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GAS AND
ELECTRIC

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July 20, 1993

U. S. Nuclear Regulatory Commission
Washington, DC 20555

ATTENTION: Document Control Desk

SUBJECT: Calvert Cliffs Nuclear Power Plant
Unit Nos. 1 & 2; Docket Nos. 50-317 & 50-318
Emergency Diesel Generator Project - SACM Design Generator and Mechanical Systems Design Report

REFERENCES:

(a) Letter from Mr. D. G. McDonald, Jr. (NRC) to Mr. G. C. Creel (BG&E), dated October 10, 1990, Response to Station Blackout Rule (TAC Nos. M68525 and M68526)

(b) Letter from Mr. D. G. McDonald, Jr. (NRC) to Mr. G. C. Creel (BG&E), dated February 12, 1991, Response to Station Blackout Rule (TAC Nos. M68525 and M68526)

(c) Letter from Mr. R. E. Denton (BG&E) to NRC Document Control Desk, dated July 7, 1993, Modification to Our Station Blackout Rule Response

(d) Letter from Mr. R. E. Denton (BG&E) to NRC Document Control Desk, dated April 7, 1993, Emergency Diesel Generator Project - Diesel Generator Qualification Report, Revision 1

(e) Letter from Mr. D. G. McDonald, Jr. (NRC) to Mr. R. E. Denton (BG&E), dated May 19, 1993, Class 1E Emergency Diesel Generator Qualification Report (TAC Nos. M85715 and M85716)

In response to the requirements of 10 CFR 50.63, Baltimore Gas and Electric Company is adding one safety-related diesel generator and one non-safety-related diesel generator at our two-Unit Calvert Cliffs Nuclear Power Plant. These diesel generators enhance our ability to meet station blackout requirements. After the installation of the new diesel generators is complete, we will have one diesel generator dedicated to each of the four engineered safety features busses, with the non-safety-related diesel generator used to mitigate station blackout conditions and as a standby for any of the four dedicated diesel generators. The NRC has reviewed and approved the basic concept of our station blackout response capability as both an alternate AC and AC independent site (References a and b). We have modified our station blackout response (Reference c) and are awaiting NRC approval of the change. The initial approval was contingent upon our submittal to the NRC of design information concerning: the new diesel generator installation, the change in our onsite emergency electrical system, and the alternate AC power source. The attachment to this letter is one of the submittals requested.

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In order to gain NRC approval of the modifications to our onsite emergency electrical system, we are preparing a series of design reports for NRC review. These design reports will cover appropriate aspects of the diesel generator design and qualification, and changes to our electrical system. The design reports have been broken down into several groups to aid in their review by the NRC. These groups are; Civil Engineering, SACM Diesel Generator and Mechanical Systems, Electrical Engineering, and Instrumentation and Controls. In addition to these design reports, other correspondence will be provided to describe the alternate AC power source. Requests to change the Technical Specifications will be supplied in separate submittals.

The SACM Diesel Generator and Mechanical Systems Design Report is attached. This report describes the SACM diesel generator and its auxiliary systems. The SACM diesel generator and its auxiliary systems is located in a separate Category I building which is designed to protect the diesel generator from environmental effects and proximity hazards. The report discusses the design bases and gives a system description for the diesel generator and its support systems. In addition, it describes the mechanical support equipment present in the Diesel Generator Building (such as HVAC and fire protection). An important function of this report is to detail our commitment to various codes, standards and Regulatory Guides. Our commitments and exceptions to the various codes and standards are explicitly described in the various sections of the report. Note, however, that these commitments are for design, procurement, fabrication and construction only; operational and surveillance commitments will be made through the License Amendment Request.

This is Revision 0 of the subject report. While the majority of the information concerning the SACM diesel generators is contained in this report, some information will be contained in other reports. The electrical connection into the existing plant electrical system and various diesel control interlocks will be described in the Electrical Design Report. Instrumentation and controls for the diesel generator will be described in the Instrumentation and Controls Report. The Qualification program for the SACM diesel was described and accepted by the NRC (References d and e). Responses to question or concerns arising from the NRC review will be included in future report revisions.

We request that this report be reviewed and approved by December 15, 1993. The first diesel generator is scheduled to arrive at Calvert Cliffs in September 1993, and the second diesel is scheduled to arrive in January 1994. At the time of shipment, both diesel generators are identical so either one could be used as the safety-related diesel generator. The approval date was requested to ensure that issues which could materially affect the fabrication of the diesel generator could be resolved before the last diesel generator left the factory.

Should you have any questions regarding this matter, we will be pleased to discuss them with you.

Very truly yours,

RED/PSF/psf/dlm/bjd

Attachment

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ATTACHMENT (1)

SACM DIESEL GENERATOR
and
MECHANICAL SYSTEMS
DESIGN REPORT

EMERGENCY DIESEL GENERATOR PROJECT

Baltimore Gas and Electric Company

Calvert Cliffs Nuclear Power Plant

July 1993

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1.0 INTRODUCTION

Baltimore Gas & Electric Company is adding a safety-related SACM diesel generator at the two-unit Calvert Cliffs Nuclear Power Plant. This diesel generator will support station blackout requirements and provide spare capacity for future plant modifications. The additional diesel generator will enhance our ability to meet 10 CFR 50.63 requirements and Regulatory Guide 1.155. Currently, Calvert Cliffs has three diesel generators; one dedicated to each unit (Diesel Generator Nos. 11 and 21) and one that swings to the accident unit (Diesel Generator No. 12). Unit 1 will be served by the additional diesel generator. A diesel generator project was initiated to install the new air-cooled 5000 kW (net) Class 1E diesel generator in the 4.16 kV bus system and to modify the existing diesel generators such that each unit is supported by two dedicated diesel generators. A non-safety-related diesel generator will be installed for use as an alternate AC source (AAC) and other hardware and software modifications are being made to bring Calvert Cliffs into compliance with the Station Blackout Rule.

Numerous systems inside the plant will be affected during the installation of the diesel generator. The work consists of mechanical, electrical and control system modifications and realignment of the existing diesel generators. Modifications and additions to the Control Room panels will be required for the diesel generator controls.

In order to gain NRC approval of these modifications to our on-site emergency electrical system, we are preparing a series of design reports for the NRC's review. These design reports will cover appropriate aspects of the diesel generator design, qualification and changes to our electrical distribution system. The design reports have been broken down into several groups to aid in their preparation and review by the NRC. These groups are; Civil Engineering, Diesel Generator and Mechanical Systems, Instrumentation and Controls, Electrical Engineering and Startup and Surveillance Testing. In addition to the design reports, other correspondence will be provided to describe any deviations, exceptions or exemptions to the codes and standards we are using to design the modifications. Discussion concerning our alternate AC power source and changes to the Technical Specifications will be provided at a later date in separate submittals.

The diesel generators are the standby, onsite source of power for the safety-related systems necessary to safely shut down the units following a design basis accident and a loss-of offsite power. This report establishes the functional adequacy of BG&E's SACM diesel generator and its associated mechanical support systems to meet the electrical demand of safety-related loads for Unit 1 at the Calvert Cliffs Nuclear Power Plant. A description of the electrical power system and the existing diesel generators is provided in Chapter 8 of the Calvert Cliffs Nuclear Power Plant Units 1 and 2 Updated Final Safety Analysis Report (UFSAR).

This design report is not intended to commit BG&E to compliance with NUREG/CR-0660 or NUREG/CR-5078 concerning the reliability and maintenance of the SACM diesel generator. BG&E is monitoring industry progress with regard to the development of guidance for implementing

NUMARC 87-00, Appendix D, and resolving Generic Issue B-56. Present operating procedures and practices have successfully maintained the three existing diesel generators within Appendix D's target reliability of .975, and it is anticipated that actions for the SACM diesel generator would provide similar results.

This design report also provides system design information for the Diesel Generator Building mechanical systems. This information includes pipe code classification and code boundaries. Analysis methods and load combinations used during the design of piping and piping support systems are also provided. Testing for piping vibration, thermal expansion and dynamic effects of safety-related piping and piping supports will be described in a separate submittal.

To the fullest extent possible, construction sequencing will be planned to allow installation during Unit 1 operation, with a minimal disruption of plant activities. Critical installation interfaces will be planned to occur during planned unit outages. Connection of mechanical systems to existing plant systems (such as fire protection) will be addressed under the 50.59 process.

2.0 ELECTRIC POWER

2.1 SACM DIESEL GENERATORS

2.1.1 DESCRIPTION

One SACM diesel generator, complete with auxiliary equipment and a fuel oil storage and transfer system, will be installed as the standby onsite power supply for safety-related loads on the 4.16 kV Emergency Bus 11 (Unit 1 Facility ZA). As shown on Figure 2-1, the SACM diesel generator will be dedicated to a single 4.16 kV Class 1E engineered safety features (ESF) bus on Unit 1. The SACM diesel generator is electrically isolated from the other diesel generators, and no provisions exist for automatically cross-connecting redundant safety features busses or the SACM diesel generator. Physical separation for fire and missile protection is provided between the SACM diesel generator and the other diesel generators since they are housed in separate Category I buildings. Power and control cables are routed to maintain physical separation.

The tandem-engine generator set is rated at 5,400 kW for continuous operation and at 5,940 kW for two-hour operation. The voltage and frequency recovery characteristics meet or exceed the requirements set forth in Regulatory Guide 1.9, draft Revision 3[1]. See Table 2-1 for additional design data concerning the diesel generators.

The diesel generator and the auxiliary equipment essential for operation in order to safely shut down the reactor or for accident mitigation following a design basis accident, are considered safety-related. Physical identification and methods used to readily distinguish among redundant Class 1E systems, associated circuits assigned to redundant Class 1E circuits, and non-Class 1E systems will be consistent with those described by Section 8.5 of the UFSAR. Interlocks on Class 1E electrical equipment and cables installed as a result of adding the SACM diesel generator are discussed in the Electrical Engineering Design Report.

Loading of the diesel generator is accomplished automatically and is carried out by the existing load sequencer system. The load sequence is the same as that described by Table 8-7 in the UFSAR with the addition of the 480 V loads associated with the Diesel Generator Building auxiliaries. Following engine start and diesel generator output breaker closure, the loading commences as soon as the generator's rated voltage and frequency are reached. The loads are applied in a sequence of 8 steps at 5-second intervals such that required loads are energized not more than 45 seconds after the start signal is received. The initial loading of each step or block of load consists of the locked rotor

[1] Where Regulatory Guide 1.9, draft Revision 3 is referenced, the design of the diesel generators uses the draft copy dated April 1992.

current of the various induction motors being started. The SACM diesel generator has the capability of starting the largest single motor with all other sequenced loads running. This ensures that a motor which tripped subsequent to the completion of load sequencing can be restarted.

At no time during the loading sequence will the frequency and voltage at the diesel generator terminals decrease to less than 95 percent of 60 Hz and 82 percent of 4.16 kV. During recovery from transients caused by step load increases, including initial step loads, or resulting from the disconnection of full load, the speed of the diesel generator will not exceed 75 percent of the difference between nominal speed and the overspeed trip set point or 15 percent above nominal, whichever is lower. These load accepting characteristics meet or exceed the design considerations recommended in Regulatory Guide 1.9, draft Revision 3.

The functional design aspects of the SACM diesel generator are discussed in the following subsections.

2.1.1.1 <u>Starting Initiation Circuits</u>

Upon receipt of an appropriate signal, the SACM diesel generator is designed to start and accelerate to the rated voltage and speed. The diesel generator is started on:

- Receipt of a SIAS.
- Loss of voltage to the 4.16 kV bus to which the diesel generator is connected.
- Manual switch operation (Main Control Room).

  There are two switches in the Main Control Room which can be used to manually start the diesel generator: "Fast Start" and "Slow Start."
- Manual switch operation (Diesel Generator Building Control Room).

  There are also two switches in the Diesel Generator Building Control Room which can be used to manually start the diesel generators: "Fast Start" and "Slow Start."
- Emergency manual switch (protective cover) operation (Diesel Generator Building Control Room).

  The emergency manual switch (protective cover) will start the diesel generator when the "local/auto-remote" selector switch is placed in the auto-remote position.

2.1.1.2 Tripping Devices

The following protective functions are provided during operation of the diesel generator under normal operating conditions:

Diesel Generator Trips	Trip Signal Logic
Engine overspeed	1 of 2
Lube oil pressure (Low-Low)	2 of 3
Lube oil temperature (Hi-Hi)	1 of 1
Low lube oil sump level	1 of 1
High HT coolant temperature	1 of 1
High LT coolant temperature	1 of 1
Low HT coolant pressure	1 of 1
Low LT coolant pressure	1 of 1
Generator bearing temperature (High-High)	1 of 2
High crankcase pressure	1 of 1
Cranking time exceeded	1 of 1
Generator ground current	2 of 3
Generator differential current	1 of 1
Generator overvoltage	1 of 1
Generator voltage controlled overcurrent	1 of 1
Excitation faults	1 of 1

Reverse power, loss of field and underfrequency protection are provided for protection of the diesel during parallel operation with plant auxiliary power distribution system.

Upon receipt of a SIAS, 4.16 kV bus undervoltage signal or emergency manual switch (protective cover) operation, the following automatic diesel generator protective functions will remain active:

- Engine overspeed
- Low lube oil pressure
- Generator ground current
- Generator differential current

2.1.1.3 Permissives and Mode of Operation

The mode of operation of the diesel generator is determined by the position of the diesel generator control mode selector switch to either "local" or "auto-remote." A brief description of the operating sequence is as follows:

- Normal Mode - Placing the "local/auto-remote" selector switch in the auto-remote position will allow automatic startup, manual start or test operation of the diesel generator from the Main Control Room.

  - Automatic Starts - Startup of the diesel generator can be initiated automatically by either an ESF bus undervoltage or a SIAS. In response to either of these two signals, the diesel generator will accelerate to the rated voltage and speed within 10 seconds.

  - Manual Starts - For manual starts or periodic testing, the diesel generator may be started and stopped through the use of manual switches. Two accelerations are available, depending upon which switch is selected. Both accelerations provide automatic operation of the field flashing circuitry and result in a "ready for load" condition when synchronous speed has been reached.

  The SLOW start is operator-selected and provides a longer acceleration time via a pre-set speed ramp within the diesel generator governor control system. The SLOW start signal is automatically overridden by the receipt of a SIAS or ESF bus undervoltage signal.

  The FAST start is operator-selected and provides a direct simulation of the rapid acceleration required in response to any automatic start signal.

- Local Test or Maintenance Mode - Selection of the "local" position on the "local/auto-remote" selector switch will allow operation similar to manual start mode with these additional features:

  - Individual operation of either engine on the tandem-engine generator set is permitted through the use of the diesel engine selector switch when the generator is decoupled from the engine.

  - The diesel generator will not respond to any automatic or emergency manual start signals when in this mode.

2.1.1.4 Load Shedding Circuits

Section 8.4.1.2 of the UFSAR describes the load-shedding circuits for the existing diesel generators. These load-shedding circuits will also be used for the SACM diesel generator.

2.1.1.5 Instrumentation and Control Systems

Relays and circuits associated with 4.16 kV Bus No. 11, which were used to provide starting signals (SIAS and 4.16 kV undervoltage) for the existing diesel generators, are also used for the SACM diesel generator.

The diesel generator is equipped with various engine-mounted instruments, control panels located in both the Main Control Room and the Diesel Generator Building Control Room, two engine auxiliaries desks, a diesel maintenance and reliability diagnostics system, and an engineering workstation.

The auxiliaries desks (one per engine), located near the diesel generator unit, includes gauges to indicate engine temperatures, pressures, rack position, and engine RPM.

Control panels, located in both the Main Control Room and Diesel Generator Building Control Rooms, provide instruments, controls and annunciation for the diesel generator and auxiliary systems. The existing control panels in the Main Control Room will be modified so that the indications and controls for the existing diesel generators, SACM diesel generator and Station Blackout diesel generator are located on one control console in the Main Control Room. Modifications to components in the Main Control Room will be addressed by the 50.59 process.

The diesel generator maintenance and reliability diagnostics system is a computer-based system whose function is to provide diagnostics and trending capability to assist in meeting the requirements of Regulatory Guide 1.9, draft Revision 3, and NUMARC 87-00. The system monitors critical parameters such as lube oil pressure, crankcase temperature, crankcase pressure and coolant outlet temperature. The system provides for early detection of potential abnormal conditions that may adversely affect the operation of the diesel generator. The system is not safety-related. It is located in the Diesel Generator Building and consists of a Remote Terminal Unit (RTU), cabling, instrument sensors, computer, CRT, modem and a printer. The monitoring system displays, stores, processes and provides alarms for diesel generator data. In order to enhance diesel generator operability, troubleshooting and maintenance, the system performs the following functions:

- Monitors diesel generator performance over time using statistical trending and engineering data to pinpoint component degradation.
- Detects and records all equipment failures.
- Records all alarm conditions.

- Generates reliability data.
- Transmits data to a remote location for display and analysis.

2.1.2 ANALYSIS

The SACM diesel generator is being furnished as an independent unit to maintain BG&E's continued compliance with the following requirements:

- Safety Guide 6 - For the independence of the redundant, standby onsite power sources.
- 10 CFR 50.63 - Station blackout requirements
- GDC-17 - Electric Power Systems
- GDC-18 - Inspection and testing of electric power systems

The analysis of the modifications to the power system required to connect the SACM diesel generator to the existing Class 1E system will be provided in the Electrical Engineering Design Report.

2.1.3 INDEPENDENCE OF REDUNDANT CLASS 1E SYSTEMS

Since the SACM diesel generator is a redundant, standby onsite power source installed in a separate and independent Category I building, the physical separation requirements of Regulatory Guide 1.75 have been satisfied. The SACM diesel generator auxiliaries, local controls and indications isolate Class 1E and non-Class 1E devices and wiring in accordance with the requirements of IEEE 384-1981. The Electrical Engineering Design report addresses the electrical separation requirements for other electrical equipment and circuits.

TABLE 2-1

EMERGENCY DIESEL GENERATOR DESIGN DATA

Diesel Engine

Manufacturer	SACM Diesel
Model/Type	UD 45 V16 S5D
Quantity	Two per generator set
Cycle	Four
Continuous full-load rating	2,789 kW per engine (nominal gross engine output)
Short-time rating	3,064 kW per engine (nominal gross engine output)
Rated engine speed	1,200 RPM
Cylinder arrangement	Vee at 50°
Number of cylinders	16

Diesel Generator

Manufacturer	Jeumont-Schneider
Type	SAT 100/100/6
Continuous full-load rating	5,400 kW (nominal electrical output at terminals)
Short-time rating	5,940 kW (nominal electrical output at terminals)
Power factor (at continuous rating)	0.8
Rated voltage	4,160 V
Frequency	60 Hz
kVA (at continuous rating)	6,750
Line current (at continuous rating)	938 amps

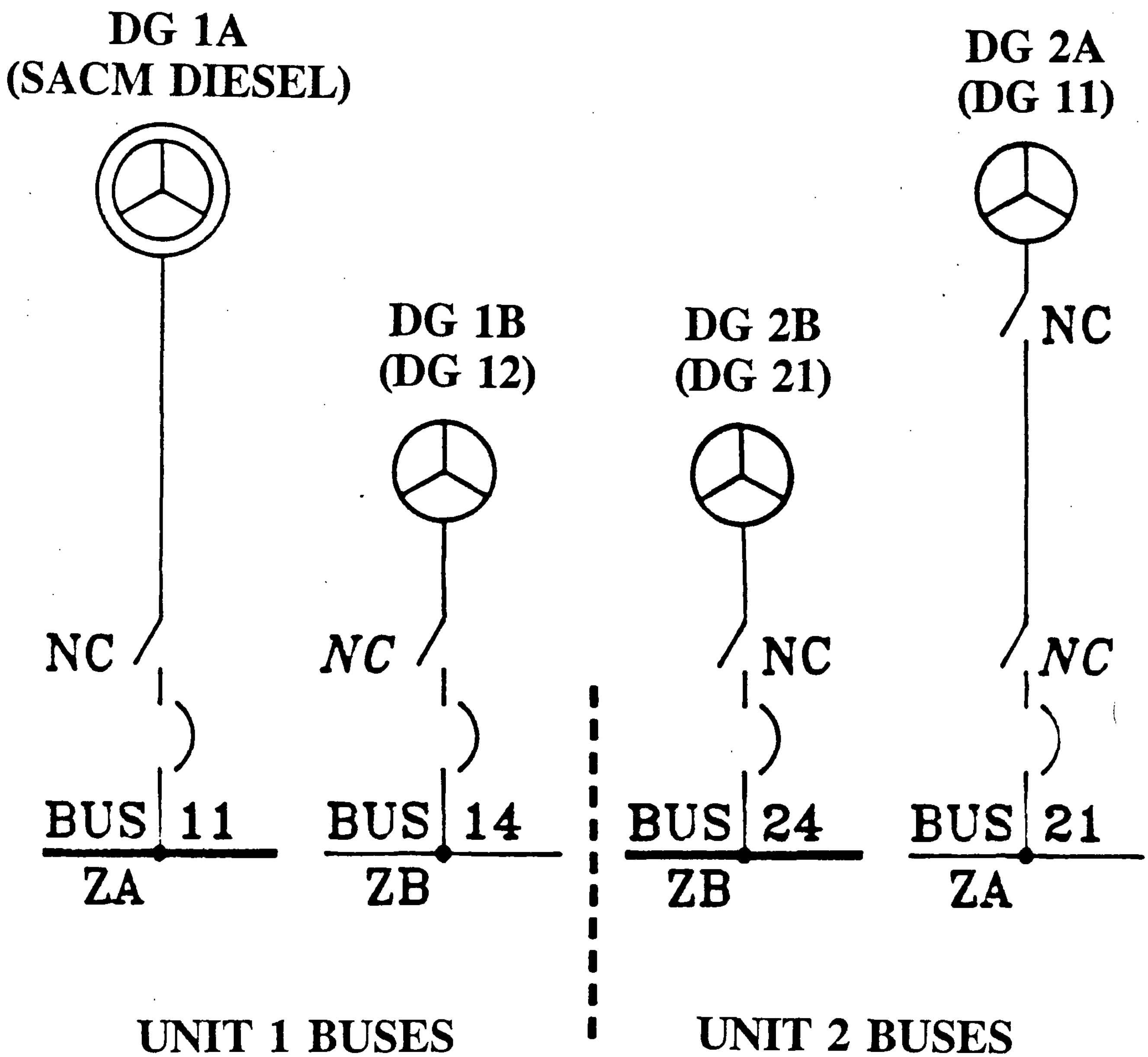

FIGURE 2-1 NEW DIESEL GENERATOR ARRANGEMENT

3.0 DIESEL GENERATOR AUXILIARY SYSTEMS

This chapter provides detailed information concerning diesel generator auxiliary subsystems. The SACM diesel generator and its supporting systems are located within a Category I building which is designed to consider high- and moderate-energy line breaks, flooding, missiles and other proximity hazards. Protection of the diesel and its support systems from flooding, missiles, wind, tornado and other environmental effects are discussed in the Civil Engineering Design Report. Protection from the dynamic effects associated with the postulated rupture of piping is discussed in Section 5.3.

The diesel generator and its support systems at Calvert Cliffs are designed such that failure of a single component will not prevent operation of plant safety-related equipment essential to safe shutdown. In the event that a single failure occurs which places a diesel generator out-of-service, each Unit has redundant diesel generators to supply power to redundant safety-related equipment required for safe shutdown or accident mitigation.

Preliminary plan views which show the location of the significant systems, structures and components (SSCs) within the Diesel Generator Building are provided in Figures 3-1, 3-2, 3-3 and 3-4. The simplified diagram shown in Figure 3-5 illustrates the mechanical design code boundaries for the diesel generator and its supporting auxiliary systems.

Pipe and pipe support installation will be in accordance with ASME Section III (1986) Class 3 and ANSI/ASME B31.1 with the following exceptions:

- No N-Stamp will be used for installation. However, ASME Section III materials will be fabricated by the supplier with an N-Stamp.
- A Certificate of Authorization for construction of this facility will not be obtained.
- A quality assurance manual will not be filed with ASME.

Non-safety-related systems are designed so that their failure will not result in the loss of function of any safety-related system, including Category II/I design provisions. Generally, this is accomplished by providing isolation between safety-related and non-safety-related portions of mechanical systems. Safety-related dampers, check valves or normally closed, safety-related manual valves provide the required isolation. Some applications do not require isolation at safety-related and non-safety-related boundaries within the system. These boundaries include:

- The Category I recirculation piping which returns fuel oil to the safety-related fuel oil storage tank.
- The overflow line from the fuel oil day tank to the fuel oil storage tank.
- Lube oil auxiliary tank overflow lines.

- The supply line for the lube oil fill pump to the lube oil auxiliary tank.
- A drain line connected to the exhaust silencer in the combustion air intake and exhaust system.
- High temperature (HT) and low temperature (LT) cooling water system expansion tank overflow lines.

Non-safety-related instruments for the diesel generators, such as indicators or switches, are located within the isolable boundaries of non-safety-related portions of each system. Non-safety-related mechanical auxiliary systems are designed to meet Category II/I requirements.

3.1 DIESEL GENERATOR FUEL OIL STORAGE AND TRANSFER SYSTEM

3.1.1 DESIGN BASES

- Portions of the diesel generator fuel oil system which are required for operation of the diesel generator are designed to remain functional during and after a safe shutdown earthquake.
- The diesel fuel oil system provides onsite storage and delivery of fuel oil for operation at 100 percent continuous rated load for seven days, assuming the loss of all offsite power sources as required by ANS 59.51-1989.

3.1.2 SYSTEM DESCRIPTION

The fuel oil storage and transfer system provides a ready supply of fuel oil for the SACM emergency diesel generator. The fuel oil supply line for the diesel generator consists of a fuel oil storage tank, a recirculation loop, two motor-driven fuel oil transfer pumps, a common day tank, a leakage tank, a common dirty fuel oil tank, a duplex filter and an engine-driven fuel oil pump with an AC motor-driven backup fuel oil pump. Fuel oil is transferred from the fuel oil storage tank to the fuel oil day tank. Fuel oil is then supplied from the day tank to a motor-driven fuel oil pump which provides flow through a set of duplex fuel oil filters to the injector pump manifold. Dedicated injector pumps and nozzles for each cylinder provide controlled distribution of fuel oil to the diesel engines. A simplified drawing of the diesel generator fuel oil storage and transfer system is shown in Figure 3-6.

Fuel oil is supplied from the fuel oil storage tank, through a set of fuel oil filters, to one of two AC motor-driven fuel oil transfer pumps which provides flow the fuel oil day tank. Each fuel oil transfer pump is capable of meeting the diesel generator's fuel needs at 100 percent continuous rated load.

The fuel oil day tank has an overflow line which directs excess fuel oil back to the storage tank. The fuel oil storage and transfer system provides a seven-day supply of fuel oil for the diesel generator.

The fuel oil storage tank will be provided with a non-safety-related, Category I recirculation loop. This loop consists of a recirculation pump, a fuel oil filter and a chemical pot for adding chemicals to the fuel oil storage tank. Oil is supplied from the fuel oil storage tank to the recirculation pump which provides flow through the fuel oil filter and then returns it back to the storage tank.

The recirculation loop is also used for replenishing the fuel oil storage tank. In the Diesel Generator Building, an external fuel oil fill line is connected to the recirculation pump suction for filling fuel oil storage tanks. Fuel oil is supplied from a tanker truck to the fuel oil storage tank via a fuel oil strainer to the suction of the fuel oil recirculation pump. The fuel oil recirculation pump then supplies fuel to the fuel oil storage tank through another fuel oil filter. In order to replenish the fuel oil supply for the existing diesel generators, an open contract is in effect with a fuel oil company in Baltimore, Maryland. With verbal authorization from the plant, fuel oil can be delivered to the site within 24 hours. The same contract will be used to replenish the fuel oil storage tank for the SACM diesel generator.

The external fuel oil fill line is not provided with barriers to protect it from tornado missiles. Instead of designing tornado missile barriers for the external fill connection, a second Category I fill line is provided inside the Diesel Generator Building. The second fill connection is protected from tornado missile by the building walls. Should the external fill connection become damaged, it can be isolated from the recirculation piping by a normally-shut valve and a check valve.

Both the fuel oil storage tank and the fuel oil day tank are equipped with vents and flame arresters. The flame arresters are located in the vent line for each tank. The walls of the Diesel Generator Building protect the vent lines and flame arresters from externally generated missiles.

The injection pumps and nozzles provide fuel oil flow to the cylinders via double wall injection piping. Any fuel oil leakage from the inner wall piping is contained by the outer wall piping and directed into the accidental leakage ramp where it drains to the leakage tank. The leakage tank level is monitored by a high-level alarm which indicates when excessive system leakage occurs. Discharge from the leakage tank drains by gravity into a common dirty fuel oil tank.

After engine start, the motor-driven fuel oil pump continues to provide fuel in parallel with the engine-driven fuel oil pump. In the unlikely event of an engine-driven fuel oil pump failure, the motor-driven fuel oil pump would continue to supply its diesel engine. Excess flow from the motor-driven fuel oil pump is recirculated to the day tank through a pressure regulator located at the discharge of the pump. Each fuel oil pump is provided with separate suction piping from the day tank.

Whereas most of the equipment in the fuel oil system will be built to manufacturer's standards, some exceptions exist. Non-safety-related equipment in the fuel oil system consists of:

- Any fuel oil system vent and drain line piping (downstream of the first isolation valve)
- Piping and components used to add chemical to the fuel oil storage tank via the recirculation line
- Piping and components in the Category I recirculation line and all fill lines
- Piping and components from the diesel engine skid to the dirty fuel oil tank
- The overflow line between the fuel oil day tank and the fuel oil storage tank

Safety-related equipment in the fuel oil system consists of:

- Piping and components from the fuel oil storage tank to the fuel oil day tank
- The fuel oil storage tank and its penetrations up to and including the first isolation valve for each penetration, except as noted above
- The fuel oil day tank and its penetrations up to and including the first isolation valve for each penetration, except as noted above
- Piping and components from the fuel oil day tank to the diesel engine, except as noted above
- The fuel oil transfer pump and filters

Where safety-related and non-safety-related portions of the diesel generator fuel oil storage and transfer system are connected, the non-safety-related portion is isolated from the safety-related portion by a normally-shut manual valve. There are two applications where this is not required in order to prevent non-safety-related components from affecting the operability of safety-related components. The first application is the Category I recirculation piping which returns fuel oil to the safety-related fuel oil storage tank. This piping is connected to the top of the fuel oil storage tank. The piping connected to the bottom of the fuel oil storage tank is isolated by a normally shut manual valve. Fuel oil would not be siphoned from the tank should a break occur in the non-safety-related recirculation system.

The second application is the overflow line from the fuel oil day tank to the fuel oil storage tank. Both safety-related tanks are connected by a non-safety-related overflow line. The line is connected to the top of the fuel oil storage tank and at a point above the minimum required fuel oil day tank level. Since the overflow lines are connected to the tanks at a point above the minimum required tank level, the operability of each tank would not be affected should the overflow piping fail (e.g., during an earthquake).

The diesel generator fuel oil storage and transfer system design complies with ANSI/ANS 59.51-1989, with the following exceptions:

> Subsection 5.3.3 and 6.3.3: There are no duplex (or simplex) fuel oil strainers on the diesel engines preceding the fuel oil filters to preclude clogging. However, there are duplex fuel oil strainers in the transfer line to the fuel oil day tank, and the on-engine filters are duplex so that routing can be switched in case of clogging.
>
> Subsection 6.3.3: Instrumentation and controls (as described in ANSI/ANS 59.51-1989) will be discussed in further detail in the Instrumentation and Controls Design Report.

3.1.3 COMPONENT DESCRIPTION

Fuel Oil Storage Tank

The SACM diesel generator is provided with a bulk fuel oil storage tank enclosed in an isolated sector within the Diesel Generator Building. With one exception, the fuel oil storage tank is provided with fire barriers which meet the requirements of ANS 59.51-1989 and Branch Technical Position CMEB 9.5-1. Section C.7.j of Branch Technical Position CMEB-9.5-1 specifies that above-ground fuel oil storage tanks should be located at least 50 feet away from any building containing safety-related equipment. The Branch Technical Position further specifies that if located within 50 feet, the fuel oil storage tank will be located within a separate building having a three-hour fire rating. The fuel oil storage tank for the SACM diesel generator is housed within an isolated sector inside the Category I Diesel Generator Building. The enclosure is large enough to hold the contents of both the fuel oil storage tank and the fuel oil day tank should a rupture occur. The enclosure has a three-hour fire rating. In addition, the Diesel Generator Building exterior walls have a three-hour fire rating. Therefore, a fire in the fuel oil storage tank would not cause any fire damage to nearby safety-related SSCs.

The design of the fuel oil storage tank allows for replenishment of fuel oil without interrupting operation of the diesel generator. The tank design also incorporates features that minimize turbulence which could stir sediment at the bottom of the fuel oil storage tank and degrade overall fuel quality. The fuel oil storage tank has an inclined bottom to divert sediment to the low side of the tank. The fuel oil storage tank supply line is equipped with angled nozzles. These nozzles direct the flow of fuel oil toward the side of the tank which is opposite the sedimented portion of the tank. Furthermore, the inclined bottom of the fuel oil storage tank provides a vertical separation of about 12 inches between the fuel oil transfer pump suction and the lowest portion of the tank. The angled bottom allows sediment to be collected at a point which minimizes any turbulence during tank recirculation or fuel replenishment. Further precautions taken to prevent detrimental effects of sediment on diesel performance include duplex filters in the diesel generator fuel oil piping and a recirculation loop equipped with a fuel oil filter.

The separation between the bottom of the fuel oil storage tank and its suction provides a reservoir for the collection and removal of sludge and water. The fuel oil day tank has a similar, but smaller, collection and removal point. In order to prevent the accumulation of sludge and water in either of the tanks, they will be periodically checked (and if necessary drained) to remove accumulated sediment and water. Both tanks are provided with drain lines located at the bottom of the tanks which can be used to remove any accumulation.

The fuel oil storage tank can be replenished from an external tanker fill connection or a separate fill connection inside the Diesel Generator Building. Fuel oil is transferred from the replenishment source to the storage tank via a recirculation pump and filter.

Fuel Oil Recirculation Pump

A fuel oil recirculation pump is provided for the fuel oil storage tank. A filter is located at the discharge of the recirculation pump to remove sediments or other solid particles while recirculating or replenishing oil in the fuel oil storage tank. As recommended by EPRI-6314-D fuel oil guidelines, the recirculation pump is sized to provide approximately three turnovers of the fuel oil storage tank contents in a 24 hour period.

Chemical Pot

A chemical pot is provided in the recirculation loop for adding stabilizer and biocide chemicals.

Fuel Oil Day Tank

The diesel generator has one day tank which supplies a separate fuel oil supply line for each diesel engine of the tandem-engine generator. The day tank is located within an enclosed, three-hour fire barrier in the Diesel Generator Building.

The day tank is equipped with both high and low level alarms. The low level alarm is set at a level which would allow one hour of operation at 100 percent continuous-rated load plus an additional margin of 10 percent. Day tank level switches can be isolated to test alarms without having to drain the contents of the tank.

The tank suction is sufficiently above the bottom of the tank to prevent any condensate or sludge from flowing into the engine. A drain is provided to allow the tank to be completely drained for cleaning. A sampling connection is provided to allow samples to be taken of the bottom oil.

