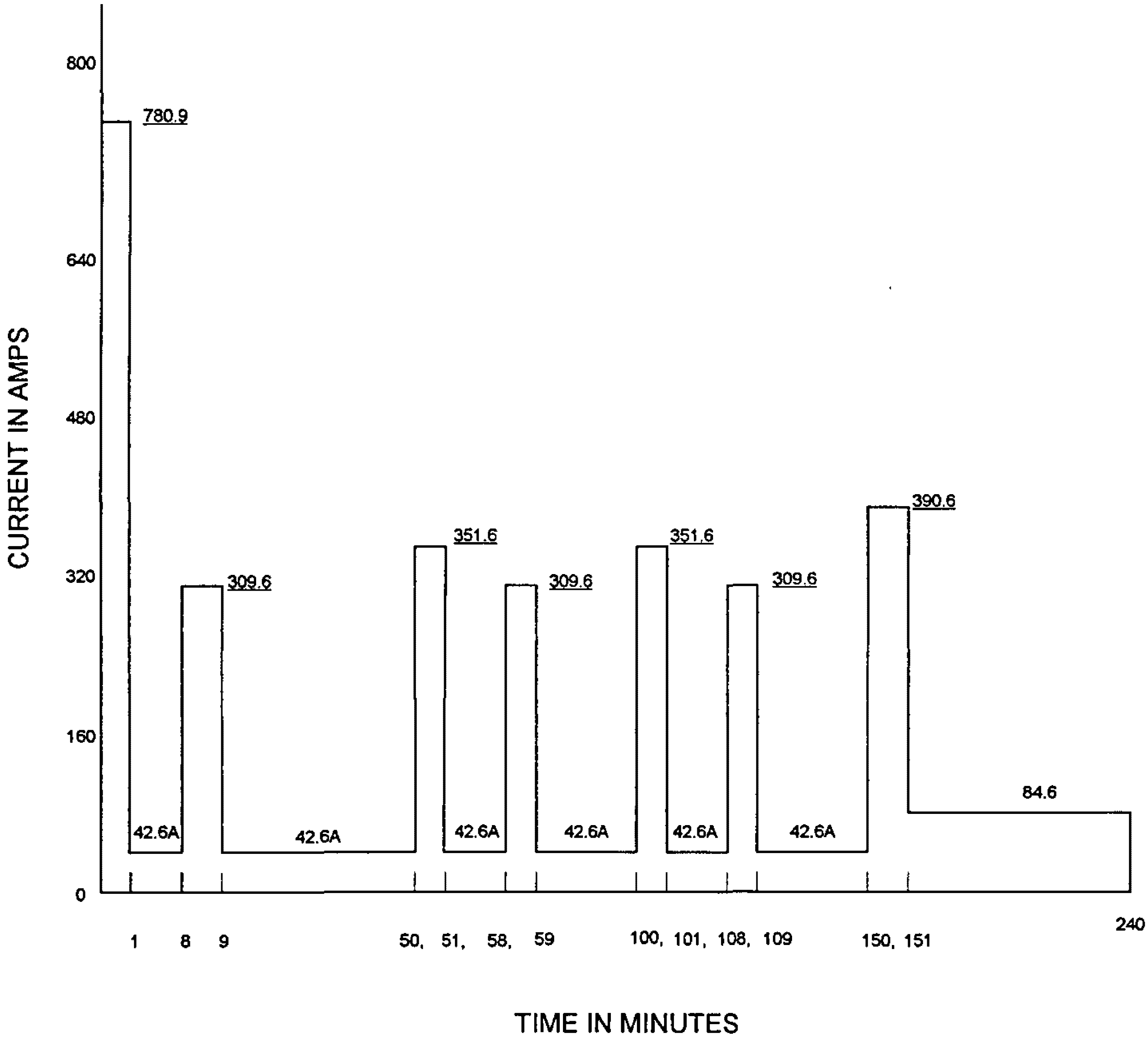
Revision 8
September 25, 1996

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

CLASS IE 125 VDC
BATTERY LOAD PROFILE

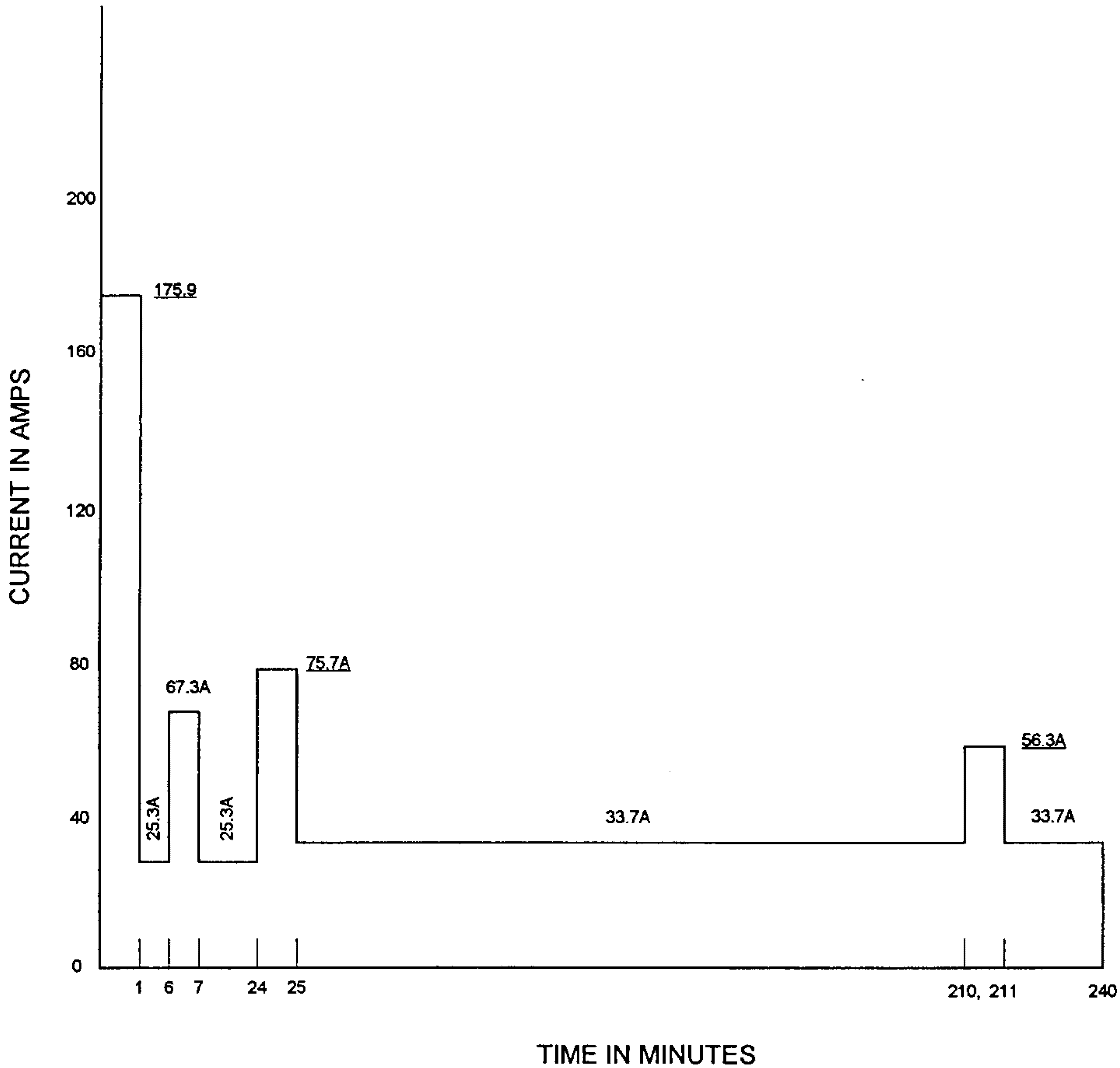
UPDATED FSAR

Sheet 6 of 8
FIGURE 8.3-16



BATTERY 10D
421

PUBLIC SERVICE ELECTRIC AND GAS COMPANY HOPE CREEK NUCLEAR GENERATING STATION
CLASS IE 250 VDC BATTERY LOAD PROFILE
Updated FSAR   Sheet 7 of 8 Revision 8, September 25, 1996   FIGURE 8.3-16



