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August 13, 1979

Mr. Paul W. O'Connor
Operating Reactors - Branch 2
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Subject: Dresden Station Unit 1
Systematic Evaluation Program
Seismic Review
NRC Docket No. 50-10

Dear Mr. O'Connor:

The enclosed information concerning the seismic analysis of Dresden Unit 1 is being sent in response to questions received during a July 20, 1979 conference call between Commonwealth Edison, Sargent & Lundy, and NRC Staff personnel.

Please direct any questions you may have concerning this matter to this office.

In accordance with previous agreements, eight (8) copies of this transmittal and enclosures are provided for your use.

Very truly yours,

Robert F. Janecek

Robert F. Janecek
Nuclear Licensing Administrator
Boiling Water Reactors

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Question

The NRC questioned the modeling of four slabs at elevation 548'0" in the horizontal seismic model of the containment interior structures in SAD Report 261, "Seismic Analysis of the Reactor and Steam Drum Support Structure Inside the Containment."

Response

The four slabs modeled at elevation 548'0" represent the four nuclear steam instrumentation rooms and FW control rooms at the four corners, as shown in S&L drawing no. M-991, transmitted to you earlier.

As you requested, the mode shape printout for the first 10 modes, along with the structural periods and participation factors in the x- and y-directions of the horizontal building model are enclosed. Table 1 shows the natural periods of vibration in various modes. Normalized mode shapes for the first 10 modes are given in Table 2, and Table 3 includes the participation factors of natural modes of vibration in the x- and y-directions. The structural model has 80 dynamic degrees of freedom. There are 10 slabs. The first 10 rows in Table 2 represent the x mode shape displacement of the ten slabs; rows 11 to 20 represent the y-displacement; and rows 21 to 30 represent θ_z, the torsional movement of each slab.

TABLE 1

STRUCTURAL PERIODS

MODE	PERIOD SEC	FREQUENCY C/S
1	.2020	4.9508
2	.1274	7.8509
3	.1250	8.0014
4	.1024	9.7656
5	.0968	10.3267
6	.0787	12.7086
7	.0775	12.9091
8	.0726	13.7793
9	.0700	14.2785
10	.0682	14.6600
11	.0604	16.5543
12	.0557	17.9611
13	.0551	18.1607
14	.0501	19.9584
15	.0489	20.4360
16	.0478	20.9145
17	.0477	20.9649
18	.0471	21.2358
19	.0467	21.4142
20	.0446	22.4328
21	.0435	22.9994
22	.0418	23.9252
23	.0385	25.9415
24	.0375	26.6978
25	.0364	27.4467
26	.0347	28.7506
27	.0336	29.7339
28	.0335	29.8321
29	.0318	31.4237
30	.0301	33.2761

