September 12, 1988

Docket No. STN 50-605

Patrick W. Marriott, Manager
Licensing & Consulting Services
General Electric Company
Nuclear Energy Business Operations
Mail Code 682
275 Curtner Avenue
San Jose, California 95125

Dear Mr. Marriott:

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION REGARDING THE GENERAL ELECTRIC COMPANY APPLICATION FOR CERTIFICATION OF THE ABWR DESIGN

In our review of your application of your Advanced Boiling Water Reactor Design, we have identified a need for additional information. Our request for additional information, contained in the enclosure, addresses the areas of SRP Chapters 1, 2, and 3 reviewed by the Plant Systems, Radiation Protection, Structural & Geosciences and Materials Engineering Branches. Questions related to the review being carried out by the Mechanical Engineering Branch will be provided in the near future.

In order for us to maintain the ABWR review schedule, we request that you provide your responses to this request by November 15, 1988. If you have any concerns regarding this request please call me on (301) 492-1104.

Sincerely,

/s/

Dino C. Scaletti, Project Manager
Standardization and Non-Power
Reactor Project Directorate
Division of Reactor Projects III,
IV, V and Special Projects
Office of Nuclear Reactor Regulation

Enclosure:
As stated

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

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ENCLOSURE

REQUEST FOR ADDITIONAL
INFORMATION
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STRUCTURAL ENGINEERING

220.1 In section 3.5.3, for local damage prediction of concrete structures and barriers, the concrete wall and roof thicknesses determined should not be less than those listed for Region II in Table 1 of SRP Section 3.5.3 unless justification is provided.

220.2 The soil-structure interaction (SSI) analyses of the reactor building (RB) discussed in Section 3.7 of the ABWR SSAR are based on Revision 2 of SRP Sections 3.7.1 and 3.7.2 as provided for by the Licensing Review Bases dated August 7, 1987. It should be noted that Revision 2 is currently in the process of public comments and to this date has not been finalized. Consequently, there may be changes to Revision 2 which may require further discussion of this topic at a later date.

220.3 It is indicated that computer programs SASSI and CLASSI/ASD will be used to perform SSI analyses. Indicate how these programs are validated. In CLASSI the contribution of radiation damping cannot be determined on a mode by mode basis and it can have a substantial impact on building response. Provide results of sensitivity studies.

220.4 Since the responses due to SSE are obtained in ratio to the response from the OBE analyes, indicate what is the purpose of establishing response spectra with .07 and 0.10 damping.

220.5 In Section 3.7.2.9, a number of conservative assumptions are listed in the calculation of floor response spectra. Some of the assumptions listed are not relevant to the generation of the floor response spectra, but to the overall design of the equipment. It is stated that the floor response spectra obtained from the time-history analysis of the building are broadened plus and minus 10% in frequency. In view of the fact that response spectra for all site-soil cases are combined to arrive at one set of final response spectra (Section 3.7.2.5), indicate how the ± 10% broadening is accomplished.

220.6 In section 3.7.3.2.2, for fatigue evaluation it is indicated that only 10 peak OBE stress cycles are taken into account which appears to be very low, considering the fact that the reactor building may also be subjected to SRV loadings. As indicated in the SRP Section 3.7.3 larger number of cycles should be considered.

220.7 in appendix 3A.6 the following statement is made in the first paragraph:

"The behavior of soil is nonlinear under seismic excitation. The soil nonlinearity can be conveniently separated into primary and secondary nonlinearities. The primary nonlinearity is associated with the state of deformations induced by the free-field ground motion. The secondary nonlinearity is attributed to the SSI effects.

This secondary effect on structural response is usually not significant and is neglected in the appendix."

Indicate if the secondary effect includes the radiation damping, if it does not, indicate how it is considered in the analysis.

220.8 In appendix 3A.6 the computer program SHAKE is used to perform free-field site response analysis. To staff's knowledge, analyses based on SHAKE under certain site conditions may give unrealistic results and it cannot be used indiscriminately. In view of this observation, indicate what control or caution has been exerted in your use.

220.9 It is noted that ABWR is designed for 60-year life versus the 40-year life for plant design in current regulation. From the point of view of structures, provide your justification for the longer plant life.

220.10 Since the containment is integral with the reactor building, the following are staff's concerns:

(1) The thermal and pressure effects of the containment on the reactor building, especially under severe accident conditions.

(2) The restraint effects of the reactor building floor slabs on the behavior of the containment, especially on the ultimate capacity of the containment. (The staff has not received Chapter 19 which is believed to contain the estimate of the ultimate capacity).

(3) The behavior of small and large penetrations which span between containment and reactor building, especially under severe accident conditions.

Your approaches to resolve these concerns should be provided. If the resolution is to be accomplished through testing, provide a description of the tests to be performed.