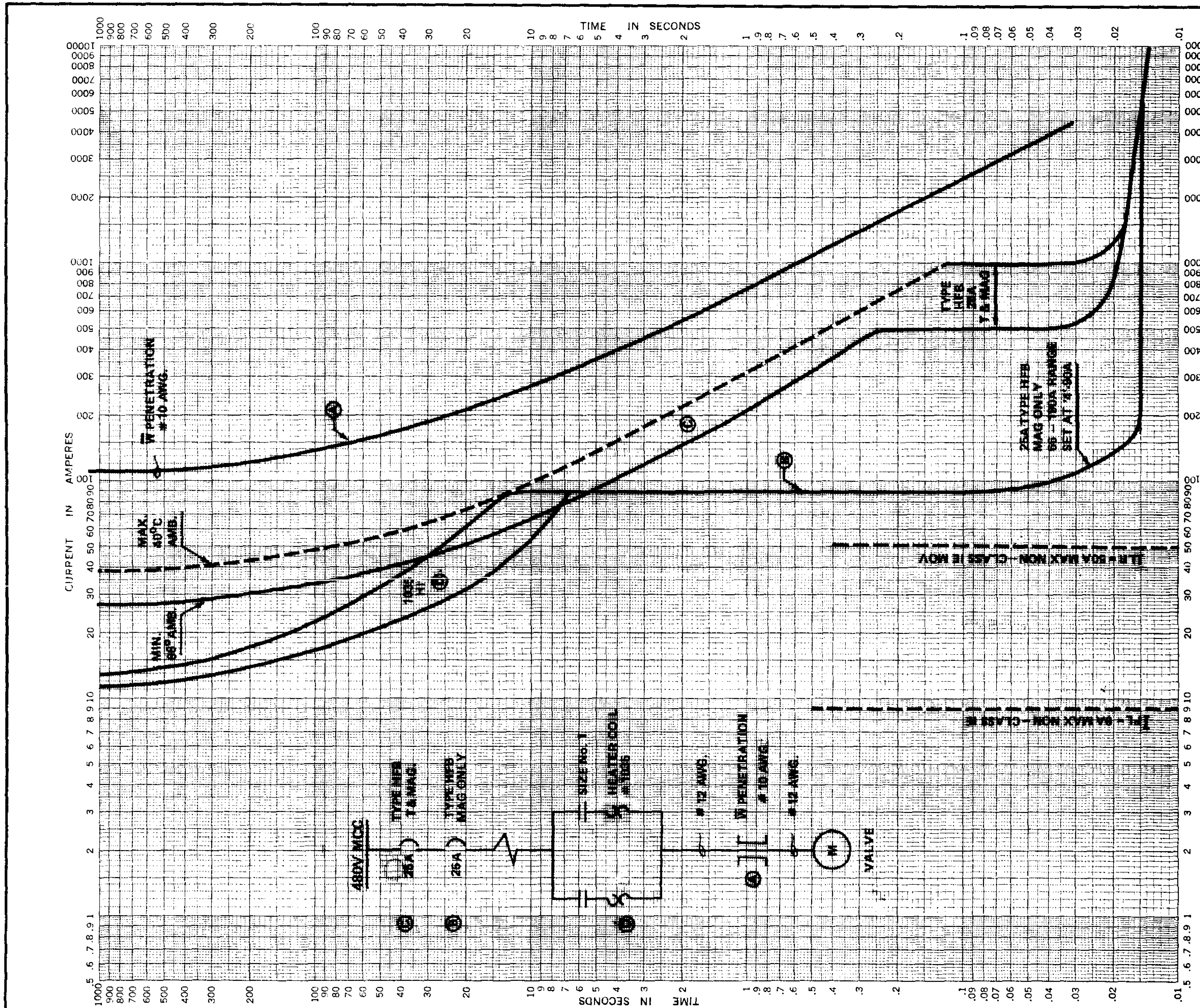
BATTERY 10D 431

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

CLASS IE 250 VDC
BATTERY LOAD PROFILE

Updated FSAR
Revision 8, September 25, 1996

Sheet 8 of 8
FIGURE 8.3-16



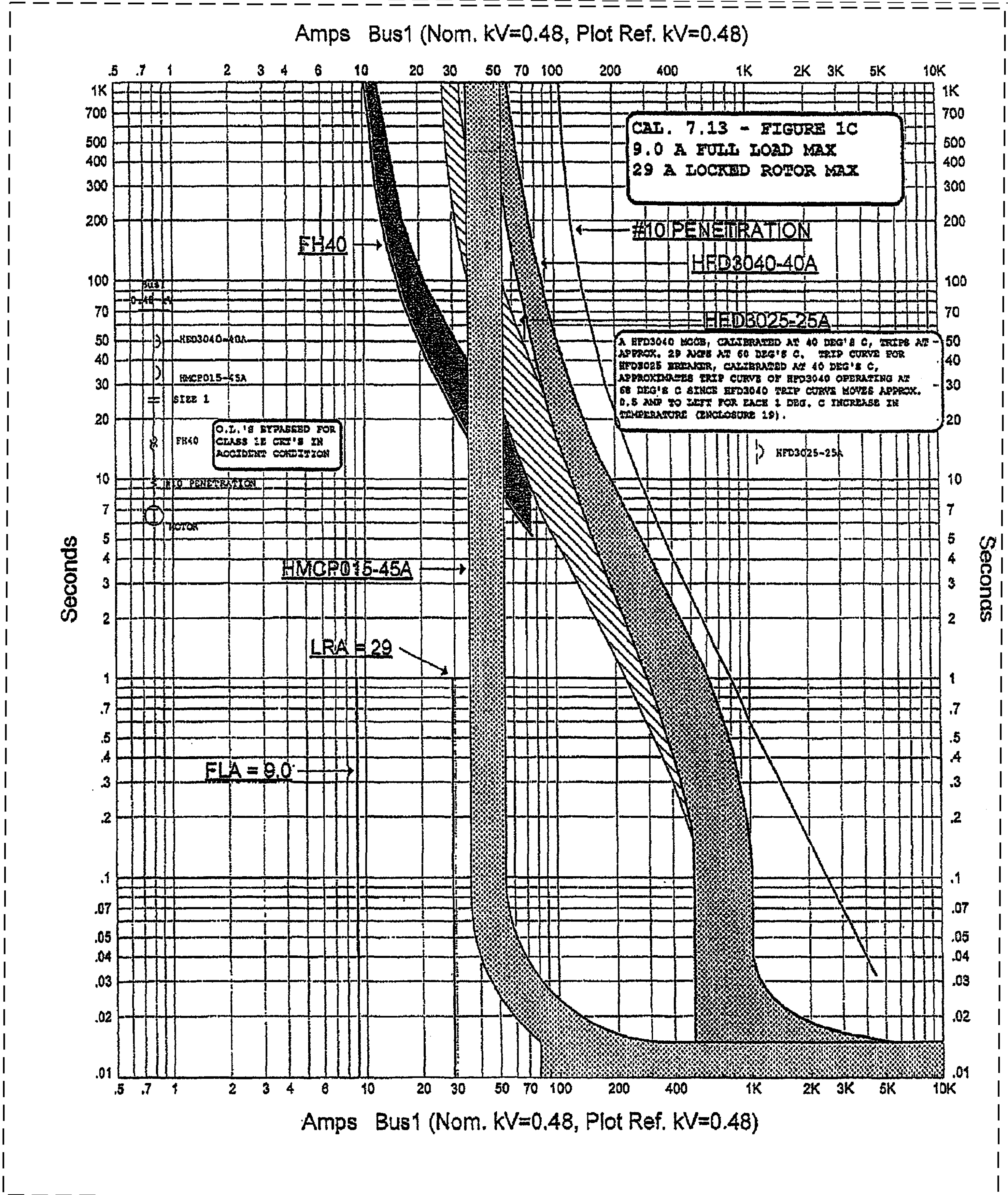
REVISION 0
APRIL 11, 1988

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

PENETRATION CONDUCTOR OVERCURRENT PROTECTION

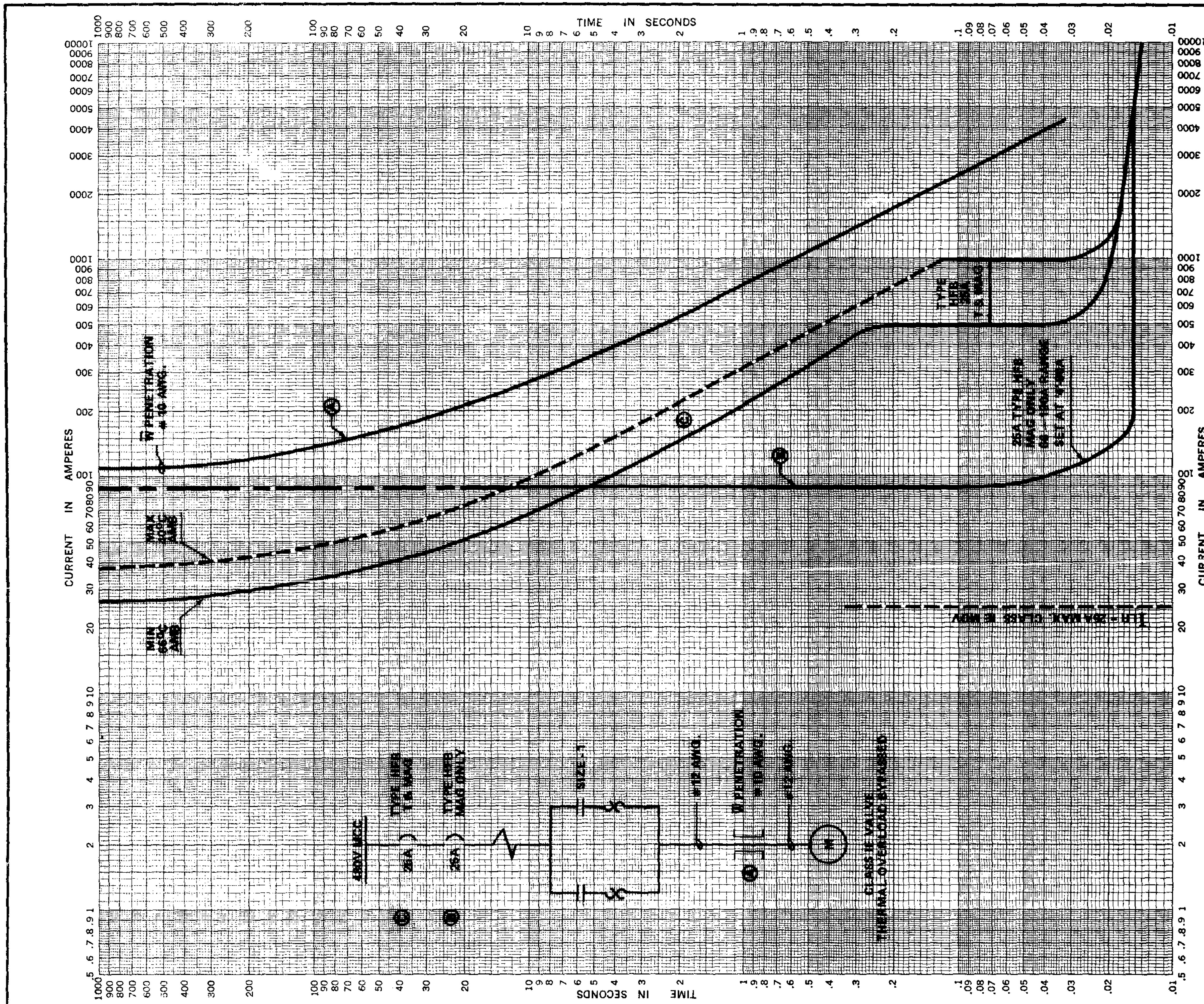
UPDATED FSAR

Sheet 1 of 21
FIGURE 8.3-17



Revision 19, Nov 5, 2012

PSEG Nuclear LLC HOPE CREEK NUCLEAR GENERATING STATION	Hope Creek Nuclear Generating Station PENETRATION CONDUCTOR OVERCURRENT PROTECTION
	Updated FSAR — Sheet 1A of 21 Figure 8.3-17



