ATTACHMENT (1)

INSTRUMENTATION & CONTROL SYSTEMS

DESIGN REPORT

EMERGENCY DIESEL GENERATOR PROJECT

Baltimore Gas and Electric Company

Calvert Cliffs Nuclear Power Plant

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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, as required by NUMARC Station Blackout Initiative 1, and provide spare capacity for future plant modifications. The installation of the SACM diesel generator will increase the site total to four safety-related diesel generators and reduce the required coping duration to four hours. In addition, Baltimore Gas & Electric Company is installing an alternate AC power source which will meet the criteria provided in NUMARC 87-00, Appendix B and Regulatory Guide 1.155, Appendix A.

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 new safety-related diesel generator. The diesel generator project was initiated to install the new air-cooled 5400 kW (nominal continuous rating) Class 1E diesel generator in the 4.16 kV bus system. A nonsafety-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 generators. 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 to accommodate the additional diesel generator controls.

In order to obtain 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, SACM Diesel Generator and Mechanical Systems, Instrumentation and Controls, and Electrical Engineering. 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 shut down the units following a design basis accident coincident with a loss-of-offsite power. This design report provides design information for instrumentation and control systems for the diesel generator auxiliary systems and the Diesel Generator Building support systems located within the Diesel Generator Building. The intent of this report is to establish the functional adequacy of instrumentation and control systems associated with the SACM diesel generator (and its associated auxiliaries) for Unit 1 at the Calvert Cliffs Nuclear Power Plant. Connection of new instrumentation and control systems, such as control panels located in the Main Control Room, to existing systems will be addressed under the 50.59 process. However, some instrumentation and control systems

outside the Diesel Generator Building are briefly described in order to provide a more complete system description.

Chapter 6.0 of the SACM Diesel Generator and Mechanical Systems Design Report describes the quality assurance requirements for the fabrication and installation of SSCs associated with the SACM diesel generator.

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.

To the maximum extent possible, construction sequencing will be planned to allow installation during unit operation, with minimal disruption of plant activities. Critical installation interfaces will be planned to occur during scheduled unit outages.

2.0 INSTRUMENTATION AND CONTROL SYSTEM EQUIPMENT

This chapter of the design report contains information to support the installation and licensing of instrumentation and control systems associated with the SACM diesel generator. The following sections summarize and expand upon information previously discussed in other design reports.

2.1 BACKGROUND

The (onsite) electrical power system[1] is the power source used in or associated with shutting down the reactor, maintaining it in a safe shutdown condition and preventing the release of radioactive material during and following a design basis event. The systems used to shut down the plant are divided into two separate load groups, group A and group B, each fed from a Class 1E diesel generator or plant service transformers.

A simplified diagram of the existing diesel generator arrangement is shown in Figure 2-1. DG 11 and DG 21 can be aligned to any one of two (one for each Unit) 4.16 kV engineered safety features buses[2]. DG 12 can be aligned to any one of the four engineered safety features buses. Since the diesel generators can supply power to either unit, each diesel generator uses independent starting signals (SIAS and engineered safety features bus undervoltage) from both Units.

With the addition of the SACM diesel generator and the re-alignment of the three original diesel generators, there is a dedicated diesel generator for each 4.16 kV engineered safety features bus (two dedicated diesel generators per unit). A simplified diagram of the new diesel generator arrangement after the addition of a SACM diesel generator is shown in Figure 2-2.

Following the addition of the new SACM diesel generator, each of the four diesel generators will be dedicated to a single 4.16 kV engineered safety features bus. Diesel generator configuration will be as follows:

- The SACM diesel generator, designated DG 1A, will be connected to the 4.16 kV Emergency Bus 11. The existing connection from DG 11 to 4.16 kV Emergency Bus 11 will be removed.
- DG 11, redesignated as DG 2A, will be dedicated to 4.16 kV Emergency Bus 21.
- DG 21, redesignated as DG 2B, will remain connected to 4.16 kV Emergency Bus 24. The existing connection from DG 21 to 4.16 kV Emergency Bus 14 will be removed.

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[1] Hereafter referred to as the standby electrical power system.

[2] The 4.16 kV engineered safety features buses are designated as 4.16 kV Emergency Buses 11, 14, 21 and 24.

- DG 12, redesignated as DG 1B, will be dedicated to 4.16 kV Emergency Bus 14. Existing connections to the other 4.16 kV Emergency Buses will be removed.

A detailed description of the modifications made to the standby electrical power system are described in subsections of Chapter 2.0 of the Electrical Engineering Design Report.

Separate Category I buildings provide physical separation between the SACM diesel generator and the other diesel generators. This separation provides fire and missile protection between the SACM diesel generator and the other dedicated diesel generators. In addition, the Category I Diesel Generator Building provides protection from rain, wind, flooding and other natural phenomena.

2.2 DESIGN BASES

- Portions of the instrumentation and control systems which are required for the operation of the SACM diesel generator are designed to remain functional during and after a safe shutdown earthquake.

- Instrumentation and control systems allow testing the standby electrical power system in accordance with 10 CFR Part 50, Appendix A, General Design Criteria 18.

- In accordance with 10 CFR Part 50, Appendix A, General Design Criteria 17, the diesel generator instrumentation and control systems 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 a dedicated diesel generator to supply power to redundant safety-related equipment required for safe shutdown or accident mitigation.

- The failure of nonsafety-related instrumentation and control system equipment will not prevent the operation of safety-related systems, structures or components.

- Cables and circuits associated with diesel generator systems are designed to meet the requirements of Appendix R to 10 CFR 50.

- The SACM diesel generator is provided with a control system that permits automatic and manual control. The automatic start signal is functional except when the diesel generator is in the maintenance mode. Provision is made for controlling the diesel generator from either the Main Control Room or the Diesel Generator Building Control Room.

2.3 DIESEL GENERATOR STARTING CIRCUITS

2.3.1 SYSTEM DESCRIPTION

Upon receipt of the following signals, the SACM diesel generator is designed to start and accelerate to the rated voltage and speed:

- Safety injection actuation signal (SIAS)
- 4.16 kV Emergency Bus 11 undervoltage signal
- Manual switch operation from the Main Control Room
- Manual switch operation from the Diesel Generator Building Control Room
- Emergency manual switch operation (located in the Diesel Generator Building Control Room)

The SIAS is part of the Engineered Safety Features Actuation Systems at the Calvert Cliffs Nuclear Power Plant. These systems are described in Section 7.3 of the UFSAR. Independent pressure transmitters are used to sense containment pressure and reactor coolant system pressurizer pressure. The pressure transmitters at each unit are designed to detect a loss-of-coolant accident and initiate two independent SIASs.

One function of a SIAS is to initiate a diesel generator start. Components used to generate a SIAS for the existing diesel generators are also used for the SACM diesel generator. Modifications made to the standby electrical power system disconnect the existing Unit 1 starting signal from DG 11 (redesignated as DG 2A) and reconnect it to the SACM diesel generator, DG 1A. Independence is assured by using separate SIASs to start redundant diesel generators at each Unit (one signal for each diesel generator).

4.16 kV Emergency Bus 11 voltage is sensed by two existing sets of dual level undervoltage relays. The dual level undervoltage relays are described in Section 8.4.1.2 of the UFSAR and Sections 2.3.1 and 2.3.4 of the Electrical Engineering Design Report. These relays currently provide a starting signal for DG 11. Modifications made to the standby electrical power system also disconnect the existing Emergency Bus 11 (Unit 1 Facility ZA) undervoltage relays from the starting circuits of DG 11 and reconnect them to the starting circuits of DG 1A. The bus undervoltage signal used to start DG 1A is a separate signal from the bus undervoltage signal used to start the redundant diesel generator at Unit 1 (DG 1B).

"Fast Start" and "Slow Start" switches are provided in both the Main Control Room and the Diesel Generator Building Control Room to manually start the SACM diesel generator. For manual starts or periodic testing, the diesel generator can be started and stopped through the use of manual switches. Depending upon which switch is selected, two acceleration times are available. Both starts

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 provides a longer acceleration time (or slower ramp) 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 emergency bus undervoltage signal.
>
> The FAST START provides a direct simulation of the rapid acceleration required in response to any automatic start signal.

