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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

EMERGENCY DIESEL GENERATOR PROJECT

INSTRUMENTATION AND CONTROL SYSTEMS DESIGN REPORT

CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2

DOCKET NOS. 50-317 AND 50-318

1.0 INTRODUCTION

Baltimore Gas and Electric (BG&E) is installing one safety-related (SR) emergency diesel generator (EDG) and one nonsafety-related (NSR) EDG at Calvert Cliffs Nuclear Power Plant, Units 1 and 2, (CC1-2) manufactured by Société Alsacienne de Construction Mécanique de Mulhouse (SACM). BG&E, by letter dated August 25, 1993, submitted a design report for Calvert Cliffs, "Emergency Diesel Generator Project - Instrumentation and Control System Design Report," and a requested NRC review and approval. The NRC staff has reviewed the proposed design of the instrumentation and control systems for the SR EDG as described in the BG&E submittal.

At present, Calvert Cliffs has three Class 1E EDGs: one SR EDG is dedicated to each unit and the third SR EDG swings to the accident unit. After the new SR EDG is installed, Calvert Cliffs will have one SR EDG dedicated to each of the four engineered safety features buses. The NSR EDG will be used as an alternate ac source (AAC) to comply with the station blackout rule. During installation, numerous systems will be affected, as the work will consist of electrical, mechanical, and instrument and control modifications and other changes to accommodate the new equipment.

BG&E prepared a series of design reports for NRC review. These are titled Civil Engineering, Diesel Generator and Mechanical Systems, Instrumentation and Controls Systems, Electrical Engineering, and Startup and Surveillance Testing.

The Instrumentation and Control Systems design report provides design information for the instrumentation and control systems of the SR EDG auxiliary systems and for the support systems for the EDG building. The intent of the report is to establish the functional adequacy of the instrumentation and control systems associated with the new SR EDG, including its associated auxiliaries. The new SR EDG will provide emergency power to one of the Unit 1 SR buses. BG&E is planning, to the maximum extent possible, to install the instrumentation during unit operation with minimal disruption of plant activities. Critical installation activities will be planned to be accomplished during scheduled unit outages.

2.0 EVALUATION

As noted, the design report details the design basis and provides descriptions of the various control systems of the new SR EDG, both in the main control room and in the EDG building. In addition, it discusses the instrumentation and control systems for the EDG building support systems such as the heating and ventilation and fire protection systems.

2.1 Electrical System

The existing standby electrical power system for each unit consists of six 4.16-kV buses, two of which supply power to the 4.16-kV engineered safety features. These buses are designated as 4.16-kV emergency buses 11 and 14 for Unit 1 and emergency buses 21 and 24 for Unit 2.

The three existing SR EDGs can be aligned to the four 4.16-kV engineered safety features buses as follows:

(1) DG 11 can be aligned to bus 11 (Unit 1) or bus 21 (Unit 2). Normally it is aligned to emergency bus 11.

(2) DG 21 can be aligned to bus 24 (Unit 2) or bus 14 (Unit 1). Normally it is aligned to emergency bus 24.

(3) DG 12, the swing EDG, can be aligned to any one of the 4.16-kV emergency buses. Normally closed disconnect switches align DG 12 to supply power to either emergency bus 14 or 21. Although DG 12 is aligned to both buses, its output breaker must still be closed to supply power to the engineered safety features bus of the selected unit. The output breaker is closed automatically by the control logic, or can be closed manually.

The existing electrical system has two independent load groups per unit. After installation of the new SR EDG, each load group will have its own dedicated standby electrical power source which includes a dedicated SR EDG, associated buses, transformers, and ac and dc control power. Each load group is independently capable of safely shutting down its associated unit.

With the addition of the new SR EDG, the electrical system will be designated as follows:

(1) The new SR EDG will be designated as DG 1A, and will be connected to 4.16-kV emergency bus 11. Unit 1.

(2) DG 11 will be designated as DG 2A, and will be dedicated to 4.16-kV emergency bus 21, Unit 2.

(3) DG 21 will be designated as DG 2B, and will remain connected to 4.16-kV emergency bus 24, Unit 2.

(4) DG 12 will be designated as DG 1B, and will be dedicated to 4.16-kV emergency bus 14, Unit 1.

