DET-15-022
Revision 0
August 1982

Responses to NRC Questions on the Enrico Fermi Atomic Power Plant Unit 2 Plant Unique Analysis Report

Prepared for:

Detroit Edison Company

Prepared by:

NUTECH Engineers, Inc.
San Jose, California

Approved by:

R. A. Lehnert, P.E.
Engineering Manager

Issued by:

C. W. Roberts
Project Director

nutech ENGINEERS

Question 13

PUAR Section 2.2.2.1 (Page 2.2-30), AC Section 2.3 and 2.4. Additional information is required concerning the torus shell pressures presented in Table 2-2.2-3 on page 2-2.48 of the PUAR. Provide the details of a specific torus shell pressure calculation at the two times specified in the table for a typical longitudinal location as a function of circumferential location (e.g., Z/ℓ = 0, θ = 180, 150, 120, and 90 degrees). The following information should be included as part of the response with and without the margins imposed by NUREG-0661.

(a) Net torus vertical load history.
(b) Average submerged pressure history.
(c) Torus airspace pressure history.

Illustrate how these pressure histories are used in conjunction with the Load Definition Report (LDR) multipliers to arrive at the values presented in the table.

Response to Question 13

As discussed in the response to Question 14, the transient structural analysis of the Fermi 2 suppression chamber for pool swell loads is performed using net pressure loadings which are obtained by subtracting the airspace pressure transient from the submerged pressure transient. The net pressures used in the structural analysis include the margins imposed by NUREG-0661. PUAR Figure 2-2.2-8 shows an example of a resulting net pressure transient used in the analysis.

The attached Table 13-1 provides additional information to clarify PUAR Table 2-2.2-3. Table 13-1 shows the torus shell pressure values used in the Fermi 2 structural analysis which were calculated in accordance with NUREG-0661 requirements. The bases for the values in Table 13-1 and PUAR Table 2-2.2-3 are described in the following paragraphs.

The sample pressure values shown in PUAR Table 2-2.2-3 were obtained by taking the net pressure loads used in

the structural analysis of the suppression chamber including the NUREG-0661 margins, and adding the torus airspace pressures obtained directly from the PULD curves without NUREG-0661 margins. For ease of review, the pressures shown in Table 2-2.2-3 were reported at the same longitudinal locations as the locations at which the Load Definition Report (LDR) longitudinal multipliers are specified. The LDR specifies values at five Z/ℓ locations for calculating longitudinal multipliers. Intermediate values used in the Fermi 2 analysis are obtained by interpolating and enveloping the LDR values. Each longitudinal multiplier is conservatively applied over a range of Z/ℓ values.

Table 13-1 shows torus shell pressure components which include all the NUREG-0661 margins. Table 13-1 also shows locations at which the LDR longitudinal multipliers were obtained and the range over which each multiplier was applied. A description of how the values in Table 13-1 were obtained is provided in the following paragraphs.

The average submerged pressure time-history, the torus airspace pressure time-history, and the net torus vertical load time-history without the margins imposed by NUREG-0661 are given in Fermi 2 PULD Figures 4.3.2-2, 4.3.2-4 and 4.3.1-2, respectively. The pressure values at the time of peak download (t = 0.3 sec) and at the time of peak upload (t = 0.54 sec) are given in the attached Table 13-2. The net torus load pressures shown in Table 13-2 are calculated by subtracting the airspace pressure values from the average submerged pressures.

