

OCT 03 1991

MEMORANDUM FOR: Robert C. Pierson, Director  
Standardization Project Directorate  
Division of Advanced Reactors

THRU: Goutam Bagchi, Chief  
Structural and Geosciences Branch  
Division of Engineering Technology

FROM: David Terao, Section Chief  
Advanced Reactor Engineering Section  
Structural and Geosciences Branch  
Division of Engineering Technology

SUBJECT: SAFETY EVALUATION ON GE CONFIRMATION OF  
ABWR SEISMIC DESIGN ADEQUACY

REFERENCE: Letter from A.E. Rogers (GE) to NRC Document Control Desk  
dated August 19, 1991

The Advanced Reactor Engineering Section of the Structural and Geosciences Branch has completed its review of GE's evaluation procedure for the confirmation of the ABWR seismic design adequacy. As a result, we find that the overall approach for the site-specific evaluation based on the eight site-dependent conditions is acceptable. However, there are several specific aspects of the approach with which the staff does not fully agree with GE. Enclosed is a draft safety evaluation that provides our position on the GE procedure and identifies the areas in which we need further information.

*David Terao*  
David Terao, Section Chief  
Advanced Reactor Engineering Section  
Structural and Geosciences Branch  
Division of Engineering Technology

Enclosure:  
As stated

cc: D. Scaletti  
C. Poslusny

DISTRIBUTION  
Central File  
ESGB R/F

GBagchi  
DTerao

~~JCheng~~  
JRichardson

BDLiaw

CONTACT: Thomas M. Cheng, ESGB  
492-0770

ESGB:DET  
TCheng: tbc  
10/4/91  
OFFICIAL RECORD COPY  
DOCUMENT NAME: SER ON ABWR

ESGB:DET  
DTerao  
10/04/91

ESGB:DET  
GBagchi  
10/4/91

9110220297

XA  
SPSS

SAFETY EVALUATION OF THE CONFIRMATION PROCEDURE FOR THE  
ADVANCED BOILING WATER REACTOR (ABWR) SEISMIC DESIGN ADEQUACY  
STRUCTURAL AND GEOSCIENCES BRANCH

Section 3.7 and Appendix 3A of the standard safety analysis report (SSAR) for General Electric's Advanced Boiling Water Reactor (ABWR) discuss the seismic design criteria of the facility, including input ground motion, damping ratios, analysis methods, consideration of the soil-structure interaction, development of floor response spectra, analysis of subsystems, and eight enveloping site conditions of the interface requirements for the soil-structure interaction analysis.

General Electric has become aware that some design parameters at potential ABWR sites may exceed the enveloping site conditions. For confirming the adequacy of the standard seismic design, GE submitted to the NRC staff an evaluation procedure on August 19, 1991 (Reference 1) for the staff approval. This document includes the procedure which the applicants referencing the ABWR design shall follow in the event any (one or more) of the site-specific conditions exceed the design envelope and the procedure for addressing all eight enveloping site conditions. The purpose of this safety evaluation is to document the staff review findings of the GE's procedure.

In the August 19, 1991 submittal (Reference 1), GE stated that to confirm the seismic design adequacy of the standard plant, the applicants referencing the ABWR design shall demonstrate that the eight site-dependent conditions specified in Section 3A.1 of SSAR are satisfied. If there is any deviation (or exceedance) of the eight site-dependent conditions, a site specific evaluation is required. The proposed procedure for site specific evaluation is as follows:

- (1) Calculate the site-specific seismic responses in terms of forces, moments, or accelerations and compare to the site-envelope responses (standard design parameters) documented in Section 3G.4 of SSAR.
- (2) For Seismic Category I structures including the RPV and its internal components that are included in the SSI analysis model:
  - (i) Design adequacy is established if maximum structural responses in terms of force, moment, or acceleration are bounded by the Section 3G.4 responses (or the actual seismic loads considered in design if, applicable) at key locations.
  - (ii) If not, calculate resulting SSE stresses. Design adequacy is confirmed if combined stresses due to SSE and other appropriate loads are within design code allowable limits.