Fuel Oil Leakage and Dirty Fuel Oil Tanks

Fuel oil leakage from injection pumps and nozzles is collected by an accidental leakage ramp and directed to the leakage tank. The leakage tank level is monitored by a high-level alarm which indicates when excessive leakage occurs. Discharge from both the leakage tank and the drip ramp (located on the outside of each engine) drains by gravity into a common dirty fuel oil tank.

Fuel Oil Pumps

The tandem-engine diesel generator is equipped with four fuel oil pumps. Two fuel oil pumps are driven by direct mechanical linkage to the diesel engine (one pump per engine) and the remaining two pumps (one pump per engine) are electric motor-driven. A relief valve is provided to protect the system from overpressurization.

Fuel Oil Transfer Pumps

Two AC motor-driven transfer pumps supply fuel oil from the storage tank to the day tank. Each pump is capable of meeting the diesel generator's fuel needs at 100 percent continuous rated load.

The fuel oil transfer pumps are automatically started and stopped by fuel oil day tank level switches. Prior to reaching a one-hour supply of oil in the fuel oil day tank, one of the two transfer pumps will automatically start. If the fuel oil day tank level continues to drop, the second transfer pump will start when the low level alarm is actuated. Both pumps will automatically stop prior to actuation of the high level alarm.

Duplex Filters

Duplex fuel oil filters are located in the common discharge piping for the fuel oil pumps on each diesel engine.

Fabrication Codes

Description	Fabrication Code
Interconnecting piping and valves between the fuel oil storage tank and the fuel oil day tank	ASME Section III Class 3
Interconnecting piping and valves between the fuel oil day tank skid and each diesel engine skid	ASME Section III Class 3
All piping on skids supplied by SACM	Manufacturer's Standards
Piping and valves which connect the tanker fill connection and alternate fill line to the recirculation loop piping	ASME B31.1 Category I
Recirculation loop piping and valves	ASME B31.1 Category I
Piping from the fuel oil storage tank to the first isolation valve which connects to non-safety-related piping (ASME B31.1 piping)	ASME Section III Class 3
Fuel oil storage tank	ASME Section III Class 3
Fuel oil day tank	ASME Section III Class 3

3.2 DIESEL GENERATOR COOLING WATER SYSTEM

3.2.1 DESIGN BASES

- Portions of the diesel generator cooling water system which are required for operation of the diesel generator are designed to remain functional during and after a safe shutdown earthquake.
- The diesel generator cooling water system is capable of removing sufficient heat to permit continuous operation of the diesel engine at maximum load.
- In standby mode, the diesel generator cooling water system maintaines the lube oil system in a warmed condition to reduce engine wear during starting.

- Active components of the diesel generator cooling water system are capable of being tested in accordance with 10 CFR Part 50, Appendix A, General Design Criteria 44, 45, and 46.

3.2.2 System Description

Each diesel engine is provided with independent HT and LT closed loop cooling systems. Simplified drawings of the diesel generator cooling water system are shown in Figures 3-7 and 3-8. The HT system provides glycol-water cooling flow to the engine block and turbochargers while the LT system provides glycol-water cooling flow to the combustion air coolers and the lube oil heat exchanger. Both systems consist of an engine-driven pump, expansion tank, thermostatic control valve and a water-to-air heat exchanger (radiator).

When not in use, the diesel engine is placed in a standby mode of operation. In order to reduce thermal stress and wear while starting the diesel generator, the HT system on each diesel engine is provided with a preheating loop (keep warm system) which maintains the cooling system at an elevated temperature. The keep warm system consists of an AC motor-driven circulating water pump, thermostatically-controlled electric water heater and a lube oil standby heat exchanger. The electric heater and pump are electrically interlocked so that the heater can only be energized when the pump is running.

In standby mode, the HT cooling water system motor-driven pump circulates glycol-water coolant through the thermostatically-controlled electric heater and supplies it to the engine water jacket and the lube oil standby heat exchanger. Coolant temperature is maintained by controlling power to the electric heater with a temperature switch. The coolant system then transfers heat to the engine's lubricating system through the standby lube oil heat exchanger. Continuous operation of the pre-lube pump then circulates the preheated lube oil throughout the lube oil system. Startup of the diesel engine automatically de-energizes the keep warm pump and the electric water heater.

A thermostatic control valve in each system regulates the coolant temperature by directing flow to the radiator for cooling or bypassing the system's radiator until the water jacket temperature increases to the point where cooling is necessary. In this manner, the engine coolant is maintained at the proper temperature for maximum engine performance.

The closed cycle cooling systems use a mixture of demineralized water and glycol base antifreeze which is treated with a corrosion inhibitor. This mixture helps prevent the formation of scale, maintain a uniform heat transfer rate in both the radiator and the engine water jacket and prevents freezing of the engine coolant. The diesel engine cooling water system's radiator is designed such that seasonal changes in the antifreeze concentration are not required.

A majority of the diesel generator cooling water system equipment will be built to manufacturer's standards. Most of the equipment in the HT and LT cooling water systems is designated as safety-related. The non-safety-related components in the HT and LT cooling systems include:

- Supply and return lines from the HT and LT expansion tanks to the coolant mixing tank
- Cooling system vent and drain line piping (downstream of the first isolation valve)

Where safety-related and non-safety-related portions of the diesel generator cooling water systems are connected, the non-safety-related portion is isolated from the safety-related portion by a normally-shut manual valve. There is one application where this is not required in order to prevent non-safety-related components from affecting the operability of safety-related components. The supply and return lines from the coolant mixing tank to the HT and LT expansion tanks are not isolated by a safety-related valve. Since these lines are connected to the tanks above the minimum required tank level, the operability of each tank would not be affected should the overflow piping fail (e.g., during an earthquake).

3.2.3 Component Description

Water-to-Air Heat Exchanger (Radiator)

Each diesel engine is equipped with a radiator unit which consists of one HT and one LT forced-draft radiator. The HT and the LT radiator for each diesel engine are combined into an integral unit and supported by a truss which anchors it to the Diesel Generator Building. The radiator is a vertical core, water-to-air heat exchanger with geared, motor-driven fans capable of cooling the engine at both the short-time and continuous ratings of 3,064 kW and 2,789 kW, respectively, without exceeding any temperature limits.

Lube Oil Cooler

The diesel generator lube oil cooler is a shell-and-tube heat exchanger which provides a means of removing heat from the engine lube oil. The lube oil flows through the shell side and glycol-water coolant from the LT cooling water system flows through the tube side.

Combustion Air Cooler

The combustion air cooler is an air-to-water heat exchanger which is cooled by the LT cooling system. There are four combustion air coolers per engine. The glycol-water mixture flows through the finned tubes of the cooler, and the combustion air passes over the finned tubes. The combustion air coolers cool the combustion air after it has passed through the turbochargers.

Thermostatic Bypass Valve

Three-way thermostatic bypass valves are installed in the diesel generator HT and LT coolant systems upstream of the radiators. The purpose of the thermostatic bypass valves is to maintain system temperature for maximum engine performance by regulating glycol-water coolant flow to the radiators.

Expansion Tanks

Each diesel engine has two expansion tanks: one for the HT system and one for the LT coolant system. Each expansion tank has sufficient reserve capacity for adequate cooling of the diesel engine for seven days of full load operation without the need for additional make-up.

Coolant Keep Warm System

Each diesel engine has a coolant keep warm system consisting of a motor-driven keep warm circulating pump and an immersion heater. The immersion heater is thermostatically-controlled to maintain the coolant at hot standby temperature. The coolant circulating pump runs continuously when the engine is idle and automatically stops when the engine is started.

Fabrication Codes

Description	Fabrication Code
Expansion tank	ASME Section III Class 3
Interconnecting piping, valves, and pumps between the expansion tank and the diesel engine skid	ASME Section III Class 3
HT and LT radiators	ASME Section VIII
Interconnecting piping and valves between the radiator and the diesel engine skid (except for the three-way valves)	ASME Section III Class 3

Diesel engine skid	Manufacturer's Standard
Three-way thermostatic control valves	Manufacturer's Standard
Interconnecting piping and components between the HT and LT expansion tanks and the demineralized water system	ASME B31.1

3.3 DIESEL GENERATOR STARTING AIR SYSTEM

3.3.1 DESIGN BASES

- Only two of the system's four air receivers are required to be operational in order to successfully start the diesel engines within 10 seconds. Air compressors are provided with normally closed cross-connect valves which could be opened to recharge all four air receivers from one compressor.
- The diesel generator starting air system initiates an engine start such that the generator attains the rated frequency and voltage within 10 seconds of receipt of the start signal.
- Portions of the starting air system which are required to start the diesel generator are designed to remain functional during and after a safe shutdown earthquake.
- Active components of the diesel generator starting air system are capable of being tested in accordance with 10 CFR Part 50, Appendix A, General Design Criterion 18.

3.3.2 SYSTEM DESCRIPTION

The starting air system for the tandem SACM diesel generator consists of skid-mounted subsystems which include four redundant air receivers and two air compressors complete with air dryers. This system supplies pressurized air to the engine mounted starting air distributor, which sequentially delivers air into each engine combustion chamber (air over piston starting). A simplified drawing of the diesel generator starting air system is shown in Figure 3-9.

Each set of redundant components provides starting air to a bank of eight engine cylinders. Air provided by any two of the four air sources is capable of starting the diesel generator and accelerating it to rated speed within 10 seconds. Starting air from any one of the four sources will produce a diesel generator start, but not within 10 seconds. Normal air system lineup provides air simultaneously to all four banks of engine cylinders.

The air receivers are sized based on test data for SACM engines, corrected for system inertia specific to the Calvert Cliffs diesel. In the event a leak occurs in the non-safety-related portion of the system, an upstream check valve is provided on each receiver to prevent system depressurization.

Each starting air skid will be provided with equipment to prevent system fouling as follows:

Moisture - Two desiccant-type air dryers capable of heaterless regeneration are connected in parallel at the discharge of each air compressor. The air towers are rated at twice the capacity of the air compressor to prevent any carryover of entrained water. Additionally, two water separators are provided upstream of the air dryers to ensure efficient dryer operation.

Oil - Two oil separators are connected in series at the discharge of the air compressors to prevent oil carryover.

Rust - Air filters are provided upstream and downstream of the air dryers to remove any particulate contaminants such as rust, dirt and desiccant. Additionally, the use of corrosion resistant piping and dry air will reduce the potential for rust formation.

Provisions will be made to blow down any accumulated moisture in the water separator provided with the compressor and the oil and water separators included with the air dryer. The air receivers are provided with drain connections which allow for periodic blowdowns of accumulated moisture.

Most of the starting air system will be built to manufacturer's standards. Equipment required to start the diesel engines on receipt of a start signal are designated as safety-related. This includes:

- Piping and components downstream of the starting air receivers, including the air receivers themselves.
- Piping upstream of the starting air receivers to the inlet check valve. This includes both a globe valve and the check valve.

The air compressor and piping up to the upstream flange of the inlet check valve for each air receiver is designated as non-safety-related.

3.3.3 Component Description

Air Compressors

One motor-driven compressor is provided for each diesel engine starting air system (two compressors). Each compressor is sized to be capable of recharging two air receivers from minimum to maximum air pressure within 30 minutes.

Air Dryers

The tandem-engine diesel generator starting air system is equipped with two automatic, desiccant-type, dual tower air dryers (one dryer per diesel engine) to ensure that moisture-free air (dew point of not more than -40°F) is available for all engine starts.

Air Receivers

The starting air system for the diesel generator is equipped with four air receivers. Two receivers (one per diesel engine) are capable of providing, without recharging, five consecutive cranking cycles to a cold diesel generator. Each receiver supplies starting air to a bank of eight engine cylinders. Normal system lineup simultaneously directs air from all four air receivers to the diesel generator. This ensures a diesel start even if a single failure in one of the starting lines should occur. Air receivers are equipped with drain valves for periodic blowdowns to eliminate any accumulated moisture.

Each starting air receiver is provided with two pressure switches. When a low pressure condition exists in the air receiver, a pressure switch starts the non-safety-related air compressor to repressurize the air reciever. If pressure continues to drop, another pressure switch signals an alarm on an annunciator panel in the Diesel Building Control Room. The alarm at the annunciator panel also initiates a common trouble alarm in the Main Control Room to alert operators to the problem. The air receivers are also monitored by pressure indicators in the Diesel Building Control Room.

Air Start Solenoid Valves

The starting air system is equipped with four 125 V dc solenoid operated air start valves which are engine mounted in the discharge piping of each air receiver. These solenoid valves are energized open upon the receipt of a start signal and have the capability of being manually opened.

Filters

A wye-strainer is installed immediately upstream of each solenoid air start valve to prevent particulate fouling.

Fabrication Codes

Description	Fabrication Code
Interconnecting piping and valves between the air compressors and the check valve upstream of the receivers	ASME B31.1
Interconnecting piping and valves between the check valve upstream of the air receivers and the diesel engine skid	ASME Section III Class 3
Air receiver	ASME Section III Class 3
Air dryer	Manufacturer's Standards
Air compressor, solenoid valves and filters	Manufacturer's Standards

3.4 DIESEL GENERATOR LUBE OIL SYSTEM

3.4.1 DESIGN BASES

- The diesel generator lube oil system provides oil to lubricate moving parts and also provides piston cooling.
- Portions of the lube oil system which are required for diesel generator operation are designed to remain functional during and after a safe shutdown earthquake.
- The diesel generator lube oil system is designed to permit seven days of continuous operation of a diesel engine at rated full load without the need for additional make-up to the lube oil auxiliary tank.
- Active components of the diesel generator lube oil system are capable of being tested in accordance with 10 CFR Part 50, Appendix A, General Design Criterion 18.

3.4.2 SYSTEM DESCRIPTION

The diesel generator lube oil system consists of two cross-tied loops, pressurized by two engine-driven lube oil pumps. The pumps supply oil from the crankcase sump to each loop, where the oil passes through a lube oil cooler and a duplex lube oil filter before being distributed to the engine block to lubricate moving parts and provide piston cooling. The lube oil is then drained by gravity back into the sump. A three-way thermostatic-control valve regulates flow through the lube oil cooler based on outlet temperature. Engine heat is transferred from the oil to the LT cooling system. Excess flow is filtered and returned to the lube oil sump. The diesel engine sump can be drained to a non-safety-related lube oil drain tank. A simplified drawing of the diesel generator lube oil system is shown in Figure 3-10.

When not in use, the diesel engine is placed in a standby mode of operation. The lube oil system is provided with a pre-lube system to maintain a constant flow of warm lubricating oil to critical areas during the standby mode of operation. The pre-lube system is mounted on a separate skid (the auxiliaries desk) and includes a pre-lube heat exchanger and two pumps. One pre-lube oil pump is motor-driven while the other pump is floor-mounted and pneumatically-driven.

The pre-lube system provides two functions:

- It maintains a constant flow of lube oil throughout critical engine areas to reduce excessive wear due to engine starts. A backup pneumatically-driven pump ensures the ability to pre-lube in the event of a prolonged loss of AC power.

- The pre-lube heat exchanger, which is heated by the keep warm portion of the HT cooling system, provides a supply of heated oil to reduce startup wear.

Engine operation shuts off the electric pre-lube pump and allows the two engine-driven oil pumps on each diesel engine (four per generator set) to supply the required lube oil flow. When in use, the pneumatically-driven pump must be manually shut down before starting the diesel engine. After engine startup, the lube oil system is cooled by the LT cooling system.

The lube oil system is designated as safety-related with a few minor exceptions:

- Interconnecting piping between the diesel engine and the lube oil drain tank is non-safety-related. Piping from the diesel engine sump to the first isolation valve is designated as safety-related (including the isolation valve).

- Piping from the lube oil fill station to the lube oil auxiliary tank is non-safety-related.

- The pneumatically-driven pre-lube pump, excluding its suction and discharge isolation valves, is non-safety-related. This pump is normally isolated from the rest of the lube oil system by safety-related valves.

Where safety-related and non-safety-related portions of the lube oil system are connected, the non-safety-related portion is isolated from the safety-related portion by a normally-shut manual valve. There are two applications where this condition is not required in order to prevent non-safety-related components from affecting the operability of safety-related components. The first application is the supply line from the lube oil fill station to the lube oil auxiliary tank. The second application is the overflow line for the lube oil auxiliary tank. Both lines are connected to the top of the lube oil auxiliary tank. Since the two lines are connected to the tank above the minimum required tank level, the operability of the tank would not be affected should the overflow piping fail (e.g., during an earthquake).

Protective measures are taken to prevent unacceptable crankcase explosions and mitigate the consequences of such an event. Relief ports are provided on the diesel generator crankcase hand-hold covers. The diesel engines operate with a negative pressure in the crankcase. The negative pressure serves to draw off any combustible gases and directs them to the combustion air inlet side of the turbocharger.

3.4.3 Component Description

Lube Oil Pumps

Two engine-driven lube oil pumps are mounted on the diesel engine skid to supply an adequate flow of lubricating oil during diesel operation.

Lube Oil Cooler

The diesel generator lube oil cooler is a shell-and-tube heat exchanger which provides a means of removing heat from the engine lube oil. The lube oil flows through the shell side and a glycol-water mixture from the LT cooling system flows through the tube side.

Lube Oil Auxiliary Tank

The diesel generator lube oil auxiliary tank is sized such that sufficient capacity exists for seven days of continuous operation at rated full load without the need for additional auxiliary tank replenishment. The auxiliary tank is sized to make up for a loss of approximately 75 gallons of lube oil per day from both engines.

Duplex Cartridge Filters

Duplex cartridge filters (four per diesel engine) are located on the discharge of the lube oil coolers on each engine. Two filters are capable of passing 100 percent continuous rated flow.

Pre-lube System

The pre-lubrication system is designed to minimize engine wear during engine startup. Most of the system's equipment is located on a separate skid and consists of a shell-and-tube pre-lube heat exchanger and two pumps. One pump is AC motor-driven, while the other pump is driven by pneumatic motor. The pneumatically-driven pump is physically located on the floor of the Diesel Generator Building, separate from the pre-lubrication skid. It is supplied with air from its own air bottle. Lube oil, pre-heated by coolant in the HT cooling system, is then circulated throughout the diesel engine.

Fabrication Codes

Description	Fabrication Code
Lube oil auxiliary tank	ASME Section III Class 3
Lube oil coolers	Manufacturer's Standards
Interconnecting piping and valves between the lube oil auxiliary tank and the diesel engine skid	ASME Section III Class 3
Interconnecting piping and valves between the auxiliaries desk and the diesel engine skid	ASME Section III Class 3
Pre-lube system on the auxiliaries desk	Manufacturer's Standards
The pneumatic pre-lube pump and associated piping	ASME B31.1

3.5 DIESEL GENERATOR COMBUSTION AIR INTAKE AND EXHAUST SYSTEM

3.5.1 DESIGN BASES

- Portions of the diesel generator combustion air intake and exhaust system which are required for diesel generator operation are designed to remain functional during and after a safe shutdown earthquake.

- Active components of the diesel generator combustion air intake and exhaust system are capable of being tested in accordance with 10 CFR Part 50, Appendix A, General Design Criterion 18.

3.5.2 SYSTEM DESCRIPTION

Each diesel engine has an independent combustion air intake and exhaust system. Upon initiation of a diesel generator start signal, combustion air is drawn into the air intake filter and integral silencer, passes through the intake piping to the turbochargers and then through the aftercooler to the engine intake manifolds. The diesel exhaust is passed through the turbochargers and an exhaust silencer before being discharged from the building. The exhaust gas discharge piping is located to prevent recirculation of the gases back into the combustion air system. A simplified drawing of the diesel generator combustion air intake and exhaust system is shown in Figure 3-11.

With one exception, all piping and components in the diesel generator combustion air intake and exhaust system are designated as safety-related. The exhaust silencer is provided with a drain line. This line protects the silencer from corrosion by draining accumulated moisture. The non-safety-related drain line is not isolated from the safety-related silencer by a manual valve. The operability of the silencer would not be affected by a break in the drain line (e.g., during an earthquake). Any combustion gases exhausted into the building through a broken drain line would be vented into the third floor. Since the silencers are located downstream of the HT/LT radiator fans, these gases would be exhausted from the building at a point near the combustion exhaust piping outlet. In addition, Diesel Generator Building habitability would not be affected since the safety-related HVAC intake is located upstream of the radiator fans.

The diesel generator combustion air intake and exhaust system components located on the engine skid were designed by SACM. The maximum system temperatures are found in the exhaust system at the engine cylinder outlets and in the exhaust piping leading to the turbochargers. Design values for exhaust gas temperatures in this piping at nominal engine power include:

- 1076°F ± 122 °F at the cylinder outlets.
- < 968°F average exhaust from the cylinder outlet. This is an average bulk temperature for the combination of the exhaust gases discharged into the piping that leads to the turbochargers.
- 842°F ± 90°F at the outlet of the turbocharger. This is the design maximum temperature for the exhaust piping downstream of the turbocharger.

American Society of Mechanical Engineers (ASME) Code Case N-253-6, "Construction of Class 2 or Class 3 Components for Elevated Temperature Service," Section III, Division 1, was approved on August 14, 1992. Code Case N-253-6 contains the rules for selecting materials and for designing Class 2 and 3 SSCs that are expected to experience metal temperatures that exceed those covered by the rules and stress limits of the ASME Code, Section III, Subsection NC, Subsection ND and Tables I-7.0 and I-8.0 of Appendix I.

The diesel exhaust system temperatures exceed the temperatures covered by the rules and stress limits of the ASME Code. Rules for the construction of the ASME Section III, Division I, Class 3 components which would experience temperatures above those covered by the rules and stress limits of ASME Subsection NC, Subsection ND, and Tables I-7.0 and I-8.0 of Appendix I, are under preparation by the Committee. In the interim, it is the opinion of the Committee that Class 3 components may be constructed in accordance with the rules of Section III, Division I, with the following modifications:

- The rules of Code Case N-253-6 shall govern the design and material selection stages of construction.
- The stamping[2] and data report shall indicate the Case number and the applicable revision.

Code Case N-253-6 is not approved for use by either Regulatory 1.84, Revision 28 or Regulatory Guide 1.85, Revision 28. Since there are no ASME Section III, Class 3 materials approved for use at the design temperatures of the diesel generator exhaust system, Code Case N-253-6 is used for the design of the ASME Section III piping in this system. We, therefore, request approval of this code case for use in this application.

Outdoor exhaust system piping is protected from the missiles described in Table 3-2 of the Civil Engineering Design Report. For trajectories which would cause a missile to enter or strike the piping, the exhaust pipe is designed to withstand the impact of a one-inch diameter steel rod tornado missile. The next largest missile, a six-inch diameter schedule 40 pipe, is prevented from entering or striking the pipe by a steel grate. Supports for the steel grate are embedded in the wall of the Diesel Generator Building. With the exception of an automobile missile, the grate is designed to withstand the impact of the design basis missiles described in the Civil Engineering Design Report. Since the grate is located approximately 45 feet above grade, an automobile impact is not considered in the design of the grate.

The diesel generator combustion air intake and exhaust system can supply an adequate quantity and quality of filtered combustion air to the diesel engine and can dispose of the resultant exhaust gases without creating an excessive backpressure on the diesel engine. The Diesel Generator Building is not equipped with a gaseous fire suppression system, and the engine exhaust is located approximately 100 feet away from the engine air intake and more than 20 feet above grade, thus minimizing the chance of engine exhaust being drawn into the combustion air intake.

The combustion air intake for the diesel generator is located within the Category I Diesel Generator Building. The diesel generator exhaust discharges from the east side of the Diesel Generator Building's third floor. With the exception of exhaust piping between the outside wall of the Diesel

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[2] As described in Section 6.1, ASME Section III materials will be fabricated with an N-Stamp, but a certificate of authorization for construction will not be obtained.

Generator Building and the building's siding, the combustion air intake and exhaust piping are protected from missiles and natural phenomena by the Category I Diesel Generator Building.

3.5.3 Component Description

Silencer

The diesel engine exhaust is directed through a multi-compartment silencer to limit noise level to the OSHA sound level requirements.

Filter

Combustion air is drawn through a filter which has an integral silencer. The filter and silencer are designed to function in accordance with the engine manufacturer's recommendations. The air intake system is designed to prevent entrained water from entering the engine air intake.

Piping

The air intake piping is carbon steel and the exhaust piping is chrome-moly. Expansion joints are strategically located to accommodate thermal growth and system vibration. The piping is of adequate size so that the total pressure drop when the engine is operating at 100 percent rated continuous load is within the diesel engine manufacturer's recommendations. Exhaust manifold piping is insulated with an oil resistant material that provides personnel protection and limits the heat transfer to the Diesel Generator Building.

Fabrication Codes

Description	Fabrication Code
Intake air filter and integral silencer	Manufacturer's Standards
Intake piping from the filter to the diesel engine skid	ASME Section III Class 3
Combustion exhaust piping from the diesel engine skid to the exhaust silencer	ASME Section III Class 3 Code Case N-253-6

Exhaust silencer	Manufacturer's Standard
Expansion bellows	Manufacturer's Standards

3.6 FLEXIBLE HOSE CONNECTIONS

Flexible hose connections supplied by SACM are used to connect and isolate skid-mounted components from piping designed by Bechtel Corporation. These flexible hoses are designed to manufacturer's standards and are composed of elastomers reinforced internally with braiding, including metal wire. None of the flexible hoses have external braided wrapping. The flexible hoses will be replaced in accordance with the manufacturer's maintenance list.

