July 15, 1992

Docket No. 52-001

Mr. Patrick W. Marriott, Manager
Licensing & Consulting Services
GE Nuclear Energy
175 Curtner Avenue
San Jose, California 95125

Dear Mr. Marriott:

SUBJECT: JUSTIFICATION FOR TURBINE BUILDING STATIC SEISMIC ANALYSIS

We have completed a review of your submittal dated May 21, 1992, regarding the justification for the turbine building static seismic analysis. Enclosed is a summary of our interim evaluation.

Should you have any questions concerning this evaluation, please contact me at (301) 504-1132.

Sincerely,

Original Signed By:

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

Enclosure:
As stated

cc w/enclosure:
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Mr. Patrick W. Marriott
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Docket No. 52-001

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BACKGROUND

In Table 3.2-1, footnote "r" of SSAR Amendment 15, GE committed to perform a dynamic analysis for the portion of the main steam line (MSL) inside the turbine building. The purpose of performing dynamic piping analysis is to ensure that the MSL will retain its structural integrity and remain functional during and after an SSE. In Section 3.7.3.16 of the SSAR, GE proposed to use a static amplification factor multiplying the ground response spectrum as the input for the analysis of the MSL, and to perform the seismic design of the turbine building using a static method equivalent to the Uniform Building Code (UBC) approach for seismic Zone 2A to ensure that the turbine will retain its structural integrity and will not endanger the function of the MSL during and after a SSE.

During the second design calculation audit conducted on March 30 through April 3, 1992, the staff identified two concerns; (1) the UBC approach used for the seismic design does not ensure that the turbine building will maintain its structural integrity during and after an SSE and that the safety function of the MSL will be protected, and (2) the use of an amplification factor to multiply the ground response spectrum for the input to the MSL seismic analysis is not acceptable because the amplification factor to be chosen is arbitrary and the dynamic characteristics of the structure was not taken into consideration. The staff requested that GE address these concerns.

On May 21, 1992, GE submitted its justification to demonstrate that the turbine building, if designed based on UBC Zone 2A requirements, will retain its structural integrity during and after an SSE, i.e., RG 1.60 ground response spectrum anchored to 0.3 g. In the same submittal, GE also provided the basis to use a site coefficient of two to multiply the 0.3g RG 1.60 response spectrum as input to the MSL dynamic analysis.

EVALUATION

From the review of this document and discussion conducted during the second design calculation audit, the staff found that GE assumed that a standard ABWR plant located in the regions east of the rocky mountain would experience a 0.3 g for SSE at the ground level. The turbine building is not a Category I structure and therefore it does not have to be designed to remain elastic during SSE. However, the building must not collapse during SSE because it houses the MSL and condenser, which are important to safety when used as an alternate leakage path. Consequently, GE proposed to use the Uniform Building Code criteria to design the turbine building. The submittal states that "Using Zone 2A with a 0.15 g input assumes the building would go nonlinear above a 0.15 g earthquake, but would not collapse to somewhere above 0.3 g. Margin is built in through code allowable on story drift and maximum stresses."

To use the RG 1.60 ground response spectrum anchored to 0.3 g for the SSE is consistent with the ABWR seismic design and is acceptable to the staff. The staff's evaluation of this ground motion is discussed in the final safety evaluation report (FSER) for the ABWR.

In its submittal, GE assumed that the building response, using UBC Zone 2A with a 0.15 g input for the design, would be nonlinear above a 0.15 g earthquake, but would not collapse at or above 0.3 g. For this issue, the staff is primarily concerned that the turbine building retains its structural integrity during and following an SSE and will not collapse. The extent to which the turbine building experiences non-linear responses is inconsequential with regards to the safety function of the MSL and condenser. however, the GE submittal has not provided enough information to justify its assumption or that the turbine building will not collapse at or below 0.3g. In accordance with the UBC criteria, a structural system, such as moment-resisting frame system, bearing wall system, and dual system, must be established first in order to estimate the amount of reduction of the design response spectra relative to its elastic design response spectra. Such information was not contained in either this submittal nor in the SSAR. Accordingly, the turbine building falls into the category of "Undefined Structural Systems," of the UBC (Section 2312 (d) 9B). Section 2312 (d) 9B of the UBC states:

> Undefined Structural Systems shall be shown by technical and test data which establish the dynamic characteristics and demonstrate the lateral force resistance and energy absorption capacity to be equivalent to systems listed in Table No. 23-O for equivalent Rw values.

Moreover, dynamic analyses procedures are required for Undefined Structural Systems (Table No. 23-O). Therefore, the static seismic analysis method proposed by GE for the design of the turbine building does not satisfy the UBC criteria.

In addition, even if a structural system or several structural systems are proposed, the use of UBC criteria alone is insufficient for the turbine building. This is because the UBC criteria were established mainly by judgement based on earthquake experience data and supplemented with some experimental data. The seismic requirements of the UBC have been increased each time as a new edition of the code is published, as a result of more experience and experimental data becoming available. Data published as a result of the U.S.-Japan Cooperative Earthquake Research Program in the last several years have indicated that many provisions in the UBC, especially related to the reduction of the design response spectra as a result of the ductility consideration, are unconservative, with some in a significant degree. Regardless of the flaws of the code provisions, which have been pointed out by experimental research results, the UBC has provided simple yet reasonable requirements for residential, and commercial buildings. However, simply to reference the use of UBC, as it was done by GE, does not provide a sufficient confidence level to assure that the turbine building would not collapse during SSE.

For the MSL analysis, GE proposed to use the site coefficient of two (which

corresponds to the soil profile containing more than 40 feet of soft soil, recommended in Table 23-J of the UBC), and to amplify the ground response spectrum (i.e., 0.3 g RG 1.60 response spectrum) for the input to the MSL analysis. It is the staff's understanding that this site coefficient considers only the amplification of the ground response spectrum due to soil flexibility but not the building flexibility effects. The staff's position is that the input response spectrum for the MSL analysis shall be calculated by considering the combined effects of the soil foundation and the structure flexibilities.

CONCLUSION

As discussed above, the following staff conclusions are drawn:

1. In general, the staff finds the design of non-seismic Category I structures which house safety related items (such as the main steam line) based on an equivalent static approach (e.g., UBC approach), and to allow a structure to be loaded beyond the elastic limit and undergo some limited inelastic deformation under a SSE is technically sound and reasonable.

2. GE should design the turbine building based on the UBC approach using Zone 3 instead of Zone 2A. In using this approach, the dual systems and concentric braced frames shall not be used.

3. As an alternative, GE may use Zone 2A for the design of the turbine building and demonstrate that the structure will retain its structural integrity under the specified SSE. However, the detailed procedures and calculations for the demonstration should be submitted for review.

4. The use of site coefficient of two to amplify the ground response spectrum for the MSL analysis is not acceptable. GE should either perform dynamic analysis for the turbine building to generate the in-structure response spectrum or to provide further justification for the use of amplification factor to generate the input of the MSL analysis.