220.11 In section 3.8.1.1.1 it is noted that the main reinforcement in the containment wall consists of inside and outside layers of hoop and vertical reinforcement and radial bars for shear reinforcement. It appears that no diagonal seismic reinforcement is used. Indicate how the tangential shear due to horizontal earthquake is to be resisted.

220.12 In section 3.8.4.3.1.2, for the same loads considered the first load combination under item (1), if compared with the first load combination under the (2), should obviously be the governing one. It appears that a re-examination of the load combinations in this section should be made to weed out load combinations which are obviously not controlling the design unless there are errors in the combinations. Furthermore since the RB is integral with the containment, effects due to such integration should be reflected in the load combinations of structural elements or components outside the containment unless considered otherwise.

220.13 The terms, Gl, Gr, and G all as defined in section 3.8.1.3.1 are not listed in table 3.8.- 1 while the terms lv and ALL listed in Table 3.8-1 are not defined. Clarification of the table is requested.

220.14 In table 3.8 - 5 for load combination No. 3, it appears the acceptance criterion should be changed to S from U unless justified otherwise.

220.15 Discuss the potentials for severe accidents that can be caused by external initiators such as high wind, tornado,tsunami, and earthquakes, and specifically flood since the reactor building has a standard soil embedment of 85 feet.

GEOTECHNICAL ENGINEERING

241.1 (Table 2.01) Table 2.01 in the Advanced BWR Standard Safety Analysis Report (SSAR) gives an envelope of ABWR plant site design parameters. This table gives the minimum bearing capacity and the minimum shear wave velocity of the foundation soil. The table also gives the values of SSE and OBE and indicates (a) that the SSE response spectra will be anchored to Regulatory Guide (RG) 1.60, and (b) that the SSE time history will envelope SSE response spectra. The following additional information/clarification should be provided in the SSAR:

a. While the SSE (PGA) of 0.3g anchored to RG 1.60 could, in general, be considered conservative for many sites in the Central and Eastern United States, the SSAR should recognize and reflect the fact that localized exceedances of this value cannot be ruled out categorically and that adequate provisions will be made in the seismic design to consider site-specific geological and seismological factors.

b. The SSAR gives an OBE (PGA) value of 0.10g and states that, "for conservatism, a value of 0.15g is employed to evaluate structural and component responses in Chapter 3." The staff, however, considers the OBE valve to be 0.15g as per criterion 2 of 10 CFR 50 Appendix A and paragraph V of 10 CFR 100 Appendix A which require, in part, that for seismic design considerations the OBE shall be no less than one-half of the SSE.

c. The SSAR should indicate the procedures that would be adopted to evaluate the liquefaction potential at selected soil sites. It is not sufficient to say that the liquefaction potential will be "none at plant site resulting from OBE and SSE."

COMPONENT INTEGRITY

251.12 (3.1.2.5.2.1) Criterion 51, Fracture Prevention of Containment Pressure Boundary, is only applicable for containments made of ferritic materials. Since the ABWR containment is made of concrete, this section should clarify the applicability of Criterion 51 to the ABWR containment.

251.13 (3.5.1.1.1.3) This section must include a discussion of all potential turbine missiles and mechanisms of missile generation. The turbine missile discussion should include failure of turbine discs and blades.

251.14 (3.5.4.1) This section must include a discussion of a favorable turbine orientation or provide a discussion on maintenance of the main steam turbine to protect against turbine missiles.

252.15 (3.6.3) Leak-Before-Break (LBB) - The staff considers LBB evaluations to be plant specific because parameters such as potential piping degradation mechanisms, piping geometry, materials, fabrication procedures, loads and leakage detection systems are plant specific. Therefore, the detailed LBB analysis should be provided when an application references the ABWR design.

AUXILIARY SYSTEMS

410 1 (3.5.1) Section 3.5.1, "Missile Selection and Description," states: "The missile protection criteria to which the plant has been analyzed comply with the intent of 10 CFR 50 Appendix A, General Design Criteria for Nuclear Power Plants." Provide a list of those instances where the protection criteria are in strict compliance with 10 CFR 50 Appendix A, and those instances where the protection criteria comply only with its "intent." Provide an explanation of and justify the acceptability of those missile protection criteria which are in compliance only with "intent" of 10 CFR 50, Appendix A.

410.2 (3.5.1) Section 3.5.1 states: "A statistically significant missile is defined as one which could cause unacceptable plant consequences or violation of the guidelines of 10 CFR 100." Provide an explanation of "unacceptable plant consequences."

410.3 (3.5.1.1) Section 3.5.1.1, "Internally Generated Missiles (Outside Containment)," states: "Failure rates (P1) for valve bonnets are in the range of 10^{-4} to 10^{-5} per year." Provide a reference or analysis in support of the above statement.