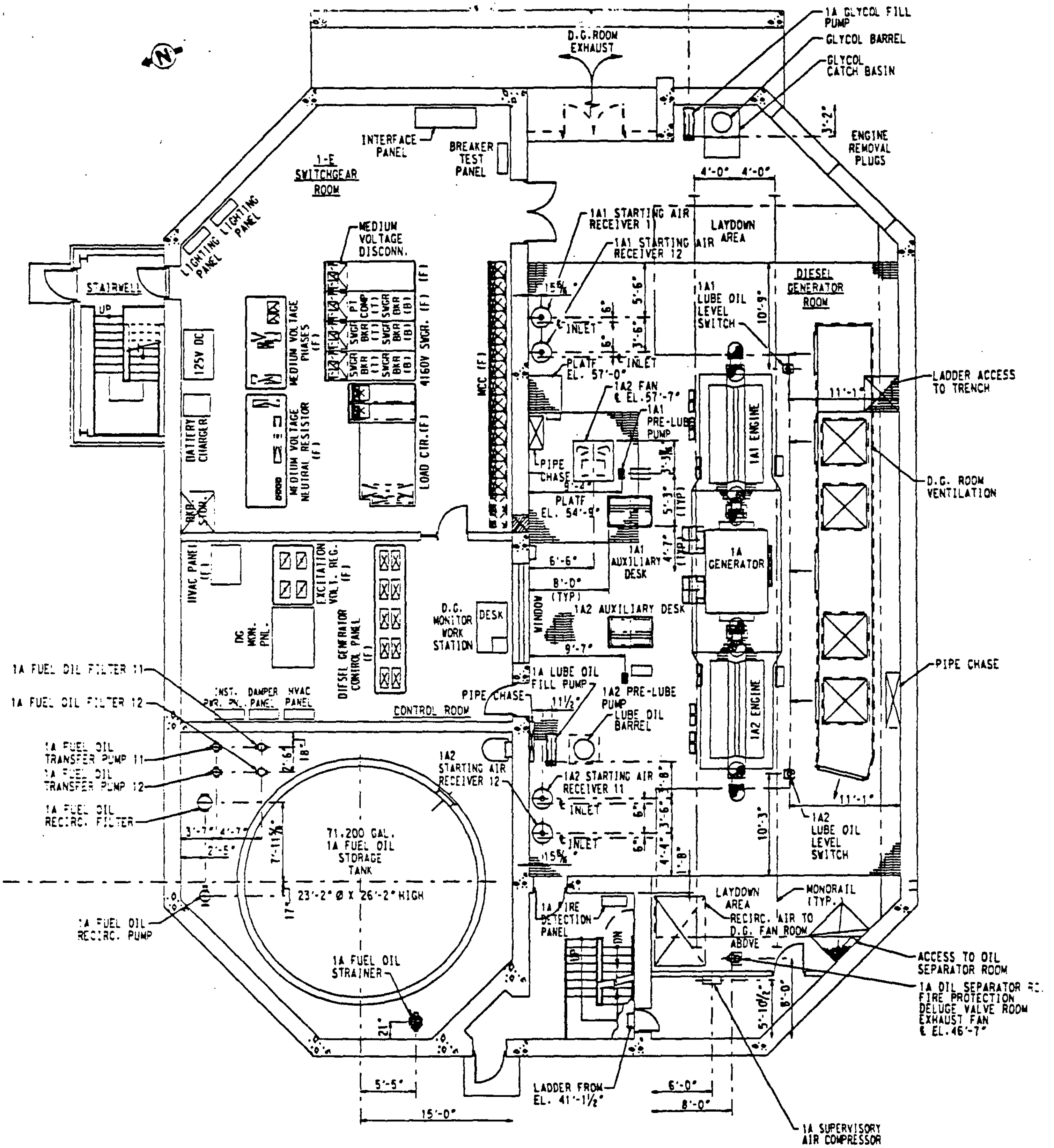

FIGURE 3-1 PRELIMINARY PLAN VIEW OF EQUIPMENT LOCATIONS FIRST FLOOR

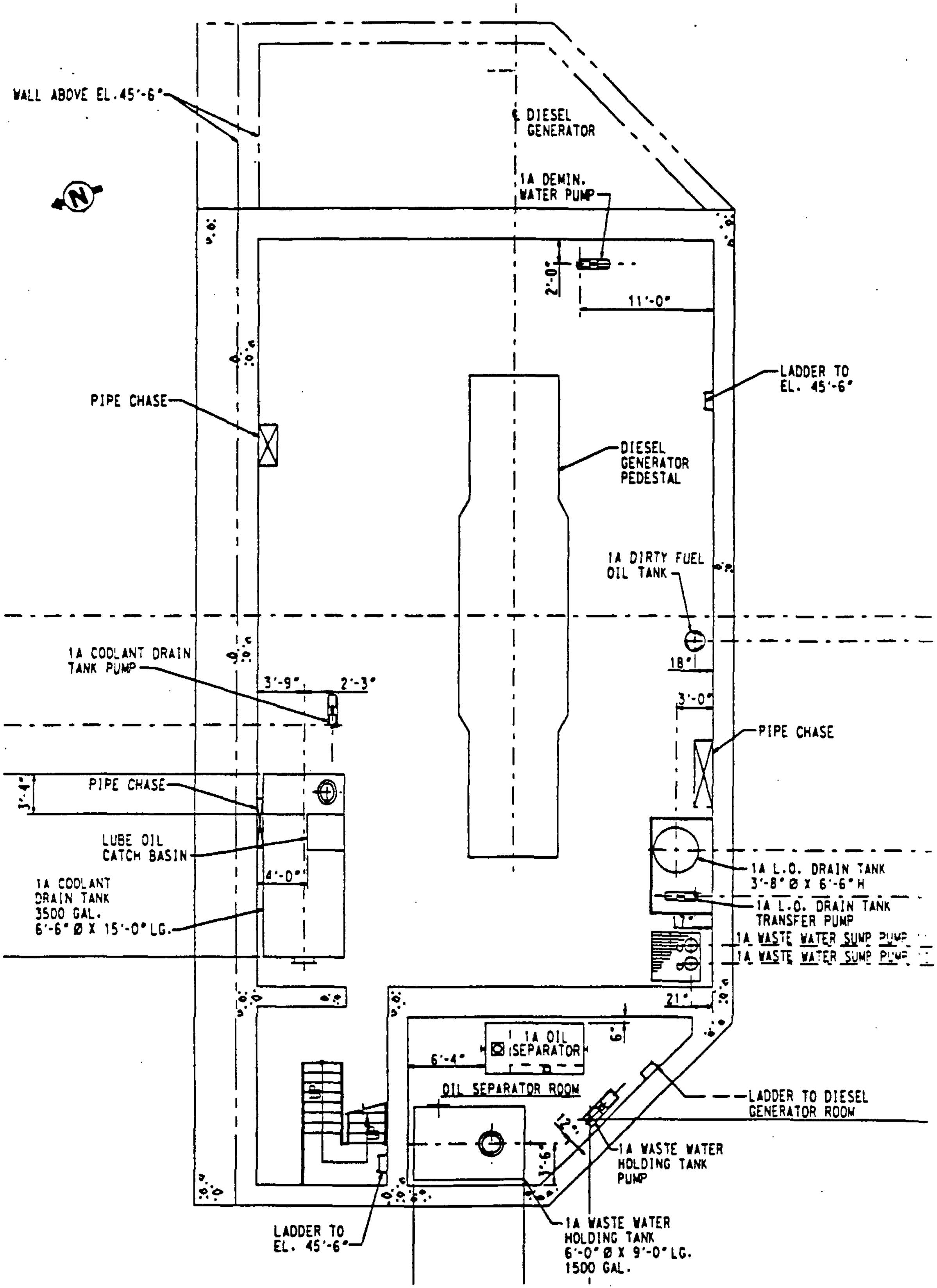

FIGURE 3-2 PRELIMINARY PLAN VIEW OF EQUIPMENT LOCATIONS DIESEL GENERATOR TRENCH

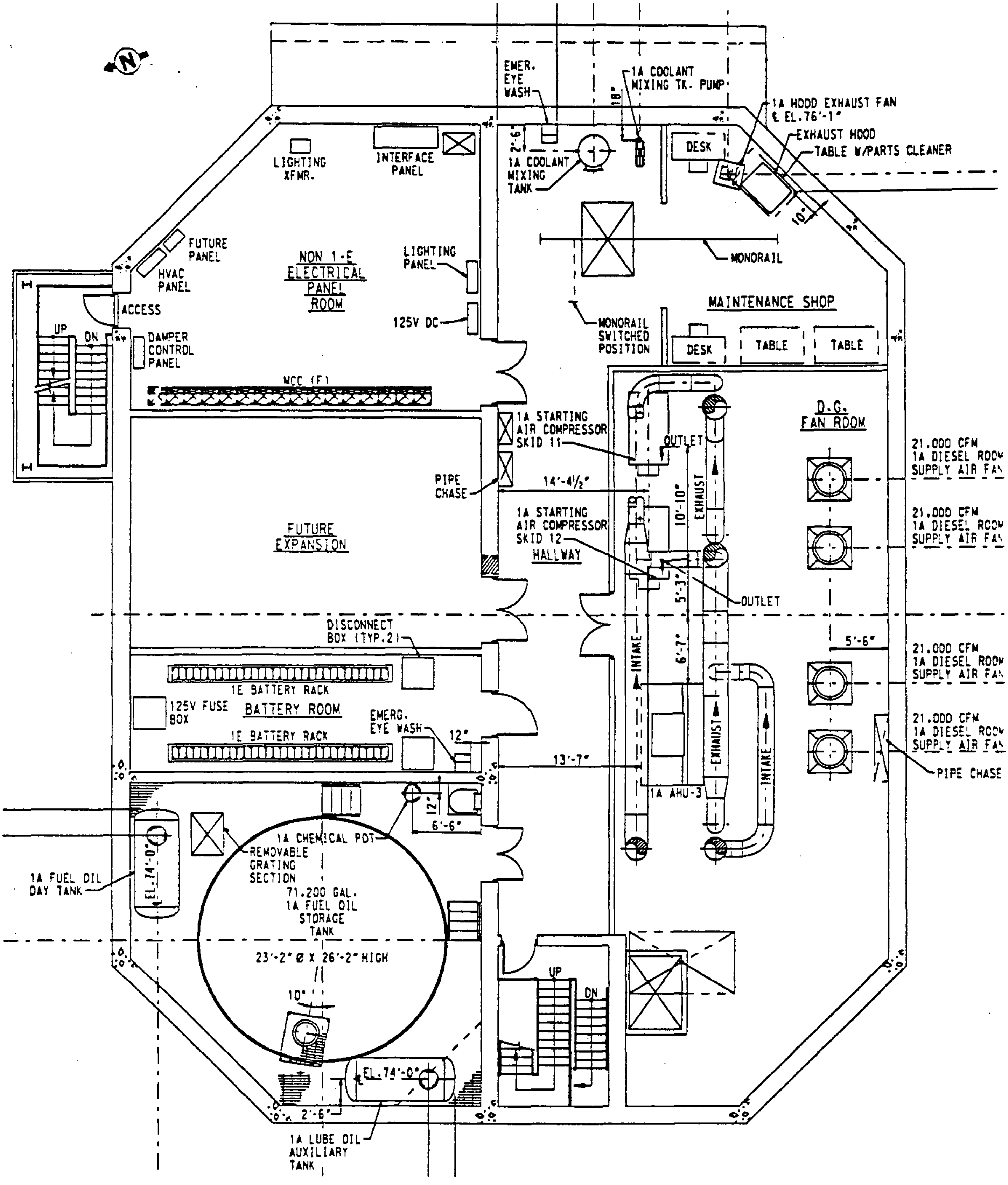

FIGURE 3-3 PRELIMINARY PLAN VIEW OF EQUIPMENT LOCATIONS SECOND FLOOR

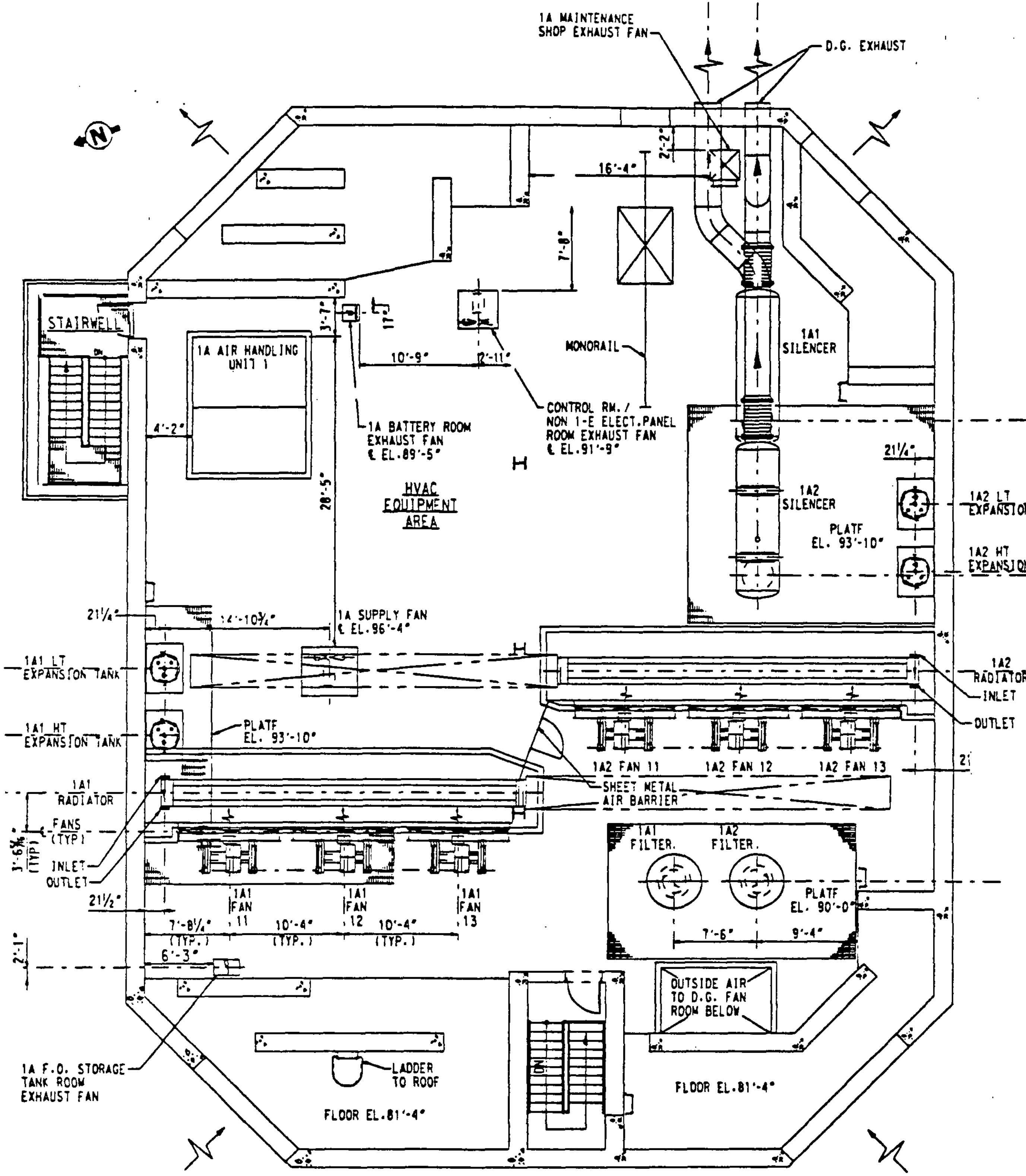

FIGURE 3-4 PRELIMINARY PLAN VIEW OF EQUIPMENT LOCATIONS THIRD FLOOR

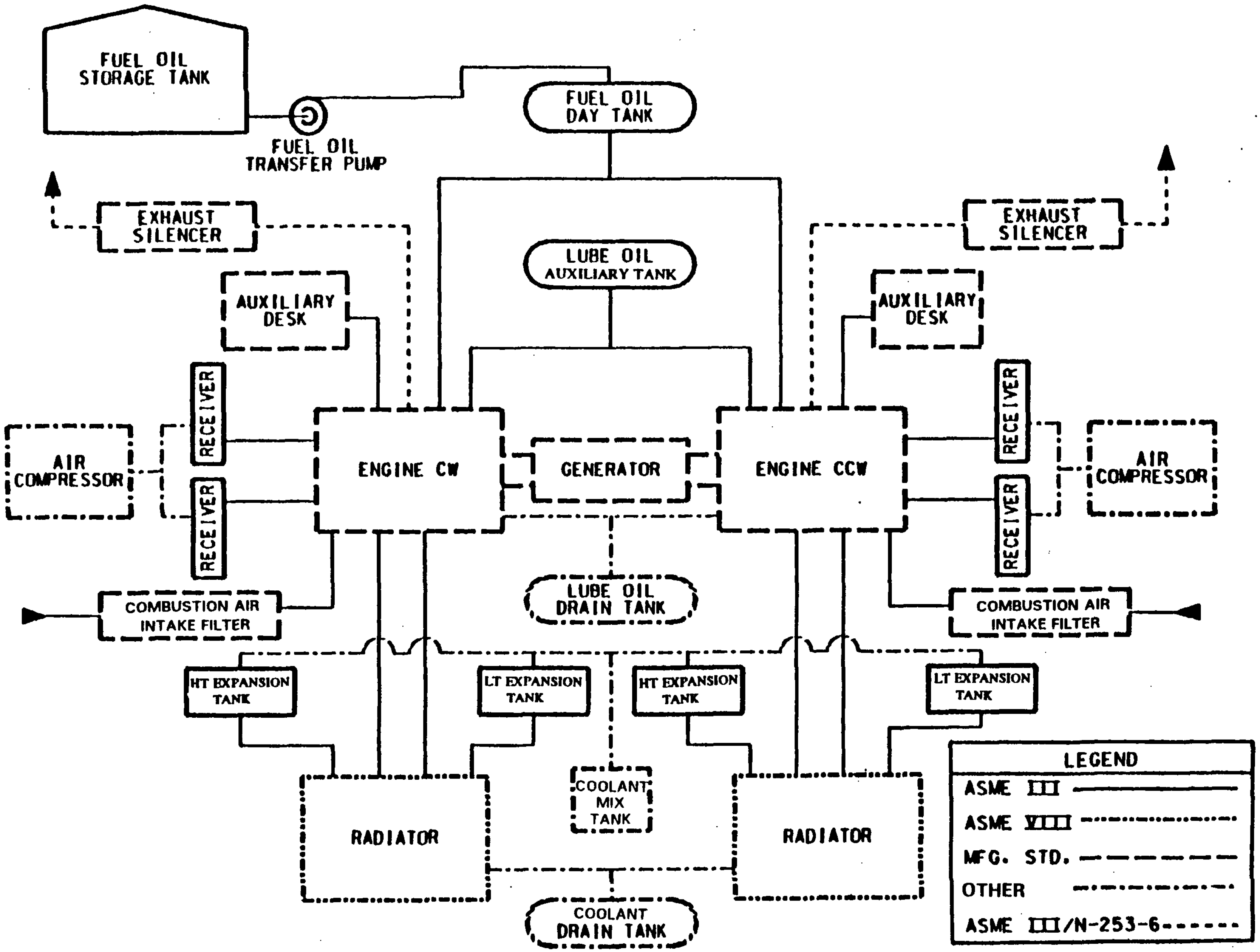

FIGURE 3-5 DIESEL GENERATOR AUXILIARY SYSTEM CODE BOUNDARIES

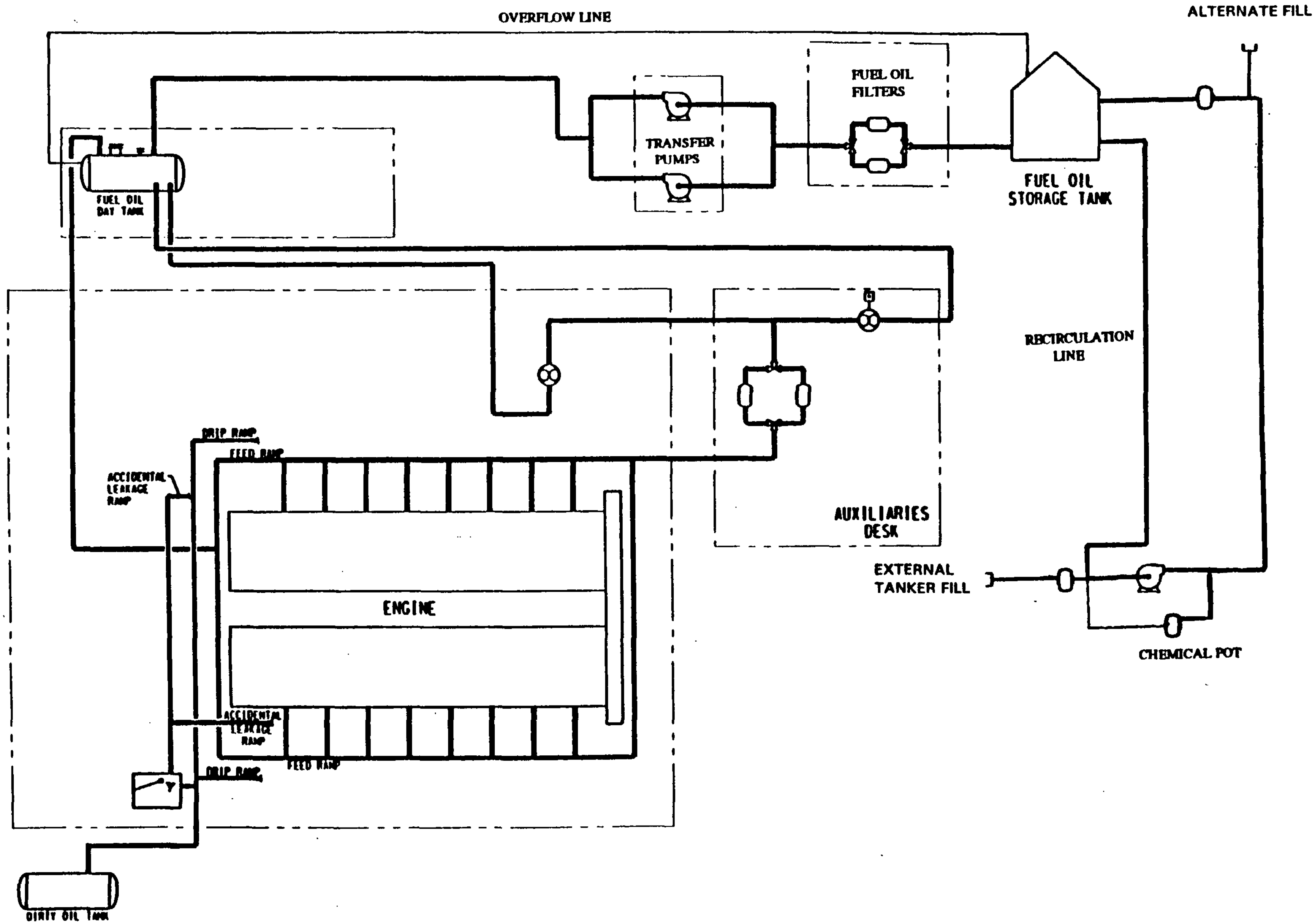

FIGURE 3-6 DIESEL GENERATOR , OIL STORAGE AND TRANSFER SYSTEM
(SHOWN FU.. SINGLE ENGINE)

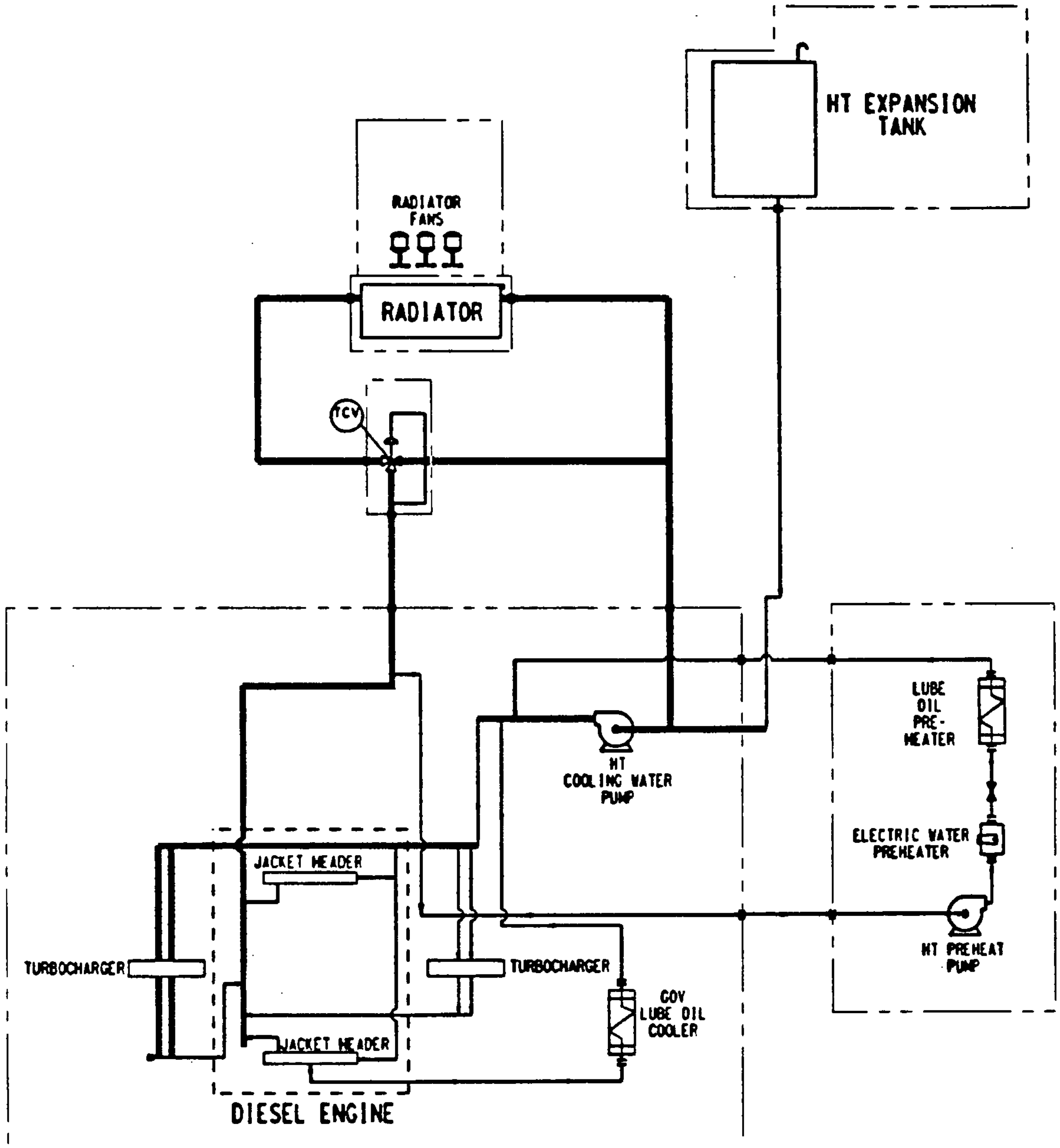

FIGURE 3-7 DIESEL GENERATOR HT COOLING WATER SYSTEM
(SHOWN FOR SINGLE ENGINE)

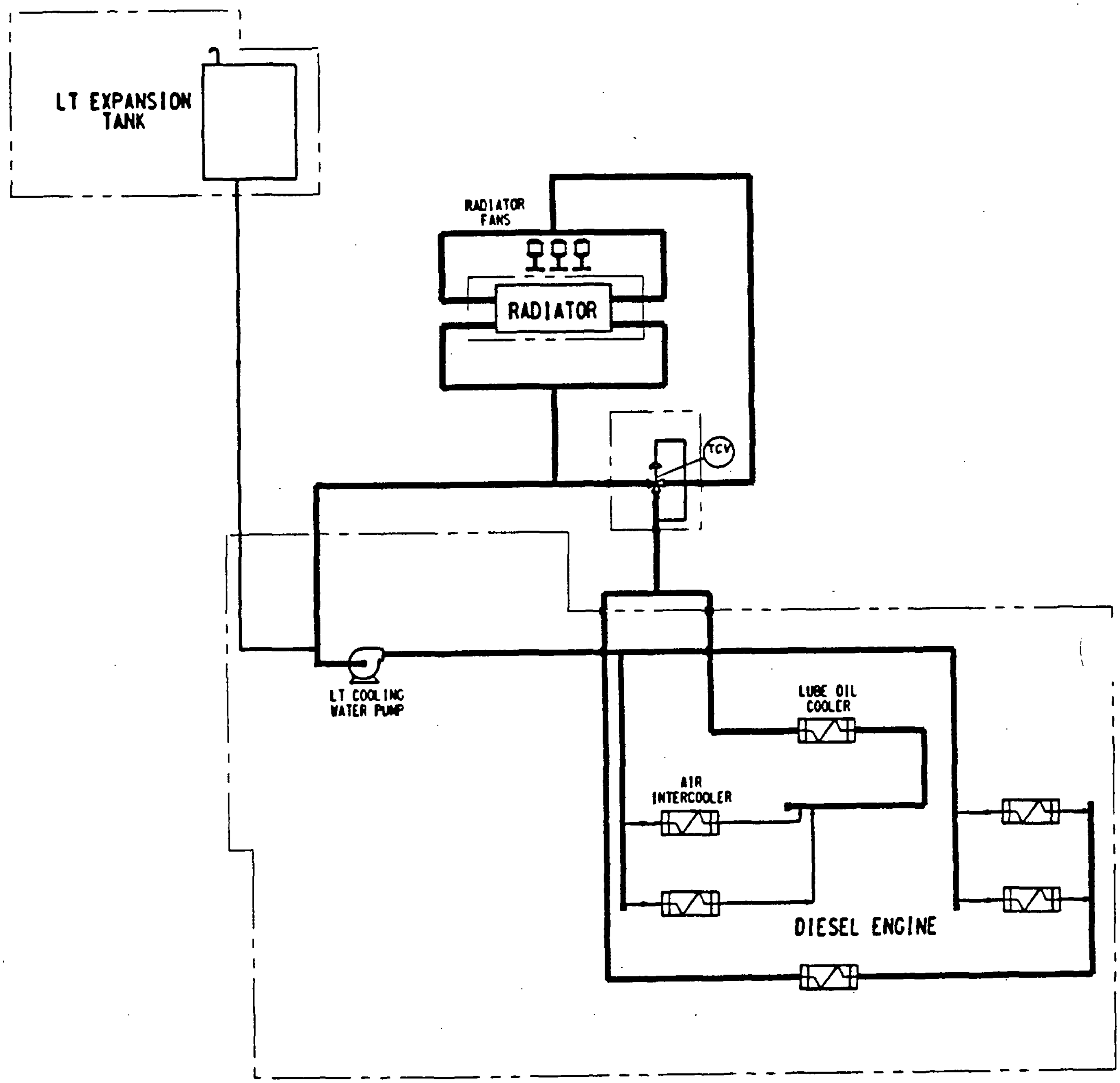

FIGURE 3-8 DIESEL GENERATOR LT COOLING WATER SYSTEM
(SHOWN FOR SINGLE ENGINE)

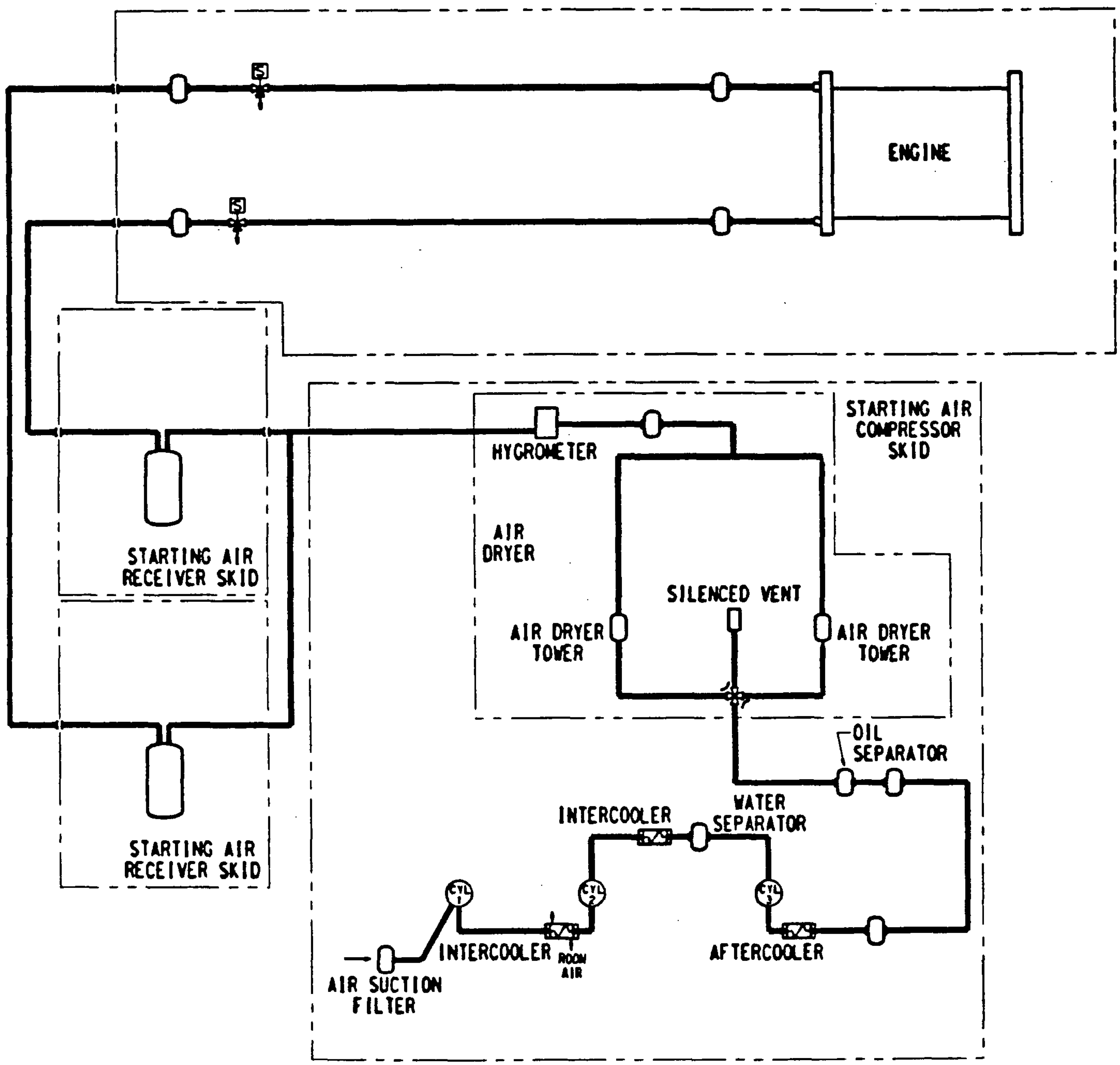

FIGURE 3-9 DIESEL GENERATOR STARTING AIR SYSTEM
(SHOWN FOR SINGLE ENGINE)

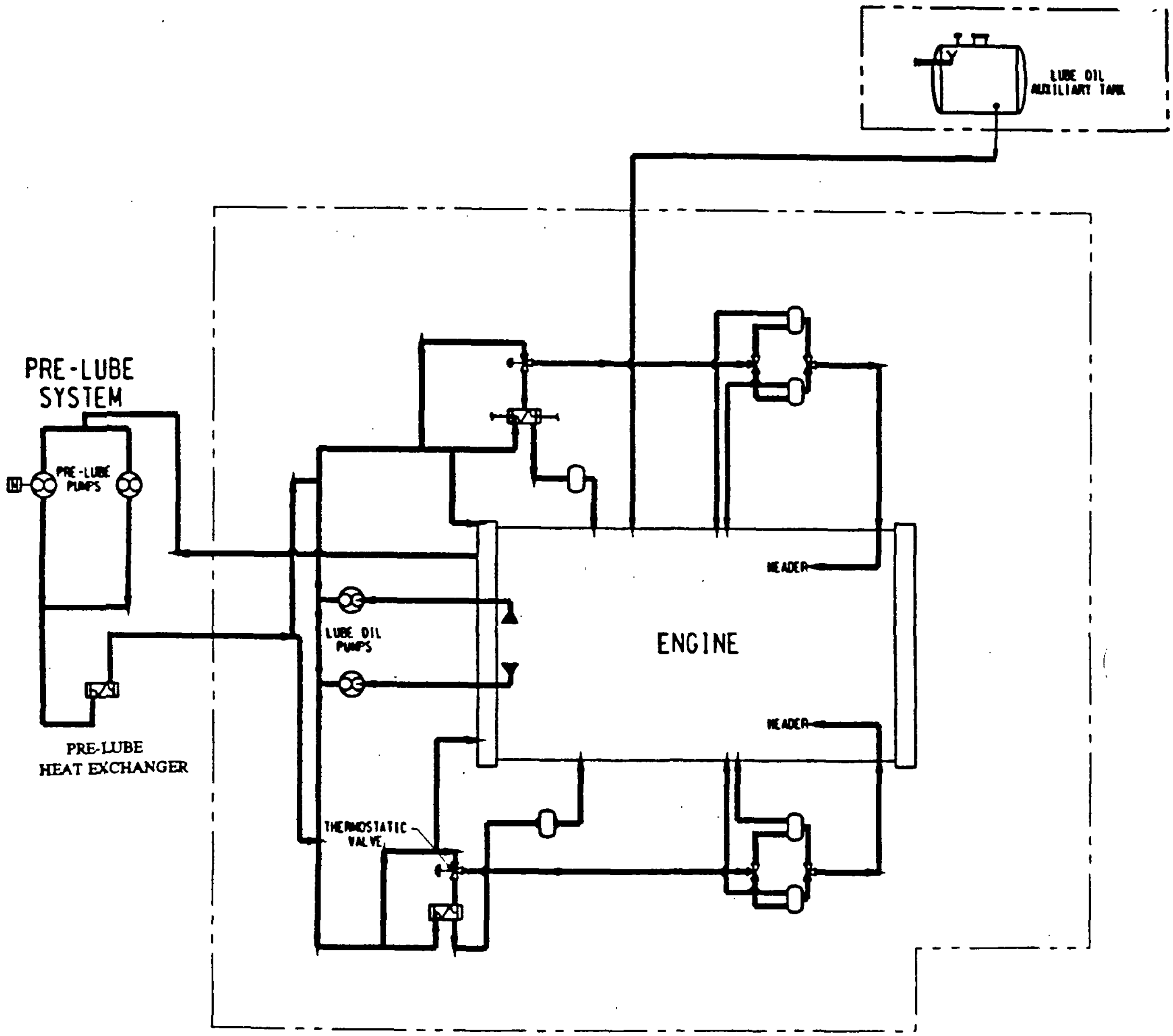

FIGURE 3-10 DIESEL GENERATOR LUBE OIL SYSTEM
(SHOWN FOR SINGLE ENGINE)

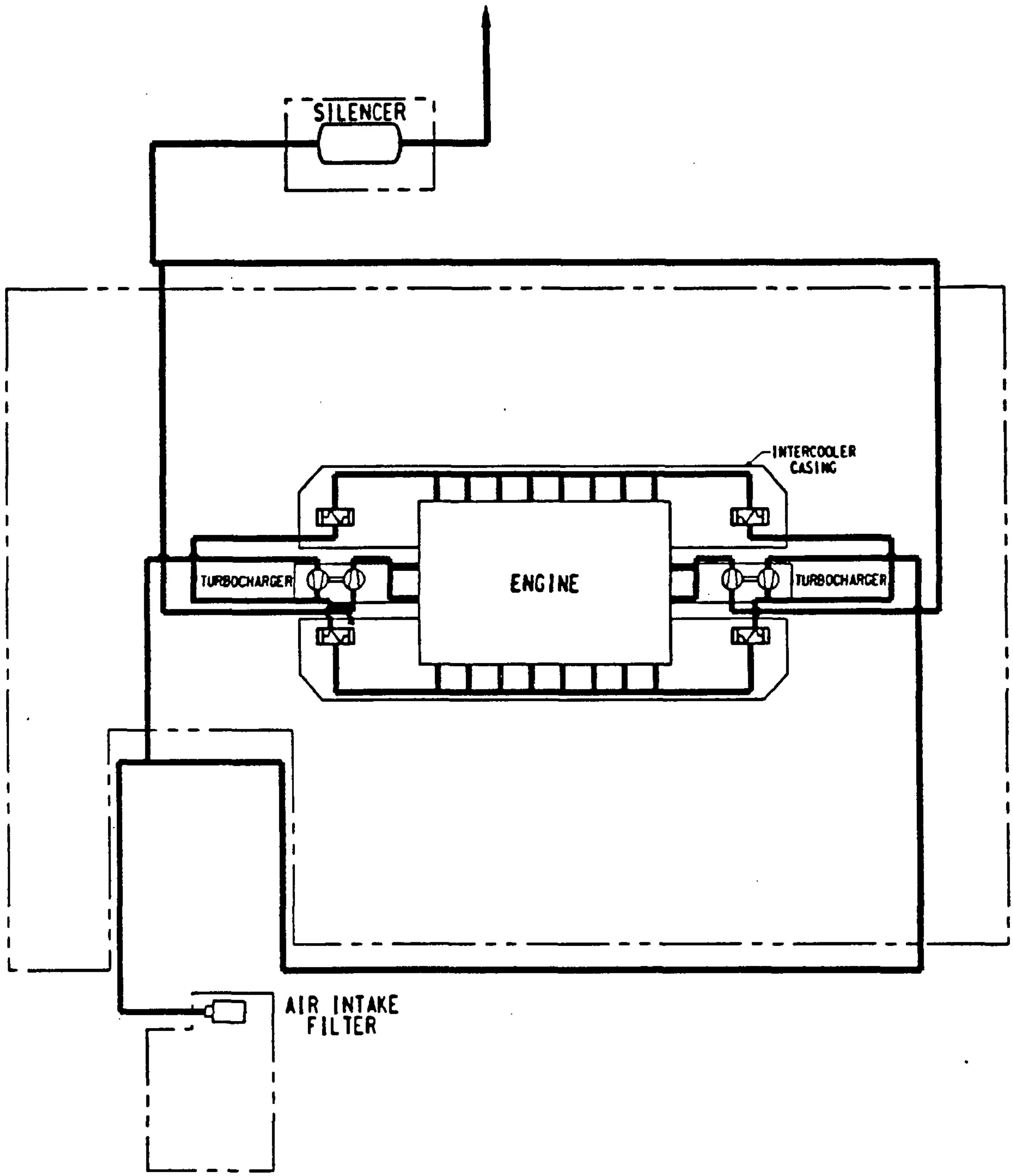

FIGURE 3-11 DIESEL GENERATOR COMBUSTION AIR INTAKE AND EXHAUST SYSTEM (SHOWN FOR SINGLE ENGINE)

4.0 DIESEL GENERATOR BUILDING SUPPORT SYSTEMS

4.1 DESCRIPTION OF THE BUILDING

The Diesel Generator Building is designed to be a three-story, rectangular, reinforced concrete structure approximately 75-feet by 97-feet in plan, excluding the east end entry ports. The corners of the building are tapered 15 feet to increase the available area on the east and west walls. This allows wall surfaces to function as both baffle areas for building ventilation and radiator cooling, as well as structural shear walls. The building is nominally 60-feet in height and is supported on a mat foundation at grade with a partial basement in the area of the diesel generator pedestal. In addition, a 20-foot high, one-story structure is provided on the east side of the buildings as missile protection for the main building entry and diesel generator area exhaust louver.

The building is divided into three isolated sectors. One two-story sector encloses the diesel generator fuel oil storage tank and fuel oil day tank. The first floor of the second sector houses the Diesel Generator Building Control Room and the Electrical Switchgear Room. The second floor of this sector houses the Battery Room a Non-1E Electric Panel Room and a Future Expansion Room. The first floor of the third sector houses the diesel generator in the partial basement (diesel generator pit). The second floor of the third sector houses the Maintenance Shop and the Fan Room. The third floor of the building houses the water-to-air radiators for the diesel generator cooling systems. Preliminary plan drawings for the Diesel Generator Building are shown in Figures 3-1 through 3-4.

4.2 COMPRESSED AIR SYSTEM (MAINTENANCE)

4.2.1 DESIGN BASES

- The compressed air system provides a means of supplying compressed air at a service connection located on each floor of the Diesel Generator Building.

- The diesel generator auxiliary systems are designed such that no safety-related equipment relies upon the compressed air system to perform a safety function.

4.2.2 SYSTEM DESCRIPTION

A maintenance compressed air system is provided for the Diesel Generator Building. This system is completely independent of the air system used to start the diesel generator. The system consists of a connection for a portable air compressor and piping leading to a service connection on each floor of the building. The system will provide the ability to distribute compressed air for use on each floor of the building. The air compressor will be connected to the system when maintenance air is required.

4.3 DIESEL GENERATOR BUILDING HEATING AND VENTILATION SYSTEM (HVAC)

The Diesel Generator Building's HVAC system functions to remove heat from the building when the diesel generator is either in standby or in operation, to assist in maintaining the diesel generator within the manufacturer's recommended temperatures and to supply sufficient heat for personnel occupancy when the diesel is not operating. The HVAC system is divided into safety-related and non-safety-related subsystems. A simplified drawing of the Diesel Generator Building HVAC system is shown in Figure 4-1.

The non-safety-related ventilation is provided by two air handling units (AHUs). One AHU supplies ducted ventilation to the Diesel Generator Building Control Room, Battery Room, 1E Switchgear Room and non-1E Electrical Panel Room. The second AHU provides ducted ventilation to the Maintenance Shop, hallway and Future Expansion Room.

The safety-related portion of the HVAC system provides ventilation to the Diesel Generator Building Control Room, Battery Room, Diesel Generator Room, 1E Switchgear Room and non-1E Electrical Panel Room. A simplified drawing of the safety-related portion of the Diesel Generator Building HVAC system is shown in Figure 4-2.

