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BWR PROJECTS DEPARTMENT

March 2, 1977

Office of Nuclear Reactor Regulation
Attn: S. A. Varga, Chief
Light Water Reactors Branch #4
Division of Project Management
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Gentlemen:

SUBJECT: LOADING CRITERIA FOR SUBMERGED STRUCTURES

As a result of discussions with members of the Containment Systems Branch during a generic meeting on dynamic loads for the design of Mark III Containment, GE provided information copies of a status report entitled "Unsteady Drag on Submerged Structures" by G. L. Gyorey's March 24, 1976 letter to R. L. Tedesco. This information was submitted to clarify how loads on submerged structures were to be treated to comply with the intent of Appendix 3B to the 238 NI GESSAR. The purpose of this letter is to transmit reponses to the questions about this information report which were set forth in the enclosure to your January 5, 1977 letter to G. G. Sherwood.

As indicated in the March 24, 1976 transmittal letter, the general methodology presented in the status report is intended to form the basis for load definition guidelines that will be incorporated in appropriate documents. Drafts of the base documents for eventual use in this manner are being prepared now. Specific methodology for Mark III application will be available for discussion with the NRC in June 1977 and will be documented for GESSAR application after NRC review.

If you have any questions or comments regarding the attached information, please contact me.

Sincerely,

L Sobon

L. J. Sobon, Manager
BWR Containment Licensing
Containment Improvement Programs

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cc: L. S. Gifford (GE, Bethesda)
J. A. Kudrick (NRC)
J. D. Thomas (NRC)
R. L. Tedesco (NRC)
Master File #083-77

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QUESTION 041.1

The method presented in the GE report "Unsteady Drag on Submerged Structures", which is attached to the letter dated March 24, 1976 (G.L. Gyorey of GE to R.L. Tedesco of NRC), has been reviewed for the calculation of submerged structure loads. Since this model presents a departure from our current acceptance load criteria for submerged structures, the following additional information should be provided:

1. Discuss and justify the applicability of this model, which assumes an idealized spherical gas bubble, for air charging through the horizontal vent system following a LOCA. Information should include methods of determining initial bubble pressure, location, size and velocity. Compare and justify these initial conditions with the PSTF test data.

2. Discuss and justify the applicability of this single spherical bubble for the SRV quencher design. Information should include methods of determining initial bubble pressure, location, size and velocity. Method of calculating bubble pressure attenuation should also be provided.

RESPONSE

1. Although later stages of observed bubble growth tend toward an eliptical shape, the initial conditions for the assumed idealized spherical gas bubble used in the model are based on observations from PSTF tests which are reported in GE topical reports NEDE-13407, "Mark III Confirmatory Test Programs" and NEDE-13435, "Mark III 1/3 Scale 3-Vent Air Test Series 5806". It was observed that the maximum LOCA bubble pressure load on the suppression pool wall was at the time of initial vent clearing. Submerged structure LOCA bubble pressure loads will also be induced at this time of maximum bubble pressure. The suppression pool boundary LOCA bubble loads identified in Appendix 3B are based on the assumption that the maximum bubble pressure is equal to peak drywell pressure. For submerged structure, LOCA bubble loads are based on a simple bubble of the same diameter as the horizontal vent in an infinite pool being charged at the peak drywell pressure. The effects of containment walls, floor, and pool surface are approximated with image bubbles.

2. The procedure for establishing SRV bubble loads on a submerged structure calls for the use of four air bubbles at the quencher. Each bubble is assumed to be spherical in shape, of equal strength, and oscillating in phase with the other bubbles for that quencher. Bubble oscillation is assumed to be isentropic and can be described by the Rayleigh equation. The maximum and minimum bubble pressures are assumed to be equal to the bottom pressures which are determined from the statistical formulations developed and presented in Attachment A of Appendix 3B. The maximum bubble air volume is determined from the initial air conditions in the SRV discharge line and assuming that the bubble temperature is equal to the maximum pool water temperature during SRV blowdown when bubble pressure is maximum.

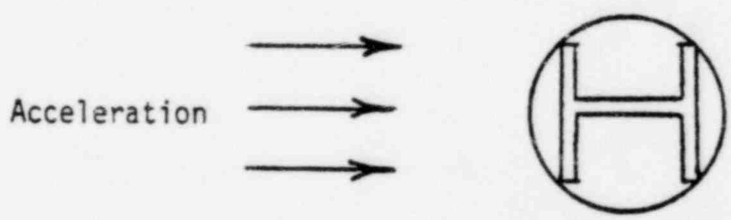
QUESTION 041.2

With respect to the development of the drag coefficients for submerged structures, provide the following additional information:

1. A detailed description of the analytical method used to calculate the drag coefficient for all complex structures (i.e., pipe supported by an I-beam).
2. Applicable experimental data.

RESPONSE

1. The fluid drag load on submerged structures will consist of two components, standard drag and acceleration drag. Standard drag is the conventional drag due to fluid velocity. Drag coefficients can be obtained from documents such as references 1, 2 and 3. For complex structures such as a pipe supported by an I-beam the drag coefficient is assumed to be between that for a cylinder and a flat plate of the same frontal area. For acceleration drag on simple structures a hydrodynamic volume is used. This is obtained from hydrodynamic mass formulas in reference 4. For complex structures, the acceleration drag volume is based on the area of a circumscribed circle about the target structure along the target length.



2. GE presumes that testing has been performed to establish the published recommendations in the liturature for drag coefficients.

References

1. Binder, R.C., 1955, Fluid Mechanics, New Jersey: Prentice-Hall, Inc.
2. Streeter, V.L. and Wylie, E.B., 1975, Fluid Mechanics, New York: McGraw-Hill.
3. Zahm, A.F. and Roshko, A., 1961, J.F.M., 10:345.
4. Patton, K.T., 1965, "Tables of Hydrodynamic Mass Factors for Translational Motion", ASME Paper No. 65-WA/UNT-2.