410.4 (3.5.1.1) Regarding the physical separation requirements, provide a list of all systems (required for safe shutdown, accident prevention or mitigation of consequences of accidents) whose redundant trains do not have missile-proof barriers, and include the minimum separation distances. Provide, for the limiting case of the minimum separation distance, an analysis demonstrating the acceptability of the approach of not calculating P2, and instead relying on the "extremely low" probability of a missile strike to both trains, or a missle from one train striking the redundant train.

410.5 (3.5.1.1) Explain how safety-related systems or components are protected from missiles generated by non-safety-related components. It is the staff's position that missles generated from nonsafety related components should not impact safety related components since a single active failure is assumed concurrent with the missile.

410.6 (3.5.1.1) Discuss the means by which stored spent fuel is protected from damage by internally generated missiles.

410.7 (3.5.1.1) Section 3.5.1.1.1.4, "Other Missile Analysis," discusses the example of analysis of a containment high purge exhaust fan for a thrown blade. Provide the details of this analysis, such as the maximum penetration of the blade and the thickness of the fan casing. Discuss whether this analysis is conservative with respect to other rotating equipment missile sources.

410.8 (3.5.1.1) Regarding Section 3.5.1.1.2.2, "Missile Analysis," provide the details of the rack, strap and cover assemble design for the pneumatic system air bottles, showing the thickness of the steel cover and the distance to the concrete slab.

410.9 (3.5.1.1) Regarding Section 3.5.1.1.3, "Missile Barriers and Loadings," provide a list of all local shields and barriers outside intended to mitigate missile effects, giving their specific locations and design data. Provide an example of an analysis showing that the design of the shield or barrier will withstand the most energetic missile which could credibly impact it.

410.10 (3.5.1.2) Section 3.5.1.2.1, "Rotating Equipment" (which can contribute to internally generated missiles inside the containment), states: "By an analysis similar to that in 3.5.1.1.1, it is concluded that no items of rotating equipment inside the containment have the capability of becoming potential missiles." Provide the details of this analysis.

410.11 (3.5.1.2) Regarding Reactor Internal Pump (RIP) motors and impellers which can contribute to internally generated missiles inside the containment, explain the bases for concluding that the RIPs are incapable of achieving an overspeed condition and that the motors and impellers are incapable of escaping the casing and the reactor vessel wall (SSAR Section 3.5.1.2.1). Your response should explain how the provision of an anti-rotation device at the bottom of the RIP motor which prevents backward rotation of the RIP will prevent its overspeed during the course of a LOCA or during normal plant operation when one RIP is stopped and the other RIPs are operating (see SSAR Section 5.4.1.5).

410.12 (3.5.1.2) Regarding pressurized components, provide justification for the statement, "FMCRD mechanisms are not credible missile sources," made in Section 3.5.1.2.2.

410.13 (3.5.1.2) Regarding Section 3.5.1.2.3, "Missile Barriers and Loadings," provide the same data for internally generated missiles inside the containment, as that requested under Question No. 430.67 above.

410.14 (3.5.1.2) Clarify whether secondary missiles generated as a result of the impact of primary missiles have been considered. Explain how protection against credible secondary missiles is provided.

410.15 (3.5.1.2) Regarding Section 3.5.1.2.4, "Evaluation of Potential Gravitational Missiles Inside Containment "Item 3, "Equipment for Maintenance," describe any interface requirements imposed by this item on applicants referencing the ABWR.

410.16 (3.5.1.4) Regarding missiles generated by natural phenomena, provide the details of the tornado-missile analysis performed, identifying the tornado region (as defined in RG 1.76) and the missile spectrum. Discuss the compliance of the analysis with NUREG-0800, Section 3.5.1.4 acceptance criteria; Regulatory Guide 1.76, Positions C.1 and C.2; and Regulatory Guide 1.117, Positions C.1 through C.3

410.17 (3.5.2) Provide specific descriptions of all provisions made to protect the charcoal delay tanks against externally generated tornado missiles. Discuss any interface requirement imposed by these design provisions.

410.18 (3.5.2) Regarding SSC to be protected from externally generated missiles, discuss compliance with NUREG-0800, Section 3.5.2 acceptance criteria; Regulatory Guide 1.13, Position C2; Regulatory Guide 1.27, Positions C2 and C3; and Regulatory Guide 1.117, Positions C.1 through C.3.

410.19 (3.5.2) Clarify whether <u>all</u> nonsafety-related SSC, that may adversely impact (as a result of <u>their</u> failure due to an external missile) the intended safety function (i.e. achieving and maintaining safe shutdown, mitigating the consequences of an accident or preventing an accident) of a safety related SSC, are protected from external missiles. Describe how such SSC are protected.