The Diesel Generator Building's safety-related supply fan supplies air through ducting used by a non-safety-related air handling unit. Motor-operated dampers isolate safety-related and non-safety-related portions of the HVAC system.

4.3.1 DESIGN BASES

- The HVAC system is designed on the basis of limiting the minimum and maximum building temperatures to those listed in Table 4-1 when the diesel generator is operating. The building is ventilated with 100 percent outside air at the summer design temperature of 95°F. When the outside temperature drops toward the winter design temperature of 0°F, the HVAC system either employs a combination of recirculated and outside air or reduces the supply of outside air into the building by means of fans equipped with variable pitch blades.

- When the diesel generator is not running, the non-safety-related subsystems limit the minimum and maximum building temperatures to those listed in Table 4-1 and ventilate the building as required to allow for maintenance and personnel access.

- Safety-related portions of the Diesel Generator Building HVAC systems are designed to remain functional during and after a safe shutdown earthquake (SSE). The failure of the non-safety-related, non-seismic HVAC equipment/ductwork will not compromise any safety-related systems, structures or components.

4.3.2 System Description

During normal plant operation, the diesel generator is not in operation. A non-safety-related AHU provides summer cooling to the Diesel Generator Building Control Room, Battery Room, 1E Switchgear Room and non-1E Electrical Panel Room using a constant volume direct-expansion cooling system (air conditioning). Using an economizer cycle, outdoor air and return air are mixed and provided to the above mentioned rooms. These rooms are provided with duct-mounted electric heaters for winter temperature control. A non-safety-related fan provides building air recirculation and system exhaust.

The Diesel Generator Room, Diesel Generator Fan Room and trench below the Diesel Generator Room are cooled in the summer using outdoor air. During winter, the supply air is tempered to 50°F. Using an economizer cycle, outdoor air and recirculated air are mixed in the Diesel Generator Fan Room before entering the diesel generator supply fans. Exhaust from these rooms is accomplished via a safety-related damper in the Diesel Generator Room.

The Maintenance Shop, hallway and Future Expansion Room are cooled in the summer using a mixture of outdoor air and recirculated air drawn from the Diesel Generator Fan Room. Outdoor air and recirculated air are mixed in the Diesel Generator Fan Room before entering the AHU. In the winter, this mixing tempers the air to approximately 50°F. Exhaust from these rooms is accomplished by a non-safety-related exhaust fan which draws air from the Maintenance Shop.

During diesel generator operation, a safety-related fan provides ventilation to the Diesel Generator Building Control Room, Battery Room, 1E Switchgear Room and non-1E Electrical Panel Room using only outdoor ambient air. The safety-related fan shares common ductwork with one of the non-safety-related AHUs to supply air to these rooms. The shared ductwork is safety-related and is isolable from non-safety-related HVAC components by safety-related motor-operated dampers and safety-related backdraft dampers. Each of the rooms of this system is provided with a duct-mounted electric heater for winter temperature control. A safety-related fan provides exhaust for these spaces via the Diesel Generator Room. In the summer, the safety-related portion of the system operates near its full capacity using 100 percent outdoor air. In the winter, as the outside temperature drops toward the design temperature of 0°F, the system flow is reduced by employing variable pitch control on the supply and exhaust fans.

The stairwell in the Diesel Generator Building is ventilated and pressurized by a non-safety-related fan. This fan is designed to maintain a positive pressure to ensure the stairwell is not obscured by smoke during a fire.

The Battery Room is continuously exhausted by a safety-related exhaust fan to ensure that hydrogen accumulation remains within the limits specified by IEEE 484-1987.

The Fuel Oil Storage Tank Room is exhausted by a non-safety-related exhaust fan. Supply air to the room is drawn from the Diesel Generator Fan Room.

Due to the flow of outdoor air required to cooling the HT and LT cooling system forced draft radiators during operation of the diesel generator, the environment on the third floor is uncontrolled. Normally, operation of the HVAC system provides ventilation on the third floor. During diesel generator operation, ventilation on the third floor is provided by circulation from the forced draft radiator fans.

Components mounted in safety-related ducting (e.g., fans, heaters and dampers) are sasfety-related.

The removal of smoke from the Diesel Generator Building is accomplished by ventilation exhaust fans assisted by the use of portable fans. Operator action is required to shut down the HVAC system during a fire.

4.3.3 COMPONENT DESCRIPTION

Safety-Related Supply Fan

A 100 percent capacity, safety-related supply fan is provided for the Diesel Generator Building. System cleanliness is maintained by a rough filter bank upstream of the fan. The safety-related fan discharge is connected in parallel with a non-safety-related AHU and provides air to the Battery Room, non-1E Electrical Panel Room, 1E Switchgear Room and Diesel Generator Building Control Room. Both the safety-related fan and the non-safety-related AHU share common ductwork to supply these rooms. Interlocks are provided to ensure that both the safety-related fan and the non-safety-related AHUs cannot operate at the same time. Isolation between the safety-related and non-safety-related portions of the system is accomplished by safety-related motor-operated dampers and backdraft dampers. The safety-related fan can be started either manually or automatically. The safety-related fan is automatically started by the following signals:

1) A safety injection actuation signal (SIAS)

2) A 4.16 kV Emergency Bus undervoltage signal

Control of the safety-related fan and the non-safety-related AHU will be discussed in more detail in the Instrumentation and Controls Design Report.

The safety-related fan provides cooling to the Diesel Generator Building by using only outdoor air. The fan is equipped with temperature controlled variable pitch blades to control the air quantity delivered to the rooms serviced. As the temperature of the exhaust from rooms changes, the quantity of air supplied by the system is varied in order to maintain room temperatures within the required limits. This arrangement permits economical operation while preventing overcooling during the winter. A variable pitch, safety-related exhaust fan operates in conjunction with the variable pitch safety-related supply fan to provide ventilation exhaust and to assist in controlling the pressurization of the spaces served by the safety-related supply fan.

Non-Safety-Related Air Handling Units

Two non-safety-related AHUs are provided for the Diesel Generator Building. One, located on the third floor near the safety-related fan, consists of a filter, a direct expansion cooling coil and a constant volume fan which delivers conditioned air to the Diesel Generator Building Control Room, 1E Switchgear Room, non-1E Electrical Panel Room and Battery Room. This non-safety-related AHU and its condensing unit operate continuously when the diesel generator is not in operation. If normal power is available to the non-safety-related AHU, it may be operated when the diesel generator is operating. AHU startup is performed manually and it can be shutdown either manually or automatically.

The second non-safety-related AHU is located in the Diesel Generator Fan Room. This AHU is a constant volume system which is composed of a rough filter and a fan. It provides air to the Maintenance Shop area, hallway and Future Expansion Room. This non-safety-related AHU operates at all times when the diesel generator is not in operation. If normal power is available, it may also be operated when the diesel generators are operating. Startup and shutdown of the unit is performed manually. The AHU provides cooling and ventilation using only outside air. However, in the winter, a mixture of outdoor air and recirculated air drawn from the Diesel Generator Fan Room is used. An exhaust fan provides for exhaust of air from the system.

The non-safety-related AHUs normally operate when the diesel generator is shut down. Upon the receipt of either a SIAS or a 4.16 kV emergency bus undervoltage signal, the non-safety-related portion of the HVAC system is disabled. When testing the diesel generator from the Main Control Room, the non-safety-related air handling unit is not stopped by a manual fast or slow start signal. The non-safety-related AHU and safety-related fan are interlocked to prevent both systems from operating simultaneously.

Alarms

When an alarm condition exists in the HVAC system, the affected instrument signals an alarm on an annunciator panel in the Diesel Building Control Room. The alarm at the annunciator panel also initiates a common trouble alarm in the Main Control Room to alert operators to the problem. The annunciator in the Main Control Room only provides a general trouble alarm. The annunciator panel in the Diesel Generator Building Control Room must be checked to determine which indication is alarming.

Diesel Generator Room Supply Fans

As many as four fixed-volume, safety-related fans operate whenever the diesel generator is in operation. Each fan is equipped with a manual on-auto-off switch and may be started either manually or automatically. When placed in automatic, the fans are individually thermostatically-controlled so that the number of fans in operation provide sufficient air flow to meet the Diesel Generator Room's cooling requirements without overcooling. When the diesel generator is not in operation, one fan is normally operated for ventilation. Outdoor air and recirculated air are mixed in the Diesel Generator Fan Room to provide a selected supply air temperature.

Maintenance Shop Exhaust Fan

This non-safety-related fan provides for exhaust of air from the hallway, Future Expansion Room and Maintenance Shop.

Stairwell Pressurization Fan

The stairwell pressurization fan normally operates continuously during all modes of operation and has a manual on-auto-off switch. In the "auto" position, the stairwell fan is interlocked to start upon receipt of a fire alarm signal in the building. A flow alarm is provided to signal low airflow.

Battery Room Exhaust Fan

The Battery Room is equipped with a safety-related exhaust fan which operates continuously during all modes of operation and has a manual on-off switch. A low-flow alarm is provided to signal low exhaust airflow.

Miscellaneous Fans

A manually controlled non-safety-related fan is installed to provide ventilation air for the Fire Protection Deluge Valve Enclosure and the Oil Separator Room. The fan circulates air from the Diesel Generator Room through these spaces for ventilation.

The Fuel Oil Tank Room is equipped with a non-safety-related exhaust fan which is manually controlled. A low-flow alarm is provided.

Electric Heaters

A safety-related, duct-mounted heater preheats the outdoor air from the safety-related supply fan. Safety-related, duct-mounted electric heaters are provided in the supply ducts for the Battery Room, 1E Switchgear Room, Diesel Generator Building Control Room and non 1E Electrical Panel Room. These heaters provide individual temperature control for spaces which contain safety-related equipment or which are likely to be occupied at times when the diesel generator operates. Each duct-mounted heater is controlled by a wall-mounted thermostat in the room served. High- and low-temperature alarms are provided for the Battery Room, 1E Switchgear Room, Diesel Generator Building Control Room and the Diesel Generator Room. The temperature alarm for the Battery Room is consistent with those approved for use in the battery rooms for existing diesel generators. In addition to the duct-mounted heater, the Battery Room also has a safety-related unit heater for supplemental heat.

Non-safety-related electric unit heaters provide supplemental heat for the Fuel Oil Storage Tank Room, Diesel Generator Fan Room, Diesel Generator Room and trench, Oil Separator Room, Fire Protection Deluge Valve Enclosure, Future Expansion Room, hallway, Maintenance Shop and the Stairwell. Each electric heater is individually controlled by its own thermostat.

Motor-Operated Dampers

Motor-operated dampers are provided to control air flows automatically and to isolate portions of the HVAC system as required.

Safety-related motor operated isolation dampers are provided on the discharge of both the safety-related fan and the non-safety-related AHU. These dampers isolate the AHU (or fan) which is not in operation. These dampers fail in a position that isolates the non-safety-related AHU from the safety-related ducting.

Backdraft Dampers

Backdraft dampers are provided to prevent undesirable backflow in the system or to isolate various portions of the system. A backdraft damper is provided in the transfer duct between the Diesel Generator Fan Room and the Fuel Oil Storage Tank Room to prevent system backflow. When the non-safety-related AHU is not in operation, a safety related backdraft damper isolates the suction of the non-safety-related AHU from the suction of the safety-related fan. In addition, a backdraft damper prevents hot air from being drawn from the hot side of the radiators into the hallway, Future Expansion Room and Maintenance Shop areas. Backdraft dampers are also provided on each of the diesel generator room supply fans to prevent backflow.

Manual Dampers and Fire Dampers

Manual, locking-type volume control dampers are provided throughout the system to provide for system balancing. Automatic fire dampers are provided in penetrations of fire-rated barriers.

Tornado Dampers and Relief Dampers

Tornado and relief dampers are installed in the system to accommodate the rapid depressurization that accompanies a tornado. Tornado and relief dampers contain the pressure so that other equipment within the structure will not be damaged or allow the affected ductwork or room to relieve its relatively higher pressure without being damaged.

Ductwork from the first and second floors of the Diesel Generator Building is routed through the third floor. Since the third floor will de-pressurize during a tornado, these ducts could be subjected to a negative 3 psi differential pressure during the transient. In order to prevent damaging the HVAC system, relief dampers are provided in any ductwork located on the third floor which is not normally vented to the third floor.

Tornado dampers are installed at each location where HVAC ductwork penetrates the third floor and on exterior wall HVAC penetrations below the third floor.

4.4 FIRE PROTECTION SYSTEM

This section describes the methods used to detect and protect against fires in the Diesel Generator Buildings. Fire protection systems for the Diesel Generator Buildings are designed to meet the requirements of 10 CFR 50.48, Appendix R to 10 CFR 50 and applicable National Fire Protection Association (NFPA) requirements. The intent of applicable guidelines outlined in Branch Technical Position CMEB 9.5-1 were met. Five positions of CMEB 9.5-1 require further clarification regarding the Diesel Generator Building design:

- Section C.5.a.(5) of Branch Technical Position CMEB 9.5-1 states that "Door openings in fire barriers should be protected with equivalently rated doors, frames and hardware that have been tested and approved by a nationally recognized laboratory." In general, this section of the Branch Technical Position is met for door openings in fire barriers. However, exterior doors required to provide both missile protection and withstand the tornado 3 psi differential pressure will not be fire rated. Due to their size, it is not standard industry practice to test these doors. Rather, these doors will be certified for use in the fire barrier in accordance with the requirements of NFPA 80.

- Section C.5.f.(1) of Branch Technical Position CMEB 9.5-1 states that ". . . Smoke and corrosive gasses should generally be discharged directly outside to an area that will not affect safety-related areas. The normal plant ventilation system may be used for this purpose if capable and available. To facilitate manual firefighting, separate smoke and heat vents should be provided in specific areas such as cable spreading rooms, diesel fuel oil storage areas, switchgear rooms and other areas where the potential exists for heavy smoke conditions." The SACM diesel generator is housed in its own stand alone, Category I building. A fire within the Category I Diesel Generator Building is assumed to disable its diesel generator and render it inoperable. Smoke and heat will not impact redundant equipment required to shutdown the affected reactor after the fire.

- Section C.5.f.(3) of Branch Technical Position CMEB 9.5-1 states that "Special protection for ventilation power and control cables may be required. The power supply and controls for mechanical ventilation systems should be run outside the fire area served by the system, where practical." The SACM diesel generator is located within a separate Category I building serviced by its own HVAC system. No other special precautions are required.

- Section C.7.i of Branch Technical Position CMEB 9.5-1 states that automatic fire suppression should be installed to combat any diesel generator or lubricating oil fires and that such systems should be designed for operation when the diesel is running without affecting the diesel. A fire in the Diesel Generator Room that would require sprinkler spray on the diesel generator is assumed to cause damage to its supporting auxiliary systems and render the diesel generator inoperable. Special features are included in the design of the preaction suppression system to ensure water is only sprayed in the building in the event of an actual fire. Failure of a single smoke or heat detector will not cause an inadvertent initiation of the preaction suppression system. In addition, the preaction suppression systems downstream of the deluge valves are designed to remain dry until receipt of a fire signal. A pipe crack downstream of the deluge valves or an opening of a sprinkler will not actuate a deluge valve nor allow water to spray on the diesel generator.

- Section C.7.j of Branch Technical Position CMEB 9.5-1 specifies that above-ground fuel oil storage tanks should be located at least 50 feet away from any building containing safety-related equipment. The fuel oil storage tank for the SACM diesel generator is housed within a separate three hour fire rated enclosure inside the Diesel Generator Building. The location of the fuel oil storage tank is described in Section 2.5.

The mechanical portions of the Diesel Generator Building's fire protection system are described in this design report. Fire protection for cable trays, conduit, communication equipment and fire protection lighting are described in the Electrical Design Report.

4.4.1 DESIGN BASES

- Loss of power or system trouble conditions shall not cause the automatic release of water nor cause a tripped deluge valve to close. The fire and smoke detection system will be used to identify the location of the fire, initiate an alarm and trip the appropriate preaction system.
- A pipe crack downstream of the deluge valves or an opening of a sprinkler will not actuate a deluge valve nor allow water to flood the Diesel Generator Building.
- Failure of one smoke or heat detector will have no adverse effect on the remaining portions of the detection system.

4.4.2 SYSTEM DESCRIPTION

The mechanical portions of the diesel generator fire protection system consist of preaction fire suppression systems, fire and smoke detectors, a standpipe system, fire extinguishers and fire-barrier walls. A simplified drawing of portions of the fire protection system for the Diesel Generator Building is shown in Figure 4-3.

The active fire protection systems include the following:

- Six zone detection system
- Three preaction suppression systems
- Standpipe system and hose stations
- Portable fire extinguishers

Fire detectors are supplied and located in accordance with NFPA 72E and NFPA 90A. The automatic functions of the fire protection system are controlled by a local control panel.

The Diesel Generator Building is equipped with three automatic preaction sprinkler systems. Each preaction sprinkler system is provided with a deluge valve, a downstream check valve (if required for the design of the deluge valve), a main drain connection and isolation valve, auxiliary drains and valves and fusible-link sprinkler heads. In addition alarm test connections, inspector test connections, pressure gauges, flow alarm pressure switches, low air pressure switches, electric and manual flow mechanisms, flushing connections, piping and fittings are provided.

During normal plant operation, the preaction sprinkler system is wet up to the deluge valves of the three preaction suppression systems. The three preaction suppression systems downstream of the deluge valves are designed to remain dry until receipt of a fire signal. Upon receipt of an automatic signal from the fire detection system, the appropriate deluge valve opens and water flow is initiated through the preaction suppression system sprinkler heads to extinguish the fire. The deluge valves can also be actuated by manual action. The water for the diesel generator fire protection system is supplied from an underground fire main.

The preaction suppression systems are pressurized with air until they are needed to extinguish a fire. Pipe breaks or system leaks are identified through system air pressure drops. A low pressure alarm is provided for the dry portions of the system to alert operators to a decreasing pressure condition. Preaction system leaks can, therefore, be detected and corrected without causing water damage to nearby safety-related equipment. Loss of preaction system air pressure will not actuate the deluge valve.

Fire suppression water discharged in the Diesel Generator Building will flow to the Trench Area sump through the grating and building drainage system. Assuming the largest sprinkler system flow and two hose stations (approximately 1400 gpm total flow) being discharged for 30 minutes, the water level in the Trench Area will accumulate to approximately 3.4 feet above the Trench Area floor. No safety-related components associated with the redundant diesel generator would be affected by this standing water. When the fire is extinguished and the preaction sprinkler system is isolated, the water is then removed from the Trench Area by use of the submersible sump pump and portable pumps.

In addition to the preaction suppression system, a standpipe system is provided in accordance with the requirements of NFPA 14. This system is installed to supply hose stations suitable for safe and effective use on identified hazards and involved equipment. The standpipe system is arranged such that every portion of the Diesel Generator Building can be reached by a 100-foot hose which delivers a 30-foot stream of water.

4.4.3 Component Description

Automatic Fire Suppression System

An automatic fire suppression system is provided for use in the Diesel Generator Building in accordance with the requirements of NFPA 13. Each preaction system is also provided with a supervisory air connection for the piping network, complete with a pressure regulating device, air compressor and associated trim pipe and valves. Piping for the fire suppression system is fabricated in accordance with ASTM A 106 or ASTM A 53.

Deluge Valves

The deluge valve is a solenoid actuated valve installed in the main supply to each preaction sprinkler system. The deluge valve perform three functions:

- The valve holds back water, keeping it from flowing into the preaction sprinkler system until such a time that the local control panel sends an opening signal.

- The valve provides a means to supervise the preaction system piping. By maintaining downstream piping dry, preaction suppression air pressure can be monitored to determine the presence of piping leaks without causing any water damage.

- The valve actuates an alarm on the local control panel when the water flows into the preaction sprinkler system.

Standpipe System

The Diesel Generator Building is provided with a standpipe system. A hose rack assembly with 100 feet of 1-1/2-inch hose and 1-1/2-inch adjustable fog nozzle is provided on each floor near the stairwell entrance. Additionally, a 2-1/2-inch hose connection is provided at each floor level inside the stairwell for fire brigade use. The standpipe system is designed and sized to provide the flow rate and pressure required for effective hose streams at the most remote hose station. Standpipe system piping is fabricated in accordance with ASTM A 106 or ASTM A 53.

Local Control Panel

The local control panel receives signals from various smoke and heat detectors and then sends a signal to the appropriate deluge valve(s) to open. The panel also incorporates audible and visual annunciating features for alarm and trouble indication of each suppression system and detection zone. Although the local control panel is not a redundant, safety-related component, it does include a battery backup in accordance with NFPA 72 requirements.

Failure of the smoke or heat detectors is indicated by a trouble signal on the local control panel. Additionally, a signal will be sent from the local control panel to the Main Control Room, actuating a local control panel alarm in the Main Control Room. The alarm in the Main Control Room is only for the local control panel; a check of the local control panel is required to determine which detector alarmed.

Fire Protection Deluge Valve Enclosures

The Fire Protection Deluge Valve Enclosure contains the deluge valves for the three suppression systems. Failure of the piping in the room and upstream of a deluge valve will cause water to flow into the Fire Protection Deluge Valve Enclosure. Water leakage in the Fire Protection Deluge Valve Enclosure flows into a dedicated floor drain which dumps directly into the storm drain system. This ensures that any leakage is directed away from safety-related equipment.

Fire Extinguishers

The fire extinguishers are provided in accordance with NFPA 10. Two types of extinguishers are provided: dry chemical (multi-purpose) and carbon dioxide. Both types are hand-held and are supplied with brackets for wall mounting.

Fire Detection

The fire detection system is available during all modes of normal and emergency operation and is separated into six detection zones. The fire detection system identifies the zone of the fire and activates the appropriate preaction suppression system. It is powered from the local control panel. Table 4-2 describes the area covered by each detection zone.

Smoke detection systems are provided to detect smoke at an early stage of a fire. Fire and smoke detection consists of heat detectors and smoke detectors. Table 4-3 describes the detection methods for each detection zone.

- Smoke Detector - A light source and a photoelectric sensor are arranged such that smoke particles scatter light onto the sensor, causing the sensor to respond.
- Heat Detector - Fire detectors are rate compensated devices which respond when the surrounding air temperature reaches a predetermined level, regardless of the rate of temperature rise.

Fire Barrier Walls and Penetrations

Walls, floors, roofing, doors and structural framing used to construct the Diesel Generator Building will comply with 10 CFR 50.48, Appendix A to 10 CFR Part 50, Branch Technical Position CMEB 9.5-1 and the Southern Building Code. Structures, systems and components which are required to be fire rated art constructed of rated materials and tested in accordance with the requirements of ASTM E 119. The location and rating of fire barriers in the Diesel Generator Building are shown in Figures 4-4, 4-5, 4-6, 4-7 and 4-8.

Piping penetrations and openings (through walls, floors and roofs which are designed for fire protection) are protected to maintain the fire rating of the penetrated SSCs.

4.5 COOLANT DRAIN AND DEMINERALIZED WATER SYSTEMS

4.5.1 DESIGN BASES

- The demineralized water system provides demineralized water for makeup to the safety-related diesel generator HT and LT cooling systems. The capacity of the demineralized water system is sufficient to supply the anticipated normal makeup demand for both cooling systems.
- The coolant drain system provides a means to drain and recharge the HT and LT cooling water systems.
- The diesel generator HT and LT cooling systems are designed such that the demineralized water system is not relied upon to perform any safety function.

4.5.2 SYSTEM DESCRIPTION

The non-safety-related demineralized water system consists of a coolant mixing tank, a glycol fill pump and a coolant mixing tank pump. The non-safety-related coolant drain system consists of a coolant drain tank and a coolant drain tank pump. The Diesel Generator Building is provided with its own coolant drains and demineralized water systems. A simplified drawing of the demineralized water system is shown in Figure 4-9.

Demineralized water is supplied to the coolant mix tank from the site demineralized water system (Demineralized Water Pump No. 11 or 12) to the coolant mixing tank. Glycol base antifreeze is then added to the mixing tank to produce an engine coolant mixture of demineralized water and a glycol base antifreeze. The coolant mixing tank pump is used to thoroughly mix the coolant before replenishing the HT and LT coolant system expansion tanks.

The diesel generator demineralized water system includes provisions for collecting used coolant. Due to the glycol base antifreeze content of the cooling water, HT and LT coolant is collected in the coolant drain tank when the system is drained. When the coolant drain tank is full, the coolant drain tank pump is used to pump the used coolant outside the Diesel Generator Building to a truck for offsite disposal or through a filter to be reused if it meets the proper chemistry requirements.

4.5.3 Component Description

Coolant Drain Tank

The coolant drain tank collects coolant from the HT and LT cooling water systems. Used coolant is either reused or transferred to a tanker truck. The coolant drain tank has the capacity to completely drain the coolant from both diesel engines.

Coolant Mixing Tank

The diesel generator demineralized water system has a coolant mixing tank which can be used to supply makeup coolant to any of the four expansion tanks associated with the diesel generator cooling system.

Coolant Mixing Tank, Glycol Fill and Coolant Drain Pumps

Three pumps are used to supply glycol-water coolant and collect waste coolant from the diesel generator cooling systems.

Fabrication Codes

Description	Fabrication Code
All interconnecting piping, valves and pumps	ASME B31.1
Coolant mixing tank	ASME VIII (unstamped)
Coolant drain tank	ASME VIII (unstamped)

TABLE 4-1

DESIGN INTERIOR TEMPERATURE RANGES
FOR THE DIESEL GENERATOR BUILDING

Area	Maximum Temperature	Minimum Temperature
Battery Room	104°F	69°F
1E Switchgear Room	104°F	50°F
Diesel Generator Building Control Room	104°F	60°F
All Other Rooms Below the Third Floor	120°F (Note 1)	50°F (Note 2)
Third Floor	104°F (Note 3)	0°F

Note:
1) The hallway, Maintenance Shop and Future Expansion Room may reach a maximum temperature of 150°F when the diesels are in operation.

2) Minimum temperature may be lower in the Fuel Oil Storage Tank Room, hallway, Maintenance Shop and the Future Expansion Room during diesel operation under accident conditions concurrent with design basis winter temperatures.

3) Downstream of the radiators on the third floor, the maximum design temperature may reach 140°F during diesel operation.

TABLE 4-2

DETECTION AND SUPPRESSION AREAS OF COVERAGE

Preaction System	Detection System	Area of Coverage
1	Z1	Third Floor
2	Z2	Diesel Generator Room Trench Area Oil Separator Room
2	Z3	Diesel Generator Fan Room Hallway and Maintenance Shop
3	Z4	1E Switchgear Room Diesel Generator Building Control Room
3	Z5	Non-1E Electrical Panel Room Future Expansion Room Battery Room
4	Z6	Fuel Oil Storage Tank Room

Note: Plan views of the Diesel Generator Building are shown in the Civil Engineering Design Report.

TABLE 4-3

FIRE AND SMOKE DETECTION

Detection Zone	Type of Detection	Approximate No. of Detectors	Temperature Limit °F
Z1	Rate Compensated Heat	17	196
Z2	Rate Compensated Heat	11	160
Z3	Rate Compensated Heat	7	160
Z4	Photoelectric Smoke	6	N/A
Z5	Photoelectric Smoke Rate Compensated Heat	5 1	N/A 160
Z6	Rate Compensated Heat	4	160