Operation of an emergency manual switch, located in the Diesel Generator Building Control Room, will manually start the diesel generator. The emergency manual switch will only start the diesel generator when the "local/auto-remote" selector switch is placed in the auto-remote position.

2.3.2 Component Description

As described in Section 2.1, DG 11, DG 21 and DG 12 are equipped with starting signals from both Units. The logic diagram for the three existing diesel generators is shown in Figure 8-6 of the UFSAR. Following the addition of the SACM diesel generator, each diesel will only start on a signal from the Unit to which it is dedicated. Therefore, dedication of the diesel generators will result in the disconnection of some of the starting signals from the existing diesel generators.

When disconnected, existing components for the automatic starting circuits associated with Emergency Bus 11 will be used for the SACM diesel generator. Therefore, the instrumentation and controls used to automatically start the SACM diesel generator during emergency operation[3] will be similar to those currently used to start the existing diesel generators.

2.4 DIESEL GENERATOR BUILDING HEATING AND VENTILATION SYSTEM (HVAC)

The following sections describe the safety-related controls and instrumentation for the Diesel Generator Building HVAC system. The design bases and a detailed description of mechanical components in the HVAC system are provided in Section 4.3 of the SACM Diesel Generator and Mechanical Systems Design Report.

2.4.1 System Description

The HVAC system is divided into safety-related and nonsafety-related subsystems. During normal plant operation, the diesel generator is not in operation and the nonsafety-related HVAC subsystem provides cooling for the Diesel Generator Building using an air conditioning system. Through the

[3] Diesel generator emergency operation is defined as a start due to a SIAS or a bus undervoltage condition.

use of an economizer cycle, outdoor air and return air are mixed in order to maintain Diesel Generator Building temperatures within design limits. Unit and duct-mounted heaters are provided for temperature control.

During diesel generator emergency operation, the safety-related HVAC subsystem provides Diesel Generator Building ventilation. This subsystem provides building ventilation using safety-related supply and exhaust fans (which only supply outdoor ambient air) and four safety-related fans (which recirculate air between the Diesel Generator Room and the Diesel Generator Fan Room). Duct-mounted heaters temper the air supplied to rooms serviced by the safety-related supply fan. A safety-related temperature control station controls safety-related motor-operated dampers in the Diesel Generator Fan Room and adjusts blade pitch on the supply and exhaust fans to provide a mixture of outdoor and recirculated air for temperature control. For example, as the outdoor temperature drops, the amount of outdoor air supplied to the building is decreased and motor-operated dampers in the Diesel Generator Fan Room reposition to increase the amount of air recirculated within the Diesel Generator Room.

A portion of the safety-related HVAC subsystem shares common ductwork with some of the nonsafety-related HVAC subsystem to ventilate the Diesel Generator Building. The shared ductwork is safety-related and is isolable from nonsafety-related portions of the HVAC system by safety-related, motor-operated dampers and safety-related backdraft dampers during diesel generator emergency operation.

A simplified drawing of the Diesel Generator Building safety-related HVAC subsystem is shown in Figure 2-3.

2.4.2 Component Description

Diesel Generator Building Safety-Related Supply and Exhaust Fan Control Circuits

When plant conditions require emergency operation of the SACM diesel generator, the Class 1E control logic automatically places the safety-related HVAC subsystem into operation while shutting down and isolating the nonsafety-related HVAC subsystem. The safety-related supply fan and the nonsafety-related air handling unit that share common ducting are interlocked to ensure that both cannot operate at the same time.

A single start-auto-stop switch is used to control the safety-related supply and exhaust fans. In the "auto" position, these fans are interlocked to start upon receipt of SIAS or a 4.16 kV bus undervoltage signal. When either of these signals is received, the HVAC control logic sends a Class 1E signal to start the safety-related supply and exhaust fans. The same Class 1E control logic opens the safety-related motor-operated damper at the discharge of the safety-related supply fan.

The control circuitry for the safety-related fans also sends non-Class 1E signals to shut down and isolate the nonsafety-related air handling unit which shares use of the safety-related ductwork. The Class 1E signal which shuts down the nonsafety-related air handling unit is isolated from non-Class 1E equipment using Class 1E isolation devices per Regulatory Guide 1.75, Revision 2. Upon receipt of a SIAS or bus undervoltage signal, the power supply to the nonsafety-related air handling unit is also interrupted when the Class 1E breaker supplying the nonsafety-related motor control center is automatically tripped. Therefore, should the non-Class 1E signal fail to shut down the nonsafety-related air handling unit, interruption of the air handling unit's power supply will ensure it will be stopped. Class 1E circuits are used to shut the safety-related motor-operated damper at the discharge of the nonsafety-related air handling unit.

A Class 1E temperature sensor monitors the temperature of the combined exhaust from the Diesel Generator Building Control Room, 1E Switchgear Room and non-1E Electrical Panel Room. The temperature sensor provides a control signal which varies the volume of outside air supplied to the Diesel Generator Building and the volume of air exhausted from the Diesel Generator Building. This is accomplished by changing the angle on variable pitch blades on the Diesel Generator Building supply and exhaust fans. As the exhaust temperature drops, the temperature sensors send a signal which decreases the volume of ventilation air supplied to the building.

A simplified logic diagram for the safety-related supply fan is provided in Figure 2-4.

Diesel Generator Room Supply Fans

As many as four fixed-volume, safety-related diesel generator room fans operate whenever the diesel generator is in operation. A Class 1E control circuit is provided for each diesel generator room fan. Each fan is equipped with a manual on-auto-off switch and may be started either manually or automatically. When the diesel generator is not in operation, one fan is normally operated for ventilation. The remaining three fans are placed in automatic operation.

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. Each fan has a Class 1E temperature switch which monitors the temperature in the Diesel Generator Room and sequentially starts and stops fans as required.

Damper Modulation

During diesel generator emergency operation, the safety-related supply fan provides ventilation to the Diesel Generator Building using only outdoor ambient air. The safety-related diesel generator room fans draw air from the Diesel Generator Fan Room and supply it to the Diesel Generator Room.

In order to provide a mixture of recirculated air with outside air, a Class 1E sensor monitors the temperature of the Diesel Generator Fan Room. The temperature sensor provides control signals for safety-related motor-operated dampers that control the mixture of recirculated and outdoor air supplied to the Diesel Generator Building Fan Room. As the Diesel Generator Building Fan Room temperature drops, the motor-operated dampers are adjusted to increase the amount of recirculated air and decrease the amount of external air supplied to the Diesel Generator Building Fan Room.

Duct-Mounted Heaters

Rooms serviced by the safety-related HVAC subsystem are provided with duct-mounted electric heaters for temperature control. Electric heaters mounted in safety-related ducting are Class 1E.

Each duct-mounted heater is provided with a Class 1E flow sensor. The flow sensor is interlocked with the heater elements to prevent energization of the elements in the absence of air flow in the duct. The interlock is designed to prevent fires which could be caused by a lack of air flow and an overheated heater element.

Battery Room Heater

In addition to a duct-mounted heater, the Battery Room also has a safety-related unit heater for supplemental heat. The unit heater is started and stopped by a Class 1E thermostat.

HVAC Control Panel

A safety-related HVAC control panel is located in the Diesel Generator Building Control Room. It provides controls and status indication for key safety-related components of the HVAC system.

The HVAC control panel alerts operators when temperature limits are approached or when low ventilation flows exist in critical rooms. It provides alarms for abnormal temperatures in the Battery Room, Diesel Generator Building Control Room, 1E Switchgear Room and the Diesel Generator Room. Ventilation for the Battery Room and Fuel Oil Storage Tank Room are equipped with individual low flow alarms. In addition, a system low flow alarm is provided to signal low air flow from the safety-related supply fan.

When alarm conditions exist, annunciator windows on the HVAC control panel display visual and audible alarms to alert operators in the Diesel Generator Building Control Room. Since the Diesel Generator Building Control Room is not normally manned, operators in the Main Control Room are alerted to these abnormal conditions via a common alarm annunciator located in the Main Control Room. 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 specific indication is alarming.