The average submerged pressures and the torus airspace pressures with the NUREG-0661 margins applied are provided in the attached Table 13-3. For the download, a

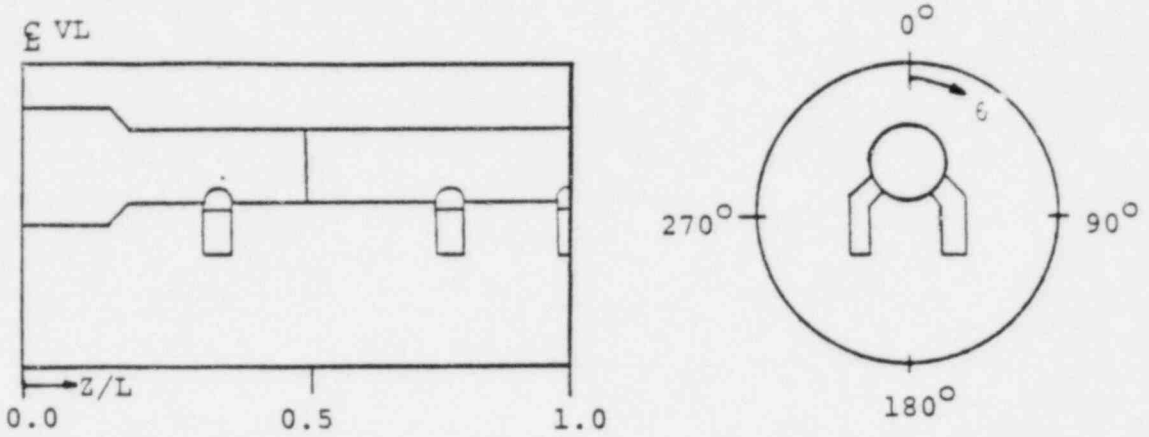
margin of 10% of the net torus vertical pressure was conservatively applied. For the upload, a margin of 21.5% was applied as required by NUREG-0661. The download margin is applied to the average submerged pressure curve during that portion of the time-history when a net download is acting on the torus, while the upload factor is applied to the torus airspace pressure curve during that portion of the time-history when a net upload is acting on the torus.

Torus shell pressures for a typical longitudinal location ($Z/\ell = 0.552$) are shown in the attached Table 13-4. As shown in this table, local pressures at each circumferential location are calculated using the relationship $P_{loc} = (P_{avg})'_M \times M_z \times M_\theta$. The pressures $(P_{avg})'_M$ are obtained by subtracting the airspace pressure from the average submerged pressure, as shown in Table 13-3. The pressure values shown in Table 13-4 are the same as in Table 13-1.

Table 13-1 provides additional information to clarify PUAR Table 2-2.2-3 and shows the net pressures used in the structural analysis which includes the margins imposed by NUREG-0661.

Table 13-1

TORUS SHELL PRESSURES DUE TO POOL SWELL AT KEY TIMES AND SELECTED LOCATIONS



Key Diagram

Longitudinal Location (Z/ℓ)		Circumferential Location (θ)(deg)	Torus Shell Pressure (psi)	
Longitudinal Factor Location	Applicable Range		Peak Download (t=0.30 sec)	Peak Upload (t=0.54 sec)
Maximum at 0.0 or 0.361	0.000 - .361	180	10.7	3.6
	0.000 - .361	150,210	9.7	3.4
	0.000 - .361	120,240	6.0	2.4
	0.000 - .361	0-90,270-0	0.3	7.5
Factor Interpolated at 0.50	0.361 - .500	180	11.6	4.0
	0.361 - .500	150,210	10.5	3.8
	0.361 - .500	120,240	6.5	2.9
	0.361 - .500	0-90,270-0	0.3	7.5
0.552	0.500 - .640	180	11.9	4.0
	0.500 - .640	150,210	10.8	3.9
	0.500 - .640	120,240	6.5	2.9
	0.500 - .640	0-90,270-0	0.3	7.5
Factor Interpolated at 0.724	0.640 - .810	180	12.4	4.1
	0.640 - .810	150,210	11.2	3.9
	0.640 - .810	120,240	6.9	3.0
	0.640 - .810	0-90,270-0	0.3	7.5
0.895	0.810 - 1.0	180	13.0	4.1
	0.810 - 1.0	150,210	11.7	4.0
	0.810 - 1.0	120,240	7.2	3.1
	0.810 - 1.0	0-90,270-0	0.3	7.5

