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September 9, 1982
EF2 - 59,281

Mr. L. L. Kintner
U. S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Division of Licensing
Washington, D. C. 20555

Dear Mr. Kintner:

References: (1) Enrico Fermi Atomic Power Plant, Unit 2 NRC Docket No. 50-341

(2) NRC letter, June 29, 1982, B. J. Youngblood to H. Tauber, "Mark I Containment - Request for Additional Information"

(3) Detroit Edison Letter EF2-58,955, "Mark I Containment - Request for Additional Information", August 7, 1982

Subject: Mark I Containment
Submittal of Additional Information

Per our telephone conversation of August 23, 1982, attached please find the additional information you requested in response to questions 1, 4 & 5 submitted in Reference 3. Due to the time constraint, the response is submitted in the question/response format. After you have reviewed and accepted our response, we will incorporate the attachment into the Plant Unique Analysis Report (PUAR), revising PUAR pages if applicable.

Should you have any questions regarding the above, please contact Mr. L. E. Schuerman, (313) 649-7562.

Sincerely,

Harry Tauber

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Attachment

cc: M. J. Ranlet (Brookhaven National Laboratory)
J. Lehner (Brookhaven National Laboratory)
G. Bienkowski (Princeton University)

Question 1

Published acceleration drag volumes were used to determine the drag loads on sharp cornered submerged structures instead of the equivalent cylinder procedure specified in the acceptance criteria. Provide a list of structures which were treated in this manner. For the ring beam, provide specific dimensions of the structure, as well as the local acceleration and velocity for the post-chug loading condition. A copy of K. T. Patton's MS thesis from the University of Rhode Island (1965) would be useful in resolving this issue if it is available.

Response to Question 1

The following information is provided in addition to the previous response to Question 1. This information presents sample calculations of post-chug submerged structure loads on segment 7 of the ring beam.

For submerged structure loads, the contribution due to velocity drag is negligible compared to acceleration drag. Attached Figure 1-1 shows the cross-section of the ring beam at segment 7 used for calculating the acceleration drag volume. For the flow direction normal to the web, the beam is idealized as a rectangular cross-section as shown by the dotted lines in Figure 1-1. From the LDR Table 4.3.4-1 the acceleration drag volume, V, for a rectangular cross-section is:

$$V = A_w \times L\ (4ab + 1.33\ \pi\ a^2)$$

Where A_w = Wall interference factor

and L = Length of the segment

For segment 7, A_w = 2.0 and L = 2.72 feet. This results in a drag volume equal to 90.36 ft^3 for segment 7.

For the bounding load case (two downcomers chugging out of phase), the acceleration, A_z, on segment 7 normal to the direction of the web for a unit source strength was calculated as 0.009342 ft/sec^2. Therefore, the force, F, for the unit source strength will be:

$$F = \frac{\rho V A_Z}{g_c} = 1.636 \text{ lbs.}$$

Table 1-1 shows the results of sample calculations for the dynamic force in each frequency range from 0 to 50 Hz. Dynamic load factors are calculated corresponding to the 48.5 Hz natural frequency of the ring beam given in PUAR Figure 2-2.4-3. The dynamic force in each frequency range is absolutely summed and multiplied by a factor of 0.65 to account for randomness in phasing. The surface area of segment 7 was calculated precisely as 1160 in^2 from the finite element model shown in PUAR Figure 2-2.4-1. Therefore, the pressure on the web at segment 7 of the ring beam as shown in PUAR Table 2-2.2-9 (without the FSI effect) is calculated as:

$$\text{Pressure} = \frac{0.65 \times \sum_{i=1}^{50} (F \times DLF)_i}{\text{Area of segment 7}}$$

and is equal to 24.1 psi as shown in attached Table 1-1.

As discussed earlier, the acceleration drag volume for various segments of the ring beam for the flow direction normal to the web has been calculated by idealizing the I-section by a rectangular section. In the equation of acceleration drag volume, the area of the cross-section was conservatively added as the area of the rectangular cross-section rather than the actual I-section. Overall, the submerged structure loads in the PUAR have been calculated conservatively.