Temperature Control Station

The safety-related temperature control station, also located in the Diesel Generator Building Control Room, houses control circuits and indications for automatic operation of the variable pitch fan blades and Diesel Generator Fan Room motor-operated supply dampers. The temperature control station sends control signals that:

- Adjust variable pitch fan blades to modulate the volume of air supplied and exhausted from the Diesel Generator Building

- Operate motor-operated dampers to modulate the amount of outdoor and recirculated air supplied to the Diesel Generator Fan Room

2.5 FIRE PROTECTION SYSTEM INSTRUMENTATION

Instrumentation and controls for the fire protection system are designed in accordance with NFPA 13 and 72. The fire protection system is described in Section 4.4 of the Diesel Generator and Mechanical Systems Design Report.

The fire protection system preaction suppression system is actuated upon the detection of a fire in the associated detection zone. Pressure switches are provided to supervise the status of the preaction suppression systems. A multi-zone detection system, consisting of heat detectors and smoke detectors, is provided to detect a fire at an early stage. Detection of an abnormal condition by the supervisory instrumentation is alarmed on a fire protection local control panel located in the Diesel Generator Building. The fire alarm system transmits fire and trouble signals from the local control panel to the fire protection panel located in the Main Control Room. The annunciator in the Main Control Room only provides a general trouble signal and fire alarm. The local control panel in the Diesel Generator Building must be checked to determine which detector is alarming.

2.6 DIESEL GENERATOR AUXILIARY SYSTEMS

Pressure-retaining instrumentation components (e.g., tubing, pressure gauges, and switches) which provide alarm signals or nonsafety-related indications are designed to maintain integrity of the system's pressure boundary. When the only safety-related function performed by a component is maintenance of system pressure boundary integrity, the pressure retaining component is considered to provide a passive safety-related function and is classified as safety-related for the pressure boundary (SR-PB) only. Instrumentation and controls that are not required to perform a safety-related function are supported such that failure of the component due to seismic loads will not result in the failure of other safety-related equipment. This section describes diesel generator auxiliary systems instrumentation and control system equipment that are required to provide an active safety-related function (SR-1E).

Section 2.1.1.2 of the Diesel Generator and Mechanical Systems Design Report describes the tripping devices for the diesel generator. Upon receipt of a SIAS, 4.16 kV bus undervoltage signal or emergency manual start, only four of these trips remain functional and are allowed to trip the diesel generator. SACM provided the mechanical and electrical components required to perform these active safety-related functions. Components used to perform these functions are classified by SACM as safety-related SC-3 or Class 1E, as applicable. Other instrumentation and controls associated with the starting air system, high temperature (HT) and low temperature (LT) cooling systems, lube oil system, and combustion air intake and exhaust system are not required to perform active, safety-related functions.

Instrumentation and controls for the diesel generator fuel oil storage and transfer system comply with the intent of the guidelines of Section 6.3.3 of ANSI/ANS 59.51-1989, with the following clarifications:

- Local differential pressure indication is provided for parallel filters in the fuel oil storage and transfer system

- Local level indication is provided for the fuel oil storage tank

The fuel oil transfer pumps are automatically controlled by safety-related fuel oil day tank level switches. Prior to reaching a one-hour supply of oil in the fuel oil day tank, a safety-related low level switch automatically starts one of the two transfer pumps. If the fuel oil day tank level continues to drop, a safety-related low-low level switch automatically starts the remaining fuel oil transfer pump and activates a nonsafety-related level alarm. Both pumps are automatically stopped by a safety-related high level switch prior to actuation of the high-high level alarm.

2.7 DIESEL GENERATOR MAINTENANCE AND RELIABILITY DIAGNOSTICS SYSTEM

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[4], Regulatory Guide 1.155 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 nonsafety-related. It is located in the Diesel Generator Building Control Room 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. However, the function of the diesel generator maintenance and reliability diagnostics system is to enhance diesel generator operability, troubleshooting and maintenance. Alarms annunciated on the diesel generator maintenance and reliability diagnostics system would not require additional operator response.

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

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 equipment failures
- Records alarm conditions
- Generates reliability records
- Transmits data to a remote location for display and analysis

The signals from Class 1E components used by the monitoring system are isolated using Class 1E isolation devices per Regulatory Guide 1.75, Revision 2.

2.8 ANNUNCIATOR SYSTEM

The annunciation system in the Diesel Generator Building Control Room is nonsafety-related. The annunciator system is designed to alert the operators when limiting conditions are approached or when abnormal conditions exist for the diesel generator and its auxiliary systems. When these conditions exist, annunciator windows on a control panel in the Diesel Generator Building Control Room alert operators by visual and audible alarms. Operators in the Main Control Room are alerted to these abnormal conditions via (common) alarm annunciators located in the Main Control Room. For systems which send a general trouble alarm to the Main Control Room (e.g., diesel generator auxiliary systems), the annunciator panel in the Diesel Generator Building Control Room must be checked to determine which indication is alarming.

The annunciator windows on the local control panel in the Diesel Generator Building Control Room are hard-wired to display system alarms such as those associated with the lube oil system, starting air system, cooling system, fuel oil supply system and building alarms such as HVAC. In accordance with Regulatory Guide 1.75, Revision 2, signals from Class 1E safety-related components to the annunciator system are electrically isolated using Class 1E isolation devices.

The annunciation sequence for the Diesel Generator Building Control Room annunciator system is designed in accordance with ISA Standard S18.1. The Main Control Room annunciator system and its installation will be addressed under the 50.59 process.

2.9 CONTROL ROOM INSTRUMENTATION

The controls and status indication for the SACM diesel generator are in accordance with the requirements of IEEE 387-1984. These controls and status indications are similar to those provided for the existing diesel generators on the Main Control Board Electrical Distribution System Panels.

2.9.1 MAIN CONTROL ROOM INSTRUMENTATION

Instrumentation and control equipment required for remote operation and testing of the safety-related SACM diesel generator are provided on a control console located in the Main Control Room. The control console, and auxiliary contacts for the associated switchgear, provide the capability for remote manual starting, remote stopping, remote synchronization, bus loading/unloading, governor and voltage regulation, governor and voltage drop selection and automatic or manual regulator selection. The diesel generator control console also provides the ability to remotely operate circuit breakers.

Modifications required to install the control console in the Main Control Room will be addressed under the 50.59 process. Circuit breakers which are capable of remote operation are described in the Electrical Engineering Design Report.

2.9.2 DIESEL GENERATOR BUILDING CONTROL ROOM INSTRUMENTATION

Instrumentation and control equipment required for local operation and testing of the safety-related SACM diesel generator are provided in control panels located in the Diesel Generator Building Control Room. These include such devices as diesel generator start/stop switches, speed adjust and selector switches, governor selector switch, switches associated with the control of the diesel generator auxiliary systems, metering indicators, and annunciators.

Instrumentation and controls in the Diesel Generator Building Control Room are similar to those provided on local panels for the existing diesel generators.

2.10 OTHER CONTROL STATIONS

In addition to the control console in the Main Control Room and the local control panels in the Diesel Generator Building Control Room, the SACM diesel generator is provided with two auxiliaries desks (one per diesel engine). The auxiliaries desks are located near the diesel generator and include gauges to indicate engine parameters (i.e., RPM, temperatures and pressures) and diesel engine auxiliary system parameters.

HVAC control stations are described in Section 2.4.2. Electrical switchgear located in the 1E Switchgear Room and Non-1E Electrical Panel Room are described in Chapter 2 of the Electrical Design Report.