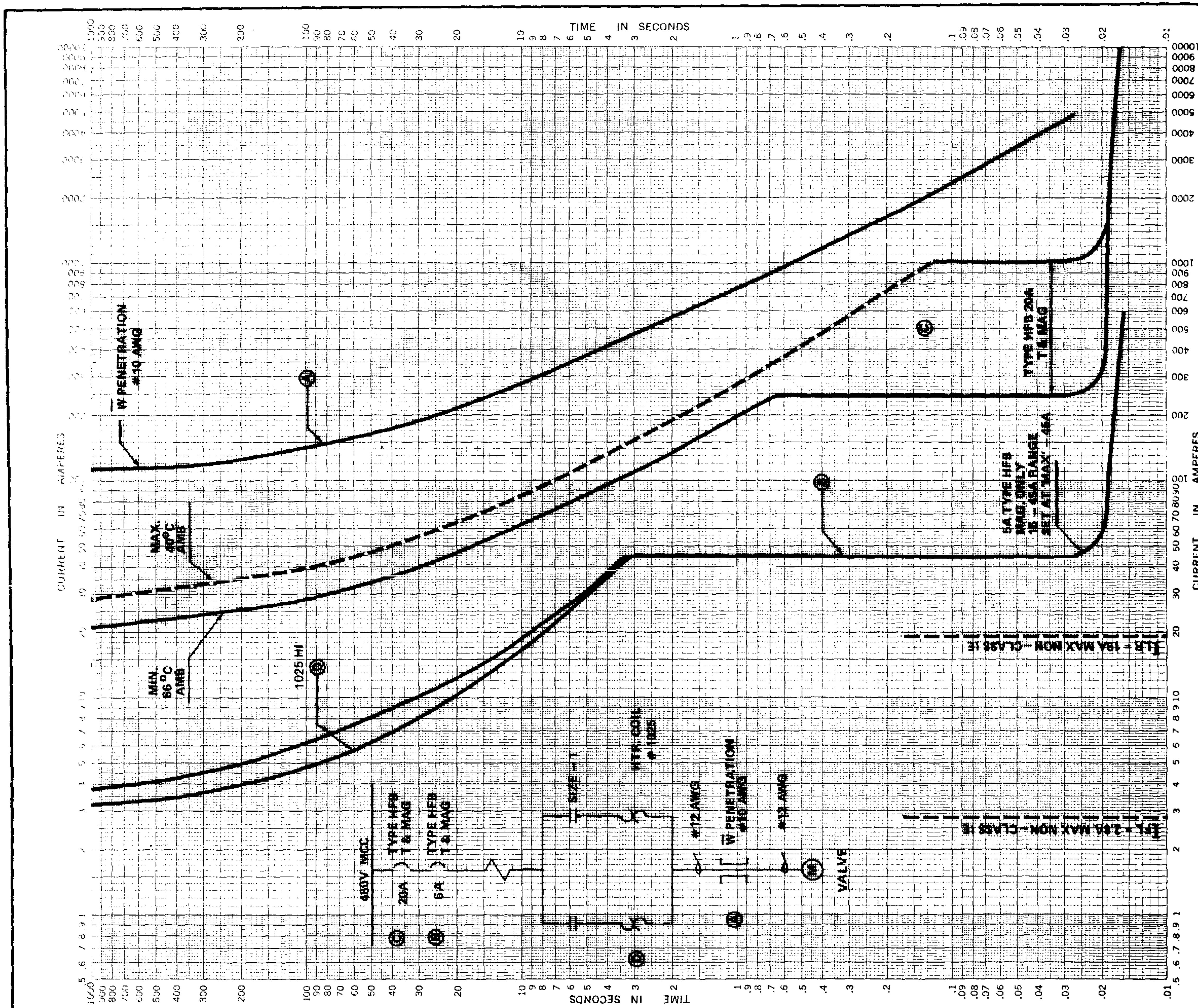
REVISION 0
APRIL 11, 1988

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

PENETRATION CONDUCTOR
OVERCURRENT PROTECTION

UPDATED FSAR

Sheet 2 of 21
FIGURE 8.3-17



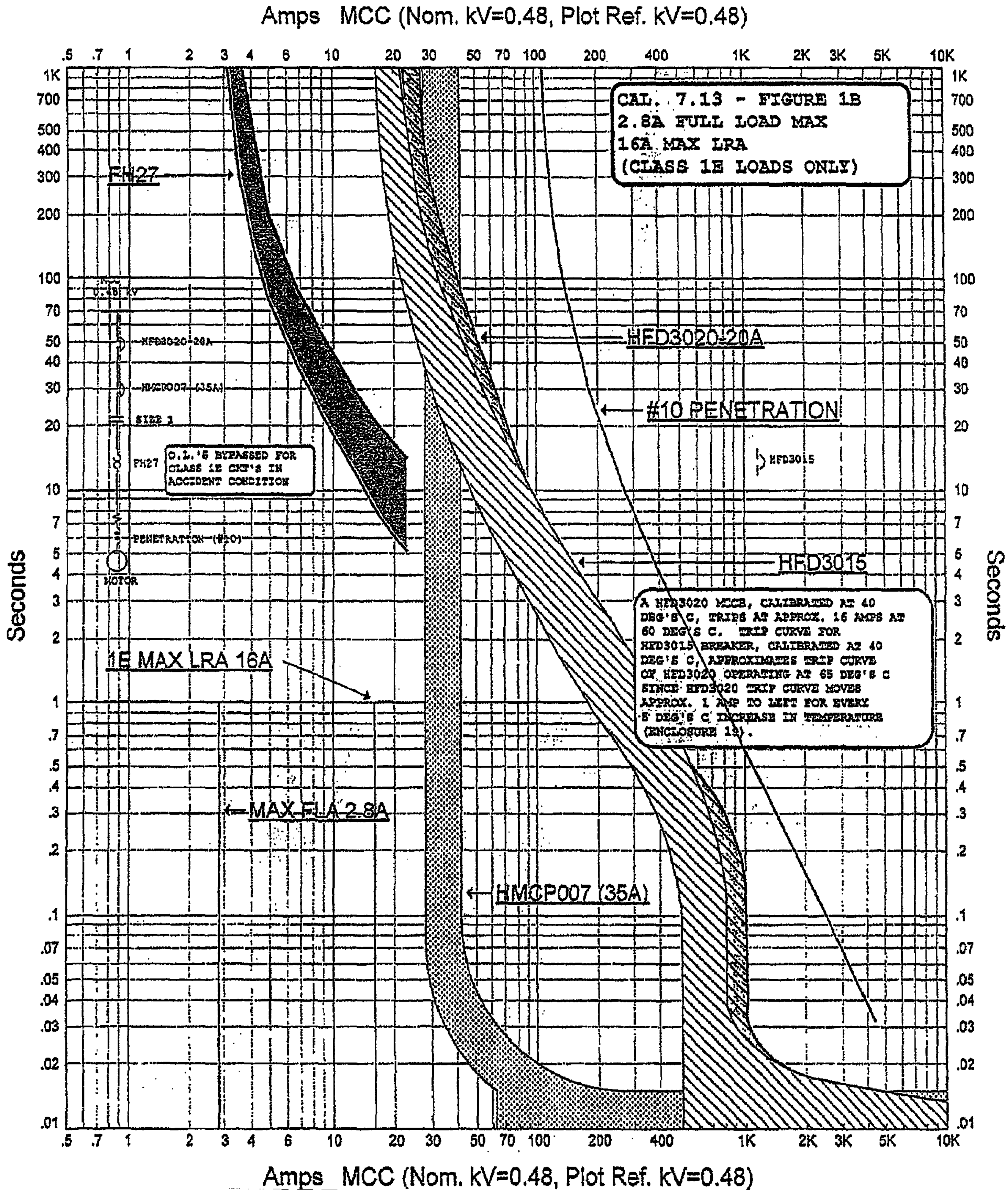
REVISION 0
APRIL 11, 1988

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

PENETRATION CONDUCTOR
OVERCURRENT PROTECTION

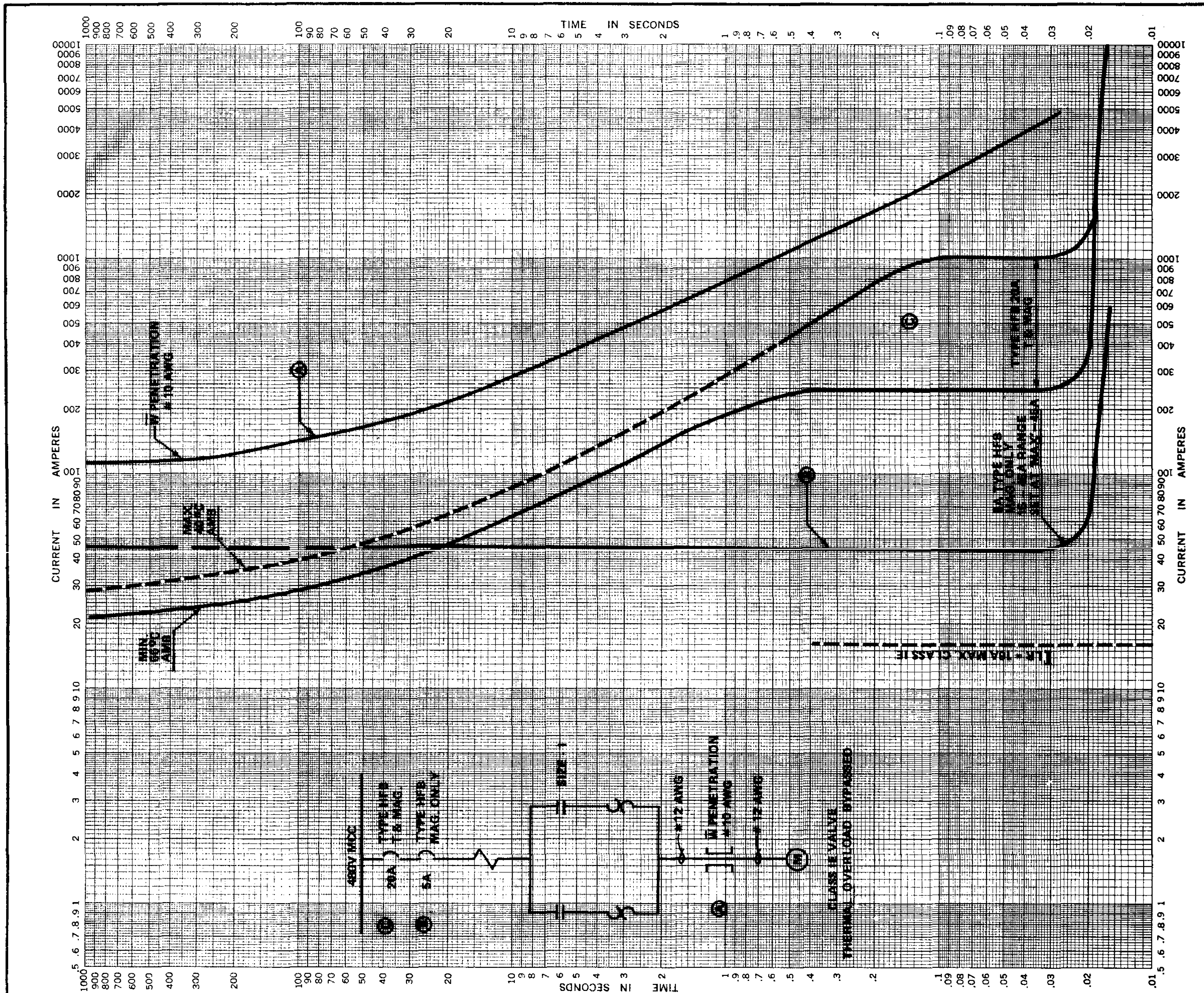
UPDATED FSAR

Sheet 3 of 21
FIGURE 8.3-17



Revision 19, Nov 5, 2012

PSEG Nuclear LLC HOPE CREEK NUCLEAR GENERATING STATION	Hope Creek Nuclear Generating Station PENETRATION CONDUCTOR OVERCURRENT PROTECTION
	Updated FSAR — Sheet 3A of 21 Figure 8.3-17



