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SUBJECT: FORWARDS "VENT CLEARING POOL BOUNDARY LOADS FOR MARK II PLANTS," PRESENTING ALTERNATIVE LOAD SPEC BASED ON CONSERVATIVE APPLICATION OF 4T TEST DATA,REPLACING THAT IDENTIFIED IN NUREG-0487.

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MFN-080-79

March 20, 1979

U. S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Washington, D.C. 20555

Attention: John F. Stolz, Chief
Light Water Reactors Branch 1
Division of Project Management

Gentlemen:

SUBJECT: VENT CLEARING POOL BOUNDARY LOADS FOR MARK II PLANTS

Enclosed are ~~twenty (20) proprietary and~~ twenty (20) non-proprietary copies of an alternate load specification information document applicable to wetwell walls to replace that identified in NUREG-0487, Mark II Containment Lead Plant Program Load Evaluation and Acceptance Criteria. This material was briefly discussed during the October 19, 1978, NRC meeting at which the Mark II Owners Group presented their alternative positions and general comments on the NRC criteria presented in NUREG-0487.

~~The proprietary enclosure to this letter contains information which General Electric Company customarily maintains in confidence and withholds from public disclosure. The information has been handled and classified proprietary by General Electric as indicated in the attached affidavit. Accordingly, we hereby request that the proprietary version of the enclosure to this letter be withheld from public disclosure in accordance with the provisions of 10CFR2.790.~~

Very truly yours,

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

T002 1/1

LJS/dm

Enclosures

cc: C. J. Anderson, NRC
H. Chau, Mark II Owners Group
H. C. Brinkmann, Mark II Owners Group
L. S. Gifford, GE Bethesda

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VENT CLEARING POOL BOUNDARY LOADS

FOR MARK II PLANTS

(MARCH 1979)

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Vent Clearing Pool Boundary
Loads for Mark II Plants
(March 1979)

I. Introduction

The vent clearing phenomenon following a loss-of-coolant-accident is the clearing of water from the main vent downcomers due to drywell pressurization. Typically, this phenomenon lasts for 0.7 seconds after the postulated pipe break. After this time water has cleared the vents and the pool swell phenomenon occurs.

The method for evaluating vent clearing loads is contained in Section 4.2.6.1 of Reference 1. Specifically, a water jet impingment load equal to $\rho V^2/g_c$, where ρ is the pool density and V is the attenuated water jet velocity, is prescribed for the basemat. Typically, this conservatively calculated load is a 33 psid increase above the initial local hydrostatic pressure. No corresponding vent clearing load is specified for the submerged wetwell walls.

Based on the Mark II 4T tests, methodology in Reference 1 is a conservative upper bound for the magnitude of the basemat impingement load. However, the NRC (Reference 2) extended the application of this 33 psi load to include the submerged wetwell walls below the downcomer exit with a linear attenuation to zero at the pool surface.

The Mark II Owners Group acknowledges the appropriateness for specifying a non-zero vent clearing load on the submerged wetwell walls. However, based on the full scale Mark II 4T Tests, a value of 33 psi is unrealistically high. This report presents an alternative load specification based on a conservative application of the 4T test data.

II. Summary

1) For the Mark II 4T Tests, the maximum observed vent clearing load on the basemat and submerged wetwell walls is less than a 20 psid increase over initial local hydrostatic pressure.

2) Based on 4T data with additional conservatism to account for drywell pressurization rates higher than in the 4T Tests, Section 4.2.6.1 of Reference 1 shall be revised to include the following:

   (i) For vent clearing loads, a 24 psid increase over local hydrostatic pressure is statically and uniformly applied to the basemat and to the submerged wetwell walls below the downcomer exit elevation.

   (ii) For the submerged walls above the downcomer exit elevation, the 24 psid increase is linearly attenuated to zero at the pool surface.

III. Vent Clearing Phenomenon

Following a postulated LOCA, water is expelled from the main vent system due to drywell pressurization. This potentially results in direct jet impingement loads on the basemat in addition to flow - induced pressure loads on submerged wetwell walls and portions of the basemat outside the direct influence of the water jet.

Figure 1 presents typical pressure/time histories for several locations on the pool boundary corresponding to a typical 4T Test. The data show that the pressure increase at the center of the basemat (location 1) and at the two-foot wall elevation (location 2) are essentially identical during vent clearing and attain a maximum of approximately 12 psid[1] increase above the initial local hydrostatic pressure at at time very nearly equal to the vent clearing time. Also note that the corresponding pressure increase on the wall at the downcomer exit elevation is approximately 7 psid at this same time.