(3.6.1) SSAR Section 3.6.1.3.2.2, "Separation," relies on physical separation between redundant essential systems including their related auxiliary systems as the basic protective measure against the dynamic effects of postulated pipe failures. The general arrangement drawings (e.g., Figure 1.2-2) are scheduled to be submitted in December 1988. Note that additional information on Section 3.6.1 may be requested as a result of the review of the above drawings.

410.20 (3.6.1) Section 3.6.1.1.1, "Criteria," states that the overall design generally complies with BTP ASB 3-1. Specify those criteria which are in strict compliance, and those which are not in strict compliance with the BTP. Also, provide justification for the items that are not in strict compliance.

410.21 (3.6.1) Provide a listing of all the moderate-energy piping outside the containment, but within the scope of ABWR. Also, describe how safety-related systems are protected from jets, flooding and other adverse environmental effects that may result from pipe failures in moderate energy piping systems.

410.22 (3.6.1) Justify the non-inclusion of pipe failure analyses for the Process Sampling System, Fire Protection System, HVAC Emergency Cooling Water System and the Reactor Building Cooling Water System as related to the Ultimate Heat Sink. Provide a summary table listing the protective measures provided against the effects of postulated pipe failures in each of the above systems and the systems listed in SSAR Tables 3.6-2 and 3.6-4.

410.23 (3.6.1) Give details for the worst case flooding arising from a postulated pipe failure and include the mitigation features provided. Note that for flooding analysis purposes, the complete failure of non-seismic Category I moderate-energy piping systems should be considered in lieu of cracks in determining the worst case flooding condition.

410.24 (3.6.1) Identify all the high-energy piping lines outside the containment (but within the ABWR scope), the adverse effects that may result from failures of applicable lines among them, and the protection provided against such effects for each of such lines (e.g., barriers and restraints).

410.25 (3.6.1) Clarify whether the reactor building steam tunnel is part of the break exclusion boundary. Also, provide a subcompartment analysis for the steam tunnel. Discuss how the structural integrity of the tunnel and the equipment in the tunnel are protected against piping failures in the tunnel.

410.26 (3.6.1) State how the MSIV functional capability [illegible] ed.

410.27 (3.6.1) Provide a summary table of the findings of an analysis of a postulated worst-case DBA rupture of a high or moderate-energy line for each of the following areas: 1) RCIC compartment, 2) RWCU equipment and valve room, 3) other applicable areas outside the containment (e.g., housing RHR piping).

410.28 (3.6.1) Clarify whether protection for safety-related systems and components against the dynamic effects of pipe failures include their enclosures in suitably designed structures or compartments, drainage systems and equipment environmental qualification as required. If so, give typical examples for the above type of protection.

410.29 (3.6.1) Regarding interfaces (Section 3.6.4.1), include results of analyses of moderate-energy piping failures (currently, the interface requirements address only the high-energy piping failures analyses).

(3.11) Appendix 3I, "Equipment Qualification Environmental Design Criteria," is scheduled to be submitted in December 1988. Note that additional information may be requested based on review of the above appendix.

410.30 (3.11) Although there are no detailed equipment qualification requirements for safety-related mechanical equipment in a harsh environment, GDC 1, "Quality Standards and Records," GDC 4 "Environmental Missile Design Bases," and Appendix B to 10 CFR 50, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Processing Plants" (Sections III, "Design Control," and XVII, "Quality Assurance Records") contain the following requirements related to equipment qualification:

a) Components shall be designed to be compatible with the postulated environmental conditions, including those associated with LOCAs.

b) Measures shall be established for the selection and review for suitability of application of materials, parts, and equipment that are essential to safety-related functions.

c) Design control measures shall be established for verifying the adequacy of design.

d) Equipment qualification records shall be maintained and shall include the results of tests and materials analyses.

Clarify whether the design complies with all the above requirements for safety-related mechanical equipment in a harsh environment within the ABWR scope. Provide justification for the non-compliance items above and identify any interface requirements needed to comply with the above.

METEOROLOGY

451.1 What are the bases (including references) for the site envelope of the ABWR design meteorological parameters listed in Table 2 0-1? Are these values intended to reflect the indicated maximum historical values for the contiguous USA? What is the combined winter precipitation load from the addition of the 100-year snow pack and the 48-hour probable maximum precipitation? What is the duration of the design temperature and wind speed values? What gust factors are associated with the extreme winds? Are any other meteorological factors (e.g., blowing dust) considered in the ABWR design?

451.2 Short-term dispersion estimates for accidental atmospheric releases are not provided explicitly in Section 2.4.3. If the X/Q values which are listed in Chapter 15 represent an upper bound for which the ABWR is designed; what is the bases for their selection?