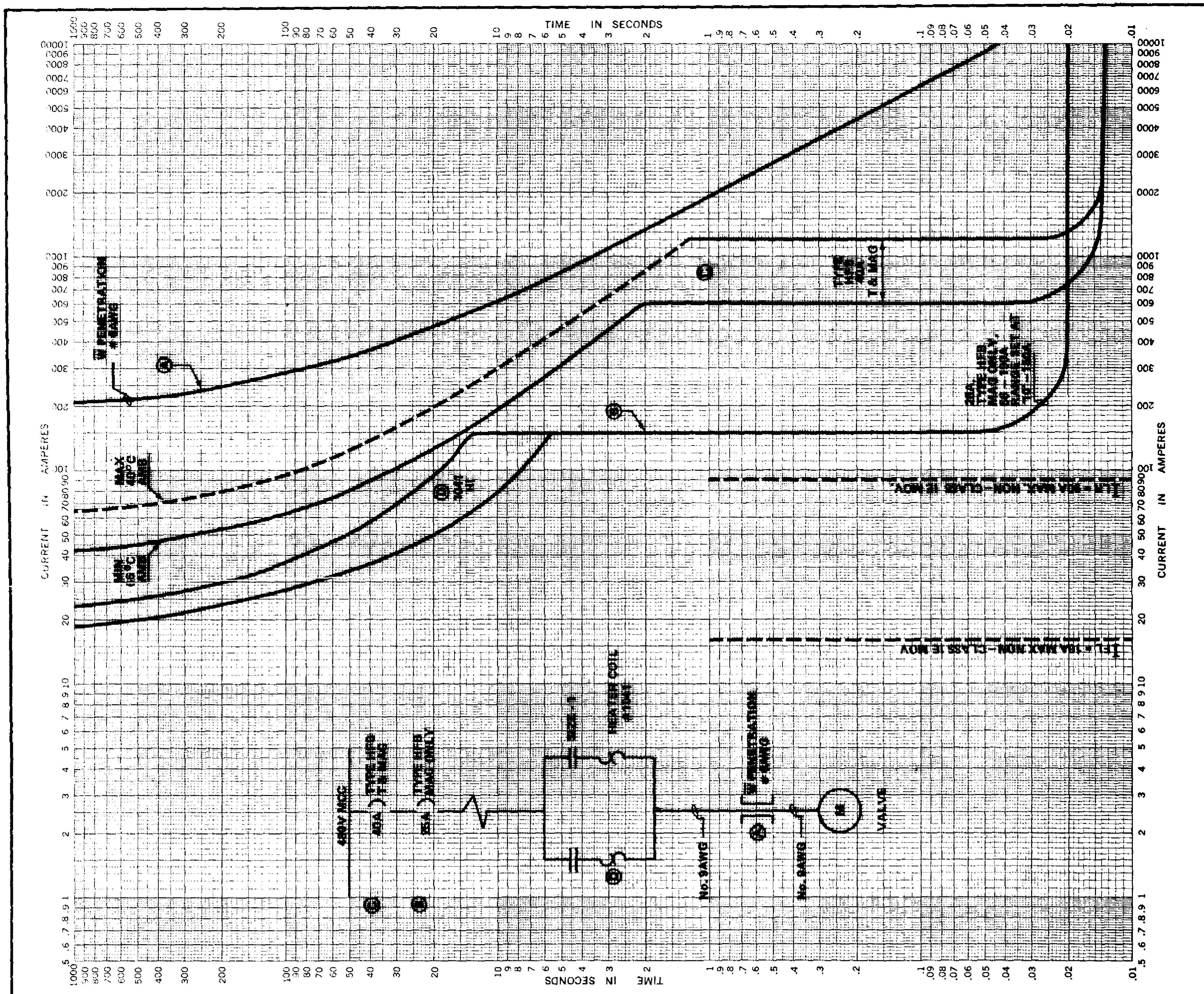
REVISION 0
APRIL 11, 1988

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

PENETRATION CONDUCTOR OVERCURRENT PROTECTION

UPDATED FSAR

Sheet 4 of 21
FIGURE 8.3-17



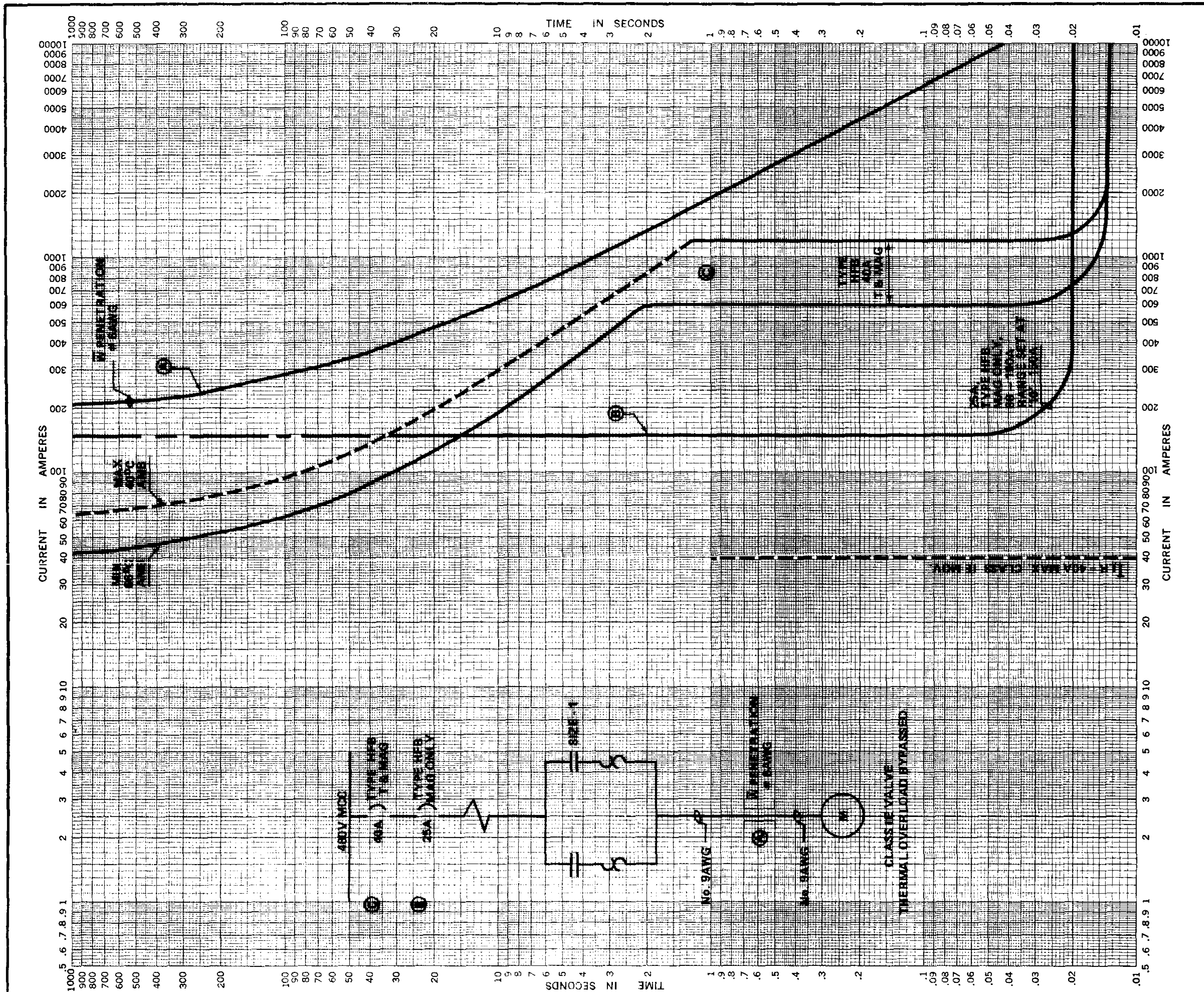
REVISION 0
APRIL 11, 1988

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

PENETRATION CONDUCTOR OVERCURRENT PROTECTION

UPDATED FSAR

Sheet 5 of 21
FIGURE 8.3-17



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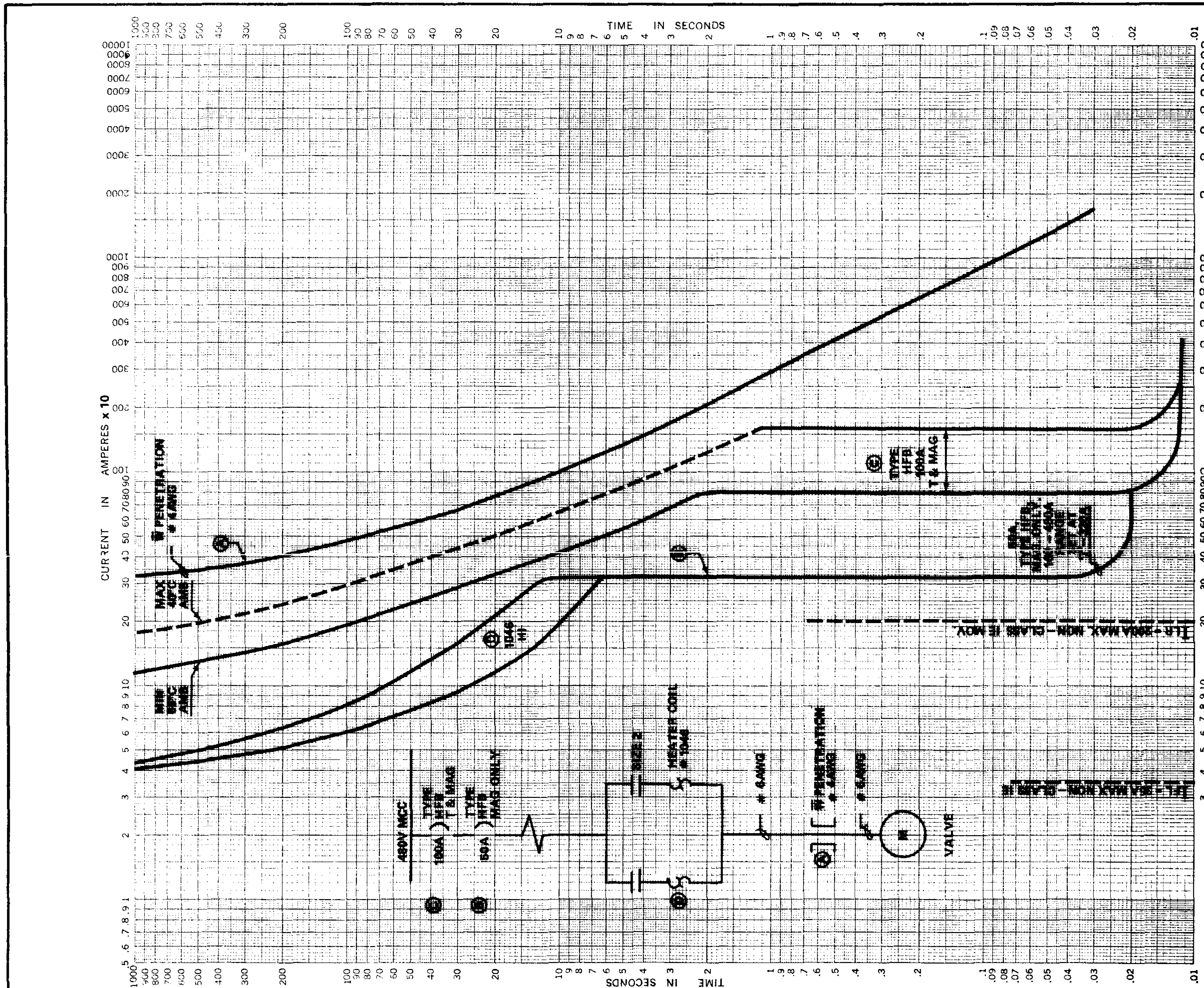
APRIL 11, 1988

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

PENETRATION CONDUCTOR OVERCURRENT PROTECTION

UPDATED FSAR

Sheet 6 of 21
FIGURE 8.3-17



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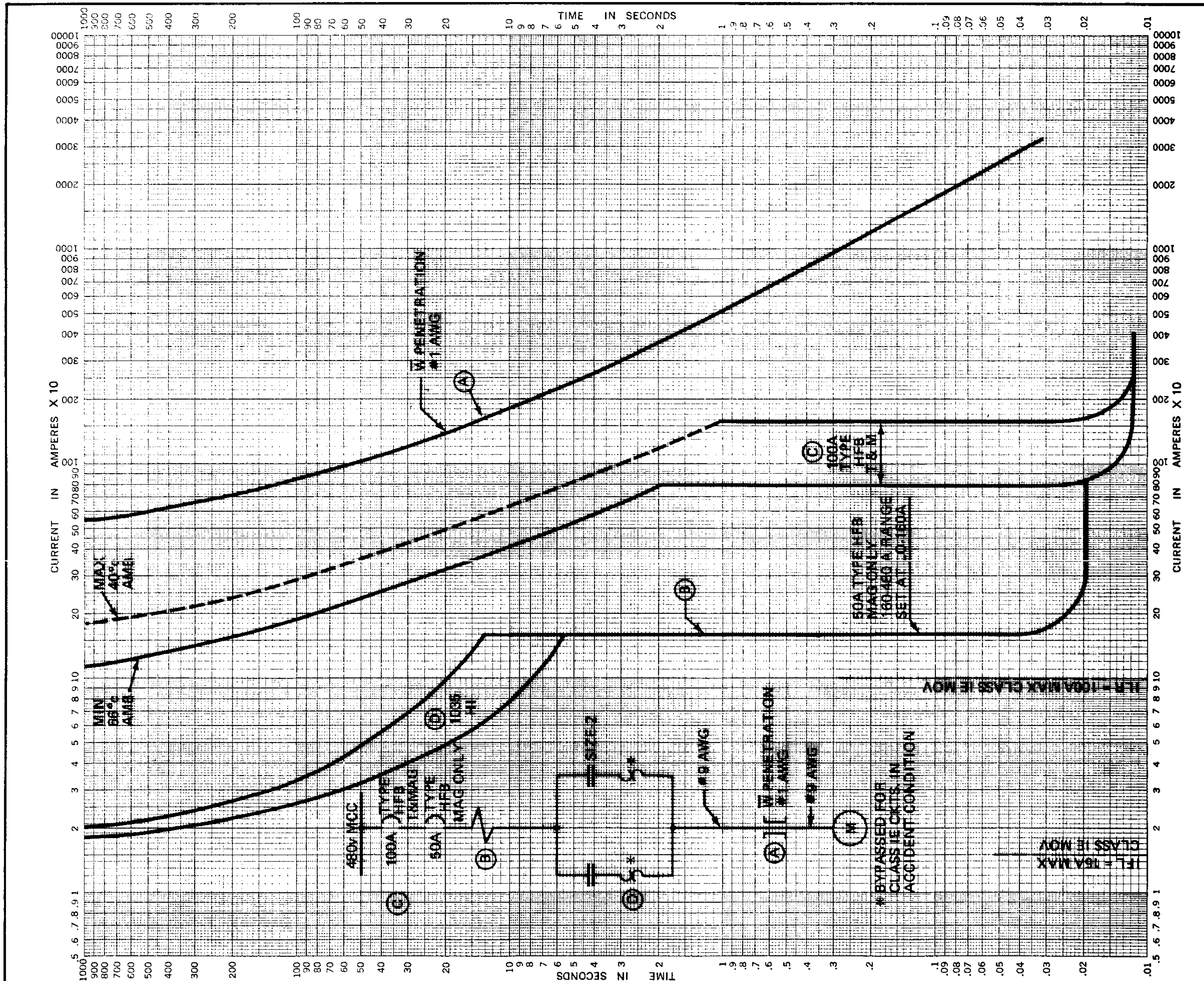
APRIL 11, 1988

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

PENETRATION CONDUCTOR OVERCURRENT PROTECTION

UPDATED FSAR

Sheet 7 of 21
FIGURE 8.3-17



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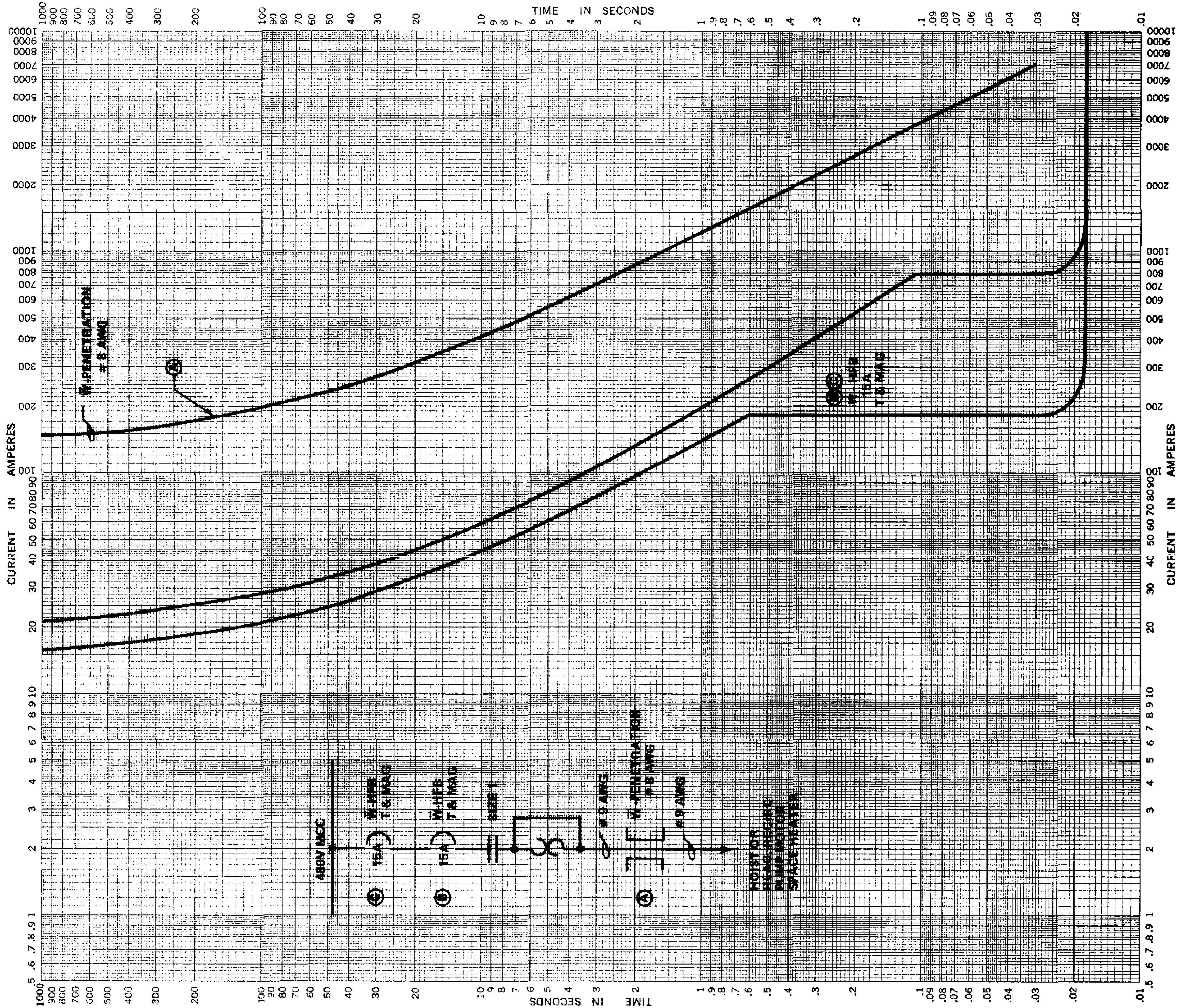
APRIL 11, 1988

