GE Nuclear Energy

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April 23, 1993

Docket No. STN 52-001

Chet Poslusny, Senior Project Manager
Standardization Project Directorate
Associate Directorate for Advanced Reactors
and License Renewal
Office of the Nuclear Reactor Regulation

Subject: Submittal Supporting Accelerated ABWR Review Schedule - **DFSER Open Item 3.10.3-1**

Dear Chet:

Enclosed is a SSAR markup addressing DFSER Open Item 3.10.3-1.

Sincerely,

Jack Fox

Jack Fox
Advanced Reactor Programs

cc: Gary Ehlert (GE)
Norman Fletcher (DOE)

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each vendor. The vendor submits test data, operating experience, and/or calculations to verify that the equipment will not suffer any loss of function before, during, or after the specified dynamic disturbance. Analysis and/or testing procedures are in accordance with Subsection 3.10.2.

In essence, these supports are inseparable from their supported items and are qualified with the items. During testing, the supports are fastened to the test table with fastening devices or methods used in the actual installation, thereby qualifying the total installation.

3.10.3.2.2 Cable Trays and Conduit Supports

All Seismic Category I cable trays and conduit supports are designed by the response spectrum method. Analysis and dynamic load restraint measures are based on combined limiting values for static load, span length, and response to excitation at the natural frequency. Restraint against excessive lateral and longitudinal movement uses the structural capacity of the tray to determine the spacing of the fixed support points. Provisions for differential motion between buildings are made by breaks in the trays and flexible connections in the conduit.

The following criteria are used in the design of Seismic Category I cable tray and conduit supports.

(1) Cable Tray Support Spacings

Tray support spacings for horizontal or vertical runs do not exceed ten feet unless noted otherwise on design drawings (design drawings generally locate supports not more than eight feet apart with a longitudinal tolerance of 1 foot to avoid interferences).

Tray supports provide resistance to three excitation directions by means of vertical, transverse, and longitudinal support and bracing systems.

(2) Support Locations

Tray supports are anchored in the following manner:

(a) support members may be attached to existing structural steel;

(b) support members may be attached to supplementary steel members spanning between existing floor beams (or between existing floor beams and walls); or

(c) support members may be attached to concrete wall/columns using:

(i) embedded steel plates with shear connectors or

(ii) steel plates or strut sections attached to concrete with concrete expansion anchors.

(3) Loads

(a) Dead loads and live loads

75 lb/linear-ft load used for 18 inch and wider trays
50 lb/linear-ft load used for 12 inch and narrower trays

(b) Dynamic loads - OBE or SSE plus other RBV dynamic loads

(4) Load Combination

(a) Dead load + live load

(b) Dead load + live load + OBE + other RBV dynamic loads

(c) Dead load + live load + SSE + other RBV dynamic loads

(5) Dynamic Analysis

(a) Regardless of cable tray function, all supports are designed to meet Seismic Category I requirements. Seismic and other RBV dynamic loads are determined

by dynamic analysis using appropriate response spectra.

(b) Floor Response Spectra

(i) Floor response spectra used are those generated for the supporting floor. In case supports are attached to the walls or to two different locations, the upper bound envelope spectra obtained by superimposing are used.

(ii) In many cases, to facilitate the design, several floor response spectra are combined by an upper bound envelope obtained by superimposing.

3.10.3.2.3 Local Instrument Supports

For field-mounted Seismic Category I instruments, the following is applicable:

(1) The mounting structures for the instruments have a fundamental frequency above the excitation frequency of the RRS.

(2) The stress level in the mounting structure does not exceed the material allowable stress when the mounting structure is subjected to the maximum acceleration level for its location.

3.10.3.2.4 Instrument Tubing Support

The following bases are used in the seismic and other RBV dynamic loads design and analysis of Seismic Category I instrument tubing supports:

(1) The supports are qualified by the response spectrum method;

(2) Dynamic load restraint measures and analysis for the supports are based on combined limiting values for static load, span length, and computed dynamic response; and

(3) The Seismic Category I instrument tubing systems are supported so that the allowable stress permitted by Section III of ASME Boiler and Pressure Vessel Code are not exceeded when the tubing is subjected to the loads specified in Subsection 3.9.2 for Class 2 and 3 piping.