Since the pressure in reases measured at locations 1 and 2 are essentially identical and since loads are measured on the wall at the downcomer exit elevation, it is apparent that vent clearing loads on the pool boundaries are not due to direct water jet impingement. The postulated source for the load is flow induced pressure forces due to water clearing and dispersal of the water jet in the pool.

That direct water jet impingment on the basemat does not occur is further substantiated by visual observations of small scale tests (EPRI 1/13 single cell tests and Mark I One-Quarter Scale Tests) which show that the LOCA water jet penetrates at most three vent diamters into the pool. Typically, the basemat is 6 vent diameters from the vent exit.

Since the data discussed above are typical of the 4T tests[2], it is concluded that vent clearing loads on the basemat and submerged wetwell walls are not due to water jet impingement, but rather are associated with flow induced pressures from the main vents.

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[1]This pressure increases during vent clearing should not be confused with the 9 psid indicated in Section 4.2.6.1 of Reference 1. To clarify this point, it is noted that the pressure increase from Reference 1 is referenced to the transient ambient pressure increase at the vent exit elevation, while the pressure increase in this report is referenced to the initial local hydrostatic pressure.

[2]Similar pressure/time histories are given in Figures 5.3, 5.4, 5.5 of Reference (3).

IV. Vent Clearing Pool Boundary Load Specification

A bounding load approach based on direct application of the 4T test data will be used to develop a load specification for the submerged pool boundary during vent clearing. Table 1 presents the maximum measured basemat pressure increase occurring at approximately the time of vent clearing for the 4T tests. In all cases the basemat pressure increase bounds the wall pressure increase. Therefore, the values in Table 1 are maximum pressures for the entire submerged pool boundary. Additionally, Table 1 presents the vent clearing time and the time corresponding to the maximum pressure increase. Since the times closely correspond, it is concluded that the pressures in Table 1 are maximum values for the entire vent clearing regime. From Table 1 the maximum pressure increase on the submerged pool boundary during vent clearing is 19.4 psid. The average over the 4T test series is 12.5 psid. These values are considerably less than the 33 psid computed by an overly conservative water jet impingement model.

As described in References 4 and 5 the 4T tests are prototypical of Mark II plants. With the exception of the calculated drywell pressurization rate - which is evaluated with the conservative model in Reference 6 ignoring condensation effects - all key Mark II plant parameters such as submergence and ratio of pool area to vent area are bounded by the 4T tests. Among all Mark II plants the maximum calculated drywell pressure at the time of vent clearing is approximately 4 psi higher than the corresponding maximum value for the 4T tests. Since the vent clearing pool boundary loads are a strong function of the drywell pressurization rate prior to vent clearing, a bounding value of 24 psid (20 psid which bounds the 4T data plus an additional 4 psid to account for maximum drywell pressurization among Mark II plants) pressure increase over initial local hydrostatic pressure will be specified to be uniformly applied to the basemat and the submerged walls below the vent exit elevation. The 24 psid increase is linearly attenuated from the vent exit elevation to zero at the pool surface. The load is applied staticly throughout the entire vent clearing regime indicated in Figure 5 - 7 of Reference (1). These last two aspects of the load specification are identical to the specifications of Reference (2).

V. Conclusion

Reference 2 specifies a 33 psid pressure increase for loads on submerged pool boundaries during vent clearing. Based on Mark II - 4T data, this is an overly conservative bounding value. Based on this report, Section 4.2.6.1 of Reference 1 will be superceded by the following load specification:

> "4.2.6.1 Pool Boundary Loads During Vent Clearing
> Based on 4T Data, a pressure increase (over initial local hydrostatic pressure) equal to 24 psid is applied uniformly to the basemat and to the submerged pool walls below the vent exit elevation. This pressure increase is linearly attenuated from 24 psid at the vent exit to zero at the pool surface. The load is applied statically during the vent clearing regime for the duration indicated in Figure 5 - 7."

REFERENCES

1) General Electric Company and Sargent and Lundy Engineers, "Mark II Containment Dynamic Forcing Functions Information Report," NEDO-21061, Rev. 3, June 1978.

2) U.S. Nuclear Regulatory Commission, NUREG 0487 "Mark II Containment Lead Plant Program Load Evaluation Report," October 1978.

3) General Electric Company, "Mark II Pressure Suppression Test Program - Phase I, II & III of the 4T Tests - Applications Memorandum," NEDE-23678-P, January 1977.

4) McIntyre, T. R. et al, "Mark II - Pressure Suppression Test Program," General Electric Company, NEDE-13442P, January 1976.

5) Grafton, W. A. et al, "Mark II Pressure Suppression Test Program - Phase II and III Tests," General Electric Company, NEDE-13468-P, October 1976.

6) James, A. J., "The General Electric Pressure Suppression Containment Analytical Model," General Electric Company, NEDM-10320, March 1971.

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