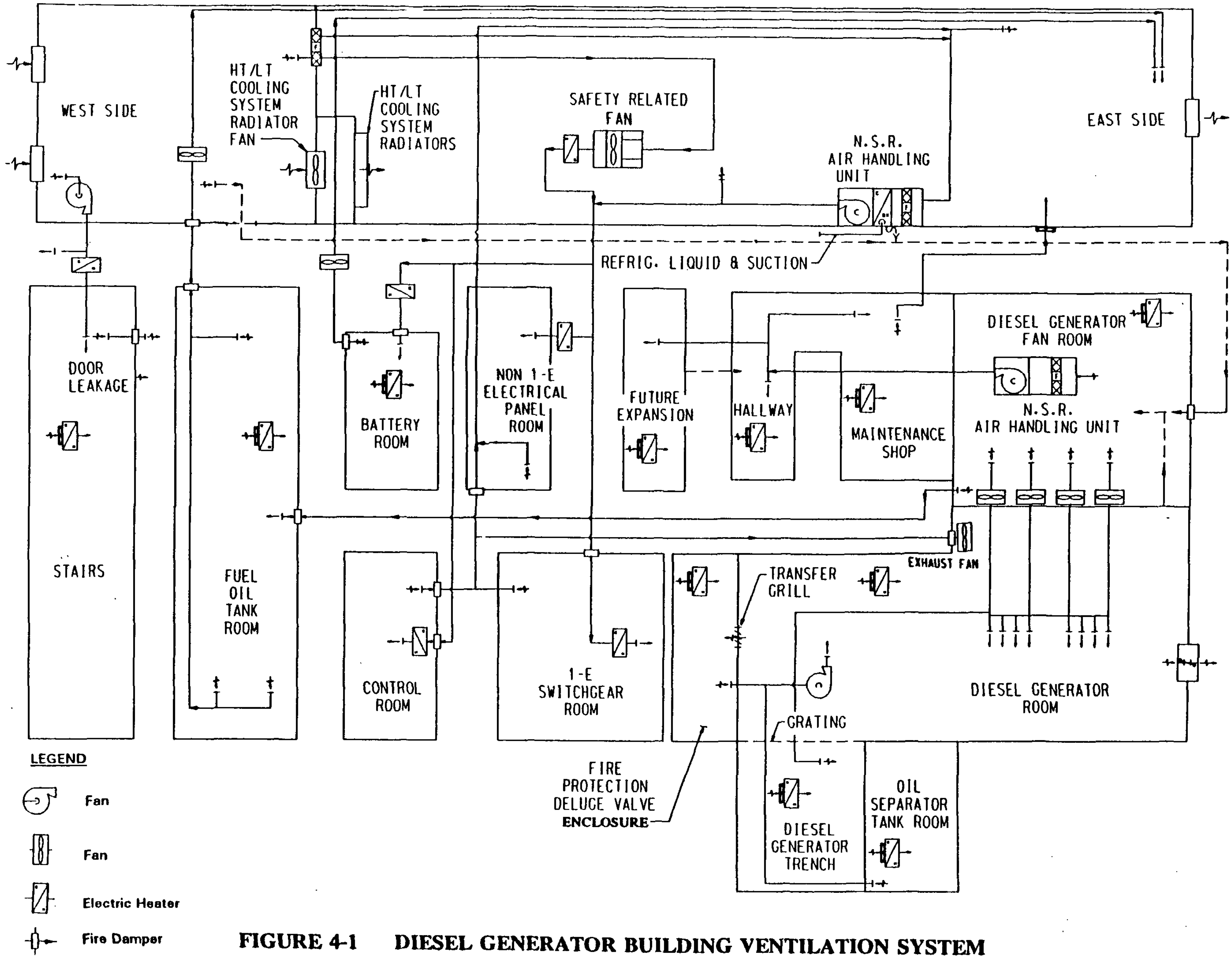

FIGURE 4-1 DIESEL GENERATOR BUILDING VENTILATION SYSTEM

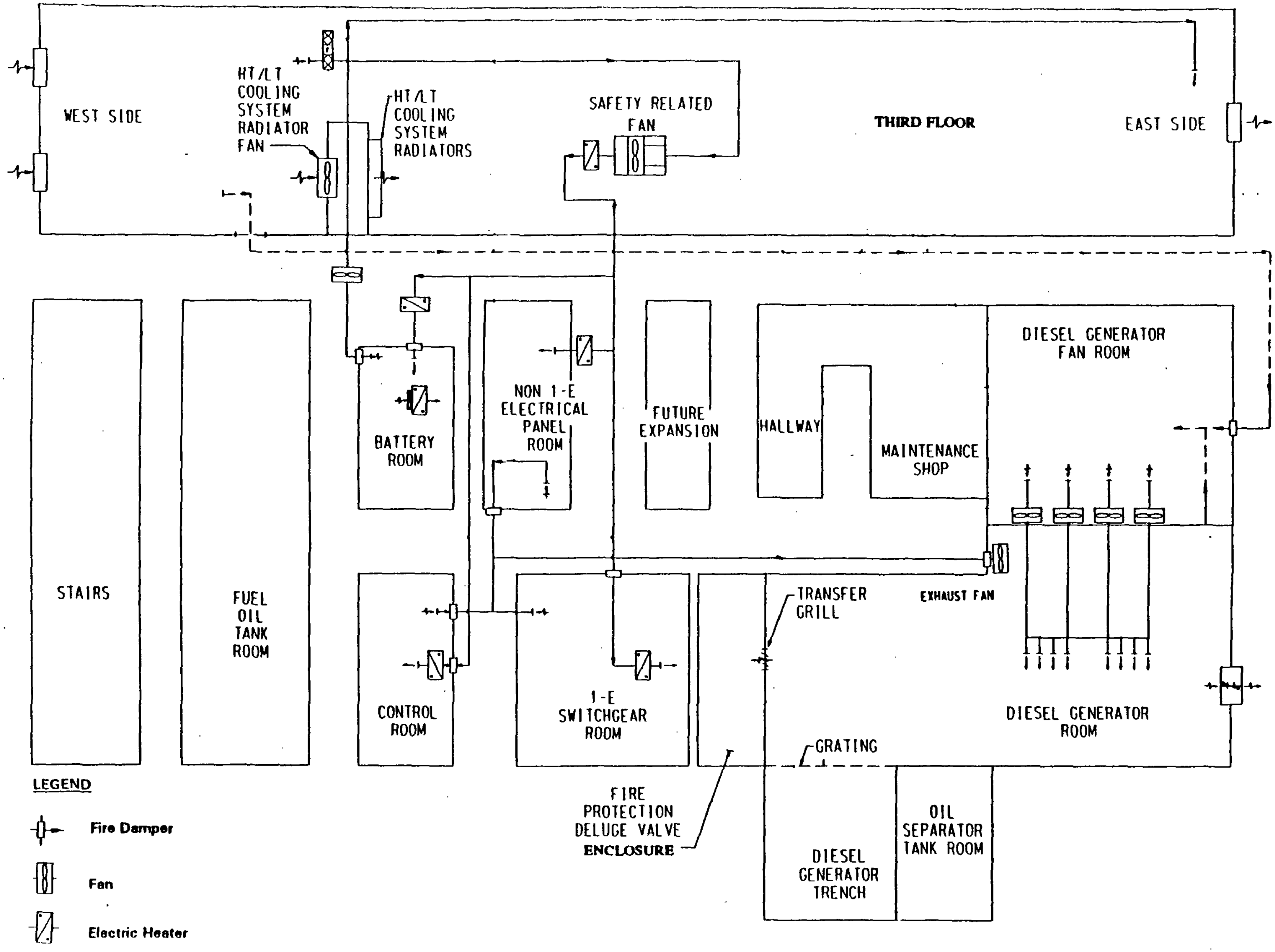

FIGURE 4-2 SAFETY-RELATED PORTION OF TI ESEL GENERATOR BUILDING VENTILATION SY 1

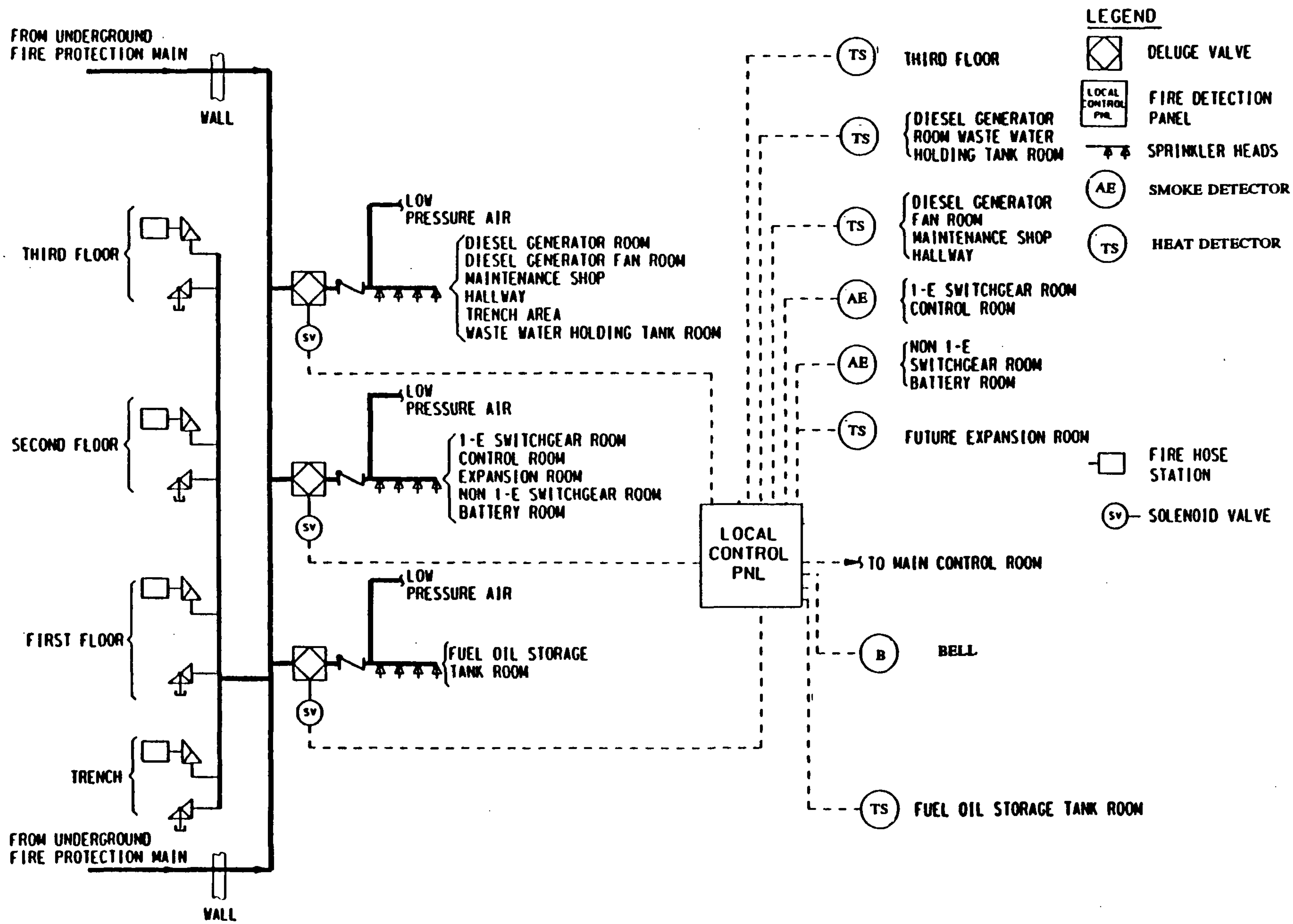

FIGURE 4-3 DIESEL GENERATOR BUILDING FIRE PROTECTION SYSTEM

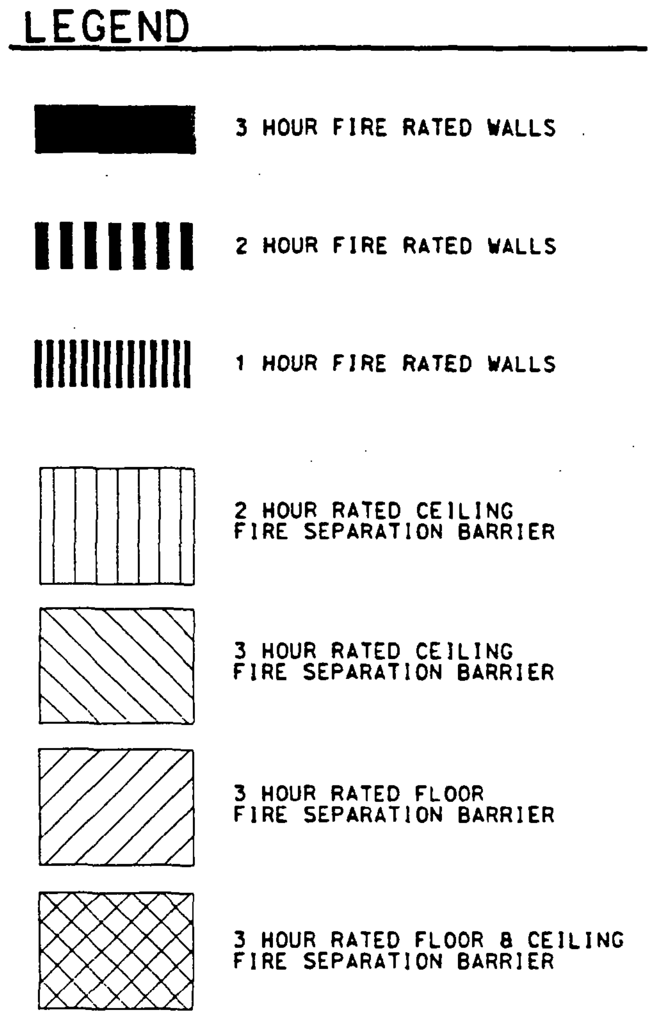

FIGURE 4-4 DIESEL GENERATOR BUILDING FIRE BARRIER LEGEND

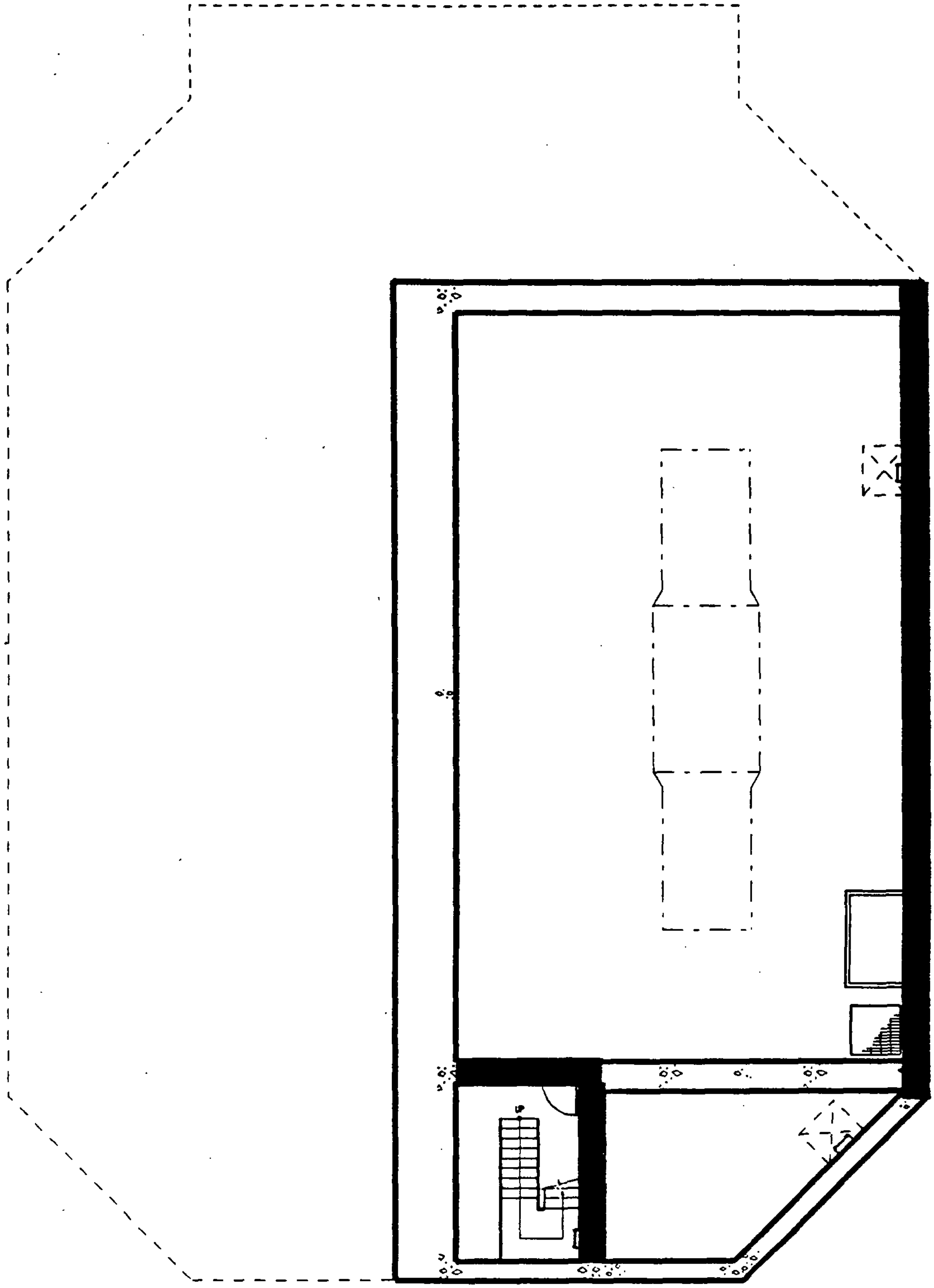

FIGURE 4-5 DIESEL GENERATOR BUILDING FIRE BARRIERS TRENCH (PRELIMINARY)

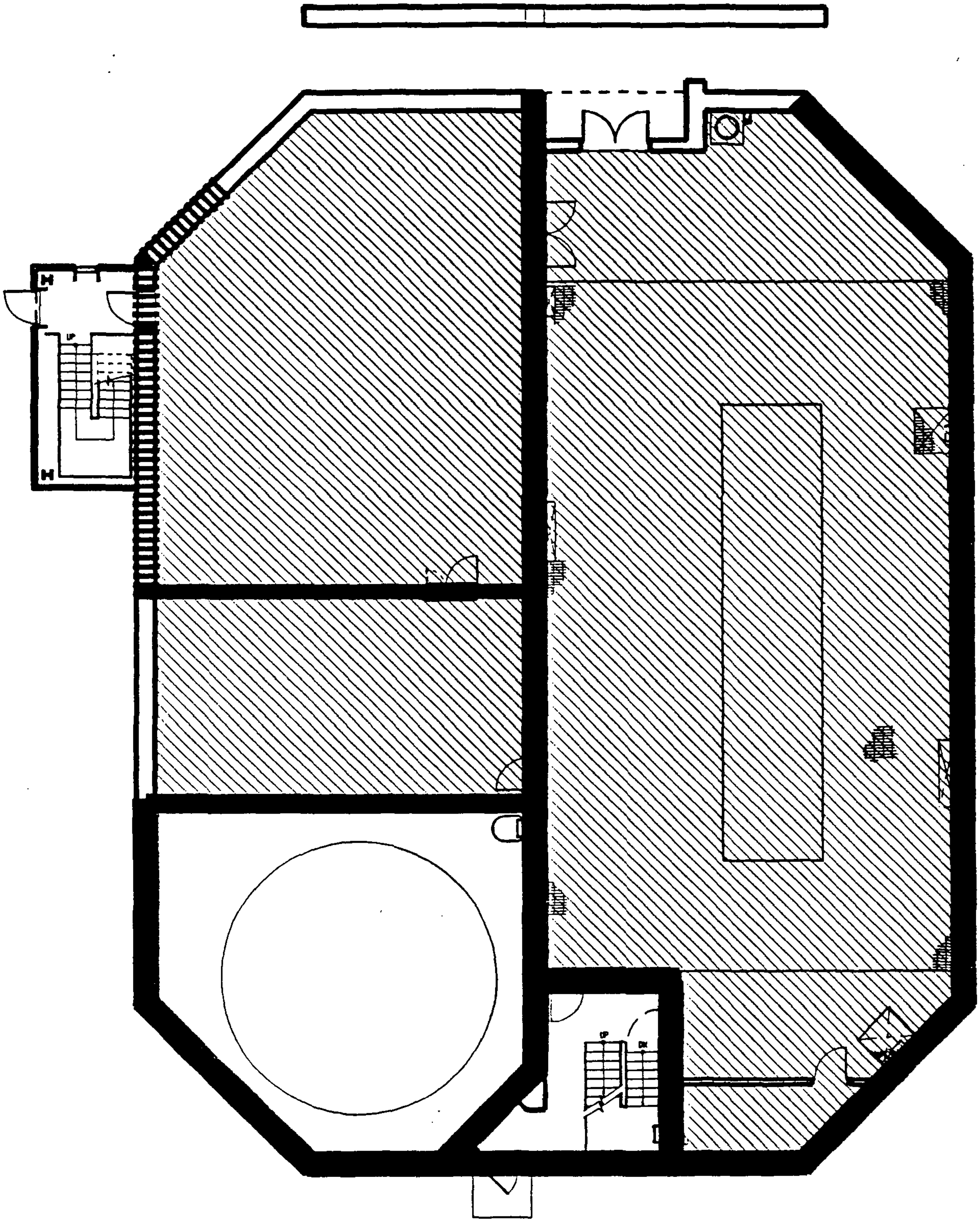

FIGURE 4-6 DIESEL GENERATOR BUILDING FIRE BARRIERS
FIRST FLOOR (PRELIMINARY)

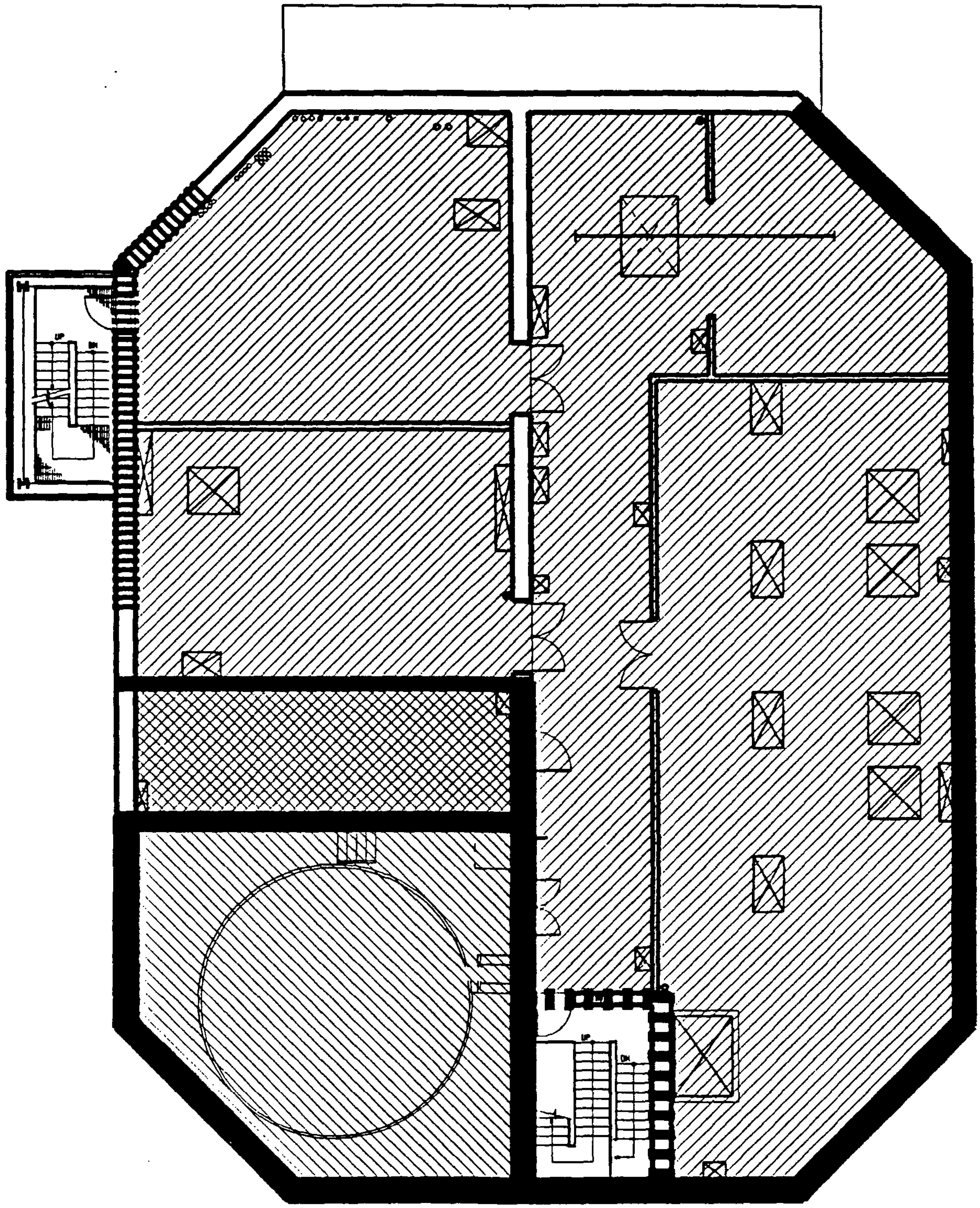

FIGURE 4-7 DIESEL GENERATOR BUILDING FIRE BARRIERS
SECOND FLOOR (PRELIMINARY)

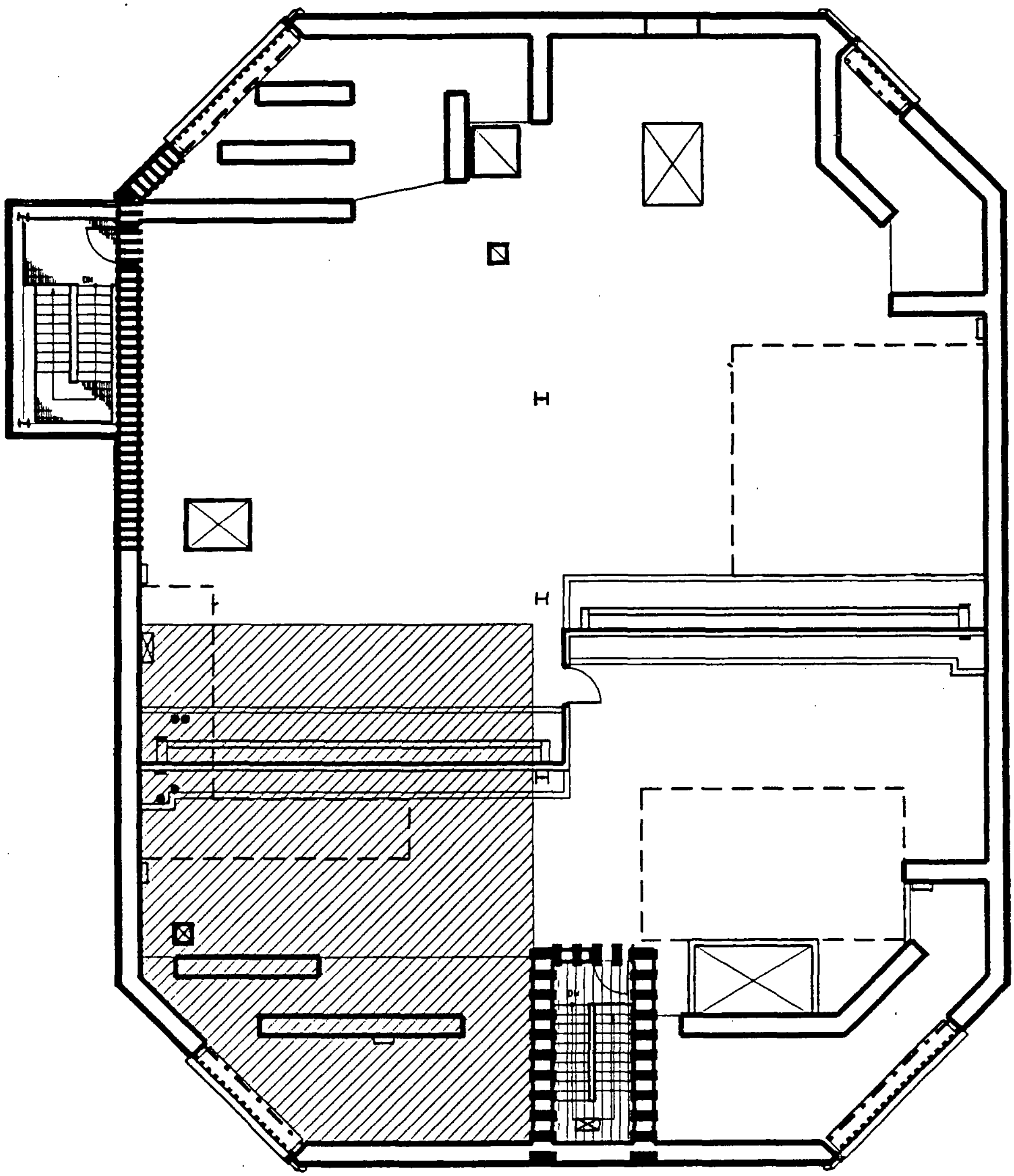

FIGURE 4-8 DIESEL GENERATOR BUILDING FIRE BARRIERS THIRD FLOOR (PRELIMINARY)

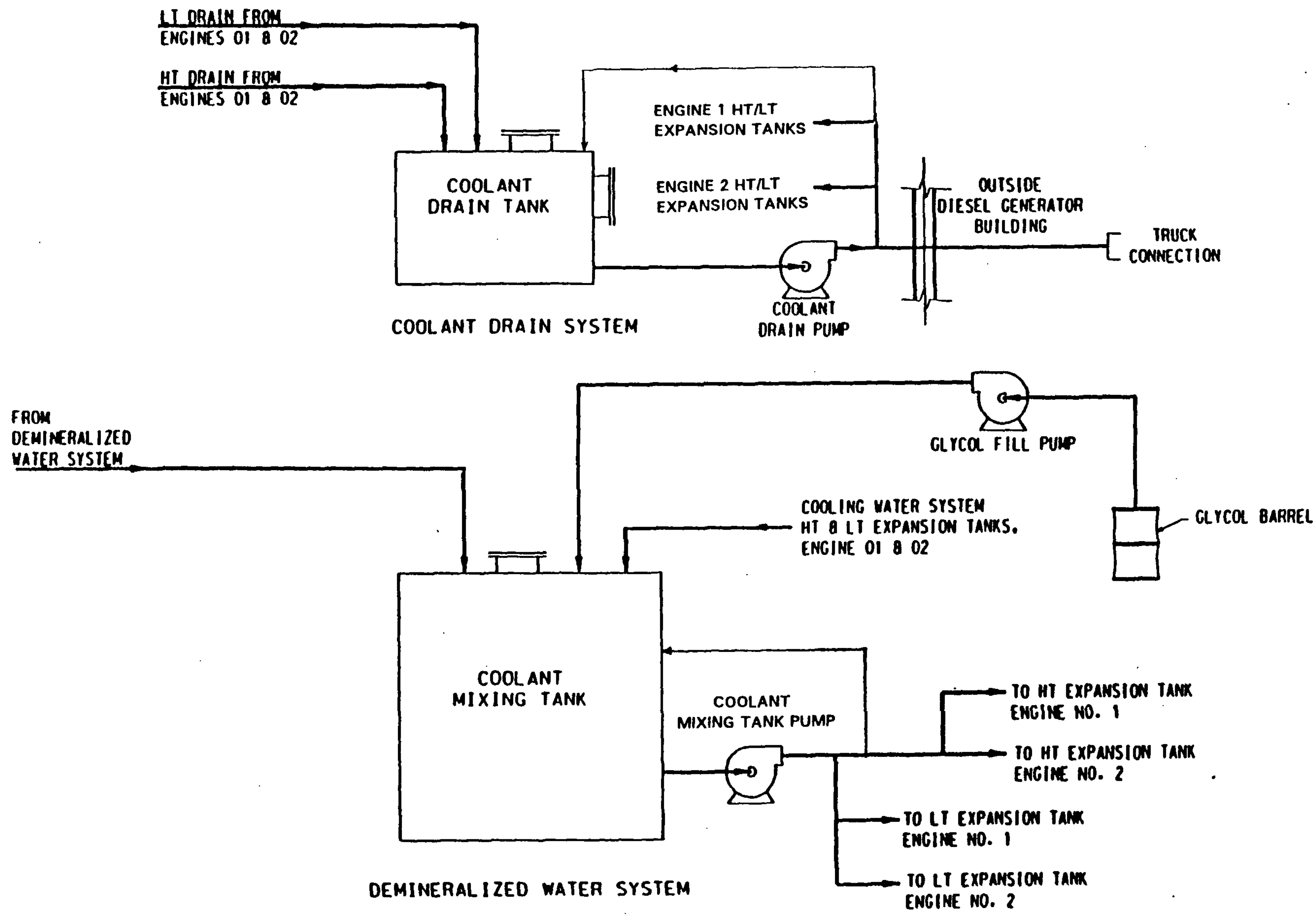

FIGURE 4-9 DIESEL GENERATOR BUILDING COOLANT DRAINS AND DEMINERALIZED WATER SYSTEMS

5.0 DESIGN OF STRUCTURES, SYSTEMS, AND COMPONENTS

This chapter identifies, describes and discusses the engineering design of the diesel generator, its support systems and the auxiliary systems for the Diesel Generator Building.

5.1 CONFORMANCE WITH NRC GENERAL DESIGN CRITERIA

Safety-related SSCs for the SACM diesel generator and the various auxiliary systems are designed using applicable design criteria specified in 10 CFR Part 50, Appendix A. Specific general design criteria which are applicable to equipment installed in the Diesel Generator Building include:

Criteria	Criterion Number
Quality Standards and Records	1
Design Bases for Protection Against Natural Phenomena	2
Fire Protection	3
Environmental and Dynamic Effects Design Bases	4
Sharing of Structures, Systems and Components	5
Instrumentation and Controls	13
Electric Power Systems	17
Inspection and Testing of Electric Power Systems	18
Cooling Water	44
Inspection of Cooling Water System	45
Testing of Cooling Water System	46

5.2 CLASSIFICATION OF STRUCTURES, SYSTEMS AND COMPONENTS

General Design Criterion 2 of Appendix A to 10 CFR Part 50, "General Design Criteria for Nuclear Power Plants," requires the nuclear power plant SSCs important to safety be designed to withstand the effects of natural phenomena, such as earthquakes, without loss of capability to perform necessary safety functions. Appendix A to 10 CFR Part 100, "Seismic and Geological Siting Criteria for Nuclear Power Plants," sets forth the principal seismic and geologic considerations which are used in the evaluation of the suitability of plant design bases established in consideration of the site seismic and geologic characteristics. Structures, systems and components designed to withstand the effects of the Design Basis Earthquake (one Safe Shutdown Earthquake [SSE] preceded by five Operating Basis Earthquakes [OBE]) are discussed in each design report. Structures, systems and components for structural systems are discussed in the Civil Engineering Design Report; for electrical systems, the Electrical Engineering Design Report; and for instrumentation, in the Instrumentation and Control System Design Report. Mechanical systems are discussed in this Design Report. The following sections discuss the classification of piping and pipe supports for the Diesel Generator Building.

Classification of equipment in accordance with its importance to nuclear safety was performed by SACM in accordance with the requirements specified in American National Standard ANSI/ANS-51.1, 1983, "American National Standard Nuclear Safety Criteria for the Design of Stationary Pressurized Water Reactor Plants." The diesel generator and the auxiliary subsystems are not associated with the reactor coolant pressure boundary and are therefore classified as either Safety Class 3 (SC-3) or Non-nuclear Safety. Electrical equipment classified as SC-3 is identified by IEEE 308-1987 and IEEE 323-1983 as "Class 1E."

The SACM diesel generator is designated as safety-related and Class 1E. As described in the subsections of Chapters 2 and 3, the SACM diesel engine and auxiliary systems are designated safety-related, Safety Class 3 and Category I. A list of significant safety-related mechanical equipment is provided in Table 5-1. A list of equipment fabricated to manufacturer's standards is provided in Table 5-2.

Structures, systems and components for the diesel generator auxiliary systems will be procured from two sources: SACM and Bechtel Corporation. SACM will supply equipment and components for the diesel generator auxiliary systems. Bechtel Corporation will procure the piping and piping supports necessary to complete these systems. Building auxiliary systems, such as the HVAC system, are supplied by Bechtel Corporation.

Piping and pipe supports are designed in accordance with the American Society of Mechanical Engineers (ASME) Section III, Boiler and Pressure (B&PV), Subsection NCA, ND and NF for Category I piping and ANSI/ASME B31.1 for Category II piping. The recommendations of Regulatory Guide 1.29, Revision 3 are followed during the seismic design of the Diesel Generator Building and its auxiliary systems. All non-ASME piping and pipe supports within the Diesel Generator Building that are not designated Category I systems are designed in accordance with Regulatory Guide 1.29, Revision 3, Category II/I criteria.

Equipment and components supplied by Bechtel Corporation will follow the guidelines specified in Regulatory Guide 1.26, Revision 3. There are no Code Class 1 or 2 piping systems required for systems in the Diesel Generator Building. Code Class 3 systems supplied by Bechtel Corporation will meet the Group C quality standards of Regulatory Guide 1.26. Non-safety-related systems, such as the compressed air system, will meet the Group D quality standards of Regulatory Guide 1.26.

5.3 PROTECTION AGAINST DYNAMIC EFFECTS ASSOCIATED WITH THE POSTULATED RUPTURE OF PIPING

The diesel generator auxiliary systems are designed to minimize the amount of high- and moderate-energy piping in the Diesel Generator Building. The structure of the Diesel Generator Building provides physical separation of high- and moderate-energy systems from essential systems and components of Unit 1's redundant diesel generator and the diesel generators associated with Unit 2.

The only high-energy system in the Diesel Generator Building, as defined by Standard Review Plan 3.6.1, is the starting air system. All piping in this system is nominally one inch or less in diameter. Therefore, the technical position described in Section B.3.a, B.3.b and B.3.c of Branch Technical Position MEB 3-1 does not require postulating circumferential or longitudinal pipe breaks or leakage cracks in this system.

As described in Chapter 4, safety-related portions of the auxiliary systems are designed such that failure of a single component will not prevent operation of plant safety-related equipment which is essential to safe shutdown. Although a single failure of a moderate-energy piping system could render its associated diesel generator inoperable, physical separation between equipment for the two Unit 1 diesel generators would prevent the second diesel generator from being affected. Missile barriers and physical separation also exist between the new Diesel Generator Building and the diesel generators for Unit 2. The dynamic and environmental effects associated with a moderate-energy pipe crack in the Diesel Generator Building will not affect any safety-related diesel generator equipment for either of Unit 2's diesel generators.

5.4 SEISMIC DESIGN FOR PIPING SYSTEMS

This section discusses the seismic analysis used for Diesel Generator Building piping systems supplied by Bechtel Corporation. The geologic and seismologic investigations conducted to support construction of the Diesel Generator Building are described in the Civil Engineering Report. The Civil Engineering Design Report also describes the methods and procedures used to develop the seismic input required for the dynamic analysis of the Diesel Generator Building and the auxiliary systems contained within it.

Seismic analyses for cable trays and cable supports are discussed in the Civil Engineering Design Report. The seismic analyses of other Class 1E subsystems are described in the Electrical Engineering Design Report. There are no buried Category I piping systems or tunnels associated with the Diesel Generator Building.

5.4.1 SEISMIC INPUT

The seismic input corresponding to the mounting location of a component is defined by the applicable floor response spectra which accounts for potential amplification of the building motions through intervening supports. The methodology used to develop the FRS used for seismic analyses is described in the Civil Engineering Design Report.

5.4.2 SEISMIC SUBSYSTEM ANALYSES

The following paragraphs describe the methods used during seismic subsystem analyses of Category I SSCs. The Calvert Cliffs Nuclear Power Plant is designed for a 40-year life with one design basis earthquake. The design basis earthquake is defined as five OBE events and one SSE event. The number of maximum stress cycles for each event is 10. Fatigue analysis, along with the stress report, shall be prepared where required by the applicable section of ASME Code, Subsection NB. However, since there are no Class 1 components in the Diesel Generator Building, no Class 1 fatigue analysis is required for any auxiliary system.

The design of the piping systems to be installed in the Diesel Generator Building includes the effects of the seismic response of the piping, the piping supports and attached equipment. Piping system responses are determined by applying three-directional earthquake spectra inputs, two horizontal and one vertical.

To determine the seismic response of a piping system, a modal analysis using the lumped mass technique is performed. Once the model is developed, the accelerations from the applicable floor response spectra are applied to the piping system to determine the piping response. Based upon the resulting piping response, supports are located which will adequately restrain the piping under seismic loading. Piping stresses, pipe support loads and equipment nozzle loads are then determined using the Bechtel Corporation computer code ME-101. Items such as valve accelerations, flange movements and pipe movements within sleeves are also checked. If the piping stresses are within the manufacturer's allowables and the support loads are reasonable, the piping analysis is complete.

Seismic Analysis Methods

Piping systems are seismically analyzed using the modal response spectrum analysis method. The number of masses used to represent the subsystem and the number of modes considered are established using the criteria defined in SRP 3.7.2. Modal responses and directional responses are combined in accordance with Regulatory Guide 1.92, Rev. 1.

When a dynamic analysis is used to predict the actual response of a piping system to a specified seismic input, the dynamic model must adequately represent the analyzed system. This representation includes correct mass point selection so as to represent all significant modes and properly locating anchors to terminate the mathematical model. Piping and pipe supports in the Diesel Generator Building are seismically modelled using either the lumped mass model or finite element modelling. Both methods are described in the following paragraphs.

Lumped Mass Modelling

When performing a dynamic analysis, a piping system may be represented as a mathematical model consisting of lumped masses connected by elastic members. The elastic members are given the properties of the piping system which is being analyzed. The lumped masses are carefully located so as to adequately represent the dynamic and elastic properties of the piping system. A lumped mass is located at the beginning and end of every elbow, at a valve's center of gravity, at extended valve operators and at the intersection of every tee. On straight runs, lumped masses are located at spacings no greater than the span of length corresponding to a frequency of at least 33 Hz. A mass point is located at every extended mass to account for torsional effects on the piping system. In addition, the increased stiffness and mass of valves is considered in the modelling of the piping system.

Finite Element Modelling

For more complex piping configurations, analysis by the finite element method is used to predict dynamic behavior. Analysis by the finite element method is performed by using Swanson Analysis Systems Inc.'s ANSYS computer code. ANSYS is an interactive program capable of performing linear or nonlinear analyses to determine both static and dynamic solutions.

Fundamental frequencies of piping systems are calculated in accordance with procedures outlined in Section 4.2.1 of BC-TOP-4A, Revision 3 (Reference 1). To avoid resonance, the fundamental frequencies of subsystems and components are, where possible, selected in such a way as to avoid excessive load amplifications. If subsystem or component frequency falls within the amplified region of the seismic spectra curves, the subsystem or component is adequately designed to meet the code requirements.

Valves and pumps and other components in piping systems are designed to be rigid.

With one exception, the cut off frequency for seismic analyses of pipe supports is 33 Hz. A cutoff frequency of 20 Hz is used for the seismic analyses of the supports for the diesel generator combustion air intake and exhaust system. The use of a different cutoff frequency criterion for this system is based on the following:

- The difference between the floor response spectra accelerations at 20 Hz and 33 Hz are not significant as compared to the spectral peak accelerations. The most significant spectral acceleration peaks occur at frequencies below 20 Hz.