- (3) For Seismic Category I equipment and piping whose seismic input is in the form of floor response spectra:
- (i) Design adequacy is established if floor response spectra are bounded by Section 3G.4 spectra (or the actual spectra considered in design if applicable) at key locations. The site-unique response spectra used for comparison need not be broadened since uncertainties in the structural frequencies have been accounted for in the smooth broadened site envelope spectra.
  - (ii) If not, examine whether the deviations are at major resonant frequencies of the component under consideration. If not, design adequacy is confirmed. Otherwise, perform analysis and/or testing to demonstrate that the acceptance criteria given in design specifications are met.

GE also stated that if the deviation is for condition 1 (peak ground acceleration), 2 (ground response spectra), 5 (embedment depth), 6 (shear wave velocity of foundation material), and 7 (layering of soil foundation), a site-specific soil-structure interaction analysis is required.

As a result of its review, the staff finds that the overall approach for the site specific evaluation based on the eight enveloping site conditions provides a reasonable basis for ensuring the seismic adequacy of the standard design. However, there are several specific aspects of the approach with which the staff does not fully agree with GE. Contingent upon an acceptable resolution of the five items identified below, the staff conclude that the evaluation procedure, when successfully implemented by the applicant, will adequately verify the site - specific characteristics for their impact on the standard plant design adequacy.

- (1) For both structures and subsystems (piping and equipment), GE proposed to compare the site-specific responses (forces, moments, acceleration, and floor response spectra) with the standard design parameters only at the "key locations." It is the staff's position that the comparison should be done for all locations.
- (2) For the comparison of the floor response spectra, GE stated that the site unique response spectra used for comparison need not to be broadened because uncertainties in the structural frequencies have been accounted for in the smooth broadened site envelope spectra. As specified in Regulatory Guide 1.122, the purpose of floor response spectra peak broadening is to cover the uncertainties due to the material properties of structures and soil foundation, modeling techniques, and assumptions made in the analysis methods. These uncertainties exist in both the design response spectra as well as in the site-specific response spectra. Therefore, the staff position is that to confirm the adequacy of the standard seismic design of the subsystems (piping and equipment), GE shall broaden the site-unique response spectrum peaks before the comparison is done.

- (3) In the case where the site-specific responses (forces, moments, accelerations and floor response spectra) exceed the standard design, GE proposed to examine whether the deviations are at major resonant frequencies of the components (equipment and piping systems) under consideration for determining whether the adequacy of the standard design is confirmed or a plant-specific evaluation (analysis and/or testing) is needed. This approach is acceptable for the cantilever-type (support) equipment, because the modal response corresponding to the fundamental frequency will dominate the overall response of the equipment. However, for the case of multi-supported components such as piping systems, this approach needs to be clarified for the major resonant frequencies of the entire piping system. In piping analysis, some frequencies may dominate the responses (piping and pipe supports) of one section of piping system but the responses of other segments of the system may be dominated by different frequencies. GE should clarify how the multi-frequencies of piping systems will be evaluated.
- (4) GE stated that if the soil properties of the site vary abruptly with the depth (condition No. 7), a site specific SSI analysis is required. This procedure is acceptable provided that the input ground motion (ground response spectrum or ground motion time history) is specified at the proper location. In the case of a shallow soil site (shallow soil layer overlain on top of the bedrock), it would not be acceptable if the input ground motion is specified at the finished grade in the free field as stated in Section 3A.4.1 of the SSAR, because the structural responses would be underestimated. For the case of a shallow soil site, the staff position, as provided in the Standard Review Plan (1989 revision), recommends the input motion be defined at the rock outcrop.
- (5) There is no discussion of the site-specific evaluation procedure for Conditions 3, 4, and 8. The staff's findings cannot be established at this time for these conditions.

## REFERENCES

1. Letter from A.E. Rogers (GE) to NRC Document Control Desk, "Confirmation of ABWR Seismic Design Adequacy," August 19, 1991.