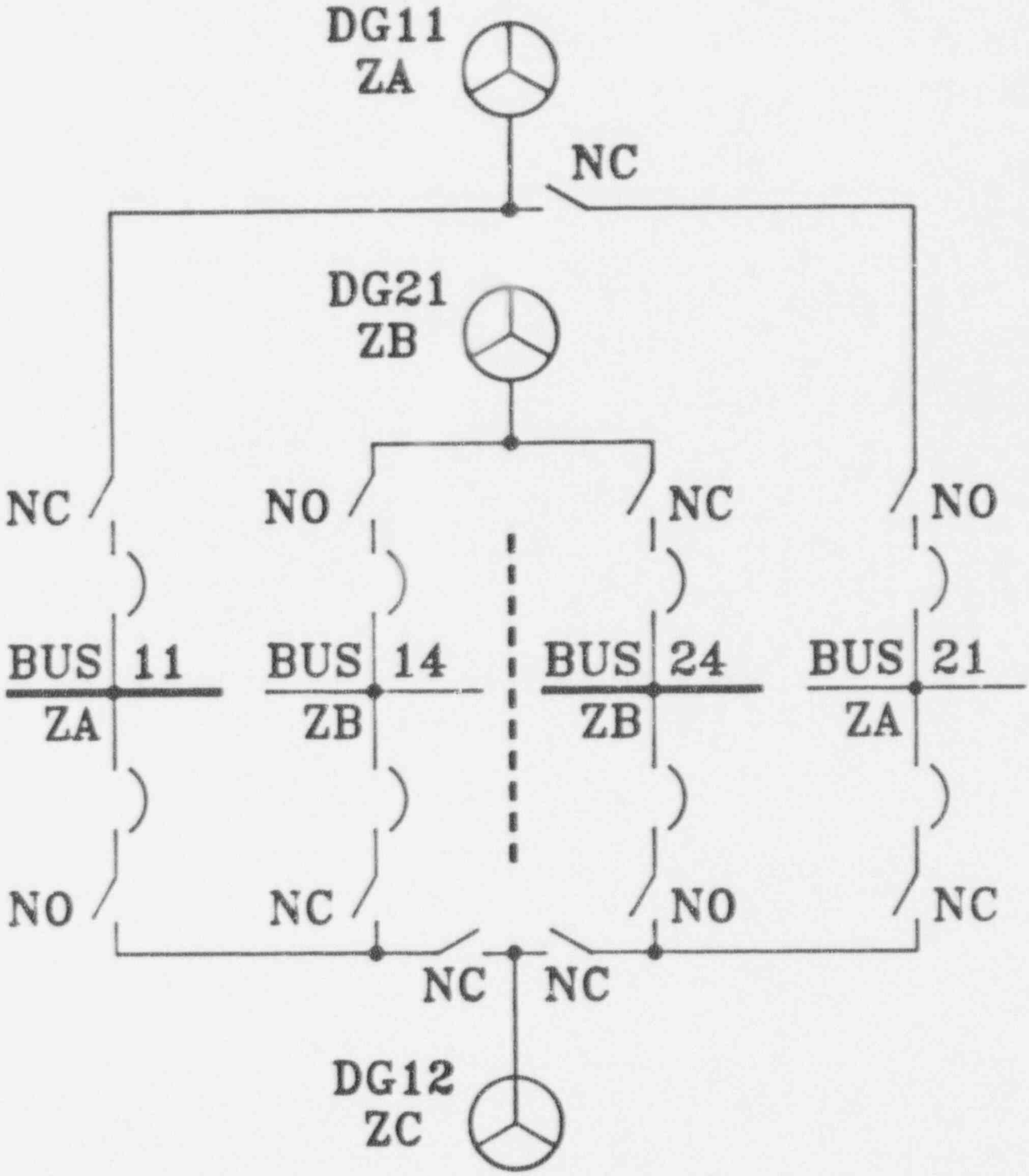


FIGURE 2-1 EXISTING DIESEL GENERATOR ARRANGEMENT

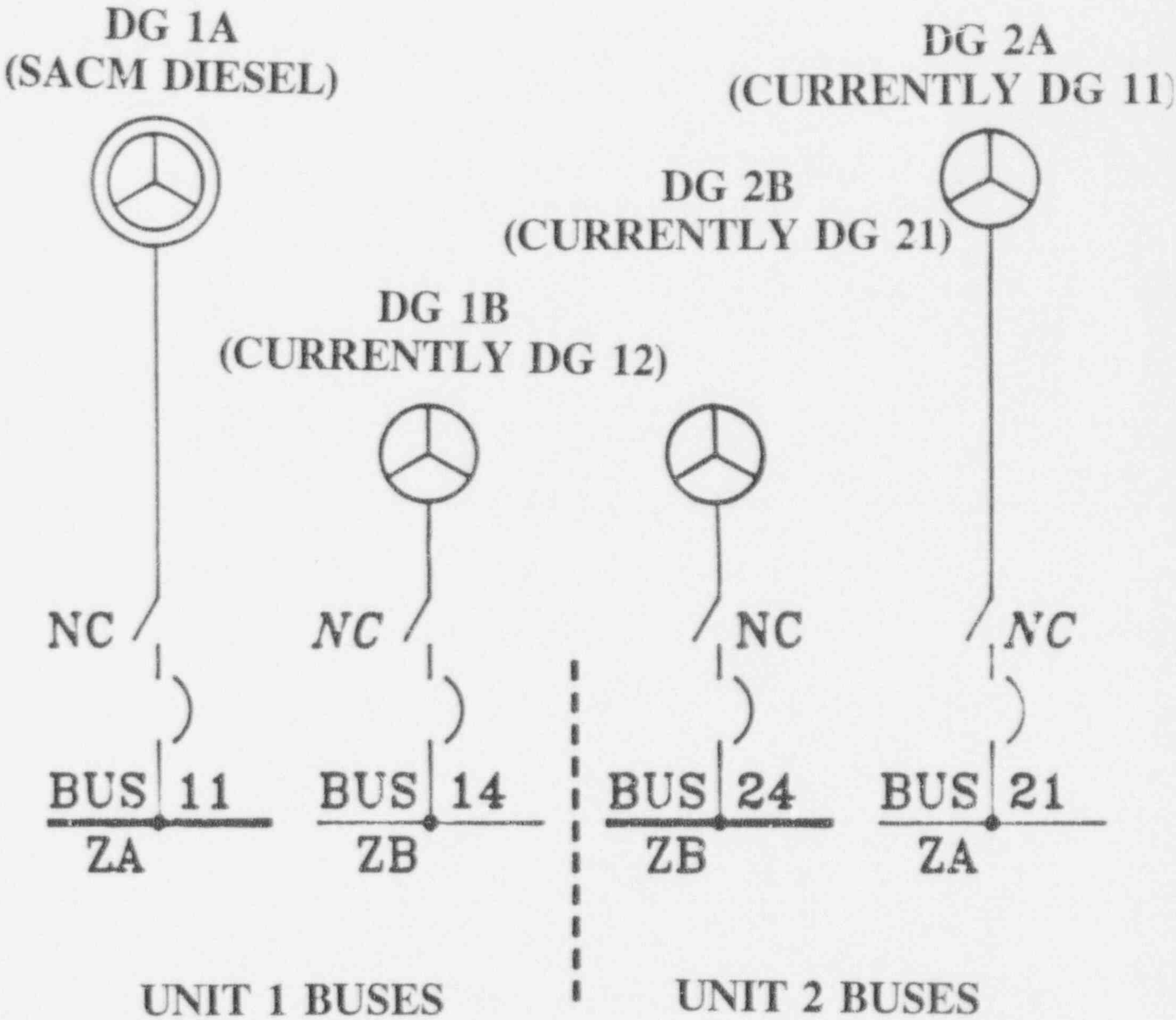


FIGURE 2-2 NEW DIESEL GENERATOR ARRANGEMENT

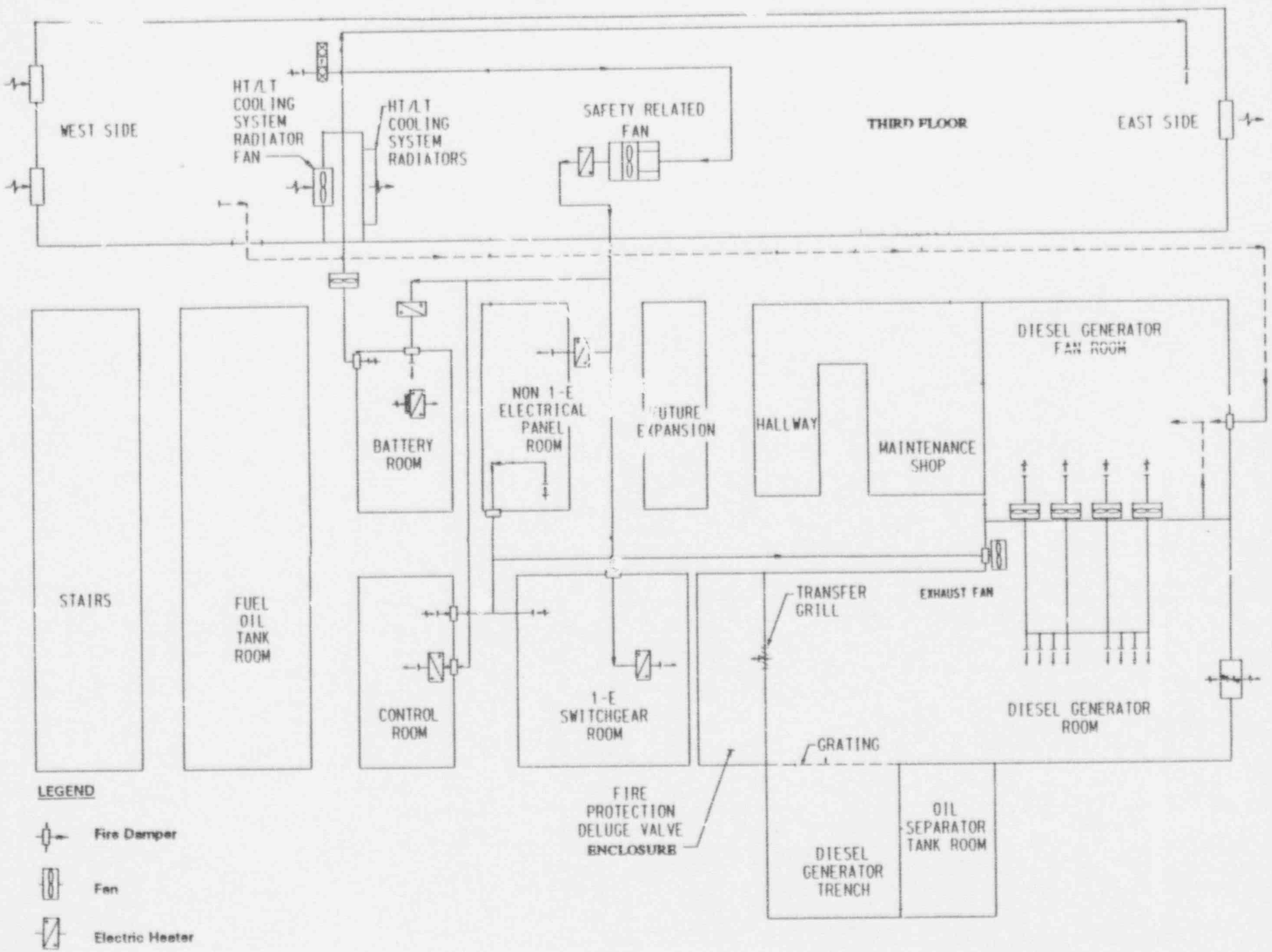
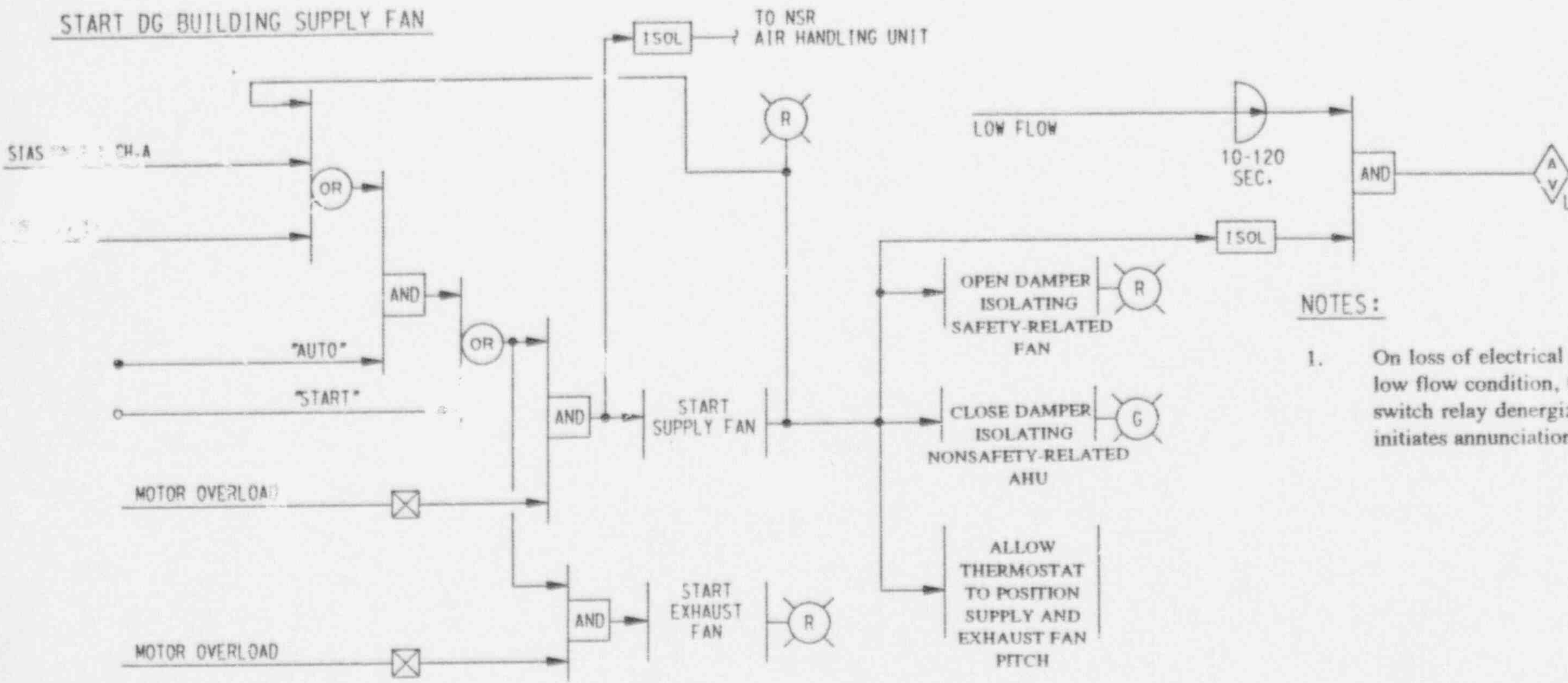


FIGURE 2-3 SAFETY-RELATED PORTION OF THE DIESEL GENERATOR BUILDING VENTILATION SYSTEM



NOTES:

1. On loss of electrical power or low flow condition, the flow switch relay denergizes and initiates annunciation.

FIGURE 2-4 DIESEL GENERATOR BUILDING SAFETY-RELATED FAN STARTING CIRCUIT LOGIC DIAGRAM

3.0 DESIGN OF STRUCTURES, COMPONENTS, EQUIPMENT AND SYSTEMS

This chapter describes the principle instrumentation and control systems design features associated with the Diesel Generator Building and the systems housed within it.

3.1 CONFORMANCE WITH NRC GENERAL DESIGN CRITERIA

Safety-related structures, systems and components (SSCs) for the SACM diesel generator are designed using all applicable design criteria specified in Appendix A to 10 CFR Part 50. Specific general design criteria which are applicable to control systems include:

Criterion	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

3.2 CLASSIFICATION OF CONTROL SYSTEMS AND COMPONENTS

General Design Criterion 2 of Appendix A to 10 CFR Part 50, "General Design Criteria for Nuclear Power Plants," requires that 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 principle 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.

Instrumentation and control equipment for diesel generator auxiliary systems is procured by SACM and Bechtel Corporation. SACM procures equipment and components for diesel generator auxiliary systems. Bechtel Corporation procures some instrumentation and the tubing and supports necessary to connect instrumentation to piping systems. Instrumentation for Diesel Generator Building auxiliary systems, such as the HVAC system, are procured by Bechtel Corporation.