3.10.4 Operating License Review (Tests and Analyses Results)

See Subsection 3.10.5.2 for COL license information requirements.

3.10.5 COL License Information

3.10.5.1 Equipment Qualification Records

The equipment qualification records including the reports (see Subsections 3.10.2.2.4 and 3.10.2.2.3) shall be maintained in a permanent file and shall be readily available for audit.

3.10.5.2 Dynamic Qualification Report

A dynamic qualification report (DQR) shall be prepared identifying all Seismic Category I instrumentation and electrical parts and equipment therein and their supports. The DQR shall contain the following: (1) A table or file for each system that is identified in Table 3.2-1 to be safety-related or having Seismic Category I equipment shall be included in the DQR containing the MPL item number and name, the qualification method and the input motion for all Seismic Category I equipment and the supporting structure in the system, and the corresponding qualification summary table or vendor's qualification report. (2) The mode of safety-related operation (i.e., active, manual active or passive) of the instrumentation and equipment along with the manufacturer identification and model numbers shall also be tabulated in the DQR. The operational mode identifies the instrumentation or equipment (a) that performs the safety-related functions automatically, (b) that is used by the operators to perform the safety-related functions manually, or (c) whose failure can prevent the satisfactory accomplishment of one or more safety-related functions. (See Subsection 3.10.4).

The Reinforced Concrete Containment Vessel (RCCV) in the center of the RB encloses the Reactor Pressure Vessel (RPV). The RCCV supports the upper pool and is integrated with the RB structure from the basemat up through the elevation of the RCCV top slab. The interior floors of the RB are also integrated with the RCCV wall. The RB has slabs and beams which join the exterior wall. Columns support the floor slabs and beams. The fuel pool girders are integrated with the RCCV top slab and with RB wall-columns. The RB is a shear wall structure designed to accommodate all seismic loads with its walls. Therefore, frame members such as beams or columns are designed to accommodate deformations of the walls in case of earthquake conditions.

3.8.4.1.2 Control Building

The control building (CB) is located between the reactor building and the turbine building. It is shown in Section 1.2.

The CB houses the essential electrical, control and instrumentation equipment, the control room for the reactor and turbine buildings, the CB HVAC equipment, RB cooling water pumps and heat-exchangers, the essential switchgear, essential battery rooms, and the steam tunnel.

The CB is a Seismic Category I structure that houses control equipment and operation personnel and is designed to provide missile and tornado protection. The CB is constructed of reinforced concrete with a steel roof. The CB has three stories above the ground level and three stories below. Its shape is a rectangle of 56 m (183 feet, 8 inches) in the E-W direction, 22 m (72 feet, 2 inches) in the N-S direction, and a height of about 38.7 m (127 feet) from the top of the base mat.

The CB is a shear wall structure designed to accomodate all seismic loads with its walls. Therefore, frame members such as beams or columns are designed to accomodate deformations of the walls in case of earthquake conditions.

3.8.4.1.3 **Radwaste Building Substructure**

The radwaste building substructure (RWB) is shown in Section 1.2.

The radwaste building is a reinforced concrete structure 53m by 40m by 29.5m high. The building consists of a below grade substructure consisting of walls and slabs of reinforced concrete, 0.6m to 1.0m thick, forming a rigid box structure which serves as a container to hold radioactive waste in case of an accident. This substructure is located below grade to increase shielding capability and to maximize safety. It is supported on a separate foundation mat whose top is -6.5m below grade. In addition, a reinforced concrete superstructure 23m high extends above grade and houses the balance of the radwaste equipment.

The radwaste building substructure houses the high and low conducivity tanks, clean-up phase separators, spend resin storage tanks, a concentrated waste storage tank, distillate tank and associated filters, and pumps for the radioactive liquid and solid waste treatment systems.

Although the radwaste superstructure is not a Seismic Category I structure, its major structural concrete walls and slabs are designed to resist Seismic Category I loads.