TABLE 2

ORMALIZED MODAL VECTORS

[illegible]	MODE 1	MODE 2	MODE 3	MODE 4	MODE 5	MODE 6	MODE 7	MODE 8	MODE 9	MODE 10
[illegible]	.3652-03	-.3167-03	-.1710-03	-.3372-03	-.4672-03	.1007-02	.2293-02	-.3551-02	-.1996-02	-.5003-02
[illegible]	.8565-03	.2174-03	-.4480-03	.3493-03	-.1403-02	.1209-01	-.5767-03	.7111-02	-.2578-02	-.3516-03
[illegible]	[illegible]	-.1872-02	-.1032-02	-.1819-02	-.3044-02	.7051-02	.1275-01	-.2317-01	-.1237-01	-.3116-01
[illegible]	[illegible]	.1110-02	-.1043-02	.0320-03	[illegible]	.6221-02	.1039-01	-.2553-01	-.1341-01	-.2405-01
[illegible]	[illegible]	.2887-03	-.1324-02	.2009-02	[illegible]	.3020-01	.4245-03	.1022-01	-.1002-01	.2319-02
[illegible]	[illegible]	-.2330-02	-.1407-02	-.2575-02	[illegible]	.3353-01	.4700-02	.2709-01	-.7976-02	-.2571-02
[illegible]	[illegible]	-.6078-03	-.7009-02	-.1573-02	[illegible]	.1770-01	.6703-02	-.1003-01	.1501-01	.1555-01
[illegible]	[illegible]	-.6539-04	-.1904-02	-.2637-03	.1219-01	.4319-02	.1703-02	-.4632-02	.4323-02	.2011-02
[illegible]	[illegible]	.1015-02	-.2101-02	.1517-02	-.6304-02	.5014-01	-.1205-02	.2077-01	-.1115-01	[illegible]
[illegible]	[illegible]	-.1207-02	-.1712-02	-.1405-02	-.4423-02	.5306-02	.2115-01	-.2237-01	-.2031-01	[illegible]
[illegible]	.5205-04	.7471-02	-.1924-03	.7207-02	.8147-05	-.2510-03	.4400-02	-.8704-02	-.2562-01	.2409-01
[illegible]	-.1977-04	.2573-02	-.4714-04	.2003-02	.1000-03	-.6234-03	.1483-02	-.7764-03	[illegible]	.4033-02
[illegible]	.5969-03	.4030-02	-.3591-03	.4173-02	-.0734-03	.2251-02	.7569-02	-.1527-01	-.2592-01	.6071-02
[illegible]	.1809-03	.9555-02	-.1559-03	.1049-01	-.1018-02	.4444-02	-.1716-01	-.1434-01	-.1673-01	[illegible]
[illegible]	-.6408-03	.2029-02	.2503-03	.2027-02	.1324-02	-.1191-01	.1803-02	-.8201-02	-.1451-02	.5393-02
[illegible]	-.1400-03	.6010-02	-.1170-03	.6316-02	.1200-02	.1512-02	-.1374-01	-.7555-02	-.3548-03	.1129-02
[illegible]	-.1332-03	.1369-01	-.1900-03	.1819-01	-.2077-04	.9037-02	-.4231-01	-.1553-01	.1447-02	-.6676-02
18	-.9917-04	.1094-01	-.1506-03	.1339-01	-.5041-04	.9966-02	-.4762-01	-.1929-01	.1942-02	-.9348-02

TABLE 2 — Contd.

