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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO THE EMERGENCY DIESEL GENERATOR PROJECT

SOCIÉTIÉ ALSACIENNE DE CONSTRUCTIONS MÉCHANIQUES DEL MULHOUSE (SACM)

DIESEL GENERATOR AND MECHANICAL DESIGN REPORT

CALVERT CLIFFS NUCLEAR POWER PLANT, UNIT NOS. 1 AND 2

DOCKET NOS. 50-317 AND 50-318

1.0 INTRODUCTION

The following is the staff's safety evaluation of the proposed design and modification by Baltimore Gas and Electric (BG&E) of the onsite emergency electrical system by installing one safety-related emergency diesel generator (EDG) and one nonsafety-related EDG at the Calvert Cliffs Nuclear Power Plant, Unit Nos. 1 and 2. These EDGs will support the Station Blackout (SBO) Rule requirements and provide spare capacity for future load expansions.

At present, the Calvert Cliffs site has three Class 1E EDGs: one EDG dedicated to each unit and one EDG that swings to the unit which would be in an accident condition. After installation of the new EDGs, Calvert Cliffs will have one EDG dedicated to each of the four engineered safety features (ESF) buses. The nonsafety-related EDG will be used as an alternate AC source (AAC) to comply with the SBO Rule. During installation, numerous systems will be affected as the work will consist of electrical, mechanical, instrumentation and control system modifications, and additions to accommodate the new equipment.

BG&E prepared a series of design reports for NRC's review. These are titled Civil Engineering, Sociétié Alsacienne De Constructions Méchaniques Del Mulhouse (SACM) Diesel Generator and Mechanical Systems, Instrumentation and Controls, Electrical Engineering, and Startup and Surveillance Testing reports.

This evaluation of the SACM Diesel Generator and Mechanical Systems Report is to establish the adequacy of SACM EDG and its associated auxiliary and support systems to meet the electrical demand of the safety-related loads at the Calvert Cliffs site.

2.0 EVALUATION

2.1 General

The subject report details the design, fabrication, procurement, and construction of two additional EDGs to be installed at the Calvert Cliffs site. This evaluation addresses the safety-related EDG.

Each EDG will be installed as a skid mounted unit, and consists of a single generator driven by two radiator-cooled, 16-cylinder diesel engines. The safety-related EDG will be housed in a newly designed building along with all associated auxiliary systems, control equipment, and electrical distribution equipment.

The new safety-related EDG, complete with auxiliary equipment and fuel oil storage and transfer system, will be dedicated to a single 4.16 kV class 1E ESF bus of Unit 1. The EDG, rated at 5400 kW continuous, with a capability of 5,940 kW for 2-hour operation (in any 24-hour period), 1200 RPM, 4160 Vac, and 0.8 power factor is manufactured by the French firm, SACM. The unit is a tandem set using two SACM model UD 45, 16-cylinder engines, coupled with a single generator manufactured by Jeumont Schneider of France. The SACM EDG is a redundant, standby onsite unit, installed in a separate and independent Seismic Category I Building (Diesel Generator Building) to comply with Regulatory Guide (RG) 1.75.

A description of the EDG and its support systems: fuel oil; engine cooling water; starting air; lube oil; and combustion air intake and exhaust systems, are included in BG&E's submittal.

This evaluation addresses BG&E's classification of the various EDG mechanical systems and components as it pertains to the design and fabrication of these items, and does not address operational or surveillance issues.

2.2 Electrical

The existing load sequence system will be used for loading the EDG. The loads are sequenced in eight steps at 5-second intervals. During loading, the frequency and voltage at the EDG terminals will not decrease to less than 95 percent of 60 Hz and 82 percent of 4.16 kV, respectively, as the unit has the capability of starting the largest single motor with all other sequenced loads running. During recovery from transients caused by step loading or disconnection of full load, the EDG speed will not exceed 75 percent of the difference between nominal speed and the overspeed trip setpoint or 15 percent above nominal speed, whichever is lower. The loading characteristics meet the recommendation of RG 1.9, Draft Revision 3, and are acceptable.