Electrical instrumentation is classified as safety-related or nonsafety-related in accordance with the definition provided in 10 CFR 50.49, paragraph (b). This definition is consistent with the broader definition of Nuclear Safety-Related in ANSI/ANS 51.1-1983 which is "SSCs designed to perform a nuclear safety function." A nuclear safety function is any function that is necessary to ensure:

- The integrity of the reactor coolant pressure boundary
- The capability to shut down the reactor and maintain it in a safe shutdown condition
- The capability to prevent or mitigate the consequences of Plant Conditions that could result in potential offsite exposures that are comparable to the guideline exposures of 10 CFR Part 100

As defined by IEEE Nuclear Power Engineering Committee (NPEC) Standards such as IEEE 308 and IEEE 323, electrical instrumentation that meets this criteria is identified as Class 1E. ANSI/ANS 51.1 assigns Class 1E equipment to Safety Class 3. Nonsafety-related electrical instrumentation is designated as non-Class 1E and is assigned Safety Class NNS for non-nuclear safety. Table 3-1 provides a list of significant safety-related instrumentation and control systems which are located in the Diesel Generator Building. 10 CFR 50.49 also includes certain post-accident monitoring equipment as safety-related. Post-accident monitoring equipment is defined by Regulatory Guide 1.97, Revision 3 and ANS 4.5-1980.

Instrumentation tubing procured by Bechtel Corporation follows 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. Therefore, tubing attached to Code Class 3 systems meets the Group C quality standards of Regulatory Guide 1.26. Nonsafety-related systems, such as the diesel generator coolant drain system, meet the Group D quality standards of Regulatory Guide 1.26. Quality standards for equipment and components supplied by SACM are discussed in Section 5.2 of the Diesel Generator and Mechanical Systems Design Report.

Instrumentation tubing and its supports installed on safety-related systems (ASME Class 3 piping) are designed in accordance with the American Society of Mechanical Engineers (ASME) Section III, Boiler and Pressure Vessel (B&PV), Subsection NCA, ND and NF. 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 tubing and tubing 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.

The plant specific classification criteria based on these requirements is found in the Calvert Cliffs Nuclear Power Plant List of Safety-Related Items Manual also called the 'Q-List'. All new or modified equipment for the Diesel Generator Building will be classified in accordance with the Q-List.

3.3 SEISMIC QUALIFICATION OF SEISMIC CATEGORY I INSTRUMENTATION AND ELECTRICAL EQUIPMENT

This section discusses the seismic analysis methods used for instrumentation and control systems in the Diesel Generator Building. The geologic and seismologic investigations conducted to support construction of the Diesel Generator Building are described in the Civil Engineering Design 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.

3.3.1 SEISMIC QUALIFICATION CRITERIA

Class 1E electrical instrumentation, Category I mechanical instrumentation and their supports in the Diesel Generator Building are 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. Qualification by experience is further described in Section 3.3.2.

The adequacy of equipment seismic design is demonstrated by one of the following methods:

- Analysis
- Testing under simulated seismic conditions
- Combination of testing and analysis

The selection of a method to establish the qualification of a component is based on the function, type, size, shape and complexity of the component. Regardless of the method selected, the qualification is based on the seismic forces corresponding to the design basis earthquake. The design basis earthquake for the Diesel Generator Building is defined as five operating basis earthquake (OBE) events and one safe shutdown earthquake (SSE) event. The number of maximum stress cycles for each event is 10. Since there are no Class 1 components in the Diesel Generator Building, no Class 1 fatigue analysis is required for any auxiliary system. In addition, given the low number of total cycles (60) and the fact that, for an SSE, stresses in electrical components will be limited to 90 percent of the applicable materials yield strength, fatigue failure is not a concern for any electrical components qualified by analysis. For mechanical instrumentation and control system components (e.g., tubing), the stresses are limited to the allowables described in the combinations of operating loads and seismic loads described by Section 5.7.1 of the Diesel Generator and Mechanical Systems Design Report. For components qualified by testing, potential fatigue induced failure is addressed by simulating the effects of five OBEs followed by one SSE.

The seismic input corresponding to the mounting location of an instrument is defined by the applicable required response spectra (RRS) which accounts for potential amplification of the building motions through intervening supports. The RRS is obtained by increasing the amplitude of the floor response spectra (FRS) by ten percent. The methodology used to develop the FRS used for seismic analyses is described in the Civil Engineering Design Report.

3.3.2 Procedures for Qualifying Mechanical and Electrical Instrumentation

Qualification By Analysis

Qualification by analysis verifies that Category I mechanical and Class 1E instrumentation and their supports will successfully meet the safety-related performance requirements when subject to the stresses induced by a combination of operating and seismic loads. For mechanical instrumentation, the analysis evaluates the combinations of operating loads and seismic loads described by Section 5.7.1 of the Diesel Generator and Mechanical Systems Design Report. For Class 1E instrumentation, the analyses evaluate the stresses induced by the combination of operating and seismic loads defined below:

- The combined normal operating stresses and the stresses due to the OBE do not exceed the allowable working stress limits that are acceptable as good practice as set forth in the applicable design standards and Codes. However, no increase in the allowable working stress resulting from the consideration of seismic loads is allowed, unless permitted by the Codes applicable to equipment used for nuclear service.

- The combined normal operating stresses and the stresses due to the SSE do not exceed 90 percent of the minimum guaranteed yield stress of the material

Where possible, the fundamental frequency of instrumentation and controls equipment, including supports, is determined by analysis. For instrumentation and controls equipment with a fundamental frequency equal to or greater than 33 Hz, the equipment is considered to be rigid. If the fundamental frequency is below 33 Hz, the equipment is considered to be flexible. If the equipment is so complex that fundamental frequencies cannot be calculated, the equipment is qualified by testing.

For rigid equipment, the seismic forces are obtained by concentrating the equipment's mass at the center of gravity and multiplying it by the appropriate maximum floor acceleration (zero period acceleration). The maximum floor acceleration is obtained from the FRS applicable to the location at which the equipment is mounted. The resulting seismic forces are distributed over the equipment, including its supports, in a manner proportional to its mass distribution. The loads caused by the accelerations in the three orthogonal directions are then combined by the square-root-of-the-sum-of-the squares (SRSS) method.

Flexible equipment is analyzed using either the static coefficient analysis method (equivalent static load method) described in IEEE 344-1975/1987, or the modal response spectrum analysis technique described below.

In the modal response spectrum analysis technique, the accelerations used to analyze flexible equipment are obtained from the appropriately damped FRS. 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 3-1.

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

When using the response spectrum analysis technique, frequencies and mode shapes are determined for two orthogonal horizontal directions and the vertical direction. The seismic loads include the effects of directional response and the combination of the response of individual modes. 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 combination of individual modal responses, including the effect of closely spaced modes, is obtained in accordance with the guidelines of Regulatory Guide 1.92, Revision 1. In addition, the multi-zone response spectra combinations are performed by absolute sum.

Dynamic models must adequately represent the analyzed system. This representation includes correct mass point selection so as to represent all significant modes. Instrumentation and control system equipment are mathematically modeled as:

- Lumped masses connected by massless elastic structural members, or
- As an assemblage of finite elements, or
- Any other acceptable mathematical model that adequately describes the mass and stiffness properties of the equipment

The number of masses used is sufficient to define the dynamic behavior of the equipment within the frequency range of interest. The mass and stiffness of equipment appendages, as well as the flexibility of the supports, is also considered in the mathematical model of the equipment.

Significant torsional effects resulting from eccentricity between an equipment's center of gravity and its center if mass are represented in the mathematical model.

Qualification By Testing

Qualification by testing is performed in accordance with the applicable sections of IEEE 344-1975/1987. A description of both the SSE and OBE, including seismic accelerations and durations, used for the design of SSCs in the Diesel Generator Building is provided in the Civil Engineering Design Report. The duration of the strong motion portion of each earthquake is assumed to be at least 15 seconds. This time period is used as the duration of each vibration test run. A vibration test run simulates the strong motion of a single SSE or OBE. The vibration testing simulates the effects of:

- Nonseismic vibration (e.g., pump vibration, if applicable)
- Five OBEs
- One SSE (subsequent to the five OBEs)

Vibration test results are satisfactory if no malfunctions or failures occur during, or after, any portion of the vibratory testing. A malfunction or failure is defined as that which would inhibit the required performance of the safety-related function(s) of the equipment. The equipment-specific acceptance criteria is based on the safety-related performance requirements.