2.2 <u>Instrumentation and Control Systems</u>

The instrumentation and control systems which are required for the operation of the new SR EDG are designed to:

- Remain functional during and after a safe-shutdown earthquake (SSE).
- Allow testing the standby electrical power system in accordance with 10 CFR Part 50, Appendix A, General Design Criterion 18.
- Allow operation of plant SR equipment essential for safe shutdown in case of the failure of a single component. In the event that a single failure occurs, which places a SR EDG out of service, each unit has a dedicated SR EDG to supply power to redundant SR equipment required for safe shutdown or accident mitigation in accordance with 10 CFR Part 50, Appendix A, General Design Criterion 17.
- Allow operation of SR systems, structures, or components in case of failure of NSR instrumentation and control system equipment.

Additional design considerations include:

- The cables and circuits associated with the new SR EDG meet the requirements of Appendix R to 10 CFR Part 50.
- The new SR EDG has a control system that permits automatic or manual control. The automatic start signal is functional except when the EDG is undergoing maintenance. Provision is made for controlling the EDG either from the main control room or the EDG building.

The new SR EDG is also designed to start and accelerate to the rated voltage and speed upon receipt of the following signals:

- A safety injection actuation signal (SIAS).
- An undervoltage signal on the 4.16-kV emergency bus.
- Manual operation from the main control room.
- Manual or emergency manual operation from the EDG building.

A discussion on each of these items follows:

(1) The SIAS is a part of engineered safety features actuation system (ESFAS) at Calvert Cliffs. One of its functions is to initiate an EDG start. Components used to generate a SIAS for the existing SR EDGs are also used for the new SR EDG. The standby electrical power system will be modified

to disconnect the existing Unit 1 starting signal from DG 11 (redesignated as DG 2A) and reconnect it to the new SR EDG, DG 1A.

Independence is ensured by using separate SIASs to start the redundant SR EDGs dedicated to each unit (a separate signal for each EDG).

(2) The 4.16-kV emergency bus 11 undervoltage is sensed by two existing sets of dual level undervoltage relays. One level of the dual level undervoltage relays is set to detect a loss of voltage at 59 percent of rated bus voltage with a time delay of 0.5 second. The second level of the dual level undervoltage relays is set at 90 percent of rated bus voltage with a time delay of 7.5 seconds. Both levels of the dual-level undervoltage relays operate in a 2-out-of-4 logic to disconnect the offsite power source, load shed the associated 4.16-kV emergency bus, and start the dedicated SR EDG whenever the undervoltage setpoint has been exceeded for the required time delay. An additional 0.5-second delay after the EDG has been started and is ready to accept load, permits the decay of the residual bus voltage before its output breaker closes. These relays currently provide a starting signal for DG 11. The standby electrical power system will be modified to disconnect the existing emergency bus 11 (Unit 1 Facility ZA) undervoltage relays from the starting circuits of DG 11 and reconnect it to the starting circuits of DG 1A.

(3) There are fast start and slow start switches in both the main control room and the EDG building to manually start the new SR EDG. For manual starts or periodic testing, the EDG 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 EDG 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.

(4) Operating an emergency switch, located in the EDG building, will start the new SR EDG manually. The emergency switch will only start the EDG when the "LOCAL/AUTO-REMOTE" selector switch is placed in the auto-remote position.

The three existing SR EDGs are equipped with starting signals from both units. After the new SR EDG is installed, each of the SR EDGs will only start on receipt of a signal from the unit to which it is dedicated. Therefore, dedication of the SR EDGs will result in the disconnection of some of the starting signals from the existing SR EDGs.

When disconnected, existing components for the automatic starting circuits associated with emergency bus 11 will be used for the new SR EDG. Therefore, the instrumentation and controls used to automatically start the new SR EDG during emergency operation will be similar to those presently used to start the existing EDGs.

2.3 Support Systems

The following sections summarize the instrumentation and control for the support systems associated with the new SR EDG.

(1) Diesel Generator Maintenance and Reliability Diagnostics System

A computer driven non-Class 1E monitoring system will be used to provide diagnostics and trending capability. The system will monitor such critical parameters as lube oil pressure, crankcase temperature, crankcase pressure, and coolant outlet temperature. The system permits early detection of potentially abnormal conditions that may impair the operation of the new SR EDG. It is located in the EDG building and consists of a remote terminal unit (RTU), cabling, instrument sensors, computer, cathode-ray tube (CRT), a modem, and a printer.

The system performs the following functions:

- It will monitor the EDG performance over time using statistical trending and engineering data to pinpoint component degradation.
- It will detect and record equipment failures.
- It will record alarm conditions.
- It will generate reliability records.
- It will transmit data to a remote location for display and analysis.