Table 1-1

Dynamic Force on Segment 7 Due to Post-Chug Submerged Structure Loads

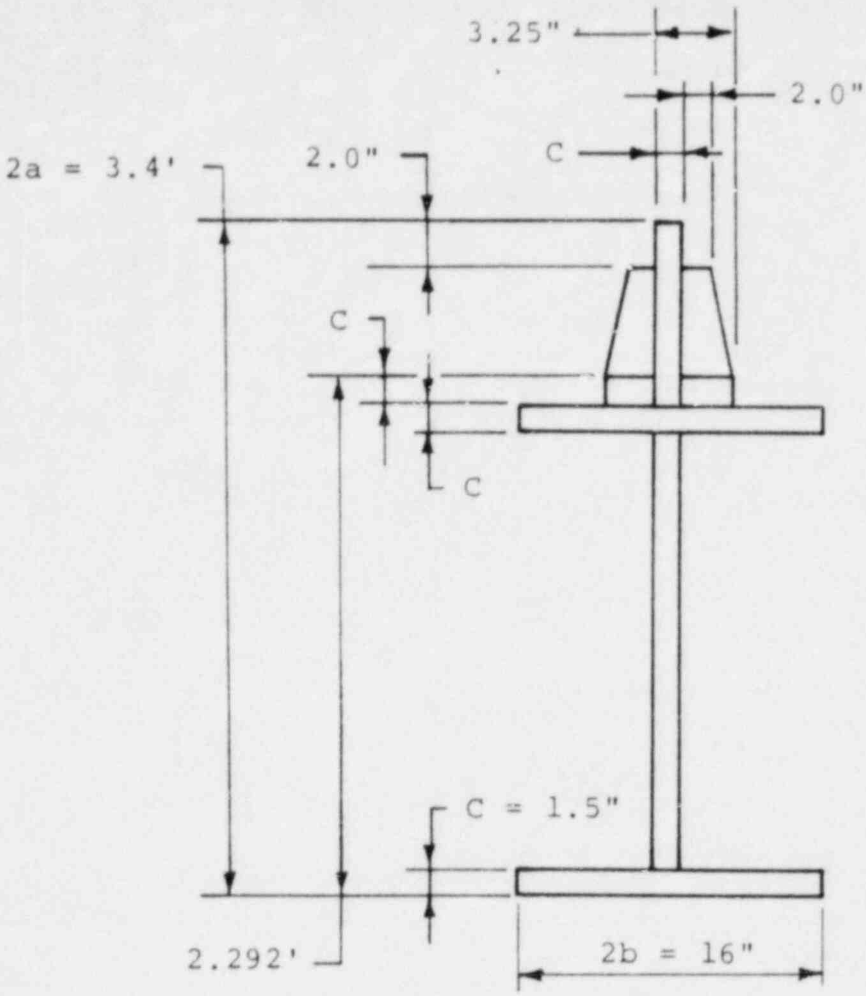
Frequency (Hz)	Force Corresponding to Amplitude at Each Frequency (F) (lbs)	Dynamic Load Factor (DLF)	Dynamic Force (F x DLF) (lbs)
0-1	19.6	1.0	19.6
1-2	19.6	1.0	19.6
2-3	16.9	1.0	16.9
3-4	16.1	1.0	16.1
4-5	28.5	1.0	28.5
5-6	27.8	1.0	27.8
6-7	30.9	1.0	30.9
7-8	30.9	1.0	30.9
8-9	30.9	1.0	30.9
9-10	30.9	1.0	30.9
10-11	143.8	1.0	143.8
11-12	124.6	1.1	137.1
12-13	67.1	1.1	73.8
13-14	58.7	1.1	64.6
14-15	11.2	1.1	12.3
15-16	10.1	1.1	11.1
16-17	5.1	1.1	5.6
17-18	6.8	1.1	7.5
18-19	4.8	1.2	5.8
19-20	27.5	1.2	33.0
20-21	28.7	1.2	34.4
21-22	50.2	1.2	60.2
22-23	151.2	1.3	196.6
23-24	151.2	1.3	196.6
24-25	220.0	1.3	286.0
25-26	513.4	1.4	718.8
26-27	618.1	1.4	865.3
27-28	412.1	1.5	618.2
28-29	267.2	1.5	400.8