The EDG is designed to start and accelerate to rated voltage and speed by one of the following:

1. Receipt of a safety injection actuation signal (SIAS)
2. Loss of the 4.16 kV bus to which the EDG is connected
3. Manual switch operation (Main Control Room)
4. Manual switch operation (Diesel Generator Building Control Room)
5. Emergency manual switch (protective cover) operation (Diesel Generator Building Control Room)

Under normal operation the necessary EDG protective trips are retained. However, when the EDG is started by a SIAS, 4.16 kV bus undervoltage signal or emergency manual switch (break glass), the only protective trips that remain active are those that prevent rapid destruction of the set with the proper trip signal logic to comply with RG 1.9, Draft Revision 3.

These are:

Trips	Logic
Engine overspeed	1 of 2
Low lube oil pressure	2 of 3
Generator ground current	2 of 3
Generator differential current	1 of 1

The EDG "local/auto-remote" selector switch in the Main Control Room is normally in the auto-remote position to allow an automatic startup, manual start, or test operation of the EDG.

The "Automatic Starts" of the EDG can be initiated by either an ESF bus undervoltage or a SIAS signal. The unit will accelerate to the rated speed and the voltage will reach its rated voltage within 10 seconds. The "Manual Starts" or periodic testing can be accomplished by manual switches. Two acceleration modes are available. The SLOW start is operator-selected and provides through the governor control system a longer acceleration time. The SLOW start signal is automatically overridden by a SIAS or ESF bus undervoltage signal. The FAST start is operator selected and provides a simulation of the rapid acceleration required in response to any automatic start signal.

The selection of "local" position of the "local/auto-remote" selector switch will allow a similar manual start mode with the additional features:

(a) Individual operation of either engine when the generator is decoupled and,

(b) the EDG will not respond to any automatic or emergency start signals when in this mode.

The Main Control Room and the EDG Building Control Room contain control panels with instruments, controls and annunciation for the EDG, and its auxiliary systems. The existing control panels in the Main Control Room will be modified so that the controls and indications of the existing EDGs, SACM EDG, and SBO EDG are located on the console in the Main Control Room. Human factors engineering will be performed as per BG&E commitments in its letter of March 6, 1992. Specifically, any upgrade to the electrical control panels associated with the onsite and offsite power supplies will comply with the requirements of NUREG-0737, Item I.D.1. This commitment to perform human factors engineering is acceptable.

An auxiliaries desk (one per engine) located near the EDG unit contains the local metering to monitor the engine temperatures, pressures, rack position, and engine RPM.

BG&E will use a computer based non-1E EDG maintenance and reliability system to provide diagnostics and trending capability to assist in meeting the requirements of RG 1.9, Draft Revision 3, and NUMARC 87-00. The system monitor displays, stores, processes, and provides alarms for EDG data, and performs the following functions:

- Monitors EDG performance over time using statistical trending and engineering data to pinpoint component degradation.
- Detects and records all equipment failures.
- Records all alarm conditions.
- Generates reliability data.
- Transmits data to a remote location for display and analysis.

Based on the above review, the staff concludes that the design bases and the system description of the EDG and its support systems are acceptable.

2.3 Auxiliary and Support Systems

The EDG auxiliary systems consist of the fuel oil storage and transfer system (FOSTS), cooling water system (CWS), starting air system (SAS), lube oil system (LOS), and the combustion air intake and exhaust system (CAIES). The EDG support systems consist of the compressed air system (CAS), heating and ventilation (HVAC) system, fire protection system (FPS), and the coolant drain and demineralized water systems (CD&DWS).

The CAS and the CD&DWS are not safety-related because they do not perform any functions related to the starting or operation of the EDG. The CAS is an independent air system used to provide maintenance air for the EDG building. The CD&DWS, together, provide a means to control the chemistry, makeup, and disposal of the coolant in the EDG cooling water system. The staff has reviewed these systems and determined that their failure would not affect any safety-related equipment and would not prevent the starting or operation of the EDG. The staff, therefore, concludes that these systems are acceptable.

