POWER AUTHORITY OF THE STATE OF NEW YORK
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November 14, 1978
JNRC-78-57

Director of Nuclear Reactor Regulation
United States Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Mr. Thomas A. Ippolito
Operating Reactors Branch No. 3
Division of Operating Reactors

Subject: James A. FitzPatrick Nuclear Power Plant
Multiple Consecutive S/RV Actuation Evaluation
Docket No. 50-333

Dear Sir:

Transmitted herewith is an analysis performed by Teledyne Engineering Services for the Authority concerning multiple consecutive safety relief valve actuation evaluation.

On September 28, 1978 the Authority transmitted information concerning the subject matter summarizing the results of the analysis and describing the methods and assumptions used. The results of the analysis supported upcoming operation of the FitzPatrick Plant during Cycle 3 by assuring that the structural capability of the torus satisfies acceptance criteria established by the Short Term Mark I Containment Program.

Subsequently, the Commission requested by telephone on October 18, 1978 that the Authority submit the analysis done by Teledyne Engineering Services.

Very truly yours,

Paul J. Early
Assistant Chief Engineer-Projects

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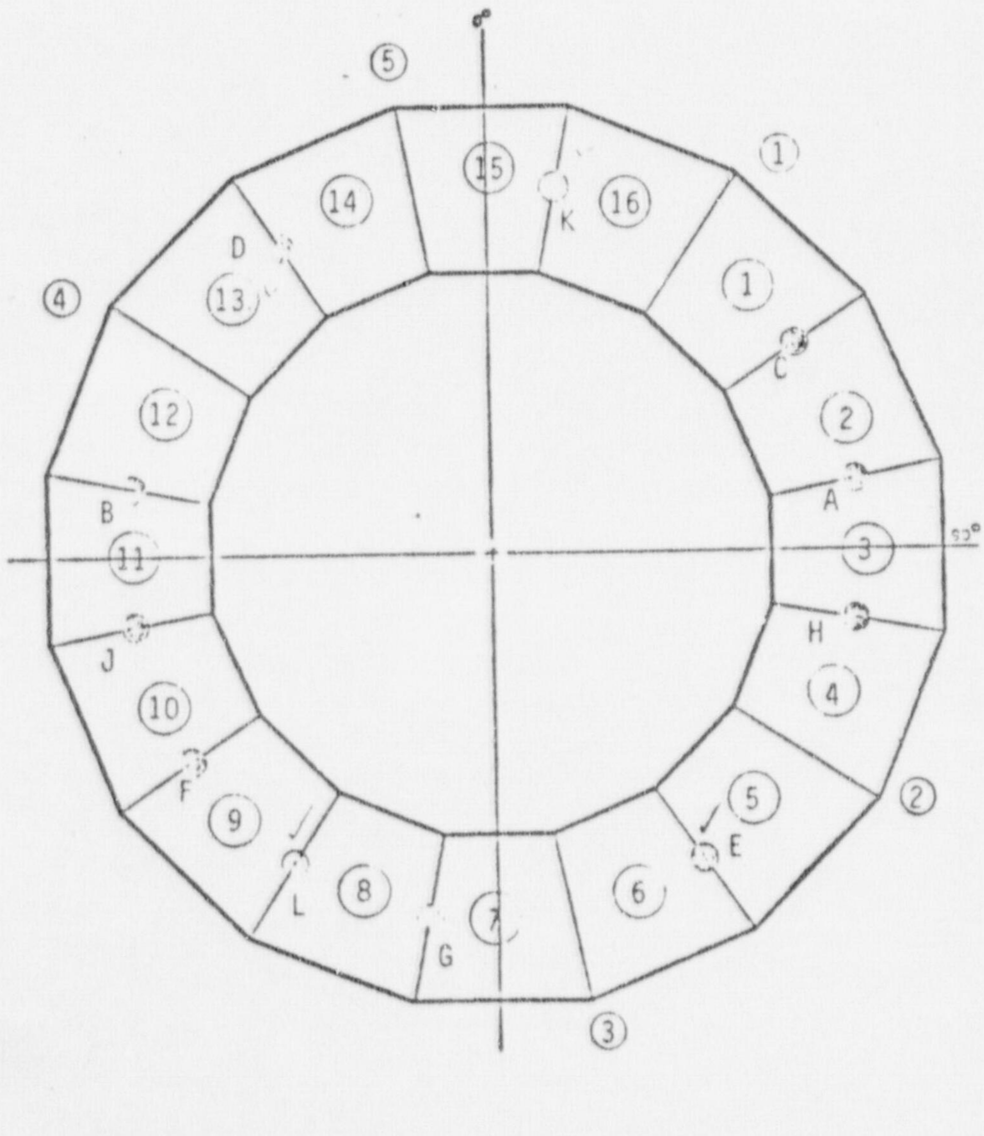
James A. Fitzpatrick Nuclear Power Plant