Table 1-1

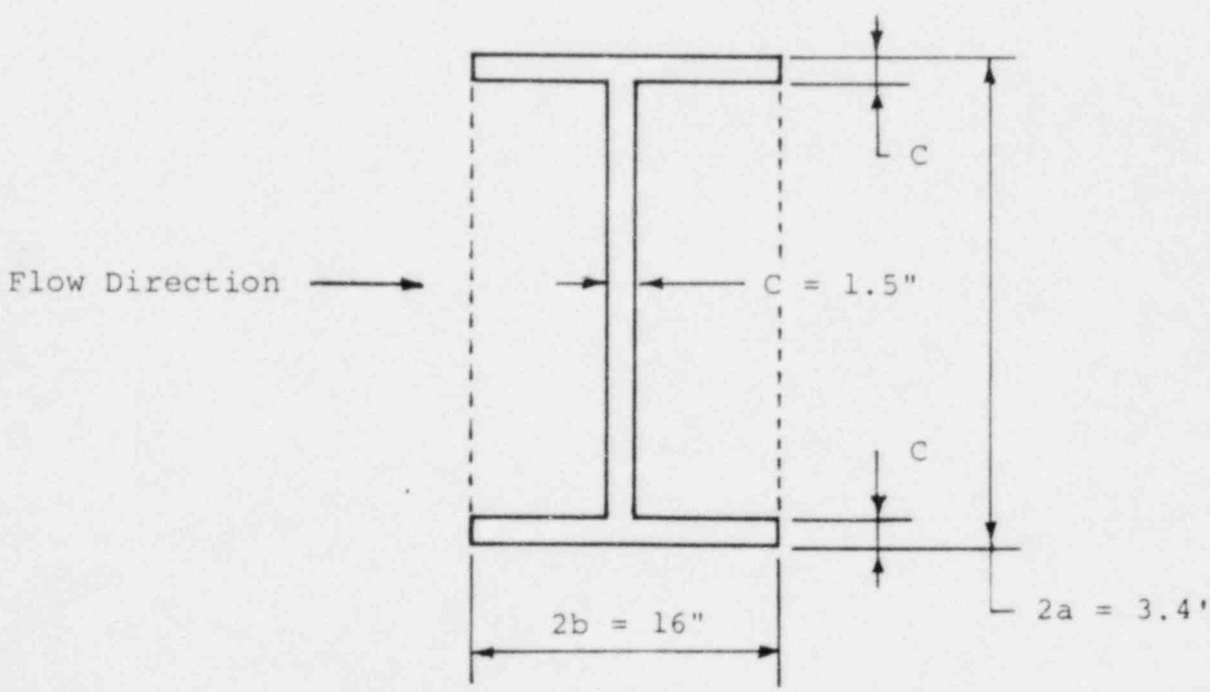
Dynamic Force on Segment 7 Due to Post-Chug Submerged Structure Loads (Concluded)

Frequency (Hz)	Force Corresponding to Amplitude at Each Frequency (F) (lbs)	Dynamic Load Factor (DLF)	Dynamic Force (F x DLF) (lbs)
29-30	190.8	1.6	305.3
30-31	70.6	1.6	113.0
31-32	35.3	1.7	60.0
32-33	62.0	1.8	111.6
33-34	82.7	1.9	157.1
34-35	69.6	2.0	139.2
35-36	101.2	2.1	212.5
36-37	68.6	2.3	157.8
37-38	34.3	2.5	85.8
38-39	40.0	2.7	108.0
39-40	48.0	3.0	144.0
40-41	367.9	3.3	1214.1
41-42	367.9	3.7	1361.2
42-43	367.9	4.3	1582.0
43-44	367.9	5.0	1839.5
44-45	367.9	6.2	2281.0
45-46	367.9	8.0	2943.2
46-47	367.9	11.2	4120.5
47-48	367.9	17.7	6511.8
48-49	367.9	25.0	9197.5
49-50	367.9	17.1	6291.1
			43059.8 = Total

$$\text{Total Pressure} = \frac{43059.8 \times 0.65}{1160} = 24.1\,\text{psi}$$



a. Actual Geometry



b. Model Geometry

Figure 1-1 - Ring Beam Cross-Section at Segment 7 for Acceleration Drag Volume Calculation

Question 4

The acceptance criteria specified that for multiple downcomer chugging the force per downcomer shall be based on an exceedance probability of 10^{-4} per LOCA. A correlation between load magnitude and probability level derived from a statistical analysis of FSTF data was utilized in the PUA. Provide the details of the correlation and justification for the use of the correlation.

Revised Response to Question 4

The methodology used to compute the probabilities of exceedance for the Fermi 2 multiple downcomer chugging loads shown in PUAR Table 3-2.2-15 is based upon the understanding that the chugging duration of 512 seconds and the number of downcomer chugs of 313 were obtained from FSTF test results.