The HVAC system consists of safety-related and nonsafety-related portions or subsystems. The nonsafety-related subsystem provides EDG building heating and cooling when the EDG is not in operation. During EDG operation the safety-related HVAC subsystem operates to maintain temperatures within the required personnel and equipment limits. To provide adequate control of airborne particulate material, i.e., dust, all fresh air intakes are located greater than 20 feet above grade elevation in accordance with Standard Review Plan (SRP) Section 9.4.5.

The safety-related portions of the HVAC system are located within the seismic Category I, tornado and flood protected EDG building, and are designed to remain functional during and after a design basis earthquake (DBE). The DBE is defined as five operating basis earthquakes (OBE) and one safe shutdown earthquake (SSE). The nonsafety-related portions of the system, also housed in the EDG building, are designed such that their failure will not result in the failure of any safety-related systems, structures, or components. The system is separated from the effects of high-energy pipe breaks and is not exposed to internally generated missiles except those that could be generated by a failure of the EDG train which it serves. Therefore, the requirements of General Design Criterion (GDC) 2 and 4 with respect to protection against natural phenomena, missiles, and environmental effects are met. The staff, therefore, concludes that the EDG HVAC system is acceptable.

The FPS is considered a support system for the purposes of this evaluation. The licensee stated that the FPS for the EDG building is designed to meet the requirements of 10 CFR 50.48, Appendix R, to 10 CFR Part 50 and applicable National Fire Protection Association (NFPA) requirements. The licensee further stated that the intent of the applicable guidelines in Branch Technical Position (BTP) CMEB 9.5.1 were also met. Five positions of BTP CMEB 9.5.1 which needed further clarification, as they relate to the EDG building design, were provided in Section 4.4 of the report. The staff reviewed these clarifications and concluded they were acceptable alternatives to specific guidelines of BTP CMEB 9.5.1.

The mechanical portions of the EDG FPS consist of preaction fire suppression systems, fire and smoke detectors, a standpipe system, fire extinguisher, and fire barrier walls. The staff has reviewed these systems and concurs with BG&E's conclusion that they are designed in accordance with the requirements and guidelines discussed above. The staff, therefore, concludes that the design of the FPS meets the requirements of GDC 3 in accordance with the acceptance criteria of SRP Section 9.5.1.

The EDG auxiliary systems, identified above, are all housed in the Seismic Category I EDG building which provides protection against the effects of tornadoes, tornado missiles, and floods. The safety-related portions of the auxiliary systems themselves are designed to remain functional during and following a SSE. The auxiliary systems are also not affected by pipe breaks or internally generated missiles except for those breaks or missiles that would also render the EDG inoperable by virtue of the component or piping failure. Therefore, the requirements of GDCs 2 and 4 are met with respect to protection against natural phenomena and environmental and missile effects.

The FOSTS provides onsite storage and delivery of fuel oil for operation at 100 percent continuous rated load for 7 days, assuming the loss of offsite power sources in accordance with American Nuclear Society (ANS) 59.51-1989 and SRP Section 9.5.4.

Each diesel engine of the tandem-driven generator unit is provided with independent high temperature (HT) and low temperature (LT) closed loop cooling systems, which together make up the EDG CWS. The HT system provides cooling flow to the engine block and turbochargers while the LT system provides cooling flow to the combustion air coolers and the lube oil heat exchanger. Both systems consist of an engine-driven pump, expansion tank, thermostatic control valve, and a water-to-air heat exchanger (radiator). The HT system also functions to keep the diesel engine warm when in the standby mode. The CWS provides diesel cooling in accordance with GDC 44, and is capable of being tested and inspected in accordance with GDCs 45 and 46 as recommended in SRP Section 9.5.5.

The SAS for the tandem EDG consist of skid mounted subsystems which include four redundant air receivers and two air compressors complete with air dryers, one air compressor, and two receivers for each diesel engine. In accordance with the acceptance criteria of SRP Section 9.5.6, two receivers (one per engine) are capable of providing, without recharging, five consecutive cranking cycles to a cold EDG.

The EDG LOS consists of two cross-tied loops, pressurized by two engine-driven pumps. Engine heat is transferred from the oil to the LT cooling water system. The LOS is provided with a pre-lube system which includes a heat exchanger and two pumps: one motor-driven and one pneumatically-driven. The pre-lube heat exchanger is heated by the keep warm portion of the HT cooling water system. The design of the system including the automatic pre-lube system is in accordance with the acceptance criteria and guidance of SRP Section 9.5.7.