Multiple Consecutive S/RV Actuation Evaluation

- 11 SRV Lines
- Assume multiple consecutive actuation of valves L, K, E and D.
- Assume multiple initial actuation of valves L and K and multiple consecutive actuation of valves E and D.
- Determination and evaluation of the maximum shell stress and support column load.



Support Column Evaluation

Consecutive Actuation Factor = 1.96

From Monticello S/RV Test - Single Cold Actuation of Valve D:

Reference Outside Column Load = 196.7 kips

Midbay to Ring Girder Factor = .84

Plant Unique Column Load Multiplier = .71

Outer Column, Single Hot Pop = (1.96)(.71)(.84)(196.7) = 230 kips

Outer Column Deadweight = 270 kips

4 Valves Hot - L, K, E and D

Factors for Multiple Actuation - Columns - Outer

Column Location	Actuated Valve L	K	E	D	ε	P_{SRV} (kips)	P_{SRV} + Deadweight (kips)
1	.08	.7	.11	-	1.04	239	509
C	.09	.15	.12	.12	.48	110	380
A	.10	.15	.15	.11	.51	117	387
H	.11	.12	.15	.10	.48	110	380
2	.12	.11	.7	.09	1.02	235	505
Ⓔ	.15	.10	1.0	.08	1.33	306	576
3	.15	.09	.7	.09	1.03	237	507
G	.7	.08	.15	.10	1.03	237	507
Ⓛ	1.0	.09	.15	.11	1.35	311	581
F	.7	.10	.12	.12	1.04	239	509
J	.15	.11	.11	.15	.52	120	390
B	.15	.12	.10	.15	.52	120	390
4	.12	.15	.09	.7	1.06	244	514
Ⓓ	.11	.15	.08	1.0	1.34	308	578
5	.10	.7	.09	.7	1.59	366	636
Ⓚ	.09	1.0	.10	.15	1.34	308	578

STP Evaluation of Outside Column - Location 5

$$f_a = \frac{636}{47.4} = 13.418 \text{ ksi} \qquad \text{factor} = \frac{636}{631.8} = 1.0066$$

$$f_{bx} = \frac{(636 \times .117 \times 1.0066) + (49.58 \times 1.0066)}{222} = .562 \text{ ksi}$$

$$f_{by} = \frac{(636 \times .057 \times 1.0066) + (9.2874 \times 1.0066)}{78} = .588 \text{ ksi}$$

$$\frac{13.418}{44.0} + \frac{(.85)(.562)}{\left[1 - \frac{13.418}{121.0}\right] 36} + \frac{(.85)(.588)}{\left[1 - \frac{13.418}{38.2}\right] 36} \leq 0.5$$

$$.305 + .0149 + .0214 \leq 0.5$$

$$.3413 \leq 0.5$$

Weld Joint SEC = 1,961 kips (includes ultimate capacity of web weld and yield capacity of flange welds)