3.8.4.1.4 **Seismic Category I Cable Trays ~~and Conduit~~ Supports**, Cable Tray, Conduit and Conduit Supports

Electrical cables are carried on continuous horizontal and vertical runs of steel trays supported at intervals by structural steel frames. The tray locations and elevations are predetermined based on the requirements of the electrical cable network. Generally, several trays of different sizes are grouped together and connected to a common support.

The support frame spacing is determined by allowable tray spans, which are governed by rigidity and stress. The frames may be ceiling-supported, or wall-supported, or a

combination of both. Various type of frames form a support system with transverse and longitudinal bracing to the nearest wall or ceiling to take the seismic loads.

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3.8.4.2 Applicable Codes, Standards, and Specifications

3.8.4.2.1 Reactor Building

The major portion of the reactor building, is not subjected to the abnormal and severe accident conditions associated with a containment. A listing of applicable documents follows:

(1) ACI 349, Code Requirements for Nuclear Safety Related Concrete Structures;

(2) AISC, Specification for Design, Fabrication and Erection of Structural Steel for Buildings;

(3) ASME Boiler and Pressure Vessel Code Section III, Subsection NE, Division 1, Class MC (for design of main steam tunnel embedment piping anchorage in the RB and CB only);

(4) AWS Structural Welding Code, AWS D1.1;

(5) AWS Structural Welding Code, AWS D12.1;

(6) NRC publications TID 7024 and TID 25021, Nuclear Reactors and Earthquakes and Summary of Current Seismic Design Practice for Nuclear Reactor Facilities;

(7) The inservice inspection requirements for the fuel pool liners in the Reactor Building are in conformance with ASME Code Section III, Division 2.

(8) NRC Regulatory Guides:

(a) Regulatory Guide 1.10, Mechanical (Cadweld) Splices in Reinforcing Bars of Category I Concrete Structures;

(b) Regulatory Guide 1.15, Testing of Reinforcing Bars for Category I Concrete Structures;

(c) Regulatory Guide 1.28, Quality Assurance Program Requirements (Design and Construction);

3.8.4.2.3 Radwaste Building Substructure

The radwaste building substructure shall be designed using the same codes and standards as the reactor building. Refer to Subsection 3.8.4.2.1 for a complete list.

In addition, the non-Seismic Category I reinforced concrete portion of the superstructure is designed according to the seismic provisions of Section 2314 of the uniform building code.

3.8.4.2.4 Seismic Category I Cable Trays ~~and~~, Cable Tray ~~Conduit Supports~~ Supports, Conduit and Conduit Supports

(1) All codes, standards, and specifications applicable to the building structures shall also apply to cable tray and conduit supports.

(2) AISI SG-673, Specification for the Design of Cold-formed Steel Structural Members.

(3) NEMA, Fittings and Supports for Conduit and Cable Assemblies.

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3.8.4.3 Loads and Load Combinations

3.8.4.3.1 Reactor Building

The temperature and pressure loads caused by a LOCA do not occur on the reactor building. The reactor building ventilation system is designed to keep the building within operating design conditions.

3.8.4.3.1.1 Loads and Notations

Loads and notations are as follows:

D = dead load of structure plus any other permanent load

L = conventional floor or roof live loads, movable equipment loads, and other variable loads such as construction loads. The following live loads are used:

Concrete floors and slabs (including roofs) - 200 psf. Stairs, stair platforms, grating floors, and platforms - 100 psf. Concrete roofs, live or snow load (not concurrent) - 50 psf. Construction live load on floor framing in addition to dead weight of floor - 50 psf*.

R_o = pipe reactions during normal operating or shutdown conditions based on the most critical transient or steady-state condition.

R_a = pipe reactions under thermal conditions generated by the postulated break and including R_o

Y_r = equivalent static load on a structure generated by the reaction on the broken high-energy pipe during the postulated break and including a calculated dynamic factor to account fro the dynamic nature of the load.