Each diesel engine of the tandem-driven generator has an independent CAIES. For each system, air is drawn into the air intake filter and integral silencer, passes through the intake piping to the turbochargers and then through the aftercooler to the engine intake manifolds. The diesel exhaust is passed through the turbocharger and an exhaust silencer before being discharged from the building. The design of the CAIES, including the location of the exhaust piping to prevent recirculation to the intakes, is in accordance with the acceptance criteria and guidance of SRP Section 9.5.8.

Based on its review as described above, the staff concludes that the design of the EDG support and auxiliary systems meets the requirements of all the GDCs identified in the acceptance criteria of the applicable SRP Sections (9.4.5, 9.5.1, and 9.5.4 through 9.5.8). The staff, therefore, concludes that the design is acceptable.

SRP Section 3.2.2 states in part that systems and components important to safety should be designed, fabricated, and erected to quality standards commensurate with the importance of the safety function to be performed. For guidance in determining the appropriate quality group designation for pressure-retaining components, RG 1.26, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste Containing Components of Nuclear Power Plants," is referenced. However, SRP Section 3.2.2 further notes that the following EDG auxiliary systems and their pressure-retaining components are not specified in RG 1.26, but should be classified as Quality Group C of RG 1.26. These are the fuel oil storage and transfer system, engine cooling water system, lube oil system, starting air system, and combustion air intake and exhaust system.

BG&E has provided a table of the Codes, standards, and guides used in the design of the new EDG systems. It should be noted that SRP Section 3.2.2 was not listed as a referenced document. However, BG&E has designated the following systems and components as safety-related:

1. Fuel Oil Storage and Transfer System: fuel oil storage tank, fuel oil transfer pumps, fuel oil transfer piping and components, fuel oil day tank, piping and components between the day tank, and diesel engine skid.

2. Cooling Water System: HT and LT expansion tanks, HT and LT radiators, HT and LT circulating pumps, piping, valves, and pumps between the expansion tanks an diesel engine skid, piping, valves, and pumps between the radiators and diesel engine skid, all system heat exchangers.

3. Starting Air System: starting air receivers, piping and solenoid valves between the air receivers and diesel engine, piping upstream of the air receivers (including the inlet check valve and globe valve).

4. Lube Oil System: piping from the diesel engine sump up to and including the first isolation valve, pre-lube system (including suction and discharge isolation valves), engine driven lube oil pumps, lube oil auxiliary tanks, thermostatic control valves, piping between the lube oil auxiliary tank, and diesel engine skid.

5. Combustion Air Intake and Exhaust System: intake air filters, intake piping from air filter to diesel engine skid, piping from the diesel engine skid to the exhaust silencer, the exhaust silencer, and expansion bellows.

In accordance with SRP 3.2.2, the above piping and components should be classified as Quality Group C and are thus required to be designed and fabricated following the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code, Section III, Subsection ND (Class 3). The items listed are supplied by either the vendor (Bechtel) or SACM. Those supplied by Bechtel are classified as Quality Group C and designed according to ASME Code, Section III, Subsection ND. Those components supplied by SACM (located on the diesel engine skid and auxiliary desk) are not specifically classified as Quality Group C in the design report, and are designed to different standards. These SACM supplied components and the standards used are described in the succeeding paragraphs.

1. The combustion exhaust piping running from the diesel engine skid to the exhaust silencer is supplied by SACM and fabricated according to ASME Code, Section III, Subsection ND, with the following modifications:

   a. The rules of Code Case N-253-6 shall govern the design and material selection stages of construction (approved August 14, 1992).

   b. The stamping and data report shall indicate the Case number and applicable revision.

   BG&E has provided justification for use of these modifications by stating that there are no ASME Code, Section III, Subsection ND, materials approved for use at the design temperatures of the diesel exhaust system, and requests NRC approval of their use. According to the design report, the Code Committee has expressed the view that the above modifications may be used for the construction of Section III, Class 3 components subject to elevated temperatures until new rules covering these temperatures are complete.