19	-.4259-04	.8111-02	-.1498-03	.6927-02	.4146-03	-.1794-02	.4235-02	-.2207-02	-.1010-01	.1140-01
20	[illegible]	.1210-01	-.3015-03	.1144-01	.7829-04	-.5676-03	.6402-02	-.1124-01	-.3789-01	.3245-01
21	.3072-05	.3647-04	.6365-06	.3251-04	.6364-05	-.1771-04	.8304-05	.2088-04	-.7764-04	.1609-03
22	.1507-05	-.5963-04	.8072-06	-.5188-04	-.3305-05	.2232-04	-.4509-04	.1952-04	.9021-04	-.1043-03
23	.6128-04	-.9463-04	-.2720-04	-.8892-04	-.6063-04	.1909-03	.3543-03	-.6205-03	-.3087-03	-.8954-03
24	-.4381-04	.4683-04	.2299-04	.7497-04	-.6460-06	.1955-04	-.9340-03	.3015-03	.7936-03	-.3079-03
25	.6961-04	.8099-04	-.3675-04	.7923-04	-.1095-03	.9230-03	.9683-05	.5433-03	-.2844-03	.5499-04
26	-.2760-04	-.1204-03	.1745-04	-.1565-03	-.9865-05	-.3774-03	.7111-03	.1793-03	-.1743-03	.2199-03
27	.3173-04	-.2291-04	-.2965-04	-.3222-04	.2155-03	.1519-03	.1592-03	-.1758-03	.2520-03	.1767-03
28	.6756-05	-.6503-05	-.3428-05	-.9397-05	.6305-04	.4668-04	.4912-04	-.5531-04	.8025-04	.5681-04
29	.3625-05	-.8513-04	.2424-06	-.7233-04	-.6670-05	.4269-04	-.6064-04	.3355-04	.1170-03	-.1370-03
30	-.1992-05	.6650-04	-.2935-06	.5339-04	.1191-04	-.3740-04	.5199-04	.7165-04	-.6789-04	.2526-03
31	.1809-01	-.7421-03	-.6972-02	-.6102-03	-.1542-01	.1956-01	.2305-01	-.4078-01	-.7873-02	-.2796-01
32	.1289-04	.1831-01	-.4126-03	.1539-01	.4727-03	-.1702-02	.9305-02	-.7303-02	-.3172-01	.2931-01
33	.1060-02	-.2030-03	-.2867-03	-.1294-03	-.7475-03	-.1403-02	-.7408-03	.7723-04	.8852-03	.1635-02
34	.4779-05	-.1615-03	.3470-05	-.9676-04	-.7257-05	.2930-04	-.1322-03	-.1215-03	-.2233-03	.1822-03
35	.7860-03	.1553-04	-.2093-03	.4270-04	-.6120-03	.9564-03	-.1235-03	-.4725-04	.1129-02	.1245-02
36	.2221-01	-.4796-03	-.1665-01	-.1541-02	.6782-01	.6832-02	-.1046-02	.1714-02	-.9539-02	-.8315-02
37	-.1237-03	.1839-01	-.3037-03	.1550-01	.1823-03	.8307-02	-.3920-01	-.1410-01	.3723-02	-.5644-02
38	.6575-04	-.2529-02	.1373-04	-.1761-02	-.6948-05	.5032-03	-.2337-02	-.1136-02	-.1713-02	.1157-02
39	-.1454-06	-.1812-03	.4325-05	-.1152-03	-.8305-05	.5493-04	-.2557-03	-.1313-03	-.1318-03	.9373-04
40	.1244-03	-.3065-03	-.3326-04	-.7347-05	-.9566-04	-.6283-04	-.8018-05	.2110-04	.2093-04	.3245-04
41	.1845-01	.3953-03	-.7241-02	.1160-02	-.1691-01	.5210-01	.5041-02	.1047-01	.9703-03	.3376-02
42	-.8513-04	.1578-01	-.3112-03	.1247-01	.6541-03	-.2632-02	.8063-02	-.1805-02	-.1253-01	.1417-01
43	-.1049-02	-.2032-03	.2289-03	-.1745-03	.7453-03	.1339-02	.2237-03	-.3231-03	-.1230-02	-.1367-02
44	-.6296-07	-.1750-03	.4015-05	-.1122-03	-.6243-05	.2534-04	-.1336-03	-.9361-04	-.1254-03	.1032-03
45	.7755-03	-.1749-04	-.2815-03	-.2007-05	-.5555-03	-.4621-03	.3854-03	-.1470-02	.8052-03	.3729-03
46	.2942-01	-.5207-03	-.1095-01	-.6745-04	-.2295-01	.2408-01	.2091-01	-.3933-01	.4805-02	-.1311-01
47	-.8483-05	.2205-01	-.4671-03	.1749-01	.6502-03	-.2310-02	.1140-01	-.4505-03	-.2822-01	.2456-01
48	.1650-02	-.3154-03	-.4454-03	-.2050-03	[illegible]	-.2302-02	-.1145-02	.1193-03	.1238-02	.2324-02
49	.5503-06	-.2254-03	.4906-05	-.1050-03	[illegible]	.4270-04	-.1953-03	-.1726-03	-.3092-03	.2578-03
50	.8246-03	.1758-04	-.2874-03	.4093-04	[illegible]	.2890-03	-.2567-03	.2597-03	.1127-02	.1481-02
51	.2664-01	.1654-03	-.1071-01	.1041-02	[illegible]	.4469-01	.9245-02	-.6370-02	.1053-01	.7606-02
52	-.7626-04	.2031-01	-.4173-03	.1543-01	[illegible]	-.2923-02	.1040-01	-.6577-03	-.1174-01	.1350-01
53	-.1634-02	-.3153-03	.4407-05	-.2709-03	.1127-02	.2459-02	.3161-03	-.4993-03	-.1500-02	-.2110-02
54	-.1065-07	-.2376-03	.5476-05	-.1512-03	-.0910-05	.3006-04	-.2031-03	-.1423-03	-.2745-03	.1691-03
55	.8134-03	-.1004-04	-.2763-03	-.1221-04	-.5844-03	-.6123-03	.3070-03	-.1310-02	.0763-02	.3553-03
56	.3804-01	-.3133-03	-.1237-01	.4469-03	-.2770-01	.2524-01	.1526-01	-.3024-01	.1590-01	.2457-02
57	-.3365-04	.2652-01	-.5720-03	.1511-01	.6372-03	-.2729-03	.1376-01	-.8974-03	-.1667-01	.1739-01
58	.2330-02	-.4447-03	-.6278-03	-.2026-03	-.1601-02	-.3129-02	-.1605-02	.1671-03	-.1039-02	.3339-02
59	.5024-06	-.2370-03	.6070-05	-.1220-03	-.1244-04	.5663-04	-.2073-03	-.2209-03	-.3709-03	.3071-03
60	.6023-03	.1311-04	-.1993-03	.2075-04	-.2020-03	.3972-05	-.3376-03	.4243-03	.8705-03	.1176-02
61	.3812-01	-.6595-04	-.1353-01	.6170-03	-.8133-01	.3299-01	.1197-01	-.2077-01	.1207-01	.1035-01
62	-.6672-04	.2567-01	-.5407-03	.1922-01	.5207-03	-.3291-02	.1286-01	.1032-02	-.9302-02	.1102-01
63	-.2307-02	-.4451-03	.5227-03	-.2312-03	.1603-02	.3448-02	.4552-03	-.6990-03	-.2701-02	-.2951-02
64	.1175-06	-.2950-03	.6743-05	-.1643-03	-.1170-04	.5023-04	-.2720-03	-.1999-03	-.3007-03	.2472-03
65	.5944-03	-.1303-04	-.1872-03	-.1025-04	-.5585-03	-.6526-03	.1597-03	-.9332-03	.5029-03	.2711-03
66	.5141-01	-.3315-03	-.2453-01	-.2153-03	.2220-01	-.2939-01	-.1605-01	.3723-01	-.3912-01	-.3180-01
67	-.1100-03	.3022-01	-.6520-03	.2273-01	.9204-03	.2007-02	-.1520-01	-.3223-02	.1222-01	-.1223-01
68	.5184-04	-.1555-02	.1050-04	-.1920-02	-.5511-03	.4200-03	-.2169-02	-.5509-03	-.1564-02	.1090-02
69	-.0974-07	-.4007-03	.7464-05	-.2474-03	-.2025-04	.1407-03	-.6034-03	-.3037-03	-.3022-03	.2749-03
70	.1995-03	-.4763-05	-.6149-05	.7207-05	-.4157-03	-.7567-04	.1701-04	-.1037-03	.2559-03	.2545-03
71	.5599-01	-.1245-03	-.1640-01	.7409-03	-.2470-01	-.1272-01	-.2210-02	-.3002-02	.1641-01	.1793-01
72	-.8287-04	.5095-01	-.1112-02	.3231-01	.1020-02	-.6610-02	.3103-01	.1717-01	.1806-01	-.1034-01
73	.2762-04	-.1022-02	.5097-03	-.5001-03	-.2020-05	.2604-03	-.1027-02	-.6358-03	-.9741-03	.6757-03
74	.8928-07	-.4170-03	.9700-05	-.2737-03	-.2072-04	.1335-03	-.6433-03	-.3945-03	-.4635-03	.3519-03
75	.1532-03	-.1340-06	-.4734-04	.4289-05	-.1660-03	-.2004-03	-.5771-04	-.1476-05	.1981-03	.2608-03