- Where piping and supports are determined to be rigid, a 1 g acceleration was used for the design of supports for the diesel generator combustion air intake and exhaust system. The vertical and horizontal floor response spectra accelerations at 20 Hz are less than the acceleration used for the system's pipe support design.

The floor response spectra used in the Diesel Generator Buildings are shown in Figures 5-1 through 5-12. Therefore, the cutoff frequency criterion is lowered to 20 Hz for the diesel generator combustion air intake and exhaust system.

Damping is accounted for in the seismic analysis of piping systems by defining the seismic input to the subsystems using floor response spectra that correspond to the damping value associated with the system's material of construction. The damping values used in the Diesel Generator Building are described in the Civil Engineering Design Report. The damping values used in the seismic analysis of piping and pipe supports are briefly described in the following paragraphs.

N-411 Damping

This method, which is preferred in most cases, uses Code Case N-411 variable damping with a three dimensional spectra input (one vertical and two horizontal earthquake responses combined by the Square-Root-of-the-Sum-of-the-Squares (SRSS) method). Where this method is adopted, the spectra curves are enveloped curves with 15 percent peak broadening and the modal combinations specified in Regulatory Guide 1.92, Revision 1, are used. Furthermore, the zero period acceleration (ZPA) effects are combined with inertia effects by the SRSS method. The multiple zone response spectra method is not used when Code Case N-411 damping is used. The use of Code Case N-411 damping was restricted as specified in Regulatory Guide 1.84, Revision 28. Code Case N-411 damping values are shown in Figure 5-13.

Regulatory Guide 1.61, Revision 0 Damping

In addition to Code Case N-411 damping, the damping values from Regulatory Guide 1.61, Revision 0 are used. With Regulatory Guide 1.61, Revision 0 damping, use of the multiple response spectra method is permitted. The following methods of combining responses are used for Regulatory Guide 1.61, Revision 0 damping:

- Three-dimensional earthquake responses are combined by the SRSS method
- Modal responses combined in accordance with Regulatory Guide 1.92, Revision 1
- ZPA effects are included and combined with inertial effects by SRSS

Regulatory Guide 1.61, Revision 0 damping values used for piping systems are shown in Table 5-3.

Potential variations in the structural response frequencies due to uncertainties in material properties of the structure and soil, damping values, soil-structure interaction techniques and approximations in modelling techniques are accounted for by enveloping and smoothing response spectra from various analyses and then broadening the peaks. The floor response spectra used for piping systems in the

Diesel Generator Building are broadened by a minimum of 15 percent to account for possible sources of variation in floor response.

To obtain the most conservative results, the three-directional responses obtained by modal superposition for each direction and are then combined by the SRSS method. For piping systems, the effects due to closely spaced modes are considered using the NRC Group Method, regulatory Guide 1.92, Revision 1, Equation 4. Internal moments are determined from the results of the combination of the three-directional responses. Piping stress and support loads can then be determined from the internal moments. After the total internal moments, support reactions and stresses are obtained, the results are then combined with other loadings (e.g., pressure, temperature and deadweight) in accordance with ASME III as described in Section 5.7.

Where multiple supported equipment components with distinct inputs are used in the design of Category I piping systems in the Diesel Generator Building, damping values from Regulatory Guide 1.61, Revision 0, are used.

Some mechanical systems in the Diesel Generator Building, such as the fuel oil storage and transfer system, use a combination of Category I and non-Category I piping. In certain instances, Category I piping may be connected to non-Category I piping at locations other than a piece of equipment, that for purposes of the seismic analysis, could be considered an anchor. These transition points typically occur near Category I valves. Since the analysis is modeled from pipe anchor point to pipe anchor point, two options exist:

- A boundary anchor can be located at the non-Category I portion of piping to terminate the effects from the non-Category I piping.
- The boundary of the seismic analysis can be extended to cover the non-Category I piping to an equipment nozzle or a free end. In this case, the B31.1 piping is analyzed to meet Category I requirements up to the first anchor.

Where a small piece of non-Category I piping is directly attached to Category I piping, such as a vent or drain, its effect on the Category I piping is accounted for by lumping a portion of its mass with the Category I piping at the point of attachment. The seismic analysis for the motion of non-category I piping are similar to those performed for Category I piping except that the allowables are based on the ANSI/ASME B31.1 Power Piping Code.

5.5 SEISMIC DESIGN OF THE DIESEL GENERATOR

Seismic loadings are defined for the SSE and the OBE. All Category I SSCs are designed for dynamic loads experienced during SSE and OBE conditions. The following subsections describe the seismic design for SSCs supplied by SACM.

5.5.1 SEISMIC INPUT

Equipment and components supplied by SACM are designed using the required response spectra derived from the seismic accelerations described in the Civil Engineering Design Report.

5.5.2 SEISMIC QUALIFICATION OF SEISMIC CATEGORY I MECHANICAL AND ELECTRICAL EQUIPMENT

Category I mechanical and Class 1E electrical equipment supplied by SACM are seismically qualified such that they could successfully function during and after a design basis earthquake. This is qualified in accordance with either IEEE 344-1975, as endorsed by Regulatory Guide 1.100, Revision 1, or with IEEE 344-1987 as endorsed by Regulatory Guide 1.100, Revision 2. Qualification by experience, addressed in Section 9.0 of IEEE 344-1987, is only employed through the use of analysis or test data from previous qualification programs. Additionally, requirements of the following standards are used for the seismic qualification of SACM equipment: IEEE 334-1974; IEEE 420-1982; and ANSI/IEEE C37.98-1987.

The following sections describe analyses and testing methods which are used to qualify SSCs provided by SACM.

Seismic Qualification By Analysis

Qualification by analysis is acceptable without testing when structural integrity alone could ensure the design's intended function. Various analytical methods, including finite element analyses for complex equipment are used.

Simple analysis is used for equipment with geometric shape and design which allow simple and conservative models, such as a beam or a plate, to express structural response. For more complex equipment, analysis by the finite element method is used. For finite element method analysis, SACM uses the computer code PERMAS.

Once modeled, the equipment response is then evaluated using a frequency determination or a static coefficient analysis (equivalent static load method). For equipment having a fundamental frequency equal to or greater than 33 Hz, the equipment is considered to be rigid. Equipment with a fundamental frequency below 33 Hz is considered to be flexible.

For rigid equipment, the seismic forces are obtained by concentrating its mass at the center of gravity and multiplying it by the zero period acceleration (ZPA). If a frequency determination is performed, the analysis is based upon the equipment's natural frequency. In accordance with the guidelines of Revision 2 to Regulatory Guide 1.100, the accelerations used for the static analysis of active, rigid, rotating equipment is 1.5 times the ZPA applied to the center of gravity of the rotating element. Flexible equipment is analyzed using the modal response spectrum analysis technique.

In lieu of a frequency determination, a static coefficient analysis is sometimes performed. For a static coefficient analysis, the design acceleration corresponds to 1.5 times the peak of the required response spectra at the appropriate damping valve.

During the seismic analysis, appropriate damping values from Regulatory Guide 1.61 are used to select the required response spectra. Load case combinations are performed in accordance with ASME Section III.

The seismic loads caused by the accelerations include the effects of directional response and the multi-modal response. To obtain the directional response, the resulting loads caused by the accelerations in the three orthogonal directions are combined by the square-root-of-the-sum-of-the-squares method. The multi-modal response is obtained in accordance with the guidelines of Regulatory Guide 1.92.

Seismic Qualification By Testing

Vibration testing qualifies equipment by using the vibratory motion of a test table which is capable of producing accelerations that are at least equal to the strongest portion of an SSE or OBE in each of two directions. Two types of testing tables are used to produce biaxial (horizontal and vertical), multi-frequency, random motion with amplitude controlled over a frequency range of 1-33 Hz.

One testing table produces independent motion in two different directions. This table is equipped with two hydraulic jacks: one acting in the horizontal direction and the other acting in the vertical direction. In this case, testing could be performed with an amplitude of horizontal acceleration independent of the amplitude of vertical acceleration. Two equipment qualification tests were performed using this testing table. The first test was performed with a specific equipment orientation; the second test was performed with the equipment rotated 90° around its vertical axis.

A second testing table produces dependent motion in two different directions. This table is equipped with one hydraulic jack which produces both horizontal and vertical movement. For example, this could be accomplished by connecting the hydraulic jack at a 45° angle to the table. In this case, testing would be performed with a vertical acceleration which is a function of the horizontal acceleration. In order to qualify equipment on this test table, four tests were performed using different orientations around the equipment's vertical axis (0°, 90°, 180°, and 270°).

The test response spectrum used is greater than or equal to 110 percent of the required response spectra and the equipment was mounted on the test tables in a manner similar to the intended service mounting. Each OBE and SSE simulation in test table qualification conservatively uses at least 15 seconds of strong motion. Equipment function for active, safety-related components is monitored before, during and after each qualification test.

Qualification By Experience

Previously qualified equipment of a design that meets the requirements of equipment specifications can be used in the Diesel Generator Building. In this case, the previous seismic qualification documentation is used in lieu of requalifying the equipment provided the following conditions are satisfied:

- The previous seismic qualification must have used a methodology consistent with the requirements of the equipment specifications
- The existing qualification documentation must have addressed required response spectra which meet or exceed the floor response spectra developed for the equipment's mounting location within the Diesel Generator Building (increased by a ten percent margin)
- The existing qualification documentation must have identified and addressed the possible impact of aging, including nonseismic vibration, on the seismic capability of the equipment

5.6 COMPUTER CODES

Piping systems and components supplied by Bechtel Corporation are designed and analyzed for the effects due to weight, thermal and seismic events. Analyses of piping systems and associated supports are performed by using the following proprietary computer programs:

ME-101

ME-035

ME-150

ME-153

ANSYS

These proprietary computer codes conform to the requirements of 10 CFR 50, Appendix B, Section III and are described in the following section.

SSCs supplied by SACM are also analyzed for the effects due to weight, thermal and seismic events. Analyses of SACM piping systems and associated supports are performed by using the proprietary computer program PERMAS.

ME-101 - Linear Elastic Analysis of Piping Systems

ME-101 determines the piping stresses, support loads and equipment nozzle loads for a piping system under different loading conditions. Diesel Generator Building piping systems are analyzed using the ME-101 program to ensure they are in accordance with the requirements of the ASME Code; Subsection NCA and ND for ASME piping and ANSI/ASME B31.1 for B31.1 piping.

The ME-101 computer code performs static and linear dynamic load analysis of piping systems. The static analysis considers one of the following:

Thermal expansion

Deadweight

Uniformly distributed loads and externally applied forces, moments, displacements and rotations

Individual force loads

Static seismic (uniformly distributed acceleration) loads

Seismic anchor movement analysis

The linear dynamic analysis is based on the standard normal mode superposition techniques. The dynamic analysis technique is used for seismic and forcing function evaluations. Input excitation may be in the form of single or multiple seismic response spectra or time dependent loading functions. ME-101 also contains the following sub-programs related to piping stress analysis:

ME-101DT - Thermal Transient Analysis

ME-101C1 - Class 1 Piping Stress Analysis

ME-101LS - Local Stress Analysis

ME-101SP - Response Spectra Merging

ME-101 results have been compared with 17 different methods of calculations, such as hand calculations, commercially available computer codes and standard ASME and NRC benchmark problems. ME-101 has been validated by Bechtel Corporation.

ME-035 - BASE PLATE

BASE PLATE is a finite element computer code used to design and analyze the base plates of pipe supports. ME-035 can analyze flexible base plates on a geometrically nonlinear foundation. The code performs geometry calculations to generate the finite element model and creates data sets for output report tables. BASE PLATE has been validated by Bechtel Corporation.

ME-150 - Frame Analysis Program for Pipe Supports (FAPPS)

FAPPS is an interactive computer code for the analysis and design of standard (simplified input) and nonstandard pipe support frames. It includes the capability to optimize member sizes, welds, baseplates and embedments contingent upon various user-specified design limits. FAPPS can perform Code evaluations to the *AISC Manual of Steel Construction* and ASME Code, Section III, Division I, Subsection NF. FAPPS has been validated by Bechtel Corporation.

ME-153 - Miscellaneous Application Programs for Pipe Supports (MAPPS)

MAPPS is an interactive computer program that enables the user to access a variety of pipe support analysis computer programs. These programs are capable of evaluating pipe support physical features such as uniform and non-uniform welds, beta and clip angles, bolt spacing, anchor plates and other local effects. MAPPS has been validated by Bechtel Corporation.

ANSYS

ANSYS is a general purpose computer code for solving several classes of engineering problems. ANSYS includes capabilities for structural analysis, including static elastic, plastic, creep, dynamic and dynamic plastic analysis, large deflection and stability analysis, one-dimensional fluid flow analyses and heat transfer analysis including conduction and convection. ANSYS was developed and validated by Swanson Analysis System, Inc.

PERMAS

PERMAS was developed from a computer system which has its roots in industrial applications of the finite elements method. The theoretical background of the code is the displacement method of structural analysis in its classical stiffness formulation where loads and kinematic boundary conditions are given and displacements and reactions are calculated.

PERMAS is capable of performing linear static and dynamic analyses, nonlinear material analyses, bifurcation buckling, heat transfer analysis, sensitivity analyses, contact analyses and fracture mechanics analysis. In order to ensure the validity of PERMAS, SACM subjects each version of the code to a testing procedure which compares the output of PERMAS to a group of problems for which solutions are well known.

5.7 AMERICAN SOCIETY OF MECHANICAL ENGINEERS CODE CLASS 3 AND B31.1 COMPONENTS AND COMPONENT SUPPORTS

The following ASME editions and addenda are applicable to piping stress analysis and pipe support design:

- Piping systems and pipe supports for Category I piping are designed in accordance with the criteria established by ASME Section III, B&PV Code , Subsections NCA, ND and NF, 1986. Category II piping and associated supports are designed in accordance with ANSI/ASME B31.1 (1989).

- Category II/I pipe supports are designed in accordance with ANSI/ASME B31.1 Power Piping Code. Multiple or gang supports are not used to support both a Category I component and a Category II component.

Dynamic effects for piping systems are calculated using the static method with dynamic load factors, time history analysis or any other method that is considered acceptable. A piping system is considered to be in the elastic range if yielding across a section does not occur. The limits of the elastic range are defined in Paragraph F-1323 of Appendix F of ASME Section III, Division I, for the Code component supports. Local yielding due to stress concentration is assumed not to affect the validity of the assumptions of elastic behavior. The stress allowables of Appendix F of ASME Section III, Division I, for elastically analyzed piping are used for Code piping systems. For non-Code piping supports, allowables are based on accepted material standards consistent with those in Appendix F for linear elastically analyzed piping.

5.7.1 LOADING COMBINATIONS, DESIGN TRANSIENTS AND STRESS LIMITS

Non-SACM piping components and supports inside the Diesel Generator Building are designed to meet the Code requirements and to ensure that the diesel generators are available to provide the power required to maintain the reactor in a safe shutdown condition or mitigate the consequences of an accident without offsite power being available. The following loading conditions, associated loading combinations and stress limits apply to the design of piping systems in the Diesel Generator Building:

Service Limits	Loading Combination
Level A	PD+DW+EL
Level B	PO+DW+EL+OBE
Level D	PO+DW+EL+SSE
Secondary	TH+SAM
Primary & Secondary	PD+DW+EL+TH+SAM

The following loading conditions, associated loading combinations and stress limits apply to the design of piping supports:

Service Limits	Loading Combination
Level A	DW+EL+TH+SAM
Level B	DW+EL+OBE+TH+SAM
Level D	DW+EL+SSE+TH+SAM

The loading components described are defined as:

PD	Design pressure
PO	Maximum operating pressure
DW	Loads due to the dead weight of the component in an operating condition
EL	External loads due to other sustained loading conditions
OBE	Loads due to the horizontal and vertical accelerations produced by the operating basis earthquake
SSE	Loads due to the horizontal and vertical accelerations produced by the safe shutdown earthquake
TH	Loads due to thermal expansion of component
SAM	Loads due to seismic anchor movement

Pipe flanges in ASME systems are qualified in accordance with NC-3658 of the ASME Code.

The maximum total stress allowables under different loading conditions for ASME piping, as defined in ASME Section III, 1986, are:

Design Condition:

$$S_{SL} = B_1 \frac{PD_o}{2t_n} + B_2 \frac{M_A}{Z} \leq 1.5S_h$$

Level A and B Service Limits:

$$S_{OL} = B_1 \frac{P_{max}D_o}{2t_n} + B_2 \left(\frac{M_A + M_B}{Z}\right) \leq 1.8S_h \qquad 1.5S_y$$

(i.e., smaller of $1.8S_h$ or $1.5S_Y$)

Level D Service Limits:

$$S_{OL} = B_1 \frac{P_{max}D_o}{2t_n} + B_2 \left(\frac{M_A + M_B}{Z}\right) \leq 3.0S_h \qquad 2.0S_y$$

(i.e., smaller of $3.0S_h$ or $2.0S_Y$)

Secondary Stress Limits:

$$S_E = \frac{iM_C}{Z} \leq S_A$$

Primary + Secondary Limit:

$$S_{TE} = \frac{PD_o}{4t_n} + 0.75i\left(\frac{M_A}{Z}\right) + i\left(\frac{M_C}{Z}\right) \leq S_h + S_A$$

Single Nonrepeated Anchor Movement:

$$\frac{iM_D}{Z} \leq 3.0S_C$$

Where:

S_{SL}	=	Total combined meridional membrane and bending stress due to pressure, weight and other sustained loads, psi
S_{OL}	=	Total combined meridional membrane and bending stress due to pressure, weight, other sustained loads and occasional loads, psi
S_E	=	Total combined meridional membrane and bending stress due to thermal expansion effects, psi
S_{TE}	=	Total combined meridional membrane and bending stress due to the effects of pressure, weight, other sustained loads and thermal expansion, psi
S_C	=	Basic material allowable stress value at room temperature, psi
B_1, B_2	=	Primary stress index for the specific component under investigation
P	=	Internal design pressure, psi
D_o	=	Outside diameter of pipe, in.
t_n	=	Nominal wall thickness, in.
M_A	=	Resultant moment loading on the cross-section due to weight and other sustained loads, in.-lb. (ND 3653.3)
Z	=	Section modulus of pipe, in.^{3}
S_h	=	Basic material allowable stress at the maximum operating temperature, psi
P_{max}	=	Peak pressure, psi
M_B	=	Resultant moment loading on the cross-section due to occasional loads, such as earthquakes and thrusts from relief and safety valve loads from pressure and flow transients, in.-lb.
S_y	=	Basic material yield strength at the design temperature, psi
M_C	=	Range of resultant moments due to thermal expansion, in.-lb.
S_A	=	Allowable stress range for expansion stresses, psi (ND 3653.1)
i	=	Stress intensification factor
M_D	=	Resultant moment due to any single nonrepeated anchor movement (i.e., predicted building settlement), in.-lb.

The stress intensity factor (i) and stress indices (B_1 and B_2) for different pipe fittings will be based on formulas provided by the ASME Code.

The maximum total stress allowables under different loading conditions for ANSI/ASME B31.1 piping, are:

Sustained Loads:

$$S_L = \frac{PD_O}{4t_n} + \frac{0.75iM_A}{Z} \leq 1.0S_h$$

Occasional Loads:

$$S_{OL} = \frac{PD_O}{4t_n} + \frac{0.75i(M_A + M_B)}{Z} \leq kS_h$$

Where:

k = 1.15 for occasional loads < 10 percent of operating period
k = 1.20 for occasional loads < 1 percent of operating period

Thermal Expansion Stress Range:

$$S_E = \frac{iM_C}{Z} \leq S_A + f(S_h - S_L)$$

Where:

- S_L = Sum of the longitudinal stresses due to pressure, weight and other sustained loads
- D_O = Outside diameter of pipe, in.
- t_n = Nominal wall thickness, in.
- i = Stress intensification factor. The product of 0.75i is never taken as less than 1.0
- M_A = Resultant loading on cross section due to weight and other sustained loads, in-lb
- Z = Section modulus, $in.^3$
- M_B = Resultant moment loading on cross section due to occasional loads such as thrusts from relief valve loads, pressure transients, flow transients, etc., in-lb
- M_C = Range of resultant moments due to thermal expansion, in-lb
- f = Stress range reduction factor for cyclic conditions for total number N of full temperature cycles over total number of years during which the system is expected to be in operation

Components expressly designed to function as supporting or restraining devices for piping are designed in accordance with the applicable Code (ASME Section III Subsection NF for ASME piping, and ANSI/ASME B31.1 for non-ASME piping, and ANSI/ASME B31.1 with seismic considerations for non-ASME piping extensions to ASME piping systems between the isolation valve and the piping stress boundary). This requirement applies to component standard pipe supports and supplemental structural steel designed expressly for pipe supports. The pipe support code jurisdiction is defined by ASME Section III, Subsection NF, Figure NF-1132-1.

The maximum deformation value for piping analysis is not a mandatory requirement; however, good engineering practice is to limit pipe deflection due to weight to about 0.1 inch and pipe deflection due to a seismic event to about 1.0 inch. The maximum deflection value for piping supports is not applicable for Code Class 3 supports.

5.7.2 GENERAL STRESS ANALYSES

Piping

The piping stress analyses are performed to evaluate the effects from the weight, thermal and seismic events. Additionally, the design pressure and maximum operating pressure are included in the piping stress analysis. The following requirements for the piping systems are met.

- ASME III Piping

  Piping will be qualified in accordance with the criteria established by ASME Section III B&PV Code, Subsection NCA and ND, 1986 Edition. Piping reactions on equipment nozzles will be verified to be less than the manufacturer's values.

- ANSI/ASME B31.1 Power Piping

  Piping will be qualified in accordance with the criteria established by ANSI/ASME B31.1, Power Piping Code, 1989 edition. Piping reactions on equipment nozzles will be verified to be less than the manufacturer's values. Power piping can also be qualified by meeting the requirements for ASME piping.

- Category II/I Piping

  Piping will be qualified in accordance with the previously stated requirements for ANSI/ASME B31.1 Power Piping. In addition, system integrity requirements will be met due to an SSE event.

The mathematical model of piping systems for the stress calculations will usually begin with an anchor and end with an anchor or free end. An anchor can be a physical anchor, equipment nozzle or similar SSC which restrains motion in all six directions (three translational and three rotational). If a run of pipe has a moment of inertia at least 25 times (or 10 times for section modulus) that of a branch pipe, then the branch pipe can be decoupled from the piping run.

A seismic anchor movement analysis (SAM) will be performed when two independent structures are involved for both OBE and SSE load cases. Since all piping systems are in one building, a SAM analysis is not required; however, if a branch line is decoupled from a run of pipe, SAM analyses may be required.

Piping Supports

Since piping systems are seismically supported, piping supports are designed to be double acting supports. In general, rigid supports are used. When the use of springs and snubbers becomes necessary, the number of springs and snubbers will be kept to a minimum.

Deadweight Analysis

A deadweight analysis is performed for the normal operating mode of the pipe system. Normal weights for piping material and water are used. (refer to Crane Catalog number 61, "Welding Fittings Forged Flanges" for weights.) If the operating medium is air, the weight of the air is assumed to be negligible. In accordance with standard industry practice, the weight of supports are not considered in the weight analysis.

The weight of insulation and piping components is included in the weight analysis. It is assumed that the piping fittings such as elbows, tees and branch connections are similar in weight to their attached piping. The weights of flanges and orifice unions are lumped at the flange face. (Refer to Crane Catalog number 61, "Welding Fittings Forged Flanges" for weights.)

A separate weight analysis is performed for air lines. This analysis includes the weight of the water during hydro-test and assumes that all spring hangers will be pinned and behave as rigid hangers.

Thermal Analysis

The analysis for thermal expansion includes all thermal operating modes, including environmental conditions and cold water modes. Enveloping thermal modes are used if some modes can be clearly enveloped by others. The nozzle thermal movements are also considered for their effects on the overall thermal evaluation.

Normal thermal modes are those that occur during normal operation of the plant or during an upset condition. All of those modes are considered in the stress range for piping qualification.

Faulted thermal modes are those that occur during the faulted plant condition which is an extremely infrequent event such as a loss-of-coolant accident or a high-energy-line break. Secondary stress limits of the faulted thermal condition are not evaluated; however, the support loads will be evaluated as part of the faulted loads.

Test modes are those that occur during test conditions. These modes are not combined with other thermal modes. A separate temperature range is used for the analysis of thermal test modes.

Diesel Generator Combustion Air Intake and Exhaust System Bellows

The piping stress analysis for the diesel generator combustion air intake and exhaust system evaluates the piping stress levels for different loading conditions and piping support loads. The analysis also considers the bellow's weight and mathematically simulates the lateral and axial flexibility of bellows that are installed as flexible joints in the system. Values for the bellow's axial and lateral stiffness are provided by SACM. These values are then used to develop properties for the bellows as follows:

Cross-sectional area, A:

$$A = \frac{S_A L}{E}$$

Moment of inertia, I:

$$I = \frac{S_L L^3}{3E}$$

Torsional moment of inertia, J:

$$J = 2I$$

Where:

S_A = Axial Stiffness
S_L = Lateral stiffness
L = Bellows length
E = Young's Modulus

The piping system with the bellows is then analyzed using the computer codes described in Section 5.6. Finally, the maximum deflection of the bellows in the axial and lateral directions are checked to ensure that movement is within the allowable limits.

5.7.3 STRESS AND STRAIN CRITERIA FOR PIPE SUPPORTS

For the stress criteria, support allowables are calculated in accordance with ASME Code, Subsection NF for ASME piping and ANSI/ASME B31.1 for B31.1 piping. In addition to imposed piping loads, pipe supports are designed to resist forces imposed on structural members due to seismic motion of the members. Pipe supports for ANSI/ASME B31.1 piping or pipe supports determined to be Category II/I are designed in accordance with Section 120.2.4 of the ANSI/ASME B31.1 Code. Therefore, supplementary structural steel for Category II/I piping and pipe supports are designed and analyzed in accordance with the standards proscribed by the American Institute of Steel Construction. Standard components of ASME piping will have a load capacity data sheet certified to the applicable code.

The acceptance strain criteria for all supports, except II/I supports and non-seismic supports, will be to design the support configuration such that its natural frequency falls within the rigid frequency range. The natural frequency of pipe supports must be greater than or equal to a value based on the rigid range frequency of the applicable response spectra. Support deflection criteria are not imposed. Calculations of natural frequency are performed in accordance with:

- Connections to main building structural steel are considered infinitely rigid except where torsion is produced on an unbraced wide flange building structural member. In this case, the contribution of rotation is considered in the frequency analysis.

- Connections to building structural concrete are considered infinitely rigid except for the motion allowed by the flexibility of base plate anchor bolts when evaluating the flexibility of a cantilever support configuration.

- The natural frequency of a pipe support is calculated based on the effective mass of piping and piping components being restrained and the attributable weight of the pipe support components. The natural frequency analysis is performed in the direction of the pipe restraint.

- For ASME Category I supports and for supports on extensions of ASME piping stress analysis problems, the analysis includes the anticipated stiffness of component standard supports. For other non-ASME pipe supports, it is assumed that component standard supports are infinitely rigid.

- Pipe anchors are designed to be rigid in all orthogonal directions.

- Category II/I pipe supports are designed such that the total allowed structural movement imposed by the maximum piping load does not exceed one-sixteenth of an inch. Any Category II/I pipe supports on the fire protection system are designed in accordance with NFPA 13 and 14.

- For supports not meeting these criteria, the impact on the associated piping stress analysis will be evaluated on a case-by-case basis.

In general, the bases used for the design and construction of both the piping and piping supports are:

- Variable springs are designed to be effective through the entire anticipated range of motion. Seismic motion is within the working range of the spring. The variability factor of the spring will not exceed 25 percent, except for springs within 10 diameters of equipment nozzles, where it is limited to 10 percent.

- Structural frames in contact with the piping system are designed to withstand the friction force of a pipe moving across the structural member. A coefficient of static friction of 0.3 is used for steel-on-steel contact between structural frames and piping systems. Friction will be considered effective in the unrestrained direction when piping thermal movement is greater than or equal to one-sixteenth of an inch. Friction forces are calculated for normal condition loading on piping. There are no strain criteria for the deflection of structural members due to friction. Structural frames are designed with sufficient gap to ensure free radial expansion of the pipe in the hot condition.

- Integral attachments on the piping system are avoided where possible. Piping attachment welds will be qualified and the compatibility of welded attachment material with the piping system determined.

- A modular system of embedded plates or cast-in-place anchor bolts is the preferred method of attaching SSCs to concrete walls. A modular system consists of plates embedded vertically in walls and spaced at approximately 6 to 8 feet and, whenever possible, coincide with the spacing of steel framing . Concrete expansion anchors are used only as a last resort. Attachments to the building structure will meet the following criteria: (1) Attachments to building structural concrete will not exceed allowables for local structural effects, (2) Attachments to building structural members will be checked for local effects on the building structural member. Local effects will include, as a minimum, local torsional effects, web buckling and web crippling.

5.8 ENVIRONMENTAL QUALIFICATION OF MECHANICAL EQUIPMENT

The Environmental Qualification Program for the Calvert Cliffs Nuclear Power Plant is established by Calvert Cliffs Instruction 208 in accordance with the requirements of 10 CFR 50.49. A mild environment is defined by 10 CFR 50.49 as " . . . an environment that would at no time be significantly more severe than the environment that would occur during normal plant operation, including anticipated operational occurrences." For the Diesel Generator Building these operational occurrences include the operation of the diesel generator for periodic testing. This operation for periodic testing produces temperatures in the Diesel Generator Building equivalent to those calculated for post-accident operation of the diesel generator.

Equipment located in a mild environment, such as the Diesel Generator Building, is not within the scope of 10 CFR 50.49. However, the applicable portions of the Environmental Qualification Program are used to qualify the SACM diesel generator auxiliary Class 1E electrical equipment. The piping systems and pipe supports are qualified to the environmental design temperature ranges listed in Table 4-1.

Due to tornado depressurization, safety-related SSCs on the third floor will be qualified to a negative pressure differential of 3 psi.

The radiation levels expected in the Diesel Generator Building are negligible.

TABLE 5-1

SIGNIFICANT SAFETY-RELATED MECHANICAL EQUIPMENT LOCATED IN THE DIESEL GENERATOR BUILDING

Diesel Generators

- The generator and both diesel engines are safety-related

Diesel Generator Building HVAC System

- One AHU, including ducting from the safety-related AHU to the Battery Room, non-Class 1E Electrical Panel Room, Class 1E Switchgear Room, and the Diesel Generator Building Control Room (including duct-mounted heaters)
- Exhaust fan and associated ducting for the non-Class 1E Electrical Panel Room, Class 1E Switchgear Room and the Diesel Generator Building Control Room
- Exhaust fan for the Battery Room, including associated ducting
- Diesel Generator Room supply fans and associated ductwork
- Exhaust damper for the Diesel Generator Room

Diesel Generator Fuel Oil Storage and Transfer System

- Fuel oil storage tank
- Fuel oil day tank
- Fuel oil filters for the transfer pumps
- AC motor-driven fuel oil transfer pumps

Diesel Generator Cooling Water System

- HT and LT expansion tanks
- HT and LT radiators
- Thermostatic valves
- HT coolant keep warm system
- HT and LT coolant circulating pumps
- All system heat exchangers

Diesel Generator Starting Air System

- Starting air receivers, isolation valves and upstream check valve
- Starting air solenoid valves

TABLE 5-1

SIGNIFICANT SAFETY-RELATED MECHANICAL EQUIPMENT LOCATED
IN THE DIESEL GENERATOR BUILDING
(Continued)

Diesel Generator Lube Oil System

- Lube oil auxiliary tank
- Two engine-driven lube oil pumps
- Lube oil prelube system
- Thermostatic valves
- Lube oil filters

Diesel Generator Combustion Air Intake and Exhaust System

- Exhaust silencer
- Intake filters

TABLE 5-2

SIGNIFICANT DIESEL GENERATOR MECHANICAL EQUIPMENT
BUILT TO MANUFACTURER'S STANDARDS

Diesel Generators

- The generator and both associated diesel engines are built to manufacturer's standards

Diesel Generator Fuel Oil Storage and Transfer System

- Engine-driven fuel oil pump
- AC motor-driven fuel oil pump
- Fuel oil filters on the auxiliaries desk
- Diesel engine injection pumps

Diesel Generator Cooling Water System

- Thermostatic valves
- HT coolant keep warm system
- HT and LT coolant circulating pumps
- All system heat exchangers

Diesel Generator Starting Air System

- Starting air solenoid valves
- Compressor skid with air dryer

Diesel Generator Lube Oil System

- Two engine-driven lube oil pumps
- Lube oil prelube system
- Thermostatic valves
- Lube oil filters

Diesel Generator Combustion Air Intake and Exhaust System

- Exhaust silencer
- Intake filters
- Turbochargers

TABLE 5-3

DAMPING VALUES FOR CATEGORY I
STRUCTURES, SYSTEMS AND COMPONENTS
(Percent of Critical Damping) (1)

Structure or Component	OBE	SSE
Equipment and large-diameter piping systems (1)(2) (pipe diameter > 12 inches)	2	3
Small-diameter piping systems (2) (pipe diameter ≤ 12 inches)	1	2

Notes:

(1) This includes both material and structural damping. If the piping system consists of only one or two spans with little structural damping, the values for small diameter piping are used.

(2) In lieu of these values, for ASME Boiler and Pressure Vessel Code, Section III, Division I, Class 3 piping systems, the damping values provided in Figure 5-13 may be used in accordance with Code Case N-411.