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

PENETRATION CONDUCTOR OVERCURRENT PROTECTION

UPDATED FSAR

Sheet 8 of 21
FIGURE 8.3-17



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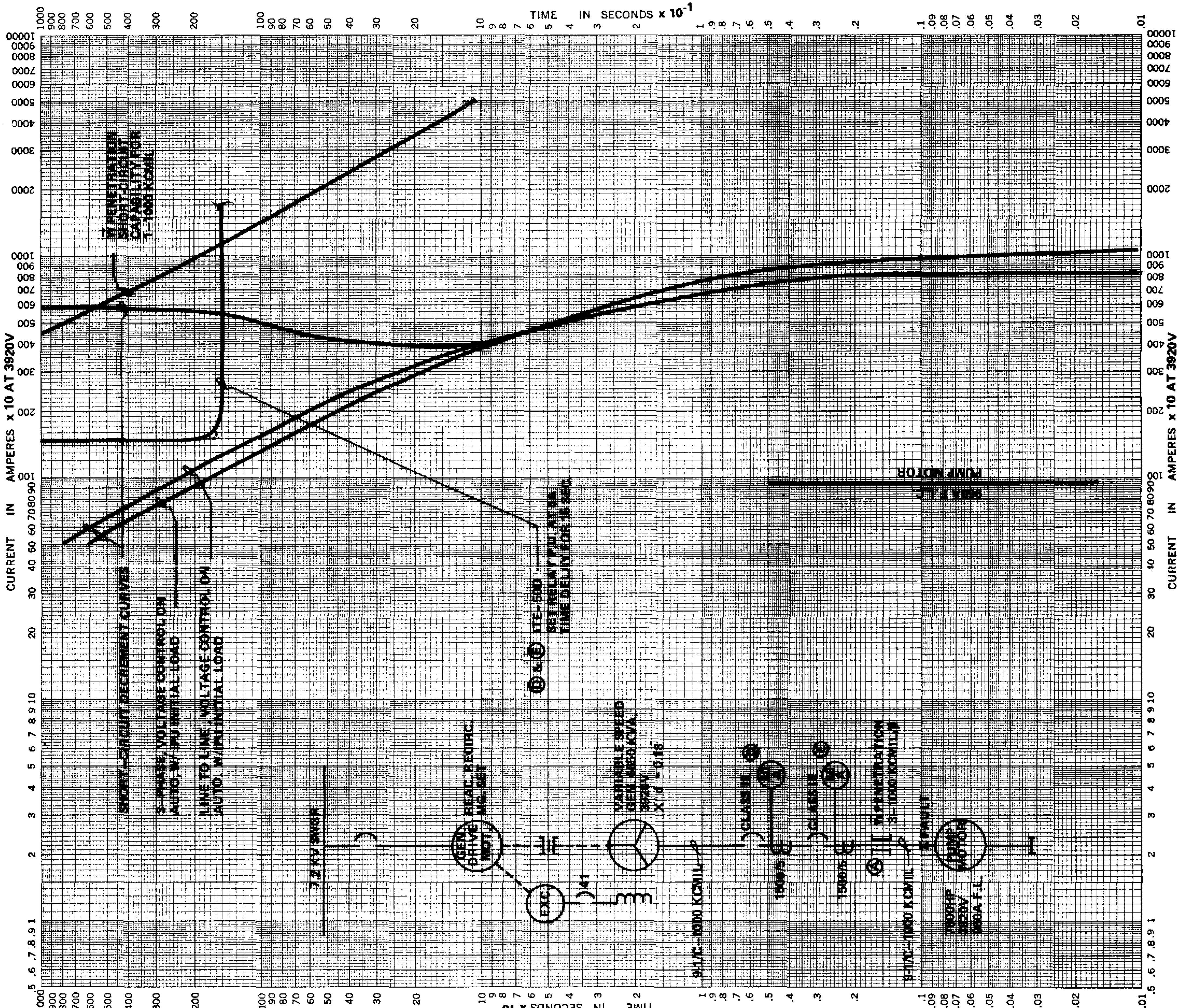
APRIL 11, 1988

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

PENETRATION CONDUCTOR OVERCURRENT PROTECTION

UPDATED FSAR

Sheet 9 of 21
FIGURE 8.3-17



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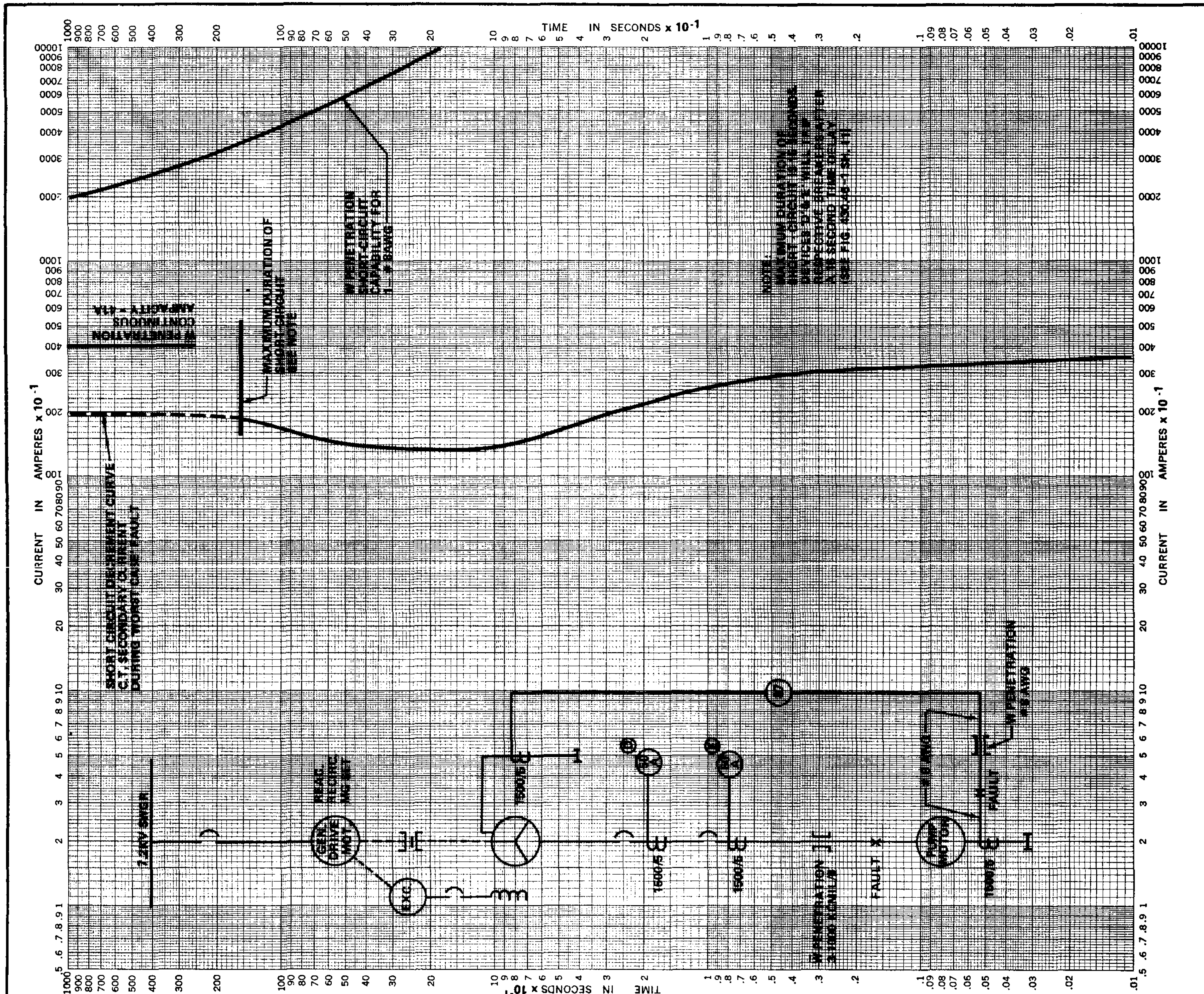
PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

UPDATED FSAR

Sheet 10 of 21
FIGURE 8.3-17



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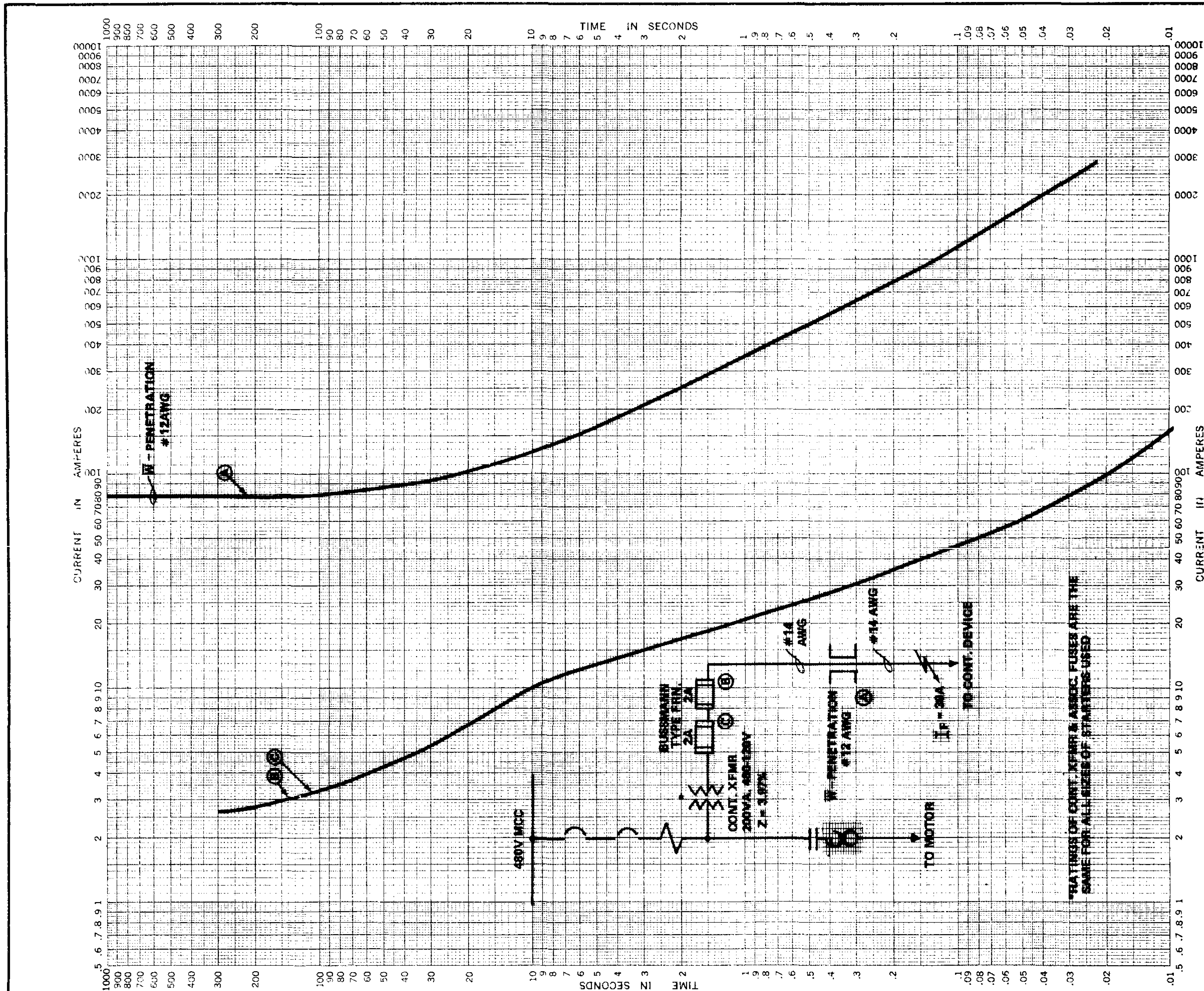
APRIL 11, 1988