Further study of the FSTF chugging data report (General Electric Report NEDE-24539-P dated April 1979) indicated that a chugging duration of 512 seconds represents a realistic duration for an actual plant. By dividing the chugging duration of 512 seconds by a conservative chugging period of approximately 1.63 seconds observed in FSTF, a total number of 313 chugs was obtained. Also it was observed that not all of the 313 chugs were synchronized pool chugs.

From FSTF Test M-1, which is representative of Fermi 2 plant conditions, it was observed that about 33 percent of all the chugs were synchronized pool chugs. The rest of the chugs were not well synchronized pool chugs and would not result in any multiple downcomer lateral load having the force in the same direction occuring at the same time. Therefore, based upon FSTF Test M-1, out of 313 chugs only about 104 chugs (33 percent) were synchronized pool chugs resulting in a number of downcomers having the lateral force in the same direction at the same time.

Scaling the above information for the conservative Fermi 2 chugging duration of 900 seconds, the number of synchronized pool chugs for Fermi 2 will be about 182. As per NUREG-0661, the probability of exceedance for calculating the force per downcomer in multiple downcomer chugging is based on the premise that the force per downcomer would exceed the design load once per LOCA. Thus, for Fermi 2 the probability that the force per downcomer in a pool chug can be exceeded once per LOCA will be the reciprocal of 182 or 5.5×10^{-3}. This probability level is applicable for any number of downcomers considered to be loaded with the same force in the same direction at the same time.

Based upon the above probability of exceedance, the chugging forces per downcomer presented in PUAR Table 3-2.2-15 are bounding for different numbers of downcomers considered to have the lateral force in the same direction occuring at the same time.

Question 5

(a) On page 1-4.113, it is stated that the peak positive bubble pressure and maximum bubble pressure differential from the Monticello T-quencher test data are 9.9 psid and 18.1 psid, respectively. Our information (Table 3-3, Page 3-10, NEDE-21878-P) indicates that these values are 9.3 psid and 17.4 psid. Provide information to permit clarification of this discrepancy.

(b) We require additional information to determine whether modification of the bubble pressure bounding factor from the LDR value of 2.5 to the proposed value of 1.75 is justified. Specifically, the peak positive and negative bubble pressure predicted by the SRV bubble pressure methodology when the 1.75 multiplier is employed should be reported. The initial conditions for this calculation are to correspond to the CP, NWL, SVA case as listed in Table 3-2 of NEDE-21878-P.

Response to Question 5

The following information is provided in addition to the previous response to Question 5.

The techniques used to model the Fermi 2 T-quencher are the same as those used for the Mark I T-quencher (General Electric Report NEDE-25090-1-P), except the Fermi 2 T-quencher geometric characteristics are used (PUAR Figure 1-4.2-6). The model described in NEDE-25090-1-P was approved in NUREG-0661 and is based on steady-state submerged jet theory, published literature on jets and test data.

The Fermi 2 T-quencher has the same hole size and hole spacing as the Mark I T-quencher. However, the Fermi 2 T-quencher arm diameter is 20" and the hole distribution is slightly different from the Mark I T-quencher. Therefore, the model described in

NEDE-25090-1-P was utilized with slight modifications to account for the Fermi 2 geometric differences.

The difference in arm diameter, and hence water volume, is taken into account in the SRV clearing model described in the PUAR. This model provides the mass flow rate information needed to calculate the water velocity in the T-quencher arm from which the hole velocity in each jet section is calculated. (A jet section is defined as the portion of the arm where the number of holes per column is equal).

Since the Fermi 2 T-quencher hole size and hole spacing are equal to the Mark I T-quencher, the jet phenomena will be similar. That is, orifice jets will be formed first. These orifice jets will then merge into rectangular column jets which, in turn, will merge into quencher arm jets. The widths and heights of the jets for Fermi 2 are based on the Fermi 2 T-quencher geometry. This is the same procedure used to determine jet widths and heights for the Mark I T-quencher. The jet velocities are derived from the jet width and height and the principle of conservation of momentum up to the time (t_o) where all the water has been cleared from the T-quencher. After all water has been cleared from the T-quencher, the quencher arm jet velocity is assumed to decrease linearly to zero in a time equal to the clearing time (t_o) as described in NEDE-25090-1-P.

The T-quencher water jet model described in NEDE-25090-1-P is based mainly on steady-state jet theory and published literature on jets. The test data were used only to confirm the prediction of the point where orifice jets merge and to estimate the time (t_o) required for the quencher arm jet to decay to a negligible velocity. The Fermi 2 T-quencher water jet model uses the same principles and assumptions while properly incorporating the Fermi 2 T-quencher geometry.