NUCLEAR REGULATORY COMMISSION
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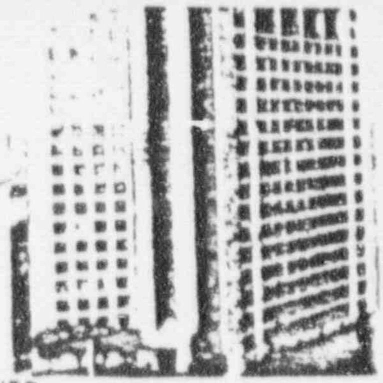

52-001

MAY 22, 1992

FAX NO'S 301 - FTS - 492-0259, 492-0260, 492-1137

VERIFICATION NO. 301 - FTS - 492-0262

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	TO	LOCATION
1.	JACK FOX	GE, SAN JOSE
	FAX # 408-925-1687	VERIFICATION
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OF PAGES 3 AND COVER SHEET

FROM S. NINH PHONE EXT. 301-504-1125

JACK,

Per telephone conversation with you on 5/13/92, GE agreed to provide additional information for items listed in the attachment to the staff by May 31, 1992.

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Enclosure

REQUEST FOR ADDITIONAL INFORMATION
PERFORMANCE OF CONTAINMENT STRUCTURE
ADVANCED BOILING WATER REACTOR

1. The discussion in Section 19F.2.1 (Ref. 1) states; "(1) the containment and building walls were connected at the upper pool and the diaphragm floor elevation, and both were anchored to a common base slab, and (2) the other floor slabs and the diaphragm floor slab were simulated by ring slabs to account for their stiffening effect on the cylindrical wall." This modelling appears to be a departure from the physical characteristics of the ABWR containment. Provide information on how such a model was justified to be representative of the actual containment behavior under pressure, temperature and horizontal force as depicted in Fig. 19F-2.4.

2. The discussion in Section 19F.2.1 (Ref. 1) further indicates that the region with the lowest strength margin is near the lower drywell acccess tunnel, and the pressure capacity of this region of concrete containment shell was estimated by using the test results supplemented by elastic analysis. the required pressure to rupture the hoop bars was found to be four times the design pressure (i.e., 180 psig). Since the region is an area of stress concentration, and the behavior with increasing pressure is likely to be highly non-linear, the procedure used in obtaining the ultimate capacity is questionable. Provide information on how the linear analysis can be relied upon to determine the ultimate pressure capacity.

3. The 1/6 scale model test contains the top slab which was further tested in the 1/10 scale top slab model. Provide information on comparision of the test results of the top slab between the two models.

4. On page 19F.2-3, the relation between the results of test and analysis is expressed by a formula with $\alpha=4$. Provide the basis for selection of this value.

5. Under Table 19F.2-1, an equation is shown. What is the relation between the first line and second line of the equation? Provide the basis (or derivation) of the equation.

6. Provide information on the analytical model and computer code (or codes) utilized (if any) to predict the behavior of the test models. How did the analytical predictions compare with the test results?

7. Although an attempt has been made to represent the ABWR containment in 1/6 scale test model, there are a number of key areas where the model does not properly represent the actual structure. These areas include the following:

a. Simulation indicated in Question 1,
b. absence of liner plate,
c. absence of discontinity area at the drywell head and concrete containment,
d. absence of realistic representation of major penetrations,
e. absence of simulation of loads due to pool dynamics in wet well

concurrent with the static pressure load in the drywell.

Also, the primary 1/6 scale model was subjected to the internal pressure up to twice the design pressure (i.e., 90 psig), and not the failure pressure. with these dissimilarities and limitations, the failure pressure of 180 psig from 1/10 scale top slab model may not be a reliable indication of the failure pressure of the actual concrete containment. Moreover, a direct usage of reinforcing bar strains in establishing stresses and strains in reinforcing bars and an imaginary liner plate at various locations of ABWR containment is an inappropriate procedure. Instead, the test results could be used in refining or updating an existing computer code, preferably, the one used to predict the test results, which, in turn, could be used to analyse the containment.

Considering the above comment, justify the use of 180 psig as the failure pressure of the ABWR containment, or provide a revised ultimate pressure (if greater than 90 psig) for the concrete portion of the ABWR containment structure based on strain limits in liner at penetrations, reinforcing bar strains and other limits imposed by surrounding structural elements and functionality of various interfacing components.

8. The equation (19F.3-2 in Ref. 1) used in calculating the internal pressure at critical buckling is based on a paper (Ref. 2) by Galletly and Radhamohan which limits its applicability to "D/t" between 500 to 1500. The "D/t" ratio for ABWR head is 324. Provide a justification for the use of the equation. A later paper by Galletly and Blachut (Ref. 3) provides equations which could be used for "D/t" ratio of 300 to 1500. The staff's calculation based on equation 3 in the reference gives a critical buckling pressure of 203 psig at 500°F. This corrresponds to ASME Level C allowable buckling pressure of 81 psig. Provide justification for using 97 psig.

9. The authors of the same paper (Ref. 3) have made a comparision of their own equation and with that of Shield and Drucker (Ref. 4) used in Appendix 19F for axisymmetric yielding pressure, and find that the later is conservative. Hence the head failure pressure would be dictated by ASME Level D limit for compressive buckling stress. This will correspond to 101 psig at 500°F. Provide justifiction for using 134 psig as the median centered failure pressure (Fig. 19FA-1) for the drywell head.

10. Section 19F.3.2.2 (Ref. 1) provides some discussion of the estimated leakage areas through the penetrations and drywell head. However, the discussion does not provide any information regarding the structural deformations at the penetrations and drywell head. One of the largest bypass leakages at high pressures and temperatures would be through the pressure unseating penetrations and drywell head. The flange rotations, bolt deformations and potential pullout of drywell head from concrete need to be properly considered in arriving at the estimated leakage areas. Provide information on this aspect of functional failure of ABWR containment.

11. In view of the discussions and questions above, provide information regarding compliance with the containment performance criteria of SECY 90-016.

12. Attachment A to Appendix 19F describes the procedure used in arriving at the median fragility curve for the ABWR containment. The curve is based on the use of 134 psig as a 50/50 value. Provide justification for this value in light of the comments in Questions 7 and 9.

13. The uncertainty factors (Bs, Bm) for variation in material properties and modelling appear to be too low when considering the analysis methods (approximate formulations), and stress-strain relationship in non-linear range at high temperatures. Provide justification for the use of these values.

References:

1. Appendix 19F as an enclosure to the letter from P. W. Marriott (General Electric) to Robert C. Pierson (NRC), dated April 24, 1992.

2. Galletly, G. D., Radhamohan, S. K.: "Elastic-Plastic Buckling of Internally Pressurized Thin Torispherical Shells," ASME Transactions, Vol. 101, dated August 1979.

3. Galletly, G. D., Blachut J.: "Torispherical Shells under Internal Pressure- Failure due to Assymetric Plastic Buckling or Axisymmetric yielding," Proc. of Institution of Mech. Engineers, Vol. 199, No. C3, 1985.

4. Shield, R. D., Drucker, D. C.: "Design of Thin-Walled Torispherical and Toriconical Pressure-Vessel Heads," Transactions of the ASME, June 1961.