Table 13-2

Presssures at Time of Peak Download and Peak Upload

Without NUREG-0661 Margins

Time	Average Submerged Pressure P_{avg} (psi)	Airspace Pressure P_a (psi)	Net Torus Load Pressure P_{net} (psi)
Peak Download (t = 0.3 sec)	8.8	0.3	8.5
Peak Upload (t = 0.54 sec)	3.6	6.8	-3.2

Table 13-3

Pressures at Time of Peak Download and

Peak Upload with NUREG-0661 Margins

Time	Average Submerged Pressure $(P_{avg})_M$ (psi)	Airspace Pressure $(Pa)_M$ (psi)	Average Pressure for Calculating Local Pressures (psi) $(P_{avg})'_M = (P_{avg})_M - (P_a)_M$
Peak Download (1) (t = 0.3 sec)	8.8 + 0.1 x 8.5 = 9.6	0.3	9.3
Peak Upload (2) (t = 0.54 sec)	3.6	6.8 + 3.2 x 0.215 =7.5	-3.9

(1) At the time of peak download (t = 0.3 sec)
$(P_{avg})_M = P_{avg} + 0.1 \times P_{net}$

(2) At the time of peak upload (t = 0.54 sec)
$(P_a)_M = P_a + 0.215 \times P_{net}$

Table 13-4

Torus Shell Pressure Calculations Due to Pool Swell

for a Typical Longitudinal Location ($Z/\ell = 0.552$)

Circumferential Location (1) (θ) (deg)	Time (sec)	Factor M_z (2)	Factor M_θ (2)	Local Pressures (psi) $P_{loc}=(P_{avg})'xM_zxM_\theta$	Local Pressures Plus Airspace Pressure (psi)
180	0.30	1.040	1.205	11.6	11.9
180	0.54	0.996	0.908	-3.5	4.0
150,210	0.30	1.040	1.083	10.5	10.8
150,210	0.54	0.996	0.940	-3.6	3.9
120,240	0.30	1.040	0.638	6.2	6.5
120,240	0.54	0.996	1.186	-4.6	2.9
0-90, 270-0	0.30	-	-	0.3	0.3
0-90, 270-0	0.54	-	-	7.5	7.5

(1) For circumferential locations, see PUAR Table 2-2.2-3.

(2) These factors are taken from the LDR, Table 4-3.2-1.

Question 14

PUAR Section 2-2.2.1 (Page 2-2.30), AC Section 2.3 and 2.4. Describe in detail how the peak download and peak upload values presented in Figure 2-2.2-8 on page 2-2.65 of the PUAR were determined. Provide any additional information required to duplicate these results which has not already been requested above. In addition, describe how this transient is used in the dynamic analysis of the torus shell loads.

Response to Question 14

The values presented in PUAR Figure 2-2.2-8 are for the mitered joint location ($Z/\ell = 0.5$) and at bottom dead center ($\theta = 180^{\circ}$). For a given location, the maximum and minimum values are obtained at the times of peak download and upload ($t = 0.3$ and 0.54 sec) by subtracting airspace pressures from the local submerged shell pressures. For example, at $Z/\ell = 0.552$ and $\theta = 180^{\circ}$ (See Table 13-4 in the response to Question 13):

Peak Download = 11.9 - 0.3 = 11.6 psi

Peak Upload = 4.0 - 7.5 = -3.5 psi

The factor M_z at $Z/\ell = 0.552$ is conservatively applied over the range of Z/ℓ values from 0.5 to 0.64. Therefore, the local pressure values at $Z/\ell = 0.5$ shown in PUAR Figure 2-2.2-8 are the same as the values at $Z/\ell = 0.552$.

Pressure time-histories, such as the one shown in PUAR Figure 2-2.2-8, are calculated at 50 submerged torus shell locations in a 1/16 segment of the torus shell. These time-histories are used in performing a transient dynamic analysis of the torus using the methods discussed in Section 2-2.4.1 of the PUAR. The airspace pressure with the NUREG-0661 margin is applied statically to the entire torus shell and added to the dynamic response to obtain the total response of the suppression chamber due to pool swell.