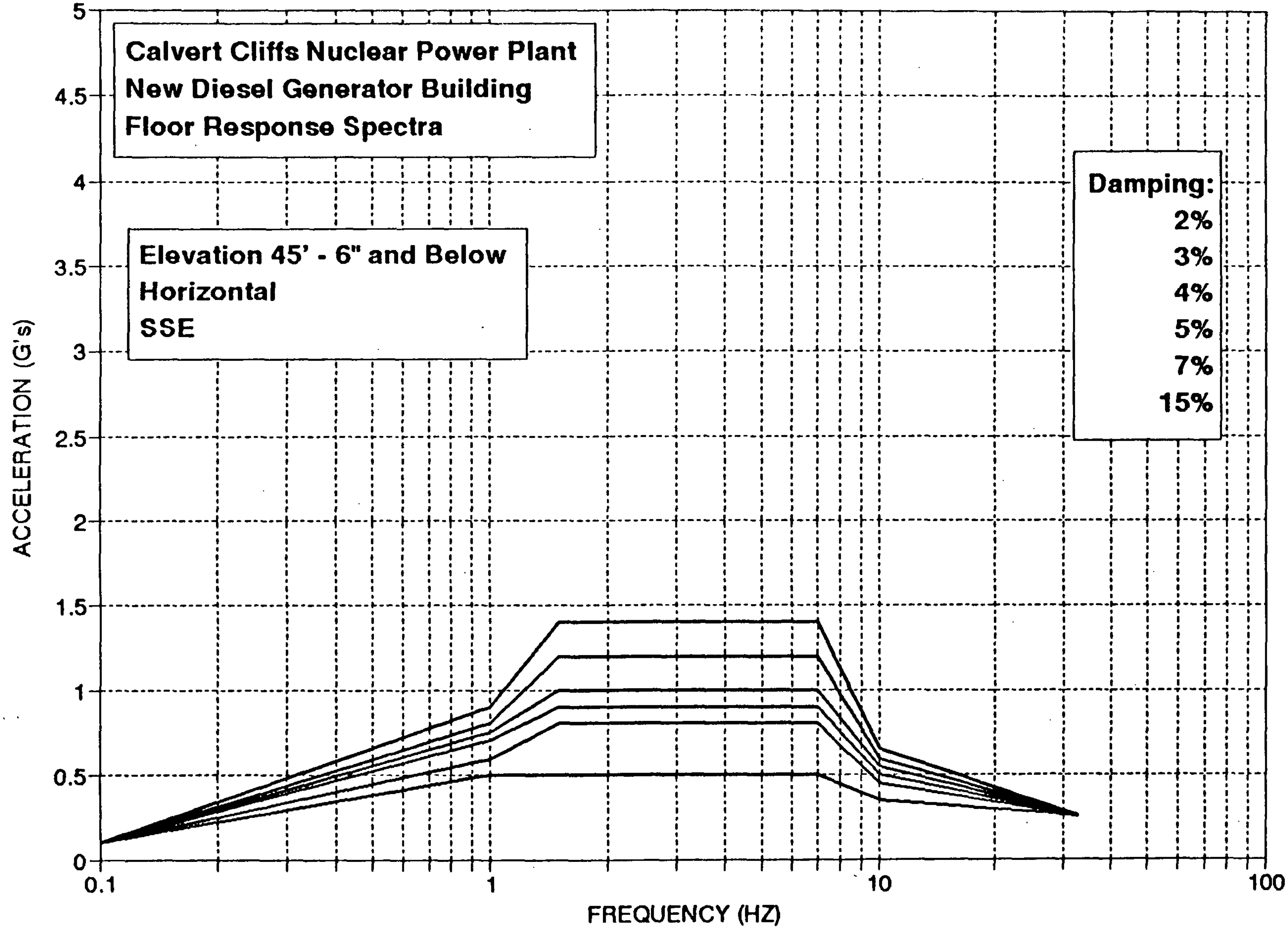

FIGURE 5-1 FLOOR RESPONSE SPECTRA (SSE)

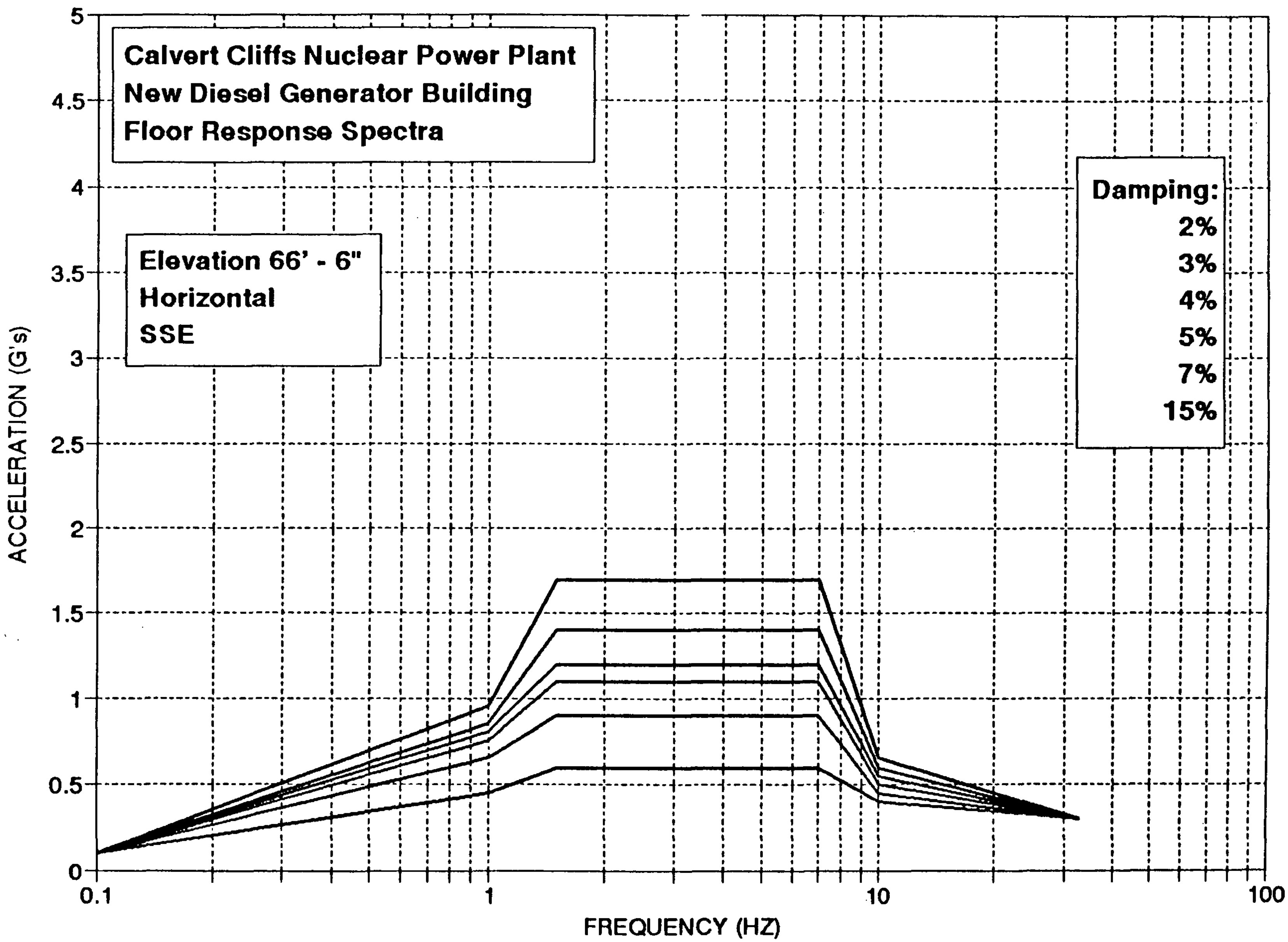

FIGURE 5-2 FLOOR RESPONSE SPECTRA (SSE)

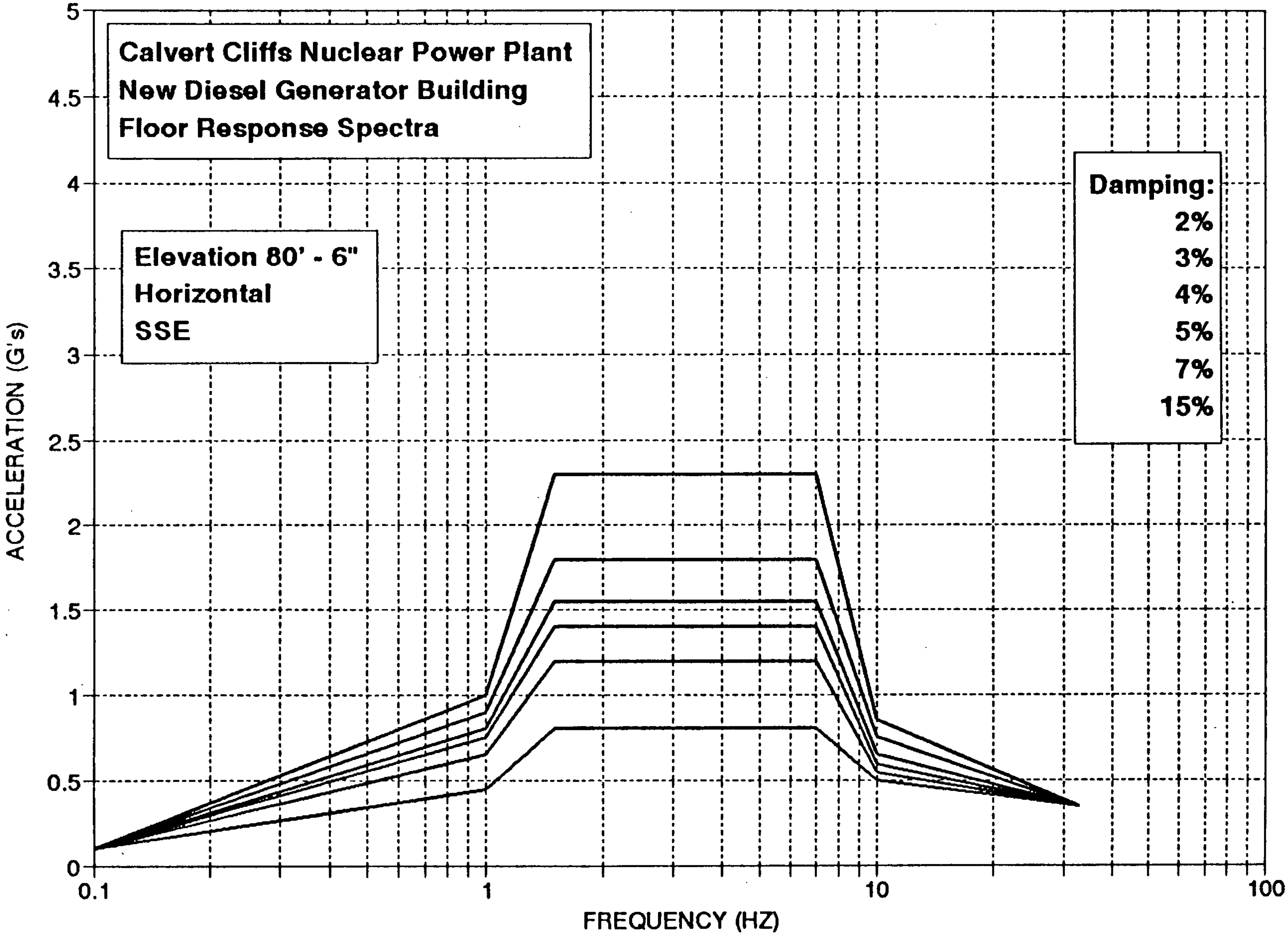

FIGURE 5-3 FLOOR RESPONSE SPECTRA (SSE)

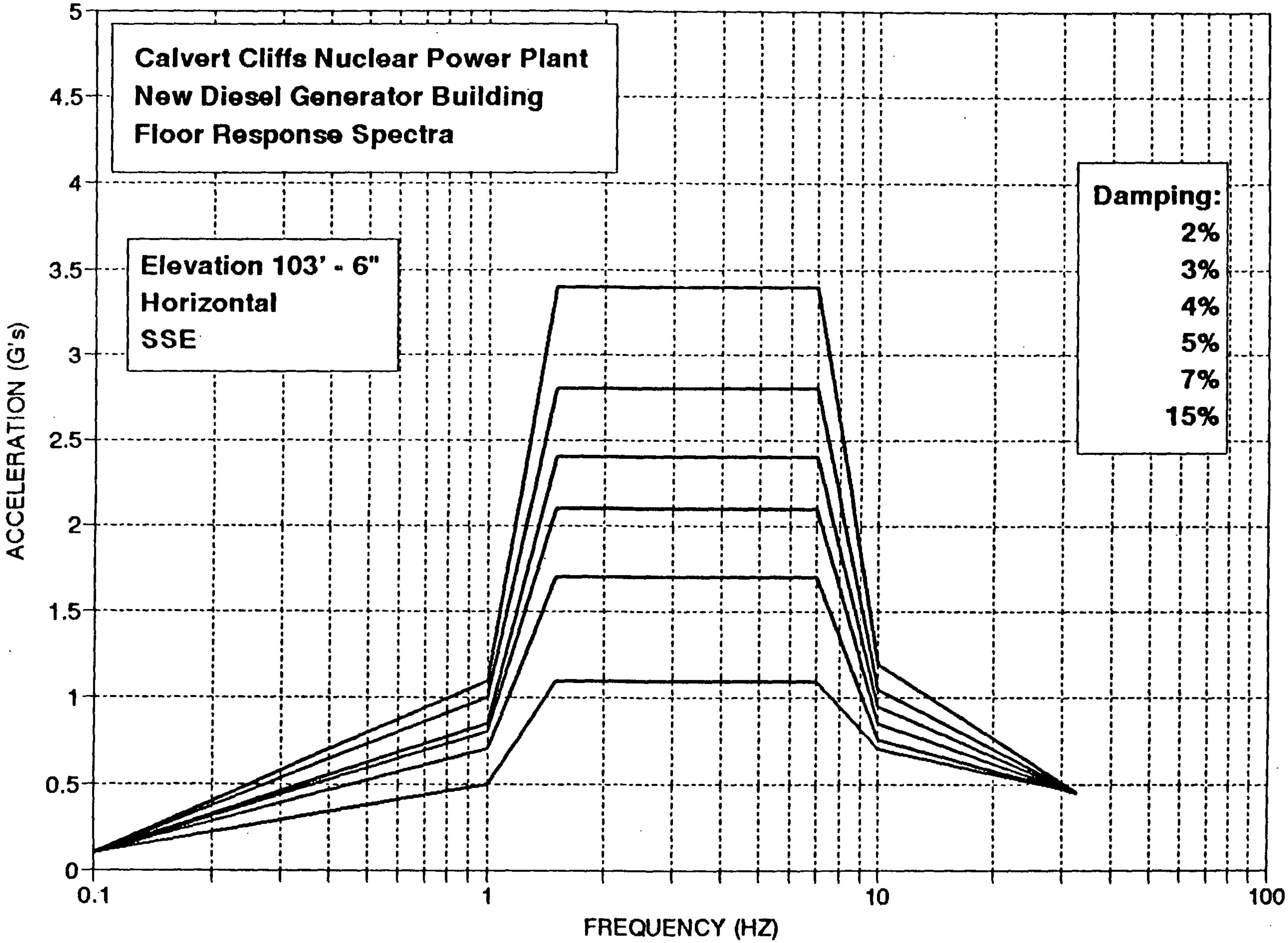

FIGURE 5-4 FLOOR RESPONSE SPECTRA (SSE)

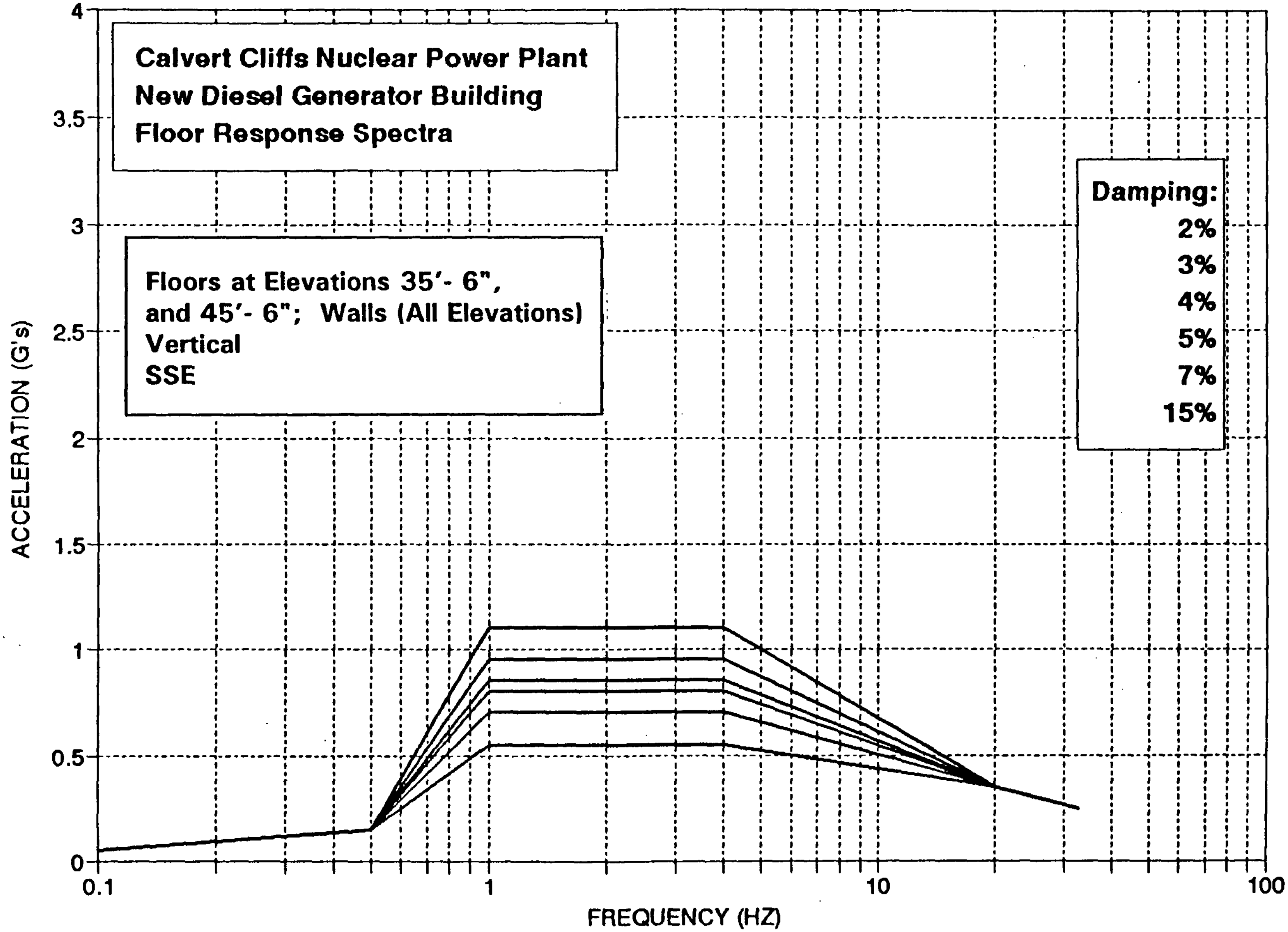

FIGURE 5-5 FLOOR RESPONSE SPECTRA (SSE)

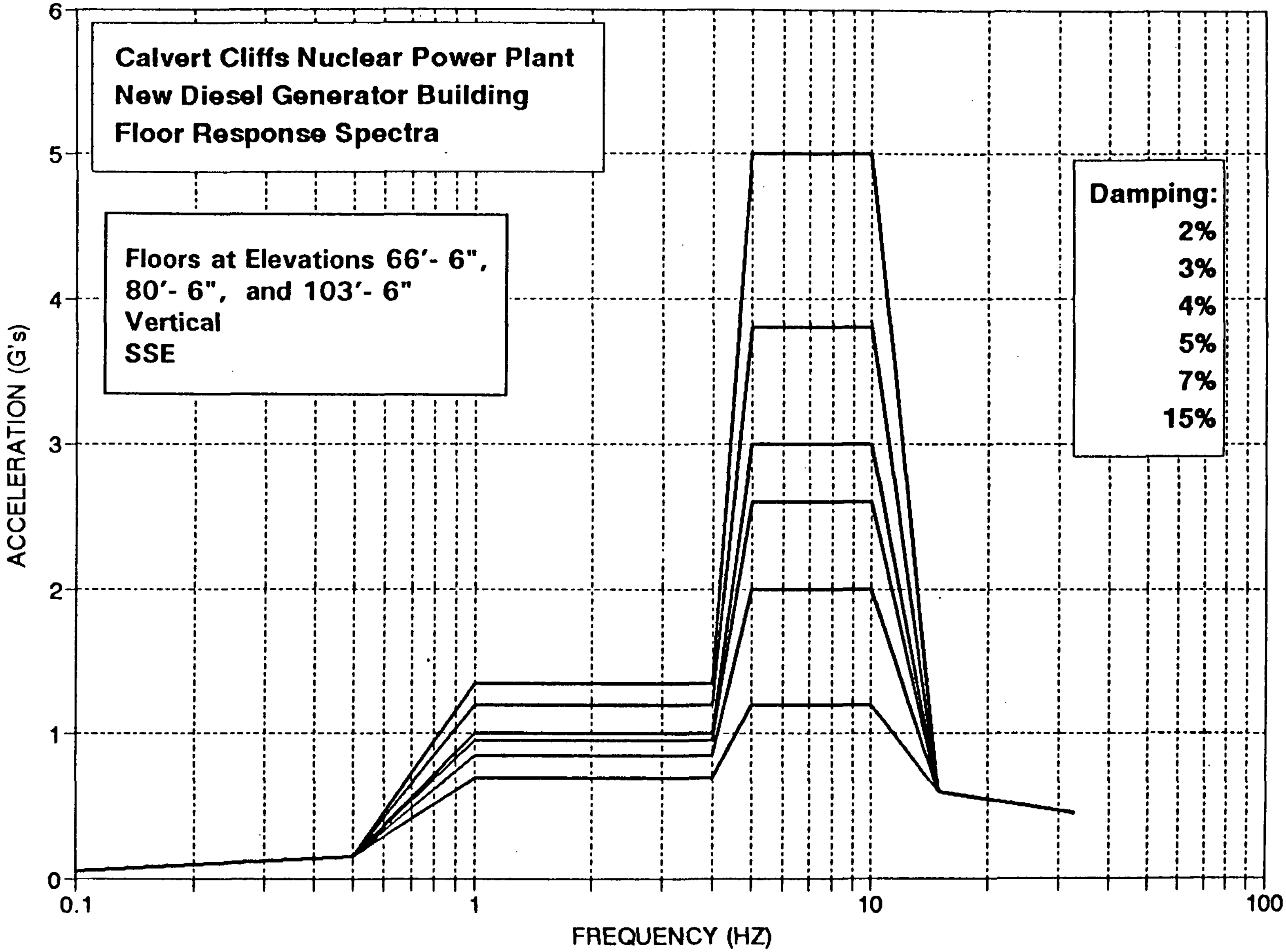

FIGURE 5-6 FLOOR RESPONSE SPECTRA (SSE)

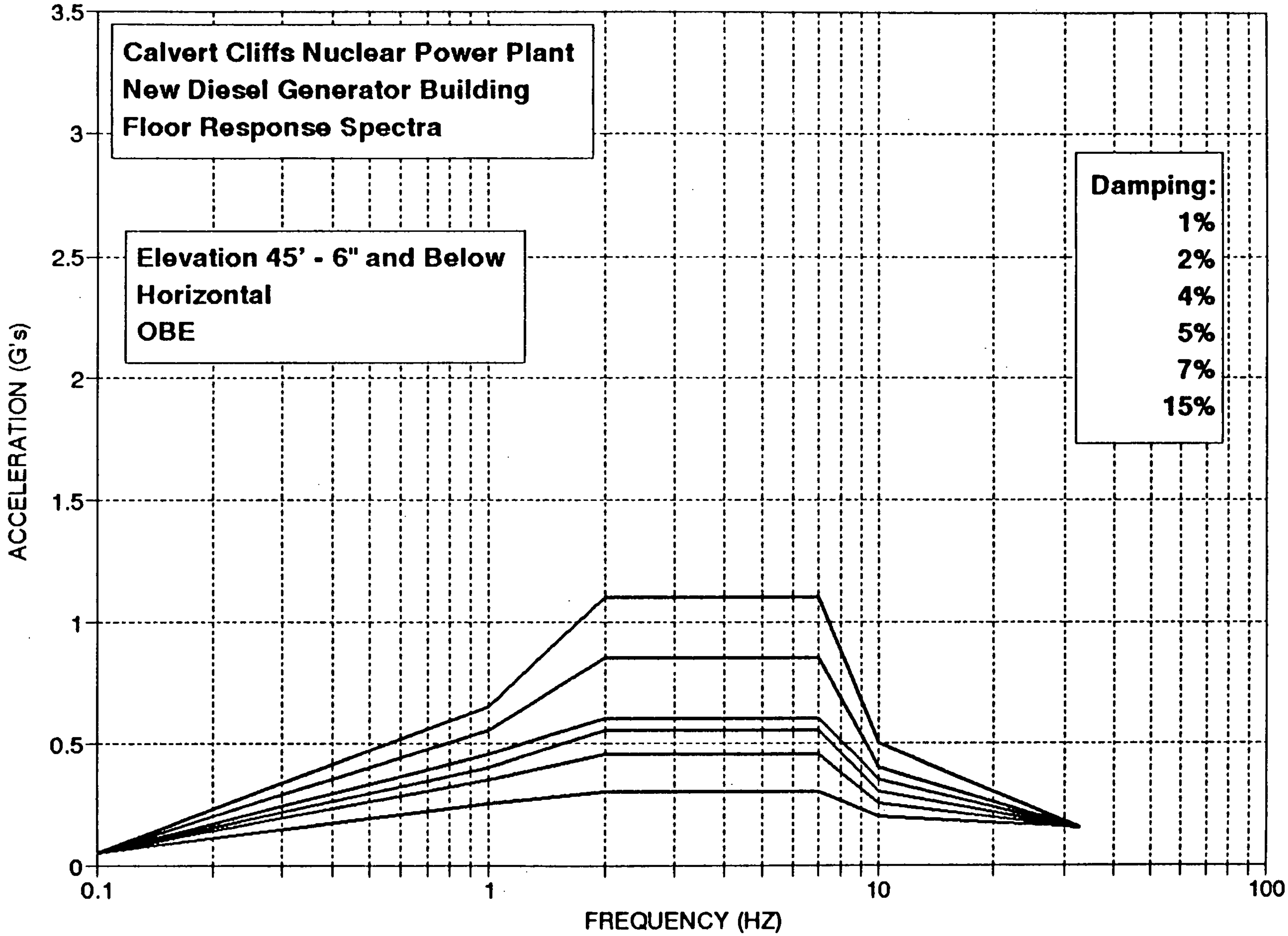

FIGURE 5-7 FLOOR RESPONSE SPECTRA (OBE)

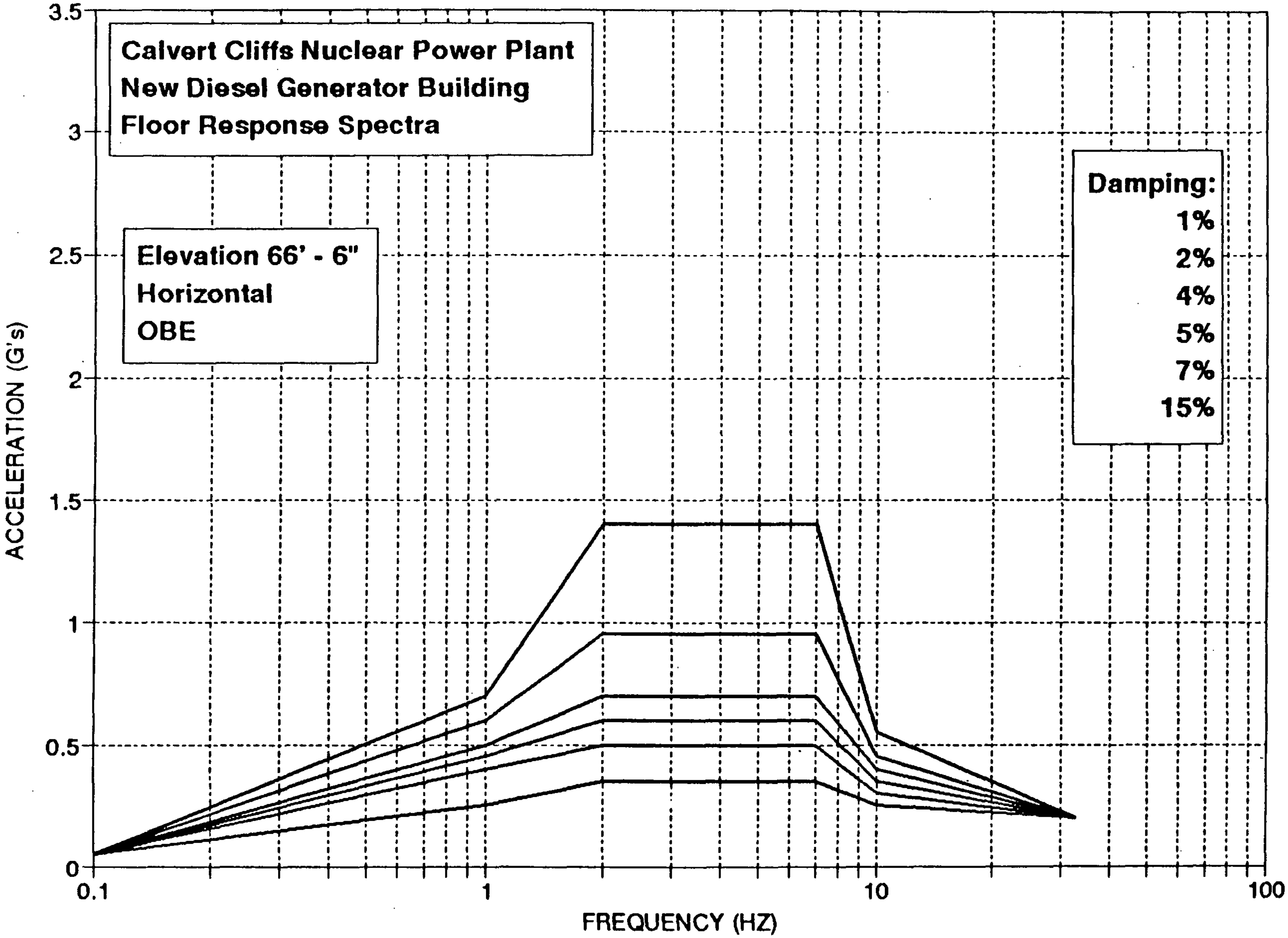

FIGURE 5-8 FLOOR RESPONSE SPECTRA (OBE)

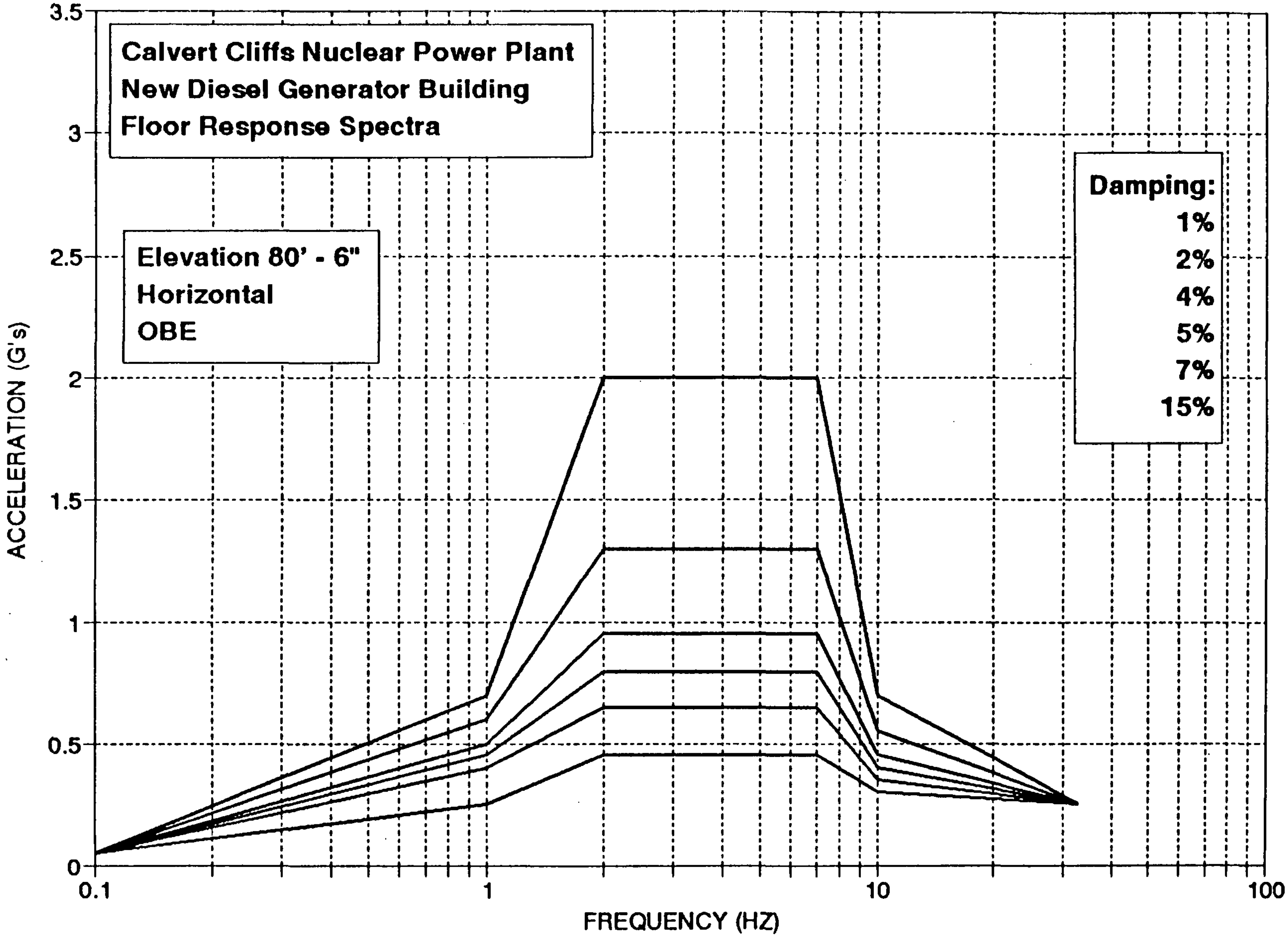

FIGURE 5-9 FLOOR RESPONSE SPECTRA (OBE)

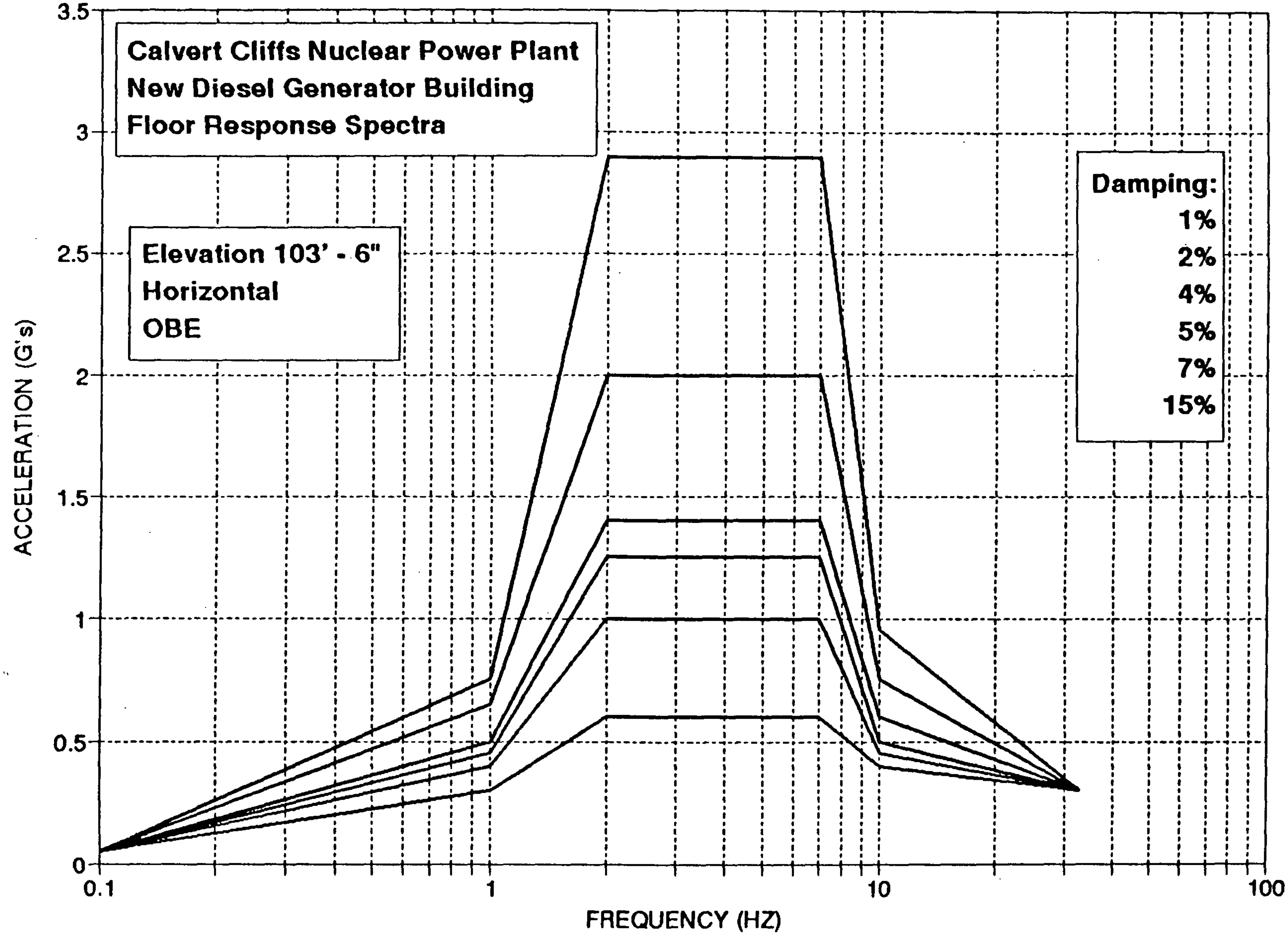

FIGURE 5-10 FLOOR RESPONSE SPECTRA (OBE)