$$\text{Weld Joint S.R.} = \frac{636}{1961} = .32$$

Valves E & D - Hot Pop

Valves L & K - Cold Pop

Factors for MultipleActuation - Columns - Outer

Column Location	E + D	(1) P_{SRV}^{Hot} (kips)	L + K	(2) P_{SRV}^{Cold} (kips)	(1) + (2) + Deadweight (kips)
1	.26	60	.78	92	422
C	.24	55	.24	28	353
A	.26	60	.25	29	359
H	.25	58	.23	27	355
2	.79	182	.23	27	479
(E)	1.08	248	.25	29	547
3	.79	182	.24	28	480
G	.25	58	.78	92	420
(L)	.26	60	1.09	128	458
F	.24	55	.80	94	419
J	.26	60	.26	31	361
B	.25	58	.27	32	360
4	.79	182	.27	32	484
(D)	1.08	248	.26	31	549
5	.79	182	.80	94	546
(K)	.25	58	1.09	128	456

Code Evaluation of Outside Column - Location D

$$\text{factor} = \frac{549}{631.8} = 0.869$$

$$f_{bx} = \frac{(549 \times .117 \times .869) + (49.58 \times 0.869)}{222} = .446 \text{ ksi}$$

$$f_{by} = \frac{(549 \times .057 \times .869) + (9.2874 \times 0.869)}{78} = .452 \text{ ksi}$$

$$f_a = \frac{549}{47.4} = 11.582 \text{ ksi}$$

$$\frac{11.582}{14.61} + \frac{(.85)(.446)}{\left[1 - \frac{11.582}{63.1}\right] 23.8} + \frac{(.85)(.452)}{\left[1 - \frac{11.582}{19.9}\right] 27.0} \leq 1.0$$

$$.793 + .0195 + .034 \leq 1.0$$

$$.847 \leq 1.0$$

STP Evaluation of Outside Column - Location D

$$\frac{11.582}{44.0} + \frac{(.85)(.446)}{\left[1 - \frac{11.582}{121.0}\right] 36} + \frac{(.85)(.452)}{\left[1 - \frac{11.582}{38.2}\right] 36} \leq 0.5$$

$$.263 + .0116 + .0153 \leq 0.5$$

$$.29 \leq 0.5$$

$$\text{Weld Joint S.R.} = \frac{549}{1961} = .28$$

Shell Evaluation

Factors for Multiple Actuation - Shell - Midbay

Shell Location	Actuated Valve L	K	E	D	①	②	③
1	.11	.39	.11	.13	.53	.204	.486
2	.11	.17	.13	.11	.32	.204	.243
3	.11	.13	.17	.11	.32	.243	.204
4	.11	.11	.39	.11	.52	.486	.187
5	.13	.11	.8	.11	.99	.969	.204
6	.17	.11	.8	.11	1.0	.969	.243
7	.39	.11	.39	.11	.69	.486	.486
8	.8	.11	.17	.11	1.0	.243	.969
9	.8	.11	.13	.11	.99	.204	.969
10	.39	.11	.11	.11	.52	.187	.486
11	.17	.11	.11	.17	.34	.243	.243
12	.13	.13	.11	.39	.53	.486	.221
13	.11	.17	.11	.8	1.0	.969	.243
14	.11	.39	.11	.8	1.084	.969	.486
15	.11	.8	.11	.39	1.084	.486	.969
16	.11	.8	.11	.17	1.0	.243	.969