2. The HT and LT radiators of the cooling water system are supplied by SACM and fabricated in accordance with ASME Code, Section VIII. BG&E has not provided justification in the design report for use of Section VIII over Section III of the ASME Code. However, this was clarified during a meeting on November 11, 1993, in which BG&E indicated that no radiators were available for procurement to ASME Code, Section III. However, BG&E noted that the design of the radiators is in accordance with the ASME Code, Section III.

3. The following components are supplied by SACM and fabricated to SACM standards:

   a. Fuel Oil Storage and Transfer System: all piping on skids supplied by the manufacturer.

   b. Cooling Water System: the three way thermostatic control valves upstream of the radiators, all system heat exchangers, and the HT and LT coolant circulating pumps.

   c. Starting Air System: the air start solenoid valves located in the discharge piping of the air receivers.

   d. Lube Oil System: the pre-lube system located on the auxiliary desk, not including the pneumatically driven pre-lube pump.

   e. Combustion Air Intake and Exhaust System: the intake air filter, exhaust silencer, and expansion bellows.

BG&E has not provided any detailed information on the standards used by SACM in the design of these components. However, BG&E referenced an evaluation of the installation of similar EDG sets at the Prairie Island Generating Facility. It is stated in the evaluation that the portions of the auxiliary systems under SACM scope, including the expansion bellows and all piping and components mounted on the diesel skid and auxiliary tables, were qualified to SACM standards. SACM performed comparisons of the French Codes and ASME Code, Section III, and concluded that they were equivalent to or met the intent of the ASME Code, Section III. The staff found the use of these Codes acceptable in this instance. However, information on the particular Codes used by SACM for the present application, and in particular the extent to which they meet the intent of ASME, Section III, were not provided in the report. However, BG&E indicated that it has the documentation and that it will be available for audit by the NRC staff.

Certain components of the EDG auxiliary systems were considered by the licensee to be nonsafety-related, and hence not classified as Quality Group C. SRP Section 3.2.2. states that changes in quality group classification are normally only permitted at valve locations, with the valve being assigned the higher classification. This quality group classification interface requirement has been adhered to with the exception of a few specific cases. The nonsafety-related components and exceptions to the isolation requirement are as follows:

1. <u>Fuel Oil Storage and Transfer System</u>

   The recirculation loop piping and valves, which returns fuel oil to the safety-related storage tank, is designated as nonsafety-related. No isolation valve has been provided. The licensee's justification for this is that since the recirculation piping at the bottom of the tank is isolated with a normally shut manual valve, a break in the recirculation system piping would not cause fuel to be siphoned from the tank.

   The overflow piping from the day tank to the storage tank is also considered nonsafety-related. BG&E states that no isolation is provided between this piping and the tanks because the piping is connected to both tanks at a point above the minimum required tank level, thus the operation of the tanks would not be compromised should the piping fail.

   Additionally, the external fill line and alternate fill line to the fuel oil storage tank and any vent and drain line piping are classified as nonsafety-related. These comply with the isolation requirement for quality group classification interfaces.

2. <u>Cooling Water System</u>

   Supply and return lines between the HT and LT expansion tanks and the coolant mixing tanks are considered nonsafety-related. No isolation valve is provided since the lines are connected to the expansion tanks at a level above the minimum required tank level.

All vent and drain lines are designated nonsafety-related. These comply with the isolation requirement for quality group classification interfaces.

3. Starting Air System

The air compressor and related piping upstream of, but not including, the inlet check valve to each air receiver is designated as nonsafety-related. These comply with the isolation requirement for quality group classification interfaces.

4. Lube Oil System

No isolation is provided between the supply line from the lube oil fill station and the lube oil auxiliary tank, nor between the overflow line and the auxiliary tank. The justification provided is that these lines connect to the safety-related tank at points above the minimum required tank level.

Interconnecting piping between the diesel engine skid and the lube oil drain tank, and the pneumatically driven pre-lube pump are considered nonsafety-related. However, the pneumatically driven pre-lube pump is provided with isolation valves at both its suction and discharge. These comply with the isolation requirement for quality group classification interfaces.