L02

.1507-01	.5433-02	.2463+00	-.1136-02	-.2313-01	.5397-02	.9567-03	.1475-02	-.4916-02	-.5123-02
[illegible]	.1628+00	-.3914-02	-.2077+00	-.5299-02	.4074-02	-.1740-01	-.6473-02	-.6898-02	[illegible]
[illegible]	[illegible]	.6811-05	-.1000-02	-.4153-05	.3937-03	-.2040-02	-.1040-02	-.1701-02	[illegible]
[illegible]	.4693-03	-.1261-04	-.2426-02	-.8844-04	.3017-03	-.1447-02	-.8948-03	-.1091-02	[illegible]
[illegible]	-.1867-03	-.2647-02	.6626-04	-.1835-02	-.2463-03	-.1558-03	-.1708-03	.5358-03	[illegible]

TABLE 3

PARTICIPATION FACTORS IN X DIRN

MODE	FACTOR
1	22.20235
2	-.30397
3	-5.66248
4	-.38295
5	7.54925
6	20.38901
7	6.86583
8	-3.81252
9	-5.04220
10	-8.12675
11	-5.93122
12	-.15104
13	2.57394
14	1.74790
15	.09778
16	-1.11039
17	2.70105
18	-4.12109
19	-.05910
20	-2.04237
21	.36484
22	-.01601
23	-.32842
24	4.12059
25	.55103
26	1.77291
27	.74341
28	-.83305
29	-1.20739
30	-3.76592