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

(2) Annunciator System

The annunciator system in the EDG building is NSR. It is designed to alert the operators that limiting conditions are approached or that abnormal conditions exist for the new SR EDG and its auxiliary systems. When these conditions exist, annunciator windows on a control panel in the EDG building alert operators by visual and audible alarms. Operators in the main control room are alerted to these abnormal conditions by alarm annunciators in the main control room. For systems that send a general trouble alarm to the main control room (e.g., EDG auxiliary systems) the annunciator panel in the EDG building must be checked to determine which indication is alarming.

The annunciator windows on the local control panel in the EDG building are hard-wired to display such system alarms as those associated with the lube oil system, starting air system, cooling system, fuel oil supply system and such building alarms as heating, ventilation, and air conditioning (HVAC). Signals from Class 1E safety-related components to the annunciator system are electrically isolated using Class 1E isolation devices as per Regulatory Guide 1.75, Revision 2.

The EDG building annunciator system's sequence of annunciation is designed in accordance with Instrument Society of America (ISA) Standard S18.1.

(3) Control Room Instrumentation

The controls and status indication for the new SR EDG are in accordance with the requirements of Institute of Electrical and Electronics Engineers (IEEE) Standard 387-1984. These controls and status indications are similar to those provided for the existing SR EDGs.

Instrumentation in the Main Control Room: Instrumentation and control equipment required for remote operation and testing of the new SR EDG are located on a control console 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 droop selection, and automatic or manual regulator selection. The new SR EDG control console also has the capability to operate circuit breakers remotely.

Instrumentation in the Diesel Generator Building: Instrumentation and control equipment required for local operation and testing of the new SR EDG are located on control panels in the EDG building. Equipment includes such devices as EDG start/stop switches, speed adjust and selector switches, governor selector switch, switches associated with the control of the EDG auxiliary systems, metering indicators, and annunciators.

(4) Other Control Stations

In addition to the control console in the main control room and the local control panels in the EDG building, the new SR EDG, which is a single generator with tandem diesel engines, has two auxiliary desks (one per diesel engine). The auxiliary desks are located near each of the diesel engines and include gauges to indicate engine parameters (i.e., RPMs, temperatures and pressures) and diesel engine auxiliary system characteristics for their associated diesel.

(5) Heating, Ventilation, and Air Conditioning System

The HVAC system for the EDG building comprises SR and NSR subsystems. During normal plant operation, the new SR EDG is not in operation and the NSR HVAC subsystem cools the EDG building by means of an air conditioning system. Through the use of an economizer cycle, outdoor air, and return air are mixed in order to maintain temperatures in the EDG building within design limits. Unit heaters and duct-mounted heaters are used to control temperature.

During emergency operation of the new SR EDG, the SR HVAC subsystem ventilates the EDG building. This subsystem ventilates the building by means of a SR supply and exhaust fans (which only supply outdoor ambient air) and four other SR fans (which recirculate air between the EDG room and the fan room in the EDG building). When plant conditions require emergency operation of the new SR EDG, the Class 1E control logic automatically places the SR HVAC subsystem into operation and shuts down and isolates the NSR HVAC subsystem.

A single START-AUTO-STOP switch controls the SR supply and exhaust fans. In the "AUTO" position, these fans are interlocked to start upon receipt of a 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 SR supply and exhaust fans.

The Class 1E signal which shuts down the NSR air handling unit is isolated from non Class 1E equipment by means of 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 NSR air handling unit is also interrupted when the Class 1E breaker supplying the NSR motor control center is automatically tripped. Class 1E circuits are used to shut the SR motor operated damper at the discharge of the NSR air handling unit.

A Class 1E temperature sensor monitors the temperature of the combined exhaust from the EDG building, the Class 1E switchgear room, and the non-Class 1E electrical panel room. The temperature sensor sends a control signal which varies the volume of outside air supplied to the EDG building and the volume of air exhausted from the EDG building. This is achieved by changing the angle on variable pitch blades on the EDG building supply and exhaust fans. As the exhaust temperature drops, the temperature sensors send a signal that decreases the volume of ventilation air supplied to the building.

As many as four fixed volume, SR EDG room fans operate whenever the new SR EDG is in operation. Each EDG room fan has Class 1E control circuit. Each fan has a manual ON-AUTO-OFF switch and may be started either manually or automatically. When the new SR EDG is not in operation, one fan is normally operated for ventilation. The other 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 provides sufficient air flow to meet the cooling requirements of EDG room without overcooling. Each fan has a Class 1E temperature switch which monitors the temperature in the EDG room and sequentially starts and stops fans as required.