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

PENETRATION CONDUCTOR OVERCURRENT PROTECTION

UPDATED FSAR

Sheet 11 of 21
FIGURE 8.3-17



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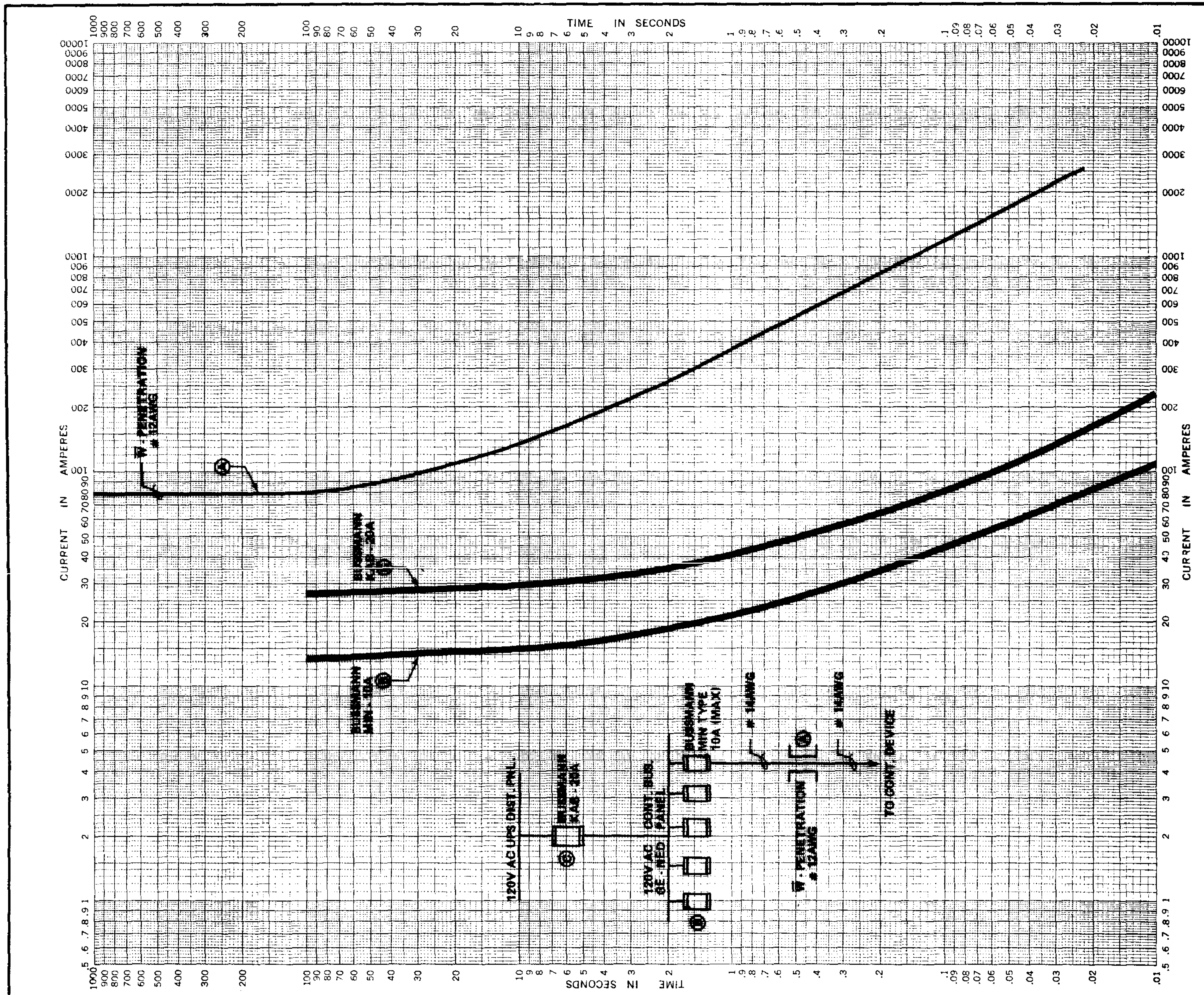
APRIL 11, 1988

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

PENETRATION CONDUCTOR OVERCURRENT PROTECTION

UPDATED FSAR

Sheet 12 of 21
FIGURE 8.3-17



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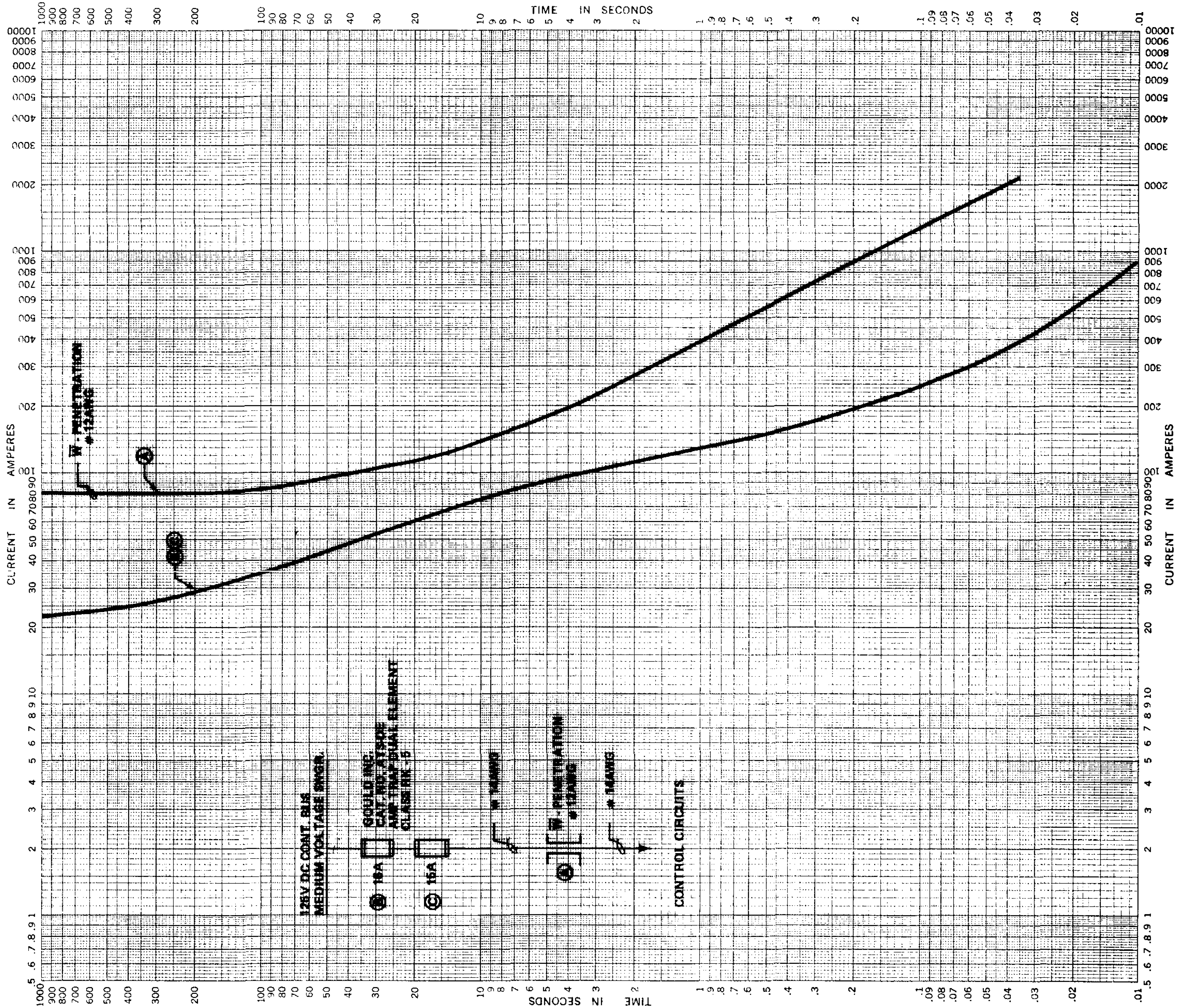
APRIL 11, 1988

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

PENETRATION CONDUCTOR OVERCURRENT PROTECTION

UPDATED FSAR

Sheet 13 of 21
FIGURE 8.3-17



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APRIL 11, 1988

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

PENETRATION CONDUCTOR OVERCURRENT PROTECTION

UPDATED FSAR

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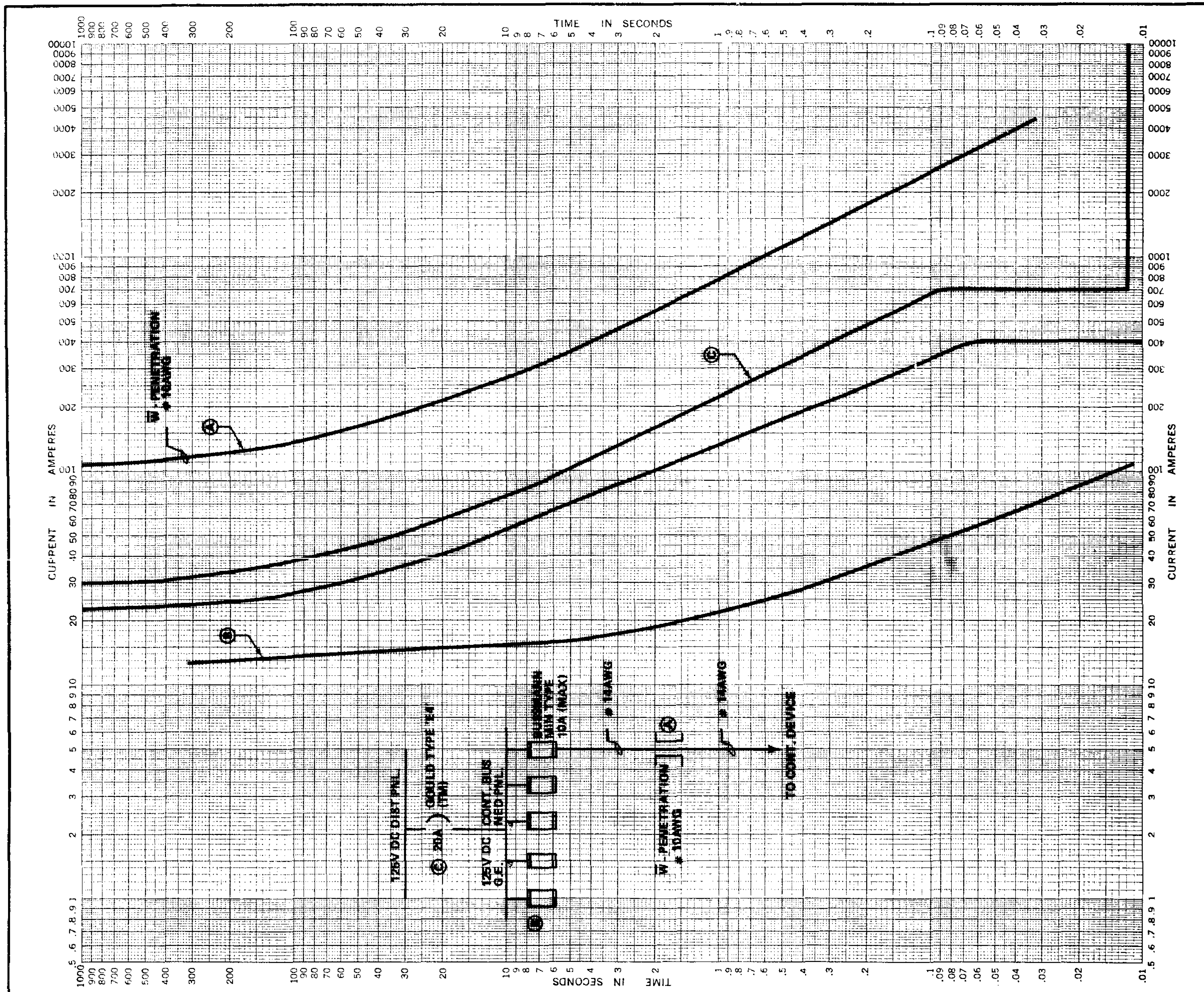
FIGURE 8.3-17



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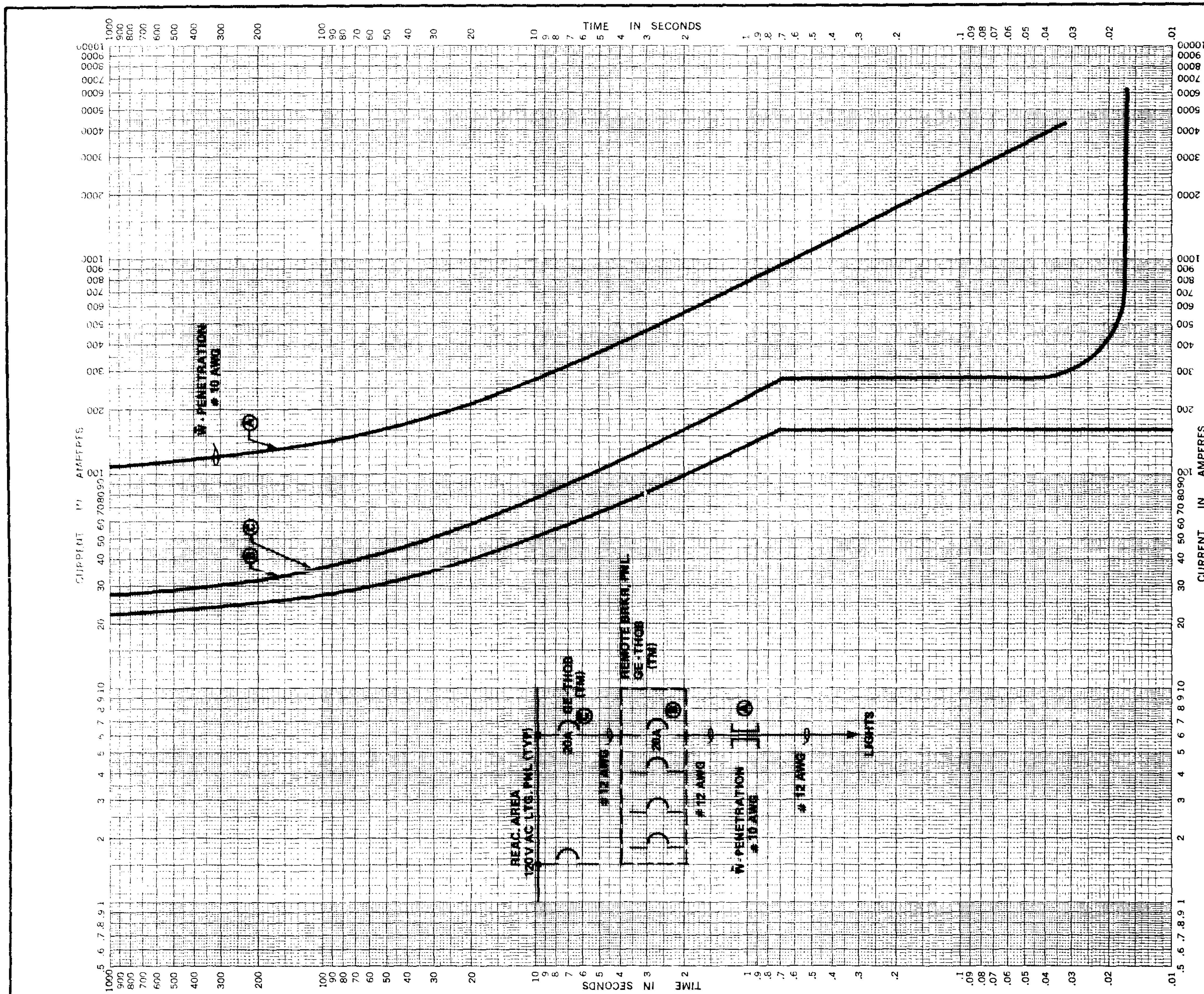
APRIL 11, 1988