① $= 1.2 \sqrt{\varepsilon(L^2 + K^2 + E^2 + D^2)}$

② $= 1.2 \sqrt{\varepsilon(E^2 + D^2)}$

③ $= 1.2 \sqrt{\varepsilon(L^2 + K^2)}$

Factors for Multiple Actuation -

Shell - Ring Girder Location

Location	Actuated Valve L	K	E	D	①	②	③
1	.11	.59	.11	.15	.754	.223	.720
2	.11	.19	.11	.11	.323	.187	.263
3	.11	.15	.15	.11	.316	.223	.223
4	.11	.11	.19	.11	.323	.263	.187
5	.11	.11	.59	.11	.744	.720	.187
6	.15	.11	1.0	.11	1.228	1.207	.223
7	.19	.11	.59	.11	.767	.720	.263
8	.59	.11	.19	.11	.767	.263	.720
9	1.0	.11	.15	.11	1.228	.223	1.207
10	.59	.11	.11	.11	.744	.187	.720
11	.19	.11	.11	.15	.345	.223	.263
12	.15	.11	.11	.19	.345	.263	.223
13	.11	.15	.11	.59	.754	.720	.223
14	.11	.19	.11	1.0	1.236	1.207	.263
15	.11	.59	.11	.59	1.019	.720	.720
16	.11	1.0	.11	.19	1.236	.263	1.207

① $= 1.2\sqrt{\varepsilon(L^2 + K^2 + E^2 + D^2)}$

② $= 1.2\sqrt{\varepsilon(E^2 + D^2)}$

③ $= 1.2\sqrt{\varepsilon(L^2 + K^2)}$

Shell Stresses

- Consecutive Actuation Factor = 2.37
- From Monticello S/RV Test - Single Cold Actuation of Valve D.

  Extreme Fiber Shell Stress at Midbay, 45° up from bottom toward inside columns = 3400 psi
- Factor relating stress at bottom midbay to stress 45° up from bottom midbay = 1.49
- Factor from extreme fiber to membrane stress = .86
- Plant unique shell stress multiplier = .63

Thickness of Monticello Shell = 0.584 in.

Thickness of Fitzpatrick Shell = 0.632 in.

Radius of Monticello Torus = 166 in.

Radius of Fitzpatrick Torus = 177 in.

$$\text{Single Hot Actuation} = (1.49)(3400)(.63)(2.37)\frac{(.584)(177)}{(.632)(166)}$$

$$= 7453 \text{ psi}$$

Hydrostatic Pressure Stress = 1708 psi

Valves L, K, E & D Hot

$$(38\% \text{ of Code})\ P_l + P_b = (1.236)(7453) + 1708 = 10{,}920 \text{ psi}$$

$$(50\% \text{ of Code})\ P_m = (.86)(1.236)(7453) + 1708 = 9{,}630 \text{ psi}$$

Valves E & D Hot, Valves L & K Cold (Bay 14)

$$P_l + P_b = \sqrt{[(1.207)(7453)]^2 + [(.263)(3145)]^2} + 1708$$

$$= 10{,}742 \text{ psi } (37\% \text{ of Code})$$

$$P_m = \sqrt{[(.86)(1.207)(7453)]^2 + [(.86)(.263)(3145)]^2} + 1708$$

$$= 9,477 \text{ psi (49\% of Code)}$$

Valves E & D Hot, Valves L & K Cold (Bay 15)

$$P_l + P_b = \sqrt{[(.720)(7453)]^2 + [(.720)(3145)]^2} + 1708$$

$$= 7532 \text{ psi (26\% of Code)}$$

$$P_m = \sqrt{[(.86)(.720)(7453)]^2 + [(.86)(.720)(3145)]^2} + 1708$$

$$= 6717 \text{ psi (35\% of Code)}$$

Material: A516 Gr. 70

S_m = 19,300 psi

1.5 S_m = 28,950 psi

Following references have been used in the preparation of this analysis.

1. G. E. Letter MI-G-179, "Mark I Containment Program - Multiple Consecutive SRV Actuation Evaluation-Task 7.1.3" dated June 16, 1978.

2. TES Report TR-2386(a), "Plant Unique Analysis Report for Torus Support System and Attached Piping for James A. FitzPatrick Nuclear Power Plant" dated August 25, 1976.