PARTICIPATION FACTORS IN Y DIRECTION

MODE	FACTOR
1	-.06126
2	24.40752
3	-.50013
4	15.93623
5	.42517
6	1.10758
7	-7.7[illegible]0
8	-9.0[illegible]5
9	-12.[illegible]9
10	8.4[illegible]9
11	-.37[illegible]5
12	3.[illegible]0
13	6.7[illegible]39
14	7.21[illegible]4
15	-.49017
16	1.51[illegible]76
17	-4.2[illegible]26
18	.70[illegible]71
19	-.5[illegible]70
20	2.[illegible]5
21	-1.[illegible]0
22	-.01410
23	1.0[illegible]6
24	-.3[illegible]6
25	-.0[illegible]3
26	-.0[illegible]2
27	1.21[illegible]4
28	-1.0[illegible]3
29	4.03418
30	-.31273

Question

NRC questioned the calculation of local stresses in the spherical containment shell of the penetrations in the Sargent & Lundy report (SAD-257), "Stress Report for Primary Containment Penetrations."

Response

Stresses in the spherical shell at the penetration attachment for the applied forces are calculated based upon Welding Research Council Bulletin No. 107. These stresses are then added to the original stress intensity values in the spherical shell due to internal pressure, weight, and temperature variation in the shell calculated by Chicago Bridge & Iron Co.

NRC raised a concern regarding the change in the original stresses in the shell (calculated by Chicago Bridge & Iron Co.) due to the penetration openings in the shell. It is true that stresses in the shell in the immediate vicinity of the openings will be different, but according to the ASME Code, Section III, Subsection NE (Class MC Component), 1974 edition, the stress limit requirements of NE-3221 in the immediate vicinity of the openings do not have to be satisfied if the rules of NE-3330 are met. The shell is reinforced around the openings as required by NE-3332. This reinforcement around the openings redistributes the localized stress concentrations. Thus, the original stress values in the spherical shell can be used to check the stress limit requirements as per NE-3221 at the penetration attachments.

Question

NRC questioned the modeling of the outside supporting columns as an equivalent axisymmetric cylindrical shell in SAD Report 267, "Feasibility Analysis of the Primary Containment Vessel to Meet NRC Criteria."

Response

For axisymmetric loads (such as dead load, snow load, LOCA pressure, flood, etc), the columns were modeled as an axisymmetric cylindrical shell of appropriate thickness and height to provide the same vertical and lateral stiffness effect as the columns. The calculations for obtaining the properties of the equivalent cyclinder are given below:

Vertical Loading

Vertical deflection in the columns due to load P_Z:

$$\Delta_Z = \frac{P_Z L}{20AE} \qquad (1)$$

where Δ = area of 1 of the 20 columns

L = length of columns

E = modulus of elasticity

For the equivalent cylinder:

$$\Delta_Z = \frac{P_Z}{2\pi R_c} \frac{L_c}{t_c E_c} \qquad (2)$$

where subscript c denotes the parameters for the equivalent cylindrical shell;

R_c = radius

t_c = thickness

L_c = length of the cylinder

Lateral Loading

Radial deflection for the column due to load P_R:

$$\Delta_R = \frac{P_R L^3}{3EI} \qquad (3)$$

where I = moment of intertia of one of the 20 columns.

For the equivalent cylinder:

$$\Delta_R = \frac{20P_R}{2\pi R_c} \left[\frac{1}{2D\lambda^3}\right] \qquad (4)$$

(Reference 1)

$$\text{where } D = \frac{E_c t_c^3}{12(1-\nu^2)} \quad ; \quad \lambda^4 = \frac{3(1-\nu^2)}{R_c^2 t_c^2}$$

Choosing $E_c = E$, $\nu = 0.3$, and $R_c = 95'$, the values of thickness t_c and length L_c for the equivalent cyclinder were obtained from the above four equations by equating the vertical and lateral deflections in the columns and the cyclindrical shell.

In the above derivation, radial (lateral) stiffness of columns has been equated to the radial stiffness of the cylindrical shell, which in turn is derived considering the hoop and the bending stiffness of the cylindrical shell (given by Equation 4). Thus, hoop stiffness is considered in the above equation in calculating the radial deflection of the cylindrical shell and is not additional.

Reference

1. Timoshenko and Krieger, "Theory of Plates and Shells," p. 469, Equation 279, McGraw-Hill Book Company, 1959.