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

PENETRATION CONDUCTOR OVERCURRENT PROTECTION

UPDATED FSAR

Sheet 15 of 21
FIGURE 8.3-17



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APRIL 11, 1988

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

PENETRATION CONDUCTOR
OVERCURRENT PROTECTION

UPDATED FSAR

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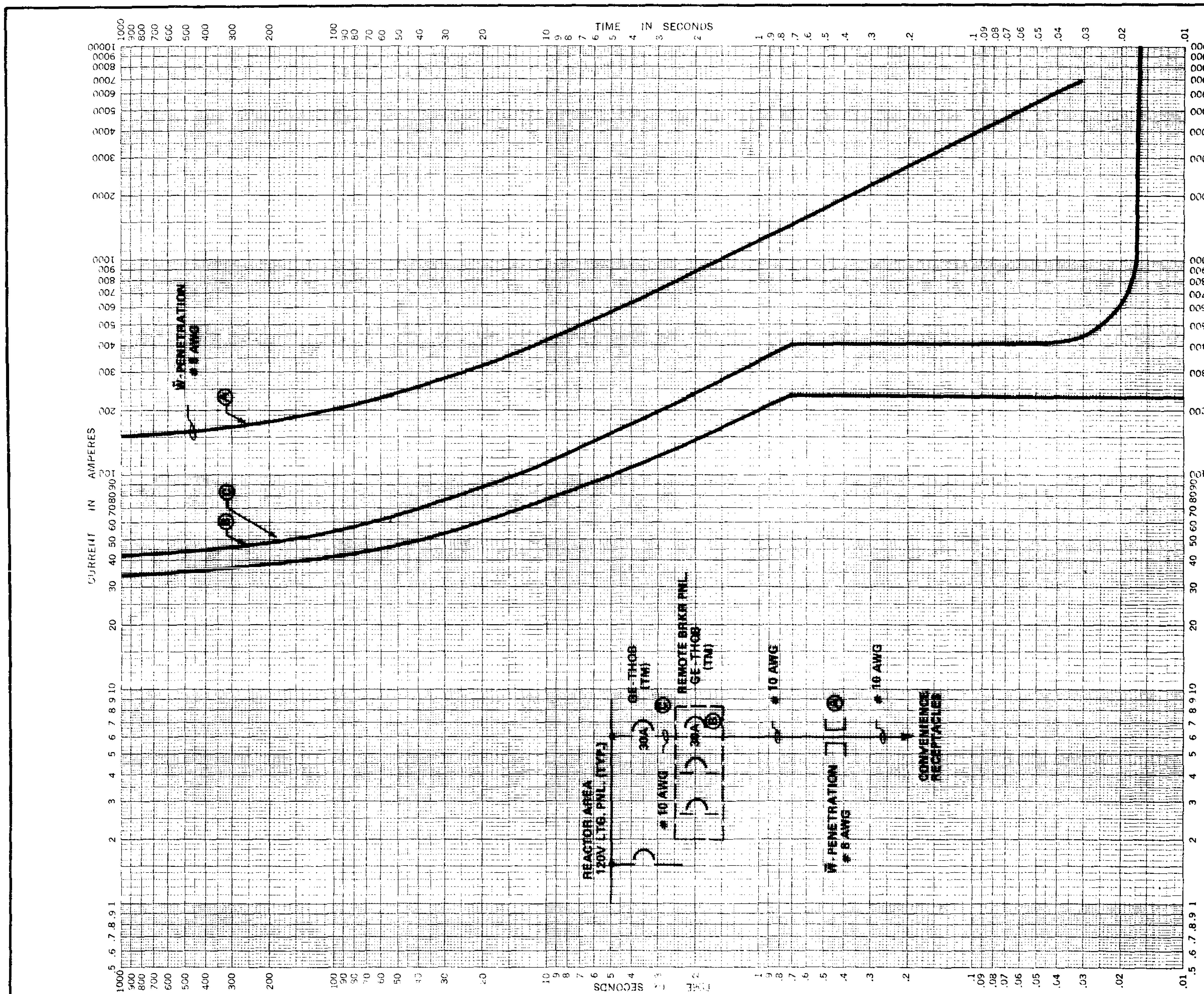
FIGURE 8.3-17



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APRIL 11, 1988

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

PENETRATION CONDUCTOR OVERCURRENT PROTECTION

UPDATED FSAR

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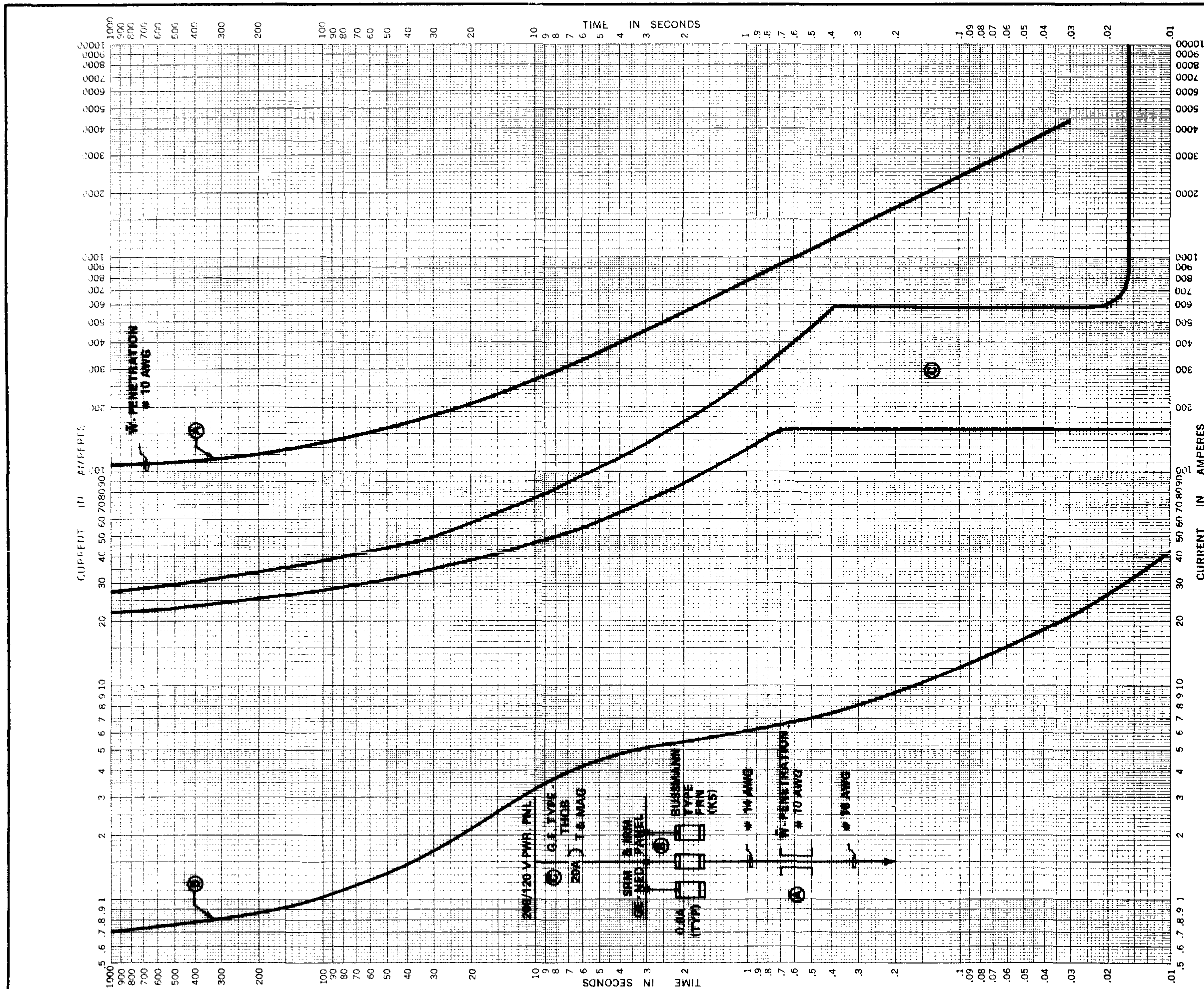
FIGURE 8.3-17