5. Combustion Air Intake and Exhaust System

The only nonsafety-related item in this system is the moisture drain line from the exhaust silencer. No isolation is provided between the drain line and silencer, with the justification that a break in the drain line would not affect the operation of the silencer, and any exhaust gases would have a safe vent path from the EDG building.

Based on the review as described above, the NRC staff concludes that the quality group classification of components and systems is in accordance with SRP Section 3.2.2 and that the isolation of safety-related components from nonsafety-related components is acceptable.

2.4 Seismic Classification

GDC 2 of 10 CFR Part 50, Appendix A, requires in part that structures, systems, and components important to safety be designed to withstand the effects of earthquakes without loss of capability to perform their safety function. RG 1.29, "Seismic Design Classification," identifies the plant features which must remain operable if the SSE occurs. SRP Section 3.2.1 provides guidelines for review of the licensee's classification.

The report indicates that the portions of the EDG auxiliary systems which are required for operation of the EDG before and after a SSE are designated as

Seismic Category I. Furthermore, the recommendations of RG 1.29 have been followed in designing the EDG building and the EDG auxiliary systems.

All piping which has been designed to ASME Code, Section III, and is seismically classified as Seismic Category I. Additionally, all components designated as safety-related are Seismic Category I, as well as the diesel engine itself.

Nonsafety-related piping and components are not classified as Category I, with the exception of the recirculation loop piping and valves (of the fuel oil system) and all piping and valves which connect the external and alternate tanker fill connections to the recirculation loop. These have been specifically designated as Seismic Category I in the design report.

Based on the above, the NRC staff concludes that the seismic classifcation of structures, systems, and components is in accordance with SRP 3.2.1 and is, therefore, acceptable.

2.5 Qualification

Seismic Category I mechanical and Class 1E electrical equipment supplied by SACM was seismically qualified to function successfully during and after a DBE. This qualification was performed in accordance with either Institute of Electrical and Electronics Engineers (IEEE) 344-1975, as endorsed by RG 1.100, Revision 1, or with IEEE 344-1987, as endorsed by RG 1.100, Revision 2. Qualification by experience, addressed in Section 9.0 of IEEE 344-1987, was only employed through the use of analyses or test data from previous qualification programs. In addition, requirements of the following standards were used for the seismic qualification of SACM equipment: IEEE 344-1974; IEEE 420-1982; and ANSI/IEEE C37.98-1987. Details of the qualification methods and their acceptability are as follows:

2.5.1. Analysis

Qualification by analysis is an acceptable approach when structural integrity alone can ensure the design's intended function. Various analytical methods, including finite element analyses were used. Simple analysis was used for equipment with geometric shape and design which allow simple and conservative models, such as a beam or a plate, to determine structural response. For more complex equipment, finite element analysis was used. The equipment is considered to be rigid if its fundamental frequency is equal to or greater than 33 Hz. Equipment with a fundamental frequency below 33 Hz is considered to be flexible. For rigid equipment, the seismic forces were obtained by concentrating its mass at the center of gravity and multiplying it by the zero period acceleration (ZPA). If a frequency determination was performed, the analysis was based on the equipment's natural frequency. In accordance with the guidelines of RG 1.10G, Revision 2, the accelerations used for the static analysis of active, rigid, rotating equipment is 1.5 times the ZPA applied to the center of gravity of the rotating element. Flexible equipment was analyzed by the modal response spectrum analysis technique. In lieu of a frequency determination, a static coefficient analysis was sometimes performed. For a static coefficient analysis, the design acceleration corresponds to 1.5 times the peak of the required response spectra at the appropriate damping value.

In the seismic analysis, appropriate damping values from RG 1.61 were used to select the required response spectra. Load combinations were performed in accordance with ASME Code, Section III, requirements. The seismic loads due to the accelerations included the effects of directional response and the multi-modal response. To obtain the directional response, the resulting loads caused by the accelerations in the three orthogonal directions were combined by the square-root-of-the-sum-of-the-squares method. The multi-modal response was obtained in accordance with the guidelines of RG 1.92.