Qualification by Experience

Previously qualified instrumentation 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 FRS 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

3.4 COMPUTER CODES

Safety-related tubing is designed and analyzed for the effects due to weight, thermal and seismic events. Analyses of tubing and its associated supports are performed by using the proprietary computer program ME-101, Linear Elastic Analysis of Piping Systems. This computer code conforms to the requirements of 10 CFR 50, Appendix B, Section III and is described below.

ME-101 determines the piping/tubing stresses, support loads and equipment nozzle loads for a system under different loading conditions. Instrumentation tubing in the Diesel Generator Building is analyzed using the ME-101 program to ensure it is in accordance with the requirements of ASME Code, Subsection NCA and ND for tubing installed on safety-related systems.

The ME-101 computer code performs static and linear dynamic load analysis of piping systems. The static analysis considers 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
- Dynamic seismic load

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 analyses:

- 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 Nuclear Regulatory Commission bench mark problems. ME-101 has been validated by Bechtel Corporation.

PERMAS

SACM uses the computer code PERMAS for seismic analysis of complex equipment. 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 systematic test procedure which is compared to a group of type problems for which solutions are well known.

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

With the exception of the fill and recirculation line on the diesel generator fuel oil storage tank, 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). The

ASME Section III bour for all safety-related instruments ends at the tubing connection to the instrument. In other wor..., tubing which connects instrumentation to piping will extend the piping's ASME Code classification up to, but not including, the instrument. Instrumentation isolation valves will conform to the Code classification applicable to the tubing.

3.5.1 Loading Combinations, Design Transients and Stress Limits

All ASME piping components and supports inside the Diesel Generator Building are designed to meet the ASME Code requirements and to ensure that the diesel generator is 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 available. The loading conditions, associated loading combinations and stress limits applicable to system piping are also applicable to the instrumentation tubing associated with the system. The loading conditions, associated loading combinations and stress limits are described by Section 5.7.1 of the Diesel Generator and Mechanical Systems Design Report.

3.5.2 General Stress Analyses

Safety-related instrumentation and control systems are designed to ensure that stresses resulting from the various loading combinations are within the applicable Code allowables. Nonsafety-related instrumentation and control systems are designed to ensure that failure of the nonsafety-related component does not affect the operability of nearby safety-related equipment. A discussion of the different types of stress analyses performed on piping systems is provided in Section 5.7.2 of the Diesel Generator and Mechanical Systems Design Report.

Tubing

In general, the analyses applicable to a system's piping are also applicable to the instrumentation tubing associated with the system. Tubing 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 tubing are met.

- ASME III Piping systems

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

- ANSI/ASME B31.1 Power Piping systems

  Tubing is qualified in accordance with the criteria established by ANSI/ASME B31.1, Power Piping Code, 1989 edition. Tubing reactions on equipment nozzles are verified to be less

than the manufacturer's values. Tubing can also be qualified by meeting the requirements for ASME III tubing.

- Category II/I Piping

  Tubing is 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.

3.5.3 Stress and Strain Criteria for Instrumentation and Control Systems

For the stress criteria, support allowables are evaluated in accordance with ASME Code, Subsection NF for ASME tubing and ANSI/ASME B31.1 for nonsafety-related tubing. Stress and strain criteria for tubing are similar to those used for the corresponding type of piping. For example, the stress and strain criteria for ANSI/ASME B31.1 tubing are the same as those for ANSI/ASME B31.1 piping. A detailed discussion of stress and strain criteria for piping systems is provided in Section 5.7.3 of the Diesel Generator and Mechanical Systems Design Report.

Safety-related tubing and instrumentation supports are designed to withstand forces imposed on the supports by seismic motion. Tubing and instrument supports for ANSI/ASME B31.1 piping or supports determined to be Category II/I are designed in accordance with Section 120.2.4 of the ANSI/ASME B31.1 Code. Section 120.2.4 requires supplementary steel to be designed in accordance with the standards as proscribed by the American Institute of Steel Construction (or the equivalent). Therefore, supplementary structural steel for Category II/I instrumentation, tubing and tubing supports are designed and analyzed in accordance with the standards proscribed by the American Institute of Steel Construction.

3.6 INDEPENDENCE OF REDUNDANT SYSTEMS

Section 3.6 of the Electrical Engineering Design Report describes instrumentation cable routing, cable tray fill and cable sizing. For SSCs located in the Diesel Generator Building, physical separation of redundant cables and wiring is maintained since SSCs for the SACM diesel generator are redundant to those existing in the plant. In addition, Section 3.9.1 of the Electrical Engineering Design Report describes the exceptions to the physical separation requirements of Regulatory Guide 1.75, Revision 2. These exceptions are also applicable to the installation of instrumentation and control systems.

3.7 ENVIRONMENTAL DESIGN OF CONTROL SYSTEMS EQUIPMENT

The Calvert Cliffs Environmental Qualification (EQ) Program is established in accordance with the requirements of 10 CFR 50.49. Requirements for dynamic and seismic qualification of electric equipment important to safety; protection of electric equipment important to safety against other natural phenomena and external events; and environmental qualification of electric equipment important to safety located in a mild environment are not included in the scope of 10 CFR 50.49. The Diesel Generator Building is considered a mild environment, which 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.

The requirements of 10 CFR 50.49 do not apply to the safety-related instrumentation in the Diesel Generator Building. Instrumentation for safety systems used in the design of the Diesel Generator Buildings are qualified in accordance with the guidance of IEEE 323-1983, as endorsed by Regulatory Guide 1.89. This standard provides an acceptable method for the environmental qualification of safety-related instrumentation which are located in a mild environment. Therefore, safety-related instrumentation located in each Diesel Generator Building is qualified in accordance with established Calvert Cliffs Nuclear Power Plant EQ design procedures to meet the performance requirements for the specific environmental and operating conditions. That is, the safety-related functional requirements and the environmental conditions are included in the specification for the equipment.