Y_j = jet impingement equivalent static load on a structure generated by the postulated break and including a calculated dynamic factor to account for the dynamic nature of the load.

Y_m = missile impact equivalent static load on a structure generated by or during the postulated break, like pipe whipping, and including a calculated dynamic factor to account for the dynamic nature of the load.

W = wind force (Subsection 3.3.1)

* *If the actual construction live load is greater than this value a design check of the structures will be r ade.*

Operating Conditions

Control room,	summer	75°F
	winter	70°F
HVAC room,	summer	95°F
	winter	60°F
Other areas,	summer	75°F
	winter	75°F

Shutdown condition

Control room,	summer	80°F
	winter	50°F
HVAC room,	summer	104°F
	winter	50°F
Other areas,	summer	90°F
	winter	50°F

3.8.4.3.3 Seismic Category I Cable Trays, Cable Tray ~~and Conduit Supports~~ Supports, Conduit and Conduit Supports

Loads and load combinations for the tray and conduit supports shall use the same criteria as for the building structures where the supports are located.

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3.8.4.4 Design and Analysis Procedures

3.8.4.4.1 Reactor Building, Control Building, and Radwaste Building Substructure

The reactor building, control building and radwaste building substructure will be designed in accordance with ACI-349 for concrete structures and AISC specification for steel structures.

The reactor building, control building, and radwaste building substructure will be analyzed using the computer codes listed in Appendix 3C.

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3.8.4.4.2 Seismic Category I Cable Tray and Conduit Supports

3.8.4.4.2.1 Cable Tray Supports

Wherever possible, the supporting frames for a tray or group of trays are designed to have adequate rigidity to avoid causing additional amplification of seismic acceleration transmitted by the building structures. Where rigidity cannot be achieved without an excessive increase in support member size, the design of the supports is then based on the amplified seismic load obtained from the floor response spectra.

Thus, two methods are used in design and analysis of cable tray supports.

(1) Rigid Support with Flexible Tray. In this method, trays are modeled as flexible elastic systems and analyzed by the response spectrum method. The resulting reactions are used for the design of the supports.

(2) Flexible Support with Flexible Tray. In this method, the composite system of trays and supports is modeled and analyzed by computer as a multidegree of freedom elastic system. The support motions can be prescribed by the appropriate floor response spectrum. The resulting responses are used to obtain design loads for the supports.

3.8.4.4.2.2 Conduit Supports

The design and analysis of conduit supports are basically the same as for cable tray supports. As conduits are more flexible and have comparatively less dead load, a rigid support approach is used as described in method (1) of cable tray support design.

3.8.4.5 Structural Acceptance Criteria

3.8.4.5.1 Reactor Building

3.8.4.5.1.1 General Criteria

The first criterion is that the reactor building shall provide biological shielding for plant personnel and the public outside of the site boundary. This criterion dictates the minimum wall and roof thicknesses.

The second criterion is that the reactor building shall protect the reinforced concrete containment from environmental hazards such as tornado and other site proximity-generated missiles. The shielding thicknesses are sufficient for this purpose.

The reactor building provides a means for collection of fission product leakage from the reinforced concrete containment following an accident.

3.8.4.4.2 Seismic Category I Cable Trays, Cable Tray Supports, Conduits and Conduit Supports

Cable trays, conduits and their supports will be analyzed using the computer codes listed in Appendix 3C. The seismic design of the cable trays, conduits and their supports will be performed by one of the methods described in Subsection 3.7.3.

differential of 6 mm of water, the reinforcing steel is designed to remain elastic during the SSE load combinations.

3.8.4.5.1.2 Materials Criteria

Refer to the materials criteria established in 3.8.5 for the strength and materials requirements for the reinforced concrete reactor building.

3.8.4.5.2 Control Building

Structural acceptance criteria are defined in the AISC Specification and ACI 318 Code. In no case does the allowable stress exceed 0.9 F_y where F_y is the minimum specified yield stress. The design criteria preclude excessive deformation of the building. The clearances between adjacent buildings are sufficient to prevent impact during a seismic event. The tornado load analysis for this building is the same as the analysis for the reactor building.