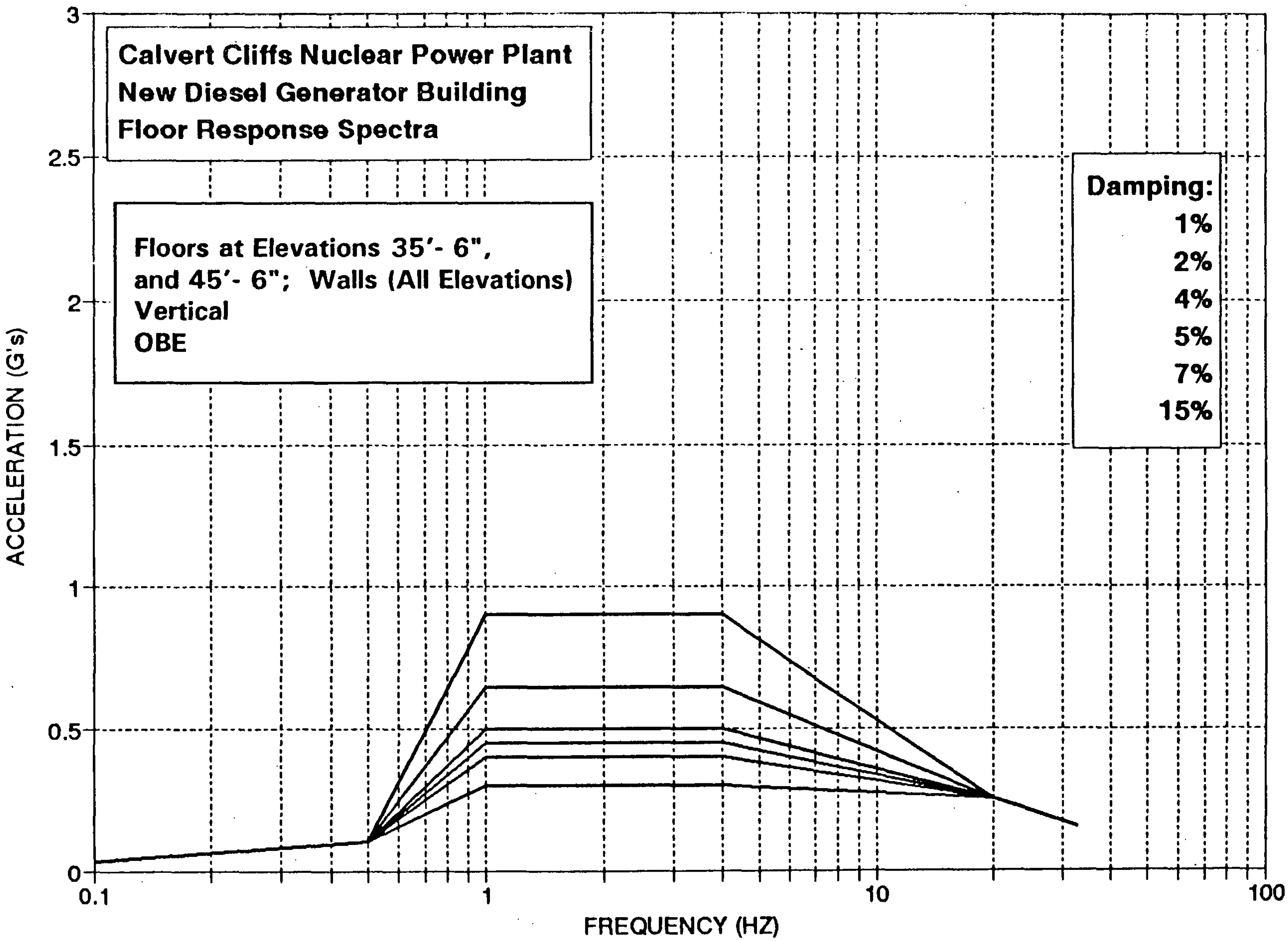

FIGURE 5-11 FLOOR RESPONSE SPECTRA (OBE)

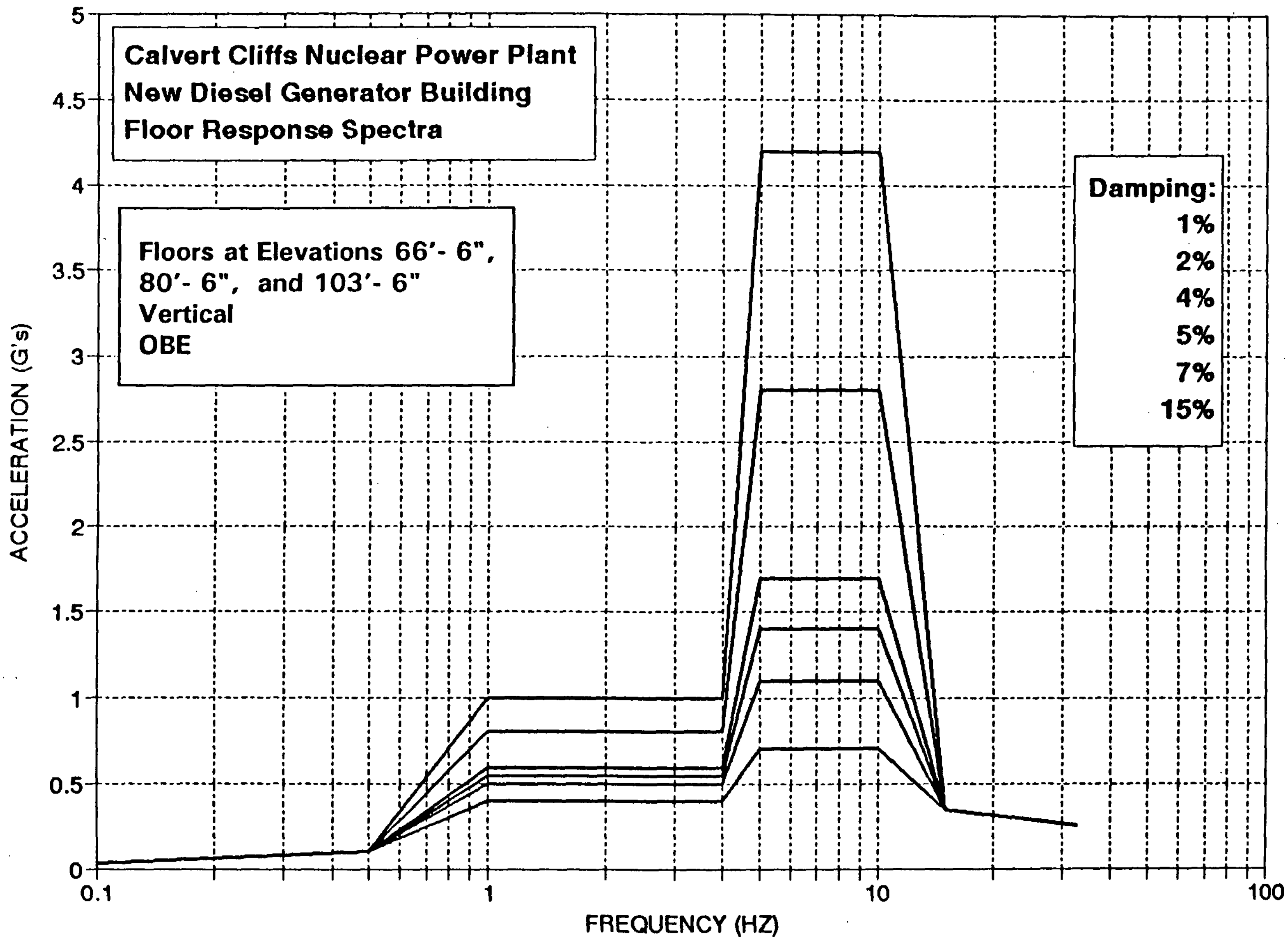

FIGURE 5-12 FLOOR RESPONSE SPECTRA (OBE)

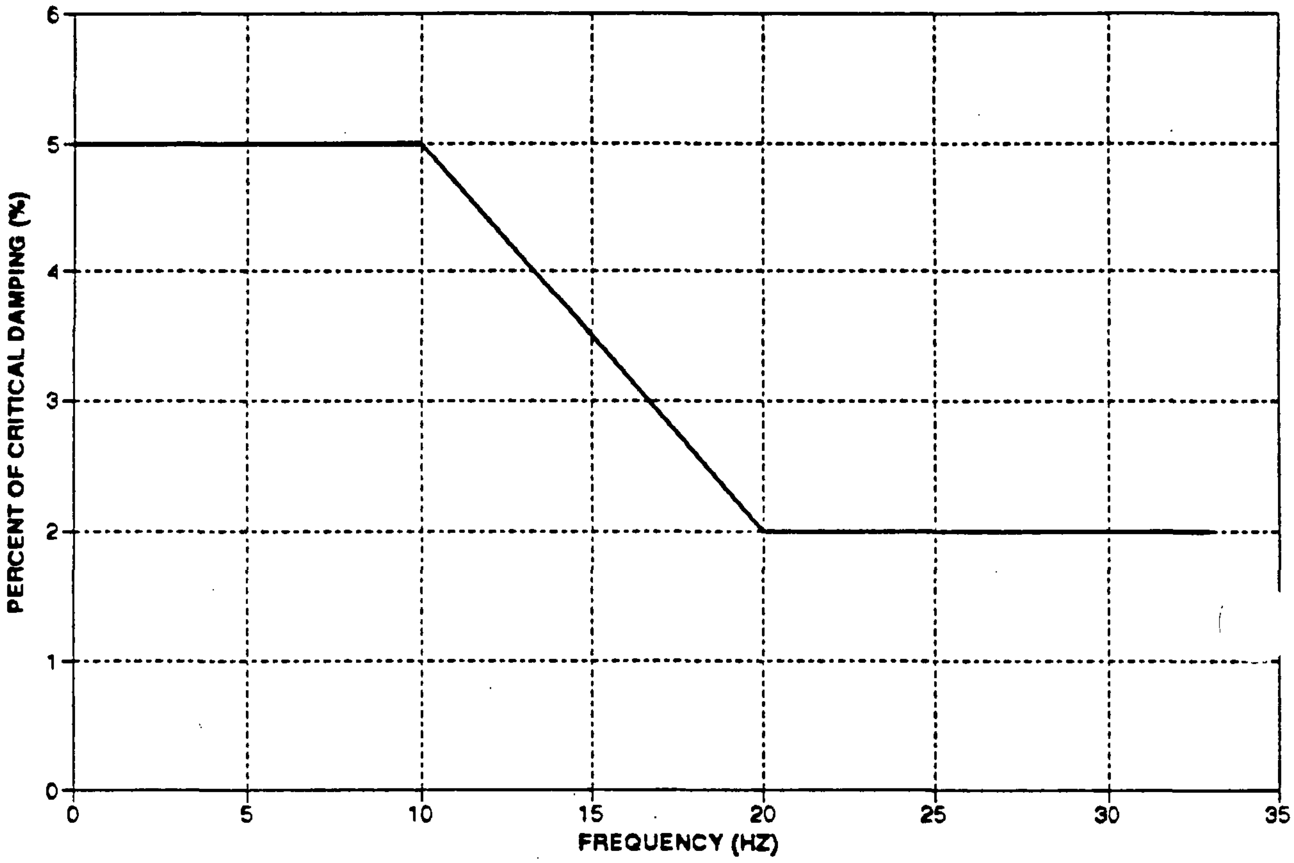

FIGURE 5-13 ALTERNATE DAMPING VALUES FOR PIPING

6.0 QUALITY ASSURANCE

6.1 DESIGN AND CONSTRUCTION QUALITY ASSURANCE

Baltimore Gas and Electric Company currently implements an NRC approved quality assurance (QA) program at our Calvert Cliffs Nuclear Power Plant which complies with the requirements of 10 CFR 50, Appendix B. Installation of the safety-related SACM diesel generator and the associated support systems will be performed in accordance with the requirements of this QA program. The construction contractor is typically responsible for the review and approval of any subcontractor QA programs in order to assure compliance with the requirements of 10 CFR 50, Appendix B. This will provide sufficient assurance that the fabrication and installation of SSCs for the Diesel Generator Building will meet the applicable design, material and fabrication requirements.

Design and construction activities will be performed by Bechtel Corporation. Bechtel's QA program for safety-related SSCs conforms to the applicable requirements of 10 CFR 50, Appendix B. The program addresses quality control functions and is applicable to construction activities involving SSCs designated in the design as Category I, Category II/I or Class 1E.

Most of the SSCs supplied by SACM are designed and fabricated to the manufacturer's standards. SACM is required, by contract, to apply a QA program which meets the requirements of 10 CFR 50, Appendix B. Our review of SACM's quality assurance program is described in Section 6.2.

Pipe and pipe support installation will be in accordance with ASME Section III (1986) Class 3 and ANSI/ASME B31.1 with the following exception:

- No N-Stamp will be used for installation. However, ASME Section III materials will be fabricated by the supplier with an N-Stamp.
- A Certificate of Authorization for construction of this facility will not be obtained.
- A quality assurance manual will not be filed with ASME.

Although no N-Stamp will be used for the installation of ASME III materials, an authorized nuclear inspector will perform independent third party checks on the installation of these materials.

6.2 SACM QUALITY ASSURANCE

SACM, a diesel generator manufacturer located in Mulhouse, France, was chosen via a competitive bid process, to supply a 5000 kW diesel generator. As the diesel is considered safety-related, an audit of SACM's 10 CFR Part 50 Appendix B Quality Assurance (QA) Program was performed prior to their selection as our supplier.

Since award of the contract, BG&E has formulated a dual-faceted approach for monitoring SACM's performance during the fabrication, and assembly and testing cycles. First, we have scheduled a series of audits which will focus on specific areas of SACM's QA Program. A brief outline of the tentative audit schedule and scope of each audit is provided as follows:

1st Audit:	Full scope, 10 CFR Part 50, Appendix B Audit	Completed March 1992
2nd Audit:	In-process Manufacturing Control, Resolution of Non-conformances, Control of Subsuppliers and Purchased Items	Late 1992 or Early 1993
3rd Audit:	Test Control, Packaging & Shipping	Summer 1993
4th Audit:	Record Retention, Design Control	Spring 1994

During each audit, BG&E will review and sign-off any documentation for components which have been completed at that time. Additionally, the audit schedule will coincide with major manufacturing and testing cycles, so that most of each audit will be performance-based.

Second, SACM develops a Plan de Qualite' de Realisation (PQR) for each major component which identifies the major operations, including inspection and testing requirements. Baltimore Gas and Electric Company has reviewed all of the PQRs and annotated all the witness and hold points that BG&E will impose, as well as concurring on those inspection points SACM will be responsible for. These PQRs include components manufactured by SACM's subsuppliers. Identifying hold and witness points for these items serves to supplement BG&E's monitoring of SACM's subsupplier controls.

Audit findings which were generated during the March 1992 audit have been responded to by SACM and corrective action proposed was acceptable and will be verified during the next audit. Areas covered by these findings included disposition of non-conforming lots during receipt inspection, control of distribution of internal QA manual, and calibration control. The following provides a brief summary and the present status of these findings:

- <u>Finding F92-SACM-01, Receiving Inspection - Disposition Of Lot Based On Non-Conforming Sample</u>

  SACM's procedure provides instructions that allow an "A-Grade" supplier to be accepted based on a 1 percent additional satisfactory sample, if the first 1 percent sample is found to be non-conforming. This was determined to be insufficient in providing assurance that the items received conform to the purchase order and specification requirements (Criterion VII of 10 CFR Part 50, Appendix B). SACM has revised this procedure to increase the lot size of a second sample taken when the first sample is found to be non-conforming. This finding is now closed based on reviews performed during a surveillance conducted in March 1993.

- Finding F92-SACM-01, Document Control

  Distribution and issuance of Revision B to SACM Manual QM004 has not been controlled in accordance with procedural requirements. This resulted in inability to provide evidence that manual holders possessed the latest revision of this manual. SACM has performed a surveillance of controlled copies of this manual to verify that all manuals contain the latest revision. Additionally, SACM is reviewing their distribution control requirements for all of their manuals to assure compliance with procedural requirements.

- Finding F92-SACM-03, Calibration Control

  Approximately 154 items of Measuring and Test Equipment (M&TE) had exceeded their calibration interval. It should be noted that this represents less than 1 percent of the total M&TE at SACM. SACM has responded that the calibration technician will perform a walkdown of all the shop areas in search of those items which have passed the calibration due date. This condition has been documented on an SACM non-conforming report. This finding is now closed based on reviews performed during a surveillance conducted in March 1993.

The findings identified do not have any significant impact on SACM's manufacturing capability, however these areas will be closely monitored during subsequent audits to ensure that problem areas have been corrected long-term. During this audit, BG&E identified a weakness in SACM's internal audit process. This was previously identified during the NRC's last audit of SACM and corrective action taken, pursuant to the NRC's finding has improved SACM's performance in this area.

For items procured from SACM which have been classified ASME Section III by BG&E, the Procurement Specification provides requirements addressing these items. The specification stipulates that SACM will perform qualification audits/surveys of all ASME certificate and stamp holders which they place on their approved vendors list. Also, the specification states that all code work shall be accomplished by ASME Section III stamp holders. Additionally, the PQRs (as previously described) for these ASME Section III components include BG&E hold points, which provides an additional level of review for determining that procurement code material is properly handled.

7.0 REFERENCES

1. "Seismic Analyses of Structures and Equipment for Nuclear Power Plants," Bechtel Corporation, BC-TOP-4A, Revision 3, San Francisco, November 1974.

APPENDIX A

CODES, STANDARDS AND REGULATIONS

CODES, STANDARDS AND REGULATIONS

UNITED STATES NUCLEAR REGULATORY COMMISSION

Title 10 of the Code of Federal Regulations

Safety Guide 6	3/71	Independence Between Redundant Standby (Onsite) Power Sources and Between Their Distribution Systems (Safety-Guide)

Division 1 Regulatory Guides

1.9 Draft Revision 3	4/92	Selection, Design, and Qualifications of Diesel Generator Units Used as Standby (Onsite) Electric Power Systems at Nuclear Power Plants
1.26	2/76	Quality Group Classification and Standards for Water, Steam, and Radioactive Waste-Containing Components of Nuclear Power Plants
1.29	9/78	Seismic Design Classification
1.36	2/73	Nonmetallic Thermal Insulation for Austenitic Stainless Steel
1.60	12/73	Design Response Spectra for Seismic Design of Nuclear Power Plants
1.61	10/73	Damping Values for Seismic Design of Nuclear Power Plants
1.75	9/78	Physical Independence of Electric Systems
1.76	4/74	Design Basis Tornado for Nuclear Power Plants
1.84	4/92	Design and Fabrication Code Case Acceptability - ASME Section III Division 1
1.85	4/92	Materials Code Case Acceptability - ASME Section III, Division 1
1.92	2/76	Combining Modal Responses and Spatial Components in Seismic Response Analysis

1.100	6/88	Seismic Qualification of Electric and Mechanical Equipment for Nuclear Power Plants
1.108	9/77	Periodic Testing of Diesel Generator Units Used as Onsite Electric Power Systems at Nuclear Power Plants (Errata to Regulatory Guide 1.108, 10/77)
1.137	10/79	Fuel-Oil Systems for Standby Diesel Generators
1.155	6/88	Station Blackout

NUREG 0700 9/81 Guidelines for Control Room Design Reviews

NUREG 0800 Standard Review Plans

3.2.1	1981	Seismic Classification
3.6.1	1990	Plant Design for Protection Against Postulated Piping Failures in Fluid Systems Outside Containment
3.6.2	1981	Determination of Rupture Locations and Dynamic Effects Associated with the Postulated Rupture of Piping
3.7.3	1989	Seismic Subsystem Analysis
3.9.2	1981	Dynamic Testing and Analysis of Systems, Components, and Equipment
3.9.3	1981	ASME Code Class 1, 2, and 3 Components, Component Supports and Core Support Structures
3.10	1981	Seismic Qualification of Category I Instrumentation and Electrical Equipment
3.11	1981	Environmental Design of Mechanical and Electrical Equipment
9.5.1	1981	Fire Protection Program
9.5.4	1981	Emergency Diesel Engine Fuel Oil Storage and Transfer System

9.5.5	1981	Emergency Diesel Engine Cooling Water System
9.5.6	1981	Emergency Diesel Engine Starting System
9.5.7	1981	Emergency Diesel Engine Lubrication System
9.5.8	1981	Emergency Diesel Engine Combustion Air Intake and Exhaust System
CMEB 9.5-1	1981	Guidelines for the Fire Protection for Nuclear Power Plants
MEB 3-1	1987	Postulated Rupture Locations in Fluid System Piping Inside and Outside Containment
ICSB 17	1981	Diesel Generator Protective Trip Circuit Bypass
PSB 2	1981	Criteria for Alarms and Indicators Associated with Diesel Generator Unit Bypassed and Inoperable Status
NUREG/CR-1161	1980	Recommended Revisions to Nuclear Regulatory Commission Seismic Design Criteria
NUREG/CR-3599	1984	Sources of Uncertainty in the Calculation of Loads on Supports of Piping Systems
NUREG/CR-4785	1987	Review and Evaluation of Design Analysis Methods for Calculating Flexibility of Nozzles and Branch Connections

STATE OF MARYLAND REGULATIONS

COMAR 09.20	1991	State Board of Plumbing
COMAR 26.11	1989	Maryland Air Pollution Control Regulation

CODES AND STANDARDS

ASA - Acoustical Society of America

47 ANSI S1.4	1983	Specification for Sound Level Meters
65 ANSI S1.11	1986	Specification for Octave-Band and Fractional-Octave-Band Analog and Digital Filters

ARI - Air Conditioning and Refrigeration Institute

410	1987	Standard for Forced Circulation Air-Cooling and Air-Heating Coils
520	1987	Standard for Positive Displacement Refrigeration Compressor and Condensing Units
850	1984	Commercial and Industrial Air Filter Equipment

AMCA - Air Movement and Control Association

210	1985	Test Code for Air Moving Devices
211	1987	Certified Rating for Air Moving Devices
300	1967	Reverberant Room Method for Sound Testing of Fans
500	1986	Test Method for Louvers, Dampers, and Shutters

AISC - American Institute of Steel Construction

Ninth Edition	1989	Manual of Steel Construction, Allowable Stress Design

ANSI - American National Standards Institute

B16.5	1988	Pipe Flanges and Flanged Fittings
B16.11	1980	Forged Steel Fittings, Socket-Welding and Threaded
B16.25	1986	Buttwelding Ends
B16.34	1988	Valves-Flanged, Threaded and Welding Ends
B30.16	1987	Overhead Hoists
B31.1 (ANSI/ASME)	1989	Power Piping
B31.5	1991	Refrigeration Piping Systems
B36.10	1985	Welded and Seamless Wrought Steel Pipe

B36.19	1985	Stainless Steel Pipe
C2	1990	National Electric Safety Code
C39.1	1981	Requirements for Electrical Analog Indicating Instruments
C50.12	1982	Requirements for Salient Pole Synchronous Generators and Generator/Motors for Hydraulic Turbine Applications
C50.13	1989	Rotating Electrical Machinery - Cylindrical-Rotor Synchronous Generators
C50.41	1982	Polyphase Induction Motors for Power Generating Stations
MC96.1	1982	Temperature Measurement Thermocouples
N45.2.2	1978	Packaging, Shipping, Receiving, Storage and Handling of Items for Nuclear Power Plants
N45.2.9	1979	Requirements for Collection, Storage, and Maintenance of Quality Assurance Records for Nuclear Power Plants
N45.2.11	1974	Quality Assurance Requirements for the Design of Nuclear Power Plants
S1.13	1971	Measurement of Sound Pressure Levels (Reaffirmed 1986)

ANS - American Nuclear Society

2.12	1978	Guidelines for Combining Natural and External Man-Made Hazards at Power Reactor Sites
59.51	1989	Fuel Oil Systems for Emergency Diesel Generators
7-4.3.2	1982	Application Criteria for Programmable Digital Computer Systems in Safety Systems of Nuclear Power Generating Stations (Reaffirmed 1990)

API - American Petroleum Institute

STD 527	1991	Commercial Seat Tightness of Safety Relief Valves with Metal-to-Metal Seats
STD 610	1989	Centrifugal Pumps for General Refinery Services
STD 650	1988	Welded Steel Tanks for Oil Storage
STD 661	1978	Air Cooled Heat Exchanger for General Refinery Service (errata 1984) (Reaffirmed 1987)

ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

Standard 15	1989	Safety Code for Mechanical Refrigeration
Standard 52	1976	Method of Testing Air Cleaning Devices used in General Ventilation for Removing Particulate Matter
Standard 62	1989	Ventilation for Acceptable Indoor Air Quality
Standard 70	1972	Method of Testing for Rating the Air Flow Performance of Outlets and Inlets

ASME - American Society of Mechanical Engineers

ASME BOILER AND PRESSURE VESSEL CODE

	1986	Section II, Material Specifications
	1986	Section III, Subsections NCA, ND and NF, Non-Mandatory Appendices F and K - 1989 - Nuclear Power Plant Components Division 1
	1986	Section V, Nondestructive Examination
	1986	Section VIII, Unfired Pressure Vessels, Division 1
	1986	Section IX, Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators

Code Case N-253-6	1991	Construction of Class 2 or Class 3 Components for Elevated Temperature Service
Code Case N-316	1987	Alternative Rules for Fillet Weld Dimensions for Socket Welded Fittings Section III, Division I, Class 1, 2, and 3
Code Case N-411	1989	Alternative Damping Values for Response Spectra Analysis of Class 1, 2, and 3 Piping.
Code Case N-468	1989	Alternate Methods of Earthquake Description for Class 2 and 3 Piping at Low Seismicity Sites
Code Case N-476	1986	Class 1, 2, 3, and MC Linear Component Supports - Design Criteria for Single Angle Members Section III, Division 1, Subsection NF

Performance Test Codes

PTC-17	1973	Reciprocating Internal Combustion Engines (Reaffirmed 1985 and 1991)
PTC-19.5	1972	Application Part II of Fluid Meters
PTC-26	1962	Speed Governing Systems for Internal Combustion Engine-Generator Units

ASTM - American Society for Testing and Materials Standards

A36	1990	Standard Specification for Structural Steel
C 1071	1986	Specification for Thermal and Acoustic Insulation
D 975	1989	Standard Specification for Diesel Fuel Oil
E 119	1990	Standard Methods of Fire Tests of Building Construction and Materials

AWS - American Welding Society Standards and Specifications

D1.1	1990	Structural Welding Code Steel
D1.3	1989	Structural Welding Code Sheet Metal

D9.1	1984	Specification for Welding of Sheet Metal

Calvert Cliffs Documentation

Revision 14		*Calvert Cliffs Nuclear Power Plant Units 1 and 2 Updated Final Safety Analysis Report*

DEMA - Diesel Engine Manufacturers Association

	1972	Standard Practices for Stationary Diesel or Gas Engines
	1985	Test Code for Measurement of Sound From Heavy Duty Reciprocating Engines

IEEE - Institute of Electrical and Electronics Engineers

32	1972	Standard Requirements, Terminology, and Test Procedure for Neutral Grounding Devices (Reaffirmed 1990)
112	1984	Standard Test Procedure for Polyphase Induction Motors and Generators
113	1985	Guide: Test Procedures for Direct-Current Machines
114	1982	Standard Test Procedures for Single-Phase Induction Motors
115	1983	Guide: Test Procedures for Synchronous Machines
126	1959	Recommended Specification for Speed Governing of Internal Combustion Engine-Generator Units (Reaffirmed 1983)
308	1980	Standard Criteria for Class 1E Power Systems for Nuclear Power Generating Stations
323	1983	Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations (Reaffirmed 1990)
334	1974	Standard for Type Tests of Continuous Duty Class 1E Motors for Nuclear Power Generating Stations (Reaffirmed 1980)

336	1985	Standard Installation, Inspection, and Testing Requirements for Power, Instrumentation, Control Equipment at Nuclear Facilities
344	1974	Recommended Practices for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations, as endorsed by Regulatory Guide 1.100, Rev. 1.
344	1987	Recommended Practices for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations, as endorsed by Regulatory Guide 1.100, Rev. 2.
352	1987	Guide for General Principles of Reliability Analysis of Nuclear Power Generating Station Safety Systems
381	1977	Standard Criteria for Type Test of Class 1E Modules in Nuclear Power Generating Stations (Reaffirmed 1984)
383	1974	Standard for Type Test of Class 1E Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations (Reaffirmed 1980)
384	1981	Standard Criteria for Independence of Class 1E Equipment and Circuits
387	1984	Diesel Generator Units Applied as Standby Power Supplies for Nuclear Power Generating Stations
420	1982	Standard for the Design and Qualification of Class 1E Control Boards, Panels and Racks Used in Nuclear Power Generating Stations
421.2	1990	Guide for Identification, Testing and Evaluation of the Dynamic Performance of Excitation Control Systems
421B	1979	Standard for High-Potential-Test Requirements for Excitation Systems for Synchronous Machines (Reaffirmed 1984)
749	1983	Standard Periodic Testing of Diesel Generator Units Applied as Standby Power Supplies in Nuclear Power Generating Stations

1012	1986	Standard for Software Verification and Validation Plans
1050	1989	Guide for Instrumentation and Control Equipment Grounding in Generating Stations
C37.18	1979	Standard Enclosed Field Discharge Circuit Breakers for Rotating Electric Machinery
C37.90	1989	Standard for Relays and Relay Systems Associated with Electric Power Apparatus
C37.98	1987	Seismic Testing of Relays
C57.13	1978	Standard Requirements for Instrument Transformers (Reaffirmed 1986)

ISA - Instrument Society of America

RP7.1	1956	Pneumatic Control Circuit Pressure Test, Recommended Practice
S18.1	1979	Annunciator Sequences and Specifications (Reaffirmed 1985)
S51.1	1979	Process Instrumentation Terminology

Manufacturer's Standards

Piping, pumps, valves, heat exchangers, flexible hoses, and other items mounted on the main diesel engine and auxiliary skids are manufactured in accordance with the manufacturer's standards. Additionally, the thermostatic valves in the HT and LT cooling system are manufactured in accordance with the manufacturer's standards.

MIL - Military Standards

STD-248D		Welding and Brazing Procedural and Performance Qualification

MSS - Manufacturers Standardization Society of the Valve and Fittings Industry

SP-55	1985	Quality Standard for Steel Castings for Valves, Flanges and Fittings and other Piping Components (Visual Method)

SP-58	1988	Pipe Hangers and Supports, Materials, Design and Manufacture
SP-61	1985	Pressure Testing of Steel Valves
SP-69	1983	Pipe Hangers and Supports - Selection and Application
SP-89	1985	Pipe Hangers and Supports - Fabrication and Installation Practices
SP-90	1990	Guidelines on Terminology for Pipe Hangers and Supports

NEMA - National Electrical Manufacturers Association

ICS 1	1988	General Standards for Industrial Control and Systems
ICS 2	1988	Industrial Control Devices, Controllers and Assemblies
ICS 6	1988	Enclosures for Industrial Control and Systems
MG 1	1987	Motors and Generators
MG 2	1983	Safety Standard for Construction and Guide for Selection, Installation, and Use of Electric Motors
MG 13	1984	Frame Assignments for Alternating Current Integral-Horsepower Induction Motors

NFPA - National Fire Protection Association

10	1990	Standard for Portable Fire Extinguishers
13	1991	Standard for the Installation of Sprinkler Systems
14	1990	Standard for the Installation of Standpipe and Hose Systems
24	1992	Standard for the Installation of Private Fire Service Mains and their Appurtenances
30	1990	Flammable and Combustible Liquids Code
37	1990	Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines

69	1986	Standard on Explosion Prevention Systems
72	1990	Standard for the Installing, Maintenance, and Use of Protective Signalling Systems
72E	1990	Standard on Automatic Fire Detectors
90A	1989	Installation of Air Conditioning and Ventilation Systems
91	1990	Standard for the Installation of Blower and Exhaust Systems for Dust, Stock, and Vapor Removal or Conveying

PFI - Pipe Fabrication Institute Standards

ES-24	1984	Pipe Bending Methods, Tolerances, Process and Material Requirements

Standard Building Code

1991 Edition	*Standard Building Code*, Southern Building Code Congress International, Inc.

SMACNA - Sheet Metal and Air Conditioning Contractors' National Association

1990	HVAC Duct Design
1980	Rectangular Industrial Duct Construction
1985	HVAC Duct Construction Standards Metal and Flexible
1977	Round Industrial Duct Construction
1983	HVAC Systems-Testing, Adjusting, and Balancing

SSPC - Steel Structures Painting Council Standards

SP-1	1982	Surface Preparation Specification No. 1 Solvent Cleaning
SP-2	1989	Surface Preparation Specification No. 2 Hand Tool Cleaning
SP-3	1989	Surface Preparation Specification No. 3 Power Tool Cleaning

SP-5	1989	Surface Preparation Specification No. 5 White Metal Blast Cleaning
SP-6	1989	Surface Preparation Specification No. 6 Commercial Blast Cleaning
SP-8	1991	Surface Preparation Specification No. 8 Pickling
SP-10	1989	Surface Preparation Specification No. 10 Near White Blast Cleaning

TEMA - Tubular Exchanger Manufacturers Association

	1988	Standards of Tubular Exchanger Manufacturer's Association, 7th Edition

29 CFR - Title 29 (Occupational Safety and Health Administration) Code of Federal Regulations

Part 1910		Occupational Health and Safety Standards

ACI - American Concrete Institute

117	1990	Standard Specification for Tolerances for Concrete Construction and Materials

EPRI - Electric Power Research Institute

NP-5024	1/87	Seismic Ruggedness of Aged Electrical Components
NP-5652	6/88	Guidelines for Utilization of Commercial Grade Items in Nuclear Safety Related Applications
NP-6314 (NUMAC 88.02)	8/88	Storage and Handling of Fuel Oil for Standby Diesel Generator Systems
NP-6406	12/89	Guidelines for Technical Evaluation of Replacement Items in Nuclear Power Plants

IEC - International Electrotechnical Commission

529	1976	Degrees of Protection Provided by Enclosures

UL - Underwriters Laboratories Standards

555	1990	Fire Dampers
674	1989	Electric Motors for Use in Hazardous (Classified) Locations
705	1990	Power Ventilators
823	1991	Electric Heaters for Use in Hazardous (Classified) Locations
883	1989	Fan Coil Units and Fan Heater Units

Welding Research Council

Bulletin 316	1986	Technical Position on Piping System Installation Tolerances
Bulletin 353	1990	Position Paper on Nuclear Plant Pipe Supports