During emergency operation of the new SR EDG, the SR supply fan ventilates the EDG building using only outdoor ambient air. The EDG room SR fans draw air from the fan room in the EDG building and supply it to the EDG room.

In order to achieve a mixture of recirculated air with outside air, a Class 1E sensor monitors the temperature of the fan room in the EDG building. The temperature sensor emits signals for SR motor operated dampers that control the mixture of recirculated and outdoor air supplied to the fan room in the EDG building. As the temperature drops in the fan room, the motor operated dampers are adjusted to increase the amount of recirculated air and decrease the amount of external air supplied to it.

Rooms serviced by the SR HVAC subsystem have Class 1E duct mounted electric heaters for temperature control. Each duct mounted heater is provided with a Class 1E flow sensor. The flow sensor is interlocked with the heater elements to prevent energizing of the heater elements in the absence of air flow in the duct. The interlock is designed to prevent fires which could be caused by the combination of no air flow and an overheated heater element.

In addition to a duct mounted heater, the battery room also has a SR unit heater for supplemental heat. The unit heater is started and stopped by a Class 1E thermostat.

A SR HVAC control panel is located in the EDG building which provides controls and status indication for key SR components of the HVAC system.

The HVAC control panel alerts operators that temperature limits are being approached or that low ventilation flows exist in critical rooms. It alarms for abnormal temperatures in the battery room, the control room, the Class 1E switchgear room, and the EDG room which are all located in the EDG building.

When alarm conditions exist, annunciator windows on the HVAC control panel display visual and audible alarms to alert operators in the EDG building. Since that control room is not normally manned, operators in the main control room are alerted to these abnormal conditions by means of a common alarm annunciator in the main control room. The annunciator in the main control room only sounds a "GENERAL TROUBLE" alarm. The annunciator panel in the EDG building must be checked to determine which specific indication is alarming.

The SR temperature control station, also located in the EDG building, houses control circuits and indications for automatic operation of the variable pitch fan blades and motor operated supply dampers in the fan room in the EDG building. 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 fan room in the EDG building.

(6) Instrumentation of the Fire Protection System

The instrumentation and controls for the fire protection system are designed in accordance with National Fire Protection Association (NPFA) Standards 13 and 72.

The fire protection preaction suppression system is actuated upon the detection of a fire in the associated detection zone. Pressure switches supervise the status of the preaction suppression systems. A multizone detection system, consisting of heat detectors and smoke detectors, detect a fire at an early stage. An abnormal condition detected by the supervisory instrumentation alarms on a local control panel in the EDG building. The fire alarm system transmits fire and trouble signals from the local control panel to the fire protection panel in the main control room. The annunciator in the main control room only signals "GENERAL TROUBLE" and "FIRE." The local control panel in the EDG building must be checked to determine which detector is alarming.

2.4 BG&E Commitments and Methodologies

The following portion of this evaluation relates to BG&E commitments and methodologies in three areas: (1) classification of the control systems and components, (2) seismic qualification of instrumentation and electrical equipment, and (3) design of instrumentation tubing and supports.

(1) Classification of Control Systems and Components

Electrical instrumentation is classified as SR in accordance with the definition given in 10 CFR 50.49, paragraph (b). A nuclear SR 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, or
- The capability to prevent or mitigate the consequences of plant conditions that could lead to potential offsite exposures that are comparable to the guideline exposures of 10 CFR Part 100.

As defined in the IEEE Nuclear Power Engineering Committee (NPEC) standards, such as IEEE 308 and IEEE 323, electrical instrumentation that meets these criteria is identified as Class 1E. ANSI/ANS 51.1 assigns Class 1E equipment to Safety Class 3. NSR electrical instrumentation is designed as non-Class 1E and is assigned Safety Class NNS for non-nuclear safety. Significant SR instrumentation and control systems are identified. The Code of Federal Regulations at 10 CFR 50.49 also assigns certain post-accident monitoring equipment to the SR category. Post-accident monitoring equipment is defined by Regulatory Guide 1.97, Revision 3, and ANS 4.5-1980.

There are no Code Class 1 or 2 piping systems designed for installation in the EDG building. Therefore, tubing attached to Code Class 3 systems meets the Group C quality standards of Regulatory Guide 1.26. NSR systems, such as the EDG coolant drain system, meet the Group D quality standards of Regulatory Guide 1.26.