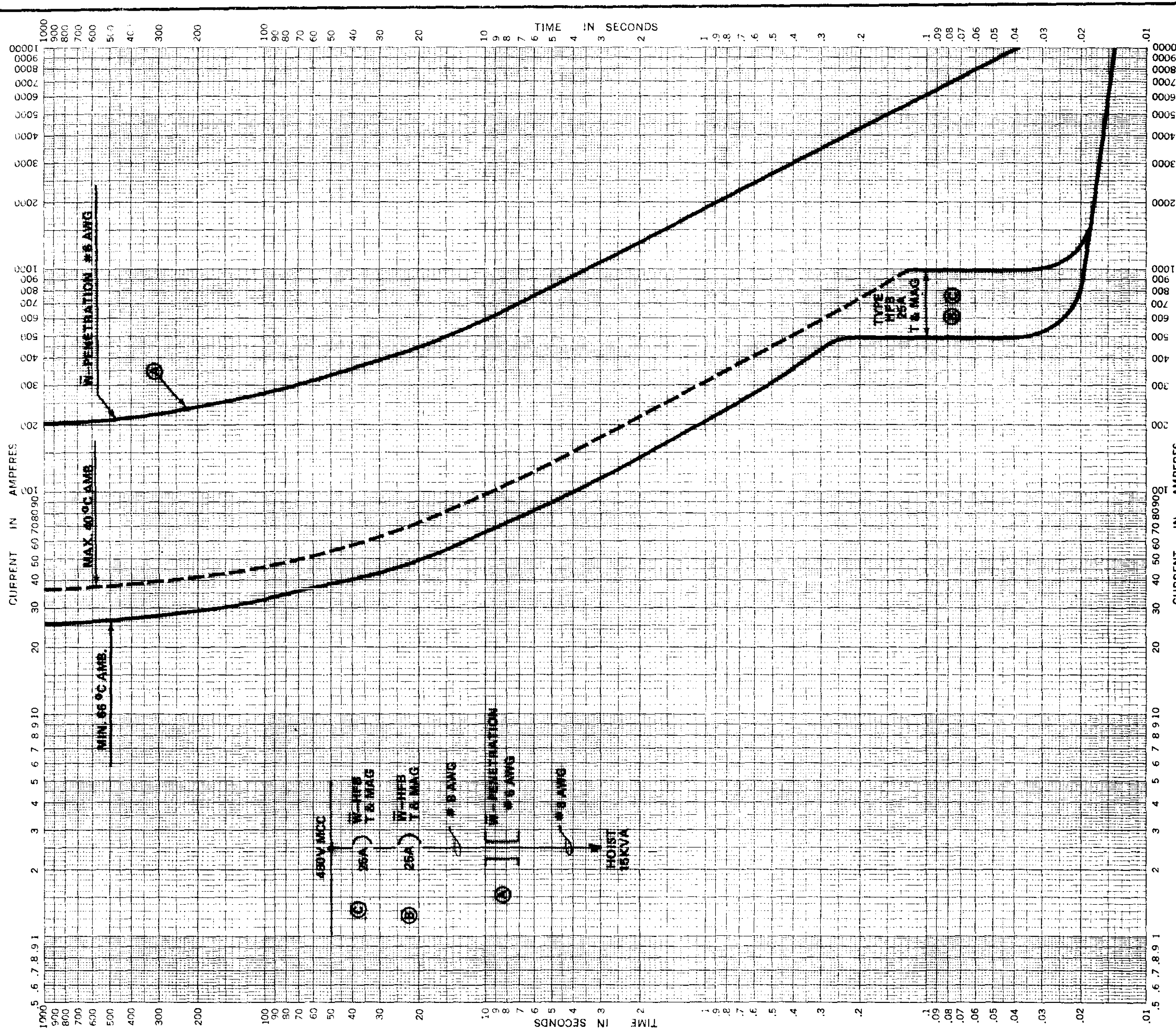
REVISION 0
APRIL 11, 1988

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

PENETRATION CONDUCTOR OVERCURRENT PROTECTION

UPDATED FSAR

Sheet 18 of 21
FIGURE 8.3-17



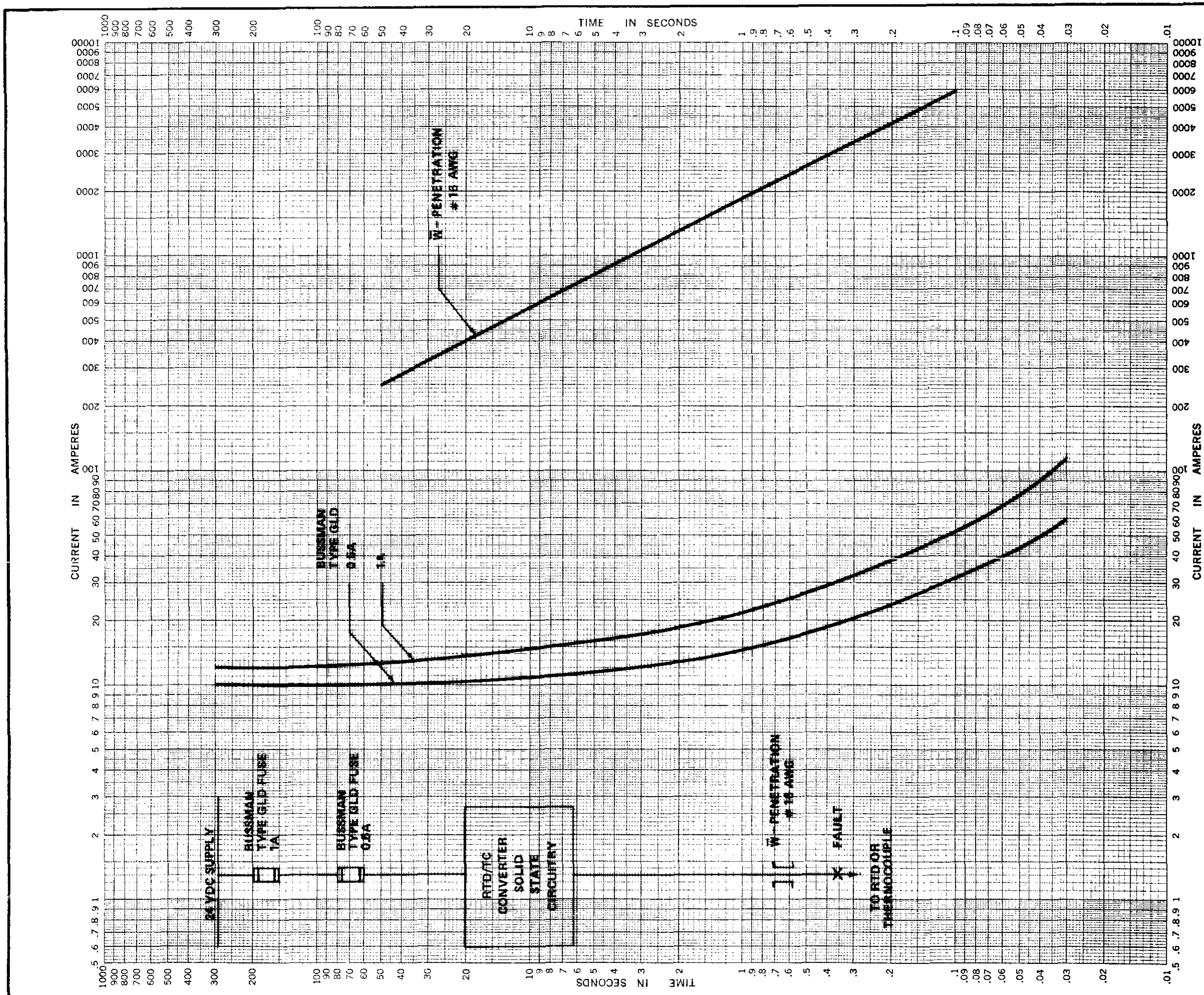
REVISION 0
APRIL 11, 1988

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

PENETRATION CONDUCTOR OVERCURRENT PROTECTION

UPDATED FSAR

Sheet 19 of 21
FIGURE 8.3-17



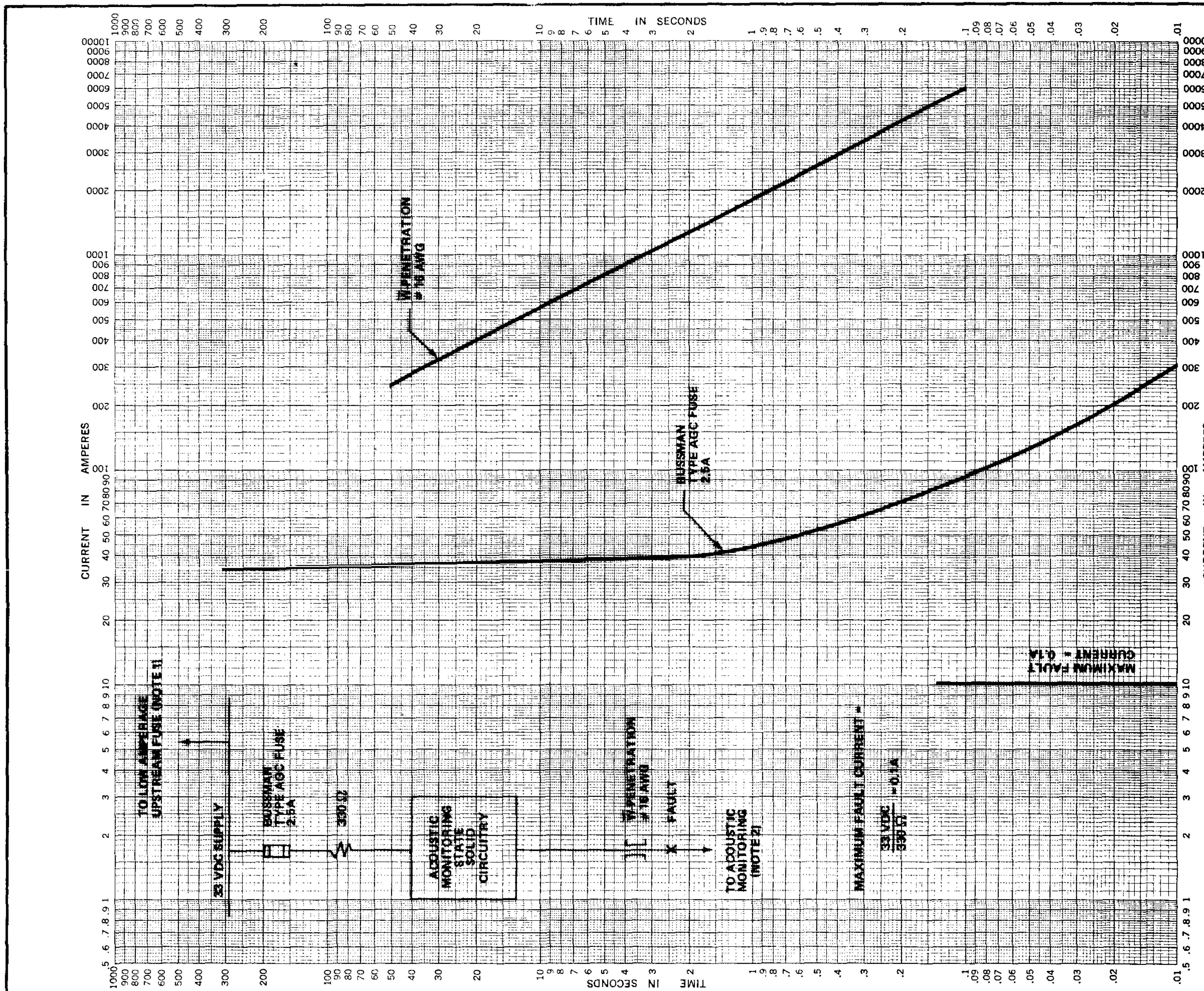
REVISION 0
APRIL 11, 1988

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

PENETRATION CONDUCTOR
OVERCURRENT PROTECTION

UPDATED FSAR

Sheet 20 of 21
FIGURE 8.3-17



NOTES:

1) THE UPSTREAM FUSE PROVIDES OVERCURRENT PROTECTION OF THIS POWER SUPPLY AND OTHER POWER SUPPLIES OF THIS SYSTEM.

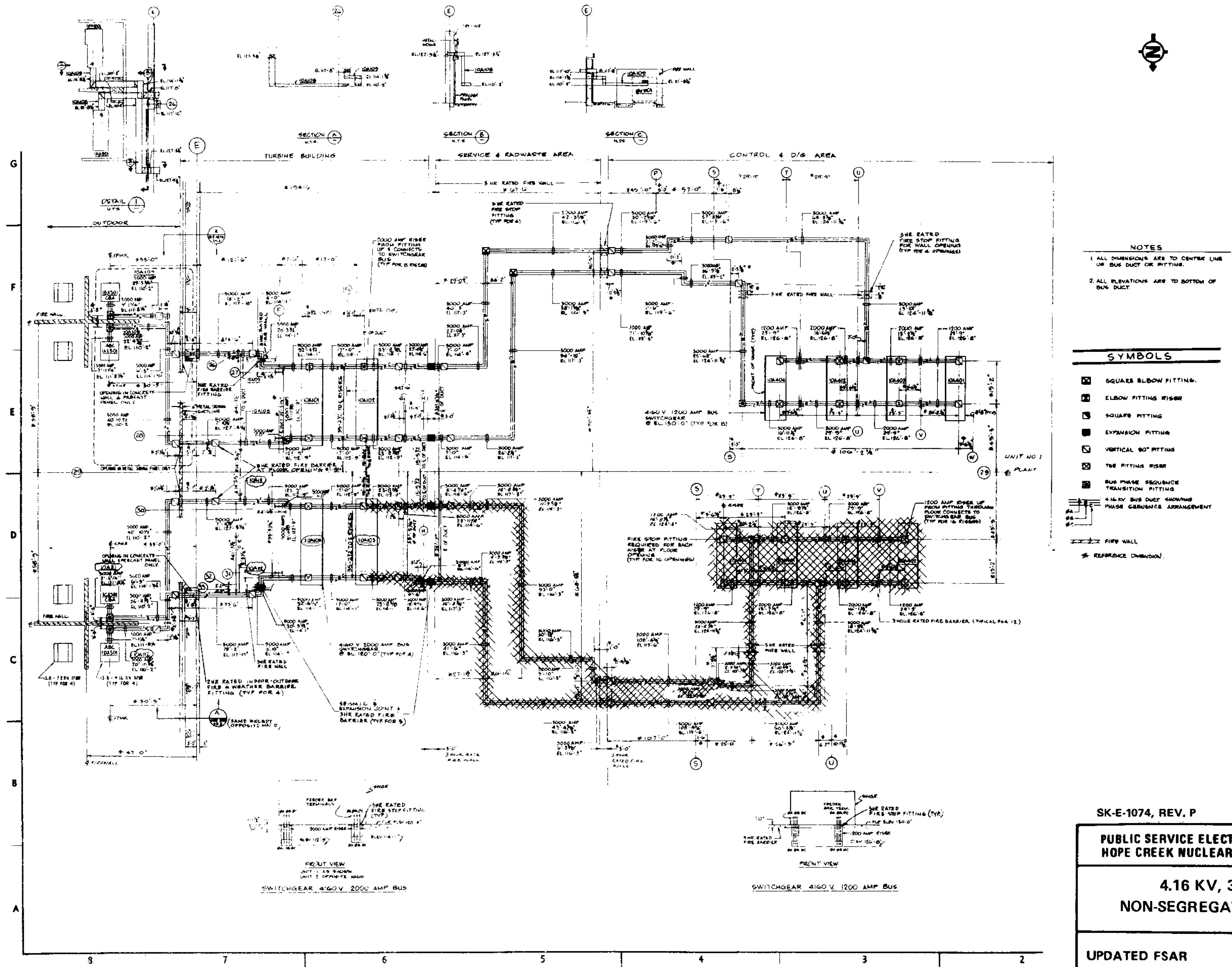
2) THIS CIRCUIT IS SIMILAR TO OTHER INSTRUMENTATION CIRCUITS THAT HAVE LOW ENERGY POWER SUPPLIES AND LOW SIGNALS LEVELS.

REVISION 0
APRIL 11, 1988

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

PENETRATION CONDUCTOR OVERCURRENT PROTECTION

UPDATED FSAR



SK-E-1074, REV. P

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

4.16 KV, 3 Ø, 60 Hz
NON-SEGREGATED BUS DUCT

UPDATED FSAR **FIGURE 8.3-18**

Figure F8.3-19 intentionally deleted.

Refer to Plant Drawing E-1670-1 in DCRMS