Based on the above, the NRC staff concludes that appropriate considerations were made in selecting the analytical methods used and appropriate standards and guides were followed in using analysis as the basis for qualification of selected Seismic Category I mechanical and Class 1E electrical equipment and is, therefore, acceptable.

2.5.2 Testing

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

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

The test response spectrum was greater than or equal to 100 percent of the required response spectra and the equipment was mounted on the test tables in a manner similar to the intended service mounting. Each OBE and SSE simulation in test table qualification conservatively used at least 15 seconds of strong motion. Equipment function for active, safety-related components was monitored before, during, and after each qualification test.

Based on the above, the NRC staff concludes that the appropriate standards and guides were followed in performing the seismic qualification testing performed. The NRC staff further determined that the testing monitored the ability of the equipment being tested to perform its safety-related function before, during, and after a seismic event; therefore, the seismic qualification testing is acceptable.

2.5.3 Experience

Previously-qualified equipment of a design that meets the requirements of equipment specifications can be used in this installation. Previous seismic qualification documentation was used in some cases instead of requalifying the equipment. It was ensured that the following conditions were satisfied.

- The previous seismic qualification must have a methodology consistent with the requirements of the equipment specifications.
- The existing qualification documentation must have addressed required response spectra which meets or exceeds the floor response spectra developed for the equipment's mounting location within the EDG 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.

The piping stress analyses were performed to evaluate the effects of weight, thermal, and seismic events. A majority of the safety-related piping was qualified in accordance with the ASME Code criteria in Section III, Subsections NCA and D, 1986 Edition. Piping reactions on equipment nozzles were verified to be less than the manufacturer's recommended limits.

Some power piping was qualified in accordance with criteria established by ANSI/ASME B31.1 Power Piping Code, 1989 Edition. Piping reactions on equipment nozzles was verified to be less than the manufacturer's values. Power piping was also qualified by meeting the requirements for ASME piping. Since piping systems are seismically supported, piping supports were designed to be double acting supports. In general, rigid supports are used. When the use of springs and snubbers became necessary, the number of springs and snubbers was kept to a minimum.

The weight of insulation and piping components was included in the weight analysis. It was assumed that the piping fittings such as elbows, tees, and branch connections are similar in weight to their attached piping. The weights of flanges and orifice unions were lumped at the flange face.

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

Normal faulted and test modes were considered in the stress range for piping qualification. In the evaluation of the air intake and exhaust systems, the analysis considered the weight of the bellows and mathematically simulated the lateral and axial flexibility of the bellows that are installed as flexible joints in the system.

All supports except Category II/I supports and nonseismic supports were designed such that their natural frequency fell within the rigid frequency range. The following assumptions were made in the calculation of the natural frequency of piping systems.

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

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

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

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

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

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

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

Based on the above, the NRC staff concludes that appropriate considerations were made and the appropriate standards and guides followed in determining the qualification of equipment by experience, therefore, that equipment determined qualified based on experience is acceptable.

3.0 <u>CONCLUSION</u>

Based on its review, the staff finds that the design bases for the EDG equipment and BG&E's commitment to various codes, standards, and regulatory guides is acceptable. The licensee's quality group classification of EDG components and systems is in accordance with SRP Section 3.2.2 and is acceptable.

With regard to the isolation of safety-related components from nonsafety-related components, BG&E's approach is acceptable.

With regard to the identification of those components and systems required to remain functional in the event of a SSE, and the classification of these systems and components as Seismic Category I, BG&E's approach is acceptable.

The documents related to the design specifications and design reports for a selected number of EDG components and piping systems are subject to an audit review at a future date. The objective of this audit will be to provide the staff with the basis for concluding that the SACM EDG design documentation meets the applicable requirements of the ASME Code, Section III, Subsection NCA.

4.0 SUMMARY

In summary, we have concluded that the subject report is acceptable. This conclusion may be subject to change based on future audit of the SACM EDG design documentation discussed above.

Principal Contributors:
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Dated: March 1, 1994

Society of Mechanical Engineers Boiler and Pressure Vessel Code should be maintained in an auditable form for a future NRC staff audit.

This completes all actions related to TAC Nos. M87070 and M87071.

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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