3.8.4.5.3 Radwaste Building Substructure

Structural acceptance criteria are defined in AISC Specification and ASCI 318 Code. In no case does the allowable stress exceed 0.9F_y where F_y is the minimum specified yield stress. The design criteria preclude excessive deformation of the building. The clearance between adjacent buildings are sufficient to prevent impact during a seismic event.

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3.8.5 Foundations

This section describes foundations for all seismic Category I structures of the ABWR Standard Plant.

3.8.5.1 Description of the Foundations

The foundations of the reactor building and control building are reinforced concrete mat foundations. The configuration and relative location of these foundations are shown in Appendix 3H.

These two foundation mats are separated from each other by a separation gap of 2 meters (6 feet, 6 inches) wide to minimize the structural interaction between the buildings.

The reactor building foundation is a rectangular reinforced concrete mat 56 m (183 feet, 8 inches) by 59 m (193 feet, 5 inches) and 5.5m (18 feet) thick. The foundation mat is constructed of cast-in-place conventionally reinforced concrete. It supports the reactor building, the containment structure, the reactor pedestal, and other internal structures. The top of the foundation mat is approximately 20.2 m(66 feet, 3 inches) below grade. The reactor building foundation is shown in Appendix 3H.

The containment structure foundation, defined as within the perimeter or the exterior surface of the containment structure, is integral with the reactor building foundation. The containment foundation mat details are discussed in Subsection 3.8.1.1.1.

The control building foundation is rectangular reinforced concrete mat 22 m (72 feet, 2 inches) by 56 m (183 feet, 8 inches) by 5.5 m (18 feet) thick. The top of the foundation mat is 13.2 m (43 feet, 4 inches) below grade.

The radwaste building foundation is a rectangular reinforced concrete mat 53m by 40m and 3m thick. The foundation mat is constructed of cast-in-place conventionally reinforced concrete. It supports the radwaste building structure.

3.8.5.2 Applicable Codes, Standards and Specifications

The applicable codes, standards, specifications and regulations are discussed in Subsection 3.8.1.2 for the containment foundation and in Subsection 3.8.4.2 for the other seismic Category I foundations.

3.8.5.3 Loads and Load Combinations

The loads and load combinations for the containment foundation mat are given in Subsection 3.8.1.3. The loads and load combinations for the other seismic category I structure foundations are given in Subsection 3.8.4.3.

The loads and load combinations for all seismic Category I foundations examined to check

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3.8.4.1.5 Seismic Category I HVAC ducts and Supports

HVAC ducts are supported at intervals by structural steel frames. The duct locations and elevations are predetermined based on the requirements of the HVAC system.

The support frame spacing is determined by allowable tray spans, which are governed by rigidity and stress. The frames may be ceiling-supported, or wall-supported, or a combination of both. Various type of frames form a support system with transverse and longitudinal bracing to the nearest wall or ceiling to take the seismic loads.

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3.8.4.2.5 Seismic Category I HVAC Ducts and Supports

All codes, standards, and specifications applicable to the building structures shall also apply to HVAC ducts and supports.

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3.8.4.3.4 Seismic Category I HVAC Ducts and Supports

Loads and load combinations for HVAC ducts and supports shall use the same as for the building structures where the supports are located.

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3.8.4.4.~~3~~2 Seismic Category I HVAC Duct and Supports

HVAC ducts and supports will be analyzed using the computer codes listed in Appendix 3C. The seismic design of the HVAC ducts and supports shall be performed by one of the methods described in ~~SSAR~~ Subsection 3.7.3.

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3.8.4.5.4 Seismic Category I Cable Trays and Conduit Supports

Structural acceptance criteria are defined in ANSI/AISC-N690 Code. In no case does the allowable stress exceed $0.9F_y$ where F_y is the minimum specified yield stress.

3.8.4.5.5 Seismic Category I HVAC Duct and Supports

Structural acceptance criteria are defined in ANSI/AISC-N690 Code. In no case does the allowable stress exceed $0.9F_y$ where F_y is the minimum specified yield stress.