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MFN 024-83
JNF 008-83

February 8, 1983

U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Washington, DC 20555

Attention: Mr. D.G. Eisenhut, Director
Division of Licensing

Gentlemen:

SUBJECT: IN THE MATTER OF 238 NUCLEAR ISLAND
GENERAL ELECTRIC STANDARD SAFETY ANALYSIS REPORT (GESSAR II)
DOCKET NO. STN 50-447

EQUIPMENT QUALIFICATION BRANCH DRAFT RESPONSES

Attached please find draft responses to the Commission's January 31, 1983 information request.

Sincerely,

Willa for

Glenn G. Sherwood, Manager
Nuclear Safety & Licensing Operation

Attachments

cc: F.J. Miraglia (w/o attachments)
D.C. Scaletti
C.O. Thomas (w/o attachments)
L.S. Gifford (w/o attachments)

E003

DRAFT RESPONSES TO EQUIPMENT QUALIFICATION BRANCH QUESTIONS

271.01
(3.10)

a. Interfaces between the Nuclear Island and Balance of Plants (BOP) are discussed in Section 1.9 of Volume 1. Listed are the minimum BOP structures and systems to be designed by the Applicant which are necessary for normal operation, safe shutdown and accident mitigation. Also listed are the safety and power generation interfaces between the Nuclear Island systems and related BOP systems. The discussion identifies where General Electric's (GE's) responsibility ends regarding these systems. The GESSAR II FSAR states that intervening structures or components that serve as interfaces between the equipment to be qualified and that supplied by others are not qualified as part of GE's program. The FSAR should clearly define (as in lists or tables) all qualified equipment to be supplied by GE and the procedures to maintain this equipment as qualified when other qualified components or parts not supplied by GE interface with the qualified equipment of GE.

b. Section 3.10.4.1 states that qualification records for safety-related panels and control equipment are maintained in a file by GE. These records should also be available at the plant.

c. A topical report or some quite detailed and comprehensive examples would be beneficial in comprehending the GE approach to equipment qualification.

Response a

Table 3E-1 contains a listing of all ~~qualified~~ safety-related equipment to be supplied by GE within the scope of this standard offering. Specific information on the environmental qualification, including the limitations on the scope of such qualification, will be available in the specific qualification report which will be prepared at that time in which qualification adequacy is demonstrated. [redacted] Maintenance of qualified equipment is the responsibility of the end user and hence will be addressed by the Applicant~~/licensee~~.

Response b

GE is not aware of any regulatoion that requires these records to be in file at GE and the plant. However, the eventual disposition of seismic qualification records will be detamed on the basis of the contractual commitments between GE and the Applicant.

Response C

NEDE-24326-1-P (General Electric Environmental Qualification Program) describes the approach GE will use in qualifying safety-related equipment.

271.02
(3.9)

a. The GESSAR II FSAR does not contain substantial discussion about the development of hydrodynamic loads for purposes of equipment qualification or how the loads are handled in the qualification. The limited discussion of this subject in Section 3.9 indicates that the hydrodynamic loads will be represented by response spectra. But no discussion is presented as to how the response spectra are developed or how the hydrodynamic loads are combined with seismic loads. If these loads are combined by performing an SRSS summation, the results may be less than conservative. Discuss more thoroughly the treatment of hydrodynamic loads, seismic loads, and their combination.

b. Persistently throughout Section 3.9 the statement is made that if equipment can be shown to have natural frequencies greater than 33 Hz, it can be considered rigid. This, of course, may not be true if the equipment is subjected to hydrodynamic loads which have a frequency content greater than 33 Hz. Where hydrodynamic loading is mentioned, a frequency of 60 Hz as the cutoff frequency should be provided since hydrodynamic loads often contain higher frequencies.

Response a

The development of hydrodynamic loads, including those for the purposes of equipment qualification, will be provided by the Applicant. The hydrodynamic loads which will be represented by response spectra will also be provided by the Applicant. As approved on other recent BWR/6 - Mark III dockets (e.g. Clinton), the hydrodynamic loads will be combined with seismic loads by performing an SRSS summation.

Response b

The 33 Hz criteria was not intended for hydrodynamic load combination. For these dynamic loads, a frequency of at least 60 Hz is used. GESSAR II will be revised accordingly.

271.03
(3.7)

The modeling approaches discussed in the document (page 3.7-38) are geared toward the low frequencies of seismic loads. Justify neglect of higher frequency dynamic loads in the modeling.

Response

Section 3.7 addresses only seismic design as required by Regulatory Guide 1.70. The higher frequency hydrodynamic loads are included in Subsections 3.9 and 3.10.

271.04
(3.10)

a. The GE position on fatigue effects due to hydrodynamic loading should be discussed. The argument for using only one OBE-intensity earthquake instead of five as stipulated in the IEEE 344-1975 Standard for seismic fatigue evaluation may be acceptable for certain plants. The use of only one OBE, however, should not be used on a generic basis. It should rather be justified for each plant where only one OBE is used.

b. The qualification program should address the degree of aging or environmental degradation that pieces of equipment could potentially incur prior to the occurrence of dynamic loading. The program should assure that the equipment has undergone its maximum expected amount of aging before the dynamic loads are applied in the qualification of the equipment. Surveillance and maintenance programs needed to assure that the equipment does not age to a degrees worse than qualified to should be described.

c. Sequential testing needs to be discussed more thoroughly. The discussion should make clear that seismic and hydrodynamic tests follow other environmental testing on the equipment. The sequence of exploratory, seismic and hydrodynamic loads and how this sequence properly qualifies the equipment for all loads incurred during the life of the equipment should be included in the discussion..

Response a

The GE method for handling fatigue effects due to hydrodynamic loading is presented in Section 4.4.2.5 of NEDE-24326-1-P.

The justification for using only one OBE instead of five for GESSAR II is given in the response to MEB (DSER) Item No. 38a.

271.04 (Continued)

Response b

The GE approach to handling aging effects on equipment potentially subject to dynamic loading is provided in Section 4.4.2.5 of NEDE-24326-P.

Surveillance and maintenance procedures are the responsibility of the end user ~~was~~ and will be addressed by the Applicant/~~licensee~~.

Response c

The sequence in which a given device is tested is dependent upon the given device and the specific event for which it is being qualified. Both Section 4.4.2 and Table 4-1 of NEDE-24326-1-P provide details on how a test sequence is developed and applied.

271.05
(3.10)

a. It is not clear whether ground level seismic response spectra presented in the document are intended to be generic spectra applicable for all plants or if response spectra will be uniquely determined for each plant. If these are generic spectra, then their development should be described.

b. Will hydrodynamic response spectra be used as part of the equipment qualification program? If not, how will hydrodynamic loads be treated?

Response a

The ground level seismic response spectra are generic. The development of these spectra are described in Appendix 3A.

Response b

Section 4.4.2.5 of NEDE-243-26-1-P provides details on how hydrodynamic responses are used as part of the GE equipment qualification program.

271.06
(3.7)

It is stated that multimodal response in multi-span structures is represented by applying a static coefficient of 1.5 to the peak acceleration of the response spectrum. For a simply supported structure a static coefficient of 1.0 is used. Regulatory Guide 1.100 allows the use of a static coefficient of 1.5 for frame-type structures, but requires justification for using static coefficients in qualifying equipment of other configurations. Thus, the use of static coefficients of 1.5 and 1.0 as specified requires more explicit justification.

Response

Subsection 3.7.3.5.2 on page 3.7-43 states:

"When the natural frequency of a structure or component is unknown, it may be analyzed by applying a static force at the center of mass. In order to conservatively account for the possibility of more than one significant dynamic mode, the static force is calculated as 1.5 times the mass times the maximum spectral acceleration from the floor response spectra of the point of attachments of multispan structures. The factor of 1.5 is adequate for simple beam type structures. For other more complicated structures, the factor used is justified."

As stated, the static coefficient of 1.5 is applied for simple beam (frame) type structures and the factor used for more complicated structures is justified.

271.07
(3.9)

It is stated that if the equipment is a rigid body while its support is flexible, the overall system can be modeled as a single-degree-of-freedom system. A substantiation is required in order to classify the system as single-degree-of-freedom.

Response

If the equipment is a rigid body, it means that there is no amplification of the dynamic vibration. With the support being flexible, the amplification will come only from the spring action of the support. In this case it is sufficient to have a single-degree-of-freedom model to represent the overall system.

271.08
(1.8)

a. It is stated that closely spaced modes are combined by either the Double Sum Method or an algebraic sum of such modes. The Double Sum Method is acceptable according to Regulatory Guide 1.92, but an algebraic sum could be inappropriate. If the modes are added algebraically, cancellation would occur among modes having opposing signs. This cancellation could result in a non-conservative calculated total response. Justify the use of the algebraic sum method.

b. Two deviations from SRP 3.7.3 criteria are given. Justification for allowing these deviations should be provided.

Response a

The statement that closely spaced modes are combined by either the Double Sum Method or an algebraic sum of such modes is in error. Only the Double Sum Method is employed. GESSAR II will be revised accordingly.

Response b

Section 1.8 has been revised to include all regulatory guides up through Regulatory Guide 1.150 (revisions as of GESSAR II docket date; February 22, 1982) and the elimination of Tables 1.8-2 through 1.8-5. These tables provided an assessment of GESSAR II against regulatory matters (including SRP 3.7.3) beyond the GESSAR PDA March 1, 1974 cutoff date in response to NRC requirements for the GESSAR PDA extension. Since GESSAR II now is current with respect to regulatory guides and GESSAR II was docketed prior to the March 17, 1982 rule requiring the applicant to address deviations from NUREG-0800, there is no requirement for GESSAR II to formally address deviations from NUREG-0800.

With regard to the two deviations noted to SRP 3.7.3, the following comments can be made: The justification on one OBE is addressed in response to MEB (SER) Item Number 38a; and GESSAR II now fully complies with the Regulatory Guide 1.92 requirements for combining modal responses.

271.09
(3.10)

Provide a list of equipment to be qualified by analysis only.

Response

It is the responsibility of the end user to verify the adequacy, including operability, of the qualification method chosen. Should the approach showing qualification by analysis be chosen it will be the responsibility of the Applicant/~~licensee~~ to ~~defend~~ the operability of the device.

demonstrate

provide the list of equipment to be qualified by analysis and to

271.10
(3.10)

a. The document indicates that a single frequency test input can be used if the input is sufficiently intense. Regulatory Guide 1.100, however, stipulates that all non-rigid modes be excited simultaneously to provide sufficient simultaneous multimodal effects. Justify the use of a single frequency test.

b. The description of qualification of some equipment items is quite brief, particularly for dynamic testing performed. In most cases it is stated that testing was done "in accordance with IEEE 344-1975." Describe how the provisions of IEEE Std. 344-1975 were met in these tests.

Response a

~~It has been~~ Equipment specifications [struck out] supporting GESSAR II ~~specified~~ require ~~that~~ multifrequency vibration input motion ~~should~~ be used for seismic qualification. However, single frequency input, such as sine beats, may be applicable if under ~~some~~ certain conditions; ~~are met:~~

(1) When the seismic ground motion has been filtered due to one predominant structural mode, the resulting floor motion may consist of one predominant frequency.

(2) When it can be demonstrated that the anticipated response of the equipment is adequately represented by one mode of vibration.

(3) The input has sufficient intensity and duration to excite all modes to the required magnitude, such that the testing response spectra will envelop the corresponding response spectra of the individual modes.

Response b

Section 4.4.7 of NEDE-24326-1-P provides additional information on how the GE environmental qualification program meets the requirements of IEEE-344-1975 and Regulatory Guide 1.100.

271.11
(3.10)

a. Qualification of equipment must sufficiently demonstrate operability of the equipment during and after application of all loads. Operability is most easily demonstrated by testing the equipment. If the equipment is qualified solely by analysis, it must be shown clearly that a structural evaluation is enough to establish equipment functionality. The FSAR should be explicit in describing limitations on the use of analysis to verify equipment operability in the qualification program.

b. The terms "tests and analyses" are used frequently in the FSAR. The FSAR should be more specific in this area; for example, it should be stated precisely what kind of test or analysis was performed for each component and the purpose for the test or analysis.

c. In many sections of the FSAR it is not stated what loads were considered during test or analysis, (e.g., LOCA, seismic, hydrodynamic, or other DBAs). The FSAR should state precisely which loads were included in any test or analysis and the sources of the loads.

Response a

Section 4.4 of NEDE-24326-1-P provides additional information on how the GE environmental qualification program will demonstrate the operability of devices subject to various loads. NEDE-24326-1-P also discusses the limitations imposed by GE on the usage ~~of the tool~~ of analysis in the qualification area.

Response b

Section 4.4 of NEDE-24326-1-P provides a discussion of the methods of approach to be used in qualifying safety related devices within the scope of ~~this document~~ GESSAR II.

Response c

The specific loads to be included in any given qualification test or analysis is a function of the device location, the specific plant, ~~at~~ and the event for which a device is being qualified. Section 4.4 of NEDE-24326-1-P provides a discussion of how loads will be addressed as part of a qualification effort. The qualification report will address the result of considering such loads. The ~~licensee~~ applicant will specify which loads are addressed.

Text modification for 271.12

3.9.3.1.20 Non-NSSS Piping

basis in accordance with Appendix F of the code. For Class 2 and 3 piping, stresses are calculated on an elastic basis in accordance with Appendix F of the code. For Class 2 and 3 piping, stresses are calculated on an elastic basis in accordance with NC/ND-3600 of the code.

3.9.3.2 Pump and Valve Operability Assurance

Table 3.9-14 lists the active pumps and valves in the NSSS. Tables 3.9-15 and 3.9-16 list the active non-NSSS pumps and valves, respectively.

Active mechanical equipment are classified as Seismic Category I and each is designed to perform a mechanical motion for its safety funtion during the life of the plant under postulated plant conditions. Equipment with faulted condition functional requirements include active pumps and valves in fluid systems such as the Residual Heat Removal System, Core Spray System, and Main Steam System.

Safety-related valves and pumps are qualified by testing and analysis and by satisfying the stress and deformation criteria at the critical locations within the pumps and valves. Operability is assured by meeting the requirements of the programs defined in Subsection 3.9.2.2, Section 3.10, Section 3.11 and the following subsections. 271.12

3.9.3.2.1 ECCS Pump/Motors

All active pumps are qualified for operability by first being subjected to rigid tests both prior to installation in the plant and after installation in the plant. The in-shop tests include: (1) hydrostatic tests of pressure-retaining parts of 125% of the design pressure; (2) seal leakage tests; and (3) performance tests while the pump is operated with flow to determine total developed head, minimum and maximum head and net positive suction head (NPSH) requirements. Also monitored during these operating tests are

Text modification for 271.12c

3.9.3.2.1.3 Environmental Qualification of ECCS Motors (Continued)

(4) The dynamic load deflection analysis on the rotor shaft is performed to ensure adequate rotation clearance, and is verified by static loading and deflection of the rotor for the type test motor.

(5) Dynamic load aging and testing is performed on a biaxial test table in accordance with IEEE 344-1975. During this test, the shake table is activated to simulate the maximum design limit for the safe shutdown earthquake and hydrodynamic loads with ~~as many~~ motor starts and operation combinations consistent with the plant events ~~as may possibly occur during a plant life, 10 inadvertent starts during plant life.~~ of Table 3.9-1 and the ECCS inadvertent injections and tests planned over the life of the plant. 271.12c

(6) An environmental test simulating a LOCA condition with a duration of 100 days is performed with the test motor fully loaded, simulating pump operation. The test consists of startup and six hours operation at 212°F ambient temperature and 100% steam environment. Another startup and operation of the test motor after one hour stanstill in the same environment is followed by sufficient operation at high humidity and temperature based on extrapolation in accordance with the temperature life characteristic curve from IEEE 275-1966 for the insulation type used on the ECCS motors.

3.9.3.2.2 SLC Pump and Motor Assembly and RCIC Pump Assembly

These equipment assemblies are small, compact, rigid assemblies, with natural frequencies well above 33 Hz. With this fact verified, each equipment assembly is qualified by the static analysis for seismic and hydrodynamic loads. This qualification assures structural loading stresses within Code limitations, and verifies operability under seismic and hydrodynamic loads.

271.12
(3.9)

a. The FSAR implies that tests and/or analysis are performed on assemblies (the pump and drive motor or the valve and actuator). The detailed descriptions however seem to indicate that motor and actuators are more often tested or analyzed separate from the pump or valve. The FSAR should state precisely whether or not equipment was tested or analyzed as an assembly or as individual components.

b. The sections of the FSAR which present the requirements for documentation of pumps and valves are different in scope. Justify why there is a difference in the documentation requirements between pumps and valves.

c. In some instances more quantitative and qualitative details are needed in order to understand the intent of a particular FSAR section. Phrases or terms are used which are unclear or subjective. Phrases such as "operation combinations," "as many motor starts as possible," should be defined or quantified. Such phrases do not convey the information needed to form an opinion with regard to the acceptability of the approach presented.

271.12 (Continued)

Response a

It is the Applicants responsibility to specify (via the qualification report) as to the method of qualification. This includes wether or not the equipment was tested or analyzed as an assembly or as individual components.

Response b

There are no actual differences in documentation requirements between pumps and valves. The documentation requirements for valves has been revised to be the same as those for pumps.

Response c

Subsection 3.9.3.2.1.3 will be revised as indicated.

3.9.3.2.5.1.3 Qualification of Electrical and Instrumentation Components Controlling Valve Actuation (Continued)

accelerations as measured by accelerometers installed at the device attachment locations are less than the levels at which the devices were qualified. Note that the purpose of installing the nonoperating devices is to assure that the panel has the structural characteristics it will have when in use. If the acceleration levels at the device locations were found to be less than the levels to which the device has been qualified, then the total assembly was considered qualified. Otherwise, either the panel has been redesigned to reduce the acceleration level to the device locations and retested, or the devices must be requalified to the higher levels.

3.9.3.2.5.2 Documentation

INSERT →

All of the applicable requirements in Subsection 3.9.3.2.5.1 have been satisfied to demonstrate that functionality is assured for valves. The vendor has presented the documentation in a suitable format for checking which clearly shows that each consideration has been properly evaluated and tests have been validated by a designated representative of the buyer. The documentation has been included as a part of the certified stress report for the Class 1 assembly.

The seller has submitted evidence that his Seismic Category I equipment satisfies the requirements of this specification. The evidence of compliance was subject to approval by the engineer prior to fabrication (or prior to shipment of standard off-the-shelf items) of the equipment.

For equipment qualified by historical performance, the circumstances and conditions under which the performance data was obtained have been clearly defined. The magnitude of the dynamic loads and the manner in which they were obtained have

2

3.9.3.2.5.2 Documentation (Continued)

been documented and compared with the dynamic load requirements established by the engineer.

The documentation has received the stamp of approval of a registered Professional Engineer.

3.9.3.3 Design and Installation of Pressure Relief Devices

3.9.3.3.1 Main Steam Safety/Relief Valves

SRV lift results in a transient that produces momentary unbalanced forces acting on the main steam and discharge piping system for the period from opening of the SRV until a steady discharge flow from the reactor pressure vessel to the suppression pool is established. This [illegible] includes clearing of the water slug from the end of the discharge piping submerged in the suppression pool. Pressure waves traveling through the main steam and discharge piping following the relatively rapid opening of the SRV cause this piping to vibrate.

The analysis of the relief valve discharge transient consists of a stepwise time-history solution of the fluid flow equation to generate a time history of the fluid properties at numerous locations along the pipe. The fluid transient properties are calculated based on the maximum set pressure specified in the steam system specification and the value of ASME Code flow rating increased by a factor to account for the conservative method of establishing the rating. Simultaneous discharge of all valves is assumed in the analysis because simultaneous discharge is considered to induce maximum stress in the piping. Reaction loads on the pipe are determined at each location corresponding to the position of an elbow. These loads are composed of pressure-times-area, momentum-change, and fluid-friction terms. Figure 3.9-4 shows a pipe section load transient typical of that produced by relief valve discharge.

(INSERT FOR SUBSECTION 3.9.3.2.5.2)

All of the preceding requirements (Subsection 3.9.3.2.5.1) must be satisfied to demonstrate that functionality is assured for pumps. The vendor shall present the documentation in a format that clearly shows that each consideration has been properly evaluated and tests have been validated by a designated representative for the buyer. The analysis shall be included as a part of the certified stress report for the assembly.

The vendor shall submit documentary evidence to the buyer that his equipment conforms to all applicable requirements for operability assurance.

Text Modification for 271.12C

3.9.3.2.1.3 Environmental Qualification of ECCS Motors (Continued)

(4) The dynamic load deflection analysis on the rotor shaft is performed to ensure adequate rotation clearance, and is verified by static loading and deflection of the rotor for the type test motor.

(5) Dynamic load aging and testing is performed on a biaxial test table in accordance with IEEE 344-1975. During this test, the shake table is activated to simulate the maximum design limit for the safe shutdown earthquake and hydrodynamic loads with as many motor starts and operation combinations ~~as may possibly occur during a plant life~~ consistent with the plant events of Table 3.9-1 and the ECCS inadvertent injections and tests planned over the life of the plant.

(6) An environmental test simulating a LOCA condition with a duration of 100 days is performed with the test motor fully loaded, simulating pump operation. The test consists of startup and six hours operation at 212°F ambient temperature and 100% steam environment. Another startup and operation of the test motor after one hour stanstill in the same environment is followed by sufficient operation at high humidity and temperature based on extrapolation in accordance with the temperature life characteristic curve from IEEE 275-1966 for the insulation type used on the ECCS motors.

3.9.3.2.2 SLC Pump and Motor Assembly and RCIC Pump Assembly

These equipment assemblies are small, compact, rigid assemblies, with natural frequencies well above 33 Hz. With this fact verified, each equipment assembly is qualified by the static analysis for seismic and hydrodynamic loads. This qualification assures structural loading stresses within Code limitations, and verifies operability under seismic and hydrodynamic loads.