Instrumentation tubing and its supports installed on SR systems are designed in accordance with the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code, Section III, Subsections NCA, ND, and NF (ASME Class 3 piping). The seismic design of the EDG building and its auxiliary systems conform to the recommendations of Regulatory Guide 1.29, Revision 3. All non-ASME tubing and tubing supports within the EDG building that are not designated as Category I systems are designed in accordance with the Category II/I criteria in Regulatory Guide 1.29, Revision 3.

The plant-specific classification criteria based on these requirements is found in the Calvert Cliffs Nuclear Power Plant List of SR Items, also called the "Q-List." All new or modified equipment for the EDG building will be classified in accordance with the Q-List.

Seismic Qualification of Seismic Category I Instrumentation and Electrical Equipment

Class 1E electrical instrumentation, Category I mechanical instrumentation, and their supports in the EDG 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 in the use of analysis or test data from previous qualification programs.

The adequacy of the seismic design of equipment is demonstrated either by analysis, testing under simulated seismic conditions, or a 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 EDG 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 EDG 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 component qualified by analysis. 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 10 percent.

Qualification by Analysis: Qualification by analysis verifies that Category I mechanical and Class 1E instrumentation and their supports will comply with the SR performance requirements when subjected to the stresses induced by a combination of operating and seismic loads. 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 stated in the applicable design standards and codes.

- The combined normal operating stresses and the stresses due to the SSE do not exceed 90 percent of the minimally 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 or the zero period acceleration (ZPA). 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 in proportion 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 analyses method (equivalent static load method) described in the IEEE 344-1975/1987 standard, or the modal response spectrum analysis technique. In this technique, the accelerations used to analyze flexible equipment are obtained from the appropriately damped FRS. The damping values used in the seismic analysis of piping and pipe supports are either based on Code Case N-411 or Regulatory Guide 1.61, Revision 0. Code Case N-411 allows the use of variable damping with a three-dimensional spectrum input (one vertical and two horizontal earthquake responses combined by the SRSS method). 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 are combined in accordance with Regulatory Guide 1.92, Revision 1.
- ZPA effects are included and combined with inertial effects by the SRSS method.

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 SRSS 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. The multizone response spectra combinations are performed by absolute sum.

Instrumentation and control system equipment is mathematically modeled as one of the following:

- 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 the equipment's center of gravity and its center of 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. 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, and
- 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 SR function(s) of the equipment. The equipment-specific acceptance criteria is based on the SR performance requirements.

Qualification by Experience: Previously qualified instrumentation of a design that complies with the requirements of equipment specifications can be used in the EDG building. In this case, the previous seismic qualification documentation is used in lieu of requalifying the equipment if 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 10% 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.

Computer Codes Used in the Seismic Analysis of Piping and Equipment: SR 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 Part 50, Appendix B, Section III.

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, Subsections NCA and ND, for tubing installed on safety-related systems.

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 subprograms 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 NRC benchmark problems.

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.

The licensee states that the PERMAS Code 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.

The PERMAS Code will be the subject of a future audit to ensure that it is acceptable for its use as detailed above. The staff will use Section 3.9.1 of the Standard Review Plan in determining the adequacy of the PERMAS Code.

Design of Instrumentation Tubing and Supports

With the exception of the fill and recirculation line on the EDG fuel oil storage tank, piping systems and pipe supports for Category I piping are designed with the criteria established by ASME B&PV Code, Section III, Subsections NCA, ND, and NF, 1986 Edition. Category II piping and associated supports are designed in accordance with ANSI/ASME B31.1 (1989). The ASME Code, Section III, boundary for all SR instruments ends at the tubing connection to the instrument. In other words, 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.

All ASME piping, components, and supports inside the EDG building are designed to meet the ASME Code requirements and to ensure that the EDG is available to supply 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.

SR instruments and control systems are designed to ensure that stresses resulting from the various loading combinations are within the applicable stresses allowed by the code. NSR instrumentation and control systems are designed to ensure that failure of the NSR component does not affect the operability of nearby SR equipment.

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:

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

- Tubing connected to ANSI/ASME B31.1 power piping systems 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 requirement of ASME III tubing.

- Tubing connected to the Category II/I piping 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.

For the stress criteria, support allowables are evaluated in accordance with ASME Code, Subsection NF for ASME tubing and ANSI/ASME B31.1 for non SR 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.

SR 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 type of problems for which the solutions are well known. This information should be maintained at the site for future NRC staff audit.

This completes all actions related to TAC Nos. M87556 and M87557.

Sincerely,

ORIGINAL SIGNED BY:

Daniel G. McDonald, Senior Project Manager
Project Directorate I-1
Division of Reactor Projects - I/II
Office of Nuclear Reactor Regulation

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