TABLE 3-1

SIGNIFICANT SAFETY-RELATED CONTROL SYSTEMS EQUIPMENT LOCATED IN THE DIESEL GENERATOR BUILDING

HVAC control panel

Temperature control station

Auxiliaries desks

Diesel generator control panels

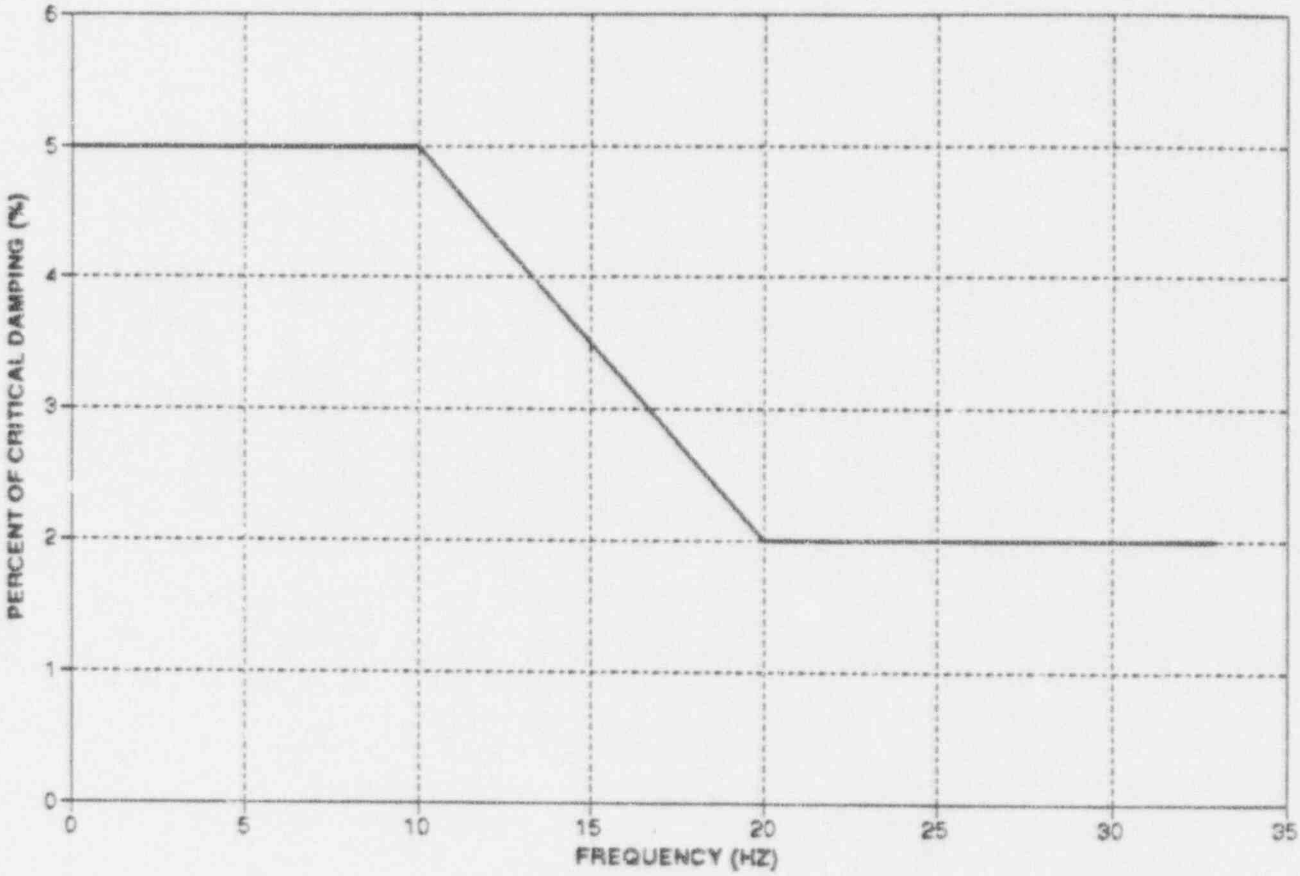


FIGURE 3-1 ALTERNATE DAMPING VALUES FOR PIPING

APPENDIX A

CODES, STANDARDS AND REGULATIONS

CODES, STANDARDS AND REGULATIONS

UNITED STATES NUCLEAR REGULATORY COMMISSION

Title 10 of the Code of Federal Regulations

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
1.47	5/73	Bypassed and Inoperable Status Indication for Nuclear Power Plant Safety Systems
1.53	6/73	Application of the Single Failure Criterion to Nuclear Power Plant Protection Systems
1.61	10/73	Damping Values for Seismic Design of Nuclear Power Plants
1.75	9/78	Physical Independence of Electric Systems
1.89	6/84	Environmental Qualification of Certain Electric Equipment Important to Safety for Nuclear Power Plants
1.92	2/76	Combining Modal Responses and Spatial Components in Seismic Response Analysis
1.97	5/83	Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant and Environs Conditions During and Following an Accident
1.100	8/77	Seismic Qualification of Electric and Mechanical Equipment for Nuclear Power Plants

1.100	6/88	Seismic Qualification of Electric and Mechanical Equipment for Nuclear Power Plants
1.151	8/83	Instrument Sensing Lines
1.153	12/85	Criteria for Power, Instrumentation and Control Portions of Safety Systems
1.155	8/88	Station Blackout

NUREG 0700 9/81 Guidelines for Control Room Design Reviews

NUREG 0800 Standard Review Plans

3.2.1	1981	Seismic Classification
3.7.3	1989	Seismic Subsystem Analysis
9.5.4	1981	Emergency Diesel Engine Fuel Oil Storage and Transfer System
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
9.5.5	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
BTP ICSB 21	1981	Guidance for Application of Regulatory Guide 1.47
BTP PSB-2	1981	Criteria for Alarms and Indicators Associated with Diesel Generator Unit Bypassed and Inoperable Status

CODES AND STANDARDS

IEEE - Institute of Electrical and Electronics Engineers

279	1971	Criteria for Nuclear Power Generating Station Protection Systems. Although this standard is no longer listed as active in the IEEE Standards Catalog, it is still endorsed by 10 CFR 50.55.a, paragraph (h)
308	1991	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)
344	1975	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 Practice 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
379	1988	Application of the Single-Failure Criterion to Nuclear Power Generating Station Safety Systems
383	1974	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

690	1984	Design and Installation of Cable Systems for Class 1E Circuits in Nuclear Power Generating Stations

ICEA - Insulated Cable Engineers Association

P-32-382	1969	Short Circuit Characteristics of Insulated Cable
P-46-426	1966	Power Cable Ampacities, Volume 1, Copper Conductors and Cumulative Errata Sheets
P-54-440	1986	Ampacities, Cables in Open-Top Cable Trays

ANSI - American National Standards Institute

B1.20.1	1992	Pipe Threads, General Purpose
B16.11	1991	Forged Fittings, Socket-Welding and Threaded
B16.5	1988	Pipe Flanges and Flanged Fittings
B16.34	1988	Valves-Flanged, Threaded and Welding Ends
B31.1 (ANSI/ASME)	1989	Power Piping
C39.1	1981	Requirements for Electrical Analog Indicating Instruments
C39.5	1974	Safety Requirements for Electrical and Electronic Measuring and Controlling Instrumentation
MC96.1	1982	Temperature Measurement Thermocouples
N45.2.1	1973	Cleaning of Fluid Systems
N45.2.2	1978	Packaging, Shipping, Receiving, Storage and Handling of Items for Nuclear Power Plants
N45.2.11	1974	Quality Assurance Requirements for the Design of Nuclear Power Plants

ANS - American Nuclear Society

7-4.3.2	1982	Application Criteria for Programmable Digital Computer Systems in Safety Systems of Nuclear Power Generating Stations (Reaffirmed 1990)
4.5	1980	Criteria for Accident Monitoring Functions in Light-Water-Cooled Reactors
51.1	1983	Nuclear Safety Criteria for the Design of Stationary Pressurized Water Reactor Plants

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 IX, Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators
B31.3	1990	Chemical Plant and Petroleum Refinery Piping
B40.1	1991	Gauges-Pressure Indicating Dial Type-Elastic Element
MFC-3M	1989	Measurement of Fluid Flow in Pipes Using Orifice, Nozzle, and Venturi

Performance Test Codes

PTC 19.3	1986	Temperature Measurement Instrument and Apparatus

AWS - American Welding Society

D1.1	1992	Structural Welding Code Steel
D1.3	1989	Structural Welding Code Sheet Metal
D9.1	1984	Specification for Welding of Sheet Metal

ASTM - American Society for Testing and Materials

The applicable industry standards published by ASTM will be used to specify:

- Materials
- Material Testing Procedures

DEMA - Diesel Engine Manufacturers Association

	1972	Standard Practices for Stationary Diesel or Gas Engines

Calvert Cliffs Documentation

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

ISA - Instrument Society of America

S18.1	1979	Annunciator Sequences and Specifications (Reaffirmed 1985)
S37.1	1982	Electrical Transducer Nomenclature and Terminology
S51.1	1979	Process Instrumentation Terminology
S67.02	1980	Nuclear Safety-Related Instrument Sensing Line Piping and Tubing

MSS - Manufacturers Standardization Society of the Valve and Fittings Industry

SP-25	1988	Standard Marking System for Valves, Fittings, Flanges, and Unions
SP-61	1985	Pressure Testing of Steel Valves

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
WC 55	1989	Instrumentation Cable and Thermocouple Wire (Insulated Cable Engineers Association Std S-82-552, 1986)

NFPA - National Fire Protection Association

13	1991	Standard for the Installation of Sprinkler Systems
72	1990	Standard for the Installing, Maintenance, and Use of Protective Signalling Systems
90A	1989	Installation of Air Conditioning and Ventilation Systems

NUMARC - Nuclear Management and Resources Council Guidelines

87-00	1991	Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors