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SUBJECT: Forwards open items from Structural Engineering Branch
811005-08 meeting in Woodbury,NY.

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Docket No. 50-397

December 14, 1981
G02-81-518

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Mr. A. Schwencer, Chief
Licensing Branch No. 2
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Schwencer:

Subject: NUCLEAR PROJECT NO. 2
OPEN ITEMS FROM SEB MEETING

Attached are sixty copies of the open items from the Structural Engineering Branch meeting held in Woodbury, New York, October 5 - 8, 1981.

Very truly yours,

G D Bouchey

G. D. Bouchey, Deputy Director
Safety and Security

CDT/rch
Attachments

cc: R Auluck - NRC
WS Chin - BPA
R Feil - NRC Site

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PDR ADOCK 05000397
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UPDATED SUMMARY LIST

WNP-2
NRC-SEB MEETING

9/29 - 10/1/81

ISSUES

1	Response provided
2	Response provided
3	Response provided
4	Response provided
5	Response provided
6	Response provided
7	Response provided
8	Response provided
9	Response provided
10	Response provided
11	Response provided
12	Response provided
13	Closed - Item resolved at meeting
14	Response provided
15	Response provided
16	Response provided
17	Open (due to NRC January 1982)
18	Response provided
19	Response provided
20	Response provided
21	Open (due to NRC January 1982)
22	Closed - Item resolved at meeting
23	Response provided
24	Response provided
25	Response provided

ISSUES (continued)

26	Response provided
27	Closed - Item resolved at meeting
28	Response provided
29	Response provided
30	Response provided
31	Response provided
32	Response provided
33	Response provided
34	Response provided

QUESTIONS

130.050	Item closed based on presented response (to be submitted in FSAR amendment first quarter 1982)
130.051	Item closed based on presented response (to be submitted in FSAR amendment)
130.052	Item closed based on presented response (to be submitted in FSAR amendment)
130.053	Response provided
130.054	Item closed based on presented response (to be submitted in FSAR amendment)
130.055	Open (partial response provided - completion by January 1982)
130.056	Open (due to NRC January 1982)
130.057	Response provided
130.058	Response provided
130.059	Response provided
130.060	Response provided

QUESTIONS (continued)

130.060	Response provided
130.062	Item closed based on presented response (to be submitted in FSAR amendment)
130.063	Response provided
130.064	Item closed based on presented response (to be in FSAR amendment)
130.065	Item closed based on presented response (to be submitted in FSAR amendment)
130.066	Response provided
130.067	Item closed based on presented response (to be submitted in FSAR amendment)
130.068	Response provided
130.069	Item closed based on presented response (to be submitted in FSAR amendment)
130.070	Item closed based on presented response (to be submitted in FSAR amendment)
130.071	Item closed based on presented response (to be submitted in FSAR amendment)
130.072	Item closed based on presented response (to be submitted in FSAR amendment)
130.073	Item closed based on presented response (to be submitted in FSAR amendment)
130.074	Item closed based on presented response (to be submitted in FSAR amendment)
130.075	Item closed based on presented response (to be submitted in FSAR amendment)
130.076	Open (due to NRC January 1982)
130.077	Item closed based on presented response (to be submitted in FSAR amendment)
130.078	Response provided

NRC - SEB

9/29/81

ISSUE LIST

Issue #1	-	Ultimate capacity of containment.
Issue #2	-	Comparison seismic response of SRSS/3 component method vs. 2 dimensional method.
Issue #3	-	Compare response spectra and values of tangential shear for Design DBE and RG 1.60 (Q13).
Issue #4	-	Provide justification for not baseline correcting time histories.
Issue #5	-	Provide discussion of concrete cracks on seismic analysis of reactor building.
Issue #6	-	Provide assessment of additional 5% accidental torsion on shear forces in wall.
Issue #7	-	Compare model used in design with more recent simpler model and show mode shapes and frequency content are comparable.
Issue #8	-	Compare design RRS for basemat and reactor pedestal with those obtained in structure/structure interaction study.
Issue #9	-	Comparison of original soil spring analysis with finite element and compliance function analysis.

NRC - SEB

9/30/81

ISSUE LIST

Issue #10 - Justification of 10% broadening of response spectra for components in the SSW Pumphouse in lieu of 15% used in SRP.

Issue #11 - Assess impact of ACI/349 as amended by RG 1.142.

Issue #12 - Provide a technical basis for 2" gap between containment and Bio-Shield Wall.

Issue #13 - Provide discussion on distribution of shear forces in walls of Reactor Building.

Issue #14 - Provide a set of pertinent calcs that account for hydrodynamic load for critical cross-sections of the containment mat.

Issue #15 - Provide justification that failure of non-seismic I structures will not adversely impact Category I structures.

Issue #16 - Discuss the seismic model of the Reactor Building crane.

Issue #17 - Compare floor response spectra for Radwaste and DG buildings obtained from original soil-spring and structure/structure finite element analyses.

Issue #18 - Provide a typical seismic analysis for cable trays.

NRC - SEB

10/1/81

ISSUE LIST

Issue #19 - Assess shift in fundamental frequency of SSW pumphouse due to 3 sided embedment effect

Issue #20 - Provide calculations for safety factors against overturning and sliding for SSW pumphouse and DG Buildings for SSE

Issue #21 - Provide an assessment of the effect of relative displacement between DG oil storage tank and connecting piping due to SSE

Issues #22-#29-Miscellaneous NRC concern on calculation details

Issue #30 - DG Building: Specify filler material between foundation of adjacent buildings

Issue #31 - DG Building: Provide calcs for a typical wall design

Issue #32 - Spray Ponds: Demonstrate conservatism of equivalent static analysis of retaining wall and slab

Issue #33 - Spray Ponds: Demonstrate conservatism of water leakage in spray pond due to back of structural continuity

Where applicable, the FSAR will be changed to conform to the resolutions attached.

NRC-SEB

ISSUE #1

Reference the question relative to inerting (Q. 220.11).

Be prepared to address the ultimate capacity of the containment vessel to resist bursting-pressure and explosion. This is discusses in recent SRP.

NRC desires the upper bound pressure that containment can withstand.

RESPONSE:

Please refer to the response to Question 130.060 for the information requested.*

*Draft revised FSAR page change attached.

Q. 130.060
(Q220.11)
(3.8.1)

Provide an ultimate capacity analysis of the steel containment responding to the internal pressure buildup due to accidents. The guideline and the staff position on this subject is enclosed (Attachment 4*).

Response:

a. The design pressure of the containment vessel is 45 psig.

b. The ultimate static pressure capacity is estimated to be 160 psig.

c. The equivalent static pressure response calculated from the dynamic pressure function is not required per Attachment I, Item 3 footnote.

d. The failure mode is considered to be a fraction of the top head wall.

e. 1. The original design meets the requirements of the ASME Code, Section NE - 3000 for the governing loading of 45 psig + OBE.

   2. The criteria used to establish the estimated failure pressure of 160 psig is that the vessel will fail when the stress intensity (which is equal to twicw the maximum shear stress) exceeds the minimum ultimate tensile strength of the shell wall material. Table Q. 130.060-1 gives the average ultimate tensile strength for each course of the vessel and the stress intensity calculated in the Final Stress Report (FSR) for the design loading 45 psig + OBE. Since the top head has the lowest ratio of ultimate tensile stress to calculated stress intensity, it governs and the failure pressure is calc-

*Attached as Attachment I to this response.

TABLE Q.130.060-1

Comparison of Calculated Shell Stress at 45 psig Internal Pressure With Actual Yield and Ultimate Tensile Stresses from Certified Material Test Reports. All Stresses are in psi

	Stress Intensity (45 psig)	Average (Standard Deviation) Yield Stress	Average (Standard Deviation) Ultimate Tensile Stress
D Ring	19,269	44,500 (1,600)	74,200 (1,200)
E Ring	19,841	44,200 (3,000)	76,500 (2,800)
F Ring	19,894	45,900 (1,900)	75,500 (2,500)
G Ring	19,214	48,000 (4,400)	78,000 (2,200)
H Ring	13,595	47,200 (3,000	75,100 (3,800)
I Ring	Low	52,400 (2,300)	78,400 (1,400)
J Ring	18,760	45,900 (1,400)	74,900 (1,100)
K Cone*	16,270	71,900 (3,700)	94,500 (1,700)
L Cone	14,680	44,400 (3,400)	76,500 (1,800)
M Cone	14,110	44,200 (3,800)	74,900 (3,300)
N Cone*	13,390	69,500 (3,900)	91,700 (3,500)
O Cone	17,470	50,600 (1,700)	76,200 (2,200)
P Cone	15,710	47,600 (4,400)	75,600 (2,300)
Q Cone	17,930	49,500 (1,600)	76,000 (1,800)
R Ring	20,858	55,900 (3,500)	83,100 (1,900)
Top Head	19,398	38,000 Specified Minimum	70,000 Specified Minimum

*SA537 CL 2; All Others SA516 GR. 70

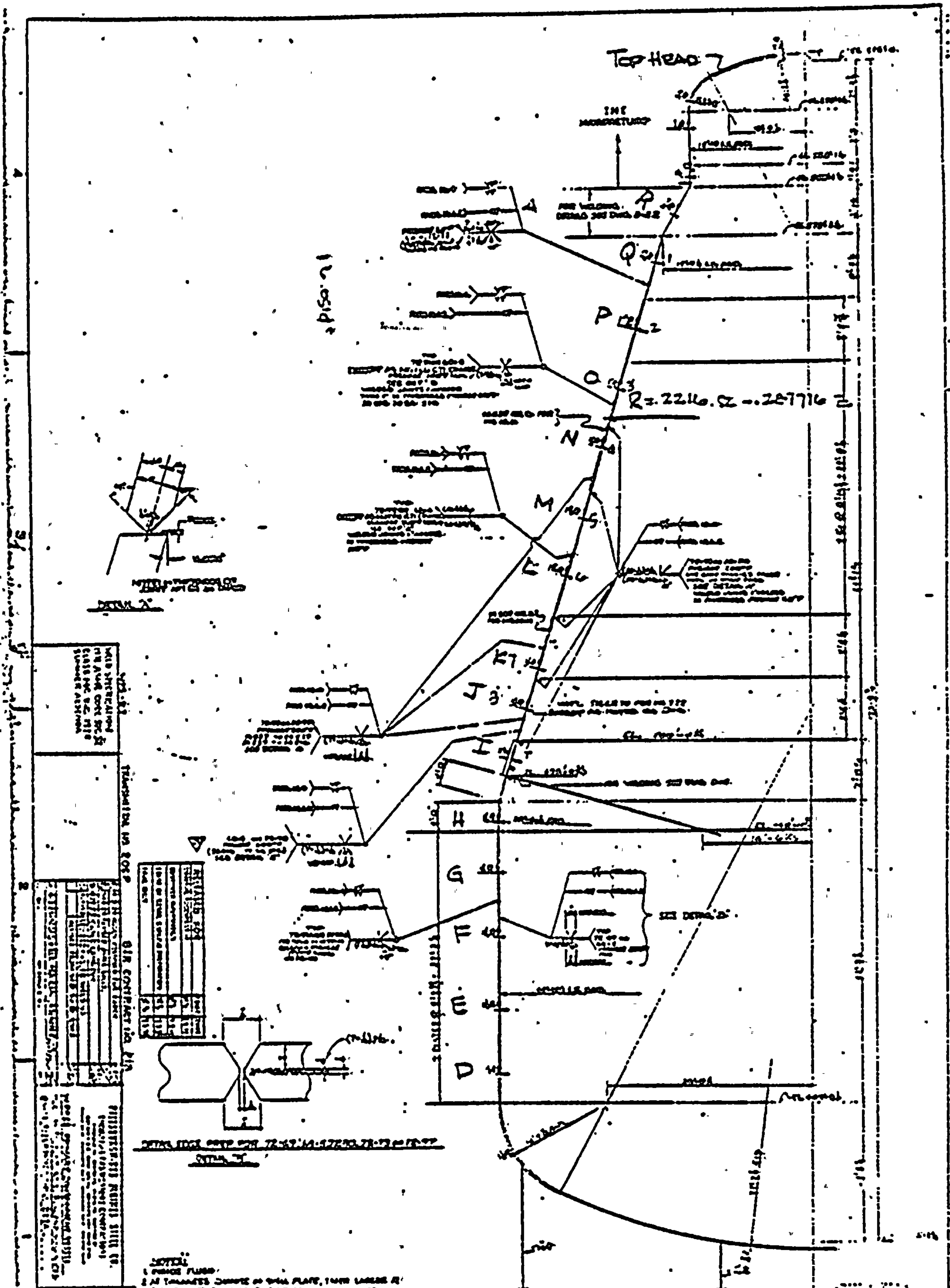
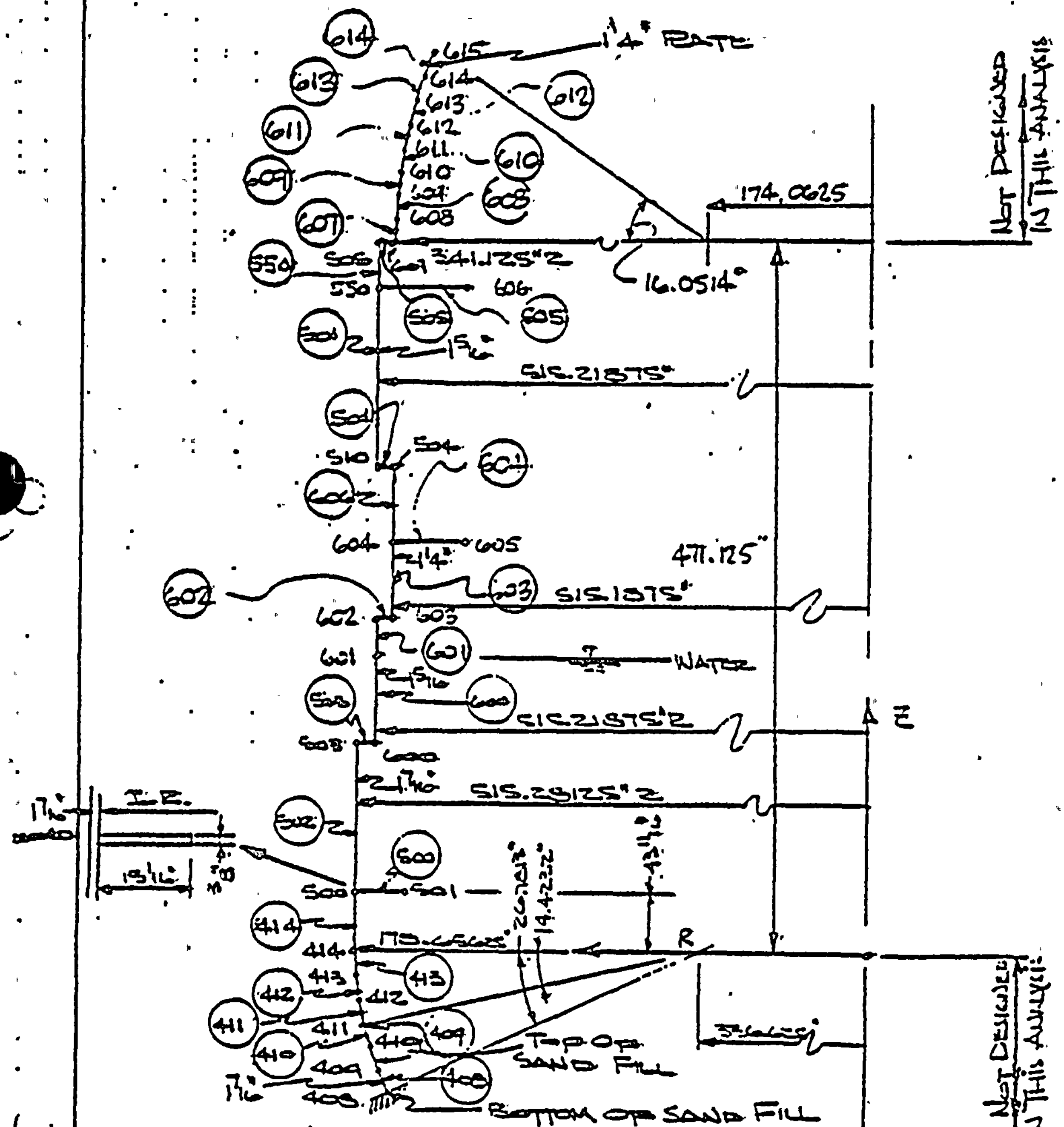


FIGURE 130.061-1

PITTSBURGH - DES MOINES STEEL CO. CONTRACT NO. 12764				FINAL STRESS REPORT	SECTION: I
WPPSS HANFORD NO. 2 CONTAINMENT VESSEL					SUBSEC: 8
PREPARED BY / DATE: RAM/12-3-72	KCL 7-10-73				ARTICLE: 1
CHECKED BY / DATE: EJW / 1-9-73	RAM/7-13-73				PAGE: 7
REVISION NUMBER:	A				

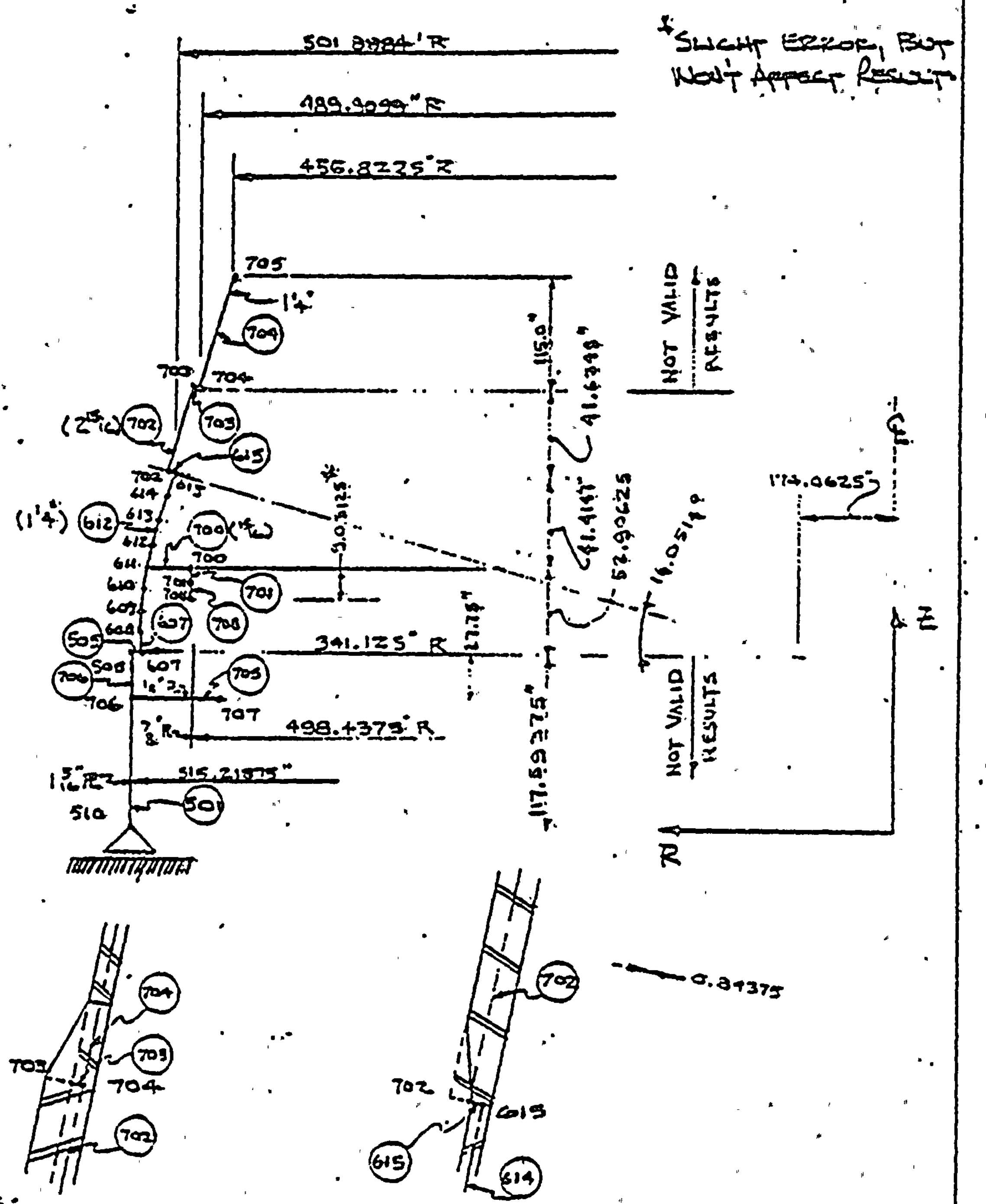
AXZ AXISYMMETRIC MODEL



NOTE: BODY NUMBERS ARE CIRCLED
THICKNESSES ARE IN THE CORRODED CONDITION.

FIGURE 130.067-2

PITTSBURGH - DES MOINES STEEL CO. CONTRACT NO. 12764				FINAL STRESS REPORT	SECTION: IV
WPPSS HANFORD NO. 2 CONTAINMENT VESSEL					SUBSEC. 1
PREPARED BY / DATE: ZLM/1-21-73	ZL/8-7-73				ARTICLE: 5
CHECKED BY / DATE: BJW/2-6-73	BJW/8-8-73				PAGE: 2
REVISION NUMBER:	A				



NOTES:

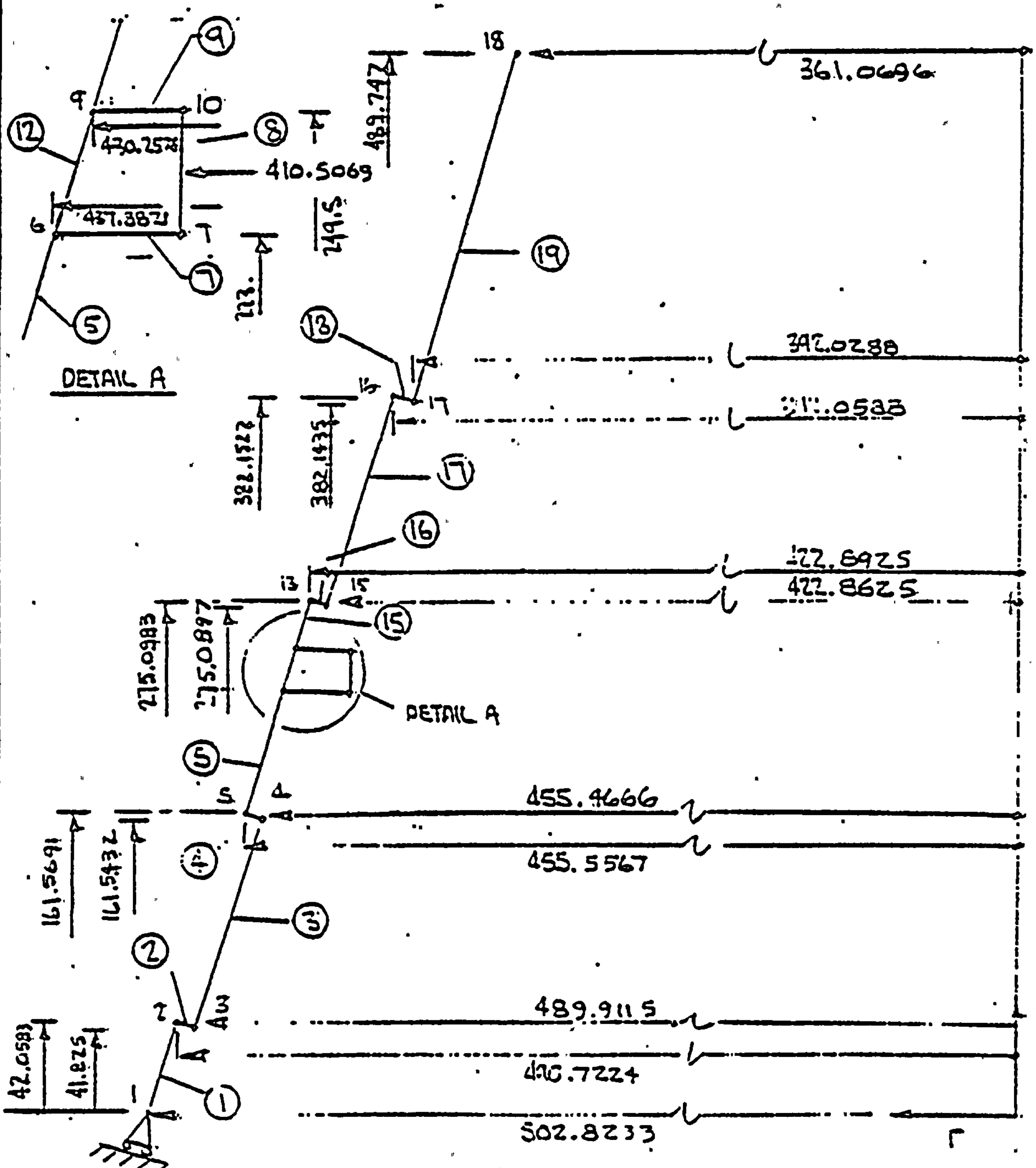
1. THICKNESSES SHOWN ARE IN THE CORRODED CONDITION
2. BODY NUMBERS ARE CIRCLED
3. MODELED THICKNESS SHOWN IN CROSS HATCH

FIGURE 130.067-3

0

PITTSBURGH - DES MOINES STEEL CO.	CONTRACT NO. 12764			SECTION: IV
WPPSS HANFORD NO. 2 CONTAINMENT VESSEL			FINAL STRESS REPORT	SUBSEC: 2
PREPARED BY / DATE: DCL / 8-24-73				ARTICLE: 1
CHECKED BY / DATE: JM / 10-5-73				PAGE: 11
REVISION NUMBER:				

AX2 AXISYMMETRIC MODEL OF CONE SHELL



NOTE: BODY NUMBERS ARE CIRCLED

FIGURE 130.06 $\frac{1}{0}$-4

AXZ AXISYMMETRIC MODEL OF CONE SHELL

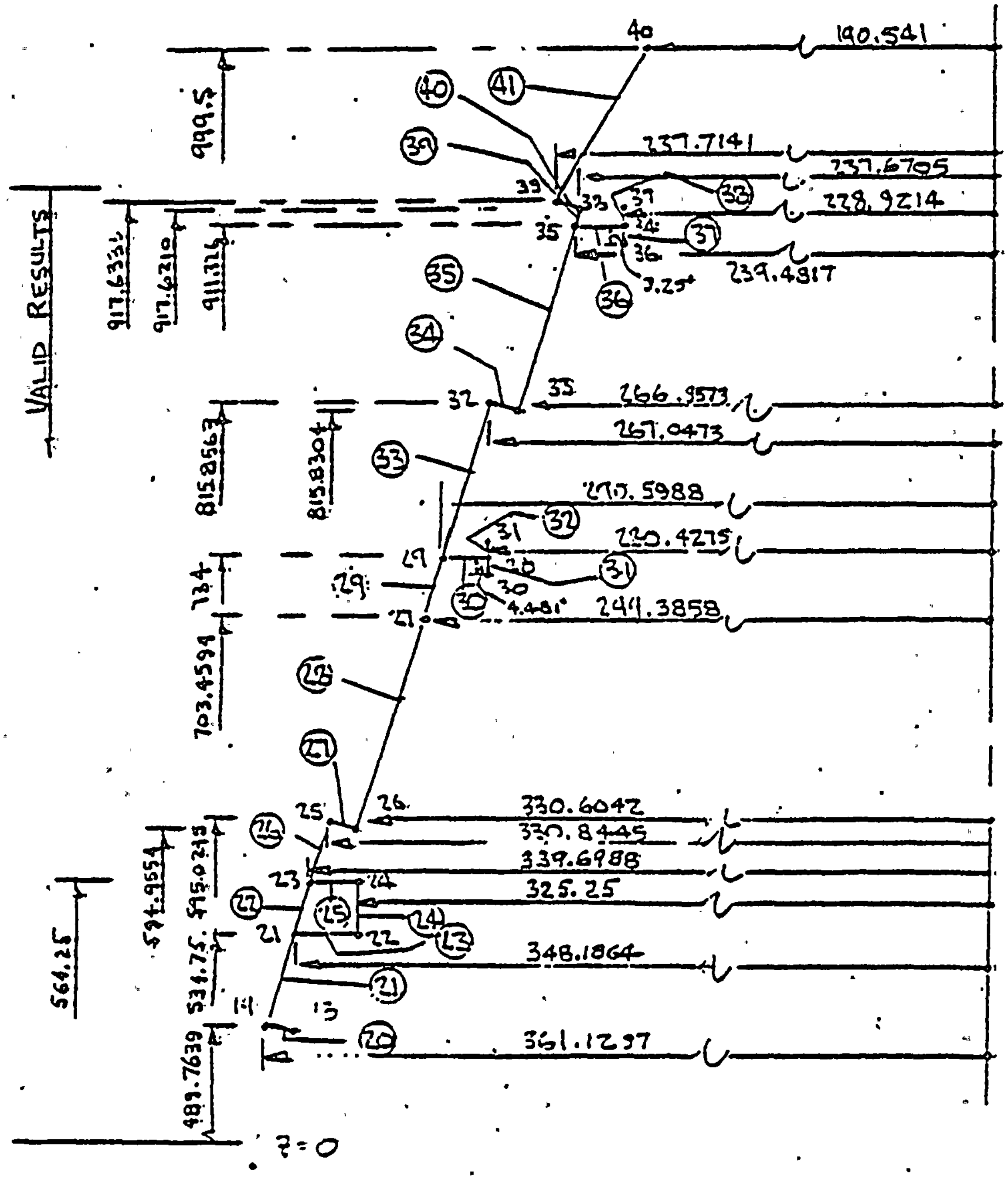


FIGURE 130,06X-5

PITTSBURGH - DES MOINES STEEL CO. CONTRACT NO. 12764			PDM	FINAL STRESS REPORT	SECTION: IV
WPPSS HANFORD NO. 2 CONTAINMENT VESSEL					SUBSEC: 10
PREPARED BY / DATE: RAM/6-11-73					ARTICLE: 3
CHECKED BY / DATE: BJW/7-11-73					PAGE: 8
REVISION NUMBER:					

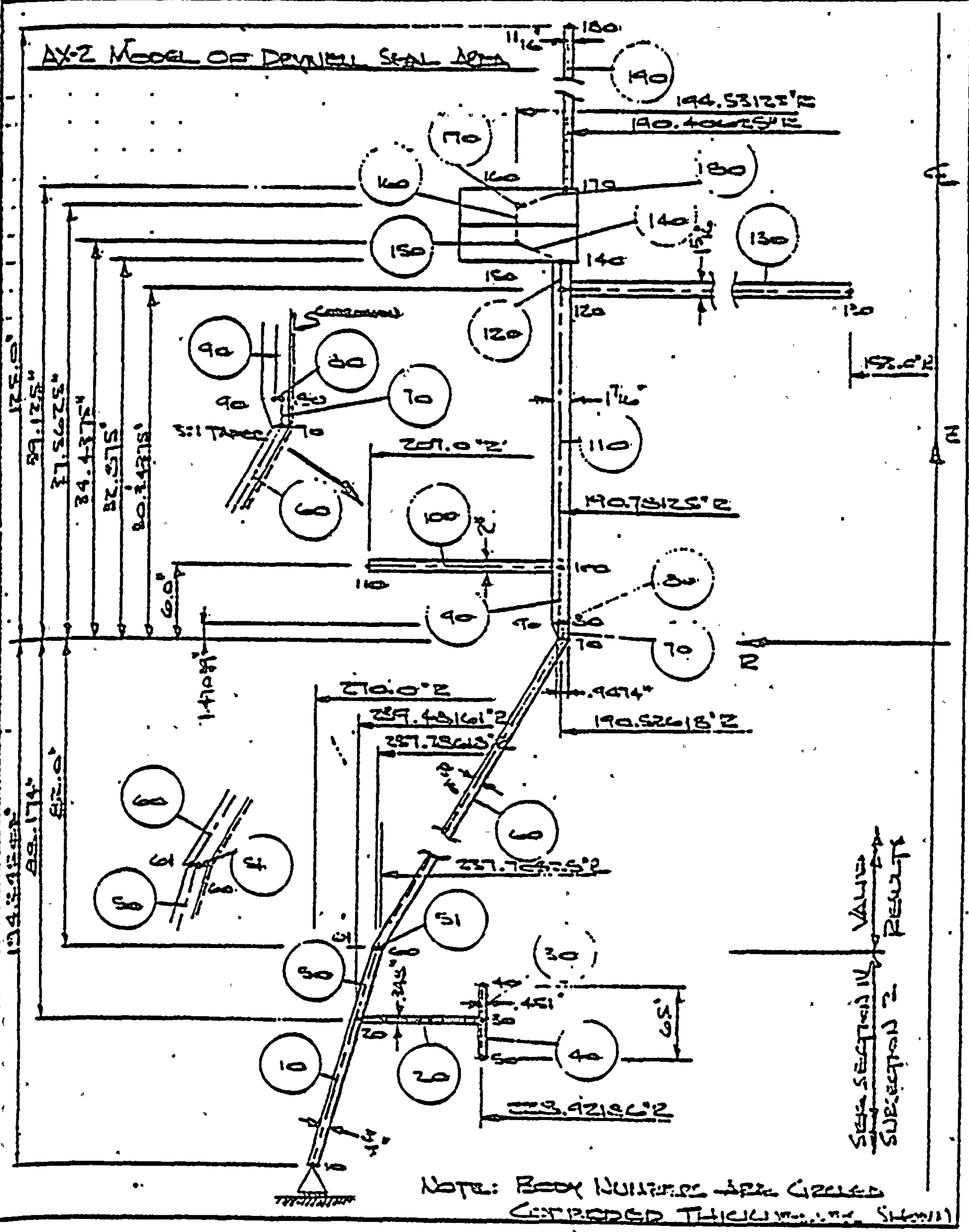
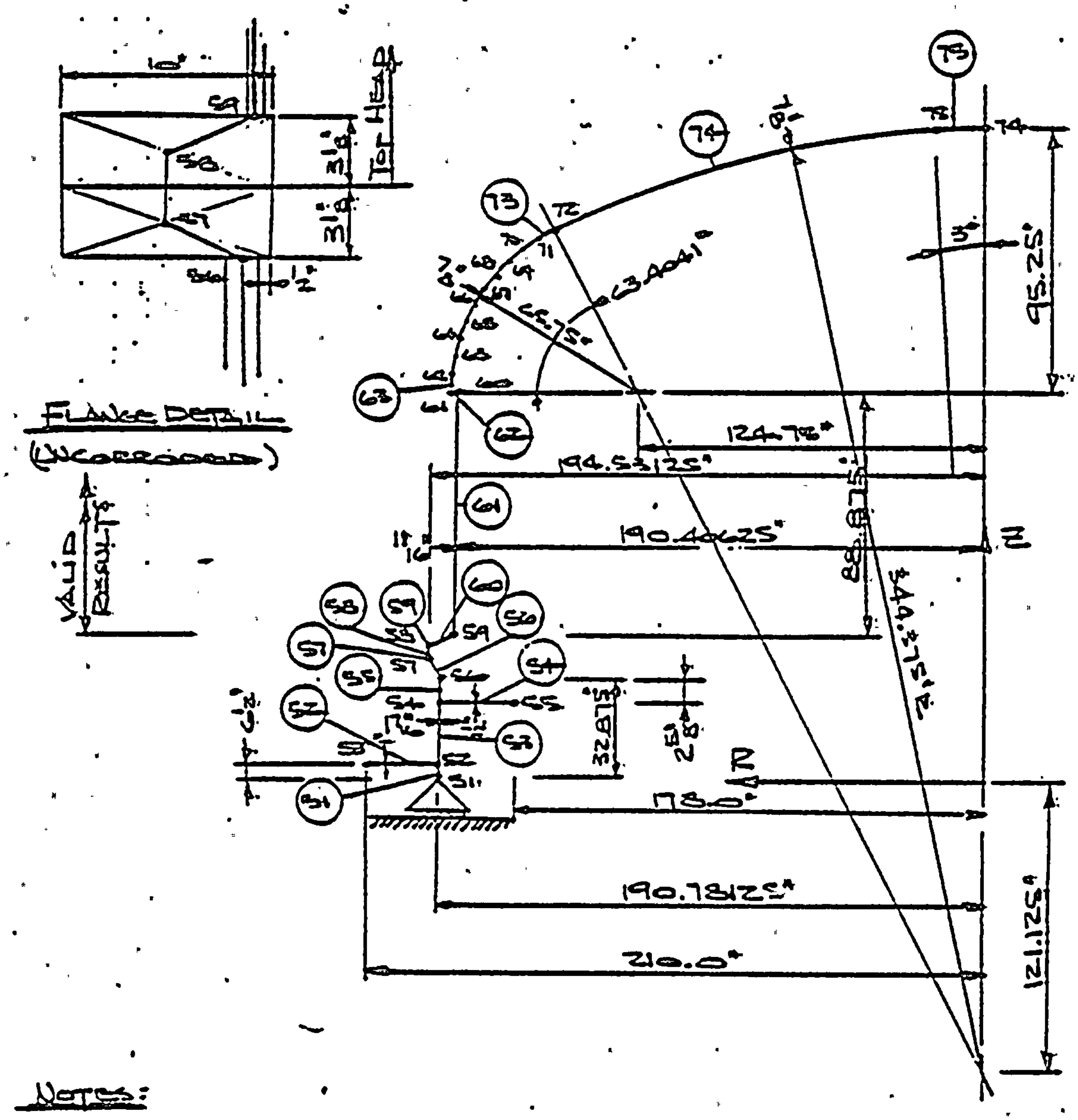


FIGURE 130.063-6

PITTSBURGH - DES MOINES STEEL CO.	CONTRACT NO. 12764		FINAL STRESS REPORT	SECTION: IV
WPPSS HANFORD NO. 2 CONTAINMENT VESSEL		PDM		SUBSEC: 9
PREPARED BY / DATE: RAM / 12-20-72				ARTICLE: 2
CHECKED BY / DATE: RJW / 1-9-73				PAGE: 2
REVISION NUMBER:				



Notes:

1. Bodies 56, 58, 60, and 62 are rigid connectors
2. Bodies 57 and 59 are circumferential ring stiffeners representing the mating flanges
3. Body numbers are circled.
4. Thicknesses shown are in the corroded condition.

FIGURE 130.060-7

ATTACHMENT I to Q130.000

Excerpt From USNRC STANDARD REVIEW PLAN 3-8

Ultimate capacity of steel containment

An analysis should be performed to determine the ultimate capacity of the containment.

The pressure-retaining capacity of localized areas as well as of the overall containment structure should be determined.

The analysis should be made on the basis of the allowable material strength specified in the Code. However, if the actual material properties such as the tested material strength, strength variations indicated by mill test certificates and other material uncertainties, are available, the lower and upper bounds of the containment capacity may be established statistically.

The details of the analysis and the results should be submitted in a report form with the following identifiable information.

(1) The original design pressure, P, as defined in the Code, Subsubarticle NE-3220.

(2) Calculated static pressure capacity,

(3) Equivalent static pressure response calculated from dynamic pressure,*

(4) The associated failure mode,

(5) The criteria governing the original design and the criteria used to establish failure;

(6) Analysis details and general results, and

(7) Appropriate engineering drawings adequate to allow verification of modeling and evaluation of analyses employed for the containment structure.

*Information not required by NRC per Burns and Roe, Inc. telecon record of conversation of 10/22/81 between K. C. Leu of NRC SEB and L. Fischer of Burns and Roe.

NRC-SEB

ISSUE #2

Provide key comparisons of the seismic responses in Reactor/Containment Building between SRSS 3 component method of combining seismic components vs. 2 component ABS method used on FSAR. Provide for following locations:

Operating Floor
Base Mat
Reactor Support Point
Apex of Reactor Building
Top of Containment Vessel
Intersection of drywell floor and containment

RESPONSE

Please refer to the response to Question 130.056 for the information requested.*

*Draft FSAR page changes attached.

Q.130.056
220.07
(3.7.2)

As indicated in Section 3.7.2.6 of the FSAR, two components of the earthquake motion (one horizontal and one vertical) are used to calculate the maximum stresses. Prove the conservativeness of this method over the SRSS of three components of earthquake motion contained in Regulatory Guide 1.92, or justify the deviations.

RESPONSE

A comparison of building response spectra between the two component earthquake motion (absolute sum method) and the three component earthquake motion (SRSS method) are provided in Figures 130.056-1 through 130.056-7 for the following locations:

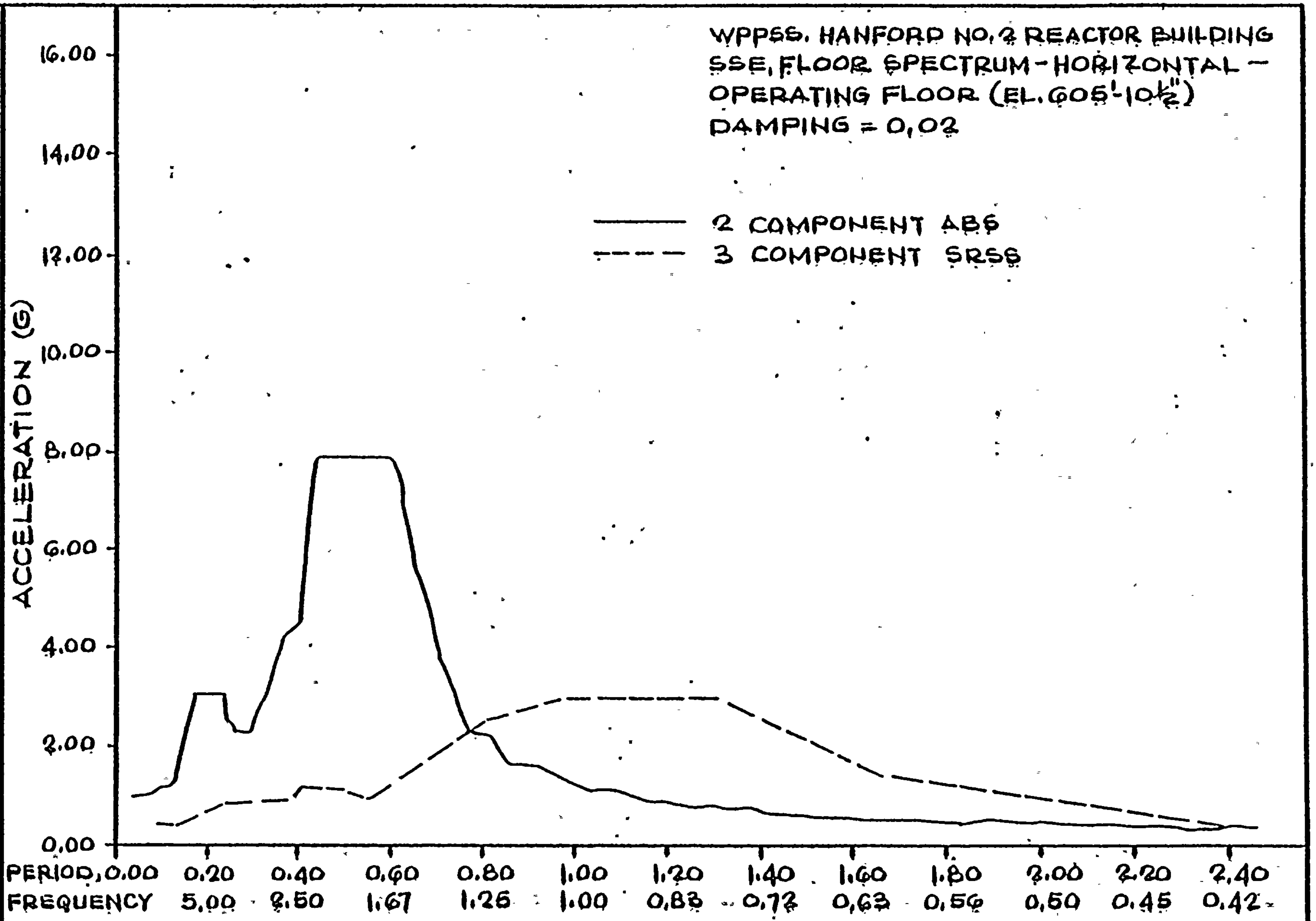
a. Operating floor
b. Base mat
c. Reactor support point
d. Apex of the reactor building
e. Top of the containment vessel
f. Intersection of the drywell floor and the containment vessel

The curves obtained from the two component earthquake motion are conservatively developed using the model and procedures defined in 3.7 of the FSAR. The curves obtained from the three component earthquake motion are developed from a recent finite element soil structure interaction analysis. This seismic analysis, which has been performed in accordance with the provisions of the NRC Regulatory Guides 1.60, 1.61, 1.92, 1.122 and NRC Standard Review Plan 3.7.2, has been conducted to establish a more realistic response of the WNP-2 reactor building.

The comparison of response spectra clearly demonstrate that the original design basis (2-D method ABS) is more conservative than the SRSS/3 component method for all frequencies larger than 1.25 Hz. In the frequency range of interest/concern in the WNP-2 design (approximately greater than 5 Hz) the margin of conservatism is very significant.

Q.130.056 Continued

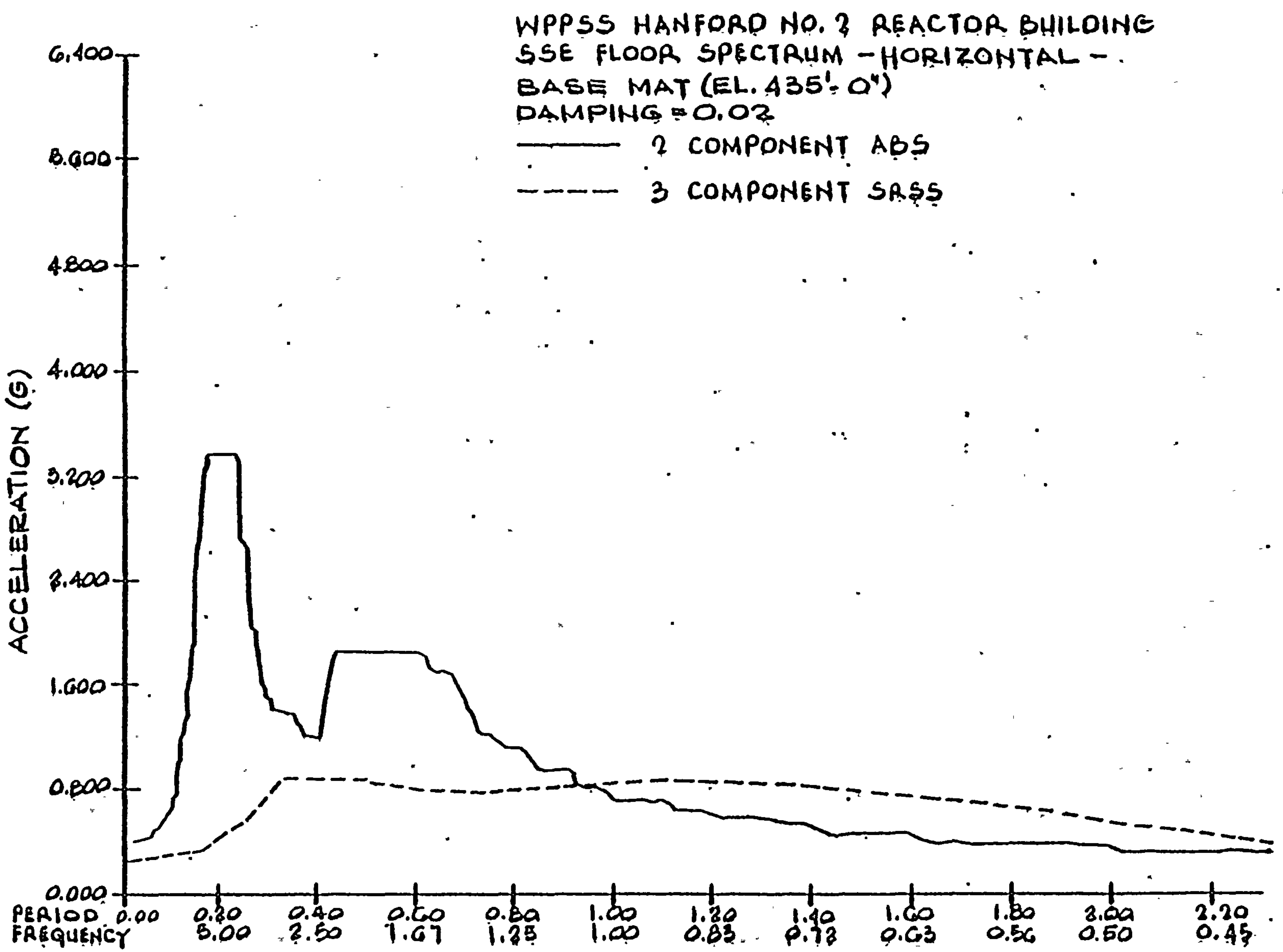
A similar finite element soil/structure interaction analysis for the radwaste/control building is presently being performed. A comparison of this analysis with the original design basis for the radwaste/control building will be provided January 1982.



WASHINGTON PUBLIC POWER SUPPLY SYSTEM
NUCLEAR PROJECT NO. 2

COMPARISON OF RESPONSE SPECTRUM – 2 COMPONENT ABS VERSUS 3 COMPONENT SRSS

FIGURE 130-86-1



WASHINGTON PUBLIC POWER SUPPLY SYSTEM
NUCLEAR PROJECT NO. 2

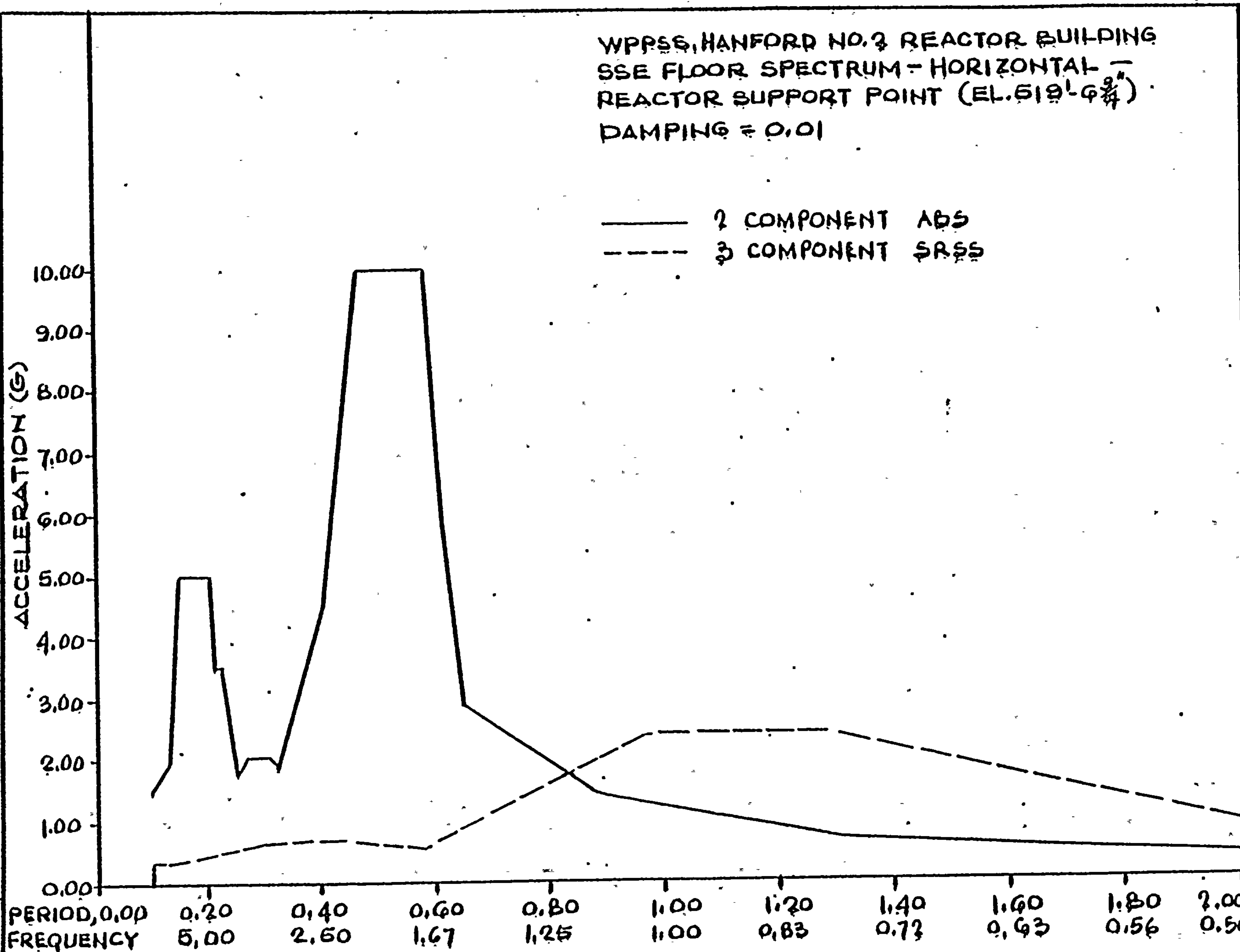
COMPARISON OF RESPONSE SPECTRUM -
2 COMPONENT ABS VERSUS
3 COMPONENT SRSS

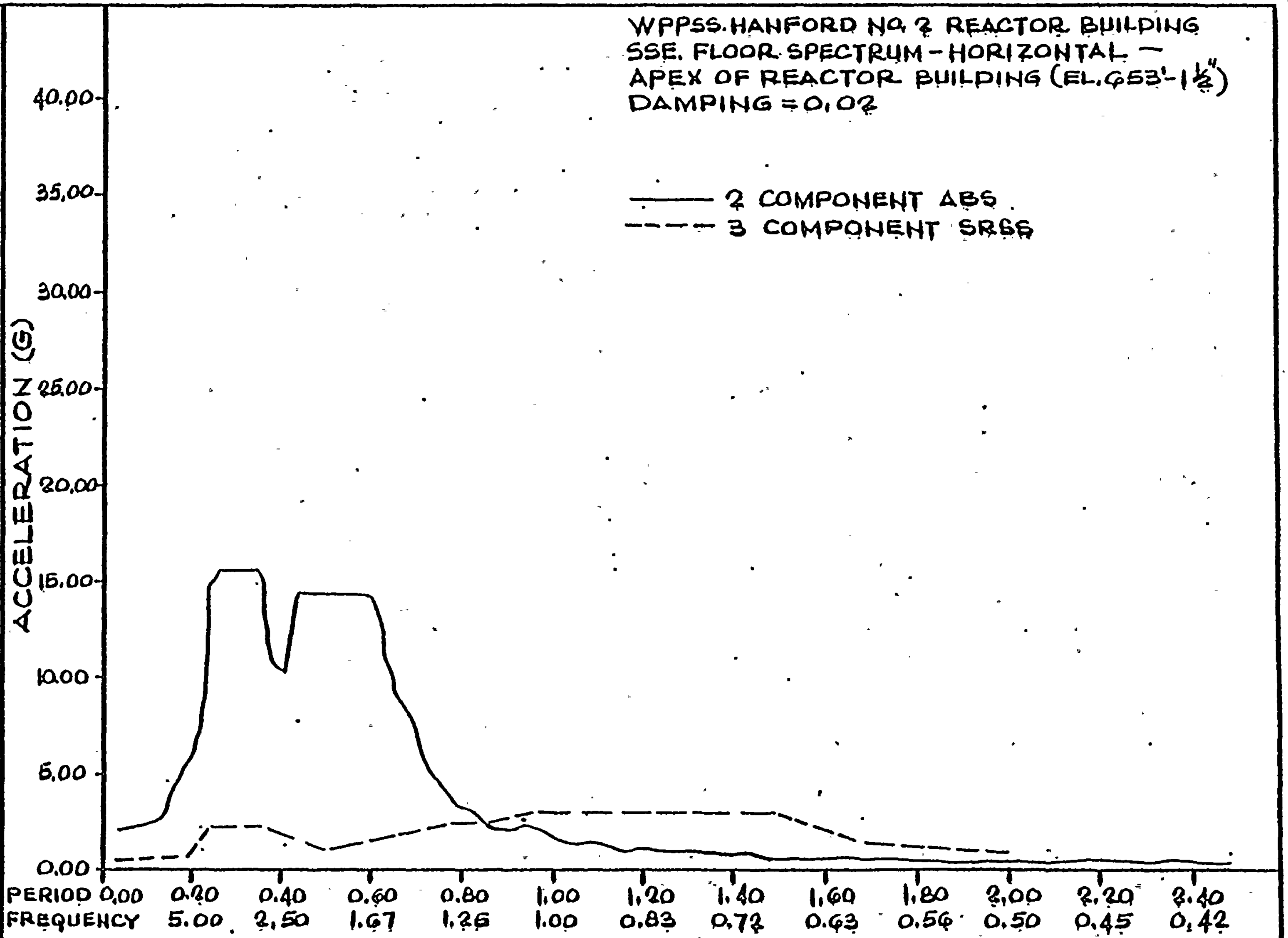
FIGURE
130.056-2

WASHINGTON PUBLIC POWER SUPPLY SYSTEM
NUCLEAR PROJECT NO. 2

COMPARISON OF RESPONSE SPECTRUM -
2 COMPONENT ABS VERSUS
3 COMPONENT SRSS

FIGURE
130.056-3

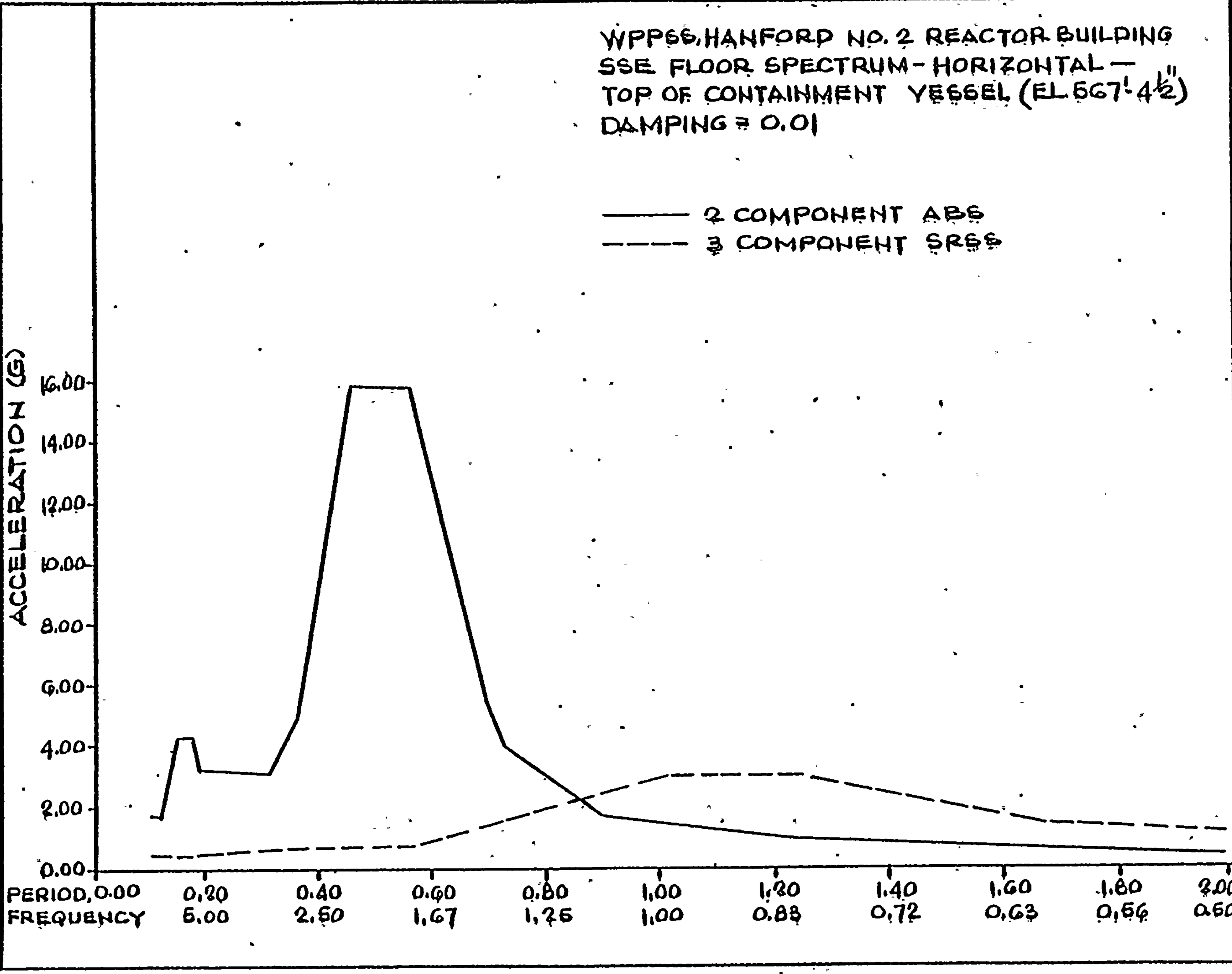




WASHINGTON PUBLIC POWER SUPPLY SYSTEM
NUCLEAR PROJECT NO. 2

COMPARISON OF RESPONSE SPECTRUM - 2 COMPONENT ABS VERSUS 3 COMPONENT SRSS

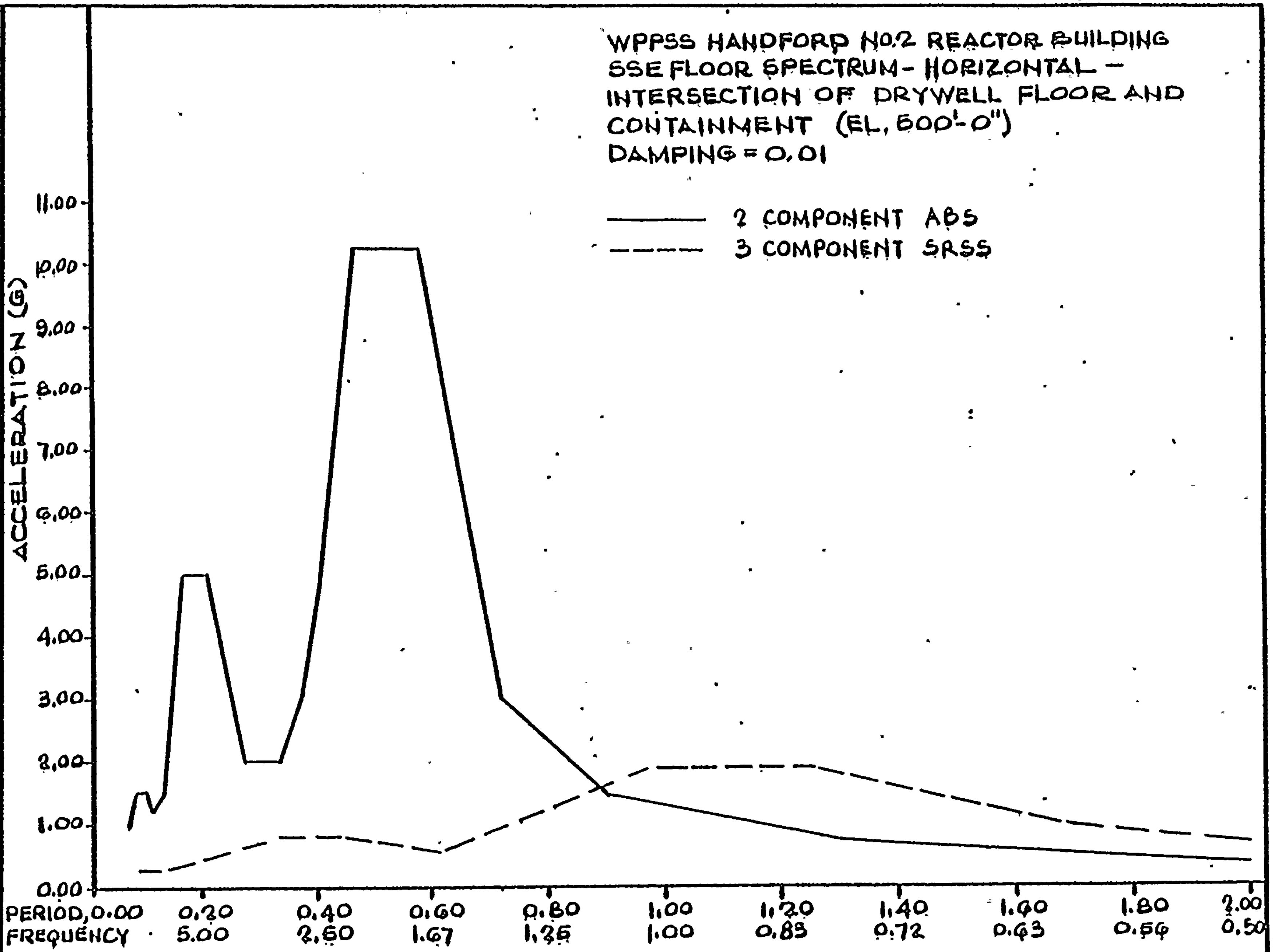
FIGURE 130.05-4



WASHINGTON PUBLIC POWER SUPPLY SYSTEM
NUCLEAR PROJECT NO. 2

COMPARISON OF RESPONSE SPECTRUM— 2 COMPONENT ABS. VERSUS 3 COMPONENT SRSS

FIGURE 3.0-56-5



WASHINGTON PUBLIC POWER SUPPLY SYSTEM
NUCLEAR PROJECT NO. 2

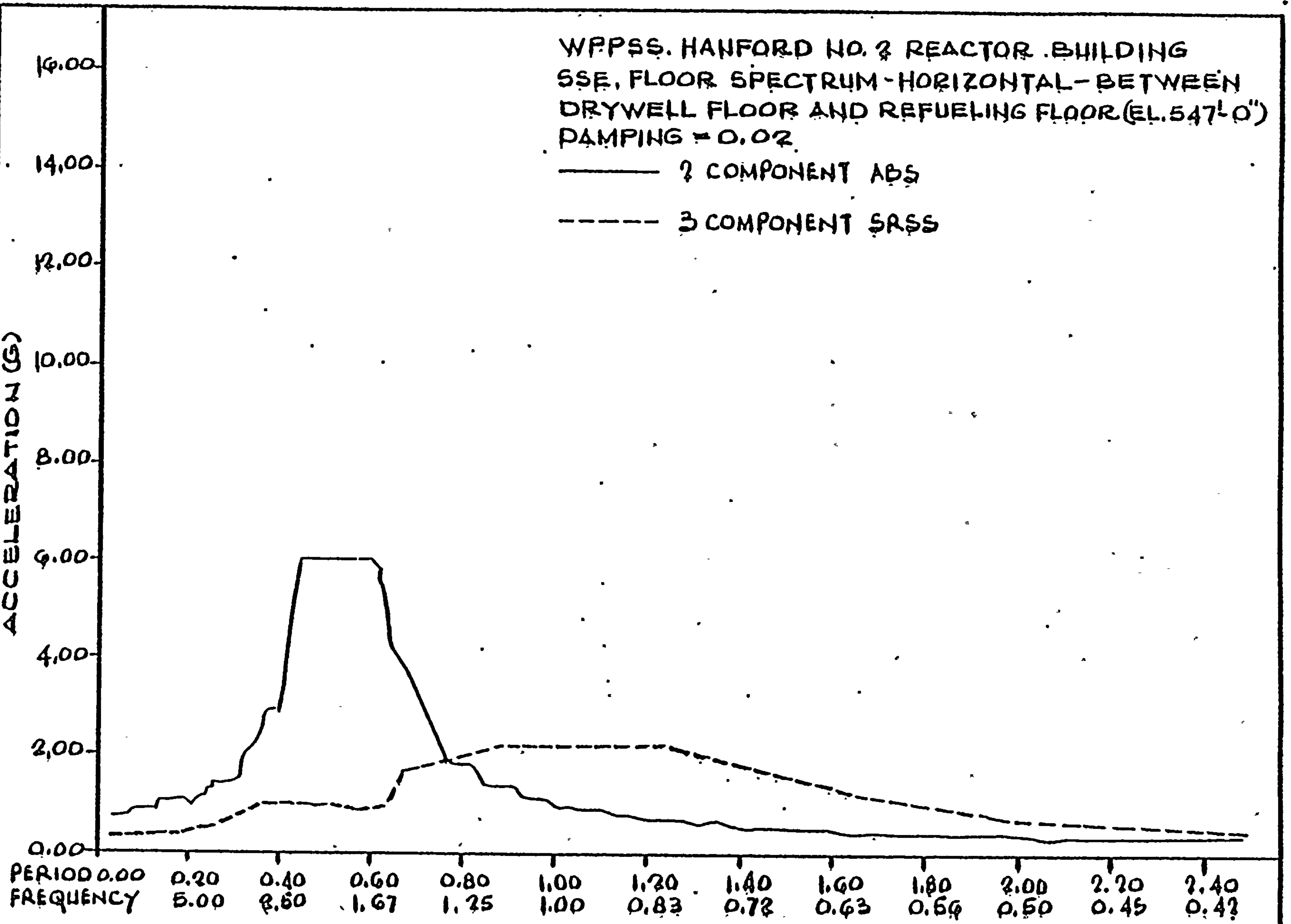
COMPARISON OF RESPONSE SPECTRUM -
2 COMPONENT ABS VERSUS
3 COMPONENT SRSS

FIGURE
130.05-

WASHINGTON PUBLIC POWER SUPPLY SYSTEM
NUCLEAR PROJECT NO. 2

COMPARISON OF RESPONSE SPECTRUM - 2 COMPONENT ABS VERSUS 3 COMPONENT SRSS

FIGURE 130.056-7



ISSUE #3

Compare design response spectra of WNP-2 (SSE) vs. Regulatory Guide 1.60 to 0.25g for each damping value.

Verify the draft table attached to the draft response to Question 130.013. Provide specific comparisons for tangential shear for results of analyses using Regulatory Guide 1.60 response spectra and the design response spectra (Question 130.013) at the following points:

Reactor pedestal (El. 501')

Sacrificial Shield Wall (El. 519')

If deviations exist, provide justification.

RESPONSE:

The comparison of response spectra as well as a tabulation comparing member forces for the seismic dynamic analysis using the FSAR design response spectra and Regulatory Guide 1.60 response spectra is provided in the response to Question 130.013. The response to Question 130.013 has also been revised to reference the response to Question 130.053.*

*Draft FSAR page changes attached.

Q.130.053
220.04
(3.7.1)
(RSP)

With regard to previous staff question 130.013 and your response, provide the detailed comparisons as indicated in your earlier response for staff review.

RESPONSE

The seismic loads used in WNP-2 design were calculated using the design response spectra as shown in FSAR Figures 3.7-1 through 3.7-4, prior to the issuance of Regulatory Guide 1.60. Subsequent to the issuance of Regulatory Guide 1.60, a dynamic analysis was performed on the horizontal model of the reactor building for the Safe Shutdown Earthquake (SSE) using: (1) The FSAR design response spectra and damping values of Table 3.7-1 of the FSAR; and (2) the design response spectra scaled to a maximum horizontal ground acceleration of 0.25g and the damping values defined in Regulatory Guides 1.60, Revision 1, and 1.61, Revision 0, respectively.

The attached calculations pages, Tables Q.130.053-1 through Q.130.053-3, tabulate the comparison of the two dynamic analyses described above. The results for moments and shear show that at all locations/sections of concern the percentage difference is less than 10% (approximately).

The response spectrum analyses described above are based on lumped spring and damper modeling for soil structure interaction effect using conservative soil damping values as shown in Table 3.7-1 of the FSAR. A finite element soil structure interaction analysis has been performed for the reactor building in accordance with the NRC regulatory guidelines. A comparison of the response spectra, developed from this more realistic finite element method and the original lumped spring and damper modeling, is shown in Figures 130.056-1 through 130.056-7. This comparison shows the large measure of conservatism in the present seismic design which is more than necessary to accommodate the percent differences presented in the table.

The same conclusions reached above for the reactor building can also be reached for other seismic Category I structures since the same modeling techniques, method of analysis, and input were used for the other structures.

WNP-2

TABLE Q 130.053-1

BURNS AND ROE, INC.
Oradell, N.J. • Hempstead, N.Y. • Los Angeles, Calif.

W.O. No. 2808-44 Date 8/23/74 Book No. SV-101 Page No. 153
Drawing No. N.A. Calc. No. 6 19.46 Sheet 5 of 8
By AHNSAH Checked HG. Approved
Title WPPSS HANFORD NO. 2 REACTOR BLDG E-W G=75KSI

COMPARISON OF THE SEISMIC ANALYSIS OF THE REACTOR BLDG. WITH OLD GROUND SPECTRA AND NEW GROUND SPECTRA (AEC REG. GUIDE 1.60) + 1.61

OBE RESULTS (COMBINED ACCLN RMS.+ABS) MODEL 2 REV 1

MEMBER NUMBER	FORCES AT BOTTOM OF MEMBER				% DIFFERENCE	
	OLD ANALYSIS		NEW ANALYSIS		{(NA-OA)/OA} × 100	
	Shear×10⁴	Moment×10⁶	Shear×10⁴	Moment×10⁶	Shear	Moment
1	0.275235	0.135698	0.293752	0.144502	6.73	6.49
2	1.18974	0.667328	1.28307	0.723243	7.85	8.38
3	2.11805	1.20448	2.27443	1.30735	7.38	8.54
4	2.60076	1.93493	2.78979	2.09275	7.27	8.16
5	2.9866	2.60955	3.19917	2.81612	7.12	7.92
6	3.30887	3.6474	3.54084	3.92485	7.01	7.61
7	3.58777	4.66562	3.83891	5.0104	7.00	7.39
8	4.02412	5.24798	4.31514	5.62952	7.23	7.27
9	4.39388	6.21432	4.73541	6.65501	7.77	7.09

REFER SV-121, VALUES OF ABSOLUTE SUMS FOR NEW ANALYSIS
REFER SV-125, VALUES OF ABSOLUTE SUMS FOR OLD ANALYSIS

WNP-2

TABLE Q 130.053-2

BURNS AND ROE, INC.
Oradell, N.J. • Hempstead, N.Y. • Los Angeles, Calif.

W.O. No. 2808-44 Date 9/19/74 Book No. SV-101 Page No. 155
Drawing No. NA Calc. No. 6.19.46 Sheet 7 of 8
By J. BRAVERMAN Checked HG. Approved
Title WPPSS HANFORD NO. 2 REACTOR BLDG. E-W G275-ESE

MODEL I REV 1 OBE (COMBINED ACCEL. ROSTRIN(3))

MEMBER NUMBER	FORCES AT BOTTOM OF MEMBER				% DIFFERENCE	
	OLD ANALYSIS		NEW ANALYSIS		[(N.A.-O.A.)/O.A.]x100	
	SHEAR x10⁴	MOMENT x10⁶	SHEAR x10⁴	MOMENT x10⁶	SHEAR	MOMENT
(1) 10	5.17778	6.70095	5.70816	7.19020	10.24	7.30
11	.0075819	.00123135	.00808448	.0013495	6.63	6.79
12	.0921995	.0101965	.101788	.0112224	10.40	10.06
13	.0937354	.0254871	.103362	.0280874	10.27	10.20
14	.0976499	.0355807	.107265	.0391880	9.84	10.14
15	.0987285	.0447137	.108303	.0492086	9.70	10.05
16	.100736	.0541889	.110231	.0595738	9.43	9.94
17	.104131	.0674854	.113414	.0740739	8.91	9.76
18	.264771	.0808867	.284468	.0876031	7.44	8.30
19	.267910	.109237	.287981	.117009	7.49	7.11
20	.271552	.140475	.292103	.149962	7.57	6.75
21	.274669	.173202	.295700	.184762	7.66	6.67
22	.346503	.217010	.381045	.231710	9.97	6.77
→ 23	.00103144	.000599884	.00110897	.00064191	7.52	7.01
24	.0506155	.00847971	.0539644	.0101936	6.61	20.21
25	.0287161	.0113702	.0321091	.0135502	11.82	19.17

Form GR 0002-2

WNP-2

TABLE Q 130.053-3

BURNS AND ROE, INC.

Oradell, N.J. • Hempstead, N.Y. • Los Angeles, Calif.

W.O. No. 2808-44 Date 9/19/74 Book No. SV-101 Page No. 156
Drawing No. NP Calc. No. 6.19.46 Sheet 8 of 8
By J. BRAVERMAN Checked HG. Approved
Title WPPSS HANFORD NO. 2 REACTOR BLDG E-W G = 75KSI
MODEL 2 REV 1 OBE (COMBINED ACCLN EMS+ANS)

	MEMBER NUMBER	FORCES AT BOTTOM OF MEMBER				% DIFFERENCE	
		OLD ANALYSIS		NEW ANALYSIS		[(NA.-O.A.)/O.A.] x100	
		SHEAR x10⁴	MOMENT x10⁶	SHEAR x10⁴	MOMENT x10⁶	SHEAR	MOMENT
	26	.0265239	.0112982	.0293448	.0136363	10.64	20.69
	27	.0435832	.0115518	.0466992	.0137729	7.15	19.23
	28	.106123	.0157987	.113790	.0173398	7.22	9.75
	29	.135691	.0298269	.146160	.0313352	7.72	5.06
	30	.0459048	.0345155	.0491934	.0363617	7.16	5.35
	31	.0732784	.0443287	.0797267	.0469334	9.80	5.88
	32	.0893086	.0562331	.0981430	.0598740	9.89	6.47
	33	.105133	.0703654	.116656	.0754030	10.96	7.16
	34	.127212	.0873013	.143062	.0942749	12.46	7.99
	35	.000853816	.000539224	.000920184	.000577737	7.78	7.02
K_1	36	.157374	0.0	.165694	0.0	5.29	0.0
K_2	37	.165280	0.0	.171865	0.0	3.98	0.0
	38	.444121	.215310	.487705	.229797	9.81	6.73
	39	.108850	.0727745	.119189	.0787661	9.50	8.23
K_3 →	40	.200198	0.0	.220416	0.0	10.10	0.0

REFER SV-121 FOR NEW ANALYSIS RESULTS
REFER SV-125 FOR OLD ANALYSIS RESULTS

130-053-4

Q. 130.013
(RSP)
(3.7.1)

You state in Section 3.7.1.1 of the FSAR that a response spectrum dynamic modal analysis was performed on the reactor building structure for a Safe Shutdown Earthquake (SSE) using: (1) the design response spectra defined in Figure 3.7-1 and the damping values of Table 3.7-1 of the FSAR; and (2) the design response spectra scaled to a maximum horizontal ground acceleration of 0.25g using the damping values defined in Regulatory Guides 1.60, Revision 1, and 1.61, Revision 0, respectively. Compare the horizontal and vertical floor response spectra in the reactor building at the locations specified below using your two design criteria cited above. Additionally, provide the same comparisons for structural responses (i.e., the seismic shear, the moments, the deflections, and the floor response spectra) in the horizontal and vertical directions for all other Seismic Category I structures. This comparison of the floor response spectra should be performed assuming damping values of two percent and five percent of the critical damping value, at the operating floor, the reactor stabilizer level, the reactor vessel support, the divider barrier, the basemat and the refueling hatch level for the reactor building and at the basemat, an intermediate elevation, and an upper elevation for all other Seismic Category I structures.

Response:

Seismic loads used in the WNP-2 design were developed before the issuance date of Regulatory Guide 1.60, and were based on the ground response spectra as shown in Figures 3.7-1 through 3.7-4 of the FSAR. Subsequent to the issuance of Regulatory Guide 1.60, studies have been performed ~~and are currently in process~~ to evaluate the adequacy of the design seismic loads with respect to the structural responses obtained using Regulatory Guide 1.60 ground response spectra and realistic damping values representing soil-structure interaction effect. A detailed comparison ~~will be provided in a future amendment.~~ is provided in the response to Question 130-053.

NRC-SEB

Issue 4

Provide justification for not having to baseline correct the time histories used in the WNP-2 analysis.

RESPONSE

Base line correction of site (input) seismic acceleration time histories are not necessary if only accelerations are used at both input/output level in seismic analyses. As an example, Reference (1) shows that a typical earthquake acceleration record Fig. 1.1.1., with no base line correction, and the base line corrected acceleration record Figs. 1.2.1 and 1.3.1., are almost identical. This is in spite of the fact that the base line corrected time histories for displacements and velocities are different from the uncorrected time histories for displacements and velocities, respectively. On a more generic basis, equations 52 of the same reference shows that the order of magnitude of the frequency spectrum of the base line correction, H_j, is:

$$H_j \simeq 0\ (10^{-6})$$

It is important to note that the order of magnitude of the frequency spectrum of the site acceleration motion used in the design of WNP-2 is 10^{-1}. Based on the above, it is concluded that the effect of the base line correction is negligible in WNP-2 seismic analyses.

Reference (1) - Kausel, E. and Ushijima, R., "Base Line Correction of Earthquake Records in the Frequency Domain", MIT Research Report, Dept. of Civil Engineering, Publication No. R79-34, Cambridge, Mass., 1979.

ISSUE #5

Provide a discussion of the impact of concrete cracking on the seismic analysis of the reactor building.

RESPONSE:

Cracking of reinforced concrete sections in the reactor building has little effect on the soil-structure interaction frequencies. To illustrate this, a simple two degrees of freedom model was used: the top mass and spring represented the reactor building, and the bottom mass and spring represented the soil. Two analyses were performed. In the first analysis, the structure was assumed uncracked, and in the second analysis the structural spring stiffness was reduced by 33% to account for cracking of concrete. It was found that the soil-structure interaction fundamental frequency of the system was reduced in the second analysis by 3.9% in comparison with the frequency obtained from the first analysis. This small shift proves that neglecting concrete cracking in the analysis is justifiable. It is noted that the WNO-2 reactor/containment building seismic response reported in the FSAR is governed by soil-structure interaction effects.

Further NRC request: Attach curves in response with 15% broadening.

Response: The curves requested are not applicable and therefore are not attached. Pertinent analysis calculations supporting the response are attached instead.

BURNS AND ROE, INC.
Headquarters Office—Oradell, N.J.

BOOK No. S XIV-1
PAGE No. 1

W.O. No. 3900-03 Calc. No. 6.42-01 Sheet 1 Cont. on Sheet 2

Title WPPSS-HANFORD No. 2 - NRC SEB Issue 5

CONCRETE CRACKING STUDY

ATTACHMENT TO ISSUE #5

LEAD SHEET 1 OF 3

CHECK PERFORMED IN ACCORDANCE
WITH ENGR'G. STD. P015105G1,
DATED January 1979 ; RESULTS ARE
SATISFACTORY.
CHKR. SIGNATURE A. Ettouney
DATE 10/15/81

PURPOSE : To prepare response to following NRC Structural Engineering Branch Issue No. 5 associated with NRC SEB Audit of 9/29 - 10/2/81 at Burns and Roe Woodbury :

NRC - SEB

ISSUE #5

Provide a discussion of the impact of concrete cracking on the seismic analysis of the Reactor Building.

Rev. No.	Description of Revision	Type (Prelim Design, Final Design, Study)	Originator Signature/Date	Checker Signature/Date	Approver Signature/Date
0	Original Issue	STUDY	J. Januever 9-30-81	A. Ettouney 10/15/81	[illegible] 10/15/81
			J. JANUEVER	M. ETTOUNEY	

Form C015104G2

ISSUE 5

BURNS AND ROE, INC.
Headquarters Office—Oradell, N.J.

W.O. No. 3900-03 Date 9-30-81 Book No. S XIV-1 Page No. 2
Drawing No. Not Applicable Calc. No. 6.42-01 Sheet 2 Cont. on Sheet 3
By JSJ Checked MF Approved 10/15/81
Title WPPSS- HANFORD NO. 2 - NRC SEB ISSUE 5 STUDY

CONCRETE CRACKING STUDY

LEAD SHEET 2 of 3

REFERENCES: See sheet 3 of 7 (Lead sheet 3 of 3)

DESIGN REQUIRENTS: None

ASSUMPTIONS: None

PROCEDURES:

Response: Cracking of reinforced concrete sections in the Reactor Building has little effect on the soil-structure interaction frequencies. To illustrate this, a simple two degrees of freedom model ~~was~~ is used: the top mass and spring represented the Reactor Building, and the bottom mass and spring represented the soil. Two analyses ~~were~~ are performed. In the first analysis, the structure ~~was~~ is assumed uncracked and in the second the structural spring stiffness ~~was~~ is reduced by 33% to account for cracking of concrete. It ~~was~~ is found that the soil-structure interaction fundamental frequency of the system ~~was~~ is reduced in the second analysis by 3.9% in comparison with the frequency obtained from the first analysis. This small shift proves that neglecting concrete cracking in the analysis is justifiable. It is noted that the WNP-2 Reactor/Containment Building seismic response reported in FSAR is governed by soil-structure interaction effects.

COMPUTER INPUT/OUTPUT: See Reference #3, Sheet 3 of 7

CONCLUSIONS: See sheet 7 of 7

Form BR 8002-2 (5/78)

ISSUE 5 — Page 7, next pg. signed approved.

BURNS AND ROE, INC.

W.O. No. 2900 02 Date 9 ... 81 Book No. S XIV - 1 Page No. 3
Drawing No. NA Calc. No. 6.42-01 Sheet 3 of 7
By ... Checked ... Approved ... 10/15/81 STUDY
Title WPPSS-HANFORD NO 2 - NRC SER ISSUE 5

LEAD SHEET 3 of 3

REFERENCES

1. SETO, W.W., THEORY AND PROBLEMS OF MECHANICAL VIBRATIONS, McGRAW-HILL BOOK COMPANY, NEW YORK, 1964.

2. B. & R. CALCULATION BOOK NO. SV-39.

3. B. & R COMPUTER RUN NAME "ACGØRDØ", REFERRED TO IN B. & R. CALCULATION BOOK NO. SV-682.

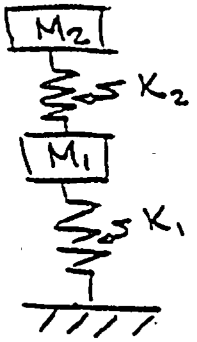
4. BRENNAN, J, "SEISMIC SOIL-STRUCTURE INTERACTION ANALYSIS OF THE REACTOR BUILDING", FOR WPPSS NUCLEAR PROJECT NO. 2, BURNS AND ROE, INC., NOVEMBER, 1978.

ISSUE 5

BURNS AND ROE, INC.

W.O. No. 391..02 Date 9.31.81 Book No. 5 XIV-1 Page No. 4
Drawing No. NA Calc. No. 6.42-01 Sheet 4 of 7
By ISJ Checked ML Approved See Sheet 7 of 7
Title WPPSS - HANFORD NO. 2 - NRC SEB ISSUE 5

CONSIDERING THE TWO DEGREE OF FREEDOM SYSTEM SHOWN;



THE TWO FREQUENCIES OF HARMONIC MOTION MAY BE FOUND FROM THE FOLLOWING EQUATION (REF. 1, P. 35);

$$\omega^2 = \frac{K_1+K_2}{2M_1} + \frac{K_2}{2M_2} \pm \sqrt{\frac{1}{4}\left(\frac{K_1+K_2}{M_1} + \frac{K_2}{M_2}\right)^2 - \frac{K_1K_2}{M_1M_2}}$$

M_1 IS REPRESENTATIVE OF THE COMBINED MASS OF THE SOIL AND FOOTING (REF. 2, P. 172-176)

$$M_1 = 377 + 2015 = 2392 \ \frac{K \cdot SEC^2}{FT}$$

THE EQUIVALENT SOIL SPRING, K_1, MAY BE CALCULATED FROM THE RELATIONSHIP;

$$K_1 = 2\pi f^2 M_1$$

WHERE f = NATURAL FREQUENCY OF SOIL AND FOOTING

ISSUE 5

BURNS AND ROE, INC.

W.O. No. 3900.03 Date 9.30.81 Book No. 5 XIV-1 Page No. 5
Drawing No. N4 Calc. No. 6.42-01 Sheet 5 of 7
By JS Checked ME Approved See Sh. 7 of 7
Title WPPSS- HANFORD NO. 2 - NRC SEB ISSUE 5

FOR $f = 2.4$ Hz (REF. 3);

$$K_1 = 2\pi(2.4)^2(2392) = 8.7\times10^4 \ \frac{K}{FT}$$

M_2 IS REPRESENTATIVE OF THE STRUCTURAL MASS (REF. 2, P. 172-176);

$$M_2 \cong 8000 - 2015 = 5985 \ \frac{K \cdot SEC^2}{FT}$$

THE EQUIVALENT STRUCTURAL SPRING, K_2, MAY BE CALCULATED FROM THE RELATIONSHIP;

$$K_2 = 2\pi f^2 M_2$$

WHERE f = NATURAL FREQUENCY OF STRUCTURE

FOR $f = 3$ Hz (REF. 4, FIG. 3-5);

$$K_2 = 2\pi(3)^2(5985) = 3.4\times10^5 \ \frac{K}{FT}$$

THE ORIGINAL ANALYSIS OF THE SYSTEM WAS MADE FOR SOIL SPRING VALUES OF $(0.67)K_1$, K_1, AND $(1.33)K_1$.

THE EFFECT OF CRACKING IN THE STRUCTURE MAY BE SIMULATED BY VARYING THE STRUCTURAL EQUIVALENT SPRING CONSTANT; VALUES OF SPRING CONSTANTS LOWER THAN K_2 REPRESENTS A CRACKED STRUCTURE.

ISSUE 5

BURNS AND ROE, INC.

W.O. No. 3900.03 Date 5.20.81 Book No. S XIV-1 Page No. 6
Drawing No. NA Calc. No. 6.42-01 Sheet 6 of 7
By — Checked ME Approved See Sheet 7 of 7
Title WPPSS - HANFORD NO 2 - NRC SEB ISSUE NO 5

THE EFFECT OF VARYING THE VALUES OF K_1 AND K_2 IN THE FREQUENCY SOLUTION EQUATION MAY BE ACCOMPLISHED BY SUBSTITUTING $K_1(1+\alpha)$ FOR K_1 AND $K_2(1+\beta)$ FOR K_2. IN THIS MANNER, CHANGES TO α AND β REPRESENT CORRESPONDING CHANGES TO K_1 AND K_2. PERFORMING THE SUBSTITUTION, THE FOLLOWING EQUATION IS OBTAINED;

$$\omega^2 = \frac{K_1}{2M_1}(1+\alpha) + K_2(1+\beta)\left(\frac{1}{2M_1}+\frac{1}{2M_2}\right)$$
$$\pm\sqrt{\frac{1}{4}\left(\frac{K_1}{M_1}(1+\alpha)+K_2(1+\beta)\left(\frac{1}{M_1}+\frac{1}{M_2}\right)\right)^2-\left(\frac{K_1}{M_1}\right)\left(\frac{K_2}{M_2}\right)(1+\alpha)(1+\beta)}$$

THE FUNDAMENTAL AND HARMONIC FREQUENCIES OF CRACKED AND NON-CRACKED STRUCTURES MAY NOW BE COMPARED FOR VARYING VALUES OF SOIL STIFFNESS. HOWEVER, FOR THIS ANALYSIS, HARMONIC FREQUENCIES ARE OF RELATIVELY LITTLE IMPORTANCE. THEREFORE ONLY FUNDAMENTAL FREQUENCIES NEED BE COMPARED.

THE FOLLOWING TABLE REPRESENTS THE EVALUATION OF FUNDAMENTAL FREQUENCIES OF CRACKED ($\beta=-0.33$) AND NON-CRACKED ($\beta=0$) STRUCTURES WITH SEVERAL VALUES OF SOIL STIFFNESS:

ISSUE 5

BURNS AND ROE, INC.

W.O. No. 3900-05 Date 9.29.81 Book No. S XIV-1 Page No. 7
Drawing No. NA Calc. No. 6-42-016 Sheet 7 of 7
By ISJ Checked HS Approved
Title WPPSS- HANFORD NO. 2 - NRC (SEB ISSUE NO 5

α	FUNDAMENTAL FREQUENCY* (Hz)		$\frac{f_{no-cr} - f_{cr}}{f_{no-cr}}$ (%)
	$\beta = 0.0$	$\beta = -0.33$	
-0.33	0.402	0.394	1.99 %
0.0	0.481	0.467	2.91 %
+0.33	0.543	0.522	3.87 %

* FUNDAMENTAL FREQUENCY (f) IS OBTAINED BY SUBTRACTING THE SQUARE-ROOT TERM IN THE FREQUENCY EQUATION INSTEAD OF ADDING. ADDITIONALLY, $f = \frac{1}{2\pi}\sqrt{\omega^2}$.

THE ABOVE SHOWS THAT FOR VALUES OF SOIL STIFFNESS WITHIN 33% OF THE MEAN VALUE, FUNDAMENTAL FREQUENCIES OF CRACKED STRUCTURES ARE WITHIN 3.9 % OF FUNDAMENTAL FREQUENCIES OF NON-CRACKED STRUCTURES. IN THE ORIGINAL DESIGN ANALYSIS, RESPONSE SPECTRA ENVELOPES WERE SPREAD BY 15% FOR FREQUENCIES AROUND RESPONSE PEAKS. A SHIFT IN RESONANT FREQUENCY OF 3.9 % DUE TO CRACKING IN THE STRUCTURE, THEREFORE, DOES NOT CONSTITUTE A NON-CONSERVATIVE DESIGN.

NRC-SEB

ISSUE #6

Provide an assessment of the effect of an additional 5% accidental torsion on the key Category I building walls with reference to the normal shear stresses.

RESPONSE:

Please refer to the response to Question 130.059 for the information requested.*

Calculations assessing the effects of an additional 5% accidental torsion on Seismic Category I buildings are attached as requested in the meeting.

*Draft FSAR page changes attached.

ATTACHMENT TO ISSUE 6

BURNS AND ROE, INC.

W.O. No. 3900-03 Date 9/30/81 Book No. S XIV-6 Page No. 1
Drawing No. ____ Calc. No. 6.42-03 Sheet ____ of ____
By ____ Checked ____ Approved ____
Title WPPSS-HANFORD NO. 2 - ASSESS ACCIDENTAL SEISMIC TORSION ON BUILDINGS

INDEX FOR BK. S XIV-6

For Calc. 6.42-03

Description	page
Lead Sheet	2
R.C.B.	3-4
R.W.B.	5-6
DGB & SSWPH	7

ISSUE #6

Form BR 8002-2

ISSUE 6

BOOK NO. S XIV - 6
PAGE NO. 2

BURNS AND ROE, INC.
Headquarters Office—Oradell, N.J.

W.O. No. 3900-03 Calc. No. 60 42-03 Sheet 1 Cont. on Sheet 2

Title WPPSS-HANFORD No. 2 - ASSESS ACCIDENTAL SEISMIC TORSION ON BUILDINGS -

Abbrev. of Title : WNP2 ASSESS ACCIDENTAL TORSION ON BUILDINGS

LEAD SHEET 1 OF 1

CHECK PERFORMED IN ACCORDANCE WITH ENG'G. STD. P01510381, DATED January 1979 ; RESULTS ARE SATISFACTORY.
CHKR. SIGNATURE Yu-Kai Tu
DATE 10/7/81

PURPOSE

To assess accidental torsion of Ref. 2. This is in response to NRC-SEB Audit meeting in Woodbury, New York on 9/29/81 to 10/2/81. This is Issue #6.

References - in the body of the calculation - p.3,5,7.

Design Requirements - Civil Engineering Criteria Document, Rev. 8

Assumptions : none to be confirmed

Procedures : Add an accidental torsion as described in Ref. 2 at critical walls as described in Refs. 1 and 4. Assess these critical walls.

Computer Input/output : none

Conclusions : The maximum change in design margin is 6% in the Radwaste & Control Building but is still acceptable. By inspection, design margins in the Diesel Generator Building and Standby Service Water Pumphouse are acceptable.

Rev. No.	Description of Revision	Type (Prelim Design, Final Design, Study)	Originator Signature/Date	Checker Signature/Date	Approver Signature/Date
0	Original Issue	Final	[signature] 9/30/81	Yu-Kai Tu 10/7/81	[signature] 10/13/81

Form C01010402

ISSUE #6

BURNS AND ROE, INC.

W.O. No. 3900-03 Date 9/30/81 Book No. SXIV-6 Page No. 3
Drawing No. — Calc. No. 6.42-63 Sheet 2 of 6
By [signature] Checked [signature] 10/7/81 Approved [signature] 10/13/81 FINAL
Title WNP2 — ASSESS ACCIDENTAL SEISMIC TORSION ON BUILDINGS

Reactor Containment Building (RCB)

Ref. 1 : Bk. SV-669, Calc. 6.19-88

Ref. 2 NRC — SRP 3.7.2 Rev. 1 July 1981

Ref. 3. Bk. SV-480, Calc. 6.19-46

From Ref. 1, p.4, the lowest design margin is 1.09 for walls 3 & 4 which are the 2'-6" exterior walls in the N-S Direction at Elev. 471'-501'.

Also; from p.4, the maximum shear stress = 581.1 psi. of which 53.1 psi is due to torsion.

Add an additional 5% accidental torsion as delineated in Ref. 2 p. 3.7.2-10.

Maximum perpendicular building dimension from drawing S709 = 135'. Therefore, accidental eccentricity

$= 135' \times 0.05 = \underline{\underline{6.75'}}$

Maximum shear at level under consideration from Ref. 3 p. 21

$= \underline{55,927^k}$

Accidental torsion at El. 471 - 501'

$= 55,927^k \times 6.75' = 377,507.2$

The increase in torsional stress:

actual torsional moment = $492,411^{'k}$ Ref. 3, p. 23

Form BR 8002-2

ISSUE #6

BURNS AND ROE, INC.

W.O. No. 3900-03 Date 9/30/81 Book No. S-XIV-6 Page No. 4
Drawing No. —— Calc. No. 6.42-03 Sheet 3 of 6
By PJMR Checked 10/?/81 Approved 10/13/81
Title WNP2 ASSESS ACCIDENTAL SEISMIC TORSION ON BUILDINGS

new torsional moment 492,411 ' original torsion
377,507.2 accidental torsion
= 869,918.2 '

increase in torsional moment

$= \frac{869,918.2}{492,411} = \underline{1.7666}$

New torsional shear stress:

= 33.1 psi * 1.7666 = 58.47 psi

New overall shear stress:

$581.1 - 33.1 + 58.47 = 606.47$ psi
$\tau_{old\ torsion}$ $\tau_{new\ torsion}$

New design margin

$= \frac{632 \text{ psi} - p.4 \text{ Ref. } 1}{606.47}$

$= \underline{1.042} = 1.04$

Form BR 8002-2

ISSUE #6

BURNS AND ROE, INC.

W.O. No. 3900-03 Date 9/30/81 Book No. 5XIV-6 Page No. 5
Drawing No. Calc. No. 6.42-03 Sheet 4 of 6
By [illegible] Checked [illegible] 10/7/81 Approved [illegible] 10/13/81
Title WNP2 ASSESS ACCIDENTAL SEISMIC TORSION ON BUILDINGS

Radwaste and Control Building (RWB)

Ref. 4 Bk. 5VIII-82, Calc. 6.22-33

Ref. 5 Bk. 5VIII-74, Calc. 6.22-24

From Ref. 4 p. 43, the lowest design margin is 1.11 for wall on Column Line H3 between Lines 10 and 17 at Elev. 466'-486' (wall 12). This is an east-west exterior wall.
Also, from Ref. 4, p. 25 maximum shear = 13,886^k on Wall 12.

Add an additional 5% accidental torsion as delineated in Ref. 2 p. 3-7.2-10.

Maximum perpendicular building dimension from Ref. 5 p. 24 is 212'. Therefore the accidental eccentricity

$= 212 \times 0.05 = 10.6'$

Maximum shear at level under consideration from Ref. 5 p. 36 is 26,430^k

Accidental torsion at El. 466'-486'

$= 26,430^k \times 10.6^f = 280,158\ ^{1k}$

From distribution of forces to various walls, Wall 12 (see Ref. 5p32A) gets an additional force due to the accidental torsion

$F_v = 0.00306 \times 280,158 = 857.28^k$
on Wall 12 (p32A)

Form BR 8002-2

ISSUE #6

BURNS AND ROE, INC.

W.O. No. 3900-03 Date 9/30/81 Book No. JXIV-6 Page No. 6
Drawing No. ______ Calc. No. 6.42-07 Sheet 5 of 6
By [signature] Checked [signature] 10/3/81 Approved [signature] 10/13/81
Title WNP2 - ASSESS ACCIDENTAL SEISMIC TORSION ON BUILDINGS

Total shear on Wall 12 . 13,886^k orig. shear
857.28 accidental torsion
= 14,743.28^k

New design margin

$= F.S. \times \frac{13886}{14743.28} = 1.0454$

$= 1.05$

Ref. 4 p. 43

Form BR 8002-2

ISSUE #6

BURNS AND ROE, INC.

W.O. No. 3900-03 Date 9/30/81 Book No. 5XIV-6 Page No. 7
Drawing No. — Calc. No. 6.42-03 Sheet 6 of 6
By [signature] Checked [signature] 10/7/81 Approved [signature] 10/13/81
Title WNP2 - ASSESS ACCIDENTAL SEISMIC TORSION ON BUILDINGS

Diesel Generator Building (DGB)

Ref. 6 Bk. 5XII-36, Calc. 6.21-10.

From Ref. 6 p. 16, the lowest design margin = 3.1

Standby Service Water Pumphouse (SSWPH)

Ref. 7 Bk. 5II-16, Calc. 6.07-02

From Ref. 7, pp 17, 24 & 25 the lowest design margin = 1.60

Assessment for DGB & SSWPH

These design margins are very large and are, by inspection, OK for the accidental torsion.

Form BR 5002-2

Q. 130.059
(Q220.10)
(3.7.2)

Confirm if an accidental torsional effect (5% of the base dimension) was considered in your design of all Category I structure in addition to the geometrical torsional effect, if applicable.

Response:

The revised response to Question 130.024 gives design margins for Category I buildings that includes coupling between translation and torsion.

Considering an accidental torsion as described in SRP 3.7.2, Revision 1, our lowest design margin in the reactor building changes from 1.09 to 1.04. Our lowest design margin in the radwaste building changes from 1.11 to 1.o5. These values change by less than 6% and the resulting adequacy is shown to be acceptable. For the diesel generator building and standby service water pumphouse, the design margins are of such a magnitude that by inspection, the accidental torsions have a negligible effect on these design margins.

Attachment to response to Question 130.059

Q. 130.024
(3.7.2)

For non-symmetric structures, there may be dynamic coupling between translational and torsional motions. As a result, calculating the torsional moment as the product of the inertial force and the distance between the centers of mass and rigidity may or may not be adequate. Accordingly, provide in Section 3.7.2.11 of the FSAR, the bases for your approach. Indicate how the torsional effects were included in the generation of the floor response spectra.

Response:

The present torsional moments are calculated according to the criteria in 3.7.2.11 as the product of the inertial force and the distance between the center of mass and the center of rigidity, such distance being not less than the eccentricity required by the Uniform Building Code.

Calculation of torsional effects using a dynamic analysis that considers coupled translational and torsional degrees of freedom as referred to in the question has been performed. The new torsional effects have been compared with those of the present design. Structures subjected to the new torsional moments have been investigated and are found to be structurally adequate under the new torsional loads considered in conjunction with the applicable load combinations.

Assessment of the shear walls under load combinations involving torsional loads are expressed in terms of their design margins in Tables Q. 130.024-1 through Q. 130.024-4. The design margins represent the ratio of the permissable stress to the actual calculated stress under the controlling load combination. The values of the design margins in the tabulations are the minimum margins for all the shear walls, both exterior and interior, as applicable, on the floor levels of each building.

TABLE 130.024-1

REACTOR BUILDING
EXTERIOR WALLS AND BIOLOGICAL SHIELD WALL
DESIGN MARGINS

FLOOR ELEVATIONS	DESIGN MARGINS: EXTERIOR SHEAR WALLS BETWEEN FLOOR ELEVATIONS	DESIGN MARGINS: BIOLOGICAL SHIELD WALL BETWEEN FLOOR ELEVATIONS
606'-10½"		
	1.27	1.62
572'-0"		
	1.13	1.82
548'-0"		
	1.15	1.51
522'-0"		
	1.11	1.54
501'-0"		
	1.09	1.33
471'-0"		
	1.15	1.38
443'-0"		
	1.15	Not Applicable
422'-3"		

TABLE Q. 130.024-2

RADWASTE AND CONTROL BUILDING
EXTERIOR AND INTERIOR SHEAR WALLS
DESIGN MARGINS

FLOOR ELEVATIONS	DESIGN MARGINS EXTERIOR AND INTERIOR SHEAR WALLS BETWEEN FLOOR ELEVATIONS
532'-0"	
	1.36
525'-0"	
	1.16
507'-0"	
	1.20
501'-0"	
	1.14
487'-0"	
	1.20
484'-0"	
	1.20
467'-0"	
	1.11
437'-0"	

FOR NEO

TABLE Q. 130.024-3

DIESEL GENERATOR BUILDING
EXTERIOR AND INTERIOR SHEAR WALLS
DESIGN MARGINS

FLOOR ELEVATIONS	DESIGN MARGINS EXTERIOR AND INTERIOR SHEAR WALLS BETWEEN FLOOR ELEVATIONS
472'-9"	
	4.50
455'-0"	
	3.10
441'-0"	

TABLE Q. 130.024-4

STANDBY SERVICE WATER PUMPHOUSE
EXTERIOR AND INTERIOR SHEAR WALLS
DESIGN MARGINS

FLOOR ELEVATIONS	DESIGN MARGINS EXTERIOR AND INTERIOR SHEAR WALLS BETWEEN FLOOR ELEVATIONS
465'-5"	
	6.80
441'-0"	
	1.60
408'-3"	

NRC - SEB

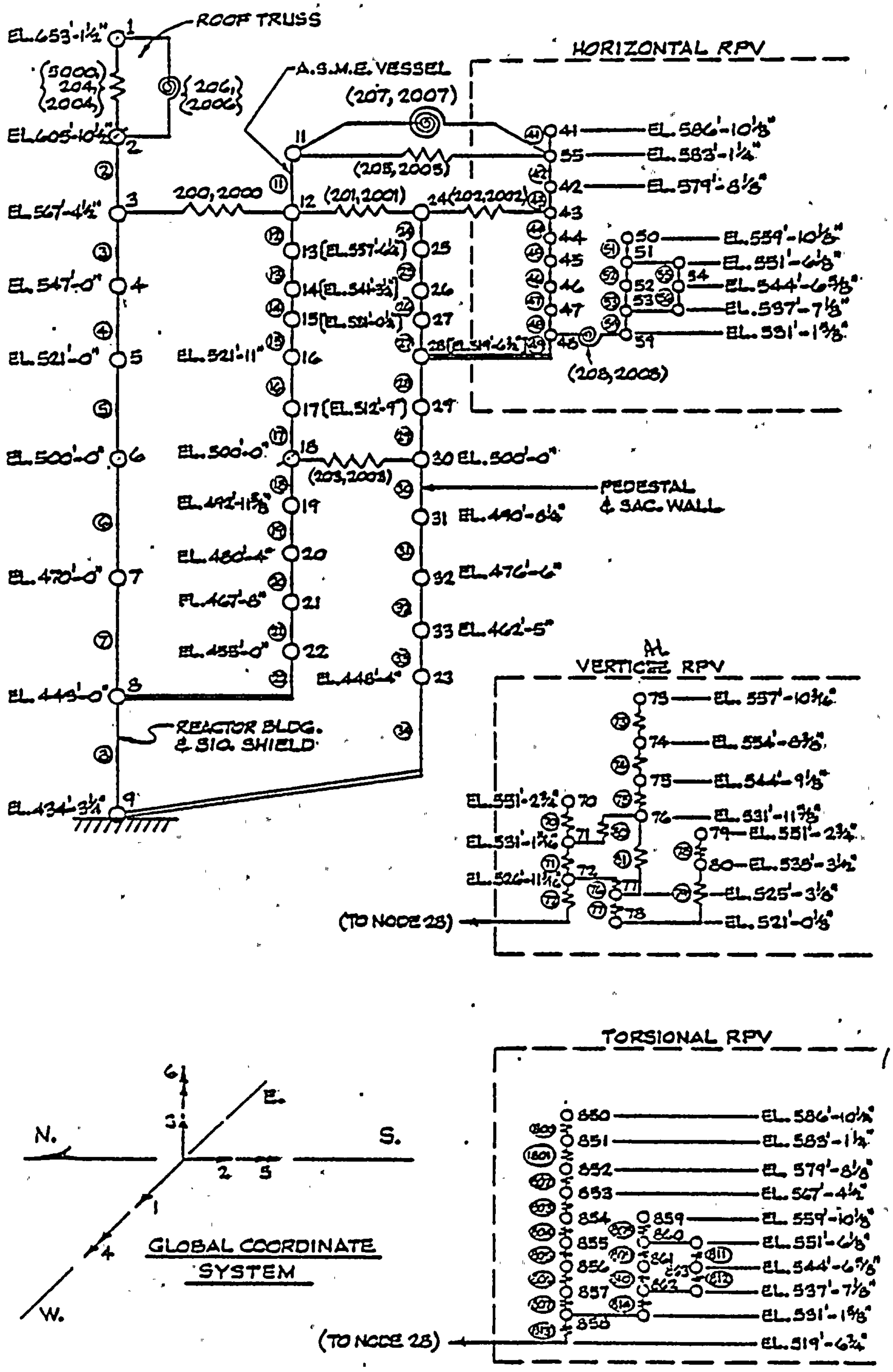
ISSUE #7

Furnish comparison of the seismic analysis model used in the design of structures with the more simplified model used in more recent studies and show that the corresponding mode shapes and frequency content are comparable.

RESPONSE

The reduced (simplified) and full models of the reactor building are shown in the figures attached. An eigen value solution was obtained for each model and corresponding natural frequencies and natural mode shapes are compared. The good agreement noted indicates the equivalence of the two models for the reactor building.

ISSUE #7

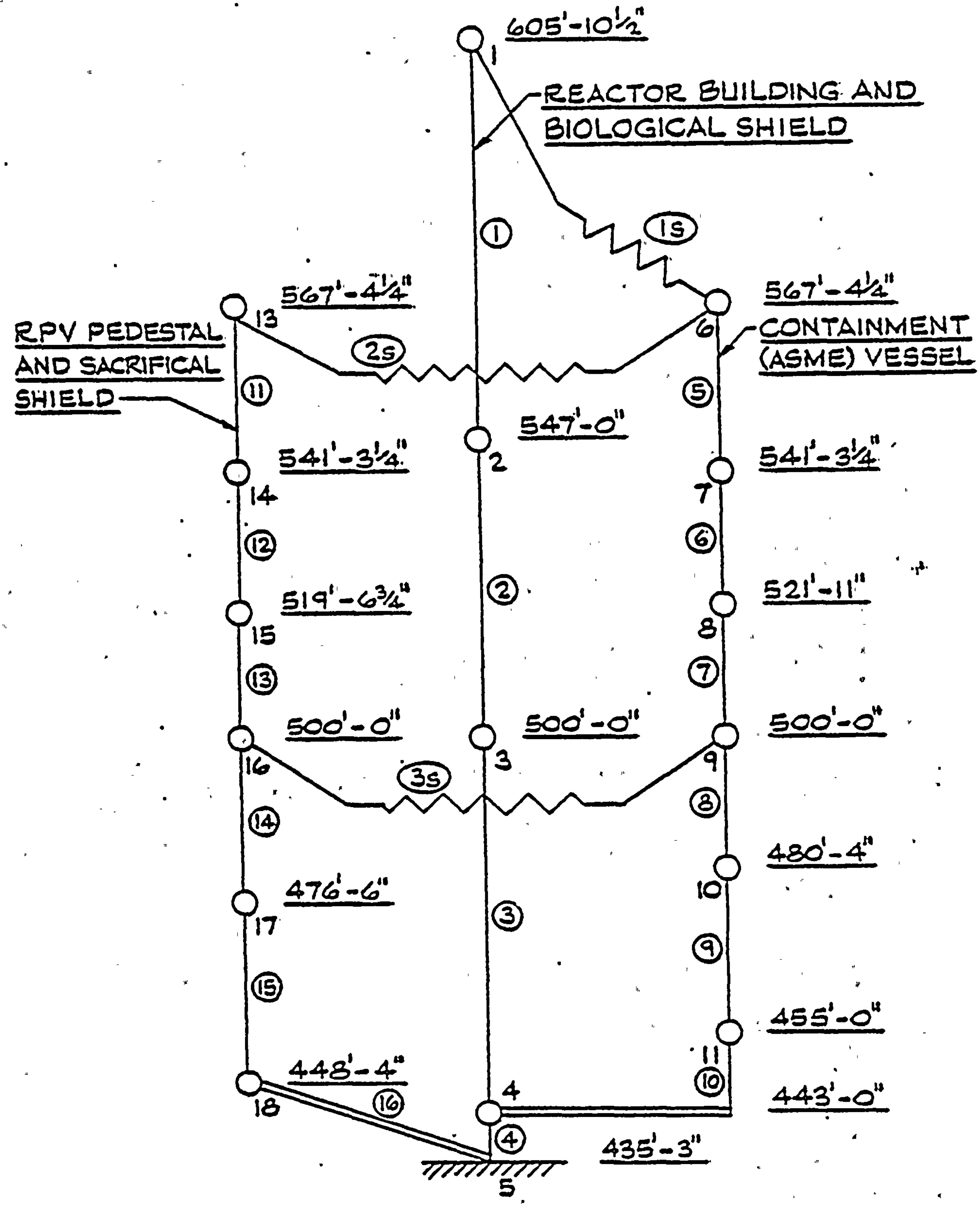


WASHINGTON PUBLIC POWER SUPPLY SYSTEM
NUCLEAR PROJECT NO. 2

3-D MATH MODEL FOR REACTOR BLDG (N-S, E-W)

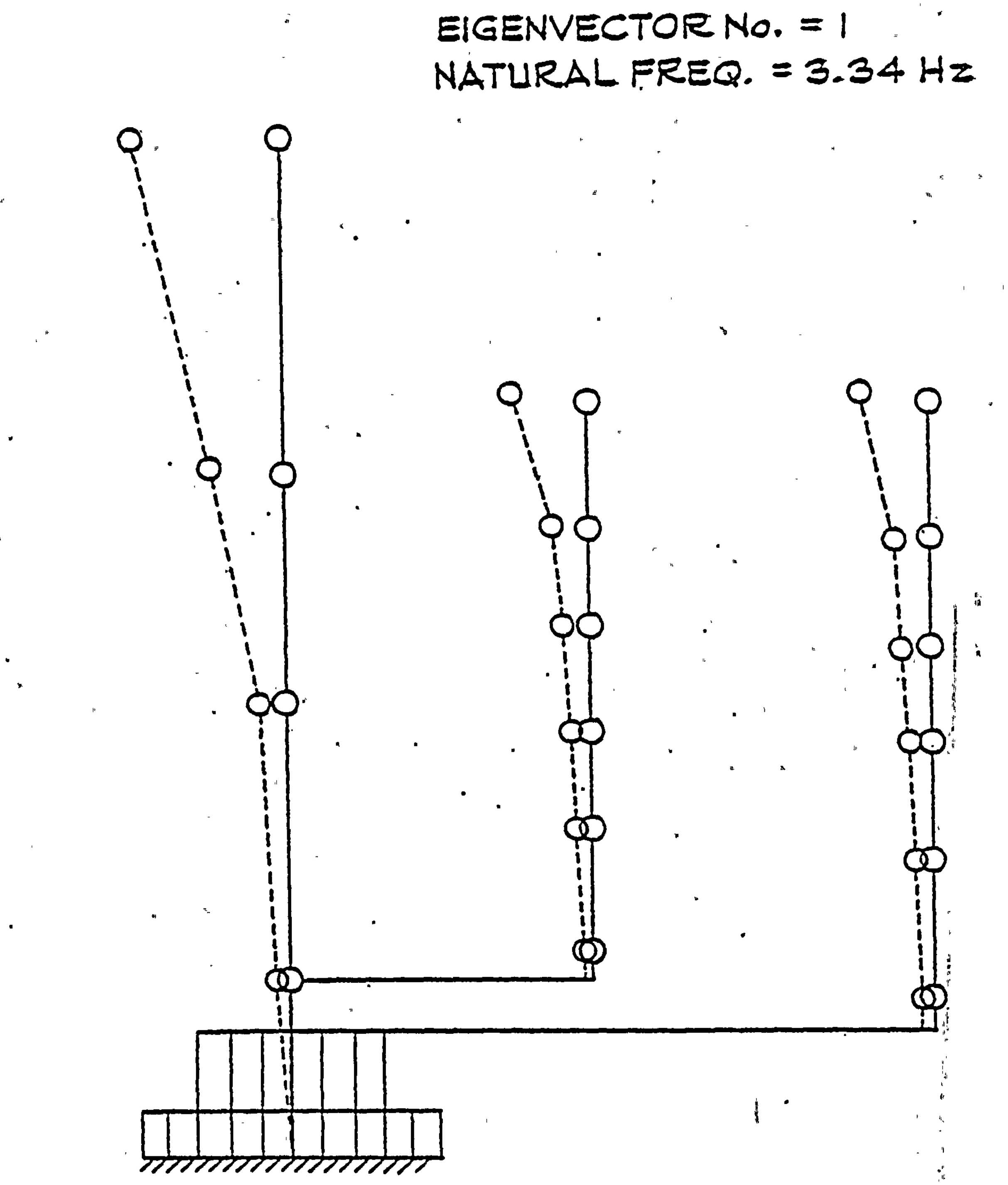
FIGURE 3.3

ISSUE #7



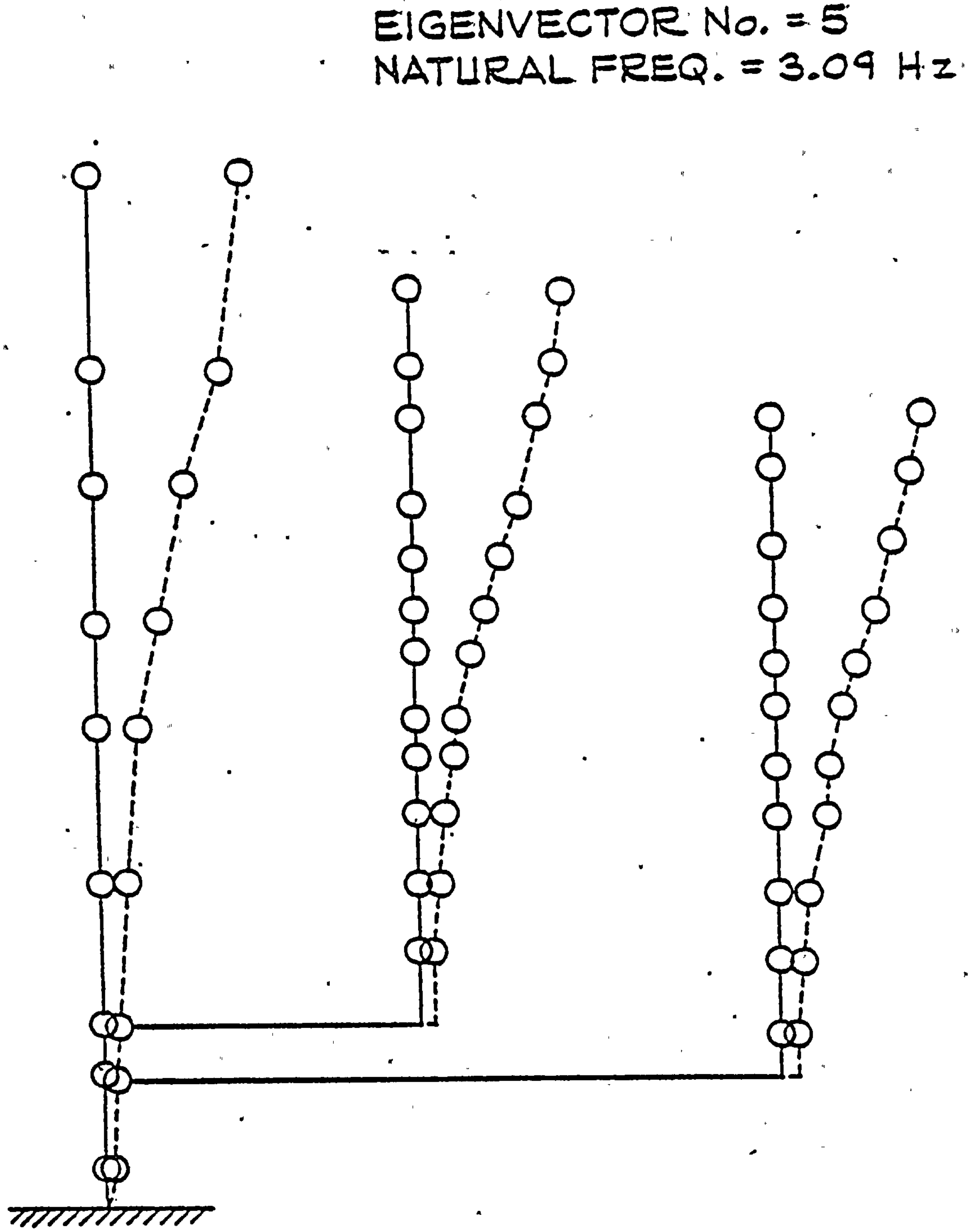
WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT NO. 2.	2-D REDUCED REACTOR BLDG. MATH MODEL (N-S & E-W)	FIGU 3--

ISSUE #7



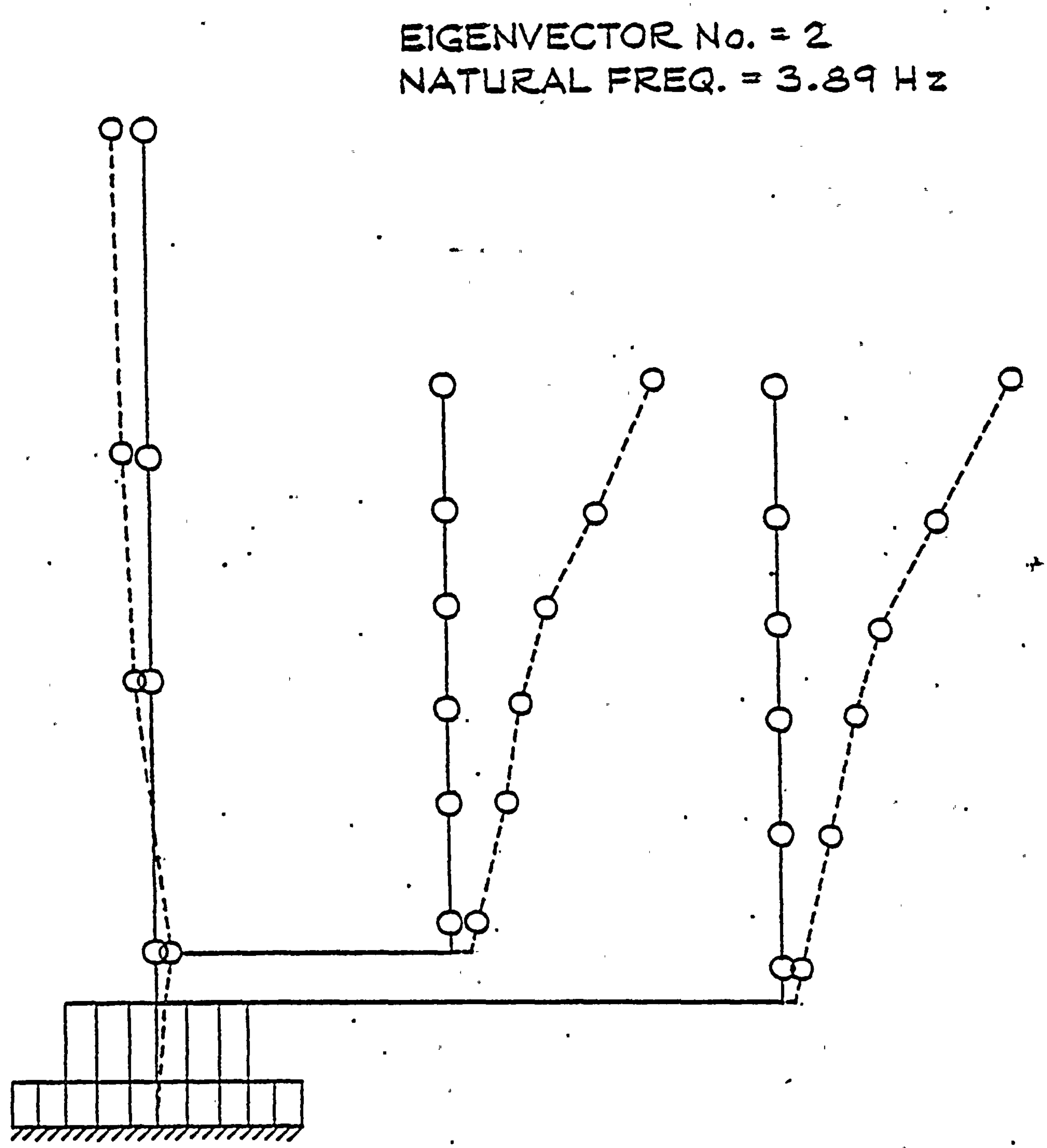
WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT NO. 2	REDUCED REACTOR BLDG.	FIGURE 3-5 A(1)

ISSUE #7



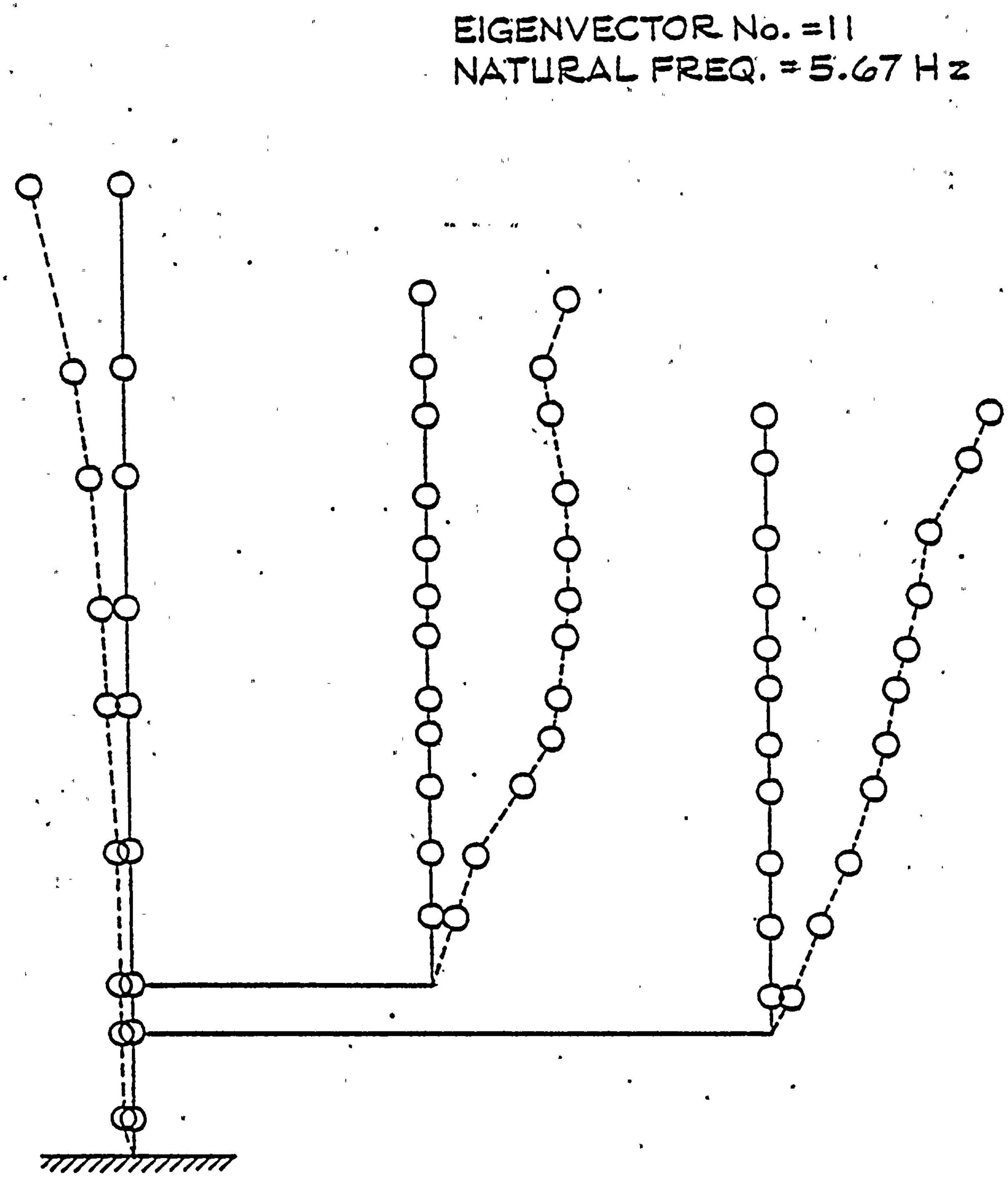
WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT NO. 2.	REACTOR BLDG. - FULL MODEL	FIGURE 3-5 A(2)

ISSUE #7



WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT NO. 2	REDUCED REACTOR BLDG.	FIGURE 3-5 B(1)

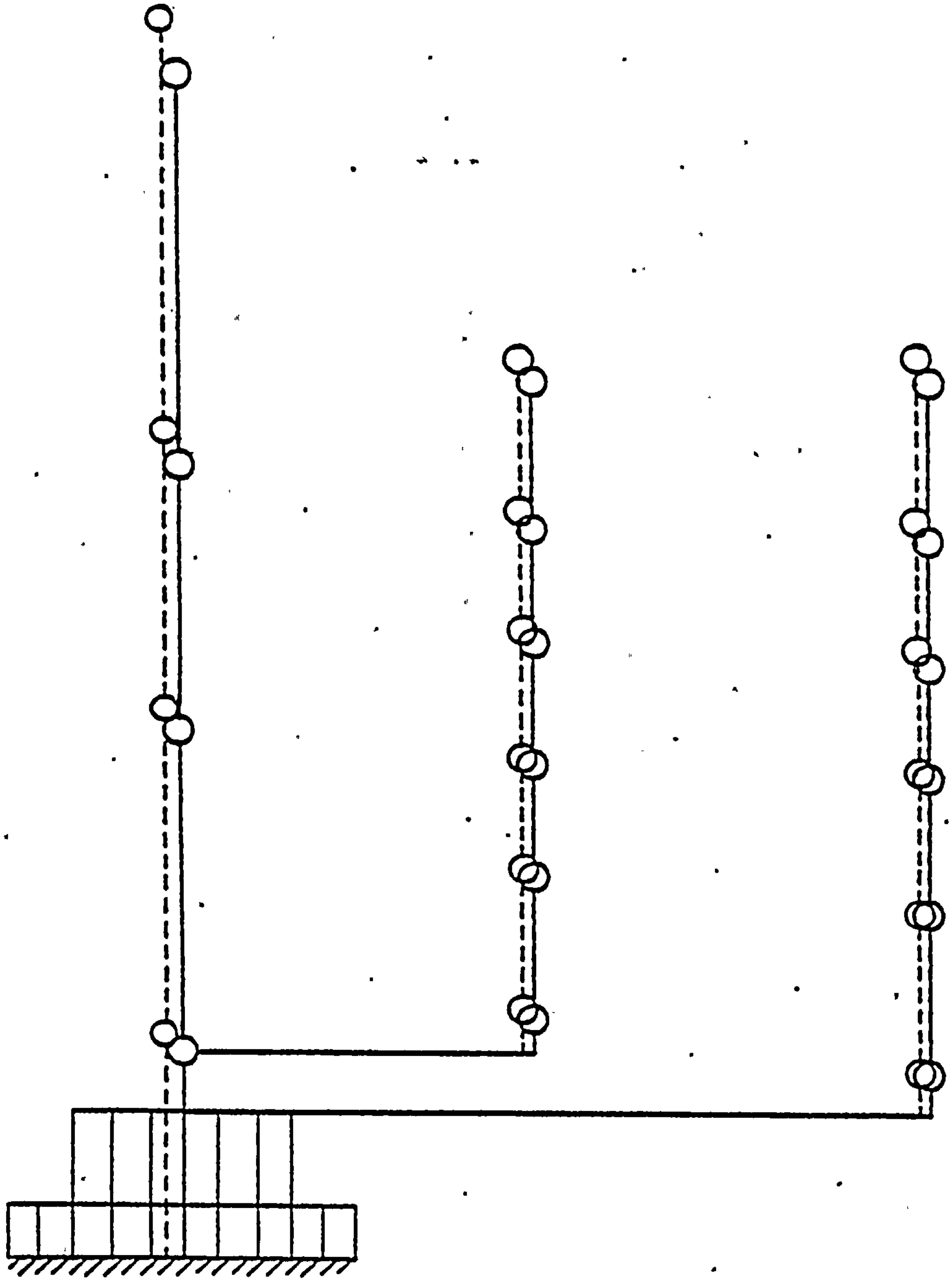
ISSUE #7



WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT NO. 2.	REACTOR BLDG.-FULL MODEL	FIGURE 3-5 B(2)

ISSUE #7

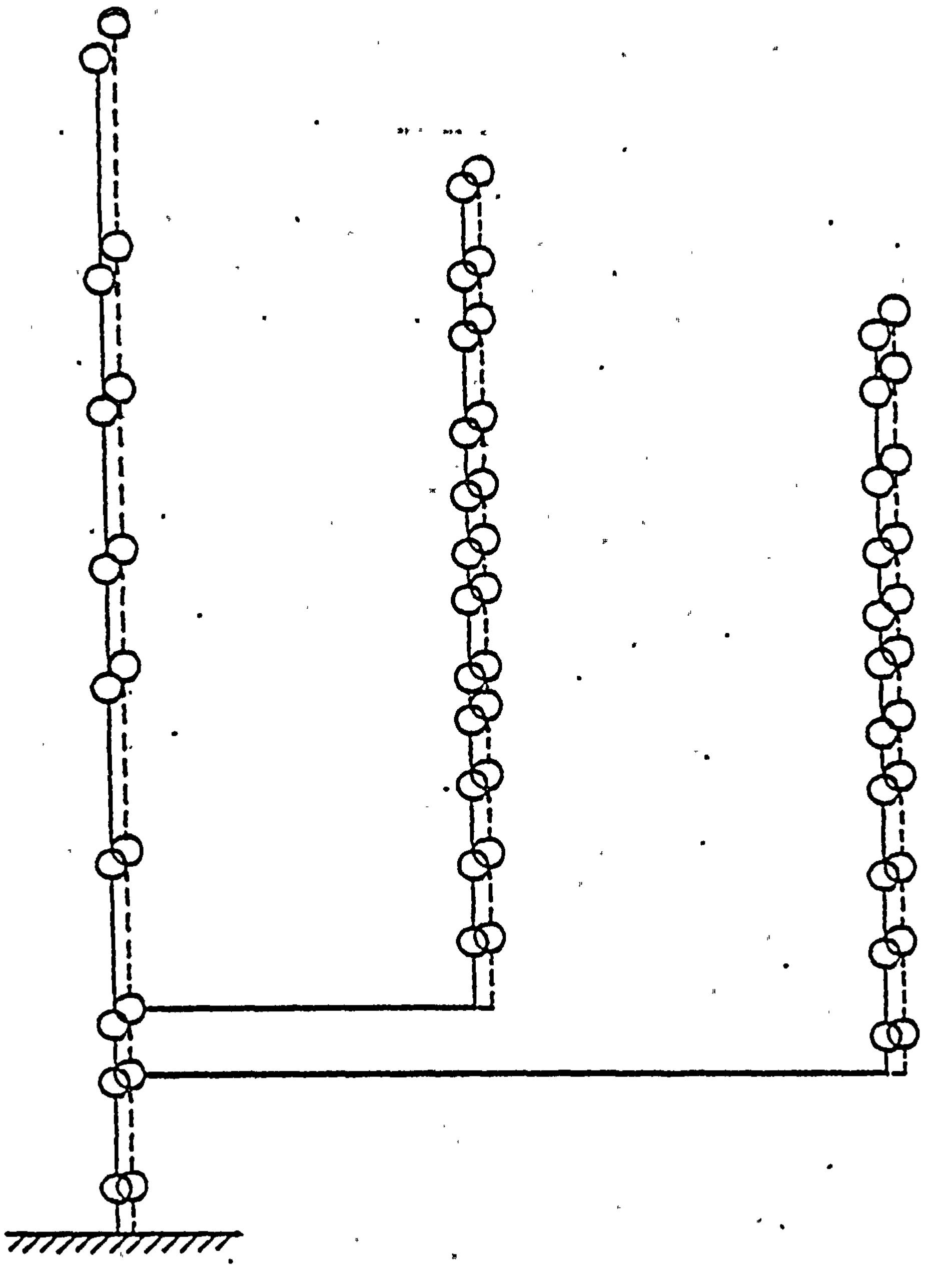
EIGENVECTOR No. = 4
NATURAL FREQ. = 9.78 Hz



WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT NO. 2	REDUCED REACTOR BLDG.	FIGURE 3-5 C(1)

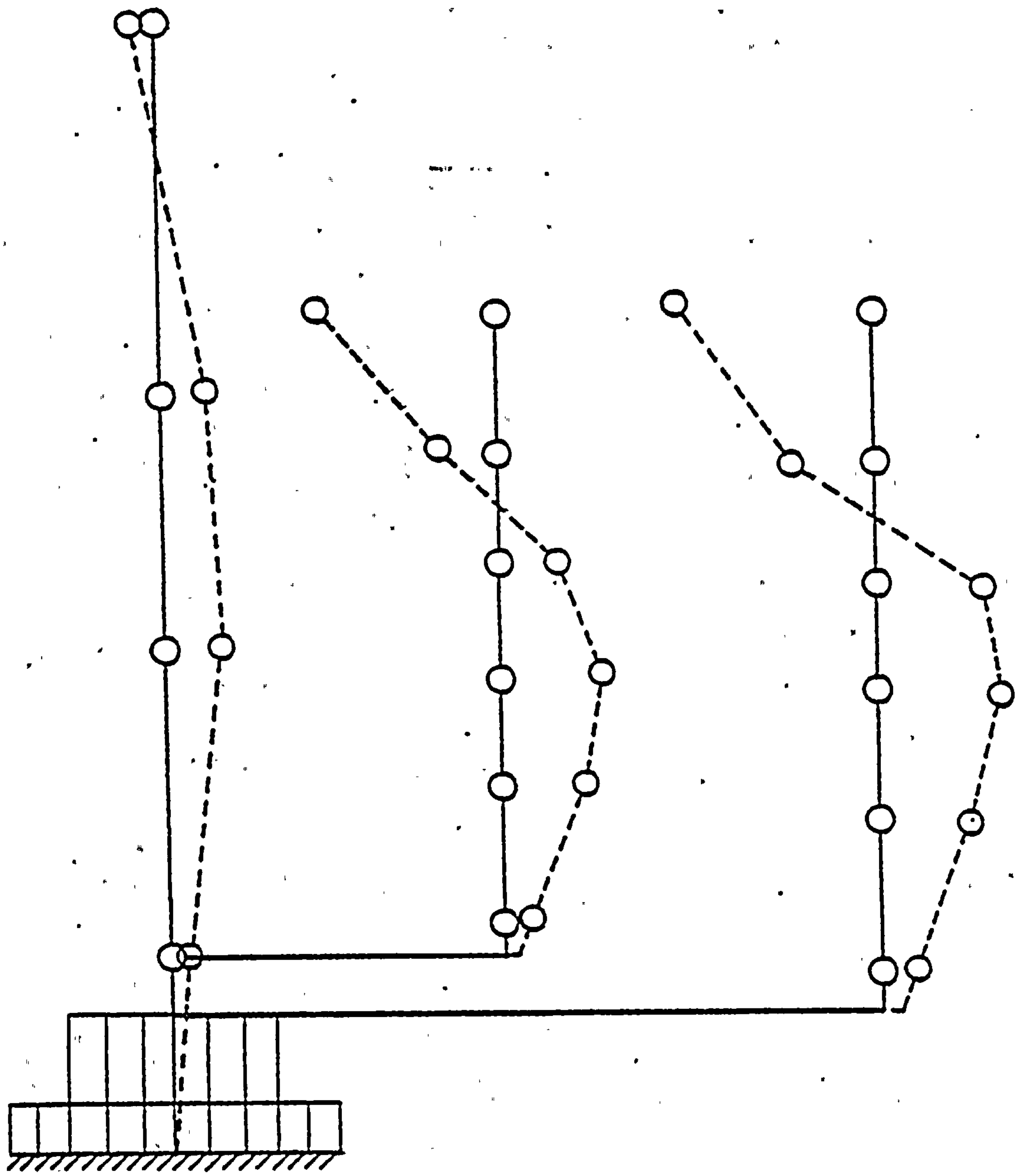
ISSUE #7 7

EIGENVECTOR No. = 17
NATURAL FREQ. = 9.70 Hz



WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT NO. 2	REACTOR BLDG. - FULL MODEL	FIGURE 3-5 C(2)

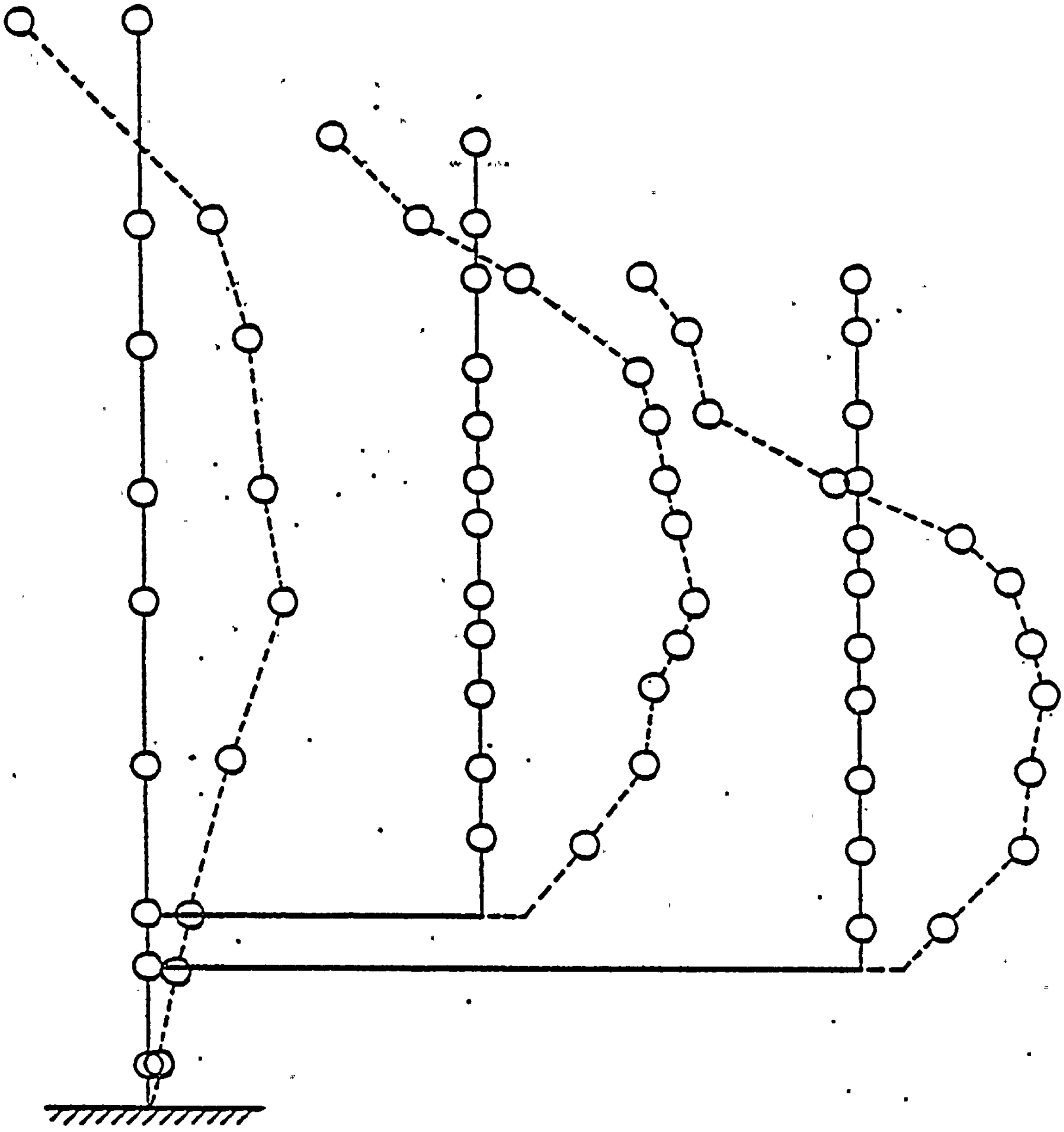
EIGENVECTOR No. = 3
NATURAL FREQ. = 9.71 Hz



WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT NO. 2	REDUCED REACTOR BLDG.	FIGURE 3-5 D(1)

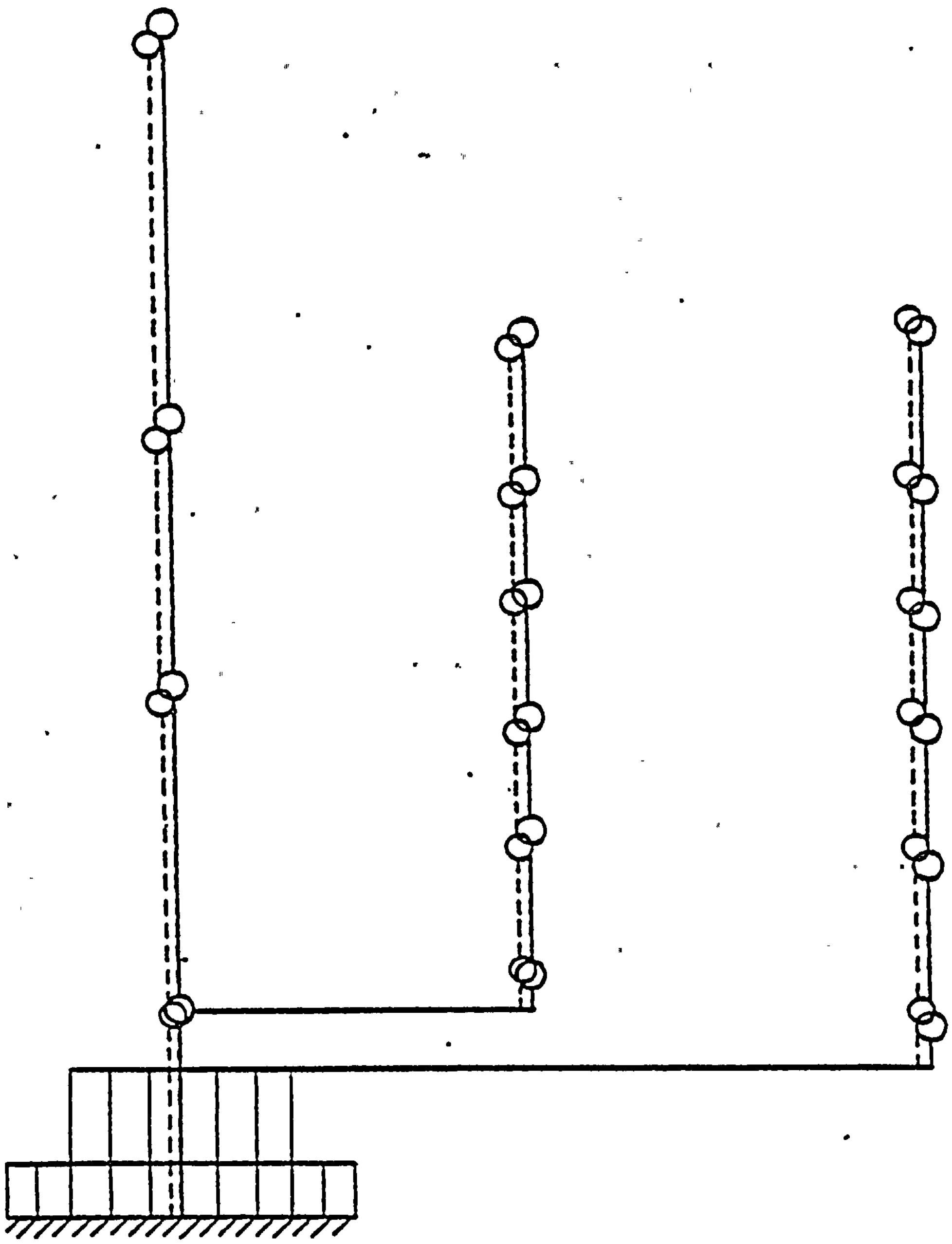
ISSUE #7

EIGENVECTOR No. = 18
NATURAL FREQ. = 10.19 Hz



WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT NO. 2	REACTOR BLDG. - FULL MODEL	FIGURE 3-5 D(2)

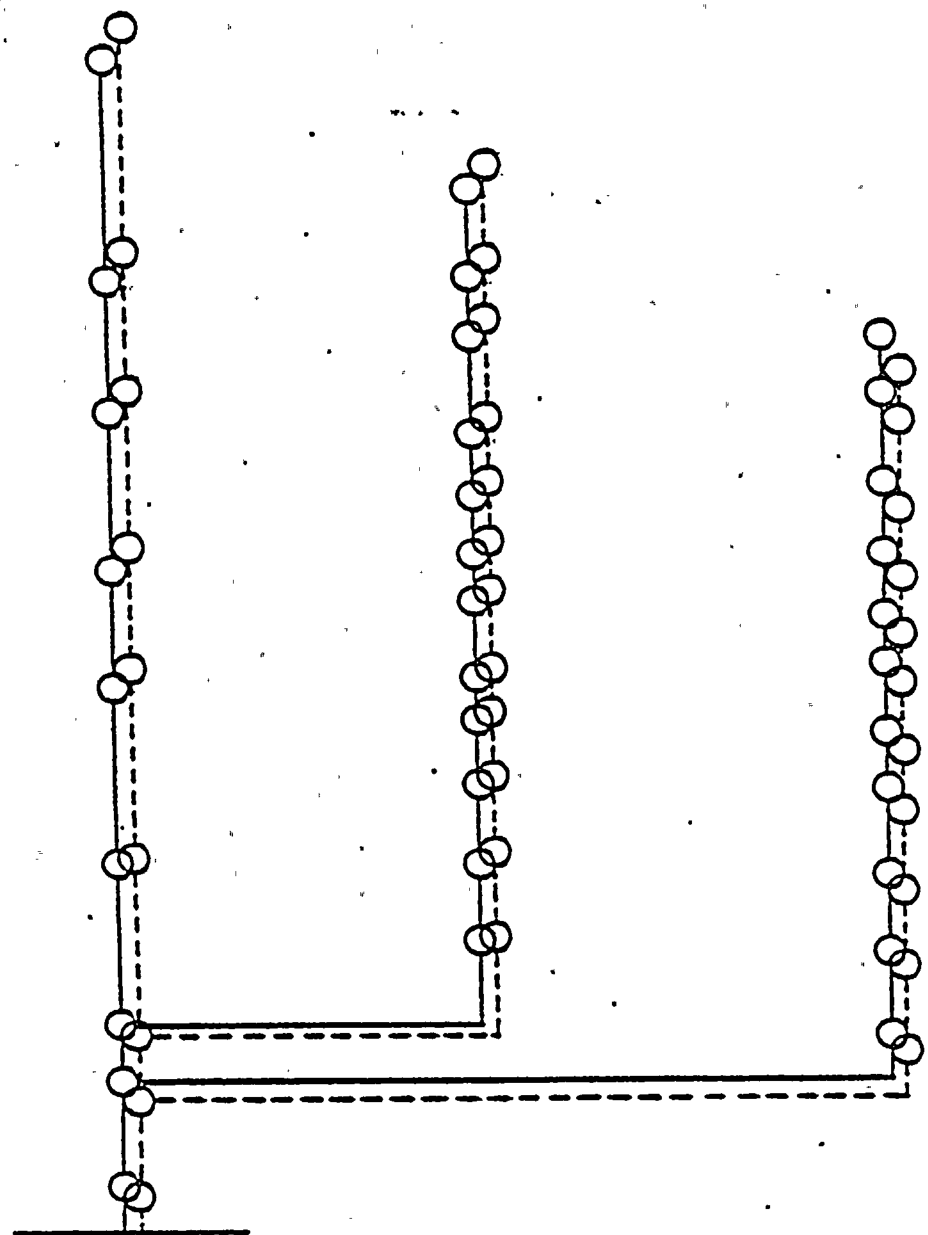
EIGENVECTOR No. = 6
NATURAL FREQ. = 9.98 Hz



WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT NO. 2	REDUCED REACTOR BLDG.	FIGURE 3-5 E(1)

ISSUE #7

EIGENVECTOR No. = 23
NATURAL FREQ. = 12.06 Hz



WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT NO. 2	REACTOR BLDG. - FULL MODEL	FIGURE 3-5 E(2)

NRC - SEB

ISSUE #8

Confirm that the design response spectra used for the RPV support and basemat are higher than those obtained in the structure/structure interaction study.

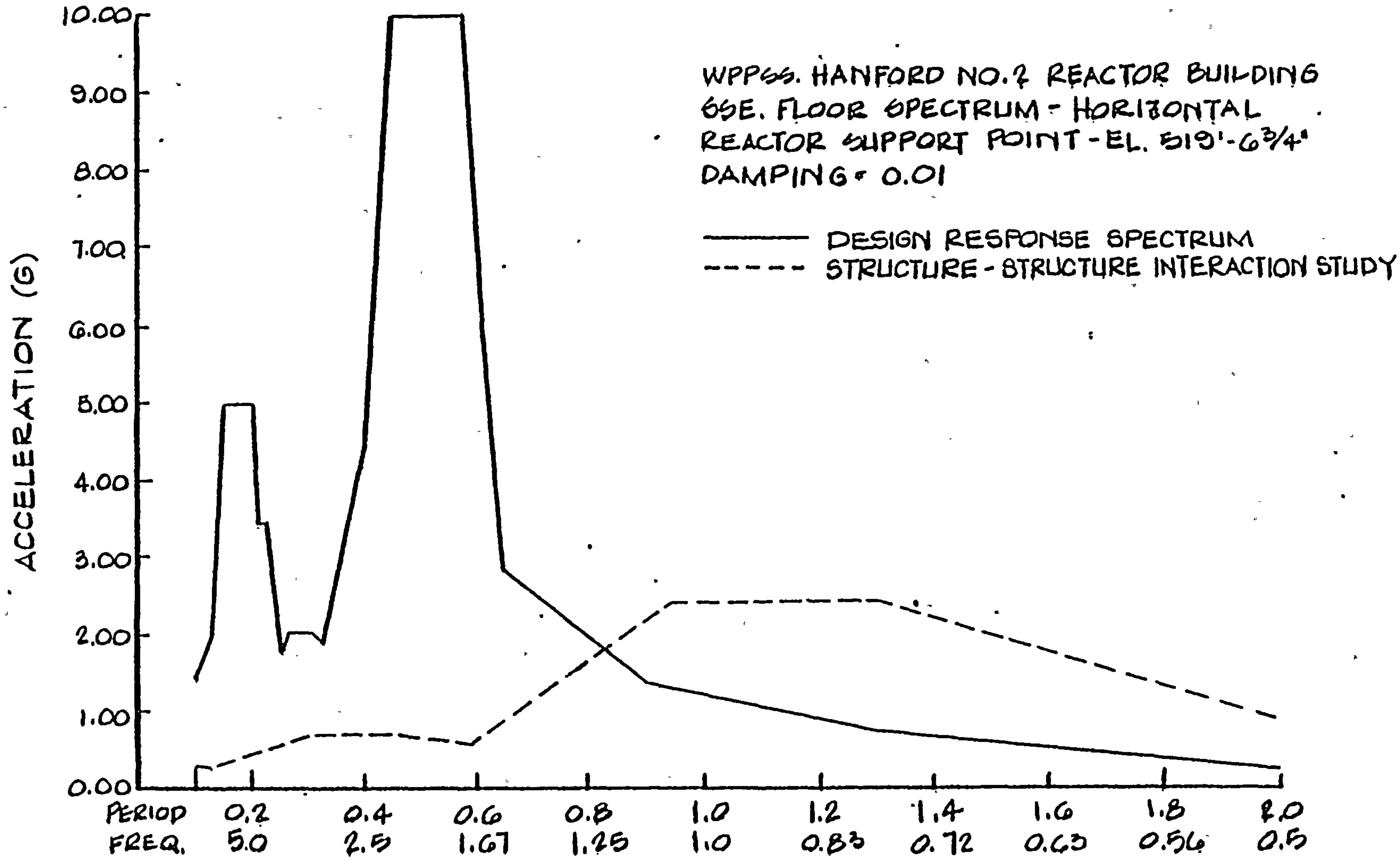
Response:

The attached figures show that the design response spectra at the RPV support and basemat are higher than those obtained in the structure/structure interaction study at all frequencies of concern (higher than 1.0 H_z approx.).

WASHINGTON PUBLIC POWER SUPPLY SYSTEM
NUCLEAR PROJECT NO. 2

COMPARISON OF RESPONSE SPECTRUM - DESIGN VERSUS STRUCTURE - STRUCTURE INTERACTION

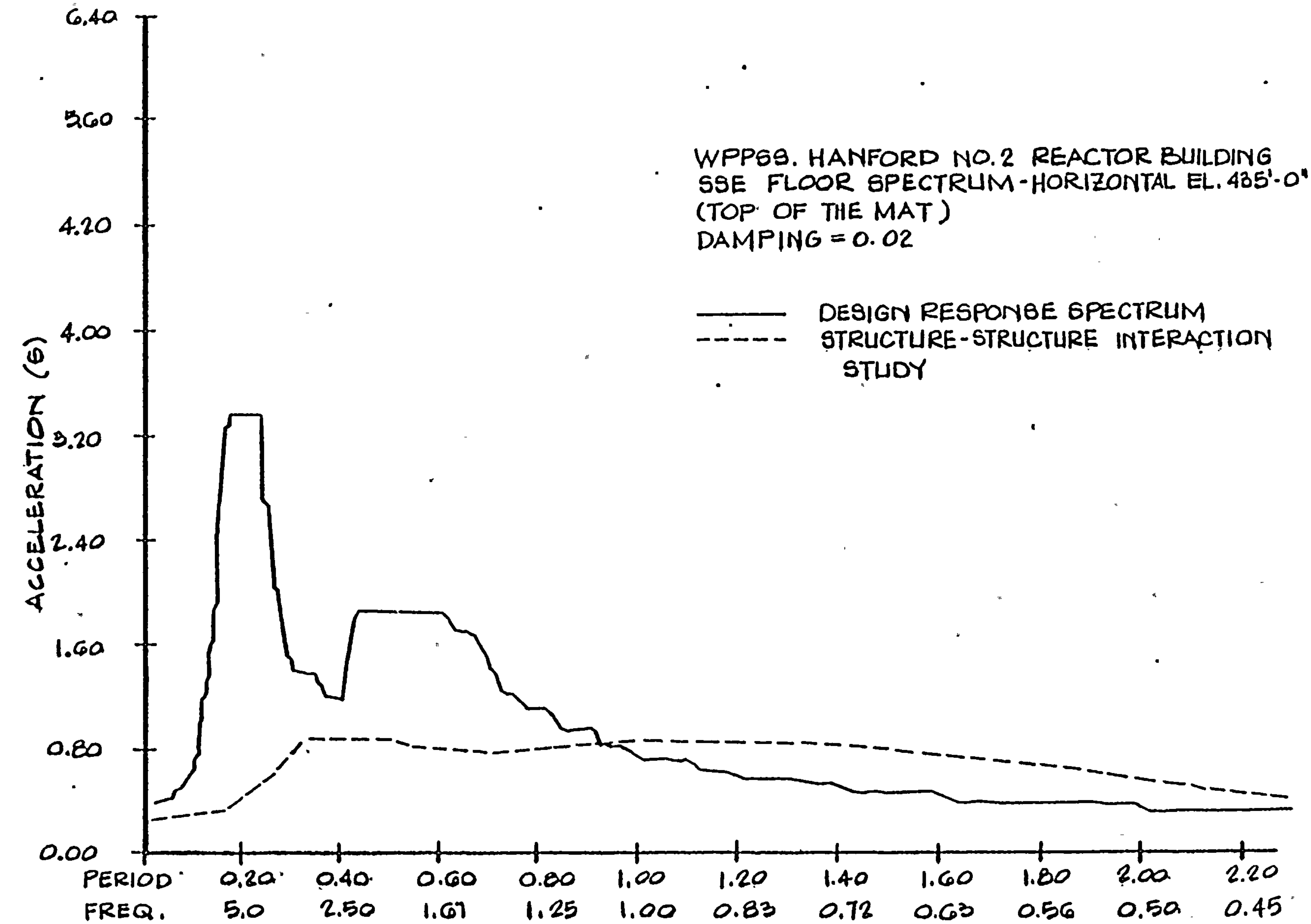
FIGURE 1



WASHINGTON PUBLIC POWER SUPPLY SYSTEM
NUCLEAR PROJECT NO. 2

COMPARISON OF RESPONSE SPECTRUM - DESIGN VERSUS STRUCTURE - STRUCTURE INTERACTION

FIGURE 2



NRC-SEB

ISSUE #9

a) Provide a comparison of floor response spectra at key locations (mat level, reactor supports, operating floor, crane support, reactor building apex, top of containment vessel, intersection of drywell floor and containment) obtained from the following analyses:

1) Original soil spring analysis in FSAR

2) Finite element analysis (FLUSH)

3) Compliance function analysis (NASTRAN)

b) Confirm that in FLUSH, the input motion was applied at the foundation level in the free field and appropriate soil property variations were accounted for.

c) Provide a discussion on the assumptions and limitations used in the Compliance Function Analysis. If the design curves at WNP-2 are exceeded by any other analysis locally, discuss the acceptability of such exceedance based on safety margin considerations.

RESPONSE

a) The comparison required is provided in the attached figures. As seen from these figures the results of the original soil spring analysis (described in FSAR) envelope the results of the other two analyses at all frequencies of concern in WNP-2 design.

b) In the FLUSH analysis, the input motion was applied at the foundation level and soil property variations were accounted for.

c) Main assumptions and limitations of two-step approach (compliance function analysis).

A two-dimensional, plane strain, horizontally layered model of the soil deposit was used. The bottom boundary (soil-rock interface) is considered rigid.

The lateral boundaries transverse to the plane of motion were sufficiently remote from the SSI zone, so as to eliminate artificial reflexions of outgoing

waves (its location was checked by a sensitivity analysis). The out-of-plane radiation of energy is modeled by providing viscous dashpots of appropriate magnitude at all nodes of soil model (same as in the FLUSH algorithm, so-called "viscous" boundaries). The soil physical properties - shear modulus and hysteretic damping factor - were assumed constant for each element. However, their values were obtained from the last step of the FLUSH iterative procedure, so as to take into account their dependence on the shear strain magnitude. The input motion, applied at the base of the soil springs, was taken as the horizontal design motion at foundation level. No rotational input was used. The foundation rocking motion was, however, computed, as the response of the structural model, supported by two soil springs (swaying + rocking), to the above mentioned horizontal input motion.

Inspection of the Figures #1 through #4 provided with this response shows that the response spectra developed by the original soil spring analysis (in the FSAR) envelope the finite element (F.E.) FLUSH analysis spectra for frequencies of interest/concern (larger than 1.3 Hz approximately). Since equipment frequencies are higher than 1.3 Hz, this would be acceptable.

The comparison of Figures #1 through #4 also shows that the response spectra developed by the original soil spring analysis (in the FSAR) envelope the compliance function analysis (NASTRAN) spectra for frequencies larger than 1.3 Hz, with the exception of the reactor building mat in the frequency range of 2.2 Hz to 3.6 Hz.

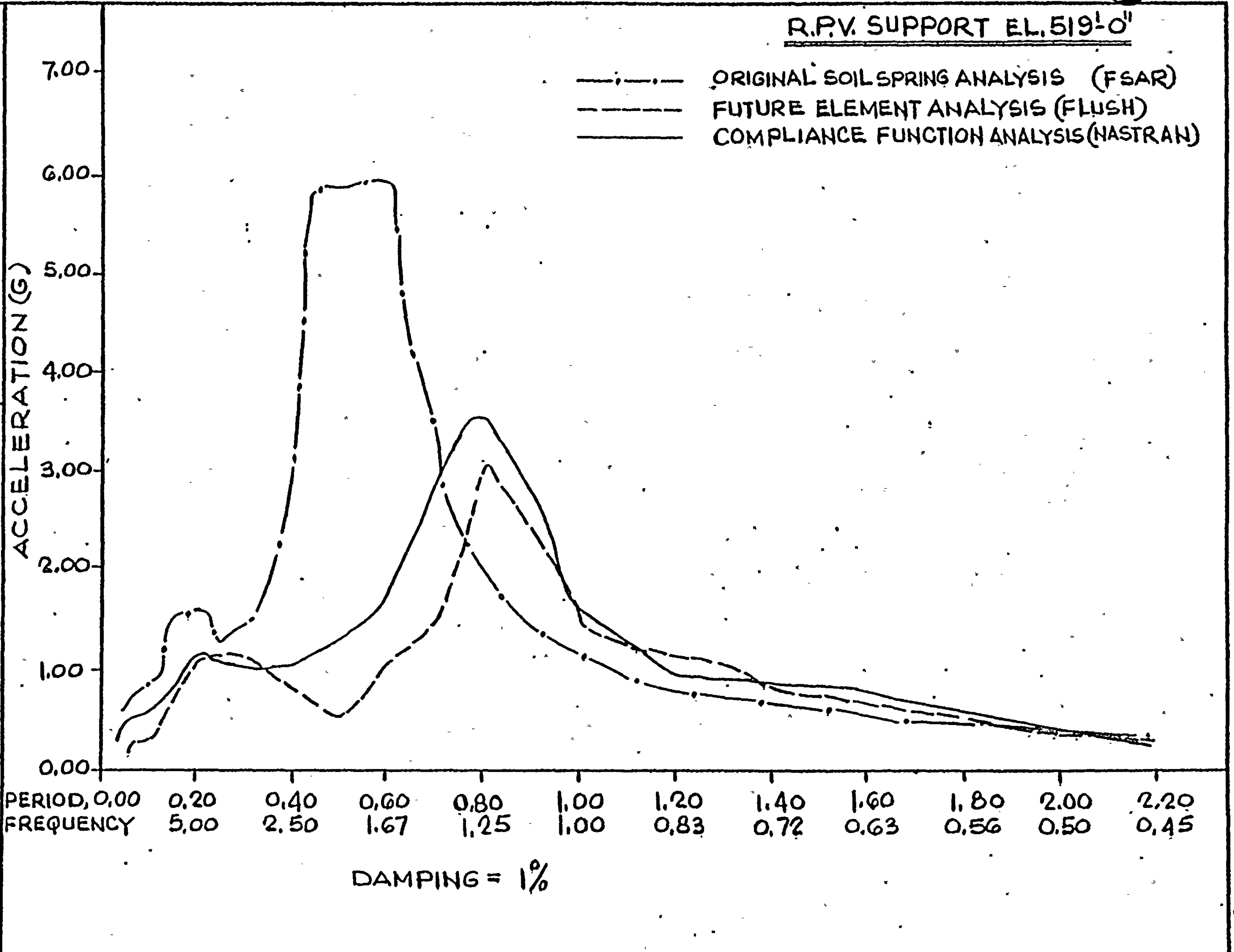
Examination of representative Seismic Category I equipment on the reactor building mat demonstrates that the equipment fundamental frequencies are greater than 3.6 Hz or have been designed to accelerations greater than the exceedance level shown on the respective curves.

Please refer to Issue #17 and Question 130.055 for additional information.

WASHINGTON PUBLIC POWER SUPPLY SYSTEM
NUCLEAR PROJECT NO. 2

COMPARISON OF DIFFERENT SEISMIC ANALYSIS METHOD

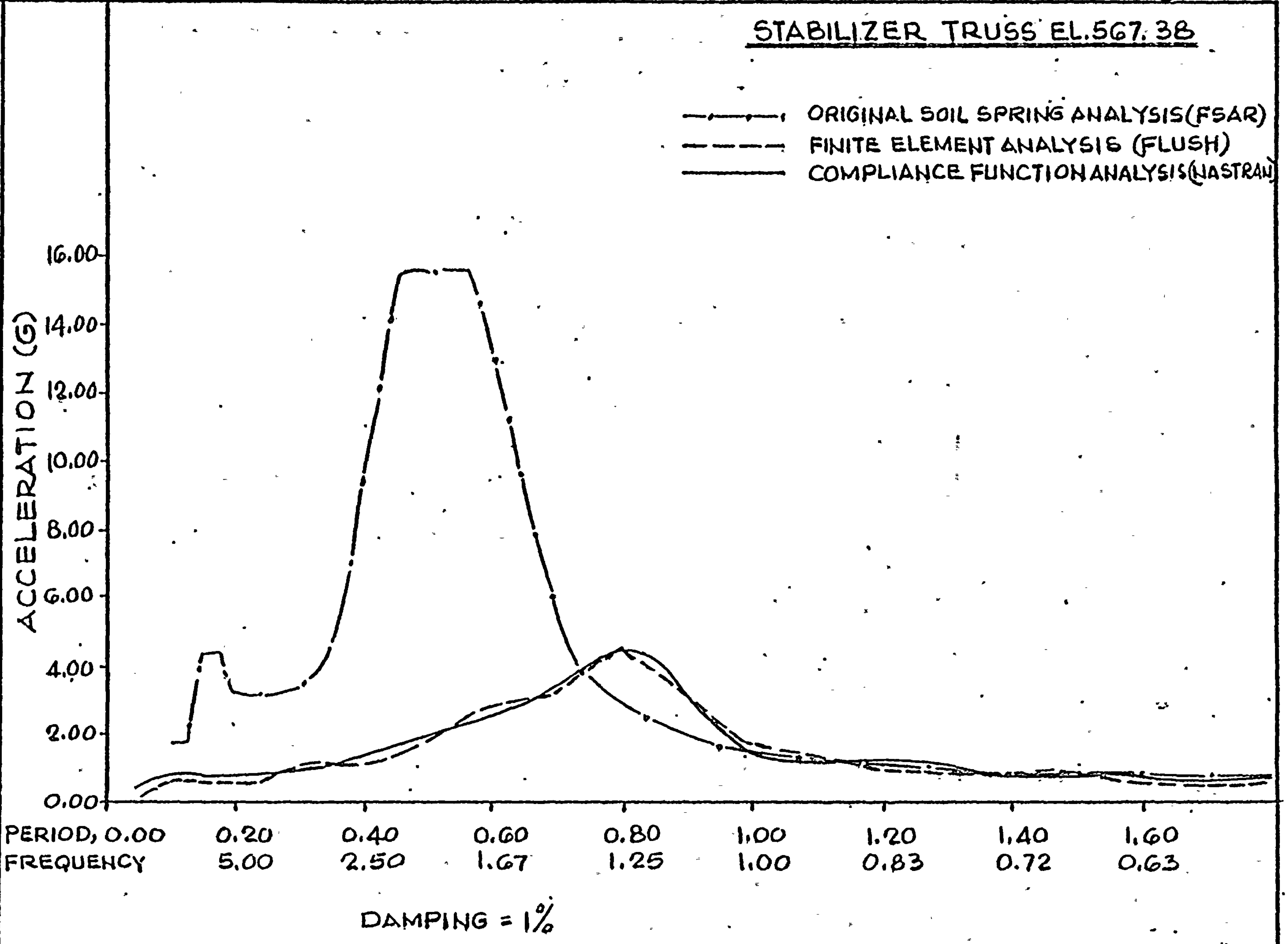
FIGURE 1
ISSUE 9

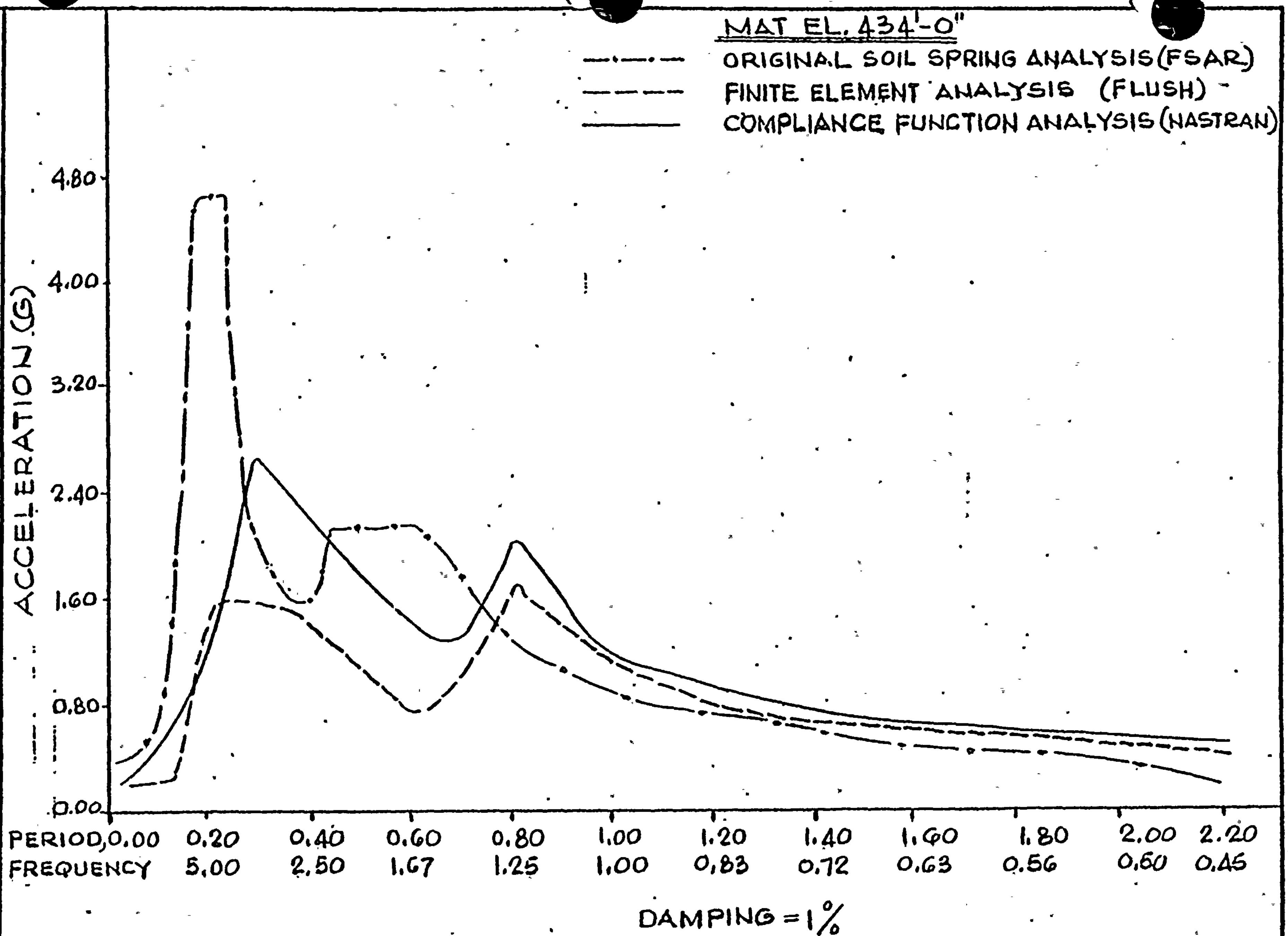


WASHINGTON PUBLIC POWER SUPPLY SYSTEM
NUCLEAR PROJECT NO. 2

COMPARISON OF DIFFERENT SEISMIC ANALYSIS METHOD

FIGURE 2
ISSUE 2





WASHINGTON PUBLIC POWER SUPPLY SYSTEM
NUCLEAR PROJECT NO. 2

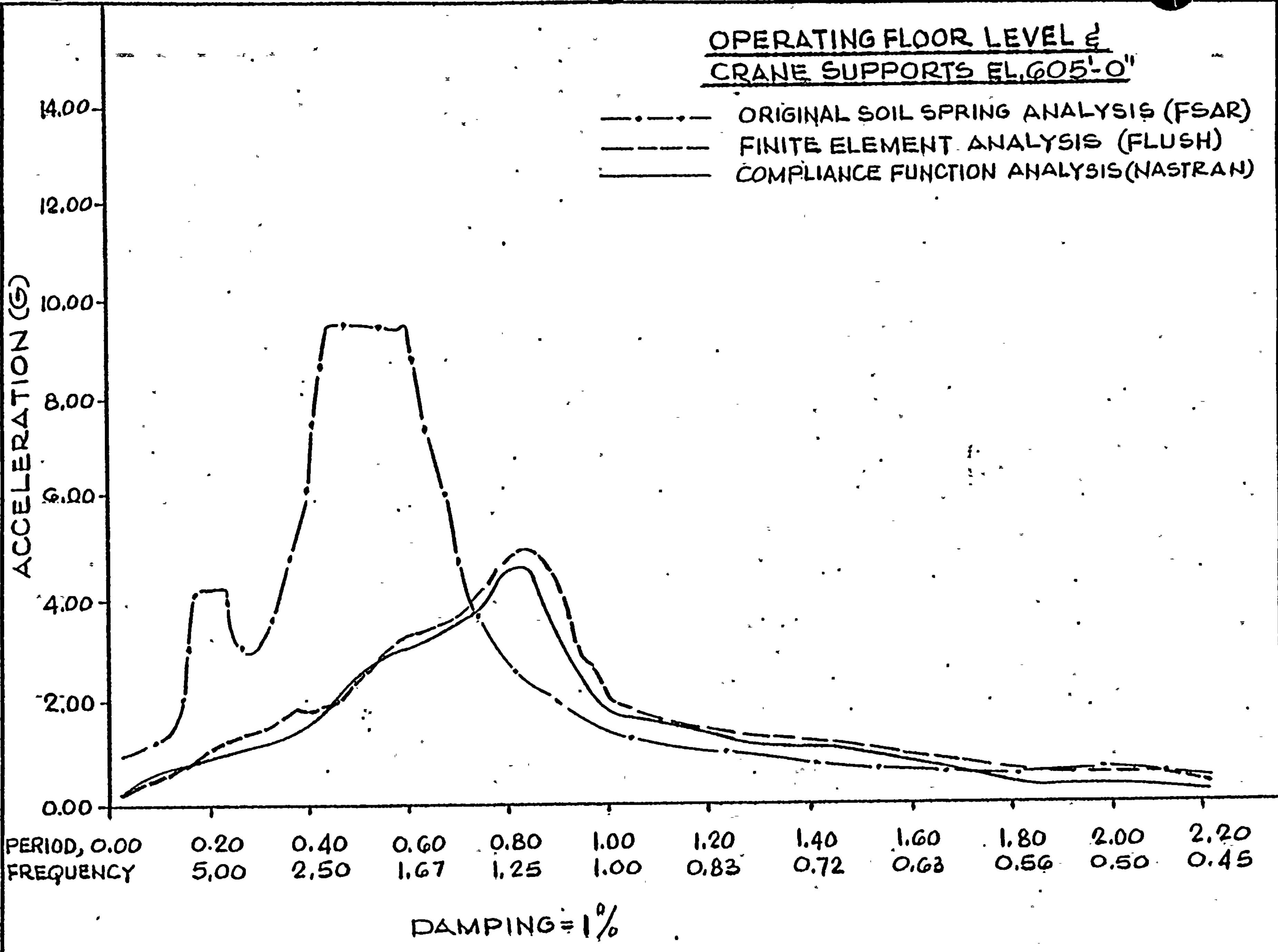
COMPARISON OF DIFFERENT SEISMIC ANALYSIS METHOD

FIGURE 3
ISSUE 0

WASHINGTON PUBLIC POWER SUPPLY SYSTEM
NUCLEAR PROJECT NO. 2

COMPARISON OF DIFFERENT SEISMIC ANALYSIS METHOD

FIGURE 4
ISSUE 9



NRC-SEB

ISSUE #10

Justify the 10% peak broadening of response spectra was adequate for components in the Standby Service Water Pumphouse in light of the 15% requirement in the SRP.

RESPONSE:

Please refer to the response to Question 130.057 for the information requested.*

*Draft FSAR page change attached.

Q.130.057
220.08
(3.7.2)

Indicate your intent to comply with the staff position on the response spectral peak widening or provide justification for your practice as stated in Section 3.7.2.5 of the FSAR where the peaks of floor response spectra were widened by only 10 percent of the peak spectral frequencies. The current staff position on this subject is contained in Regulatory Guide 1.122 and Section 3.7.2.II.9 of the SRP.

RESPONSE

The peaks of all floor response spectra for Seismic Category I structures are broadened by 15% with the exception of the Standby Service Water Pumphouse Building for which the peaks are broadened by 10%.

In lieu of performing an analysis to justify the 10% peak broadening of the Standby Service Water Pumphouse response spectra, the effects of using a 15% peak broadening of the same response spectra have been reviewed. Examination of representative Seismic Category I equipment demonstrates that the equipment meets the 15% broadened curves.

In addition, the response spectra utilized in the above examination are conservative since they are developed using a lumped mass spring model and conservative soil damping values of FSAR Table 3.7-1. The conservatism in this approach can be seen by comparing the response spectra of the lumped mass spring model with the response spectra developed in the finite element soil/structure interaction analysis. Such a comparison of response spectra for the Reactor Building is illustrated in Figures 130.056-1 through 130.056-7 of Question 130.056.

NRC-SEB

ISSUE #11

Assess impact of ACI/349 as amended by RG 1.142 for Category I structures other than the containment shell. Justify any deviations.

Also, assess the impact of the use of ACI/318 vs. ASME Section III, Division 2, on the drywell floor and basemat.

RESPONSE

An assessment has been made of the impact of ACI 349 as amended by Regulatory Guide 1.142 for Seismic Category I structures other than the primary containment shell. Category I structures (concrete) other than the containment shell are designed on the basis of the strength design method of ACI 318-71 except for load combinations. The designs satisfy the load combination requirements of Standard Review Plan 3.8.3 and 3.8.4. The significant design requirements of ACI 349 amended by Regulatory Guide 1.142 are the same as those of ACI 318-71 with load combinations in accordance with SRP 3.8.3 and 3.8.4. Consequently, the Category I structures (concrete) other than primary containment comply with the design requirements of ACI 349-76 as amended by Regulatory Guide 1.142.

An assessment of the impact of the use of ACI 318-71 versus ASME Section III, Division 2, on the drywell floor and basemat has also been made. The drywell floor and basemat are designed on the basis of the strength design method of ACI 318-71 except for the load combinations. These designs have been checked against and found to satisfy the requirements of ASME Section III, Division 2, including the requirements for method of analysis and design, acceptable stress levels, and load combinations.

See the response to Question 130.078 which is related.*

*Draft FSAR page change attached.

Q. 130.078
(220.29)
(3.8.5)

Your response to previous question Q130.043 regarding reactor building foundation mat design code is unacceptable to the staff. The staff position is that Section III, Division 2 of the ASME Boiler and Pressure Vessel Code should be used in the design and analysis of the reactor building foundation mat. Accordingly, identify and discuss the deviations of your reactor building foundation mat design from the requirements of the ASME Code, Section III, Division 2, and demonstrate that the intent of the code is fully complied with or justify the deviations.

RESPONSE

Review of the reactor building foundation mat design has been made against the requirements of the ASME Code, Section III, Division 2, including the requirements for method of analysis and design, acceptable stress levels, and load combinations. It has been determined that the ASME Code requirements are satisfied.

NRC-SEB

ISSUE #12

Provide a technical basis for the ~ 2" free space between the containment shell and the biological shield wall to insure that the thermal, seismic, and construction requirements are appropriately met.

RESPONSE

In actuality, a 2½-inch free space is provided between the steel containment vessel and the biological shield wall to ensure no contact as a result of any differential movements between the containment vessel and the biological shield wall. The free space is provided to allow for a 1½-inch average movement of the vessel normal to its surface due to thermal expansion and seismic displacement (of which 1/16-inch is due to seismic displacement) during the postulated LOCA event. Tolerances specified in this construction were plus ½-inch and minus zero inches to ensure no intrusion upon the 2½-inches. Pressure can only be developed between the containment vessel and the biological shield wall as a result of the compression of the polyurethane filler material that fills the 2½-inch space.

The movement of the containment vessel compresses the polyurethane filler and develops an external pressure acting on the containment vessel. The compressive force reaches a maximum of 2.0 psi based on tests of the polyurethane filler material. The tests established the relationship between the filler compression displacement or strain and the resulting compression stress, under varying temperature conditions. The tests were conducted by Tenneco Chemicals, Inc., the manufacturer of the filler material. This 2.0 psi compressive stress is provided for in the design of the steel containment vessel.

In order to ascertain that the 2½-inch free space between the containment vessel and the biological shield wall does exist, a field test program was conducted (prior to the placement of the biological shield wall concrete) which measured the clear distance between the inner face of the premolded fiberglass formwork for the biological shield wall (refer to FSAR Figure 3.8-4 for formwork and containment vessel shell relationship) and the containment vessel at random points over the exterior surface of the containment vessel. The test results confirm that the 2½-inch clear space is maintained.

NRC-SEB

ISSUE #13

Provide a discussion of the assumptions used in the distribution of shear forces in the exterior and biological shield walls of the reactor building. Also, confirm that the allowable shear stresses used are consistent with those of ACI/349, as amended by Regulatory Guide 1.142.

RESPONSE

The assumptions used in the distribution of shear forces in the exterior and biological shield walls of the reactor building were discussed and resolved in the meeting.

The allowable shear stresses used for the exterior and biological shield walls of the reactor building are consistent with those of ACI 349, as amended by Regulatory Guide 1.142.

Refer to Issue #11 for associated response.

NRC-SEB

ISSUE #14

Provide a set of pertinent calculations that account for hydrodynamic load for critical cross-sections of the reactor building mat and demonstrate that the design is adequate for the combined loads.

RESPONSE

The design forces and moments for the critical sections of the reactor building mat are listed in the attached table. Please note that the additions due to the hydrodynamic loads (P_{sr} & P_c) are small in comparison with the original design values. In the table also shown are the design margins; the minimum value is 1.25.

In the above response which was furnished to the NRC by Burns and Roe at the meeting, NRC requested the basis for the value of the beam shear capacity (232 Kips per foot) given in the attached table. The beam shear capacity of the mat is calculated on the basis of ACI 318-71. No shear reinforcement is provided in the mat. Hence:

$V_u = V_c = v_c\, bd$, where $f'_c = 4000$ psi. b=12" d=15'-0"

$$= \phi \times 2\sqrt{f'_c} \times 12 \times (15\times12)\frac{1}{1000}$$

$$= 0.85\times2\sqrt{4000}\ \frac{\times12\times180}{1000}$$

$$= 232.2 \text{ k/Ft.}$$

BURNS AND ROE, INC.
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W.O. No. 3980-03 Date 5/2/79 Book No. SV-470 Page No. 103
Drawing No. 51079 Calc. No. 6.14.52 Sheet 5 of 5
By ANTHONY AGUERO Checked D.M. 5-9-79 Approved
Title WPPSS- HANFORD NO.2 - REACTOR BLDG. - CONTAINMENT VERTICAL AND HORIZONTAL TEE ASSESSMENT

II DAR REV. 2 - BASEMAT
C) SUMMARY OF RESULTS
JUST OUTSIDE THE BIOLOGICAL SHIELD WALL

LOAD	BENDING MOM. (K-FT/FT)	BEAM SHEAR (K/FT)	PUNCHING SHEAR (K/FT)
$D + E_{SS}$	3,132	125	315
P_{SR}	226	14	14
P_C	30.1	.084	8.0
* $(D+E_{SS}) + \sqrt{P_{SR}^2 + P_C^2}$	3360	139	331
ABS. Σ	3388	139	337
CAPACITY	4230	232	465
MARGIN OF SAFETY SRSS	1.26	1.67	1.40
MARGIN OF SAFETY ABS. Σ	1.25	1.67	1.38

* NOTE: BECAUSE THE DEAD LOADS ARE COMBINED WITH THE SEISMIC, THE $(D+E_{SS})$ WILL NOT BE SRSS WITH THE OTHE HYDRODYNAMIC LOADS.

NRC-SEB

ISSUE #15

Provide justification that failure of the non-Category I structures will not adversely impact the Category I structures (Service Building and non-seismic I parts of Radwaste/Control and Turbine Building).

RESPONSE

Although the Turbine Building and part of the Radwaste/ Control Building are not designated Seismic Category I structures, both buildings are designed to withstand an SSE (see FSAR Sections 3.8, 3.8.4.1.2, 3.8.4.1.3, and 3.8.4.5). These structures, therefore, cannot adversely impact the adjacent Seismic Category I structures during and after the design seismic events.

Although the Service Building is designed to Seismic Category II criteria, it is a low building of relatively little mass and cannot develop the impact energy necessary to potentially damage the adjacent Reactor Building; the four foot thick east wall (see FSAR Section 3.8.4.1.1.1) of the Reactor Building extends up to the top of the Service Building roof.

New ¶

Furthermore, the Service Building is of structural steel construction, except for the basement retaining walls and the two interior walls (one foot thick reinforced concrete). If gross structural failure of the Service Building is postulated during a design seismic event of SSE magnitude, in view of the strength capacity and stiffness of the interior walls (which run perpendicular to the adjacent east wall of the Reactor Building) it is expected that the building structure will fail preferentially in a direction parallel to the Reactor Building.

In view of the above, it is con~~sidered~~cluded that a postulated failure of the Service Building cannot adversely impact the adjacent Reactor Building structure.

NRC-SEB

ISSUE #16

Provide discussion of the seismic model of the Reactor Building crane including the flexible wire rope.

RESPONSE

The seismic analysis of the Reactor Building crane has been performed using the mathematical models shown on the following two pages.

Model 1 was utilized to perform a modal analysis for north-south and vertical seismic excitation whereas Model 2 was used to perform a time history analysis for east-west and vertical seismic excitation.

Three dimensional elastic beam elements having tension-compression, torsion, and bending capabilities were used to represent most of the structural elements. Spring~~s~~ elements were included to represent the supporting columns and a uniaxial three dimensional spar element was used to represent the rope supporting the 125 ton load. Since it was found from the time history analysis that the spar element is always in tension, the use of this element to represent the rope is ~~considered~~ acceptable.

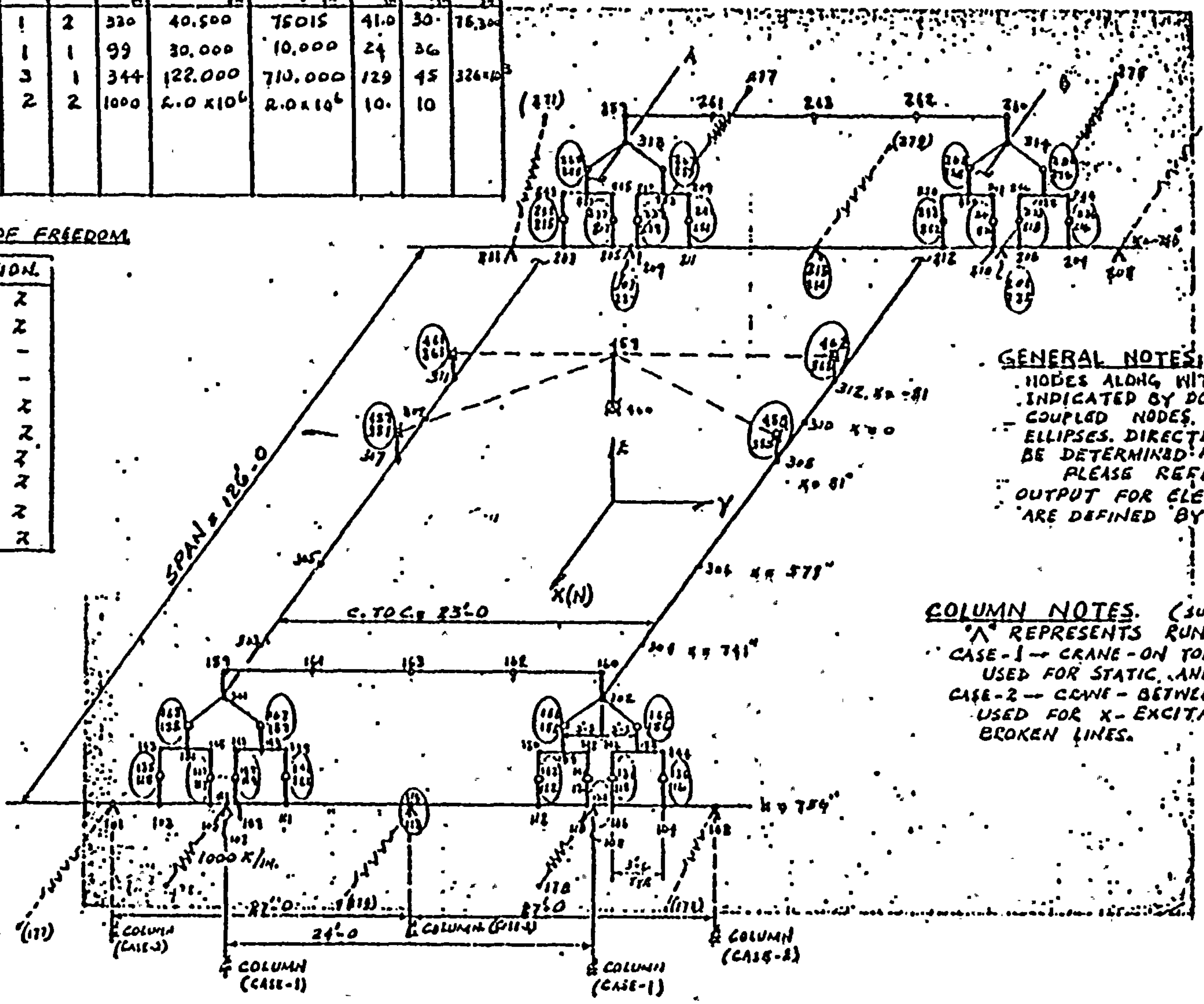
MODEL NO. 1

MATH. MODEL - BURNS AND ROE (W.P.P.S) REACTOR ROOM CRANE.
FOR MODAL ANALYSIS. - REQN. # 61303.

BEAM	DESCRIP.	MATL #	TYPE	A in²	Ixx in⁴	Iyy in⁴	Tx in	Ty in	J in⁴
1	Runway	1	2	320	40,500	75015	41.0	30.	78,300
2	Gid. Conn.	1	1	99	30,000	10,000	24	36	
3	Girder	3	1	344	122,000	710,000	129	45	326×10^3
4	Rigid.	2	2	1000	2.0×10^6	2.0×10^6	10.	10	

MASTER DEG. OF FREEDOM

NODE	DIRECTION		
460	–	–	Z
459	X	–	Z
309	X	Y	–
310	X	Y	–
301	–	Y	Z
302	–	–	Z
313	–	Y	Z
314	–	–	Z
113	X	–	Z
213	X	–	Z



GENERAL NOTES:
- NODES ALONG WITH THEIR NUMBERS ARE INDICATED BY DOTS.
- COUPLED NODES ARE REPRESENTED BY ELLIPSES. DIRECTION OF COUPLING CAN BE DETERMINED FROM COMPUTER OUTPUT.

PLEASE REFER TO THE COMPUTER OUTPUT FOR ELEMENT NUMBERS, WHICH ARE DEFINED BY NODE NUMBERS.

COLUMN NOTES. (SUGGESTED BY B&R)
"Λ" REPRESENTS RUNWAY COLUMNS.
CASE-1 → CRANE-ON TOP OF COLUMNS USED FOR STATIC AND VERT. EXCITATION.
CASE-2 → CRANE - BETWEEN COLUMNS. USED FOR X-EXCITATION; SHOWN BY BROKEN LINES.

REF: B&R FILE NO. 31A 00 0024

ATTACHMENT TO ISSUE #16

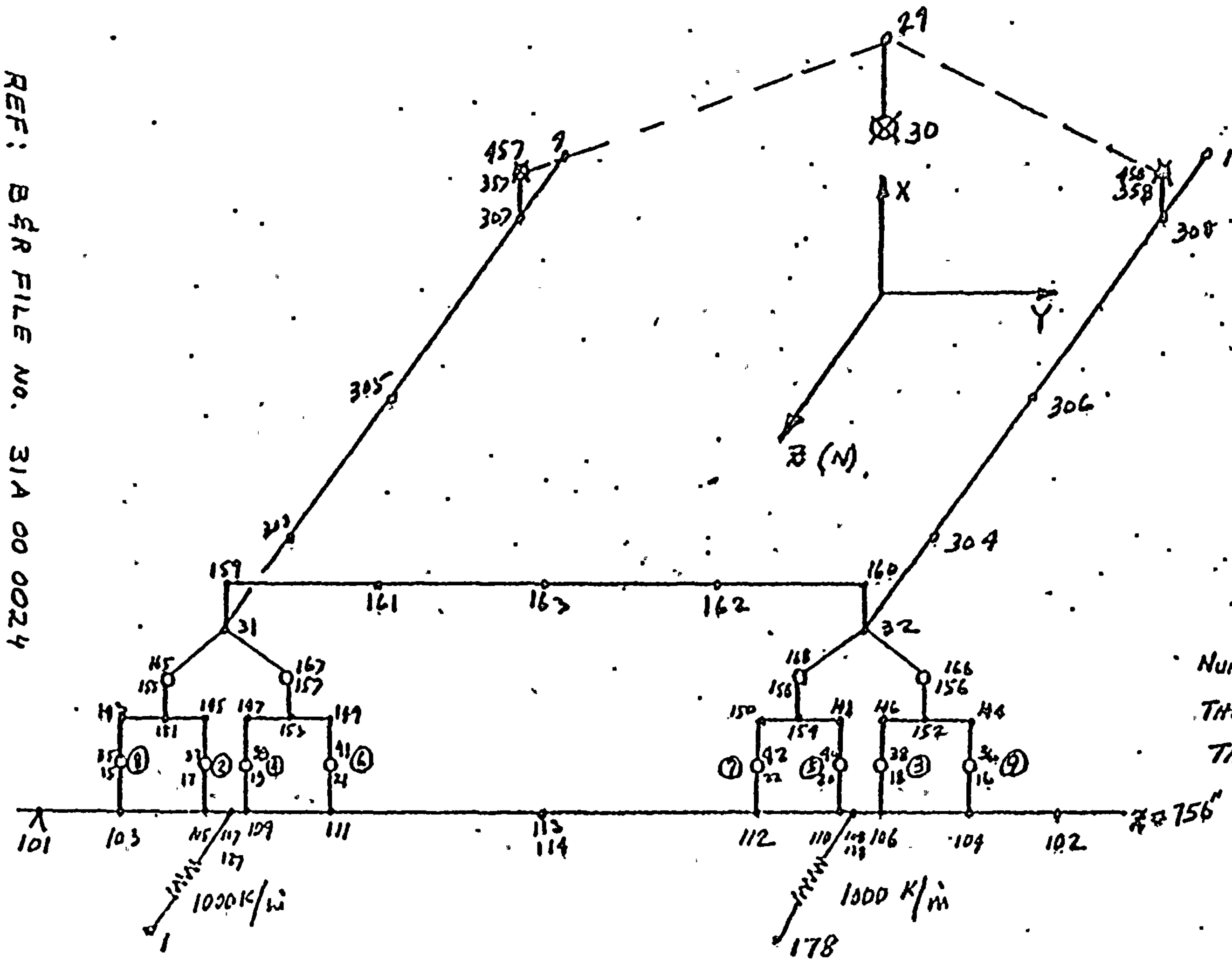
BURNS & ROE - REACTOR ROOM CRA.
FOR W.P.P.S - REQ'N. # 61303
CAP. = 125T/15T.

MODEL #2

MODEL FOR TIME-HISTORY ANALYSIS FOR E-W AND VERT. EXCITATIONS: (STATIC INCL.)

GEN. NOTES AND TABLES FOR SECTION PROPERTIES ARE SAME AS ON MODEL #1.

REF: B&R FILE NO. 31A 00 0024



NUMBER IN THE CIRCLE INDICATES THE GAP ELEMENT NUMBER IN THE TRANSIENT RUN.

ATTACHMENT TO ISSUE NO. 10

NRC-SEB

ISSUE #17

With respect to the Radwaste/Control and Diesel Generator Buildings, provide the following information:

a) A comparison of the floor response spectra at key locations obtained from:

   i) original soil spring analysis
   ii) structure/structure interaction finite element analysis

b) Confirm that the design floor response spectra do envelope the results obtained in 'a' or justify any exceedance from the standpoint of design conservatisms.

With respect to the Standby Service Water Pumphouse, provide a qualitative discussion of the technical basis demonstrating the intent of the NRC SSI position (ref. SRP 3.7.2., Rev. 1) is met.

RESPONSE

The information requested will be furnished by January 1982.

Please refer to the response to Issue #9 and Question 130.055 for additional information.

NRC - SEB

ISSUE #18

Provide a typical seismic analysis of a section of cable trays (including supports). ~~Give~~ Give examples for both horizontal and vertical runs (1 each).

RESPONSE

~~The~~ attached N.P.S. Report G39-179 provides a seismic analysis of a typical cable tray support as requested.

ATTACHMENT TO ISSUE #18

JOB NO. G-804

SHEET – OF –

CLIENT/PROJECT FISCHBACH/LORD, WPPSS-2 ENGR. AB DATE 3/17/7

SUBJECT CABLE TRAY SUPPORT, G39-179 CHK'D. – DATE –

N.P.S REPORT G39-179

EL. 547'-0" AND BELOW

REACTOR BLDG.

THIS REPORT INCLUDES DWG. 1) TS-4780

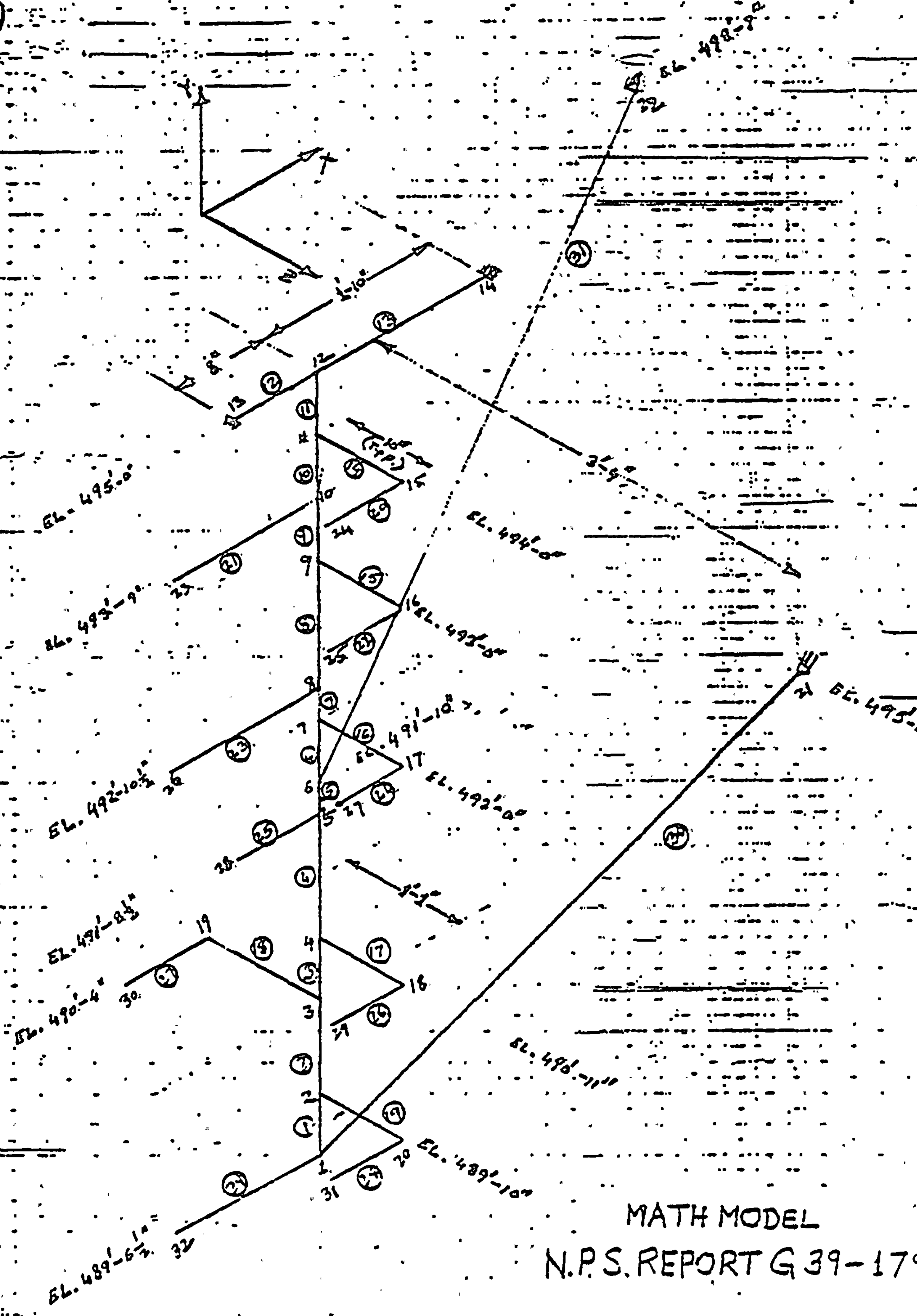
BR FILE NUMBER 218 00 2578

	CONTRACT
Washington Public Power Supply Sys WPPSS Nuclear Project No 2 W. O. 2000	
BURNS AND ROE, INC. ORADELL, N.J. - HEMPSTEAD, N.Y. - LOS ANGELES, CAL	
REVIEWED AS CHECKED BELOW	
X Approved for Fabrication.....A	
☐ NOT Approved.....NA	
☐ Approved as noted for Fabrication.....AN See Acceptance Note - Para. 1.2, of Appendix A, Section 1.6	
☐ For Information Only.....I	
Subject To All Contractual Provisions	
This review does not imply acceptance of any material or equipment not fulfilling all specification requirements.	
PROCESSED BY / DATE 4-4-79	

2316

1

ISSUE #18



MATH MODEL

N.P.S. REPORT G 39-179

ISSUE #18

JOB. NO. G-864
SHEET 1 OF 8
CLIENT/PROJECT FISCHBACH / LORD ; IUPACC-2
SUBJECT CABLE TRAY SUPPORT ; G-39-779
ENGR. HBG DATE
CHK'D. HYC DATE

DESIGN FORCES

(1) GRAVITY CASE

(A) = MAIN MEMBERS ELEMENTS 1 - 19 (5"x5"x3/8" STR. TUBE)

	ELM	NODE	GRAVITY
AXIAL FORCE	6	6	2.8 K
Y - SHEAR	"	"	1.01 K
Z - SHEAR	"	"	0.15 K
TORSION	"	"	— K-IN
YY-MOMENT	"	"	1.74 K-IN
ZZ-MOMENT	"	"	22.58 K-IN

(B) SUPPORT ARMS ELEMENTS 20 — 29 (5"x3"x3/8" ANGLE)

	ELM.	NODE	GRAVITY
AXIAL FORCE	26	18	— K
Y - SHEAR	"	"	0.22 K
Z - SHEAR	"	"	— K
TORSION	"	"	— K-IN
YY - MOMENT	"	"	— K-IN
ZZ - MOMENT	"	"	5.51 K-IN

JOB NO: G-804
SHEET 2 OF 8
CLIENT/PROJECT FISCHBACH / LORDS / WPPSS-2 ENGR. ABG DATE 3/17/77
SUBJECT CABLE TRAY SUPPORT; G39-179 CHKD. HYL DATE 3/17/77

GRAVITY CASE CONTD.

MAIN SUPPORT REACTION: FIXED END; NODES - 13 & 14

	UNIT	NODE	FORCES & MOMENTS
X-FORCE	LB	13	742.23
Y- "	"	"	3590.05
Z- "	"	"	120.63
XX-MOMENT	FT-LB	"	10.11
YY-MOMENT	"	"	52.45
ZZ-MOMENT	"	"	1447.74

BRACE SUPPORT REACTION PIN SUPPORT; NODES - 21 & 22

	UNIT	NODE	FORCES & MOMENTS
X-FORCE	LB	22	1012.33
Y- "	"	"	1750.58
Z- "	"	"	—

ISSUE #18

JOB NO. G-504

SHEET 3 OF 8

CLIENT/PROJECT FISCHBACH / LCRS ; WPPSS-2 ENGR: ABG DATE 3/17/[illegible]

SUBJECT CABLE TRAY SUPPORT ; G39-179 CHK'D. HYC DATE 3/[illegible]

(2) GRAVITY + SEISMIC CASE

(A) MAIN MEMBERS ELEMENTS 1-19 (5"x5"x3/8" STR. TUBE)

	ELM	NODE	GRAVITY	SEISMIC (X+Y)	TOTAL
AXIAL FORCE	6	6	2.8 K	5.82 K	8.62 K
Y-SHEAR	"	"	1.01 K	1.6 K	2.61 K
Z-SHEAR	"	"	0.15 K	0.35 K	0.50 K
TORSION	"	"	— K-IN	19.2 K-IN	19.20 K-IN
YY-MOMENT	"	"	1.74 K-IN	10.87 K-IN	12.61 K-IN
ZZ-MOMENT	"	"	22.58 K-IN	52.32 K-IN	74.9 K-IN

(B) SUPPORT ARMS ELEMENTS 20-29 (5"x3"x3/8" ANGLE)

	ELM	NODE	GRAVITY	SEISMIC (Y+Z)	TOTAL
AXIAL FORCE	27	19	— K	0.55 K	0.55 K
Y-SHEAR	"	"	0.22 K	0.34 K	0.56 K
Z-SHEAR	"	"	— K	0.56 K	0.56 K
TORSION	"	"	— K-IN	— K-IN	— K-IN
YY-MOMENT	"	"	— K-IN	15.17 K-IN	15.17 K-IN
ZZ-MOMENT	"	"	5.51 K-IN	9.30 K-IN	14.81 K-IN

(C) BRACES ELEMENTS 30 & 31

	ELM	NODE	GRAVITY	SEISMIC (X+Y)	TOTAL
AXIAL FORCE	31	6	2.02 K	5.70 K	7.72 K

ISSUE #18

JOB NO. G-E14
SHEET 4 OF 8
ENGR. ABS DATE 3/17/--
CHK'D. JYL DATE 3/17/--

CLIENT/PROJECT FISCH BACH / LORD; WPPSS-2
SUBJECT CABLE TRAY SUPPORT, G39-179

GRAVITY + SEISMIC CONTD.

MAIN SUPPORT REACTION:- FIXED END; NODES - 13 & 14

	UNIT	NODE	GRAVITY	SEISMIC (Y+Z)	TOTAL
X-FORCE	LB	13	742.23	951.21	1693.44
Y-FORCE	"	"	3590.05	6117.17	9707.22
Z-FORCE	"	"	120.63	2957.87	3078.50
XX-MOMENTS	FT-LB	"	10.11	1288.61	1298.72
YY-MOMENTS	"	"	52.45	498.69	551.14
ZZ-MOMENTS	"	"	1447.74	2197.96	3645.70

BRACE SUPPORT REACTION:- PIN SUPPORT, NODES - 21 & 22

	UNIT	NODE	GRAVITY	SEISMIC (X+Y)	TOTAL
X-FORCE	LB	22	1012.33	2855.29	3867.62
Y-FORCE	"	"	1750.58	4937.54	6688.12
Z-FORCE	"	"	—	—	—

STRESS ANALYSIS

MAIN MEMBERS:— ELEMENTS 1-19

USE 5"×5"×3/8" STR. TUBE
$A = 6.8 \text{ in}^2$;
$S_{yy} = S_{zz} = 9.63 \text{ in}^3$
$F_y = 36$ ksi.

GRAVITY + SEISMIC CASE:—

$$\sigma_{TOTAL} = \sigma_A + \sigma_{B_{yy}} + \sigma_{B_{zz}}$$

$$= \frac{8.62}{6.8} + \frac{12.61 + 74.9}{9.63}$$

$$= 10.36 \text{ ksi} < 0.9 F_y \therefore \text{O.K.}$$

$$\tau_y = \frac{2.61}{(1/2)\times 6.8} = 0.77 \text{ ksi} \; ; \; \tau_z = \frac{0.5}{(1/2)\times 6.8} = 0.15 \text{ ksi}$$

$$\tau_{TORSION} = \frac{19.2}{2t(a-t)^2} = \frac{19.2}{2\times 0.375\,(5-0.375)^2} = 1.2 \text{ ksi}$$

$$\tau_{total} = \left\{(0.77+1.2)^2 + (0.15+1.2)^2\right\}^{1/2} = 2.39 \text{ ksi} < 0.4 F_y \therefore \text{O.K.}$$

GRAVITY CASE:— NEGLECT, AS MOMENTS AND FORCES ARE SMALL

SUPPORT ARMS:—

ELEMENTS 20 — 29

USE 5"×3"×3/8" ANGLE.
$A = 2.86 \text{ in}^2$
$S_{yy} = 0.808 \text{ in}^3$; $S_{zz} = 2.24 \text{ in}^3$;
$F_y = 36$ ksi.

GRAVITY + SEISMIC CASE:-

$$\sigma_{TOTAL} = \frac{0.55}{2.86} + \frac{15.17}{0.888} + \frac{14.81}{2.24}$$

$$= 23.89\ ksi < 0.9\ F_y \quad \therefore\ O.K.$$

NEGLECT Y, Z - SHEAR AND TORSION AS THEY ARE SMALL.

GRAVITY CASE:-

NEGLECT, AS FORCES AND MOMENTS ARE SMALL

BRACES:- ELEMENTS 30 & 31

USE 3"x3"x0.25" ANGLE

LENGTH = l = 7.99 ft. $A = 1.44\ in^2$, $r = 0.592\ in$.

$$\frac{kl}{r} = \frac{1 \times 7.99 \times 12}{0.592} = 162 \Longrightarrow F_a = 7.2\ ksi.$$

$$\sigma_A = \frac{7.72}{1.44} = 5.37\ ksi < 1.33\ F_a$$

MAIN SUPPORT REACTION:- NODES 13 & 14, FIXED END ;

GRAVITY + SEISMIC CASE - EMBEDDED PLATE (12"x12"x3/4").

REFER N.P.S. REPORT G39-159

$$f_t = \frac{9707.22}{4} + \frac{(1298.72 + 3645.7) \times 12}{2 \times 8} = 6135.12\ \#/STUD.$$

$$f_s = \left\{ \left(\frac{1693.44}{4} + \frac{551.14 \times 1.2 \times 4}{128} \right)^2 + \left(\frac{3078.5}{4} + \frac{551.14 \times 1.2 \times 4}{128} \right)^2 \right\}^{1/2} = 1162\ \#/STUD$$

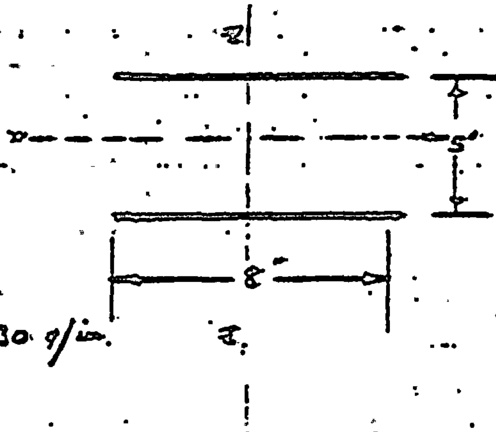
$$f_t + f_s = 6135.12 + 1162 = 7297.12\ \#/STUD < 11,300\ \#/STUD.$$

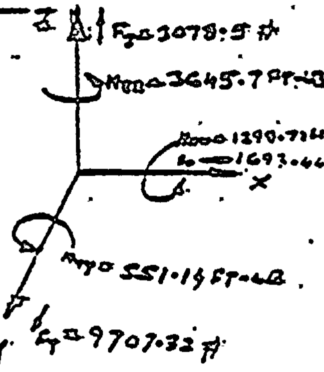
$\therefore$ O.K.

ISSUE #18

JOB NO. G-805
SHEET 7 OF 8
CLIENT/PROJECT FISCHBACH/LORD, WPPSS-2 ENGR: ABP DATE 3/17/77
SUBJECT CABLE TRAY SUPPORT, G39-179 CHK'D: HYC DATE 3/.../77

CHECK OF WELD :-





$Sw_{xx} = 8 \times 5 = 40 \text{ in}^2$

$Sw_{zz} = \dfrac{8^2}{3} = 21.333 \text{ in}^3$

$J = Jw_{yy} = Jw_{zz} = 185.3 \text{ in}^3$

$F_{ALLOWABLE}$ FOR 1/16" WELD = 1.33 × 930 #/in.

$$F_{TENSION} = \frac{9707.32}{2 \times 8} + \frac{1298.72 \times 12}{40} + \frac{3645.7 \times 12}{21.333}$$

$= 3047.1$ #/in

$$\text{SHEAR ALONG } z\text{-}z = \frac{3078.5}{16} + \frac{551.14 \times 12 \times 4}{185.3} = 336 \text{ \#/in.}$$

$$\text{" " } x\text{-}x = \frac{1693.44}{16} + \frac{551.14 \times 12 \times 2.5}{185.3} = 196 \text{ \#/in.}$$

$$F_{RESULTANT} \text{ ON WELD} = \left\{(3047.1)^2 + (336)^2 + (196)^2\right\}^{1/2} = 3072 \text{ \#/in.}$$

$F_{ALLOWABLE}$ FOR 1/4" WELD = 1.33 × 930 × 4 = 4947 #/in.

$F_{RESULTANT} < F_{ALLOWABLE}$ ∴ O.K.

GRAVITY CASE :-

NO ANLYSIS REQUIRED AS IT CAN BE SEEN THE FORCES & MOMENTS ARE SMALL.

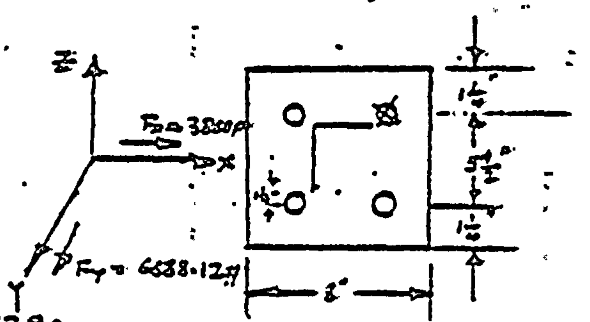
ISSUE #18

JOB NO. G-806
SHEET 8 OF 8
CLIENT/PROJECT FISCHBACH/LOND, WPPSS-2 ENGR. ABG DATE 3/17/77
SUBJECT CABLE TRAY SUPPORT, G39-199 CHK'D. HYL DATE 3/17/77

BRACE SUPPORT REACTION :- PIN SUPPORT NODE 21.
GRAVITY + SEISMIC CASE

USE DETAIL 2 TS-307 i.e. 8"x8"x 1/2" PLATE
WITH 4 H.D.I. DROP-IN-ANCHOR WITH $5\frac{1}{2}$" SPACING.
$F_t = 1.33 \times 3670$ #/bolt ; $F_s = 1.33 \times 4090$ #/bolt.

ASSUME ONE BOLT FAILS



TOTAL PULL OUT / bolt

$f_t = \frac{F_y}{3} = \frac{6688.12}{3} = 2230$ #/bolt

f_s = TOTAL SHEAR $= \frac{F_x}{3} = \frac{3868}{3} = 1290$ #/bolt

$\therefore \frac{f_t}{F_t} + \frac{f_s}{F_s} = \frac{2230}{5.5/7.5 \times 1.33 \times 3670} + \frac{1290}{5.5/7.5 \times 1.33 \times 4090}$

$= 0.623 + .328 = 0.951 < 1 \quad \therefore$ O.K.

S_x = SECTION MODULUS OF THE PLATE $= \frac{1}{6} bt^2$

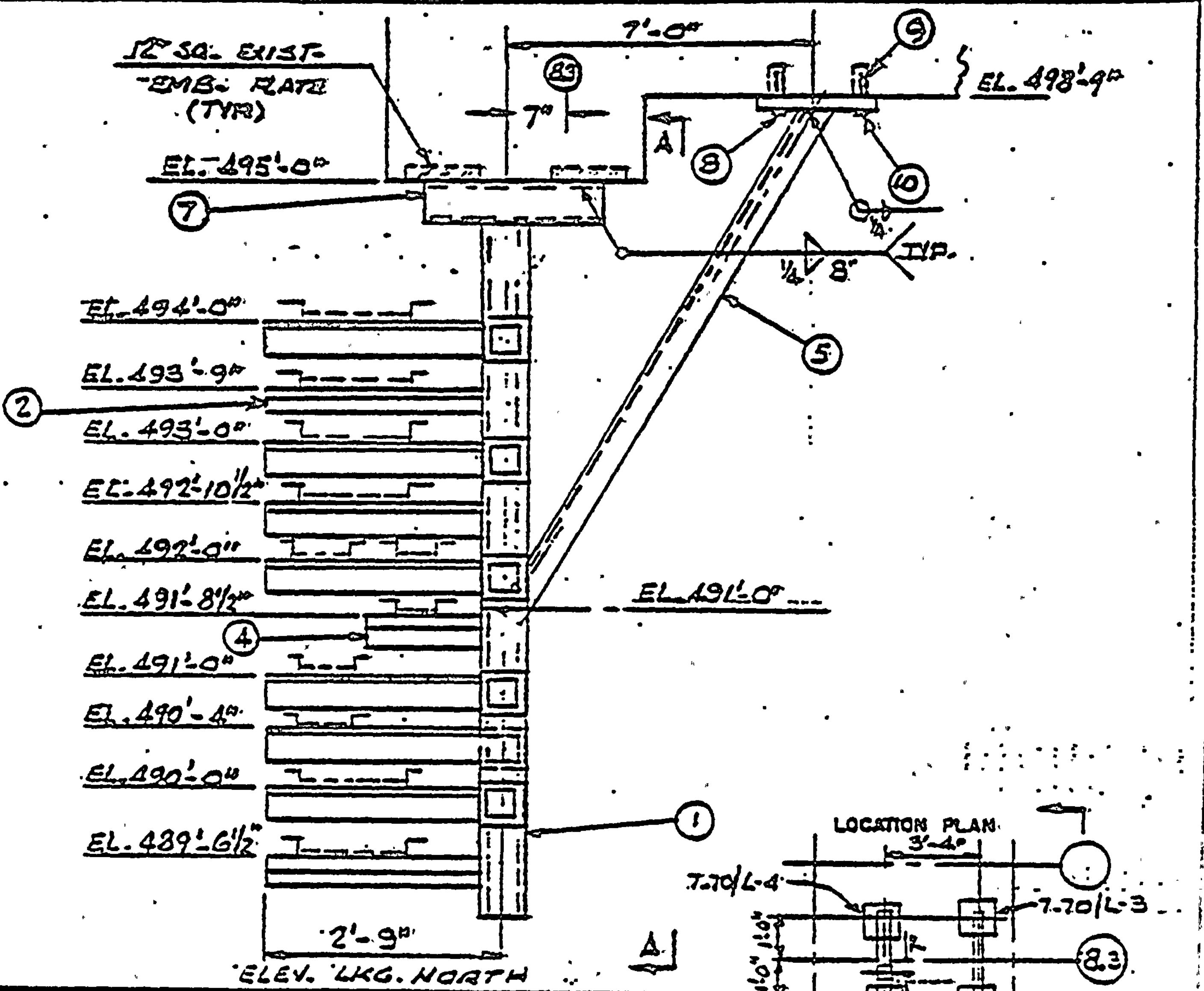
MAX^m B.M. ON THE PLATE DUE TO THE PULL OUT FORCE

$= 2 \times 2230 \times 1.25$ #-inch.

$\therefore t = \sqrt{\frac{2 \times 2230 \times 1.25 \times 6}{8 \times 0.9 \times 36{,}000}} = 0.36 \quad \therefore$ 1/2" PLATE IS O.K.

ISSUE #18.

ITEM NO.	NO. REQ'D	DESCRIPTION	MATERIAL
1	1	TS 5x5 x 3/8 x 5'-7" LG.	A501/A500
2	9	L5 x 3 x 3/8 x 2'-4 1/2" LG.	A-36
3	1	TS 5x5 x 3/8 x 1'-1" LG.	A501/A500
4	1	L5 x 3 x 3/8 x 1'-0" LG.	A-36
5	1	L3 x 3 x 3/8 x 3'-3" LG.	A-36
6	1	L3 x 3 x 3/8 x 6'-9" LG.	A-36
7	1	TS 5x5 x 3/8 x 2'-3" LG.	A-36
		CONTINUED ON SHEET NO-2	



LOADS:
GRAVITY 1242 lb
VERT. SEIS. 0.6 G
HORIZ. SEIS. 1.6 G

BLDG. REACTOR
FLOOR EL. 471'-0"
REF. DWG. E 673
REF. CALC. C-39-179

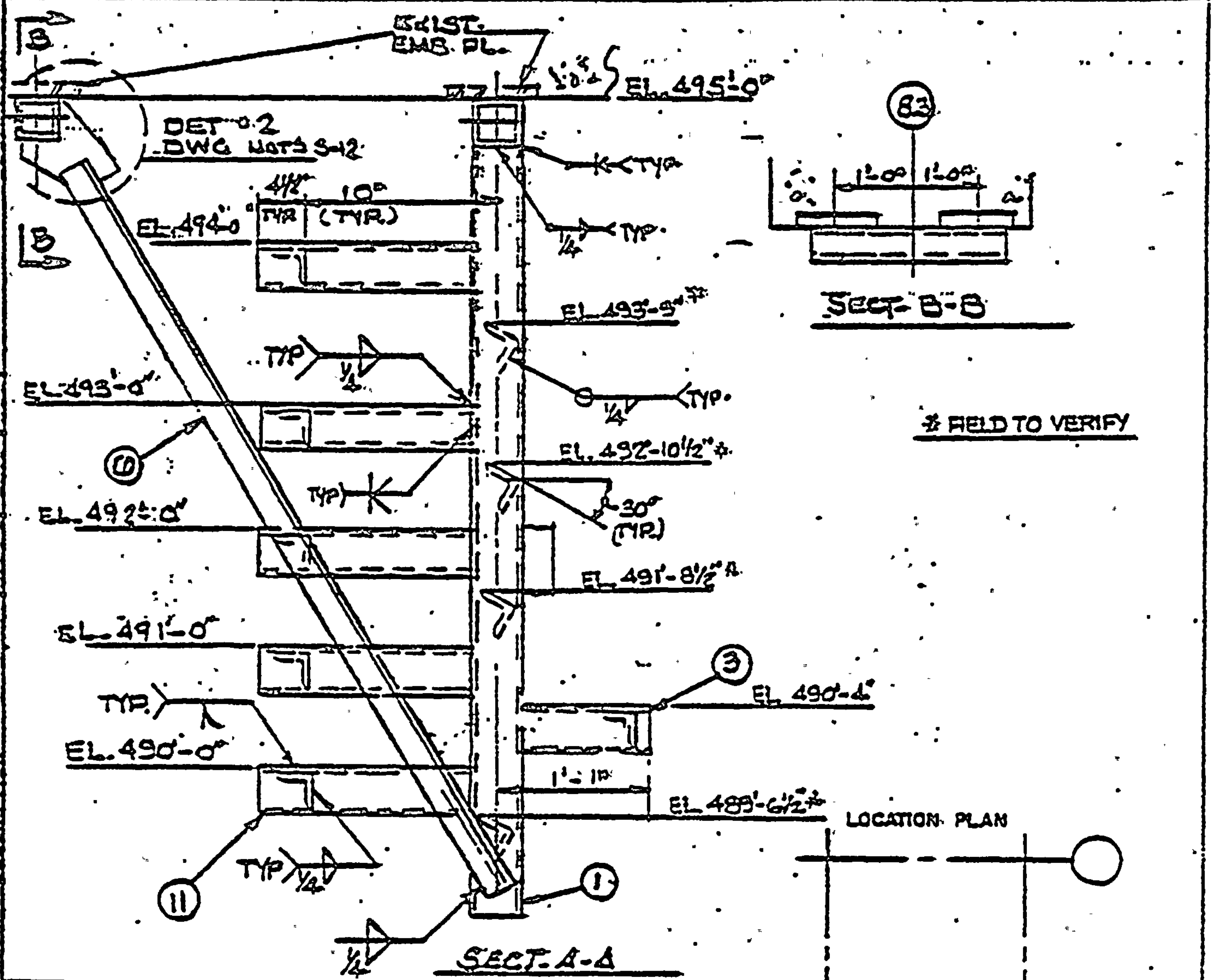
SEISMIC CLASS:
QUALITY CLASS:

OWNER: WASHINGTON PUBLIC POWER SUPPLY SYSTEM
PROJECT: HANFORD NO.2
ENGINEER: BURNS & ROE INC.
CUSTOMER: FISCHBACH / LORD ELECTRIC CO.

nuclear power services, inc.
25 broadway - new york, n.y. 10004

	BY	DATE	PROJECT NO.	DRAWING NO	REV
DRAWN	EV	3-23-7	G-100	TS-4780 SH. 1	0
CHK'D	[illegible]	[illegible]			
APPV'D	[illegible]	[illegible]			

ITEM NO.	NO. REQ'D	DESCRIPTION	MATERIAL
8	4	3/4" ⌀ x 1 3/4" LG. HEX. HD. BOLT & WASHER	A-36
9	4	3/4" HDI DROP IN ANCHOR (MFR'D BY McCLOUGH IND.)	
10	1	1/2" x 8" x 8" PLATE	A-36
11	1	TS 5 x 5 x 3/8 x 1'-0" LG.	A501/A500



LOADS:
GRAVITY 1242#
VERT. SEIS. 0.6G
HORIZ. SEIS. 1.6G

BLDG. REACTOR
FLOOR EL. 471'-0"
REF. DWG. E 673
REF. CALC. 633-139

SEISMIC CLASS:
QUALITY CLASS:

OWNER: WASHINGTON PUBLIC POWER SUPPLY SYSTEM
PROJECT: HANFORD NO. 2
ENGINEER: BURNS & ROE INC.
CUSTOMER: FISCHBACH / LORD ELECTRIC CO.

nuclear power services, inc.
25 broadway-new york, n.y. 10004

	BY	DATE	PROJECT NO.	DRAWING NO.	REV
DRAWN	FV	3-21-77	G-100	TS-4780 Sht 2	5
CHK'D					
APPV'D					

A79LMA1

N.P.S. REPORT G39-179
(REACTOR BLDG.)
EL. 547'-0" AND BELOW
DWGS 1) TS-4780
TR. NO. - 2316

NR FILE NUMBER 218-00-2578

ISSUE #18

A79LMAI

A79LMAI 6100 03/16/77 15.53.00 7600 LM

Issue #18

15

NUCLEAR POWER SERVICES

DXNAP03

Issue #18

NUCLEAR POWER SERVICES   JOB ****   CABLE TRAY SUPPORT   DY:ABS   CHKD: 03/16/77   **DYNAPO3, VERSION 03, 6/20/74**

NPS ALPURT 639-170 REACTOR BLDG,EL.490.75FT,   NUCLEAR POWER SERVICES INC,NEW-YORK,

CONTROL PARAMETERS

TOTAL NO. OF ELEMENTS.....................=	31
NO. OF ELEMENT GROUPS.....................=	1
NO. OF MATERIALS..........................=	1
NO. OF CROSS SECTIONS.....................=	3
NO. OF CONNECTION STIFFNESSES.............=	-0
TOTAL NO. OF NODES........................=	32
NO. OF TANGENT NODE GENERATIONS...........=	-0
NO. OF CONTROL POINTS.....................=	-0
NO. OF BEND NODE GENERATIONS..............=	-0
NO. OF SPECIFIED NODES....................=	32
NO. OF LINEAR NODE GENERATIONS............=	-0
NO. OF SINGLE COMPONENT SUPPORTS..........=	10
NO. OF MULTIPLE COMPONENT SUPPORTS........=	-0
NO. OF EXTRA WEIGHT GENERATIONS...........=	10
NO. OF ROTATIONAL INERTIAS................=	-0
NO. OF SPECIAL ELEMENTS...................=	-0
NO. OF REDISTRIBUTED MASSES...............=	4
MAXIMUM NO. OF MODES......................=	20
SHORTEST SIGNIFICANT PERIOD...............=	.0100

ISSUE #18

16

MATERIAL PROPERTIES

MATERIAL NO,	MODULUS (KSI)	POISSON RATIO	EXPANSION COEFF.	
1	29000.	.300	.0000061	ASTM A-36

CROSS SECTION PROPERTIES

SECTION NO.	WEIGHT (LB/FT)	OUT.DIAM, (IN)	THICKNESS (IN)	AREAS (IN**2) X	Y	Z	INERTIAS (IN**4) XX	YY	ZZ	DESCRIPTION OF SECTION USED
1	23.12	N.A.	N.A.	6.00	-0.00	-0.00	80.80	29.10	80.10	TS 5X5X.375
2	9.80	N.A.	N.A.	2.86	-0.00	-0.00	.14	7.09	7.37	L 5X3X.375
3	-0.00	N.A.	N.A.	1.44	-0.00	-0.00	.00	.00	.00	L 3X3X.25

ISSUE #18

NODES WITH SPECIFIED COORDINATES (FT)

NODE NO,	OFFSET NODE	COORDINATES OR OFFSETS X	Y	Z
1	-0	0,000	489,592	0,000
2	1	-0,000	,292	-0,000
3	1	-0,000	,792	-0,000
4	1	-0,000	1,372	-0,000
5	1	-0,000	2,167	-0,000
6	1	-0,000	2,292	-0,000
7	1	-0,000	2,450	-0,000
8	1	-0,000	3,333	-0,000
9	7	-0,000	1,000	-0,000
10	9	-0,000	,750	-0,000
11	9	-0,000	1,000	-0,000
12	11	-0,000	1,000	-0,000
13	12	-,667	-0,000	-0,000
14	12	1,833	-0,000	-0,000
15	11	-0,000	-0,000	,034
16	9	-0,000	-0,000	,034
17	7	-0,000	-0,000	,034
18	4	-0,000	-0,000	,034
20	2	-0,000	-0,000	,034
19	3	-0,000	-0,000	-1,084
21	1	-0,000	5,458	3,330
22	6	0,000	6,917	-0,000
23	18	-1,500	-0,000	-0,000
24	15	-1,500	-0,000	-0,000
25	16	-1,500	-0,000	-0,000
26	8	-1,500	-0,000	-0,000
27	17	-,750	-0,000	-0,000
28	5	-,750	-0,000	-0,000
29	18	-2,250	-0,000	-0,000
30	19	-2,250	-0,000	-0,000
31	20	-1,500	-0,000	-0,000
32	1	-1,500	-0,000	-0,000

NO GENERATION COMMANDS

Issue #18

18

NODE COORDINATES (FT)

NODE	X	Y	Z
1	0.000	489.542	0.000
2	0.000	489.834	0.000
3	0.000	490.334	0.000
4	0.000	490.914	0.000
5	0.000	491.709	0.000
6	0.000	491.834	0.000
7	0.000	492.000	0.000
8	0.000	492.875	0.000
9	0.000	493.000	0.000
10	0.000	493.750	0.000
11	0.000	494.000	0.000
12	0.000	495.000	0.000
13	-.667	495.000	0.000
14	1.033	495.000	0.000
15	0.000	494.000	.834
16	0.000	493.000	.834
17	0.000	492.000	.834
18	0.000	490.914	.834
19	0.000	490.334	-1.000
20	0.000	489.834	.834
21	0.000	495.000	3.334
22	0.000	490.751	0.000
23	-1.500	493.750	0.000
24	-1.500	494.000	.834
25	-1.500	493.000	.834
26	-1.500	492.875	0.000
27	-.750	492.000	.834
28	-.750	491.709	0.000
29	-2.250	490.914	.834
30	-2.250	490.334	-1.000
31	-1.500	489.834	.834
32	-1.500	489.542	0.000

ISSUE #18

19

NON-SKEW SUPPORTS

JOINT NO	SUPPORT IDENT	CONSTRAINT DIRECTIONS TRANSLATIONS	ROTATIONS	SUPPORT-TYPE
13	FIXED END	X Y Z	XX YY ZZ	STATIC
13	FIXED END	X Y Z	XX YY ZZ	DYNAMIC
14	FIXED END	X Y Z	XX YY ZZ	STATIC
14	FIXED END	X Y Z	XX YY ZZ	DYNAMIC
21	PIN SUPPORT	X Y Z		STATIC
21	PIN SUPPORT	X Y Z		DYNAMIC
22	PIN SUPPORT	X Y Z		STATIC
22	PIN SUPPORT	X Y Z		DYNAMIC

WEIGHTS IN ADDITION TO MEMBER WEIGHTS (K)

NODE	WEIGHT
23	.220
24	.220
25	.275
26	.275
27	.152
28	.152
29	.193
30	.193
31	.275
32	.275

ISSUE #18

20

ELEMENT GROUP 1 - FRAME ELEMENTS

NO. OF ELEMENTS = 31

ELEM NO.	TYPE	NODE I	NODE J	DIRN CODE	SECT NO.	MATL NO.	STIFF. FACTOR	STRESS FACTOR	LENGTH (FT)	RADIUS (IN)	COORDINATES OF NODE I/T.I.P.(FT) X	Y	Z
1	STRT	1	2	-0	1	1	1.000	1.000	.29		0.000	489.548	0.000
2	STRT	2	3	-0	1	1	1.000	1.000	.50		0.000	489.834	0.000
3	STRT	3	4	-0	1	1	1.000	1.000	.58		0.000	490.334	0.000
4	STRT	4	5	-0	1	1	1.000	1.000	.80		0.000	490.914	0.000
5	STRT	5	6	-0	1	1	1.000	1.000	.13		0.000	491.709	0.000
6	STRT	6	7	-0	1	1	1.000	1.000	.17		0.000	491.834	0.000
7	STRT	7	8	-0	1	1	1.000	1.000	.88		0.000	492.000	0.000
8	STRT	8	9	-0	1	1	1.000	1.000	.13		0.000	492.875	0.000
9	STRT	9	10	-0	1	1	1.000	1.000	.75		0.000	493.000	0.000
10	STRT	10	11	-0	1	1	1.000	1.000	.25		0.000	493.750	0.000
11	STRT	11	12	-0	1	1	1.000	1.000	1.00		0.000	494.000	0.000
12	STRT	12	13	-0	1	1	1.000	1.000	.67		0.000	495.000	0.000
13	STRT	12	14	-0	1	1	1.000	1.000	1.03		0.000	495.000	0.000
14	STRT	11	15	-0	1	1	1.000	1.000	.03		0.000	494.000	0.000
15	STRT	9	16	-0	1	1	1.000	1.000	.03		0.000	493.000	0.000
16	STRT	7	17	-0	1	1	1.000	1.000	.03		0.000	492.000	0.000
17	STRT	4	18	-0	1	1	1.000	1.000	.03		0.000	490.914	0.000
18	STRT	3	19	-0	1	1	1.000	1.000	1.00		0.000	490.334	0.000
19	STRT	2	20	-0	1	1	1.000	1.000	.03		0.000	489.834	0.000
20	STRT	15	24	-0	2	1	1.000	1.000	1.50		0.000	494.000	.034
21	STRT	10	23	-0	2	1	1.000	1.000	1.50		0.000	493.750	0.000
22	STRT	16	25	-0	2	1	1.000	1.000	1.50		0.000	493.000	.034
23	STRT	8	26	-0	2	1	1.000	1.000	1.50		0.000	492.875	0.000
24	STRT	17	27	-0	2	1	1.000	1.000	.75		0.000	492.000	.034
25	STRT	5	28	-0	2	1	1.000	1.000	.75		0.000	491.709	0.000
26	STRT	18	29	-0	2	1	1.000	1.000	2.25		0.000	490.914	.034

ISSUE #18

118

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[illegible]	STAT	0	26	-0	2	1	1.000	1.000	[illegible]	0.000	002.073	0.000
24	STAT	17	27	-0	2	1	1.000	1.000	.73	0.000	002.000	.030
25	STAT	5	20	-0	2	1	1.000	1.000	.70	0.000	001.700	0.000
26	STAT	10	29	-0	2	1	1.000	1.000	2.29	0.000	000.019	.034
27	STAT	19	30	-0	2	1	1.000	1.000	2.35	0.000	000.330	-1.000
28	STAT	20	31	-0	2	1	1.000	1.000	1.50	0.000	000.034	.039
29	STAT	1	32	-0	2	1	1.000	1.000	1.50	0.000	000.002	0.000
30	STAT	1	31	-0	3	1	1.000	1.000	0.40	0.000	000.540	0.000
31	STAT	6	33	-0	3	1	1.000	1.000	7.99	0.000	001.036	0.000

ISSUE #18

22

MASS REDISTRIBUTION

NODE NO.	MASS DIRN	NODES TO WHICH REDISTRIBUTED
13	ALL	NONE - DELETED COMPLETELY
19	ALL	NONE - DELETED COMPLETELY
21	ALL	NONE - DELETED COMPLETELY
22	ALL	NONE - DELETED COMPLETELY

ISSUE #18

TRANSLATIONAL DYNAMIC DEGREES OF FREEDOM

-1 = DELETED MASS
-2 = REDISTRIBUTED MASS
-3 = ZERO MASS
OTHERWISE = D.O.F. NUMBER

NODE NO.	X DIR	Y DIR	Z DIR
1	1	2	3
2	4	5	6
3	7	8	9
4	10	11	12
5	13	14	15
6	16	17	18
7	19	20	21
8	22	23	24
9	25	26	27
10	28	29	30
11	31	32	33
12	34	35	36
13	-1	-1	-1
14	-1	-1	-1
15	37	38	39
16	40	41	42
17	43	44	45
18	46	47	48
19	49	50	51
20	52	53	54
21	-1	-1	-1
22	-1	-1	-1
23	55	56	57
24	58	59	60
25	61	62	63
26	64	65	66
27	67	68	69
28	70	71	72
29	73	74	75
30	76	77	78
31	79	80	81
32	82	83	84

NO. OF TRANSLATIONAL D.O.F. = 84

NO. OF ADDITIONAL ROTATIONAL D.O.F. = 0

ISSUE #18

WEIGHTS (LBS) OF TRANSLATIONAL MASSES

MODE NO.	X DIR	Y DIR	Z DIR
1	10.726	10.726	10.726
2	18.797	18.797	18.797
3	25.016	25.016	25.016
4	25.536	25.536	25.536
5	18.310	18.310	18.310
6	3.368	3.368	3.368
7	21.678	21.678	21.678
8	18.910	18.910	18.910
9	19.756	19.756	19.756
10	18.918	18.918	18.918
11	24.091	24.091	24.091
12	40.460	40.460	40.460
13	0.000	0.000	0.000
14	0.000	0.000	0.000
15	16.991	16.991	16.991
16	16.991	16.991	16.991
17	13.316	13.316	13.316
18	20.666	20.666	20.666
19	23.556	23.556	23.556
20	16.991	16.991	16.991
21	0.000	0.000	0.000
22	0.000	0.000	0.000
23	227.350	227.350	227.350
24	227.350	227.350	227.350
25	282.350	282.350	282.350
26	282.350	282.350	282.350
27	155.675	155.675	155.675
28	155.675	155.675	155.675
29	204.025	204.025	204.025
30	204.025	204.025	204.025
31	282.350	282.350	282.350
32	282.350	282.350	282.350

ISSUE #18

25

STATIC LOAD CASE NO. 1 - GRAVITY ANALYSIS

NO. OF NODAL LOAD GENERATIONS = 0
NO. OF SUPPORT DISPLACEMENTS = 0

GRAVITY LOAD FACTORS FOR EXTRA WEIGHTS

X	Y	Z
-0.000	-1.000	-0.000

LOADS ON ELEMENT GROUPS

GROUP NO.	PRESSURE (PSI)	TEMPERATURE	GRAVITY LOAD FACTORS X	Y	Z
1	-0.0	-0.00	-0.000	-1.000	-0.000

NODAL-LOADS

NONE

SUPPORT DISPLACEMENTS

NONE

ISSUE #18

STATIC LOAD CASE NO. 2 - X-SEISMIC

NO. OF NODAL LOAD GENERATIONS = 0
NO. OF SUPPORT DISPLACEMENTS = 0

GRAVITY LOAD FACTORS FOR EXTRA WEIGHTS

X	Y	Z
2.500	-0.000	-0.000

LOADS ON ELEMENT GROUPS

GROUP NO.	PRESSURE (PSI)	TEMPERATURE	GRAVITY LOAD FACTORS X	Y	Z
1	-0.0	-0.00	2.500	-0.000	-0.000

NODAL LOADS

NONE

SUPPORT DISPLACEMENTS

NONE

ISSUE #18

27

NPS REPORT 639-170 REACTOR BLDG.EL.490.75FT.   NUCLEAR POWER SERVICES INC.NEW-YORK.

STATIC LOAD CASE NO. 3 - Y-SEISMIC

NO. OF NODAL LOAD GENERATIONS = -0
NO. OF SUPPORT DISPLACEMENTS = -0

GRAVITY LOAD FACTORS FOR EXTRA WEIGHTS

X	Y	Z
-0.000	.000	-0.000

LOADS ON ELEMENT GROUPS

GROUP NO.	PRESSURE (PSI)	TEMPERATURE	GRAVITY LOAD FACTORS X	Y	Z
1	-0.0	-0.00	-0.000	.000	-0.000

NODAL LOADS

NONE

SUPPORT DISPLACEMENTS

NONE

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ISSUE #18

STATIC LOAD CASE NO. 9 - Z-SEISMIC

NO. OF NODAL LOAD GENERATIONS = 0
NO. OF SUPPORT DISPLACEMENTS = 0

GRAVITY LOAD FACTORS FOR EXTRA WEIGHTS

X	Y	Z
-0.000	-0.000	2.800

LOADS ON ELEMENT GROUPS

GROUP NO.	PRESSURE (PSI)	TEMPERATURE	GRAVITY LOAD FACTORS X	Y	Z
1	-0.0	-0.00	-0.000	-0.000	2.800

NODAL LOADS

NONE

SUPPORT DISPLACEMENTS

NONE

ISSUE #18

NODAL DISPLACEMENTS, STATIC LOAD CASE NO. 1 - GRAVITY ANALYSIS

NODE NO.	X DISPL (IN)	Y DISPL (IN)	Z DISPL (IN)	XX ROTN (RAD)	YY ROTN (RAD)	ZZ ROTN (RAD)
1	.041448	-.001120	.000059	-.000032	-.000002	.001348
2	.036763	-.001120	.000747	-.000031	-.000002	.001319
3	.029132	-.001117	.000503	-.000049	-.000002	.001231
4	.021108	-.001095	.000222	-.000030	-.000002	.001078
5	.012224	-.001052	-.000027	-.000019	-.000002	.000786
6	.011081	-.001045	-.000053	-.000015	-.000002	.000730
7	.009674	-.001016	-.000070	-.000010	-.000002	.000676
8	.004026	-.000857	-.000110	.000007	-.000002	.000426
9	.003412	-.000832	-.000105	.000011	-.000002	.000393
10	.000862	-.000667	-.000034	.000008	-.000002	.000198
11	.000376	-.000609	-.000007	.000010	-.000002	.000136
12	-.000030	-.000150	.000014	-.000002	-.000002	-.000035
13	-.000000	-.000000	.000000	-.000000	-.000000	-.000000
14	-.000000	-.000000	.000000	-.000000	.000000	.000000
15	.000353	-.000020	-.000007	.000020	-.000002	.000212
16	.003396	-.001082	-.000105	.000032	-.000002	.000487
17	.009657	-.000995	-.000070	.000002	-.000002	.000702
18	.021088	-.000890	.000222	-.000014	-.000002	.001178
19	.029153	-.001987	.000503	-.000076	-.000002	.001365
20	.036766	-.000950	.000747	-.000010	-.000002	.001413
21	-.000000	-.000000	-.000000	-.000010	.000476	.000566
22	.000000	.000000	-.000000	.000002	-.000012	-.000211
23	.000862	-.006208	-.000060	.000000	-.000002	.000364
24	.000353	-.006781	-.000038	.000028	-.000002	.000383
25	.003396	-.012402	-.000135	.000032	-.000002	.000690
26	.004026	-.011019	-.000148	.000007	-.000002	.000630
27	.009657	-.007492	-.000094	.000002	-.000002	.000732
28	.012224	-.030305	-.000042	-.000019	-.000002	.000816
29	.021088	-.038881	.000178	-.000014	-.000002	.001520
30	.029153	-.045013	.000459	-.000076	-.000002	.001706
31	.036766	-.028949	.000717	-.000010	-.000002	.001625
32	.041448	-.027876	.000029	-.000032	-.000002	.001556

ISSUE #18

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ISSUE #18

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NPS REPORT 539-170 REACTOR BLDG.EL.090.TEST. NUCLEAR POWER SERVICES, INC.NEW-YORK.

ELEMENT FORCES, STATIC LOAD CASE NO. 1 GRAVITY ANALYSIS

ELEMENT GROUP 1 FRAME ELEMENTS

ELEM NO.	NODE NO.	AX. FORCE (K)	Y SHEAR (K)	Z SHEAR (K)	TORSION (K.IN)	YY MOMENT (K.IN)	ZZ MOMENT (K.IN)	EFF. STRESS (KSI)
1	1	-.05	.00	-.15	.00	.00	-5.08	NON-CIRCULAR
	2	.05	-.00	.15	-.00	.51	5.00	CROSS SECTION
2	2	-.37	.00	-.15	.00	2.40	-10.16	NON-CIRCULAR
	3	.38	-.00	.15	-.00	-1.61	10.16	CROSS SECTION
3	3	-.62	.00	-.15	.00	-1.35	-15.67	NON-CIRCULAR
	4	.63	-.00	.15	-.00	2.37	15.67	CROSS SECTION
4	4	-.87	.00	-.15	.00	-.12	-21.10	NON-CIRCULAR
	5	.88	-.00	.15	-.00	1.52	21.10	CROSS SECTION
5	5	-1.04	.00	-.15	.00	-1.52	-22.50	NON-CIRCULAR
	6	1.05	-.00	.15	-.00	1.78	22.50	CROSS SECTION
6	6	-2.00	-1.01	-.15	.00	-1.74	-22.50	NON-CIRCULAR
	7	2.00	1.01	.15	-.00	2.03	20.57	CROSS SECTION
7	7	-2.90	-1.01	-.15	.00	-.34	-21.97	NON-CIRCULAR
	8	3.00	1.01	.15	-.00	1.80	11.35	CROSS SECTION
8	8	-3.20	-1.01	-.15	.00	-1.08	-16.42	NON-CIRCULAR
	9	3.20	1.01	.15	-.00	2.10	14.90	CROSS SECTION
9	9	-3.60	-1.01	-.15	.00	.90	-19.90	NON-CIRCULAR
	10	3.62	1.01	.15	-.00	.48	10.01	CROSS SECTION
10	10	-3.85	-1.01	-.15	.00	-.02	-10.06	NON-CIRCULAR
	11	3.86	1.01	.15	-.00	.06	11.93	CROSS SECTION
11	11	-4.11	-1.01	-.15	.00	1.59	-16.02	NON-CIRCULAR
	12	4.14	1.01	.15	-.00	.12	3.87	CROSS SECTION
12	12	.74	-3.37	-.12	.12	.39	-11.30	NON-CIRCULAR
	13	-.74	3.50	.12	-.12	.65	-17.37	CROSS SECTION
13	12	-.27	-.36	.03	-.04	-.34	-7.03	NON-CIRCULAR
	14	.27	.60	-.03	.04	-.21	-5.30	CROSS SECTION
14	11	.00	.25	-.00	-8.09	.00	2.45	NON-CIRCULAR
	15	-.00	-.23	.00	8.09	-.00	.00	CROSS SECTION
15	9	.00	.31	.00	-5.08	-.00	3.00	NON-CIRCULAR
	16	-.00	-.30	-.00	5.08	-.00	.00	CROSS SECTION
16	7	.00	.18	.00	-1.40	-.00	1.69	NON-CIRCULAR
	17	-.00	-.16	-.00	1.40	-.00	.00	CROSS SECTION
17	4	-.00	.23	.00	-5.51	-.00	2.25	NON-CIRCULAR
	[illegible]	.00	-.22	-.00	5.51	-.00	.00	CROSS SECTION

[illegible]	[illegible] 16	[illegible] -.00	[illegible] -.29	[illegible] -.00	-5.00 5.00	-.00 -.00	3.00 .00	NON-CIRCULAR CROSS SECTION
16	7 17	.00 -.00	.18 -.16	.00 -.00	-1.40 1.40	-.00 -.00	1.49 .00	NON-CIRCULAR CROSS SECTION
17	4 18	-.00 .00	.22 -.22	.00 -.00	-5.51 5.51	-.00 -.00	2.23 .00	NON-CIRCULAR CROSS SECTION
18	3 19	.00 -.00	.24 -.22	-.00 .00	5.51 -5.51	.00 .00	2.96 .00	NON-CIRCULAR CROSS SECTION
19	2 20	0.00 0.00	.31 -.29	-.00 .00	-5.00 5.00	.08 -.00	3.00 .00	NON-CIRCULAR CROSS SECTION
20	15 24	.00 -.00	.23 -.22	-.00 .00	.00 -.00	-.00 .00	4.09 -.00	NON-CIRCULAR CROSS SECTION
21	10 23	.00 -.00	.23 -.22	-.00 .00	.00 -.00	.00 .00	0.09 -.00	NON-CIRCULAR CROSS SECTION
22	16 25	.00 -.00	.29 -.27	.00 -.00	.00 -.00	-.00 -.00	5.00 -.00	NON-CIRCULAR CROSS SECTION
23	0 26	0.00 0.00	.29 -.27	.00 -.00	0.00 0.00	-.00 -.00	5.00 -.00	NON-CIRCULAR CROSS SECTION
24	17 27	.00 -.00	.16 -.15	-.00 .00	.00 -.00	.00 .00	1.40 .00	NON-CIRCULAR CROSS SECTION
25	5 28	0.00 0.00	.16 -.15	.00 -.00	0.00 0.00	-.00 .00	1.40 -.00	NON-CIRCULAR CROSS SECTION
26	18 29	.00 -.00	.22 -.19	.00 -.00	.00 -.00	-.00 -.00	5.51 .00	NON-CIRCULAR CROSS SECTION
27	19 30	0.00 0.00	.22 -.19	-.00 .00	0.00 0.00	.00 .00	5.51 -.00	NON-CIRCULAR CROSS SECTION
28	20 31	.00 -.00	.29 -.27	.00 -.00	.00 -.00	-.00 -.00	5.00 .00	NON-CIRCULAR CROSS SECTION
29	1 32	0.00 0.00	.29 -.27	.00 -.00	-.00 .00	-.00 .00	5.00 .00	NON-CIRCULAR CROSS SECTION
30	1 21	-.28 .28	.00 -.00	.00 -.00	-.00 .00	-.00 -.00	.00 .00	NON-CIRCULAR CROSS SECTION
31	6 22	2.02 -2.02	.00 -.00	-.00 .00	.00 -.00	.00 -.00	.00 0.00	NON-CIRCULAR CROSS SECTION

ISSUE #18

NPS REPORT 039-179 REACTOR BLDG.EL.499.75FT. NUCLEAR POWER SERVICES INC.NEW-YORK.

SUPPORT REACTIONS, STATIC LOAD CASE NO. 1 - GRAVITY ANALYSIS

SUPPORT REACTIONS

NODE NO.	X FORCE (LB)	Y FORCE (LB)	Z FORCE (LB)	XX MOMENT (FT-LB)	YY MOMENT (FT-LB)	ZZ MOMENT (FT-LB)	SUPPORT IDENT
13	742.23	3590.05	-180.63	10.11	52.45	1447.74	FIXED END
14	270.00	603.40	-25.67	3.60	-10.60	-040.30	FIXED END
21	.01	239.50	100.30	0.00	0.00	0.00	PIN SUPPORT
22	-1012.33	-1750.50	.00	0.00	0.00	0.00	PIN SUPPORT

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ISSUE #18

NPS REPORT 639-179 REACTOR BLDG.EL.490,75FT. NUCLEAR POWER SERVICES INC.NEW-YORK.

PERIODS OF VIBRATION (SEC)

.0970	.0611	.0510	.0450	.0423	.0392	.0380	.0353	.0323	.0310
.0287	.0265	.0226	.0213	.0200	.0185	.0171	.0160	.0157	.0129
.0092	.0086	.0073	.0069	.0063	.0060	.0051	.0051	.0047	.0039
.0031	.0027	.0026	.0023	.0017	.0015	.0013	.0012	.0011	.0010
.0008	.0008	.0008	.0007	.0007	.0007	.0006	.0006	.0006	.0006
.0006	.0005	.0005	.0004	.0004	.0004	.0004	.0003	.0003	.0003
.0003	.0003	.0003	.0003	.0002	.0002	.0002	.0002	.0002	.0001
.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001
.0001	.0000	.0000	.0000						

NO. OF SIGNIFICANT MODES = 20

ORTHOGONALITY CHECK ON GENERALIZED MASS MATRIX

MAX DIAGONAL TERM = .10000000E+01
MIN DIAGONAL TERM = .10000000E+01

MAX OFF-DIAG TERM = .14743762E-12
MIN OFF-DIAG TERM = -.51625371E-13

ISSUE #18

MODE SHAPES (DYNAMIC D.O.F. ONLY)

D.O.F.	MODE 1	MODE 2	MODE 3	MODE 4	MODE 5	MODE 6	MODE 7	MODE 8	MODE 9	MODE 10
1	-.2922E+01	.1674E+02	.1773E+00	-.5006E+00	.8805E+00	-.8709E+01	.8426E+01	.7703E+00	-.3663E+00	-.8086E+00
2	.1525E+00	-.2464E+00	-.8731E-01	-.6845E-01	.1042E+00	-.1171E+00	-.5114E-01	.6311E-02	-.2350E-01	.4403E-01
3	-.1344E+01	-.1020E-01	.8701E+00	.9846E+00	-.2481E+01	.1080E+01	.3903E+00	-.1260E+00	.2007E+00	-.4525E+00
4	-.2632E+01	.1497E+02	.1303E+00	-.3624E+00	.7814E+00	-.6818E+01	.8738E+01	.8029E+00	-.3761E+00	-.7804E+00
5	.1477E+00	-.2474E+00	-.2625E-01	-.6107E-01	.1751E+00	-.1081E+00	-.5070E-01	.5726E-02	-.2245E-01	.4309E-01
6	-.1376E+01	-.4885E-01	.1211E+00	.1122E+01	-.1737E+01	.1666E+01	-.2530E+00	-.1252E+00	.2903E+00	-.5071E+00
7	-.2147E+01	.1202E+02	.7558E-01	-.1359E+00	.6401E+00	-.7527E+01	.3176E+01	.8436E+00	-.3894E+00	-.7707E+00
8	.1393E+00	-.2478E+00	-.2465E-01	-.5505E-01	.1610E+00	-.8013E-01	-.5492E-01	.4480E-02	-.2038E-01	.3963E-01
9	-.1410E+01	-.1176E+00	-.1503E+00	.1361E+01	-.5406E+00	.1357E+01	-.1316E+01	-.1074E+00	.3294E+00	-.5803E+00
10	-.1617E+01	.8822E+01	.1536E-01	.8397E-01	.4806E+00	-.8190E+01	.3761E+01	.1004E+01	-.5078E+00	-.8360E+00
11	.1294E+00	-.2665E+00	-.2215E-01	-.5000E-01	.1425E+00	-.4726E-01	-.5034E-01	.6715E-02	-.2155E-01	.3425E-01
12	-.1392E+01	-.1772E+00	-.8412E+00	.1667E+01	.6785E+00	.1039E+01	-.2363E+01	-.3760E+00	.4120E+00	-.6883E+00
13	-.9036E+00	.5153E+01	-.3189E-01	.2652E+00	.2763E+00	-.7635E+01	.4215E+01	.1109E+01	-.6871E+00	-.8868E+00
14	.1155E+00	-.2420E+00	-.1805E-01	-.4216E-01	.1198E+00	.1137E-01	-.7289E-01	-.2701E-02	-.1304E-01	.3518E-01
15	-.1249E+01	-.2017E+00	-.6685E+00	.2050E+01	.1050E+01	.8610E+00	-.3057E+01	-.5674E+00	.4355E+00	-.5913E+00
16	-.9098E+00	.4674E+01	-.3639E-01	.2813E+00	.2527E+00	-.7032E+01	.4190E+01	.1107E+01	-.6949E+00	-.8737E+00
17	.1134E+00	-.2419E+00	-.1845E-01	-.4093E-01	.1162E+00	.2048E-01	-.7642E-01	-.4103E-02	-.1261E-01	.3531E-01
18	-.1214E+01	-.2014E+00	-.6043E+00	.2091E+01	.1071E+01	.8450E+00	-.3072E+01	-.5001E+00	.4230E+00	-.5832E+00
19	-.8852E+00	.4042E+01	-.4131E-01	.2973E+00	.2248E+00	-.7129E+01	.4124E+01	.1175E+01	-.6979E+00	-.8493E+00
20	.1091E+00	-.2329E+00	-.1301E-01	-.3809E-01	.1123E+00	.1807E-01	-.7337E-01	-.3900E-02	-.1236E-01	.3394E-01
21	-.1164E+01	-.1991E+00	-.6973E+00	.2134E+01	.2104E+01	.8246E+00	-.3055E+01	-.5982E+00	.4000E+00	-.5679E+00
22	-.3712E+00	.1735E+01	-.4948E-01	.2954E+00	.1301E+00	-.4935E+01	.3155E+01	.9125E+00	-.5778E+00	-.6059E+00
23	.8659E-01	-.1650E+00	-.1567E-01	-.2009E-01	.4212E-01	.6727E-02	-.5673E-01	-.2361E-02	-.1112E-01	.2663E-01
24	-.8232E+00	-.1577E+00	-.6274E+00	.2035E+01	.2244E+01	.6718E+00	-.2418E+01	-.5381E+00	.1982E+00	-.3507E+00
25	-.3219E+00	.1494E+01	-.4846E-01	.2835E+00	.1216E+00	-.4549E+01	.2936E+01	.8503E+00	-.5431E+00	-.5580E+00
26	.8336E-01	-.1761E+00	-.1866E-01	-.2051E-01	.8924E-01	.4822E-02	-.5366E-01	-.1939E-02	-.1105E-01	.2542E-01
27	-.7666E+00	-.1480E+00	-.6083E+00	.1966E+01	.2184E+01	.6335E+00	-.2267E+01	-.5086E+00	.1603E+00	-.3067E+00
28	-.1100E+00	.4730E+00	-.3345E-01	.1727E+00	.7580E-01	-.2277E+01	.1534E+01	.4459E+00	-.3049E+00	-.2697E+00
29	.6394E-01	-.1357E+00	-.1210E-01	-.1745E-01	.7147E-01	-.2052E-01	-.2716E-01	.2649E-02	-.1210E-01	.1753E-01
30	-.4189E+00	-.8186E-01	-.3768E+00	.1292E+01	.1483E+01	.3729E+00	-.1201E+01	-.3546E+00	-.5163E-01	.4213E-02
31	-.6497E-01	.2736E+00	-.2642E-01	.1287E+00	.6247E-01	-.1597E+01	.1003E+01	.3146E+00	-.2224E+00	-.1834E+00
32	.5745E-01	-.1215E+00	-.1125E-01	-.1437E-01	.6554E-01	-.3017E-01	-.1721E-01	.4522E-02	-.1276E-01	.1465E-01
33	-.2953E+00	-.5897E-01	-.2900E+00	.1002E+01	.1164E+01	.2795E+00	-.9725E+00	-.2845E+00	-.7836E-01	.6474E-01
34	.2500E-03	-.5803E-02	-.5576E-03	.3377E-02	.8215E-03	-.1193E-01	.9966E-02	.3550E-02	-.3179E-02	-.6424E-03
35	.3151E-01	-.6444E-01	-.7681E-02	-.2705E-02	.4078E-01	-.7547E-01	.2907E-01	.1413E-01	-.1615E-01	.2224E-02
36	.6144E-01	.1327E-01	.5769E-02	-.5036E-01	-.8001E-02	.5630E-03	-.5418E-01	.9105E-02	.4414E-01	-.3998E-01
37	-.1657E+01	-.7075E-01	-.4175E+00	.2436E+01	.1579E+01	-.1529E+01	.2101E+01	-.5022E+00	-.2400E+01	.2307E+01
38	-.3192E+00	-.1994E+00	-.3841E+00	.9842E+00	.1172E+01	.3390E+00	-.1110E+01	-.2668E+00	.2010E-01	-.7190E-01
39	-.2957E+00	-.5911E-01	-.2986E+00	.1007E+01	.1169E+01	.2806E+00	-.9680E+00	-.2037E+00	-.1004E+00	.8512E-01
40	-.3235E+01	.8716E+00	-.6988E+00	.3923E+01	.2361E+01	-.4459E+01	.4327E+01	.1340E+01	-.3203E+00	-.4571E+00
41	-.2987E+00	-.2526E+00	-.2897E+00	.4051E+00	.5601E+00	.3676E+00	-.1177E+01	-.1731E+00	.2671E+00	-.3302E+00
42	-.7677E+00	-.1404E+00	-.6018E+00	.1979E+01	.2194E+01	.6384E+00	-.2261E+01	-.4891E+00	.1918E+00	-.2976E+00
43	-.4802E+01	.3237E+01	-.6328E+00	.2781E+01	.9143E+00	-.7598E+01	.5048E+01	.9077E+00	-.1282E+01	-.1180E+01
44	-.1579E+00	-.2532E+00	.2496E-01	-.2128E+00	-.4767E+00	.1313E+00	-.2569E+00	.2694E-01	.1161E+00	-.5777E-01
45	-.1164E+01	-.1992E+00	-.6977E+00	.2136E+01	.2105E+01	.8250E+00	-.3057E+01	-.5989E+00	.4007E+00	-.5687E+00
46	-.6841E+01	.7699E+01	-.9674E+00	.9191E+00	-.1203E+00	-.8026E+01	.4421E+01	.8324E+00	-.7408E+00	-.8306E+00
47	.5539E-01	-.2184E+00	.3359E+00	-.8950E+00	-.1449E+01	.2482E+00	.1555E+01	.4306E+00	-.2415E+00	-.6361E-01
48	-.1305E+01	-.1780E+00	-.4537E+00	.1657E+01	.6011E+00	.1040E+01	-.2363E+01	-.3753E+00	.4130E+00	-.6079E+00
49	.5243E+01	.1372E+02	-.1204E+01	-.1224E+01	.2678E+01	-.6784E+01	.2820E+01	.1194E+01	-.2958E+00	-.9902E+00
50	.1161E+00	-.4561E+00	-.6256E+00	.5297E+00	.2724E+01	-.1507E+01	-.2558E+01	-.3081E+00	.2374E+00	-.2839E-01
51	-.1413E+01	-.1196E+00	-.1354E+00	.1351E+01	-.5307E+00	.1351E+01	-.1316E+01	-.1965E+00	.3203E+00	-.5803E+00
52	-.8440E+01	.1360E+02	.6565E+00	.1633E+01	-.2840E+01	-.7304E+01	.2400E+01	.1172E+01	-.6664E+00	-.5144E+00
53	.2348E+00	-.1608E+00	.4276E+00	-.4504E+00	-.1891E+01	.2508E+00	.1077E+01	.4188E-01	-.4151E-01	.2016E+00
54	-.1370E+01	-.4942E-01	-.1220E+00	.1120E+01	-.1752E+01	.1665E+01	-.2714E+00	-.9742E-01	.2760E+00	-.5057E+00
55	-.1106E+00	.4734E+00	-.3352E-01	.1731E+00	.7601E-01	-.2287E+01	.1541E+01	.4481E+00	-.3063E+00	-.2711E+00

ISSUE #18

	[illegible]	[illegible]	[illegible]	[illegible]	.6011E+00	[illegible]	-.2163E+01	-.3753E+00	.4130E+00	-.6079E+00
	.5243E+01	.1372E+02	-.1204E+01	-.1224E+01	.2678E+01	-.[illegible]	.2820E+01	.1104E+01	-.2954E+00	-.9902E+00
	.1161E+00	-.4561E+00	-.6256E+00	.5207E+00	.2724E+01	-.1[illegible]	-.2558E+01	-.3801E+00	.2374E+00	-.2839E-01
51	-.1413E+01	-.1190E+00	-.1354E+00	.1351E+01	-.5387E+00	.1357E+01	-.1316E+01	-.1965E+00	.3293E+00	-.5803E+00
52	-.8440E+01	.1160E+02	.6565E+00	.1633E+01	-.2840E+01	-.7394E+01	.2408E+01	.1172E+01	-.6664E+00	-.5144E+00
53	.2348E+00	-.1608E+00	.4276E+00	-.4584E+00	-.1091E+01	.2580E+00	.1077E+01	.4100E-01	-.8151E-01	.2016E+00
54	-.1370E+01	-.4962E-01	.1220E+00	.1180E+01	-.1752E+01	.1005E+01	-.2714E+00	-.9742E+01	.2760E+00	-.5097E+00
55	-.1106E+00	.4734E+00	-.3352E-01	.1731E+00	.7601E-01	-.2287E+01	.1541E+01	.4401E+00	-.3063E+00	-.2711E+00
56	.1435E+00	-.1574E+01	.3136E-01	-.3153E+00	-.1363E-01	.5141E+01	-.3513E+01	-.1010E+01	.6147E+00	.7204E+00
57	-.4169E+01	-.9369E+00	-.1636E+01	.9379E+01	.7579E+01	.1272E+01	.1986E+01	-.8700E+01	-.1041E+02	.1107E+02
58	-.1658E+01	-.7681E-01	-.4183E+00	.2442E+01	.1584E+01	-.1535E+01	.2191E+01	-.5046E+00	-.2500E+01	.2318E+01
59	-.8537E-01	-.1281E+01	-.3006E+00	.8769E+00	.1364E+01	.5864E+01	-.5498E+01	-.1541E+01	.7766E+00	.6344E+00
60	-.3462E+01	-.7749E+00	-.1431E+01	.8676E+01	.7181E+01	.1147E+01	.4204E+01	-.8098E+01	-.1943E+02	.2564E+02
61	-.3237E+01	.8724E+00	-.7804E+00	.3935E+01	.2372E+01	-.4482E+01	.4352E+01	.1340E+01	-.3222E+00	-.4608E+00
62	.2063E+00	-.3233E+01	-.2336E+00	.4249E+00	.6107E+00	.7886E+01	-.6532E+01	-.1623E+01	.1211E+01	.4441E+00
63	-.6735E+01	-.1496E+01	-.2853E+01	.1716E+02	.1840E+02	.4154E+01	.8709E+01	.1400E+02	.2215E+02	.6179E+01
64	-.3715E+00	.1737E+01	-.4952E-01	.2963E+00	.1306E+00	-.4960E+01	.3173E+01	.9180E+00	-.5811E+00	-.6098E+00
65	.6447E+00	-.3345E+01	-.7245E-02	-.1732E+00	-.1823E-01	.5805E+01	-.3426E+01	-.9619E+00	.8132E+00	.7085E+00
66	-.6971E+01	-.1546E+01	-.2604E+01	.1494E+02	.1183E+02	.2808E+01	-.3626E+01	-.8576E+01	-.1167E+02	-.2524E+02
67	-.4803E+01	.3238E+01	-.6325E+00	.2783E+01	.9152E+00	-.7601E+01	.5048E+01	.9994E+00	-.1224E+01	-.1182E+01
68	.2949E+00	-.2831E+01	.5583E-02	-.1547E+00	-.6085E+00	.1645E+01	-.6699E+00	-.6138E-01	.1269E+00	.7278E-01
69	-.4798E+01	-.9675E+00	-.1265E+01	.4541E+01	.2846E+01	.4117E+00	-.2388E+01	-.8816E+00	-.8038E-01	-.9406E+00
70	-.9938E+00	.5155E+01	-.3101E-01	.2654E+00	.2766E+00	-.7646E+01	.4221E+01	.1191E+01	-.6082E+00	-.8883E+00
71	.6329E+00	-.3217E+01	-.4841E-01	.6473E-01	-.2928E-01	.1175E+01	-.1540E+00	.9819E-02	-.7718E-01	.1015E+00
72	-.5148E+01	-.1837E+01	-.1207E+01	.4102E+01	.2158E+01	.4492E+00	-.2485E+01	-.7868E+00	.4479E-01	-.8604E+00
73	-.6846E+01	.7707E+01	-.9699E+00	.9222E+00	-.3305E+00	-.8075E+01	.4449E+01	.8370E+00	-.7457E+00	-.8444E+00
74	.2232E+01	-.1391E+02	.2293E+00	.4036E+00	-.4453E+01	-.1548E+01	.1079E+02	.1289E+02	-.9600E+01	-.8189E+01
75	-.2087E+02	-.5053E+01	-.3152E+02	-.1987E+02	.4293E+01	.1082E+01	.4234E+00	.6279E+00	.1712E+00	.4302E+00
76	.5247E+01	.1373E+02	-.1207E+01	-.1228E+01	.2648E+01	-.6821E+01	.2830E+01	.1201E+01	-.2973E+00	-.9978E+00
77	.2529E+01	-.1501E+02	-.1451E+01	.3034E+01	.5026E+01	-.3328E+02	-.1351E+02	-.5108E+01	.5027E+01	.1049E+01
78	-.2264E+02	-.5904E+01	.2025E+02	-.1780E+02	.1308E+02	.4798E-01	.5090E+00	.7069E+00	-.1045E+00	.6788E-01
79	-.8445E+01	.1161E+02	.6581E+00	.1634E+01	-.2850E+01	-.7431E+01	.2414E+01	.1179E+01	-.6704E+00	-.5177E+00
80	.1799E+01	-.9836E+01	.2005E+00	.3165E+00	-.3164E+01	-.5111E+01	.5766E+01	.2866E+00	-.1479E+00	.5308E+00
81	-.1327E+02	-.2531E+01	.1697E+01	.9493E+01	-.1911E+02	-.9292E+00	-.1363E+02	.1986E+02	-.9627E+01	.1002E+01
82	-.2923E+01	.1675E+02	.1777E+00	-.5021E+00	.8836E+00	-.5738E+01	.2440E+01	.7630E+00	-.3685E+00	-.8137E+00
83	.1690E+01	-.9738E+01	-.2490E+00	.7507E+00	-.3873E+00	-.4871E+01	.2104E+01	.1015E+00	-.9437E-01	.2100E+00
84	-.1367E+02	-.2550E+01	.1859E+01	.8459E+01	-.1878E+02	.1401E+01	.8473E+01	-.2184E+02	.1243E+02	.9882E+00

ISSUE #18

MODE SHAPES (DYNAMIC D.O.F. ONLY)

D.O.F.	MODE 11	MODE 12	MODE 13	MODE 14	MODE 15	MODE 16	MODE 17	MODE 18	MODE 19	MODE 20
1	.9695E-01	.2821E+01	.3000E+01	-.5038E+01	.8190E+01	-.0307E+00	-.2090E+01	-.6060E+01	-.0830E+00	.3665E+01
2	.2704E-02	-.0607E-01	.4366E+00	.0767E-02	.2142E+00	-.1968E+01	-.2032E+00	-.3092E+00	-.2896E-01	-.1595E+00
3	-.9242E-01	.2702E+00	.9940E+00	-.8281E+01	-.2811E+01	.1479E+02	-.0260E+01	-.2100E+01	-.3600E+01	-.2036E+01
4	-.7863E-02	.1148E+01	.3590E+01	-.8134E+01	.6353E+00	-.7038E+00	-.3942E+01	-.5021E+01	-.4163E+00	.2890E+01
5	.2917E-02	-.8705E-01	.4410E+00	-.1241E-01	.2410E+00	-.1003E+01	.1715E+00	-.3001E+00	-.4506E-01	-.1009E+00
6	-.5790E-02	.1231E+01	.1049E+01	-.8429E+01	-.3754E+01	.1496E+02	-.8709E+01	-.1515E+01	-.4790E+01	-.2890E+01
7	-.1382E+00	-.9836E+00	.3560E+01	-.4939E+01	-.1107E+01	-.3021E+00	-.2851E+01	-.4960E+01	-.3316E+00	.8630E+00
8	.4954E-02	-.4439E-01	.4387E+00	-.2426E-01	.2476E+00	-.1002E+01	.1239E+00	-.3772E+00	-.6201E-01	-.2508E+00
9	.1290E+00	.2662E+01	.1107E+01	-.5758E+01	-.5683E+01	.1512E+02	-.9371E+01	-.3667E+00	-.6760E+01	-.6627E+00
10	-.1919E+00	-.2848E+01	.3170E+01	-.3958E+01	-.2376E+01	.4103E+00	-.2449E+01	-.2920E+01	.0348E-03	-.2173E+01
11	.6816E-02	-.0031E-02	.0146E+00	-.3595E-01	.2462E+00	-.1603E+01	.6892E-01	-.3540E+00	-.0210E-01	-.3401E+00
12	.2446E+00	.3632E+01	.1103E+01	-.6108E+01	-.7089E+01	.1489E+02	-.9772E+01	.9635E+00	-.0690E+01	.1110E+01
13	-.2033E+00	-.2489E+01	.2382E+01	-.1631E+01	-.3235E+01	.1450E+01	-.1903E+01	.6333E+00	.7710E+00	-.6843E+01
14	.7659E-02	.1898E-01	.4246E+00	-.4064E-01	.2374E+00	-.1516E+01	-.3377E-02	-.3125E+00	-.1052E+00	-.4879E+00
15	.3447E+00	.3892E+01	.1475E+01	-.6481E+01	-.7604E+01	.1342E+02	-.9315E+01	.2252E+01	-.0828E+01	.3295E+01
16	-.2013E+00	-.2509E+01	.2276E+01	-.1218E+01	-.3282E+01	.1874E+01	-.1863E+01	.1172E+01	.0143E+00	-.7541E+01
17	.7789E-02	.2316E-01	.4231E+00	-.4206E-01	.2162E+00	-.1889E+01	-.1400E-01	-.3072E+00	-.1092E+00	-.5056E+00
18	.3558E+00	.3851E+01	.1451E+01	-.6471E+01	-.7526E+01	.1304E+02	-.9146E+01	.2332E+01	-.0771E+01	.1876E+01
19	-.1975E+00	-.2514E+01	.2161E+01	-.6540E+00	-.3306E+01	.1706E+01	-.1846E+01	.1034E+01	.1103E+01	-.0394E+01
20	.7603E-02	.2411E-01	.4264E+00	-.4640E-01	.2292E+00	-.1455E+01	-.3375E-01	-.2090E+00	-.1131E+00	-.5491E+00
21	.3605E+00	.3766E+01	.1395E+01	-.6424E+01	-.7350E+01	.1249E+02	-.8841E+01	.2377E+01	-.9501E+01	.3913E+01
22	-.1535E+00	-.2053E+01	.2290E+01	.1702E+01	-.2614E+01	.1303E+01	-.2617E+01	.3642E+01	.1793E+01	-.1030E+02
23	.6662E-02	.2839E-01	.4456E+00	-.7360E-01	.1948E+00	-.1284E+01	-.1267E+00	-.2647E+00	-.1310E+00	-.7047E+00
24	.4047E+00	.2820E+01	.5607E+00	-.5420E+01	-.5514E+01	.0770E+01	-.6503E+01	.1019E+01	-.7017E+01	.4808E+01
25	-.1434E+00	-.1913E+01	.2453E+01	.1689E+01	-.2412E+01	.1128E+01	-.2792E+01	.3616E+01	.1000E+01	-.1015E+02
26	.6479E-02	.2835E-01	.4461E+00	-.0683E-01	.1847E+00	-.1249E+01	-.1174E+00	-.2565E+00	-.1315E+00	-.7266E+00
27	.4066E+00	.2642E+01	.3658E+00	-.5166E+01	-.8162E+01	.0175E+01	-.6210E+01	.1605E+01	-.6546E+01	.4314E+01
28	-.7724E-01	-.1001E+01	.2250E+01	.1769E+01	-.1166E+01	.1182E+00	-.2196E+01	.2226E+01	.0525E+00	-.7452E+01
29	.4951E-02	.1673E-01	.3652E+00	-.1057E+00	.1384E+00	-.1033E+01	-.0739E-01	-.2072E+00	-.1539E+00	-.0462E+00
30	.3464E+00	.1495E+01	-.3305E+00	-.3217E+01	-.2943E+01	.4620E+01	-.3740E+01	.0349E+00	-.3652E+01	.3105E+01
31	-.5177E-01	-.6991E+00	.1762E+01	.1278E+01	-.7913E+00	-.1003E+00	-.1629E+01	.1535E+01	.5022E+00	-.6100E+01
32	.4356E-02	.1175E-01	.3407E+00	-.1105E+00	.1126E+00	-.9510E+00	-.1651E+00	-.1637E+00	-.1242E+00	-.0512E+00
33	.2703E+00	.1127E+01	-.3322E+00	-.2487E+01	-.2223E+01	.3569E+01	-.2882E+01	.5013E+00	-.2791E+01	.2584E+01
34	-.1856E-03	-.3594E-02	.1550E-01	-.0204E-02	-.7945E-02	-.4229E-01	-.3190E-01	.2606E-01	-.1031E-01	-.2470E+00
35	.6906E-03	-.1777E-01	.2724E+00	-.2574E-01	.3628E-01	-.5089E+00	-.1209E+00	-.3302E-01	-.6035E-01	-.0069E+00
36	-.9193E-02	.4759E-01	-.4313E-01	-.6113E-01	-.7412E-01	.2396E+00	-.1425E+00	-.1247E+00	-.9002E-01	.3660E+00
37	-.2677E+00	-.1331E+01	.2035E+01	.2778E+01	.1328E+00	-.3046E+01	-.0347E-01	.3519E+01	.9601E+00	-.1137E+02
38	.2763E+00	.1289E+01	-.5268E-01	-.3766E+01	-.2320E+01	.1908E+01	-.3025E+01	.1175E+01	-.2374E+01	.3753E+00
39	.2494E+00	.1131E+01	-.3331E+00	-.2409E+01	-.2221E+01	.3574E+01	-.2883E+01	.5323E+00	-.2706E+01	.2599E+01
40	.1231E-01	-.3293E+01	.2751E+01	.4490E+01	-.1040E+01	-.4251E+01	.2648E-02	.0136E+01	.0346E+00	-.1731E+02
41	.2165E-02	.1821E+01	.2779E+01	-.2036E+01	-.2262E+01	.2713E+01	-.2222E+01	.6531E+00	-.3078E+01	-.9997E-01
42	.4011E+00	.2641E+01	.3630E+00	-.5166E+01	-.5157E+01	.0101E+01	-.6217E+01	.1665E+01	-.6533E+01	.4334E+01
43	-.1419E-01	-.3008E+01	.2695E+01	.1695E+01	-.2989E+01	-.5622E+01	.1403E+01	.1126E+02	-.5052E+01	-.1061E+02
44	-.5134E-01	.5477E+00	.7857E+00	-.3407E+00	-.0187E+00	.1553E+01	-.1769E+01	-.2636E+00	-.1416E+01	-.2563E+01
45	.3491E+00	.3769E+01	.1394E+01	-.6434E+01	-.7377E+01	.1251E+02	-.0865E+01	.2422E+01	-.0658E+01	.3037E+01
46	-.1176E+00	-.3105E+01	.3375E+01	-.1096E+01	-.9003E+00	-.1004E+02	.3230E+01	.5061E+01	-.4426E+01	.1932E+01
47	-.1069E+00	-.5512E+00	.2432E+00	.3571E+00	.1726E+01	-.9516E+00	.2145E+00	-.2326E+01	.2130E+01	-.2623E+01
48	.2443E+00	.3632E+01	.1102E+01	-.6190E+01	-.7090E+01	.1490E+02	-.9778E+01	.9527E+00	-.0603E+01	.1113E+01
49	-.2220E+00	.1079E+00	.3912E+01	-.9676E+01	-.3045E+01	.1541E+02	-.1242E+02	-.1606E+02	.0346E+01	-.9019E+01
50	.2021E+00	.2986E+01	.0240E+00	-.9458E+00	-.2023E+01	-.1700E+01	-.1084E+01	.1074E+01	-.4110E+01	.3352E+01
51	.1208E+00	.2062E+01	-.1107E+01	-.5763E+01	-.5605E+01	.1514E+02	-.0384E+01	-.3022E+00	-.6758E+01	-.6762E+00
52	.3134E-01	.5410E+00	.3537E+01	-.2048E+01	.2764E+01	-.1276E+02	.3757E+01	.1476E+00	-.2076E+01	.1126E+02
53	-.2737E+00	-.3265E+01	.4009E+00	-.1903E-01	.4678E+01	-.2138E+01	.1292E+01	-.2207E+01	.3076E+01	-.2010E+01
54	-.0284E-02	.1230E+01	.1040E+01	-.5430E+01	-.3750E+01	.1490E+02	-.8110E+01	.1539E+01	-.4774E+01	-.2115E+01
55	-.7777E-01	-.1007E+01	.2273E+01	.1809E+01	-.1101E+01	.1200E+00	-.2235E+01	.2267E+01	.9723E+00	-.7705E+01
56	.1977E+00	.2519E+01	-.3644E+01	-.0740E+01	.5630E+01	-.7931E+01	.1216E+02	-.2114E+02	-.2606E+02	-.1511E+02

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	.2443E+00	.3032E+01	.1382E+01	-.6196E+01	-.7090E+01	[illegible]	.9770E+01	.9527E+00	-.8683E+01	.1113E+01
	-.2228E+00	.1079E+00	.3912E+01	-.9676E+01	-.1845E+01	.15[illegible]	.1242E+02	-.1666E+02	.0346E+01	-.9019E+01
50	.2821E+00	.2986E+01	.0248E+00	-.9458E+00	-.2823E+01	-.1706E+01	-.1044E+01	.1074E+01	-.4110E+01	.3352E+01
51	.1268E+00	.2662E+01	.1167E+01	-.5763E+01	-.5685E+01	.1514E+02	-.0384E+01	-.3822E+00	-.6788E+01	-.6782E+00
52	.3134E-01	.5818E+00	.3537E+01	-.2848E+01	.2764E+01	-.1276E+02	.3757E+01	.1476E+00	-.2076E+01	.1126E+02
53	-.2731E+00	-.3265E+01	.4889E+00	-.1903E-01	.4678E+01	-.2138E+01	.1292E+01	-.2247E+01	.3076E+01	-.2018E+01
54	-.6284E-02	.1236E+01	.1090E+01	-.5430E+01	-.1756E+01	.1490E+02	-.6716E+01	-.1534E+01	.4774E+01	-.2115E+01
55	-.7771E-01	-.1087E+01	.8273E+01	.1809E+01	-.1181E+01	.1200E+00	-.2235E+01	.2267E+01	.0723E+00	-.7705E+01
56	.1472E+00	.2539E+01	-.3644E+01	-.4708E+01	.5638E+01	-.7031E+01	.1216E+02	-.2114E+02	-.2686E+02	-.1511E+02
57	.3518E+02	-.8191E+01	-.2339E+00	.2139E+00	.1109E+01	.1217E+01	.2546E+00	-.3031E+01	.2084E+01	.1387E+01
58	-.2693E+00	-.1348E+01	.2855E+01	.2809E+01	.1345E+00	-.3092E+01	-.8494E-01	.3505E+01	.5799E+00	-.1176E+02
59	.7249E+00	.5398E+01	-.1081E+02	-.3307E+02	-.2850E+01	-.1250E+02	-.1179E+01	.8548E+01	.9036E+01	-.6923E+01
60	-.2021E+02	.2488E+01	-.3352E+00	-.4436E+00	.5279E+00	.1285E+01	.5936E-01	-.2167E+01	.1149E+01	.1753E+01
61	.3256E-01	-.3318E+01	.2785E+01	.4553E+01	-.1057E+01	-.4330E+01	.2706E-02	.0324E+01	.0563E+00	-.1805E+02
62	.2648E+00	.6931E+01	.3310E+02	-.5275E+01	-.1501E+01	-.9557E+00	.7272E+01	.3062E-01	.3948E+01	-.1318E+01
63	-.3076E+01	-.4285E+00	-.9835E+00	.2037E+00	.1758E+01	.0463E+00	.4808E+00	-.3014E+01	.8659E+01	.1002E+01
64	-.1546E+00	-.2069E+01	.2327E+01	.1725E+01	-.2655E+01	.1368E+01	-.2674E+01	.3726E+01	.1039E+01	-.1074E+02
65	.1801E+00	.2383E+01	.8378E+01	.6096E+01	.7696E+01	-.1702E+02	-.2934E+02	-.4217E+01	-.2403E+01	-.5075E+00
66	-.5221E+01	-.2608E+01	-.1249E+01	.9201E+00	.2315E+01	.6637E+00	.6440E+00	-.0364E+01	.3625E+01	.9723E+00
67	-.1022E-01	-.3607E+01	.2704E+01	.1701E+01	-.3602E+01	-.5650E+01	.1411E+01	.1131E+02	-.5903E+01	-.1012E+02
68	-.3331E-01	.6176E+00	.3609E+00	.2363E+01	-.9198E+00	.8344E+01	-.2898E+01	.3027E+01	-.6904E+00	-.6524E+01
69	.5911E+00	.2079E+01	.2223E+01	-.5154E+01	-.8760E+01	.7489E+01	-.7957E+01	.1813E+02	-.2302E+02	.4357E+01
70	-.2837E+00	-.2494E+01	.2390E+01	-.1638E+01	-.3258E+01	.1457E+01	-.1914E+01	.6373E+00	.7764E+00	-.6921E+01
71	.1007E-01	-.1400E+00	-.2604E+00	.2588E+01	-.1220E+00	-.7569E+00	.3161E+00	.3211E+01	.0131E+00	-.5407E+01
72	.5319E+00	.3102E+01	.2165E+01	-.4954E+01	-.0362E+01	.7620E+01	-.7509E+01	.1327E+02	-.2008E+02	.6368E+01
73	-.1146E+00	-.3131E+01	.3421E+01	-.1113E+01	-.9251E+00	-.1024E+02	.3316E+01	.5108E+01	-.4550E+01	.2821E+01
74	.1405E+01	.1844E+02	.2130E+01	-.5141E+01	.1537E+01	-.1175E+01	-.9196E+00	-.2024E+01	-.1307E+01	.2080E+01
75	-.2164E+00	-.3510E+00	-.5440E+00	-.1451E+00	.6232E+00	.2266E+01	-.7065E+00	-.2034E+01	.2301E+01	-.0396E+00
76	-.2218E+00	.1088E+00	.3964E+01	-.9821E+01	-.3912E+01	.1572E+02	-.1271E+02	-.1647E+02	.4468E+01	-.9416E+01
77	.5259E+00	.1811E+02	.1001E+00	-.1156E+01	.5794E+01	-.4193E+00	.5499E-02	-.2077E+01	.9908E+00	.1323E+01
78	-.1562E+00	-.2344E+00	-.7268E-01	-.1049E+01	-.8765E-01	.3024E+01	-.1563E+01	-.3069E+01	.1908E+01	-.1038E+01
79	.3158E-01	.5452E+00	.3561E+01	-.2077E+01	.2808E+01	-.1380E+02	.3834E+01	.1510E+00	-.2951E+01	.1173E+02
80	-.1679E+01	-.2490E+02	.6822E+01	-.1263E+02	.1746E+02	.4274E+01	-.2273E+01	.1022E+01	-.3067E+01	.3590E+01
81	-.2773E+00	-.6094E+00	-.1042E+01	-.4849E-01	-.1068E+00	.3598E+01	-.1415E+01	-.3514E+01	.3008E+01	-.2488E+01
82	.9764E-01	.2843E+01	.3527E+01	-.5104E+01	.2229E+01	-.8563E+00	-.2957E+01	-.6208E+01	-.4339E+00	.3020E+01
83	-.8216E+00	-.1347E+02	.2209E+01	-.1311E+01	-.2767E+02	-.1815E+02	-.1408E+01	-.1147E+02	.6157E+00	.4012E+01
84	.1663E-02	.3172E+01	-.8577E+00	-.3241E+00	-.8144E+00	.3320E+01	-.1535E+01	-.3612E+01	.2764E+01	-.2827E+01

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NPS REPORT 639-179 REACTOR BLDG.EL.498.75FT.　　　　NUCLEAR POWER SERVICES INC,NEW-YORK,

MASS PARTICIPATION FACTORS

MODE	X-MOTION	Y-MOTION	Z-MOTION
1	-.16557E-01	.63581E-02	-.01601E-01
2	.84306E-01	-.10159E-01	-.11633E-01
3	-.17017E-02	-.10083E-02	-.57203E-02
4	.69892E-02	.30971E-02	.32456E-01
5	.35001E-02	-.11904E-02	.11805E-01
6	-.37920E-01	-.81844E-02	.05477E-02
7	.21325E-01	.10407E-02	-.21037E-02
8	.56872E-02	.98804E-03	-.52896E-02
9	-.48670E-02	-.49104E-03	-.74659E-02
10	-.27802E-02	-.10312E-02	.83338E-02
11	-.55722E-03	.73581E-04	.29761E-02
12	-.80030E-02	.94777E-03	.39008E-02
13	.19709E-01	.27242E-01	-.12968E-02
14	-.47437E-02	-.33484E-01	-.65019E-02
15	-.56541E-02	.21580E-02	-.73716E-02
16	-.13282E-01	-.30473E-01	.25523E-01
17	-.94548E-02	-.13969E-01	-.14650E-01
18	.66214E-02	-.18981E-01	-.54487E-02
19	-.16760E-02	-.11278E-01	-.99475E-02
20	-.35492E-01	-.12024E-01	.50782E-02

ISSUE #18

NPS REPORT 039-179 REACTOR BLDG.EL.490.75FT. NUCLEAR POWER SERVICES INC.NEW-YORK.

RESPONSE SPECTRUM NO. 1 - REACTOR BLDG OSE HORIZ SPECTRA AT EL 507 DAMPING .05

NO. OF TIME-ACCN PAIRS = 15

TIME (SEC)	ACCN (G)
0.000	.7000
.030	.7000
.139	1.0700
.220	1.1200
.320	1.0500
.409	3.4200
.429	5.2900
.462	6.5000
.607	5.5000
.711	3.0200
.780	2.0000
.828	1.0900
.980	1.2900
1.240	.9200
2.200	.3000

ISSUE #18

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NPS REPORT 639-179 REACTOR BLDG,EL,490.75FT,   NUCLEAR POWER SERVICES INC,NEW-YORK,

RESPONSE SPECTRUM NO. 8 - REACTOR BLDG OBE VERT SPECTRA AT EL [illegible] DAMPING .05

NO. OF TIME-ACCN PAIRS = 15

TIME (SEC)	ACCN (G)
0.000	.3700
.030	.5700
.098	.8200
.144	1.5000
.170	2.4700
.368	2.4700
.389	2.0000
.648	2.0000
.668	1.5600
.883	.8100
1.049	.5500
1.329	.4000
1.600	.3000
1.800	.2500
2.200	.2000

ISSUE #18

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NPS REPORT 539-179 REACTOR BLDG.EL.496.75FT.   NUCLEAR POWER SERVICES INC.NEW-YORK.

RESPONSE SPECTRUM   A   /INPUT SPECTRUM NO. 1 /

TITLE: HORIZONTAL FLOOR SPECTRUM
SPECTRAL ACCELERATIONS AT MODE PERIODS

MODE NO.	PERIOD (SEC)	ACCN (G)
1	.097	.9581
2	.081	.9158
3	.052	.8361
4	.045	.8198
5	.042	.8128
6	.035	.7938
7	.033	.7877
8	.032	.7862
9	.032	.7861
10	.032	.7841
11	.029	.7800
12	.026	.7800
13	.023	.7800
14	.021	.7800
15	.020	.7800
16	.019	.7800
17	.017	.7800
18	.017	.7800
19	.016	.7800
20	.012	.7800

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RESPONSE SPECTRUM 8 /INPUT SPECTRUM NO. 8 /

TITLE: VERTICAL FLOOR SPECTRUM
SPECTRAL ACCELERATIONS AT MODE PERIODS

MODE NO.	PERIOD (SEC)	ACCN (G)
1	.097	.8162
2	.081	.7577
3	.052	.6502
4	.045	.6250
5	.042	.6153
6	.035	.5891
7	.033	.5807
8	.032	.5786
9	.032	.5784
10	.032	.5757
11	.029	.5700
12	.028	.5700
13	.023	.5700
14	.021	.5700
15	.020	.5700
16	.019	.5700
17	.017	.5700
18	.017	.5700
19	.016	.5700
20	.012	.5700

ISSUE #18

DYNAMIC LOAD CASE NO. 1 - SEISMIC-X+Y

SPECTRUM NUMBERS

X AXIS =A
Y AXIS =B
Z AXIS =

COMBINATION TYPE = 3, ADD SUM COMBINATION THROUGHOUT

SPECTRUM SCALE FACTORS

X AXIS = 1.00000
Y AXIS = 1.00000
Z AXIS = -0.00000

CONVERGENCE OF DISPLACEMENTS

MODE NO.	MODAL AMPLITUDE	MAXIMUM MODAL DISPLACEMENTS (IN) X	NODE	Y	NODE	Z	NODE
1	.81332E+01	.01636	31	.00490	30	.00309	30
2	.27176E+02	.07578	32	.07105	30	.02671	30
3	.83030E+00	.00007	30	.00008	30	.00170	29
4	.29628E+01	.00080	25	.00086	30	.00301	29
5	.13623E+01	.00010	31	.00032	30	.00120	31
6	.13497E+02	.00388	20	.01410	30	.00176	25
7	.69036E+01	.00096	27	.00503	29	.00250	31
8	.19463E+01	.00007	25	.00066	29	.00111	32
9	.15942E+01	.00011	24	.00080	29	.00003	25
10	.10718E+01	.00006	24	.00022	29	.00069	20
11	.18415E+00	.00000	20	.00001	31	.00014	23
12	.26208E+01	.00020	27	.00134	31	.00021	5
13	.11948E+02	.00061	30	.00511	25	.00039	27
14	.88165E+01	.00100	30	.00336	24	.00066	9
15	.22397E+01	.00009	30	.00062	32	.00020	27
16	.10715E+02	.00146	30	.00158	26	.00101	19
17	.59262E+01	.00856	30	.00129	26	.00043	10
18	.61584E+01	.00071	30	.00091	23	.00065	27
19	.29692E+01	.00011	27	.00040	23	.00043	27
20	.13466E+02	.00095	28	.00079	23	.00033	20

ISSUE #18

NPS REPORT 639-179 REACTOR BLDG.EL.499.75FT. NUCLEAR POWER SERVICES INC.NEW-YORK.

NODAL DISPLACEMENTS, DYNAMIC LOAD CASE NO. 1

NODE NO.	X DISPL (IN)	Y DISPL (IN)	Z DISPL (IN)	RX ROTN (RAD)	RY ROTN (RAD)	RZ ROTN (RAD)
1	.086379	.001791	.006607	.000210	.002016	.002623
2	.078022	.001776	.006859	.000283	.001907	.002598
3	.064010	.001743	.007409	.000281	.001956	.002560
4	.044804	.001667	.008032	.000148	.001789	.002237
5	.030800	.001615	.008102	.000107	.001505	.001755
6	.028193	.001610	.008089	.000118	.001469	.001664
7	.025387	.001568	.007913	.000134	.001416	.001542
8	.013068	.001288	.006041	.000247	.001128	.001025
9	.011681	.001246	.005657	.000268	.001080	.000960
10	.004906	.000988	.003287	.000276	.000748	.000616
11	.003246	.000890	.002470	.000270	.000629	.000518
12	.000061	.000546	.000214	.000136	.000084	.000072
13	.000000	.000000	.000000	.000000	.000000	.000000
14	.000000	.000000	.000000	.000000	.000000	.000000
15	.006992	.003876	.002884	.000288	.000664	.000631
16	.016544	.003453	.005664	.000298	.001146	.001115
17	.031324	.002225	.007925	.000142	.001429	.001562
18	.055302	.002231	.008041	.000133	.001037	.002383
19	.081046	.004723	.007422	.000267	.002079	.002796
20	.085743	.002730	.006073	.000186	.002048	.002750
21	.000000	.000000	.000000	.000176	.001444	.001790
22	.000000	.000000	.000000	.000947	.000922	.000508
23	.004937	.015623	.016938	.000276	.001021	.000943
24	.007835	.017371	.015907	.000288	.000972	.001016
25	.016638	.026530	.028623	.000298	.001012	.001544
26	.013131	.024425	.028039	.000247	.001713	.001422
27	.031351	.015536	.018868	.000142	.001450	.001584
28	.038821	.017162	.010736	.000107	.001546	.001772
29	.055428	.077783	.060550	.000133	.003022	.003895
30	.081246	.096169	.076574	.000267	.003302	.003763
31	.085847	.056482	.045246	.000186	.002755	.003210
32	.086586	.053558	.044330	.000210	.002595	.003021

ISSUE #18

ELEMENT FORCES, DYNAMIC LOAD CASE NO. 1

ELEMENT GROUP 1 - FRAME ELEMENTS

ELEM NO.	NODE NO.	AX. FORCE (K)	Y SHEAR (K)	Z SHEAR (K)	TORSION (K.IN)	YY MOMENT (K.IN)	ZZ MOMENT (K.IN)	EFF. STRESS (KSI)
1	1	1.84	.60	.96	6.51	.00	9.98	NON-CIRCULAR
	2	1.84	.60	.96	6.51	3.15	10.43	CROSS SECTION
2	2	1.62	1.36	.82	0.73	5.08	18.76	NON-CIRCULAR
	3	1.62	1.36	.82	0.73	6.27	19.62	CROSS SECTION
3	3	1.97	1.65	.50	15.37	9.66	33.20	NON-CIRCULAR
	4	1.97	1.65	.50	15.37	11.25	35.76	CROSS SECTION
4	4	2.26	2.00	.45	19.47	9.79	43.07	NON-CIRCULAR
	5	2.26	2.00	.45	19.47	11.03	50.12	CROSS SECTION
5	5	2.27	2.10	.35	19.20	11.03	50.63	NON-CIRCULAR
	6	2.27	2.10	.35	19.20	10.07	52.32	CROSS SECTION
6	6	5.02	1.60	.35	19.20	10.07	52.32	NON-CIRCULAR
	7	5.02	1.60	.35	19.20	10.79	51.22	CROSS SECTION
7	7	5.79	1.40	.50	19.84	10.70	51.99	NON-CIRCULAR
	8	5.79	1.40	.50	19.84	8.42	45.42	CROSS SECTION
8	8	6.07	1.52	.60	20.47	8.42	44.74	NON-CIRCULAR
	9	6.07	1.52	.60	20.47	7.87	43.22	CROSS SECTION
9	9	6.45	1.78	.67	21.43	6.78	43.94	NON-CIRCULAR
	10	6.45	1.78	.67	21.43	8.43	33.10	CROSS SECTION
10	10	6.53	1.89	.72	21.69	8.43	33.10	NON-CIRCULAR
	11	6.53	1.89	.72	21.69	5.37	31.54	CROSS SECTION
11	11	6.71	2.06	.83	24.45	5.47	32.04	NON-CIRCULAR
	12	6.71	2.06	.83	24.45	12.40	27.88	CROSS SECTION
12	12	1.51	6.39	1.38	9.16	11.65	27.23	NON-CIRCULAR
	13	1.51	6.39	1.38	9.16	3.97	26.48	CROSS SECTION
13	12	.55	1.05	.94	3.33	13.02	13.79	NON-CIRCULAR
	14	.55	1.05	.94	3.33	7.69	9.21	CROSS SECTION
14	11	.17	.54	.21	9.75	3.54	3.45	NON-CIRCULAR
	15	.17	.54	.21	9.75	2.94	.00	CROSS SECTION
15	9	.30	.50	.45	10.45	6.03	9.03	NON-CIRCULAR
	16	.30	.50	.45	10.45	5.44	.00	CROSS SECTION
16	7	.24	.13	.28	1.12	3.22	1.20	NON-CIRCULAR
	17	.24	.13	.28	1.12	2.02	.00	CROSS SECTION
17	4	.27	.47	.40	12.60	6.27	4.70	NON-CIRCULAR
	[illegible]	[illegible]	[illegible]	[illegible]	12.60	7.06	.00	CROSS SECTION

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	9 16	.30 .30	.50 .50	.45 .45	10.45 10.45	[illegible] [illegible]4	9.03 .00	NON-CIRCULAR CROSS SECTION
16	7 17	.24 .24	.13 .13	.20 .20	1.18 1.18	3.22 2.02	1.20 .00	NON-CIRCULAR CROSS SECTION
17	9 18	.27 .27	.47 .47	.40 .40	12.60 12.60	6.21 7.06	4.70 .00	NON-CIRCULAR CROSS SECTION
18	3 19	.30 .30	.61 .61	.69 .69	16.22 16.22	13.67 7.60	7.91 .00	NON-CIRCULAR CROSS SECTION
19	2 20	.30 .30	.60 .60	.35 .35	10.79 10.79	9.68 6.04	9.90 .00	NON-CIRCULAR CROSS SECTION
20	15 24	.20 .20	.54 .54	.16 .16	.00 .00	2.94 .00	9.75 .00	NON-CIRCULAR CROSS SECTION
21	10 23	.14 .14	.48 .48	.14 .14	.00 .00	2.00 .00	0.65 .00	NON-CIRCULAR CROSS SECTION
22	16 25	.43 .43	.58 .58	.30 .30	.00 .00	5.44 .00	10.45 .00	NON-CIRCULAR CROSS SECTION
23	8 26	.29 .29	.53 .53	.20 .20	0.00 0.00	5.06 .00	9.59 .00	NON-CIRCULAR CROSS SECTION
24	17 27	.26 .26	.12 .12	.22 .22	.00 .00	2.02 .00	1.12 .00	NON-CIRCULAR CROSS SECTION
25	5 28	.19 .19	.10 .10	.23 .23	0.00 0.00	2.04 .00	.08 .00	NON-CIRCULAR CROSS SECTION
26	18 29	.36 .36	.47 .47	.26 .26	.00 .00	7.06 .00	12.60 .00	NON-CIRCULAR CROSS SECTION
27	19 30	.62 .62	.60 .60	.28 .28	0.00 0.00	7.60 .00	16.22 .00	NON-CIRCULAR CROSS SECTION
28	20 31	.71 .71	.60 .60	.38 .38	.00 .00	6.04 .00	10.79 .00	NON-CIRCULAR CROSS SECTION
29	1 32	.50 .50	.55 .55	.36 .36	.00 .00	6.51 .00	9.91 .00	NON-CIRCULAR CROSS SECTION
30	1 21	2.10 2.10	.00 .00	.00 .00	.00 .00	.00 .00	.00 .00	NON-CIRCULAR CROSS SECTION
31	6 22	5.70 5.70	.00 .00	.00 .00	.00 .00	.00 .00	.00 .00	NON-CIRCULAR CROSS SECTION

ISSUE #18

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SUPPORT REACTIONS, DYNAMIC LOAD CASE NO. 1

SUPPORT REACTIONS

NODE NO.	X FORCE (LB)	Y FORCE (LB)	Z FORCE (LB)	XX MOMENT (FT-LB)	YY MOMENT (FT-LB)	ZZ MOMENT (FT-LB)	SUPPORT IDENT
13	1568.15	6386.41	1382.51	763.21	330.09	2206.31	FIXED END
14	548.19	1845.80	941.62	277.72	691.86	767.91	FIXED END
21	.03	1856.52	1134.65	0.00	0.00	0.00	PIN SUPPORT
22	2855.29	4037.54	.01	0.00	0.00	0.00	PIN SUPPORT

ISSUE #18

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NPS REPORT 639-179 REACTOR BLDG,EL,490,75FT,   NUCLEAR POWER SERVICES INC,NEW-YORK,

DYNAMIC LOAD CASE NO, 2 - SEISMIC-Y+Z

SPECTRUM NUMBERS

X AXIS =
Y AXIS =B
Z AXIS =A

COMBINATION TYPE = 3, ABS SUM COMBINATION THROUGHOUT

SPECTRUM SCALE FACTORS

X AXIS = -0,00000
Y AXIS = 1,00000
Z AXIS = 1,00000

CONVERGENCE OF DISPLACEMENTS

MODE NO,	MODAL AMPLITUDE	MAXIMUM NODAL DISPLACEMENTS (IN) X	NODE	Y	NODE	Z	NODE
1	,24811E+02	,04990	31	,01498	30	,13000	30
2	,16289E+02	,04542	32	,04313	30	,01601	30
3	,21084E+01	,00017	30	,00021	30	,00452	29
4	,11030E+02	,00222	26	,00171	30	,01122	29
5	,40158E+01	,00052	31	,00092	30	,00340	31
6	,44451E+01	,00126	29	,00469	30	,00058	25
7	,10774E+01	,00015	27	,00091	29	,00040	31
8	,14260E+01	,00007	25	,00062	29	,00106	32
9	,24990E+01	,00016	28	,00063	29	,00146	25
10	,27544E+01	,00016	28	,00057	29	,00170	28
11	,91310E+00	,00001	24	,00003	31	,00067	23
12	,14114E+01	,00011	27	,00072	31	,00011	5
13	,61908E+01	,00033	30	,00274	25	,00010	27
14	,99372E+01	,00112	30	,00378	24	,00074	5
15	,26970E+01	,00011	30	,00075	32	,00024	27
16	,14404E+02	,00196	30	,00213	26	,00189	10
17	,74920E+01	,00070	30	,00163	26	,00054	10
18	,58050E+01	,00067	30	,00086	23	,00061	27
19	,54822E+01	,00021	27	,00090	23	,00079	27
20	,41748E+01	,00029	25	,00025	23	,00010	28

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NPS REPORT 619-170 REACTOR BLDG.EL.490.75FT. NUCLEAR POWER SERVICES INC.NEW-YORK.

NODAL DISPLACEMENTS, DYNAMIC LOAD CASE NO. 8

NODE NO.	X DISPL (IN)	Y DISPL (IN)	Z DISPL (IN)	XX ROTN (RAD)	YY ROTN (RAD)	ZZ ROTN (RAD)
1	.065696	.001989	.012660	.000226	.004210	.001966
2	.059117	.001951	.012990	.000216	.004174	.001949
3	.048094	.001870	.013490	.000179	.004010	.001885
4	.036202	.001707	.014022	.000173	.003692	.001713
5	.022409	.001657	.013692	.000214	.003150	.001340
6	.020585	.001640	.013474	.000220	.003069	.001267
7	.018311	.001586	.013111	.000251	.002963	.001160
8	.004217	.001290	.009924	.000395	.002368	.000760
9	.008210	.001255	.009314	.000418	.002257	.000702
10	.003312	.000985	.005317	.000460	.001546	.000447
11	.002141	.000691	.003902	.000456	.001291	.000365
12	.000039	.000508	.000504	.000238	.000166	.000053
13	.000000	.000000	.000000	.000000	.000000	.000000
14	.000000	.000000	.000000	.000000	.000000	.000000
15	.013600	.004432	.003993	.000463	.001352	.000470
16	.027135	.004153	.009331	.000433	.002364	.000782
17	.042618	.002465	.013126	.000255	.002984	.001180
18	.065893	.002101	.014836	.000161	.003777	.001791
19	.075817	.004032	.014516	.000207	.004189	.002045
20	.092750	.003432	.015012	.000286	.004286	.002075
21	.000000	.000000	.000000	.000383	.002751	.003251
22	.000000	.000000	.000000	.001910	.001922	.000382
23	.003329	.012424	.037333	.000460	.002135	.000748
24	.013633	.013283	.033568	.000463	.001957	.000814
25	.027205	.016436	.068516	.000433	.003536	.001048
26	.009253	.019687	.068686	.000395	.003527	.001150
27	.042681	.016947	.018441	.000255	.003047	.001194
28	.022421	.013370	.040149	.000214	.003211	.001351
29	.066002	.056701	.154453	.000161	.006526	.002232
30	.075995	.067650	.167095	.000207	.007011	.002591
31	.092892	.063169	.097408	.000286	.005458	.002421
32	.065705	.041184	.096015	.000226	.005338	.002295

ISSUE #18

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ELEMENT FORCES, DYNAMIC LOAD CASE NO. 8

ELEMENT GROUP 1 - FRAME ELEMENTS

ELEM. NO.	NODE NO.	AX. FORCE (K)	Y SHEAR (K)	Z SHEAR (K)	TORSION (K.IN)	YY MOMENT (K.IN)	ZZ MOMENT (K.IN)	EFF. STRESS (KSI)
1	1	2.90	.42	1.33	9.03	.00	7.96	NON-CIRCULAR
	2	2.90	.42	1.33	9.03	4.66	0.43	CROSS SECTION
2	2	2.65	1.05	1.09	17.75	6.09	13.55	NON-CIRCULAR
	3	2.65	1.05	1.09	17.75	9.69	14.03	CROSS SECTION
3	3	2.82	1.14	.62	27.60	10.73	22.56	NON-CIRCULAR
	4	2.82	1.14	.62	27.60	13.63	24.60	CROSS SECTION
4	4	2.97	1.45	.53	30.46	12.84	-30.11	NON-CIRCULAR
	5	2.97	1.45	.53	30.46	14.94	-36.25	CROSS SECTION
5	5	2.99	1.52	.46	37.02	14.94	-36.50	NON-CIRCULAR
	6	2.99	1.52	.46	37.02	14.06	-30.06	CROSS SECTION
6	6	5.88	1.24	.46	37.02	14.06	-30.06	NON-CIRCULAR
	7	5.88	1.24	.46	37.02	14.79	-37.30	CROSS SECTION
7	7	5.87	1.16	.66	39.16	10.54	-37.79	NON-CIRCULAR
	8	5.87	1.16	.66	39.16	11.01	-34.13	CROSS SECTION
8	8	6.14	1.14	.81	39.59	11.01	-34.24	NON-CIRCULAR
	9	6.14	1.14	.81	39.59	10.82	-33.18	CROSS SECTION
9	9	6.30	1.19	1.11	45.02	9.73	-33.62	NON-CIRCULAR
	10	6.30	1.19	1.11	45.02	6.35	26.36	CROSS SECTION
10	10	6.47	1.23	1.24	46.72	6.35	26.61	NON-CIRCULAR
	11	6.47	1.23	1.24	46.72	7.74	24.42	CROSS SECTION
11	11	6.63	1.30	1.43	50.43	7.06	20.67	NON-CIRCULAR
	12	6.63	1.30	1.43	50.43	21.09	19.61	CROSS SECTION
12	12	.95	6.12	2.96	15.46	25.20	23.71	NON-CIRCULAR
	13	.95	6.12	2.96	15.46	5.98	26.38	CROSS SECTION
13	12	.35	.85	1.83	5.63	25.44	10.97	NON-CIRCULAR
	14	.35	.85	1.83	5.63	14.96	7.62	CROSS SECTION
14	11	.27	.48	.16	0.62	5.31	4.02	NON-CIRCULAR
	15	.27	.48	.16	0.62	4.70	.00	CROSS SECTION
15	9	.47	.36	.34	6.44	10.00	3.57	NON-CIRCULAR
	16	.47	.36	.34	6.44	0.47	.00	CROSS SECTION
16	7	.30	.08	.23	.73	3.61	.04	NON-CIRCULAR
	17	.30	.08	.23	.73	2.54	.00	CROSS SECTION
17	4	.54	.30	.37	8.15	14.15	3.03	NON-CIRCULAR
	18	.54	.30	.37	8.15	14.15	.00	CROSS SECTION

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							.00	CROSS SECTION
		.30	.00	.23	.73	3.61	.04	NON-CIRCULAR
	17	.30	.00	.23	.73	8.54	.00	CROSS SECTION
17	4	.54	.30	.37	0.15	14.11	3.03	NON-CIRCULAR
	18	.54	.30	.37	0.15	14.15	.00	CROSS SECTION
18	3	.58	.35	.61	0.30	10.00	0.53	NON-CIRCULAR
	19	.58	.35	.61	9.30	15.17	.00	CROSS SECTION
19	2	.57	.46	.65	0.20	12.93	0.56	NON-CIRCULAR
	20	.57	.46	.65	0.20	9.94	.00	CROSS SECTION
20	15	.15	.40	.26	.00	4.70	0.68	NON-CIRCULAR
	24	.15	.40	.26	.00	.00	.00	CROSS SECTION
21	10	.08	.41	.25	.00	0.52	7.35	NON-CIRCULAR
	21	.08	.41	.25	.00	.00	.00	CROSS SECTION
22	16	.32	.36	.47	.00	0.47	0.44	NON-CIRCULAR
	25	.32	.36	.47	.00	.00	.00	CROSS SECTION
23	0	.17	.53	.47	0.00	0.45	9.56	NON-CIRCULAR
	26	.17	.53	.47	0.00	.00	.00	CROSS SECTION
24	17	.22	.08	.28	.00	3.34	.73	NON-CIRCULAR
	27	.22	.08	.28	.00	.00	.00	CROSS SECTION
25	5	.11	.07	.28	0.00	8.40	.59	NON-CIRCULAR
	28	.11	.07	.28	0.00	.00	.00	CROSS SECTION
26	18	.34	.30	.52	.00	14.15	0.15	NON-CIRCULAR
	29	.34	.30	.52	.00	.00	.00	CROSS SECTION
27	19	.55	.34	.56	0.00	15.17	9.30	NON-CIRCULAR
	30	.55	.34	.56	0.00	.00	.00	CROSS SECTION
28	20	.61	.46	.55	.00	0.94	0.24	NON-CIRCULAR
	31	.61	.46	.55	.00	.00	.00	CROSS SECTION
29	1	.41	.44	.55	.00	9.02	7.96	NON-CIRCULAR
	32	.41	.44	.55	.00	.00	.00	CROSS SECTION
30	1	3.34	.00	.00	.00	.00	.00	NON-CIRCULAR
	21	3.34	.00	.00	.00	.00	.00	CROSS SECTION
31	6	3.98	.00	.00	.00	.00	.00	NON-CIRCULAR
	23	3.98	.00	.00	.00	.00	.00	CROSS SECTION

Issue #18

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SUPPORT REACTIONS, DYNAMIC LOAD CASE NO. 2

SUPPORT REACTIONS

NODE NO.	X FORCE (LB)	Y FORCE (LB)	Z FORCE (LB)	XX MOMENT (FT-LB)	YY MOMENT (FT-LB)	ZZ MOMENT (FT-LB)	SUPPORT IDENT
13	951.21	6117.17	2957.07	1200.61	498.69	2197.96	FIXED END
14	346.13	845.32	1034.80	468.91	1241.91	635.38	FIXED END
21	.04	2849.77	1740.78	0.00	0.00	0.00	PIN SUPPORT
22	1992.32	3445.24	.01	0.00	0.00	0.00	PIN SUPPORT

ISSUE #18

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ISSUE #19

Provide an assessment of the potential shift of the fundamental frequencies of the Standby Service Water Pumphouse accounting for the three sided embedment affect on the structural response and assess the design adequacy therefrom.

RESPONSE:

To evaluate the possible shift of the fundamental frequencies of the Standby Service Water Pumphouse due to the three sided embedment effect, new spring constants and dampingcoefficients have been calculated. The Y. Beredugo and M. Novak paper, "Coupled Horizontal and Rocking Vibration of Embedment Footings," Canadian Géotechnical Journal, September 1972, is utilized in this evaluation.

Results of the evaluation indicate that with three sided embedment considered, the frequency of the translational mode is increased by 20% and the frequency of the rotational mode is increased by 12.6%. Based on the available modal analysis for the pumphouse building, the primary structural response is due to the rotational mode which would shift by only 12.6% whereas less significant contribution is due to the translational mode which would shift by 20%. Therefore, the total shift in frequency would be closer to 12.6% than 20%.

The effect of this shift in frequency is greatly diminished by simultaneously considering the significant increase in soil damping (using the same paper referenced above) over the low damping values in FSAR Table 3.7-1 used in the original Standby Service Water Pumphouse seismic analysis.

NRC-SEB

ISSUE #20

Provide the calculations for safety factors against overturning and sliding for the Standby Service Water Pumphouse and DG Building for the SSE.

RESPONSE

Please refer to the attached calculations for the information requested.

ATTACHMENT TO NRC SEB ISSUE 20

BURNS AND ROE, INC.

W.O. No. 3900 Date 10/13/81 Book No. SII-3 SVII-4 Page No. ____
Drawing No. ____ Calc. No. 6.67-02 ; 6.21-10 Sheet 1 of 1
By ____ Checked ____ 10/23/81 Approved ____
Title WPPSS- HANFORD NO. 2 - F/S AGAINST OVERTURNING & SLIDING

SUMMARY
OF F/S FOR OVERTURNING & SLIDING

CONDITION \ STRUCTURE	DIESEL-GEN. BLDG.	STANBY SERVICE WATER PUMPHOUSE
OVERTURNING		
D.L. + O.B.E. + VERT. SEIS.↑	2.84	2.23
D.L. + O.B.E. + SEIS.↑ + BOUYANCY	N.A.*	2.04
D.L + SSE + SEIS.↑	1.48	1.18
D.L. + SSE + SEIS.↑ + BOUYANCY	N.A.*	1.07
SLIDING		
D.L. + O.B.E. + VERT. SEIS.↑	3.03	4.72
D.L. + O.B.E. + SEIS.↑ + BOUYANCY	N.A.*	4.24
D.L. + SSE + SEIS.↑	1.40	2.42
D.L. + SSE + SEIS.↑ + BOUYANCY	N.A.*	2.11

* Not applicable since bottom of foundation is above elevation 420'-0" MSL - 10-31-81

ATTACHMENT TO NRC SEB ISSUE 20

BURNS AND ROE, INC.

W.O. No. 3780 -03 Date 10/1/81 Book No. SVII-4 Page No.
Drawing No. 5-857 & 856 Calc. No. 6.21-10 Sheet 1 of 3
By Yen-Lan Tu Checked [illegible] 10/2/81 Approved [illegible]
Title WPPSS - HANFORD NO. 2 — DIESEL GENERATOR BUILDING

FACTOR OF SAFETY AGAINST OVERTURNING MOMENT AND SLIDING:

TOTAL D.L. = 487 × 32.2 (MASS = 487 SEE SH. 3 OF 3)

$= 15.7 \times 10^3$ Kips & ECC. MOM. $= 15.7 \times 10^3 \times 2.64' = 41.5 \times$

$= 41.5 \times 10^3$ kip-ft

N-S SEISMIC: (P.103, OF S VII-4, 6.21-10)

	OBE	DBE (SSE)
N-S SHEAR	3.12×10^3 K	5.75×10^3 K
N-S OVERTURNING MOMENT	12.40×10^4 K'	22.86×10^4 K'
N-S VERTICAL "g"	0.141	0.268

(Refer to FSAR Drawings M158 and M161 in FSAR Reduced size Drawing Binder for general arrangement plans / [illegible] 10/31/81)

FACTOR OF SAFETY AGAINST OVERTURNING IN E-W DIRECTION SHOULD BE LARGER THAN IN N-S DIRECTION, IT IS TO BE NEGLECTED.

Form BR 8002-2

ATTACHMENT TO NRC SEB ISSUE 20

BURNS AND ROE, INC.

W.O. No. 3900-03 Date 10/1/81 Book No. SYII-4 Page No. ____
Drawing No. S-851 & 856 Calc. No. 6.21-10 Sheet 2 of 3
By Yu-Kun Tu Checked JEL 10/2/81 Approved ____
Title WPPSS - HANFORD NO. 2 - DIESEL GENERATOR BUILDING

FACTOR OF SAFETY AGAINST OVERTURNING MOMENT:

OBE:

$$F.S. = \frac{C.: [15.7 \times 10^3] \cdot [1.0 - 0.141] \times [37.5 - 2.643]}{1.4 \times 12.40 \times 10^4 + 4.15 \times 10^4}$$

(.859; 34.857)

$= 2.84 > 1.5$ (REF. FSAR § 3.8.5.5) O.K.

DBE: (SSE)

$$F.S. = \frac{1. [15.7 \times 10^3] \cdot [1.0 - 0.268] \cdot [37.5 - 2.643]}{22.82 \times 10^4 + 4.15 \times 10^4}$$

(.732; 34.857)

$= 1.48 > 1.1$ (REF. FSAR § 3.8.5.5) O.K.

FACTOR OF SAFETY AGAINST SLIDING:

OBE:

$$F.S. = \frac{[1.0 - 0.141] \times [15.7 \times 10^3]\, 0.7}{[3.12 \times 10^3]}$$

(.859)

$= 3.03 > 1.5$ (REF. FSAR § 3.8.5.5) O.K.

DBE: (SSE)

$$F.S. = \frac{[1.0 - 0.268] \cdot [15.7 \times 10^3] \cdot (0.7)}{[5.75 \times 10^3]}$$

(.732)

$= 1.40 > 1.1$ (REF. FSAR § 3.8.5.5) O.K.

3

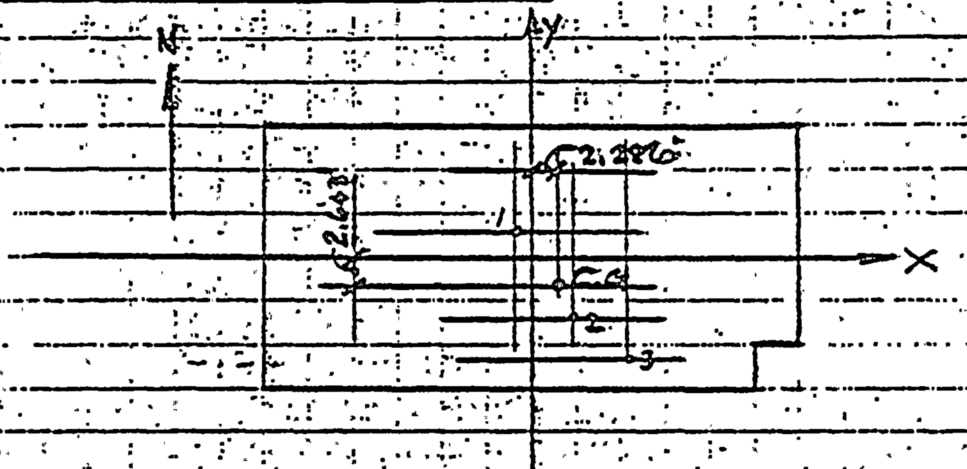
Form BR 8002-2

ATTACHMENT TO NRC SER ISSUE 20

BURNS AND ROE, INC.

W.O. No. 3900 - 03 Date 10/1/81 Book No. SVII-4 Page No.
Drawing No. S851 & 856 Calc. No. 6.21-10 Sheet 3 of 3
By: [illegible] Checked [illegible] 10/2/81 Approved [illegible]
Title WPPSS - HANFORD NO. 2 - DIESEL GENERATOR BUILDING

CALCULATION OF C.G. REF. Book SVII-4 PP. 76, 78 & 80



FOR 472'-9" Level C.G. @ $X_1 = -0.52'$, $Y_1 = 1.90'$ (P.76 REF)

MASS = 243 $K\ sec^2/FT$

FOR 455'-0" Level C.G. @ $X_2 = 4.1'$, $Y_2 = -6.0'$ (P.78, REF)

MASS = 130 $K\ sec^2/FT$

FOR 437'-6" Level C.G. @ $X_3 = 6.2'$, $Y_3 = -8.5'$ (P.80, REF.)

MASS = 114 $K\ sec^2/FT$

$\therefore$ 243+130+114 = 487 $K\ sec^2/FT$ (P.P. 76, 78 & 80)

$$\therefore \bar{X} = \frac{243 \times (-0.52) + 130 \times 4.1 + 114 \times 6.2}{487} = 2.286'$$

$$\bar{Y} = \frac{243 \times 1.90 + 130 \times (-6.0) + 114 \times (-8.5)}{487} = -2.643'$$

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Form BR 8002-2

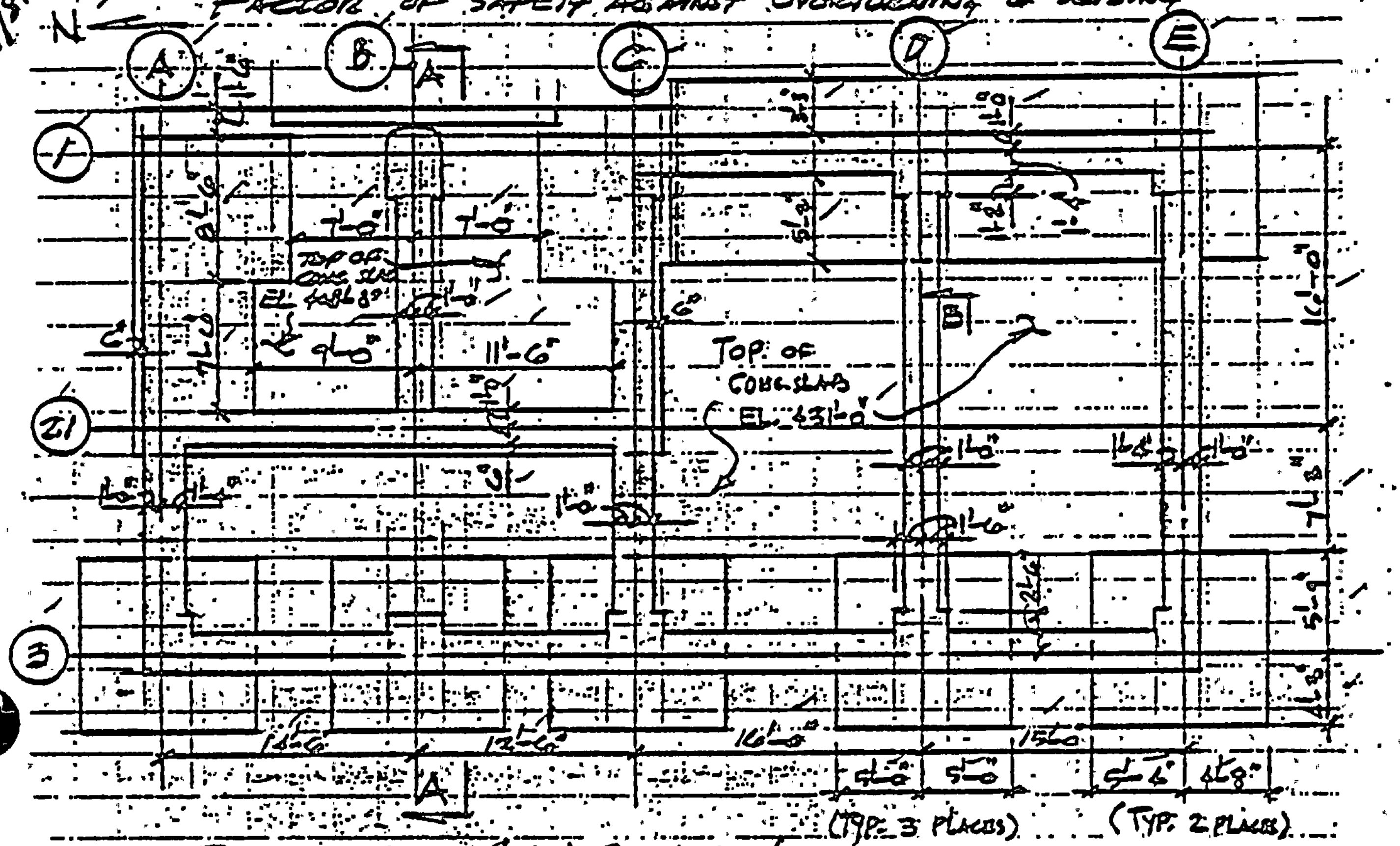
ATTACHMENT TO NRC SEB ISSUE 20

BURNS AND ROE, INC.

W.O. No. 3900-03 Date 10/8/81 Book No. SII-vol. 3 Page No.
Drawing No. S513 Thru S516 Calc. No. 6-07-02 Sheet 1 of 6
By Yu-Kan Tu Checked JW 10/9/81 Approved
Title WNP2 - STANDBY SERVICE WATER PUMP HOUSE - F

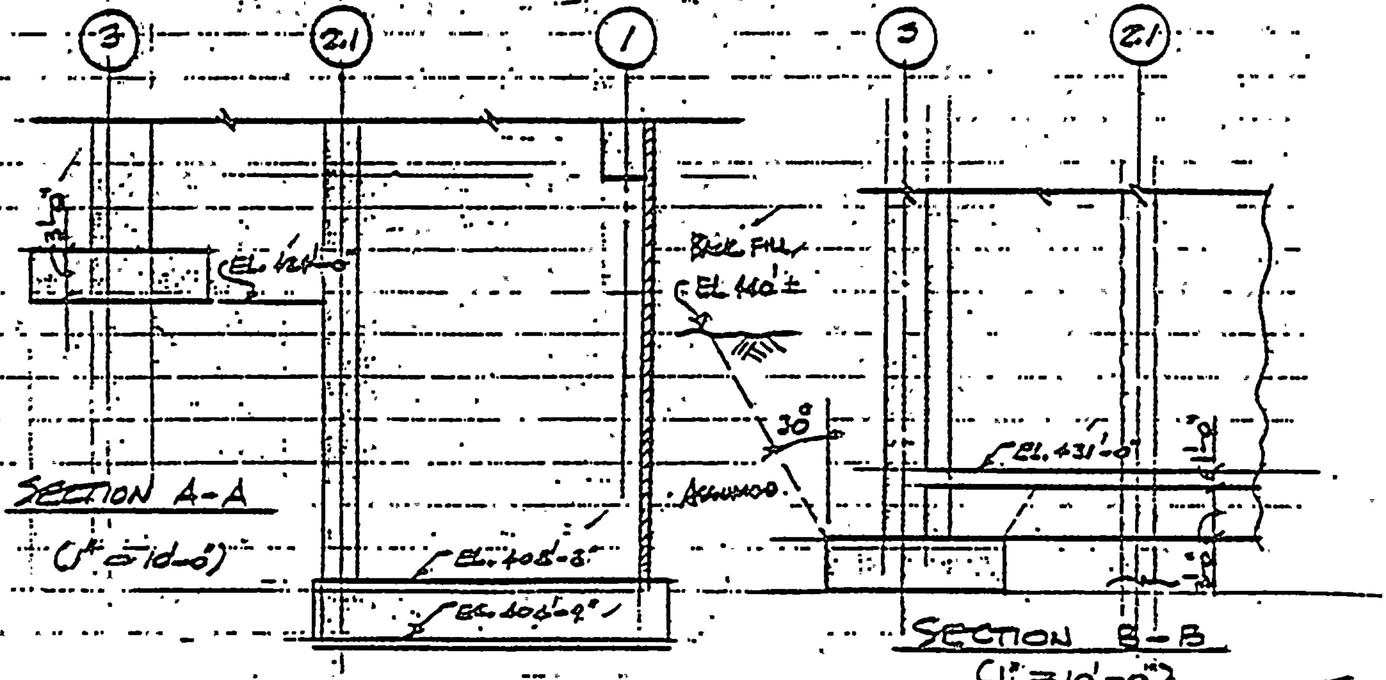
SEE NOTE 1 SHEET 6 OF 6

FACTOR OF SAFETY AGAINST OVERTURNING & SLIDING



SECTIONAL PLAN @ EL 435'(±)

(1" = 10'-0")



SECTION A-A

(1" = 10'-0")

SECTION B-B

(1" = 10'-0")

Form BR 8002-2

ATTACHMENT TO NRC SEB ISSUE 20

BURNS AND ROE, INC.

W.O. No. 3900-03 Date 10/8/81 Book No. S II - Vol 8 Page No. ____
Drawing No. 5513 ~ 5516 Calc. No. 6-07-02 Sheet 2 of 6
By ____ Checked JW 10/9/81 Approved ____
Title WNP 2 - STANDBY SERVICE WATER PUMP HOUSE -
FACTOR OF SAFETY AGAINST OVERTURNING AND SLIDING

DEAD WT OF STRUCTURE: [REF. BOOK, S II-3, 6-07-02]

$W_D = (38.9 + 68.8 + 47.1) \times 32.2$ (1253, 2215, 1517)

$= 4,985\ K$ (REF. P. 14~18)

ECCENTRICITY $\bar{Y} = +2.58'$ (REF. P. 130)

SEISMIC IN E-W DIRECTION: (REF. P. 39)

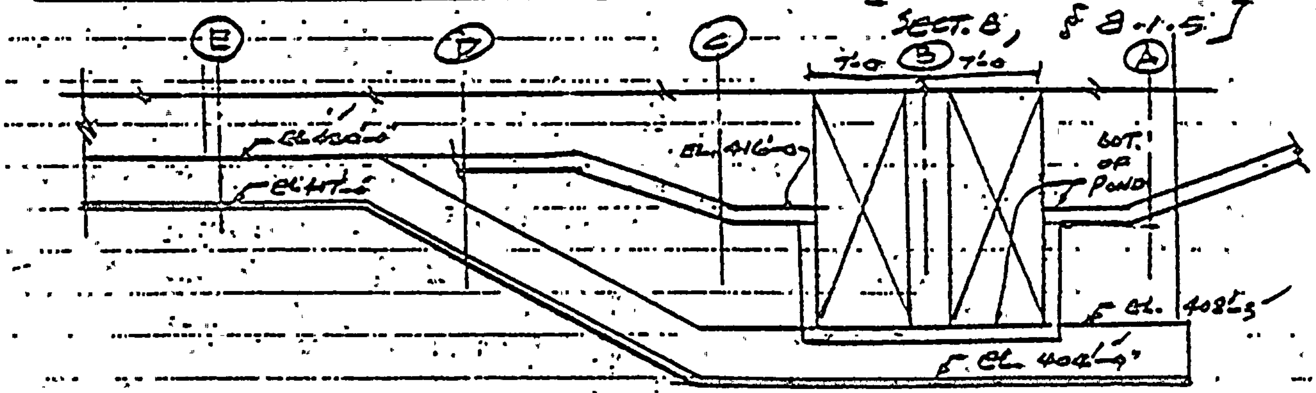
	OBE	DBE (SSE)
SHEAR	9.62×10^2 K	16.64×10^2 K
OVERTURNING MOMENT	50.11×10^3 K'	86.10×10^3 K'

RESISTING MOMENT FROM DEAD WT OF BLDG = 71.88×10^3 K' (REF. P. 131)

MAX. VERT. G VALUE IN E-W SEISMIC CONDITION: (REF. P. 38)

	WT	OBE FACTOR	DBE FACTOR
EL. 462 L+	1253	.124	.236
440'-8	2215	.117	.222
409-6	1517	.098	.189
AVERAGE USE FOR BACK FILL		.12	.22

MAX. GROUND WATER LEVEL USE 420' [REF. CRITERIA DOCUMENT. SECT. 8, § 8.1.5]



EAST ELEVATION

Form BR 8002-2

ATTACHMENT TO NRC SEB ISSUE 20

BURNS AND ROE, INC.

W.O. No. 3900-03 Date 10/8/81 Book No. 5II - Vol. 3 Page No.
Drawing No. 5513 thru 5516 Calc. No. 6.07-02 Sheet 3 of 6
By Yu-Kan Tu Checked JW 10/12/81 Approved
Title WNP2 - STANDBY SERVICE WATER PUMP HOUSE F.S. AGAINST OVERTURN

ADD'L WT. OF WATER TO BE ADDED:

TOP OF WATER IN POND @ EL. 434'-0" (REF. 5513) MAX.

$\therefore W_w = 0.0624 \times (434 - 408.25) \times [(2 \times 6 \times 10) + 7.5 \times (8 + 10.5)]$ (25.75, 120, 258.75, 138.75)

@ DEPRESSION

$= 192.82 + 222.94 = 415.76^k$

$\bar{Y}_w = \dfrac{192.82 \times 5 + 222.94 \times (10 + 3.75)}{415.76} = 9.69'$

SINCE GROUND WATER LEVEL @ EL. 420'

BUOYANCY WILL BE:

$W_{B1} = -0.0624 \times [(420 - 408.25) \times (29 \times 18) + (3.50) \times (30 \times 30)]$ (382.73, 131.04)

$= -513.77^k$

$\bar{Y}_{B1} = \dfrac{382.73 \times 16.0 + 131.04 \times 15.}{513.77} = 15.74'$

$W_{B2} \doteq -0.0624 \times (10.75 \times 3. \times 32 + 2.33 \times 20. \times 12. \times \frac{1}{2})$ (64.39, 17.45)

$= 81.84^k$

$\bar{Y}_{B2} = \dfrac{64.39 \times 3.625 + 17.45 \times 2.665}{81.84} = 3.42'$

WT. OF BACK FILL ON FTGS ALONG COL. LINE (3):

WT. OF SATURATED SOIL = 130 PCF (CRITERIA DOCUMENT SECT. 8, § 8.1.3)

$\therefore (440 - 427) \tan 30^\circ = 7.5'$ (13)

$(430 - 427) \tan 30^\circ = 1.73'$ (3)

$\therefore W_{F1} = (7.67 + \frac{7.5}{2}) \times 13 \times (14.5 + 12.5 + 4.67 + \frac{7.5}{3}) \times 0.130$ (15.17, 34.17)

$= 876.03^k \quad \bar{Y}_{F1} \doteq 30.75'$

$W_{F2} = (3.25 + \frac{7.5}{2}) \times 13 \times (16.0 + 15.0 + 4.67 + \frac{7.5}{3}) \times 0.130$ (38.17)

$= 451.55^k \quad \bar{Y}_{F2} \doteq 36.65'$

$W_{F3} = (4.42 + \frac{1.73}{2}) \times 3 \times (16.0 + 15.0 + 4.67 + \frac{7.5}{3}) \times 0.130$ (5.285, 38.17)

$= 78.67^k \quad \bar{Y}_{F3} \doteq 27.20'$

Form BR 8002-2

7

ATTACHMENT TO NRC SEB ISSUE 20

BURNS AND ROE, INC.

W.O. No. 3900-03 Date 10/8/81 Book No. SII-Vol. 3 Page No.

Drawing No. 5513 thru 5516 Calc. No. 6.07-02 Sheet 4 of 6

By Lei-Ren Tu Checked JW 10-12-81 Approved

Title WNP2 - STANDBY SERVICE WATER PUMP HOUSE - F.S. AGAINST OVERTURNING & SLIDING

$430 - 418'(\pm) = 12'$

$12 \times \tan 30^\circ = 6.93'$

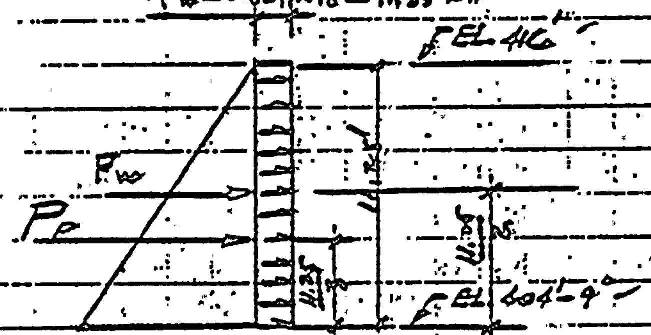
$\therefore W_{PL} = (5.167 + \frac{6.93}{2}) \times 12 \times (16 + 15 + 4.67 + \frac{6.93}{2}) \times 0.13$

$= 526.99^K$ Say 527^K

$Y_{PL} = (2.5 + 1.33 + 2.583 + 2.31) = 8.72'$

RESISTING SOIL PRESSURE FROM POND SIDE:

$P_w = .0624 \times 18 = 1.123$ KSF



REF. CRITERIA DOCUMENT

SECT. B, § 8-1.2

$K_p = 8.5$

USE F.S. OF 2 FOR K_p

$\therefore K_p = 4.25$

SECT. B, - § 8.1.3

SUBMERGED ~ 68 KCF

$\frac{434}{416}$ $18'$

$P_p = 4.25 \times .068 \times 11.25 = 3.25\ ^K/_{FT^2}$

$\therefore P_p = \frac{1}{2} \times 3.25 \times 11.25 + 1.123 \times 11.25$

$= 18.28 + 12.63 = 30.91\ ^K/_{FT}$

$\therefore M_p = 18.28 \times \frac{11.25}{3} + 12.63 \times \frac{11.25}{2}$

$= 68.55 + 71.04 = 139.59\ ^{K'}/_{FT}$

$\therefore$ TOTAL $M_p = 139.59 \times (14.50 + 12.5 + 16.0 + 1 - 14)$ 30.

$= \cancel{4187.7^{K'}}$

$P_{TOTAL} = 30.91 \times 30 = 927.3^K$

Form BR 8002-2

8

ATTACHMENT TO NRC SEB ISSUE 20

BURNS AND ROE, INC.

W.O. No. 3900-03 Date 10/8/81 Book No. 5 II - Vol. 3 Page No.
Drawing No. 5513 Thru. 5516 Calc. No. G-07-02 Sheet 3 of 6
By Yu-Ron Tu Checked [illegible] 10-13-81 Approved [illegible]
Title WNP2 - STANDBY SERVICE WATER PUMP HOUSE

FACTOR OF SAFETY AGAINST OVERTURNING: (W/BUOYANCY)

OBE CONDITION:

WT. OF CONC.

$W_{CONC} = 1253(1-.124) + 2215(1-.117) + 1517(1-.098)$

$= 4421.81^k$ ✓

$F.S. = \frac{1}{59110}$ [4421.81 × (17' - 2.58) + 415.76 × .88 × 9.69

− 513.77 × 412 × 15.74 − 81.84 × 1.12 × 3.42

+ 876.03 × .88 × 30.75 + 451.55 × .88 × 36.65

+ 78.67 × .88 × 27.20 + 527.00 × .88 × 8.72]

= 2.04 > 1.5 ✓ OR 2.23 > 1.5 O.K.
(W/BOUYANCY) (W/O BOUYANCY)

DBE (SSE) CONDITION:

WT. OF CONC.

$W_{CONC} = 1253(1-.236) + 2215(1-.222) + 1517(1-.189)$

$= 3910.85^k$ ✓

$F.S. = \frac{1}{86100}$ [3910.85 × 14.42 + 415.76 × .78 × 9.69

− 513.77 × 422 × 15.74 − 81.84 × 1.22 × 3.42

+ 876.03 × .78 × 30.75 + 451.55 × .78 × 36.65

+ 78.67 × .78 × 27.20 + 527.00 × .78 × 8.72 + 4187.7 × .78]

= 1.07 ≈ 1.1 ✓ OK
(W/BOUYANCY)

OR 1.18 > 1.10 O.K.
(W/O BOUYANCY)

BURNS AND ROE, INC.

W.O. No. 3300-03 Date 10/9/81 Book No. SII - Vol 3 Page No.
Drawing No. S513 thru S546 Calc No. 6.07-02 Sheet 6 of 6
By Yu-Ran Tu Checked HJT 10-13-81 Approved
Title WNP2 - STANDBY SERVICE WATER PUMP HOUSE

FACTOR OF SAFETY AGAINST SLIDING: (W/ BOUYANCY)

OBE CONDITION

$$F.S. = \frac{0.7}{926} \left[4421.81 + 365.87 - \underbrace{579.42}_{\text{BOUYANCY}} - 92.66 + 770.91 + 397.36 + 69.23 + 463.75 \right]$$

$= 4.24 > 1.5$ O.K. ✓ OR $4.72 > 1.5$ O.K.
(W/BOUYANCY) (W/O BOUYANCY)

DBE (SSE) CONDITION:

$$F.S. = \frac{0.7}{1664} \times \left[3910.85 + 324.29 - \underbrace{626.80}_{\text{BOUYANCY}} - 59.34 + 683.30 + 352.21 + 61.36 + 411.05 \right]$$

$= 2.21 > 1.1$ ✓ O.K. OR $2.42 > 1.1$ O.K.
(W/ BOUYANCY) (W/O BOUYANCY)

(Note: Refer to FSAR Drawing M164 in FSAR Reduced Size Drawing Binder for general arrangement plans. /[illegible] 10-31-81)

Form BR 8002-2

NRC-SEB

ISSUE #21

Provide an assessment of the effect of the relative displacement between the DG oil storage tank and connecting piping and the additional stresses which could be produced by the seismic wave passage.

RESPONSE

The assessment of the small diameter piping associated with the DG oil storage tank is currently in progress, and the information requested will be furnished in January, 1982.

NRC-SEB

INTERNAL STRUCTURES

ISSUE #22

Reference Book SV-89, page 6 of 48. Identify if the total base shear is the result of 3 dimensional seismic analysis.

RESPONSE

Item closed at meeting.

NRC-SEB

INTERNAL STRUCTURES

ISSUE #23

Demonstrate with the provisions of Standard Review Plan 3.8.1 for the reactor pedestal if tangential shear requirements are met. Code Case N250 ASME/ACI 359 may be used.

RESPONSE

Design of the RPV pedestal for tangential shear is accomplished on the basis of the strength design method of ACI 318-71. The design calculation for the required shear reinforcement, A_v, is stated below. For actual calculations, refer to calculation book SV-80.

$$\text{Required } A_v = \frac{(v_u - v_c)\, b_w s}{f_y}, \text{ where:}$$

v_u = 228 p.s.i. = total design shear stress

$v_c = 2\sqrt{f'_c}$ = permissible shear stress carried by concrete

$= 2\sqrt{4000}$ = 126 p.s.i.

b_w = 60 inches = width of pedestal

s = 13 inches = spacing of reinforcement

f_y = 60,000 p.s.i.

$$\text{Required } A_v = \frac{(228-126) \times 60 \times 13}{60{,}000} = 1.3 \text{ square inches at 13 inches, center to center}$$

Supplied A_v = 4 No. 10 bars at 13" cc

= 5.08 sq. inches at 13" cc.

Code Case N250 sets the maximum value of the v_c at 60 p.s.i. On this basis the required shear reinforcement is recalculated below.

$$\text{Required } A_v = \frac{(228-60) \times 60 \times 13}{60{,}000} = 2.2 \text{ sq.inches at } 13\text{"cc.}$$

It is evident that the supplied tangential shear reinforcement exceeds that required by Code Case N250 and its requirements are satisfied.

NRC-SEB

INTERNAL STRUCTURES

ISSUE #24

Provide information to demonstrate that the temperature stresses are not coincidental with other LOCA loads and, therefore, need not be included.

RESPONSE

This issue arose in connection with the review of the design of the RPV pedestal. It was observed that no thermal loads T_a are included in the load combinations which represent abnormal loads due to LOCA, caused by break in the 24-inch recirculation line. The significant load terms due to LOCA which are included are the pressure load P_a and the pipe reaction Y_r.

The following data and information are submitted as pertinent to the foregoing approach:

a. Figure 19, entitled "24 Inch Recirculation Line Node 1", is attached. This figure shows a typical short term time history of the pressure P_a in the annular space. It is seen that the peak dynamic pressure, which controls in design, occurs in less than 0.01 seconds. After the pressure peak, the pressure drops substantially to an interim steady state value. Although the pipe reaction Y_r is not pictured it is known that its basic time history characteristics are similar to those of P_a.

b. Figure 3.2-48, entitled "Large Recirculation Line Break-Pressure Response-Minimum ECCS", is attached. This figure shows the pressure in the drywell indicating that the main pressure pulse has a duration of about 100 seconds. One can derive from the figure that after 100 seconds, pressures generally have decreased to values which are small compared to the peak dynamic pressure.

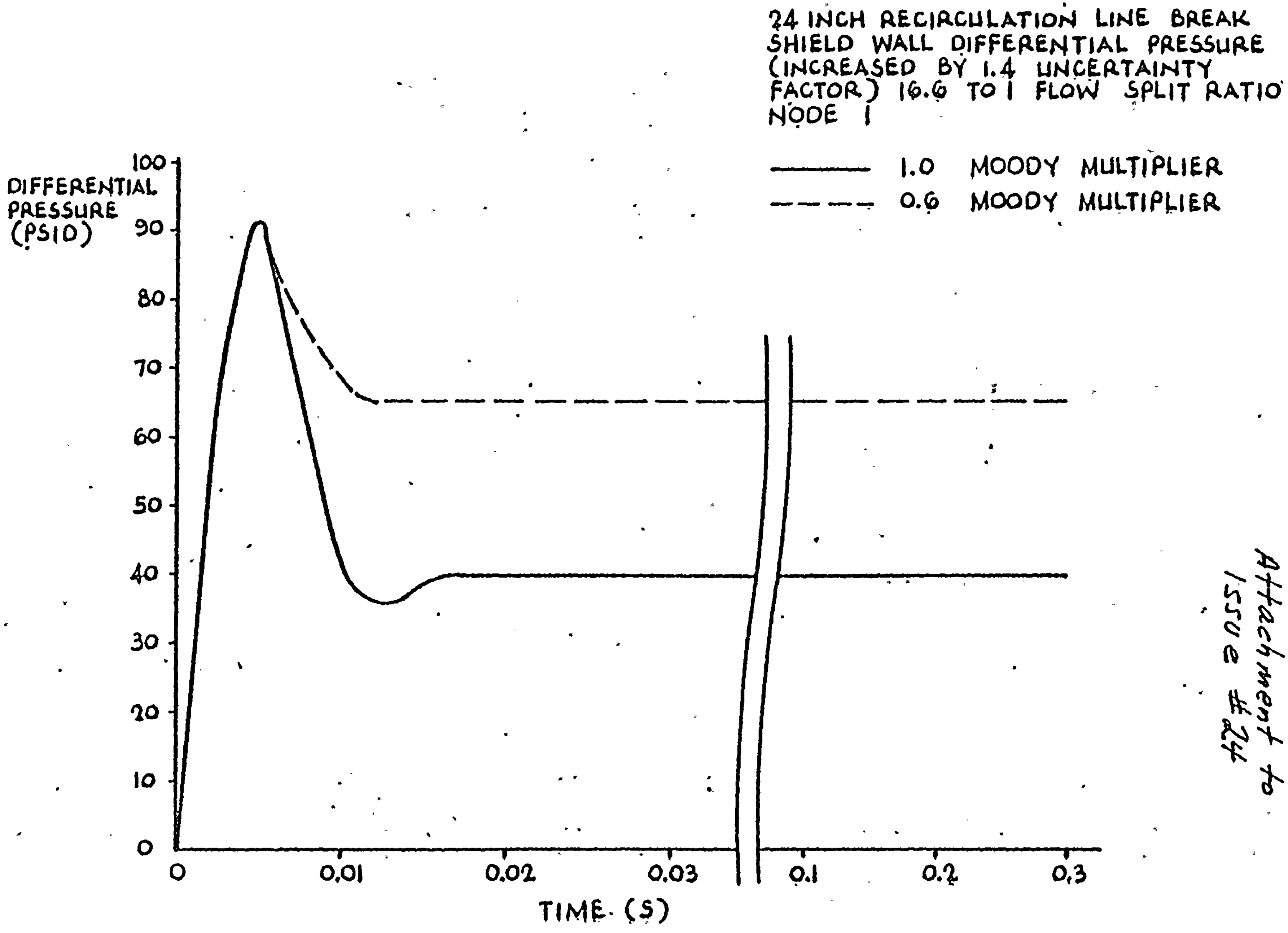
c. Figure 3.2-50, entitled "Large Recirculation Line Break-Temperature Response", is attached. This figure, which pictures the temperature response in the drywell, shows that the duration of the temperature rise is about 100 seconds. It is also evident from the figure that at the time of occurrence of the design pressure and pipe reaction, no substantial rise in drywell temperature has occurred.

d. An analysis was made to determine the change in temperature in the RPV pedestal due to the LOCA. It is evident that the greatest change can be expected at the end of the temperature rise in the drywell. However, it was concluded that because of the short duration of the accident transient (about 100 seconds) and the low thermal conductivity of the concrete pedestal very little temperature rise would result.

In summary, it is seen that the controlling design loads P_a and Y_r due to LOCA occur almost instantaneously after the pipe break. At that time, the thermal load T_a is effectively non-existent. Even at the end of the drywell temperature rise, the very small temperature increase in the pedestal results in insignificant thermal load. On this basis, omission of T_a from the significant load terms in the load combination is justified.

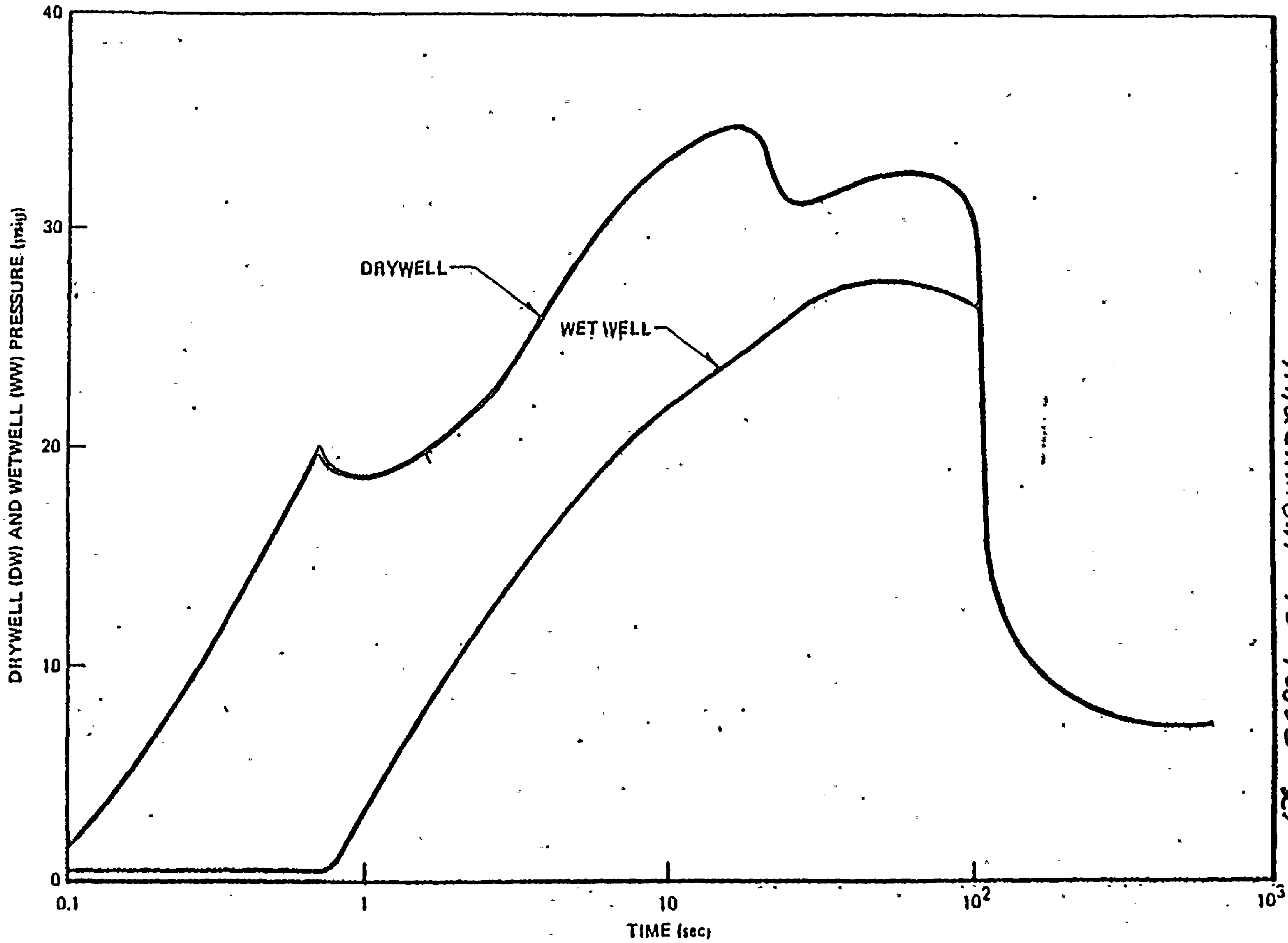
WASHINGTON PUBLIC POWER SUPPLY SYSTEM
NUCLEAR PROJECT NO. 2

24 INCH RECIRCULATION LINE
NODE 1



Attachment to
Issue #24

FIGURE
19

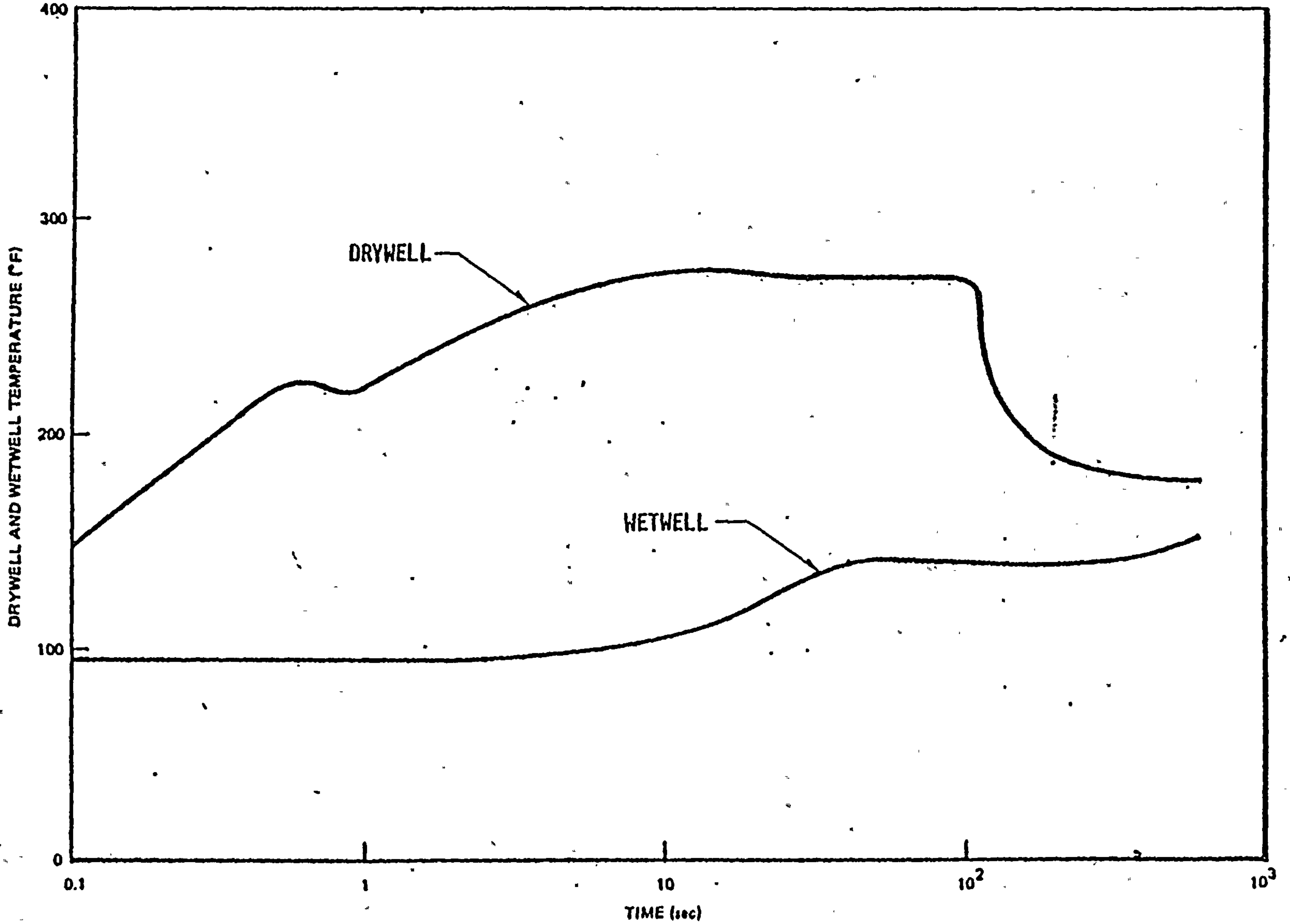


Attachment to Issue #24

WASHINGTON PUBLIC POWER SUPPLY SYSTEM
NUCLEAR PROJECT NO. 2

LARGE RECIRCULATION LINE BREAK-PRESSURE RESPONSE-MINIMUM ECCS

FIGURE 3.2-48



WASHINGTON PUBLIC POWER SUPPLY SYSTEM
NUCLEAR PROJECT NO. 2

LARGE RECIRCULATION LINE BREAK-
TEMPERATURE RESPONSE

FIGURE
3.2-50

Attachment to Issue #24

NRC-SEB

INTERNAL STRUCTURES

ISSUE #25

Provide information with respect to completion of the new assessments of internal structures.

RESPONSE

Please refer to the response to Question 130.062 for the information requested.

NRC-SEB

RADWASTE BUILDING

ISSUE #26

Reference Page 32 of SVIII 4. Identify the loads.

RESPONSE

The loads shown on page 32 of Calculation Book SVIII-4 (Attachment 1) are column and wall loads tabulated for input to strip #1 for design of the mat foundation. The dead and live loads used as input to calculate the factored loads shown on page 32 are from Book SVIII-4, page 12 (Attachment 2), and the earthquake loads are taken from Book SVIII-4 page 28 (Attachment 3). Copies of these pages are attached to demonstrate this.

An example of how page 32 is constructed is as follows using column line H.3 as the loading of interest. On page 12 of Book SVIII-4 (Attachment 2) at the H.3 column line the loads shown are 4093K dead load and 447K live load. On page 32 of Book SVIII-4 (Attachment 1) at the H.3 column line the loads shown are:

(1) $1.4D = 1.4 \times 4093K = 5730K$

(2) $1.7L = 1.7 \times \frac{447K}{4} = 190K$ (*)

(3) $0.25D = 0.25 \times 4093K = 1020K$

Seismic loads (OBE) are calculated from page 28 of Book SVIII-4 (Attachment 3). For column line H.3 the seismic load is 4100K and this is shown on page 32 as:

(4) $1.9\ OBE = 1.9 \times 4100K = 7790K$

(*) 25% of live loads are used for design of mat foundation. Refer to Issue #27.

The loads for each column line on page 32 of Book SVIII-4 (Attachment 1) are obtained in the same way as shown for H.3.

The uniform loads tabulated at the bottom of page 32 are obtained from page 12 as follows:

$$D = 147.3K/ft. \times 1.4 = 206\ K/ft.$$

$$L + 21.7K/ft. \times \frac{1.7}{4} = 9\ K/ft.$$

The remaining loads on page 32 of Book SVIII-4 (Attachment 1) shown in columns A through E are determined as indicated in the calculation by combinations of the loads discussed above.

STRIP #1 (54'-11" WIDE)

	COL. LINE	① 1.4 D	② 1.7 L	③ 0.25 D	④ 1.9 OBE	A = ①+②	B = ①+② +③+④	C = ①+② +③−④	D = ①−③+④	E = ①−③−④
0.00										
1.83	H.3	5730	190	1020	-7790	5920	-850	14730	-3080	12500
23.83	J.5	1380	100	250	–	1480	1730	1730	1130	1130
31.33	J.6	2770	90	490	–	2860	3350	3350	2280	2280
41.33	K.1	6900	530	1230	-4830	7430	3830	13490	840	10500
55.83	K.7	2810	150	500	–	2960	3460	3460	2310	2310
80.83	L.9	5230	370	930	–	5600	6530	6530	4300	4300
107.83	N.1	3000	230	540	–	3230	3770	3770	2460	2460
127.83	N.7	980	20	180	–	1000	1180	1180	800	800
134.83	N.9	1650	210	290	–	1860	2150	2150	1360	1360
161.83	Q.1	1820	200	330	3140	2020	5490	-790	4630	-1650
188.83	R.2	1630	210	290	1690	1840	3820	440	3030	-350
210.83	S.	1860	90	330	7790	1950	10070	-5510	9320	-6260
212.66										

PLUS UDL = (206 k/' D + 9 k/' L) = 215 k/' = 3.91 k/□' (A, B, C)
= 206 k/' D = 3.75 k/□' (D, E)

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W.O. No. 2808 Date 11.29.72 Book No. SVIII-4 Page No. 32 of 47
Drawing No. 5901 Calc. No. 6.22.02 Sheet 1A
By J.P. Checked [illegible] 11/17/72 Approved [illegible]
Title WPPSS HANFORD #2, RADWASTE BLDG FOUNDATION MAT

SHIPPED OCT 1 7 1977

Attachment #1 To Issue 26

Form BR 8002-2

SHIPPED MAY 0 2 1975

BURNS AND ROE, INC.

W.O. No. 2808-26 Date 11-27-72 Book No. SHIPPED DEC 12 1977

Drawing No. 901 Calc. No. 6.23.07 Sheet 3A of 47

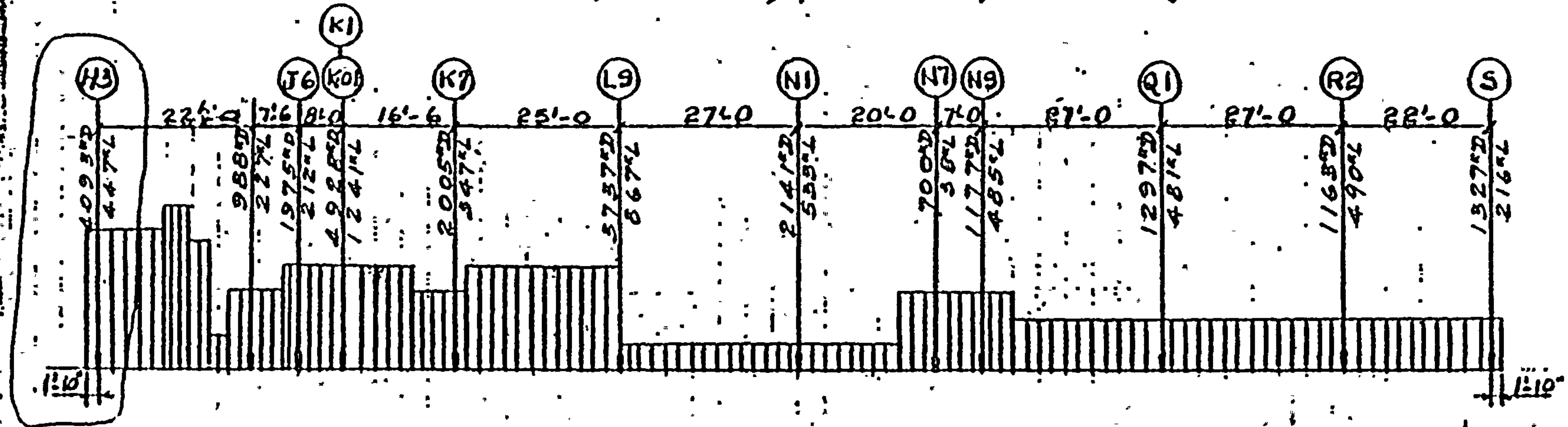
By A.J.R. Checked J.H. 11.30.72 Approved

Title: WPPSS HANFORD #2 RADWASTE BLDG FDN PLAN

Note: Sheets 1 and 2 of 47 have not been used and will not appear in this volume JJX

SHIPPED OCT 17 1977

LOAD DIAGRAM MAT STRIP #1 (54'-11" WIDE) (212'-8" LONG)



NOTES:

For uniform loads diagram see Sh. 3B of 47

Loads on Mat:

LL = 300 #/ft

DL = 1200 #/ft

Eq. = 115 #/ft

D	L
31328	4616
4093	447
988	227
1975	212
4928	1241
2005	347
3737	867
2141	533
700	38
1177	485
1297	481
1163	490
1327	216
Σ 56859	10200

TOTAL LOADS:

$D = 56859$

$L = 10200$

$\Sigma = 67059$

$L = 17.94\% D$

Average Uniform Loads:

$$D = \frac{31328}{212.66} = 147.3 \text{ k/l}$$

$$L = \frac{4616}{212.66} = 21.7 \text{ k/l}$$

Attachment #2 to Issue 26

Form BR 8002 2A

SHIPPED MAY 0 2 1975

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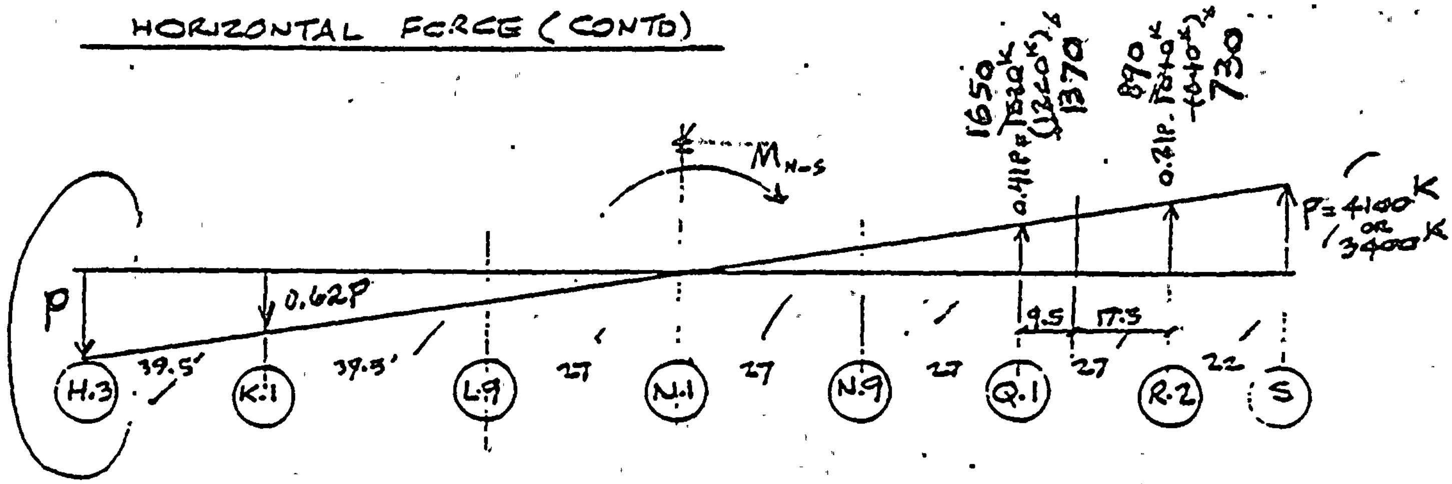
Attachment #3 to Issue 26

W.O. No. 2808 Date 9.14.72 Book No. SVIII-4 Page No. 28
Drawing No. 5900-901 Calc. No. 6.22.02 Sheet 10 of 47
RLK Checked [illegible] 11.22.72 Approved [illegible]

WPPSS HANFORD #2 RADWASTE BLDG. FOUNDATION PLAN

SHIPPED OCT 1 7 1977

HORIZONTAL FORCE (CONTD)



EARTHQUAKE N-S

$209P + 130 \times 0.62P = 3351,000$ ✓

$P = 11,570$ ✓

$0.62P = 7,170$ ✓

TO BE SHARED BY THREE WALLS THUS —

WALL ON (10) (3' THK) $P = 11570 \times \frac{3}{8.5} = 4100^K$ ✓

WALL ON (17) (3' THK) $P = 4100^K$ ✓

WALL ON (12.2) (~~3'~~ 2'-6 THK) $P = 11570 \times \frac{2.5}{8.5} = 3400^K$ ✓

THEN $0.62P = 2540^K, 2100^K$ & 2540^K RESP.

Form BR 8002-2

NRC-SEB

RADWASTE BUILDING

ISSUE #27

Reference Page 26 of SVIII 4. Explain and justify reduction of live load in mat of Radwaste Building.

RESPONSE

Item resolved at meeting.

NRC-SEB

RADWASTE BUILDING

ISSUE #28

Provide an example of calculations of overall response to tornado missiles (12 inch diameter pipe and 4,000 lb. automobile).

RESPONSE

In accordance with Regulatory Guide 1.76 (April 1974), the WNP-2 site is in tornado Region III. In Region III, the Design Basis Tornado is characterized by a maximum wind speed of 240 miles per hour.

The following missiles are described in the Standard Review Plan (NUREG-75/087, dated 11/24/75) for 3.5.1.4 of the FSAR as being appropriate for evaluating operating license applications of applicants who were not required at the construction permit stage to design to the full missile spectrum given in the SRP:

a. Steel rod, 1-inch diameter, 3 ft. long, weight 8 lb., 259 ft. per second horizontal speed.

b. Utility pole, 14-inch diameter, 35 ft. long, weight 1500 lb., 241 ft. per second horizontal speed.

Missiles (a) and (b) above have been considered to be capable of striking in all directions with vertical speeds equal to 80% of the horizontal speeds listed above.

The tornado missile protection provided by the WNP-2 safety-related structures is as described in 3.5 of the FSAR.

NRC-SEB

RADWASTE BUILDING

ISSUE #29

Provide calculations showing center of mass and center of rigidity.

RESPONSE

This issue was resolved through discussion at the meeting.

Sample calculations are attached as requested at the meeting. The sample calculations show the center of mass and the center of rigidity for the Radwaste Building. They are taken from calculation book SVIII-1 and are as follows:

a. Pages 22 and 23 provide sample calculations for the center of mass at elevation 466'-0".

b. Pages 77, 78 and 79 provide sample calculations for the center or rigidity for the stick model member between elevations 466'-0" and 431'-0".

SHIPPED MAY 0 [illegible] 1975 BURNS AND ROE, INC.

ROOM NO. 32

SEISMIC ANALYSIS

LUMP MASS AT NODE POINT NO. [illegible] — MASS INCLUDES BEAMS, EL. SLAB, WIND, EXHAUST CANT..., EXTERIOR AND INTERIOR WALLS & LIVE LOADS

CLUSTER MASS AT EL. [illegible]

DESCRIPTION	WEIGHT	MASS	X (FT)	Y (FT)	ΔX (FT)	ΔY (FT)	Jx	M.P	Jz	Jx	M.B	Jy	REMARKS
[illegible]	[illegible]	[illegible]	0	0	0	0	729000	—	6997000	856000	—	725990	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	181000	121000	85100	220	137010	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	392	2840	32500	132840	—	86490	4141	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	650	6200	74250	148880	1122	13890	1840	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	000	3900	79900	38100	3740	65900	69600	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	798	18900	39740	51350	410	66700	67170	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	160	710	2410	1920	1650	5180	4830	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	226	920	10170	11100	210	22740	23170	
[illegible]	[illegible]	[illegible]	0	0	[illegible]	[illegible]	114000	—	111600	80000	—	80000	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	212	160	1270	2210	2300	149200	151500	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	22500	—	1880	2250	
[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]	[illegible]	101000	—	101000	—	16900	16420	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	200	1890	—	1800	—	3215	3215	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1910	100600	83000	92600	1490	5700	7190	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1000	—	18400	18400	2950	73100	75150	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	280	11500	35700	47200	—	845	845	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	41	1470	19100	20870	—	610	610	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	—	—	11000	22540	34440	
TOTAL	26827	881			+1171	+1249			8032250			3175760	

NOTE: X, Y: DISTANCE BETWEEN C.G. OF EACH ELEMENT TO C.G. OF [illegible] WASTE BUILDING ALONG E-W AND N-S DIRECTIONS RESPECTIVELY.

[illegible] MOMENT OF MASS INERTIA OF ELEMENT WITH RESPECT TO ITS CENTER OF GRAVITY ALONG E-W & N-S DIRECTIONS USING FOLLOWING FORMULAE:

(a) RECTANGULAR WALL (b) CIRCULAR WALL (c) RECTANGULAR SLAB (d) CIRCULAR SLAB

ATTACHMENT TO 6/23/75

SHIPPERMAN (C) 1976 BURNS AND ROE, INC.

[illegible]

NEPS [illegible] No. 2 [illegible]

[illegible] NO. 7

[illegible]

	Description	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	F	[illegible]	In	[illegible]	[illegible]	Iy	Remarks
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	4880	18880	19650	3760	6810	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	12000	23160	21360	—	20650	22660	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	5560	2760	—	2580	7280	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	20940	31980	—	9868	8258	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	7050	107940	115330	12000	11329	23885	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9230	14000	87130	7000	5085	12485	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	80000	90000	—	11380	11335	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	33000	31800	—			
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	800	15840	56700	—	23250	23750	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	11980	41988	—	2480	2480	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	41000	168900	122800	11800	1590	70530	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	33800	126000	148800	1200	10870	11670	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	400	2150	2520	200	1712	2410	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	10510	25580	136670	—	161470	162173	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	2000	2010	21600	1800	48800	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	7070	7010	—	—		
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	13000	14000	—	3012	3012	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	6730	6730	—	530	530	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	70800	71800	—	—		
	Subtotal this sheet	[illegible]	[illegible]			[illegible]	[illegible]			529720			527822	
	Subtotal from sh. [illegible]	[illegible]	[illegible]			[illegible]	[illegible]			1632250			2875280	
	Grand Total	[illegible]	[illegible]			[illegible]	[illegible]			2184970			3423802	

[illegible] DIRECTIONS RESPECTIVELY [illegible] DIRECTIONS USING [illegible]

[illegible]

ISSUE 29

SHIPPED MAY 0 1 1975

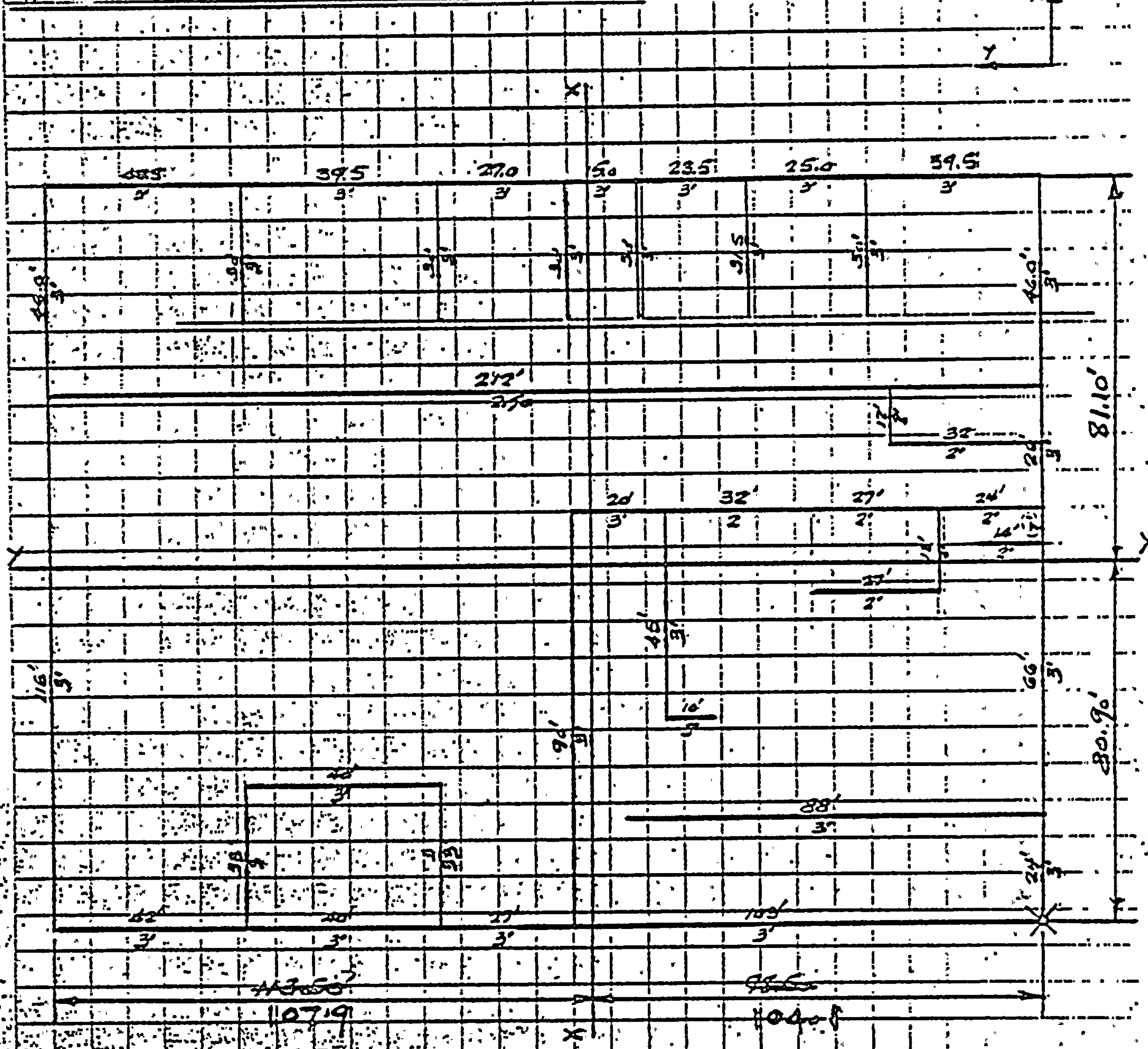
BURNS AND ROE, INC.

Oradell, N.J. • Hempstead, N.Y. • Los Angeles, Calif.

W.O. No. 2808	Date Aug 31, 1972	Book No. SVIII - I	Page No. 77
Drawing No. NA	Calc. No. 622.24		Sheet 1 of 3
By AML	Checked C. Moses 9/5/72	Approved	

Title WPPSS Hanford No 2 Radwaste Bldg Seismic Analysis

7' Walls MT Between 466'-0 & 431'-0"



$A_x = 2(162 \times 3) + (30 \times 3)5 + 31.5 \times 3 + (33 \times 3)2 + 90 \times 3 + 45 \times 3 + 18 \times 2 + 12 \times 2 =$

$= 972 + 450 + 94.5 + 198 + 270 + 135 + 36 + 24 =$

$= 2179.5\ \square'$

$A_y = (212 \times 3)2 + (212 \times 2.5) + (32 \times 2) + 14 \times 2 + 27 \times 2 + 10 \times 3 + 88 \times 3 + 83 \times 2 +$

$20 \times 3 + 40 \times 3 =$

$= 1272 + 530 + 64 + 28 + 54 + 30 + 264 + 166 + 60 + 120 =$

$= 2588\ \square'$

Form BR 0003-2

ISSUE 29

SHIPPED MAY 01 1975

BURNS AND ROE, INC.

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W.O. No. 2808 Date Aug 31, 1972 Book No. SVIII - I Page No. 78

Drawing No. NA Calc. No. 622.24 Sheet 2 of 3

By AML Checked C. Moses 9/5/72 Approved

Title WPPSS Hanford No 2 Radwaste Bldg Seismic Analysis

T. Walls MT Between 466'-0" & 431'-0"

$$\bar{x}_a = \frac{636\times162 + 530\times116 + 64\times104 + 90(60+166) + 28\times83 + 54\times72 + 30\times45 + 26.4\times24 + 120\times33}{2588}$$

$$= \frac{103,090 + 61,480 + 6660 + 20,340 + 2320 + 3890 + 1350 + 6340 + 3960}{2588} = \frac{209,370}{2588}$$

$$\bar{x}_A = 80.9'$$

$$\bar{y}_a = \frac{36\times24 + 24\times32 + 90(59.5 + 88 + 103 + 130 + 169.5) + 135\times83 + 270\times103 + 99(130+170) + 486\times212}{2180}$$

$$= \frac{870 + 770 + 27,700 + 7910 + 27,810 + 29,700 + 105,030}{2180} = \frac{214,790}{2180}$$

$$\bar{y}_a = \cancel{98.5'}\ 104.1'$$

$I_{xa} = 2(\frac{1}{12}\times162\times3^3) + 486\times113.5^2 + (\frac{1}{12}\times33\times3^3)2 + 99(71.5^2 + 31.5^2) + \frac{1}{12}\times90\times3^3 + 270\times4.5^2 +$
$\frac{1}{12}\times45\times3^3 + 135\times15.5^2 + \frac{1}{12}\times18\times2^3 + 36\times74.5^2 + 486\times98.5^2 + \frac{1}{12}\times12\times2^3 + 24\times66.5^2 +$
$(\frac{1}{12}\times30\times3^3)5 + 90(71.0^2 + 30.5^2 + 4.5^2 + 15.5^2 + 64.0^2) + (\frac{1}{12}\times3\times212^3)2 + (636\times7.5^2)2 + \frac{1}{12}\times2.5\times212^3 +$
$530\times7.5^2 + \frac{1}{12}\times2\times32^3 + 64\times82.50^2 + \frac{1}{12}\times2\times14^3 + 28\times91.5^2 + \frac{1}{12}\times2\times27^3 + 54\times61.0^2 + \frac{1}{12}\times2\times83^3 +$
$166\times57.0^2 + \frac{1}{12}\times3\times20^3 + 60\times5.5^2 + \frac{1}{12}\times3\times10^3 + 30\times20.5^2 + \frac{1}{12}\times3\times88^3 + 264\times54.5^2 +$
$\frac{1}{12}\times3\times40^3 + 120\times57.5^2 =$

= 730 + 6260,780 + 150 + 604,350 + 200 + 5470 + 100 + 32,440 + 40 + 199,810 + 4,715,300 + 10 +
106,140 + 340 + 929,500 + 4,764,070 + 71,550 + 1,985,030 + 29,810 + 5460 + 435,600 +
370 + 234,420 + 3280 + 200,940 + 95,300 + 539,340 + 2000 + 1820 + 250 + 17,610 +
170,370 + 784,150 + 16000 + 318,270 =

$I_{xA} = \cancel{22,696,000\ ft^4}$ 22,713,497

$I_{ya} = [\frac{1}{12}\times212\times3^3]2 + 636(81.1^2 + 80.9^2) + \frac{1}{12}\times212\times2.5^3 + 530\times35.1^2 + \frac{1}{12}\times32\times2^3 + 64\times23.1^2$
$+ \frac{1}{12}\times83\times2^3 + 166\times9.1^2 + \frac{1}{12}\times20\times3^3 + 60\times9.1^2 + \frac{1}{12}\times14\times2^3 + 28\times21.1^2 + \frac{1}{12}\times27\times2^3 +$
$54\times8.9^2 + \frac{1}{12}\times18\times3^3 + 30\times35.9^2 + \frac{1}{12}\times88\times3^3 + 264\times56.9^2 + \frac{1}{12}\times40\times3^3 + 120\times47.9^2$
$+ (\frac{1}{12}\times3\times162^3 + 486\times0.10^2)2 + ((\frac{1}{12}\times3\times30^3) + 90\times66.1^2)5 + \frac{1}{12}\times3\times311.5^3 + 94.5\times66.1^2 +$
$\frac{1}{12}\times2\times12^3 + 24\times29.1^2 + \frac{1}{12}\times2\times18^3 + 36\times0.1^2 + \frac{1}{12}\times3\times45^3 + 135\times13.4^2 + \frac{1}{12}\times3\times90^3 +$
$270\times35.9^2 + (\frac{1}{12}\times3\times33^3 + 99\times64.4^2)2 =$

= 480 + 8,345,610 + 280 + 653,000 + 200 + 34,420 + 60 + 13,750 + 50 + 4970 + 10 + 120 + 20 + 12,205 + 20 + 38,670 +
2000 + 30,473 + 90 + 275,330 + 2,125,730 + 1,999,900 + 7870 + 412,590 + 290 + 20,320 + 970 + 10 + 22,730 +
34,140 + 153,250 + 347,980 + 839,160 =

$I_{ya} = \cancel{15,663,540\ ft^4}$ 16,210,200 ft^4

~~16,210,200 ft^4~~

Form B/R 0002-2

ISSUE 29

BURNS AND ROE, INC.

SHIPPED MAY 01 1975

P.O. No. 2808 Date 9-6-72 Book No. 3011-I Page No. 29

Drawing No. N/A Calc. No. 688-2.6

By GMO'S Checked ... Approved ... Sheet 3 of 3

Title WPPSS HANFORD NO. 2 RADWASTE BLDG. SEISMIC ANALYSIS

IxA

$2 \times \frac{1}{12} \times 162 \times 3^3 = 729$

$486 \times 107.9^2 = 5,658,211$

$2 \times \frac{1}{12} \times 33 \times 3^3 = 149$

$99 \times 65.9^2 = 429,938$

$99 \times 25.9^2 = 66,410$

$\frac{1}{12} \times 90 \times 3^3 = 203$

$270 \times 1.1^2 = 327$

$\frac{1}{12} \times 45 \times 3^3 = 101$

$135 \times 21.1^2 = 60,103$

$\frac{1}{12} \times 18 \times 2^3 = 12$

$36 \times 80.1^2 = 230,976$

$486 \times 104.45^2 = 5,307,242$

$\frac{1}{12} \times 12 \times 2^3 = 8$

$24 \times 72.1^2 = 124,762$

$\frac{1}{12} \times 30 \times 3^3 \times 5 = 338$

$90 \times 65.4^2 = 384,944$

$" \times 25.9^2 = 60,373$

$" \times 1.1^2 = 109$

$" \times 16.1^2 = 23,329$

$" \times 64.6^2 = 375,584$

$\frac{1}{12} \times 3 \times 212^3 \times 2 = 4,764,064$

$636 \times 1.9^2 \times 2 = 4,592$

$\frac{1}{12} \times 2.15 \times 212^3 = 1,985,027$

$530 \times 1.9^2 = 1,913$

$\frac{1}{12} \times 2 \times 32^3 = 5,461$

$64 \times 88.1^2 = 496,743$

$\frac{1}{12} \times 2 \times 14^3 = 457$

$28 \times 97.1^2 = 263,996$

$\frac{1}{12} \times 2 \times 27^3 = 3,281$

$54 \times 66.6^2 = 295,408$

$\frac{1}{12} \times 2 \times 83^3 = 95,298$

$166 \times 62.6^2 = 650,514$

$\frac{1}{12} \times 3 \times 20^3 = 2,000$

$60 \times 11.1^2 = 7,393$

$\frac{1}{12} \times 3 \times 10^3 = 250$

$30 \times 26.1^2 = 20,436$

$\frac{1}{12} \times 3 \times 88^3 = 170,368$

$264 \times 60.1^2 = 953,571$

$\frac{1}{12} \times 3 \times 40^3 = 16,000$

$120 \times 45.9^2 = 252,817$

IxA = 22,713,437

Sheet 8

NRC-SEB

Diesel Generator Building

ISSUE #30

Specify the filler material between foundations of adjacent buildings, if any, and its properties.

RESPONSE

The major fill material between the foundations of adjacent buildings is compacted backfill. Where expansion joints are specified on the engineering drawings, the filler material specified is premolded joint filler conforming to ASTM D1752 Type III, self-expanding cork (non-extruding and resilient non-bituminous type).

NRC-SEB

ISSUE #31

Diesel Generator Building

Provide calculations for a typical wall design.

RESPONSE

Attached are typical calculations for the diesel-generator building shear walls. Included is a tabulation of the design margins for the building shear walls.

BURNS AND ROE, INC. 5XII-94

W.O. No. 5902-03 Date 10/11/78 Book No. 3-XIII-78 Page No. 17

Drawing No. Calc. No. Sheet B7 of

By DUB Checked DK Approved

Title: RGB - Seismic Anal - 6 DOF

MEMBER (1)(2) loads sh. B.1 — SSE - Medium Soil (See Note A)

(1) EW (6) T = 4906E4[k] ΣJ = 2,636,271.7 G/l sh. A.3 — NS (1) T = 9.784[1k]

Vert. (1) V_x = 3598.4[k] ΣKx = 642 G/l sh. A.3 — Vert. V_y = 3401.1[k] ΣKy = 577 G/l sh. A.3

Member (2): T = 7.9909E4[m]; V_x = 5443.5[k]

Member (2): T = 1.405E6[k]; V_y = 4947.7[k]

WALL	(1) = K_x	(2) = $K_x/\Sigma K_x$	(3) = $\bar{y}$	(4) = $K_x \bar{y}/J$	SHEAR (5) = (2)·V_x + (4)·T	(6) = K_y	(7) = $K_y/\Sigma K_y$	(8) = $\bar{x}$	(9) = $K_y \bar{x}/J$	SHEAR (10) = (7)·V_y + (9)·T Member (1) - K	(2) - K
EAST						197	0.344	55.85	0.00417	1570.6	2247.9
3.8						81	0.142	39.65	0.00122	601.3	859.0
5.6						98	0.171	-1.95	0.000072	588.6	839.1
7.4						98	-do-	-47.55	0.00177	753.3	1,077.6
9.4						98	-do-	-94.35	0.00351	922.1	1,322.1
					member (1)	(2)					
South	428	0.667	-25.17	0.0041	2,601.3	3,953.0					
North	214	0.333	50.33	-do-	1,399.4	2,140.3					

Note A: increase these values by 5% for hard and soft soils.
for OBE: take ½ of these loads and increase by 10%

ATTACHMENT TO ISSUE No. 31

BURNS AND ROE, INC. SEE-90

W.O. No. 3912-03 Date 10/11/79 Book No. [illegible] Proj No. 12

Drawing No. Calc. No. [illegible] Sheet [illegible]

By AUB Checked [illegible] Approved [illegible]

Title [illegible] RGB - SEISMIC [illegible]

MEMBER ①② loads sh. B.1 SSE - Medium Soil (see note A)

① EW (1) T = 4906E4[1k] ΣJ = 2,636,271.7 G/k sh. A.3 NS: ① T = 9.784[1k]

1 VERT. (1) V_x = 3598.4[k] ΣK_x = 642 G/k sh. A.3 VERT. V_y = 3401.1[k] ΣK_y = 572 G/k sh. A.3

Member ② T = 7.990 E4[1k] V_x = 5443.5[k]

Member ② T = 6.405E6[1k] V_y = 4947.7[k]

WALL	① = K_x	② = $K_x/\Sigma K_x$	③ = $\bar{y}$	④ = $K_x\bar{y}/J$	SHEAR ⑤ = ①·V_x + ④·T	⑥ = K_y	⑦ = $K_y/\Sigma K_y$	⑧ = $\bar{x}$	⑨ = $K_y\bar{x}/J$	SHEAR ⑩ = ⑧·V_y + ⑨·T Member ①-K	②-K
EAST						197	0.344	55.25	0.00413	1570.6	2247.9
3.8						81	0.142	39.65	0.00122	601.3	859.0
5.6						98	0.171	-1.95	0.00007	588.6	839.1
7.4						98	-do-	-47.55	0.00177	753.3	1077.6
9.4						98	-do-	-94.35	0.00351	922.1	1322.1
					member ①	②					
South	428	0.667	-25.17	0.0041	2601.3	3953.0					
North	214	0.333	50.33	-do-	1399.4	2140.3					

Note A : increase these values by 5% for hard and soft soils.
for OBE : take ½ of these loads and increase by 10%

ATTACHMENT TO ISSUE No. 31

ATTACHMENT TO ISSUE NO. 31

BURNS AND ROE, INC.

W.O. No. 3900 Date 11-16-79 Book No. SVII-36 Page No. 3
Drawing No: 5854 Calc No. 6.21.10 Sheet 1 of 1
By: LF Checked MJL 11-16-79 Approved
Title: WPPSS - Hanford No. 2 - Diesel Generator Bldg - Assessment of Shear Walls

I. Summary of Loads & Moments (Ref. Book No. SVII-34, Page 12)*

Note: Loads are SSE Seismic (including building torsion)

A. Node 1: Elev. 472' - 454'-6"

Member	Description	Shear (k)	Moment (1-k)
East	15'-8½" east of 3.8 (P to S)	1703	29,803
3.8	3.8 (P.1 to 14'-8" north of S)	639	11,183
5.5	5.5 (P.1 to S)	594	10,395
7.4	7.4 (P.1 to S)	811	14,193
9.4	9.4 (P.1 to S)	1033	18,078
South	S (11'-10" west of 9.4 to 15'-8½" east of 3.8)	3130	34,775
North	P.1 (11'-10" west of 9.4 to 15'-8½" east of 3.8)	1863	32,603

B. Node 2: Elev. 454'-6" - 437'-6"

Member	Description	Shear (k)	Moment (1-k)
East	same as	2484	72,031
3.8	A above	928	26,959
5.5		849	24,828
7.4		1180	34,253
9.4		1520	43,918
South		5005	139,860
North		3091	85,150

* SHEAR LOADS GENERATED IN THIS CALC. AND USED FOR CHECKING D.G. BLDG. WALLS WERE SUBSEQUENTLY FOUND TO BE LOWER. THEREFORE LOADS SHOWN ABOVE ARE CONSERVATIVE. MJL 1/9/80

Form BR 8002-2

ATTACHMENT TO ISSUE NO. 31

BURNS AND ROE, INC.

W.O. No. 3900 Date 12/26/79 Book No. SIII-36 Page No. 6
Drawing No. 5854 Calc. No. 6.2.10 Sheet 3 of 8
By MJH Checked LE 1-9-80 Approved [illegible]
Title WPPSS - HANFORD No. 2 - D.G. BLDG. - SHEAR WALLS

SOUTH WALL (LINE S)

WALL LENTH = 145'
WALL WIDTH = 2'-8"

CONSERVATIVELY CHECK WALL OVERTURNING NEGLECTING NET DOWNWARD AXIAL LOADS.

SSE $M = 139,860^{1K}$ @ EL. 437'-6"
SSE $V = 5005^{K}$

ASSUME $d = 0.8 l_w = 0.8(145') = 116'$
TENSION ZONE = 0.4(145) = 58'

$F = \frac{bd^2}{12000} = \frac{32(116 \times 12)}{12000} = 5167$

$K_u = \frac{M_u}{F} = \frac{139860}{5167} = 27$

SOLVE FOR q:

$K_u = \phi f'_c q (1 - 0.59 q) = 0.9(4000)(q - .59 q^2)$

$\frac{27}{3600} = 0.0075 = q - 0.59 q^2 \Rightarrow q = 0.00754$

$a_u = \phi f_y (1 - 0.59 q) / 12000 = \frac{0.9(60000)(1 - .59(.00754))}{12000}$

$a_u = 4.48$

$A_s = \frac{M_u}{a_u d} = \frac{139860}{4.48(116)12} = 22.4^{\square''}$

$A_s = \frac{22.4^{\square''}}{58'} = 0.38 (\square''/FT)$

A_s PROVIDED = #9 @ 10" EF = 2.4 $\square''$/FT ∴ STEEL OK!

Form BR 8002-2

ATTACHMENT TO ISSUE NO. 31

BURNS AND ROE, INC.

W.O. No: 3900 Date 12/27/79 Book No. SVII-36 Page No. 7
Drawing No. 5854 Calc. No. 6.21.10 Sheet 4 of 8
By MeH Checked LF 1-9-80 Approved
Title WPPSS - HANFORD No. 2 - D. G. BLDG. - SHEAR WALLS

SOUTH WALL (CONT'D):

CHECK SHEAR

$$v_u = \frac{V_u}{\phi h d} = \frac{5005^k}{(.85)(32)(116)in^2} = 0.132 \text{ ksi}$$

MIN. STEEL REQ'D - A_s PROVIDED = 2-#8@10"

∴ SHEAR OK

Form BR 8002-Z

ATTACHMENT TO ISSUE NO. 31

BURNS AND ROE, INC.

W.O. No. 3900 Date 12/27/79 Book No. SVII-36 Page No. 8
Drawing No. 5854 Calc. No. 6.2.10 Sheet 5 of 8
By MGH Checked LF 1-9-80 Approved
Title WPPSS - HANFORD NO. 2 - D.G. BLDG. - SHEAR WALLS

NORTH WALL (LINE P.1)

WALL LENGTH = 143'-8"
WALL WIDTH = 1'-4"

CONSERVATIVELY CHECK WALL OVERTURNING NEGLECTING NET DOWNWARD AXIAL LOADS.

SSE M = $85{,}150^{'K}$
SSE V = 3091^{K}

ASSUME $d = 0.8\, l_w = 0.8(143.67) = 114.9'$
TENSION ZONE = $0.4(143.67) = 57.5'$

$F = \frac{bd^2}{12000} = \frac{16(114.9 \times 12)^2}{12000} = 2534$

$K_u = \frac{M_u}{F} = \frac{85150}{2534} = 33.6$

SOLVE FOR q:

$K_u = \phi f'_c\, q\,(1 - 0.59q) = 0.9(4000)(q - 0.59q^2)$

$\frac{33.6}{3600} = 0.0093 = q - 0.59q^2 \Rightarrow q = 0.00936$

$a_u = \phi f_y (1 - 0.59q)/12000 = \frac{0.9(60000)(1 - .59(0.0936))}{12000}$

$a_u = 4.48$

$A_s = \frac{M_u}{a_u d} = \frac{85150}{4.48(114.9)12} = 13.8^{\square''}$

$A_s = \frac{13.8}{57.5} = 0.24^{\square''}/FT$ — NOMINAL STEEL REQ'D

A_s PROVIDED = 2-#7 @ 12"

$\therefore$ STEEL OK!

Form BR 8002-2

ATTACHMENT TO ISSUE NO. 31

BURNS AND ROE, INC.

W.O. No. 3900 Date 12/27/79 Book No. SVII-36 Page No. 9
Drawing No. S854 Calc No. 6.21.10 Sheet 6 of 8
By MOH. Checked LF 1-9-80 Approved
Title WPPSS - HANFORD No. 2 - D.G. BLDG. - SHEAR WALLS.

NORTH WALL (CONT'D)

CHECK SHEAR

$$v_u = \frac{V_u}{\phi h d} = \frac{3091}{(.85)(16)(1149)(12)} = 0.165 \text{ ksi}$$

$$A_v = \frac{(165-126)\,16\,(10)}{60000} = 0.104^{\square''}$$

#6 @ 10" PROVIDED

∴ SHEAR OK!

ATTACHMENT TO ISSUE NO. 31

BURNS AND ROE, INC.

W.O. No. 3900-03 Date 2-11-81 Book No. SVII-36 Page No. 14

Drawing No. See CALCS Calc. No. G.2.1-10 Sheet 1 of 2

By T. J. [illegible] Checked [illegible] Approved [illegible]

Title WPPSS-HANFORD #2 - D.G. BLDG - SHEAR WALLS - RESPONSE TO NRC-FSAR QUESTION 130.02A

① & ② SEE TYP CALC (SHEET 2)

WALL DESCRIPTION	BETWEEN ELEVATIONS	WALL AREA $\square'$	HORIZONTAL STEEL PROVIDED	NEW HORIZONTAL SHEAR INCL TORSION (K)	① [illegible] NEW UNIT PSI SHEAR	② HORIZ STEEL REQD $^{\square}$/FT	DESIGN MARGIN	REMARKS
SOUTH WALL	474'-4 / 455'	2.07 × 166 = 387 $\square'$	#8@10" EF MIN. $A_s = 1.9$ $\square''$/FT	2601 K	68 PSI	0	6.2	WALL AREA REDUCED SEE PLAN SKETCHES
NORTH WALL		145×1.33 = 193 $\square'$	#6@10" $A_s = 1.06$ E.F/FT	1399 K	74 PSI	0	6.2	
EAST WALL		267 × 63 = 168 $\square'$	#8@10" EF $A_s = 1.9$ SEE DWG S 850	1570.6 K	95 PSI	0	4.45	
WALL ON LINE (3.8)		1.33 × 81	#6@10" EF $A_s = 1.06$ SEE [illegible]	601.3 K	75.8 PSI	0	6.0	
WALL ON LINE (5.5)		1.33 × 98	DWG S 856	588.6 K	61.3 PSI	0	7.5	
WALL ON LINE (7.9)				755.3 K	78.5 PSI	0	5.8	
WALL ON LINE (9.4)				922.1 K	96.0 PSI	0	4.7	
SOUTH WALL	BELOW EL 455	355 $\square'$ ← 2.67	#8@10" EF MIN $A_s = 1.9$	3953 K	113.1 PSI	0	3.7	REDUCED WALL AREA FOR OPENINGS
NORTH WALL		(59-14) × 1.33 = 193 $\square'$	#6@10" EF $A_s = 1.06$	2190 K	113.2 PSI	0	4.0	
EAST WALL		2.67 × 63 = 168 $\square'$	#8@10" EF $A_s = 1.90$ $\square''$	2208 K	136.1 PSI	0.055	3.1	
WALL ON LINE (3.8)		1.33 × 81	#6@10" EF $A_s = 1.06$ $\square''$	859.8 K	108.4 PSI	0	4.2	
WALL ON LINE (5.5)		1.33 × 98		839.1 K	87.4 PSI	0	5.2	
WALL ON LINE (7.9)				1077.6 K	112.3 PSI	0	4.1	
WALL ON LINE 9.4			#6@10 EF $A_s = 1.06$	1322 K	137.8 PSI	0.03	3.3	

SEE PG. 12 THRU 34 (vertical note in table)

COMMENT: D.G. BLDG WALLS ADEQUATE TO TAKE ALL SEISMIC SHEARS.

Form BR 8002-2

ATTACHMENT TO ISSUE NO. 31

BURNS AND ROE, INC.

W.O. No. 3900-03 Date 2-11-81 Book No. S VII-36 Page No. 15
Drawing No. Sul. CALCS Calc. No. 6.21-10 Sheet 2 of 2
By T. J. Twomey Checked [illegible] Approved [illegible]
Title: WPPSS-HANFORD #2 D.G BLDG - SHEARWALLS - RESPONSE TO NRC FSAR QUESTION 130.02A

(1) TYPICAL CALC FOR UNIT SHEAR FOR SOUTH WALL BET ELS 474 & 452

$$v = \frac{V \times 1000}{0.8 \times 0.85 \times A_{wall} \times 144} = \text{PSI}$$

$$v = \frac{2601 \times 1000}{0.8 \times 0.85 \times 387 \times 144} = 68 \text{ psi}$$

(2) TYPICAL CALC FOR NEW HORIZONTAL STEEL REQD FOR SHEAR FOR EAST WALL BELOW EL 455'

$$\text{REQD } A_v = \frac{(136.7 - 126.6) \times 10 \times 32}{60000} = .053 \square''$$

(3) % MARGIN OF SAFETY FOR EAST WALL BELOW EL 455'

$$\cancel{\%\text{ MARGIN OF SAFETY} = \frac{(1.90 - .053) \times 60000 \times 100}{32 \times 10 \times 136.7} = 253\%}$$ SEE BELOW

$$\text{Design Margin} = \left(\frac{1.9 \times 60000}{32 \times 12} + 126.6\right) \times \frac{1}{136.7}$$

$$= 3.1$$

Form BR 5002-2

NRC-SEB

ISSUE #32

SPRAY PONDS

Demonstrate the conservatism of the equivalent static analysis of the retaining wall and the slab.

RESPONSE

Attached are the criteria used for the design and analyses of the spray pond and retaining walls.

1. SHIPPED MAY 14 1975

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SEP 21 1977

W.O. No. 2808 Date 1-16-74 Book No. 4TT VOL. 4 Page No. 72
Drawing No. 2513 Calc. No. 6-06-01 Sheet 1 of 15
By B.B. Checked Ou 5-7-76 Approved
Title WPPSS - HANFORD NO. 2 - SPRAY POND

EARTHQUAKE ANALYSIS OF THE SPRAY POND STRUCTURE (BOTTOM SLAB AND RETAINING SIDE WALLS)

This paper describes in detail the procedures employed in the seismic analysis of the spray pond structures. Two effects are considered:

I the interaction between structure and supporting and/or surrounding soil, and

II the dynamic effects (sloshing) of the water contained in the spray pond.

A summary of numerical results is also presented.

ATTACHMENT TO ISSUE #32

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W.O. No. 2808 Date 1-16-74 Book No. SII VOL. 4 Page No. 73
Drawing No. 4513 Calc. No. 6.06.01 Sheet 2 of 15
By S.B. Checked LF 7/7/76 Approved
Title WPPSS - HANFORD NO. 2 - SPRAY POND

I INTERACTION BETWEEN STRUCTURE AND SUPPORTING AND/OR SURROUNDING SOIL

A. Bottom Slab of Pond Structure

In a direction normal to the middle surface, the spray pond bottom slab is a sufficiently flexible structure relative to the underlying soil and; consequently, it will follow essentially the displacements and deformations that the soil would have if the structure were absent.

To determine flexural stresses in the slab due to displacements normal to its middle surface, the following procedure is used.

Considering the soil displacement component normal to the slab's middle surface, w, and assuming that it is associated with a wave that travels with velocity c in a horizontal direction, if the soil is considered a linearly elastic and homogeneous material, the displacement will satisfy the differential equation[(2), (4), (1)]:

$$\frac{\partial^2 w}{\partial t^2} = c^2 \frac{\partial^2 w}{\partial x^2}, \qquad (1)$$

Where: x is the coordinate axis measured in the horizontal direction of wave travel.

Using Eq. (1), the curvature of the slab, K_x, and the induced bending moment, M_x, assuming the slab bending to a cylindrical surface (i.e., in single curvature), may be obtained from Eq's. (2) and (3), respectively[(3), (1)]:

$$K_x = -\frac{\partial^2 w}{\partial x^2} = -\frac{1}{c^2}\frac{\partial^2 w}{\partial t^2}, \qquad (2)$$

$$M_x = -D\frac{\partial^2 w}{\partial x^2} = -D\frac{1}{c^2}\cdot\frac{\partial^2 w}{\partial t^2}. \qquad (3)$$

ATTACHMENT TO ISSUE #32

Here:

$D = \frac{E_c h^3}{12(1-\nu^2)}$ is the flexural rigidity of the slab,

E_c is the modulus of elasticity for slab material (concrete),

ν is Poisson's ratio for slab material (concrete), and

h is the slab thickness.

Since actual records of strong motion earthquake accelerations display orthogonal components of almost equal intensity, it is reasonable to consider the slab bending in double curvature and assuming that maximum values for the curvatures associated with any two orthogonal horizontal directions, x and y, are given by Eq. (4) (3), (1):

$$K_{x,\,max.} = K_{y,\,max.} = -\frac{1}{c^2}\cdot\left.\frac{\partial^2 w}{\partial t^2}\right]_{max.} , \tag{4}$$

the associated bending moments are computed from Eq. (5) (3), (1):

$$M_{x,\,max.} = M_{y,\,max.} = -D\,(1+\nu)\,K_{x,max} = +D\,(1+\nu)\,\frac{1}{c^2}\cdot\left.\frac{\partial^2 w}{\partial t^2}\right]_{max.} . \tag{5}$$

For reinforced concrete slabs the effective flexural rigidity is approximated by:

$$D_{eff.} \cong 0.70\,D . \tag{6}$$

The design bending moments are then obtained from:

$$M_{x,\,max.} = M_{y,\,max.} = +0.70\,D\,(1+\nu)\,\frac{1}{c^2}\left.\frac{\partial^2 w}{\partial t^2}\right]_{max.} . \tag{7}$$

Since it is difficult to distinguish between the various component waves that form an earthquake record, it is appropriate to make the conservative assumption that the maximum acceleration, $\left.\frac{\partial^2 w}{\partial t^2}\right]_{max.}$, in which we are interested is equal to the peak vertical ground acceleration for the postulated Safe Shutdown Earthquake (SSE) event, (1) i.e.,

$$\left.\frac{\partial^2 w}{\partial t^2}\right]_{max.} = 0.167\,g = 5.37\ ft/sec^2 .$$

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W.O. No. ~~SHIPPED MAY~~ Date 4 1975 16-74 Book No. SII VOL. 4 Page No. 75
Drawing No. 5512 Calc. No. 6-06-01 Sheet 4 of 15
By SE. Checked LF 7/7/76 Approved
Title WPPSS - HANFORD NO. 2 SPRAY POND SLAB

For a 7" thick reinforced concrete slab made of concrete with f'_c = 4000 psi the flexural rigidity of the slab (see Eq. (6)) is:

$$D_{eff} = 0.70 \times \frac{(3.83\times10^6 \times 144) \times (7/12)^3}{12(1-0.17^2)} = 6.58\times10^6 \text{ lbs-ft}^2/\text{ft},$$

and the maximum design bending moments (see Eq. (7)) are:

$$M_x, \max. = M_y, \max. = 6.58\times10^6 \times (1+0.17)\times 5.37 \times \frac{1}{(1000)^2} = 41.34 \text{ lbs-ft/ft};$$

assuming, conservatively, that c = 1000 fps. (see below).

The resulting bending stresses are negligible:

$$\sigma_{t,c} = \pm\frac{M}{S} = \pm\frac{41.34}{\frac{1\times7^2}{6}} = \pm 5.06 \text{ psi}.$$

To determine stresses in the slab due to distortions in its middle surface the procedure outlined below is used.

The foundation soils for the Hanford site may be divided into two layers (7) as follows:

Layer 1 consisting of a structural fill underlying all central plant structures and other safety-related facilities (including the spray ponds) and extending in depth approximately to El. 395', the top of the Ringold Formation; this layer is made of inorganic sand or sand and gravel mixtures compacted to high density (a minimum of 75 percent relative density). Based on the available information, it is estimated (7) that for this layer the shear wave velocity, c_s, will range from 1000 fps. to 2000 fps.

Layer 2 consisting of the Ringold Formation sediments of late Pliocene to Pleistocene age, the principal characteristic of the layer being its high density.

Because the lower layer is relatively hard, the foundation soil is considered to be a horizontal one-layer system which responds to an earthquake event by moving in a continuous sinusoidal plane wave.

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W.O. No. SHIPPED MAY 1 1975-16-74 Book No. SIT VOL. 4 Page No. 76
Drawing No. 5512 Calc. No. 6-06-01 Sheet 5 of 15
By BB Checked LF 7/7/74 Approved
Title WPPSS - HANFORD NO. 2 - SPRAY POND SLAB

The fundamental period, T, of the single (top) layer can be calculated from Eq. (8)(1), (2):

$$T = \frac{4H}{c_s}, \tag{8}$$

Where: H is the thickness of the layer, and
c_s is the shear wave velocity of the material in the soil layer.

The wave length, L, is calculated from Eq. (9)(1), (2):

$$L = c_s \cdot T, \tag{9}$$

and the displacement amplitude, A, from Eq. (10)(1), (2).

$$A = \left(\frac{T}{2\pi}\right)^2 \cdot \left.\frac{\partial^2 u}{\partial t^2}\right]_{max.} \tag{10}$$

In Eq. (10), as previously noted for Eq. (7), since it is difficult to distinguish between the various component waves that form an earthquake record, it will be conservatively assumed that the maximum particle acceleration (for the wave motion considered) equals the peak horizontal ground acceleration of the postulated Safe Shutdown Earthquake event,(1) i.e.,

$$\left.\frac{\partial^2 u}{\partial t^2}\right]_{max.} = 0.250\,g = 8.05\ ft/sec^2.$$

Assuming, conservatively, that the slab will deform in the plane of its middle surface to a distortion wave of amplitude A and wave length L, the in plane shear stresses may be estimated from the approximate relation of Eq. (11):

$$\tau_{max.} = G_c \cdot \gamma_{max} = G_c\left(\frac{A}{L/4}\right), \tag{11}$$

Where $G_c = \frac{E_c}{2(1+\nu)}$ is the shear modulus for slab material (concrete).

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SEP 21 1977

W.O. No. 2808 Date 1-16-74 Book No. SII VOL. 4 Page No. 77
Drawing No. 5513 Calc. No. 6.06.21 Sheet 6 of 15
By A.E. Checked LE 7/7/76 Approved
Title WPPSS - HANFORD NO. 2 - SPRAY POND SLAB

A conservative evaluation of in plane shear stresses assuming $H = 25$ ft. $\pm$ and $c_s = 1000$ fps. follows. Using Eq's. (8) through (11) one obtains:

$$T = \frac{4 \times 25}{1000} = 0.10 \text{ sec.},$$

$$L = 1000 \times 0.10 = 100 \text{ ft.},$$

$$A = \left(\frac{0.1}{2 \times 3.14}\right)^2 \times 8.05 = 2.04 \times 10^{-3} \text{ ft.},$$

and with:

$$G_c = \frac{3.83 \times 10^6}{2(1+0.17)} = 1.64 \times 10^6 \text{ psi},$$

the calculated shear stress equals:

$$\tau_{max} = 1.64 \times 10^6 \cdot \left(\frac{2.04 \times 10^{-3}}{100/4}\right) = 133.8 \text{ psi}.$$

The required reinforcement is:

$$A_{sv} = \frac{(\tau_{max}/\phi - v_c)\, b_w \cdot s}{f_y} = \frac{(133.2/0.25 - 126)\, 6 \times 12}{60\,000} = 0.058 \text{ in}^2/\text{ft}.$$

Variations from the assumed value for c_s will result in less critical stresses: for e.g., with $H_{min.} = 25$ ft. and $c = 1500$ fps., $\tau_{max} = 60$ psi, and with $H = 50$ ft. and $c = 1500$ fps., $\tau_{max} = 118.4$ psi.

The reinforcement actually provided in the spray pond bottom slab amply covers the stress requirements evaluated above.

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SEP 21 1977

W.O. No. 2808 Date 1-16-74 Book No. SII VOL 4 Page No. 78
Drawing No. 5513 Calc. No. 6.06.01 Sheet 7 of 15
By Checked 7/7/76 Approved
Title WPPSS - HANFORD NO. 2 - SPRAY POND - RETAINING WALL

B. Retaining Side Walls

Several investigations have arrived at procedures for estimating earth pressures on walls subjected to dynamic loading. Seed and Whitman[5] have summarized some of these investigations in their review paper of the state of knowledge concerning the "Design of earth retaining structures for (lateral pressures due to earthquakes and other) dynamic loads", presented at the ASCE Specialty Conference on lateral stresses (Cornell University, 1970).

A detailed description of the lateral dynamic earth pressures due to an earthquake occurrence which was implemented in design of retaining walls is contained in a report by Shannon and Wilson, Inc., appended to Volume I of the PSAR[7] and is not duplicated here. A summary of this seismic loading criteria (based on information contained in Seed and Whitman[5] state of the art paper and other pertinent data) is contained in Fig. 22 of the above mentioned report and is reproduced hereinafter.

ATTACHMENT TO ISSUE #32

SHIPPED MAY 14 1975 BURNS AND ROE, INC. SEP 21 1977
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W.O. No: 2808 Date 1-16-74 Book No. SIT VOL. 4 Page No. 79
Drawing No. 3513 Calc. No. 6-06-01 Sheet 3 of 17
By E.S. Checked LF 7/7/76 Approved.
Title WPPSS - HANFORD NO. 2 - SPRAY POND

II HYDRODYNAMIC EFFECTS OF WATER CONTAINED IN SPRAY PONDS DUE TO EARTHQUAKE

The spray pond is a prismatic reservoir with a flat bottom having the shape of a square (2L X 2L). Let H be the depth at rest of the liquid contained and 2L the length of the reservoir in the direction of motion. Since for the actual geometry of the spray ponds $2L/H = 18.6$ and is $\gg 1$, the problem of hydrodynamic pressures against the retaining walls admits a two dimensional idealization with $2L/H \rightarrow \infty$ (1). For the rather small body of water contained in the spray pond, the effects of water compressibility may be neglected (1). Considering that the retaining walls are rigid structures (boundaries), assuming that fluid displacements are small and neglecting the formation of waves in the water surface it may be shown (1) that the total hydrodynamic pressure acting on the wall approximately equals the total hydrostatic pressure times the ratio of max. horizontal acceleration to the acceleration of gravity, i.e., the total hydrodynamic pressure equals approximately 25% of the total hydrostatic force for a seismic event of SSE magnitude at the Hanford site, and this resultant dynamic force is applied at a distance of approximately 0.4 X H above the bottom of the reservoir.

Following the procedure outlined in reference (6), assuming that the spray pond walls are rigid structures, that water is incompressible and that water displacements are small the following results were obtained:

A. The total hydrodynamic pressure equals approximately 31% of the total hydrostatic pressure and is applied at a distance of approximately 0.38 X H above the bottom of the reservoir;

B. The rise of water above its level at rest is approximately 0.2 ft. and consequently not significant; the freeboard actually provided will prevent the water from spilling outside the spray pond.

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W.O. No. 2808 Date 1-16-74 Book No. S.I.I.-VOL.4 Page No. 88
Drawing No. 5513 Calc. No. 6.06.01 Sheet 9 of 5
By B.D. Checked LE 7/7/76 Approved
Title WPPSS - HANFORD NO. 2 - SPRAY POND

In the design of the spray ponds sidewalls the most conservative estimates obtained following the latter procedure (of reference (6)) were used.

The effects of hydrodynamic pressures on the bottom slab of the spray ponds during earthquake are not significant and will not affect the integrity of the slab placed on highly compacted subgrade (7) (structural fill made of sand and gravel compacted to minimum 75% relative density).

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W.O. No. 2865 Date 2-5-74 Book No. SLI VOL. 4 Page No. 61

Drawing No. 5515 Calc. No. 6 06.01 Sheet 10 of 15

By SP Checked [illegible] 3-12-74 Approved [illegible]

Title WPPSS - HANFORD No 2 - SPRAY POND SLAB

HYDRODYNAMIC EFFECTS OF WATER CONTAINED IN SPRAY PONDS DUE TO EARTHQUAKES:

CONSIDER THE SPRAY POND AS A RIGID RECTANGULAR CONTAINER WITH FLAT BOTTOM MEASURING 2L IN THE DIRECTION OF MOTION AND HAVING A UNIT WIDTH (THE FOLLOWING ANALYSIS IS MADE FOR A VOLUME OF LIQUID CONTAINED IN A UNIT WIDTH OF CONTAINER).

IF H IS THE DEPTH AT REST OF THE LIQUID CONTAINED AND W ITS WEIGHT, LIMITING OUR INVESTIGATION TO OBTAIN THE SOLUTIONS WHICH ACCOUNT ONLY FOR THE EFFECTS OF THE FIRST NATURAL MODE OF THE CONTAINER SUBJECTED TO TRANSLATORY MOTION, AND USING THE FORMULATION OF U.S.A.E.C - TID-7024, CHAPTER 6, THE FOLLOWING ARE COMPUTED:

$W = 2L \times 1 \times H \times \gamma_{WATER}$ ✓

$= 250 \times 1 \times 14 \times 62.4$ ✓

$= 218 \times 10^3$ lbs ✓

$W_0 = W \dfrac{\tanh(\sqrt{3}\, L/H)}{\sqrt{3}\, L/H}$

$= 218 \dfrac{\tanh\left(\sqrt{3} \times \frac{125}{14}\right)}{\sqrt{3} \times \frac{125}{14}}$ ✓

$= 218 \dfrac{\tanh(15.46)}{15.46}$ ✓

$= 14.1$ KIPS ✓

$H_0 = \dfrac{3}{8} H = \dfrac{3}{8} \times 14 = 5.25'$ FT. (EBP)

$P_0 = \left.\dfrac{\partial^2 u}{\partial t^2}\right]_{max} \times \dfrac{W_0}{g} = 0.25 \times 14.1 = 3.525$ KIPS

$M_0 = P_0 H_0 = 3.53 \times 5.25 = 18.53$ K-FT. (EBP)

$W_1 = W \times 0.527 \dfrac{L}{H} \tanh\left(1.58 \dfrac{H}{L}\right)$ ✓

$= 218 \times 0.527 \times \dfrac{125}{14} \tanh\left(1.58 \times \dfrac{14}{125}\right)$

~~0.168~~ 0.178

$= \cancel{172}$ KIPS 182 K

$H_1 = H \left[1 - \dfrac{\cosh(1.58 \times H/L) - 1}{1.58\, H/L \sinh(1.58\, H/L)}\right]$ ✓

$= 14 \left[1 - \dfrac{1.\cancel{01448}\,016 - 1}{0.177 \times 0.17082}\right]$

Form BR 8003-2

ATTACHMENT TO ISSUE #32

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W.O. No. 2808 Date 2-5-74 Book No. SII VOL. 4 Page No. 32
Drawing No. 5515 Calc. No. 6.06.01 Sheet 11 of 15
By SP Checked [illegible] 3/12/76 Approved [illegible]
Title WPPSS - HANFORD NO-2 - SPRAY POND SLAB

$H_L = 14 [1 - 0.5]$ ✓

$= 7$ FT. — (EBP) ✓

$\omega^2 = 1.58\, g/L$ ✓ $\tanh(1.58\, H/L)$

$= 1.58 \times \frac{32.2}{125}$ ✓ $\tanh\left(1.58 \times \frac{14}{125}\right)$ 0.178

$= \cancel{0.068}$ 0.072

$T = \frac{2\pi}{\omega} = \frac{2 \times 3.14}{0.2648} = \cancel{24.1}$ SECS. 23.4 SEC

GROUND ACC^n $= S_a = 0.25g = 0.25 \times 32.2$

$= 8.05$ FT/SEC² ✓

THE RESPONSE OF A VERY FLEXIBLE DYNAMIC SYSTEM IS GOVERNED BY MAXIMUM GROUND DISPLACEMENT. REFER FIG. 1 OF U.S.A.E.C. REGULATORY GUIDE 1.60. THE MAXIMUM GROUND DISPLACEMENT IS DEFINED TO BE 36" FOR A SEISMIC EVENT OF 1g MAXIMUM ACCELERATION.

$\therefore A_1 = Y_{max} \leq 0.25 \times \frac{36}{12} = 0.75'$ ✓

$\theta_h = 1.58 \frac{A_1}{L} \tanh(1.58\, H/L)$ ✓

$= 1.58 \times \frac{0.75}{125} \tanh\left(1.58 \times \frac{14}{125}\right)$

$= \cancel{0.159}$ 0.169 $\times 10^{-2}$ ✓

$P_1 = W_1\, \theta_h \sin \omega t$ ✓

$= \cancel{172}$ 182 $\times \cancel{0.159}$ 0.169 $\times 10^{-2} \sin \omega t$

$= \cancel{0.273}$ 0.31 $\sin \omega t$ KIPS

$M_{1\,max} = P_{1\,max} \times H_1$

$= \cancel{0.273 \times 7}$ 0.31×7

$= \cancel{1.911}$ ~~K-FT.~~ 2.17 FT-K.

$d_{max} = \dfrac{0.527\, L \coth(1.58\, H/L)}{\frac{g}{\omega^2 \theta_h L} - 1}$

$= \dfrac{0.527 \times 125 \times \coth\left(1.58 \times \frac{14}{125}\right)}{\frac{32.2}{\cancel{0.068}\ 0.072 \times \cancel{0.159}\ 0.169 \times 10^{-2} \times 125} - 1}$ ✓ $= \cancel{0.155}$ 0.19 FT < 1 FT. — FREEBOARD

THE RISE OF WATER ABOVE ITS LEVEL AT REST IS NOT SIGNIFICANT.

Form BR 8083-2

ATTACHMENT TO ISSUE #32

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W.O. No. 2808 Date 9-7-74 Book No. SEI VOL. 4 Page No. 83

Drawing No. 4513 Calc. No. G-06-01 Sheet 12 of 15

By SP Checked 3/12/74 Approved

Title WPPSS - HANFORD NO. 2 - SPRAY POND

$$H_1 = H\left[1 - \frac{\cosh(1.58 \times \frac{H}{L}) - 2}{1.58\frac{H}{L}\sinh(1.58\frac{H}{L})}\right] \text{ IBP}$$

$$= 14\left[1 - \frac{1.016 - 2}{0.177 \times 0.17082}\right]$$

$= 14 \times 33.6$ — CHANGE OF SIGN INDICATES THIS CALC. IS BEYOND THE SCOPE OF THE THEORY

USE H_1 (IBP) $= H_1$ (EBP) $+ 3'$ — THICKNESS OF FTG.

$= 7 + 3$

$= 10'$

$$\frac{H_0}{H} = \frac{1}{8}\left[\frac{4}{\frac{\tanh(\sqrt{3}\,L/H)}{\sqrt{3}\,L/H}} - 1\right]$$

$$\therefore H_0 = \frac{14}{8}\left[4 \times 15.5 - 1\right]$$

$= 106.8'$ — IBP

USE H_0 (IBP) $= H_0$ (EBP) $+ 3'$

$= 5.25 + 3$

$= 8.25'$

MOMENT IN CLOCKWISE DIRECTION ON WALL FOOTING I DUE TO DYNAMIC PRESSURE OF WATER (REFER PAGE NO 42)

$= P_0 H_0{}_{(IBP)} + P_1 H_1{}_{(IBP)}$

$= 5.53 \times 8.25 + \cancel{1.293}\ 0.31 \times 10$

$= 31.9\ 'K \approx 32\ 'K$

Form GR 8003-2

ATTACHMENT TO ISSUE #32

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SEP 21 1977

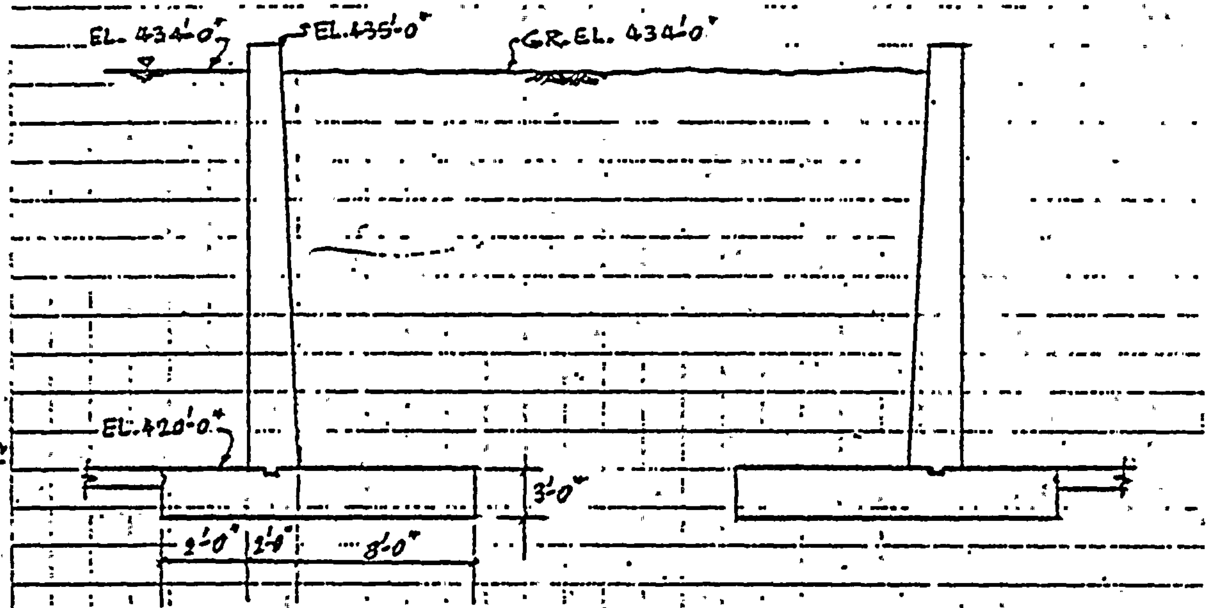
W.O. No. 2808 Date 2-7-74 Book No. SII VOL. 4 Page No. 54

Drawing No. 5513 Calc. No. 6.06 G1 Sheet 13 of 15

By SP Checked [illegible] Approved [illegible]

Title WPPSS - HANFORD NO. 2 - SPRAY POND

TO DETERMINE THE EFFECT OF STATIC & DYNAMIC PRESSURE OF WATER ON RETAINED SOIL:



WALL I — WALL II

TAKING MOMENTS @ HEEL:

I. MOMENTS IN CLOCK-WISE DIRECTION:

DUE TO STATIC PRESSURE OF WATER: $.0625 \times \frac{(14)^2}{2}\left(\frac{14}{3}+3\right)$ = 47 'k ✓

DUE TO DYNAMIC PRESSURE OF WATER (PAGE NO. DT. = 32 'k ✓

79 'k ✓

II. MOMENTS IN ANTI-CLOCK-WISE DIRECTION:

WT. OF WATER ON TOE: 2 x 14 x .0625 x 11 = 19.2 'k

WT. OF FTG. & WALL (REFER SH. 13 OF 18. DT. 9-26-72) (P. 20)

2.8 (12 - 2.63) = 26.2 'k ✓

0.8 (12 - 3.5) = 6.8 'k ✓

5.4 x 6 = 32.4 'k

WT. OF SOIL = 8 x 14 x 0.125 x 4 (WEDGE NEGLECTED) = 56.0 'k ✓

140.6 'k ✓

> 79 'k O.K.

BESIDES WE HAVE PASSIVE RESISTANCE OF SOIL.

Form BR 8003-2

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SEP 2 1 1977

W.O. No. 2808 Date 1-16-74 Book No. SII VOL. 4 Page No. 85
Drawing No. 5513 Calc. No. 6-66-01 Sheet 14 of 5
By BB Checked LE 7/7/76 Approved
Title WPPSS - HANFORD NO. 2 - SPRAY POND

References:

1. N. M. Newmark and E. Rosenblueth: "Fundamental of Earthquake Engineering", Prentice-Hall, 1972.

2. F. E. Richart, Jr., J. R. Hall, Jr., R. D. Woods: "Vibrations of Soils and Foundations", Prentice-Hall, Inc., 1970.

3. S. Timoshenko and S. Woinowsky-Krieger: "Theory of Plates and Shells", McGraw-Hill Book Co., 2nd Edition, 1959.

4. S. Timoshenko and J. N. Goodier: "Theory of Elasticity", McGraw-Hill Book Co., 2nd Edition, 1951.

5. ASCE, 1970 Specialty Conference: "Lateral Stresses in the ground and the Design of Earth-Retaining Structures", Cornell University, Ithaca, N. Y., June 22-24, 1970.

6. USAEC, TID 7024: "Nuclear Reactors and Earthquakes" by Lockheed Aircraft Corp. and Holmes and Harver, Inc., August 1963.

7. WPPSS, Preliminary Safety Analysis Report, Hanford No. 2, 1100 MW Nuclear Power Plant, Volume 1, Section 2: Site.

ATTACHMENT TO ISSUE #32

SHIPPED MAY 14 1975 **BURNS AND ROE, INC.** SEP 21 1977

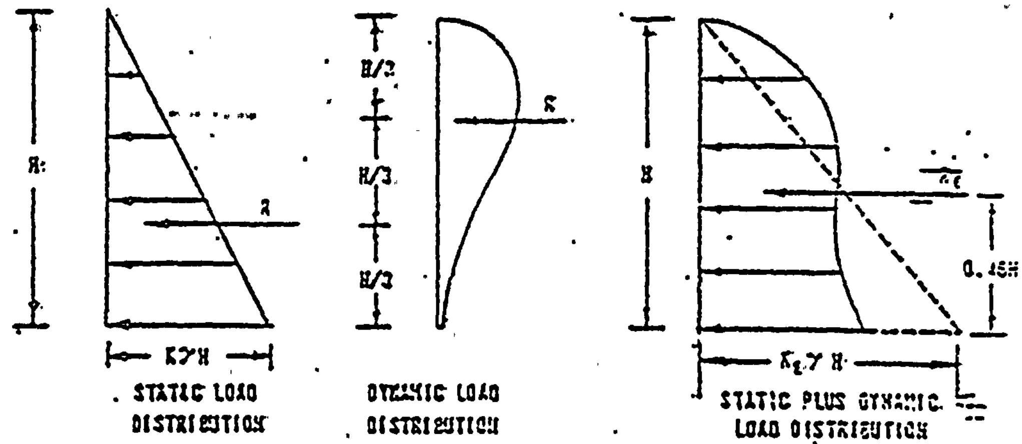
Oradell, N.J. • Hempstead, N.Y. • Los Angeles, Calif.

W.O. No. 2273 Date 1-16-76 Book No. 311 VOL. 4 Page No. 86

Drawing No. 2313 Calc. No. 5.06.01 Sheet 15 of 15

By RO. Checked [illegible] 7/7/76 Approved [illegible]

Title WPPSS - HANFORD NO. 2 - SPRAY POND RETAINING WALL



WHERE K = COEFF. OF LATERAL EARTH PRESSURE

K_0 (AT REST)

K_A (ACTIVE)

K_E (DYNAMIC)

K_{0E} (AT REST PLUS DYNAMIC)

γ = 125 pcf. (MOIST UNIT WEIGHT)

H = HEIGHT OF WALL

R = RESULTANT

DESIGN OF BASEMENT WALLS UNDER STATIC LOAD CONDITIONS

USE $K = K_0 = 0.5$

FOR DESIGN OF FLEXIBLE (YIELDING) WALLS USING ACTIVE EARTH PRESSURES

USE $K = K_A = 0.28$

FOR DESIGN OF WALLS TO RESIST DYNAMIC PRESSURES

USE $K_E = K_{0E} = 0.5 + 0.3 = 0.8$ (AT REST)

$K_E = K_{AE} = 0.28 + 0.3 = 0.58$ (ACTIVE)

$R_E = \frac{1}{2} K_E \gamma H^2$

NOTE: SURCHARGE LOADINGS NOT SHOWN. WHERE APPLICABLE, ADD TO LOAD DIAGRAMS SHOWN ABOVE A RECTANGULAR LATERAL LOAD EQUAL TO THE VERTICAL UNIT LOAD TIMES THE APPROPRIATE COEFFICIENT OF EARTH PRESSURE (K).

W.P.P.S.S.

HANFORD NO. 2 NUCLEAR PLANT

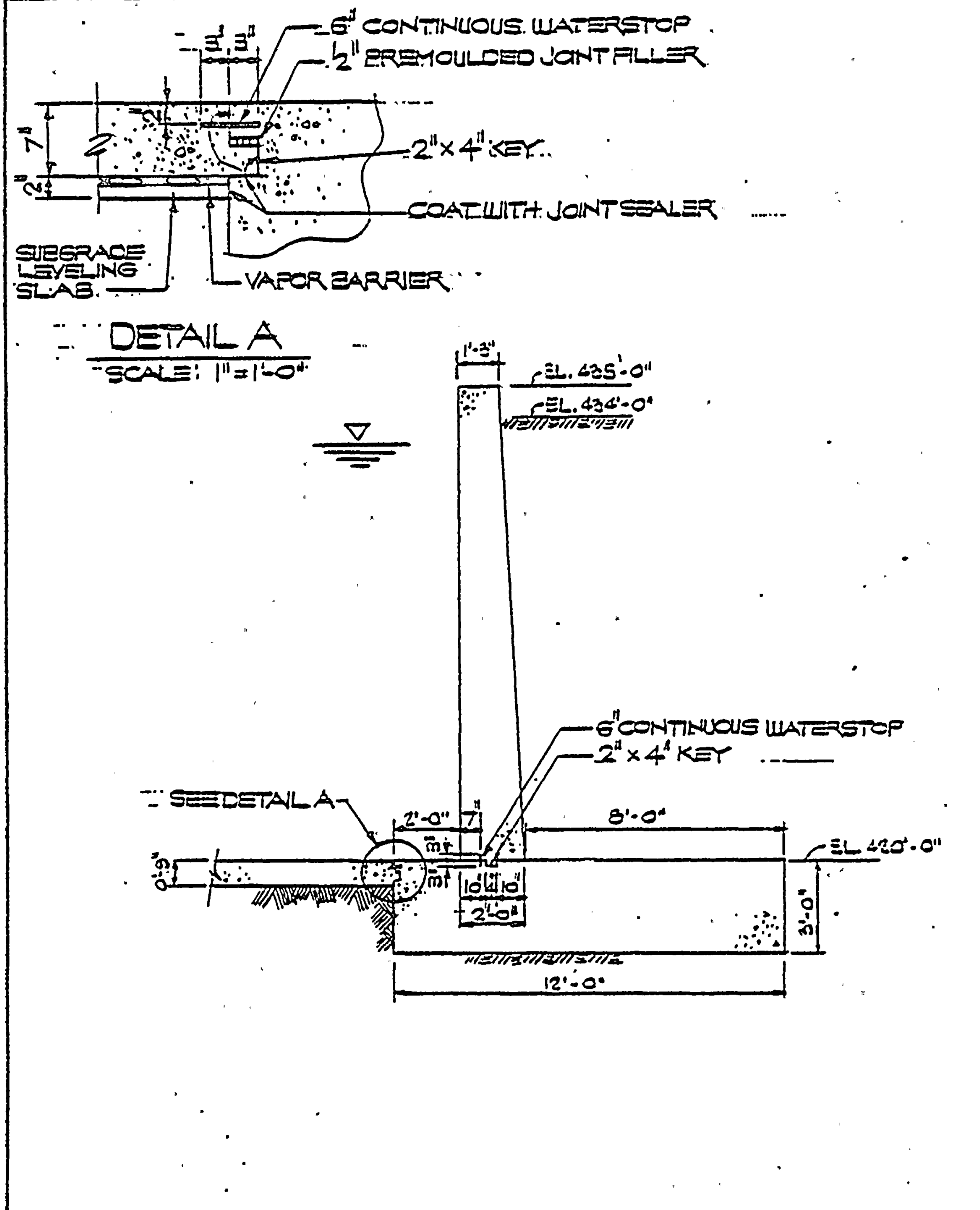
LATERAL EARTH PRESSURES

JUNE 30, 1977 [illegible]

SHANNON & WILSON

SOIL MECHANICS & FOUNDATION ENGINEERS

FIG. 2



WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT NO. 2	TYPICAL SECTION OF RETAINING WALL AND BOTTOM SLAB OF SPRAY POND WITH WATERSTOP	FIGURE 1 ISSUE #32 & 33

ISSUE #33

Demonstrate the conservatism of water leakage in spray pond due to the lack of structural continuity (Dwg, S-513 Detail D208).

RESPONSE:

The retaining wall structure is designed to withstand (a) the static earth pressure due to the Quality Class I structural backfill, and (b) the added dynamic earth pressure resulting from the specified design basis earthquake for WNP-2 site: an SSE with 0.25g peak horizontal ground acceleration. The backfill is designed to remain stable during earthquakes.

The static and dynamic design earth pressures are defined by the soil consultants, Shannon & Wilson, and are described in 2.5.4.10 of the FSAR and in Section IV of Appendix 2.5F.

The dynamic pressure induced by an SSE is derived by Shannon & Wilson in accordance with the state-of-the-art as described in reference 1. In reference 1, the authors conclude that if a retaining wall is designed with an adequate factor of safety against translation due to static earth pressure alone, the wall structure can resist the additional dynamic earth pressure induced by an earthquake similar in magnitude to that of the SSE for the WNP-2 site. This is reflected in Table 4 of reference 1. On this basis, it is concluded that the wall will not slide relative to the surrounding ground.

The floor slab of the spray pond is a flexible concrete slab of small mass expected to deform during an SSE in a manner compatible with the surrounding ground. It is designed accordingly, as demonstrated in Calculation No. 6.06.01 attached to the response to Issue #32.

Based on the above considerations, it is concluded that:

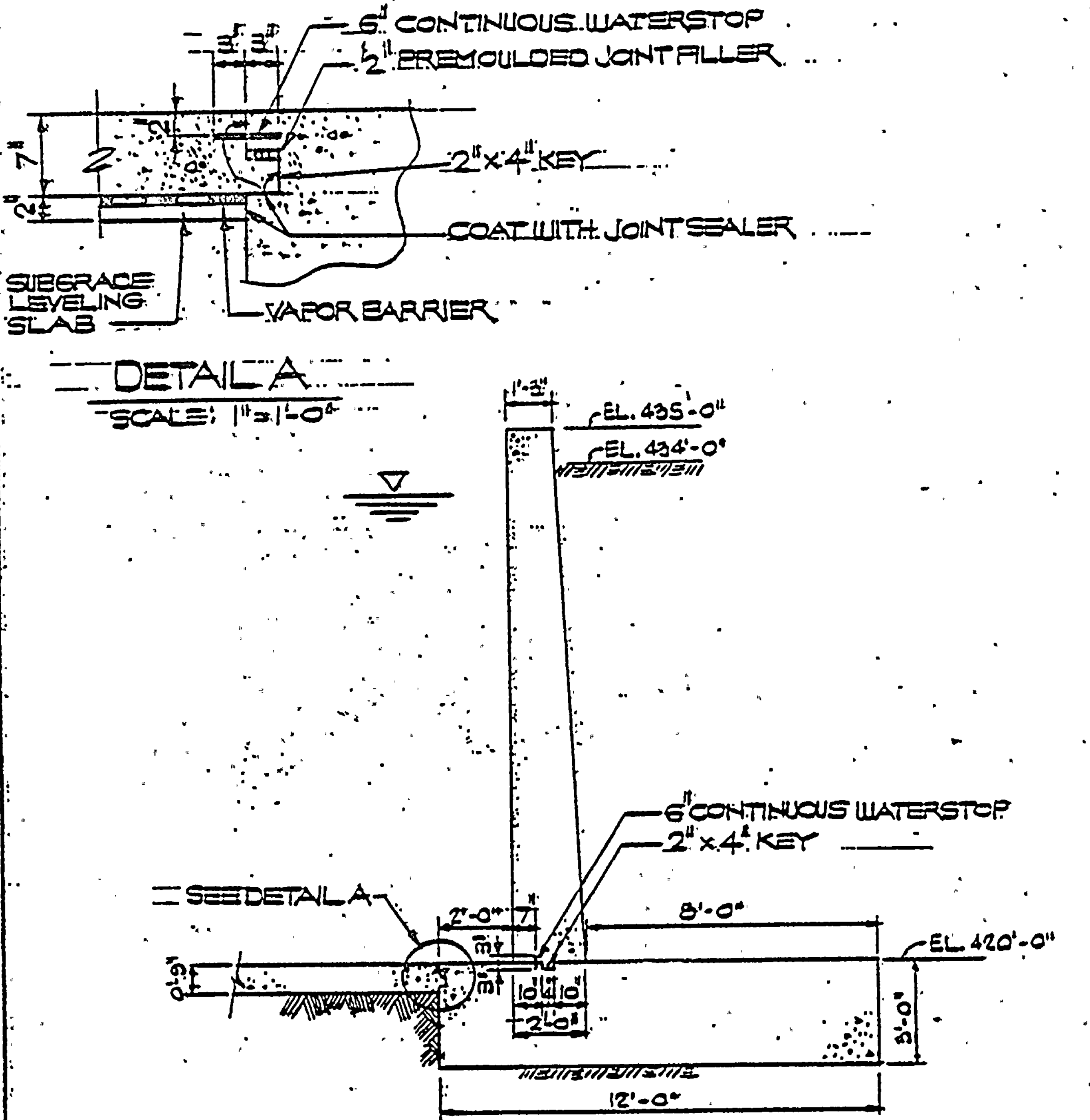
a. Both the floor slab and the retaining wall will move or "ride" with the surrounding soil mass.

b. Differential deflections between the slab and the wall of any significant magnitude will not occur.

c. The flexible continuous water stop embedded jointly in the floor slab and the retaining wall footing precludes any leakage which would result due to minor differential movement at the joint.

Reference

1. H. Bolton Seed and Robert V. Whitman, Design of Earth Retaining Structures for Dynamic Loads, Paper presented before the 1970 American Society of Civil Engineers Specialty Conference on Lateral Stresses in the Ground and the Design of Earth Retaining Structures, at Cornell University, Ithaca, N. Y., June 22-24, 1970.



WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT NO. 2	TYPICAL SECTION OF RETAINING WALL AND BOTTOM SLAB OF SPRAY POND WITH WATERSTOP	FIGURE 1 ISSUE #32 & 33

NRC-SEB

ISSUE 34

Submit one (1) sample of typical representative calculations for seismic category I underground piping.

RESPONSE

Please refer to the attached set of calculations for the information requested.

ISSUE 34

BURNS AND ROE, INC.
Headquarters Office—Oradell, N.J.

W.O. No. 3900-10 Date 7/16/80 Book No. 8.50 3 Page No.
Drawing No. N A Calc. No. 8.50.29 Sheet 1A Cont. on Sheet 1B
By MOHIBULLAH N. DURRANI Checked Approved
Title BURIED PIPING — WPPSS NP-2 (STRAIGHT P...)

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2.0 REFERENCES

3.0 DESIGN REQUIREMENTS

4.0 ASSUMPTIONS

5.0 PROCEDURES

6.0 COMPUTER INPUT/OUTPUT

7.0 CONCLUSIONS

8.0 CALCULATIONS

1.0 CALCULATIONS

Form BR 8002-2 (5/78)

ISSUE 34

BURNS AND ROE, INC.

W.O. No. 3900-10 Date 2/28/1980 Book No. 8.50-3 Page No.
Drawing No. NA Calc. No. 8.50-9 Sheet 1B of 10
By MOHIBULLAH N. DURRANI Checked 7/16/80 Approved
Title BURIED PIPING — WPPSS-NP-2 (STRAIGHT PIPES)

LEAD SHEET

1.0 PURPOSE:— TO CALCULATE THE PIPE STRESSES IN STRAIGHT PIPES DUE TO SEISMIC WAVES AND OTHER LOADINGS (PRESSURE, TEMP. ETC.) THE PIPES ARE IN DIRECT CONTACT WITH SOIL AND THESE ARE SAFETY CATEGORY I AND SEISMIC CATEGORY I PIPING.

2.0 REFERENCES:—

2.1. "SEISMIC DESIGN OF BURIED PIPING", M. AYUB IQBAL, EVANS C. GOODLING, STRUCT. DES. OF NUC. PLANT FACILITIES, ASCE, 1975.

2.2. "EARTHQUAKE RESPONSE ANALYSIS OF REACTOR STRUCTURES", N. M. NEWMARK, NUC. ENG. & DES. 20 (1972) 303-322.

2.3. "SEISMIC ANALYSIS OF SLENDER BURIED BEAMS" GORDON C. K. YEH, BULL. SEISMOLOGICAL SOC. OF AMERICA, 64, No. 5, Oct. 74, 1551

2.4. "WPPSS-HANFORD NO. 2 - MAXIMUM VELOCITY OF SOIL, Vm", ANDRE TOUMA, BURNS & ROE CALCULATION No. 6.37-01, BOOK No. S XIII-1

2.5. BURNS & ROE MECH. DRWGS. M 740-M745, 779-782, 859, 860

2.6. BURNS & ROE SPEC. CONTRACT 215 - SEC. 15B

2.7. BURNS & ROE SPEC. CONTRACT 233 - SEC. 15A

2.8. BURNS & ROE CALC. NO. 8.50-13, BOOK NO. 8.50-3

3.0 DESIGN REQUIREMENTS:—

3.1. NRC QUESTION ON FSAR, Q 130.30 ON BURIED PIPES

3.2 THIS CALCULATION IS REQUIRED TO GUARANTEE THE ADEQUACY OF STRAIGHT BURIED PIPING IN DIRECT CONTACT WITH SOIL.

Form BR 8002-2

4.0 ASSUMPTIONS :-

4.1 THE ASSUMPTIONS OF REFERENCES 2.1, 2.2, 2.3 AND 2.4 ARE ALSO APPLICABLE IN THIS CALCULATION.

4.2 SINCE THE S-WAVE AND THE P-WAVE TRAVEL AT DIFFERENT SPEEDS (THE FORMER IS NEARLY HALF AS FAST AS THE LATTER) THE TOTAL EFFECT ON THE PIPE IS ASSUMED TO BE THE SRSS OF EACH INDIVIDUAL WAVE.

5.0 PROCEDURES :-

THE REFERENCES DETAILED IN 2.1 AND 2.3 ARE FOLLOWED, IN ADDITION TO ENGINEERING PRINCIPLES, WHEN THE PROCEDURES ARE EXTENDED.

6.0 COMPUTER INPUT/OUTPUT :-

THE TEXAS INSTRUMENT PROGRAMABLE CALCULATOR TI-59 WAS USED TO DEVELOP AND SOLVE THE EQUATIONS WHICH REQUIRED

a) DETERMINATION OF THE ROOT OF A NON-LINEAR EQUATION, AND

b) DETERMINATION OF MAXIMUM COMBINED STRESS FOR ANY INCLINATION OF THE SEISMIC S-WAVE AND P-WAVE.

NOTE:- APPENDIX A IS A CHECKERS CALC. & ALSO ACTS AS A CHECK FOR THE CALCULATOR PROGRAM.

7.0 CONCLUSIONS :-

THE STRAIGHT BURIED PIPING (IN CONTACT WITH SOIL) FOR WNP-2 WAS FOUND TO BE ADEQUATE.

ISSUE 27

BURNS AND ROE, INC.

W.O. No. 3900-10 Date 2/28/1980 Book No. 8.50- 3 Page No.
Drawing No. NA Calc. No. 8.50.29 Sheet 3 of 10
By MOHIB. N. DURRANI Checked I.F. Approved
Title BURIED PIPING — WPPSS NP2 (STRAIGHT PIPES)

9.0 CALCULATIONS

FOR THE WPPSS NP2 IT WAS DETERMINED THAT

ALL THE SAFETY RELATED BURIED PIPING (QUALITY CLASS I, SEIS. CLASS I) IS ONLY OF THE SERVICE WATER SYSTEM.

IT WAS ALSO DETERMINED THAT ALL THE SEISMIC CATG. I BURIED PIPING IS ONLY OF THE SERVICE WATER SYSTEM.

THE BURIED PIPING WHICH IS SAFETY RELATED AND SEISMIC CATEGORY I HAVE BEEN IDENTIFIED AS:

30" SW(35)-2
20" SW(1)-2
20" SW(2)-2
18" SW(21)-2
18" SW(22)-2
8" SW(7.0)-1
8" SW(7.1)-1
6" SW(15)-2
6" SW(16)-2
2" SW(56)-2

ONLY THE STRAIGHT PORTIONS OF THESE BURIED PIPING HAS BEEN ANALYZED IN THIS CALCULATION. A SEPARATE CALCULATION WILL COVER THE BENDS WHICH ARE IN THIS PIPING.

Form BR 8002-2

BURNS AND ROE, INC.

W.O. No. 3900-10 Date 3/3/1980 Book No. 8.50- 3 Page No.
Drawing No. N/A Calc. No. 8.50.29 Sheet 4 of 10
By MOHAN N. DURRANI Checked ✓ Approved
Title BURIED PIPING— WPPSS NP2 (STRAIGHT PIPES)

PIPE SIZE & DESIGNATION	PIPE SCHEDULE	PIPE THICKNESS (IN)	OUTSIDE PIPE DIAM. (IN)	OPERATING PRESS. (PSIG)	OPERATING TEMP. (°F)
30" SW (35) - 2	STD.	0.375	30.000	216	106
20" SW (1) - 2	"	"	20.000	"	"
20" SW (2) - 2	"	"	"	"	"
18" SW (21) - 2	"	"	18.000	"	"
18" SW (22) - 2	"	"	"	"	"
8" SW (70) - 1	"	0.322	8.625	100	"
8" SW (71) - 1	"	"	"	"	"
6" SW (15) - 2	"	0.280	6.625	216	"
6" SW (16) - 2	"	"	"	"	"
2" SW (56) - 2	80	0.218	2.375	"	"

CORROSION ALLOWANCE = 0.08 INCHES

ALL LINES ARE ASME CODE SECTION III-CLASS 3, SEIS. CAT. I; MATERIAL: ASME SA106 GR. B.

ISSUE 34

BURNS AND ROE, INC.

W.O. No. 3900-10 Date 3/17/80 Book No. 8.50- 3 Page No.
Drawing No. NA Calc. No. 8.50.29 Sheet 5 of 10
By MOHIB. N. DURRANI Checked Approved
Title BURRIED PIPING - WPPSS NP2 (STRAIGHT PIPES)

FOR SA 106 GR. B PIPING, @ 106° F,

THE COEFF. OF LINEAR EXPANSION, $\alpha = 6.13 \times 10^{-6}$ in/in/°F
THE MODULUS OF ELASTICITY, $E = 27.9 \times 10^{6}$ LBS/IN²

FOR SOIL @ WPPSS-WNP-2 SITE; FROM CALCULATIONS MADE BY A. TOUMA, OF 12/11/79 BOOK NO. 5 XIV - 1 CALC NO. 6.37-01

MAXIMUM SOIL ACCELERATION, $a_m = 68.31$ IN/SEC²
MAXIMUM SOIL VELOCITY (OBE), $V_M = 8.1$ IN/SEC
SHEAR WAVE VELOCITY, $C_s = 900$ FT/SEC

FROM THE ENG. CRITERIA DOCUMENT (SEC. 8.1.4.1, FIG. B-68a)
SOIL POISSON'S RATIO, $\nu = 0.35$

THE SEISMIC MODEL FOR THE CONTAINMENT OF WNP-2 HAD ASSUMED THAT THE HYPOCENTER OF A HYPOTHETICAL EARTHQUAKE OF MAXIMUM EXPECTED INTENSITY IS DIRECTLY BELOW THE WNP-2 SITE. THIS LEADS TO THE CONSERVATIVE ASSUMPTION THAT THE POSTULATED EPI-CENTER IS AT THE SITE. ACCORDING TO DR. B. BEDROSIAN, THE ONLY WAVES THAT THE SITE WOULD BE SUBJECTED TO ARE THE SHEAR WAVE AND THE PRESSURE WAVE (NO EFFECT OF EITHER THE RAYLEIGH WAVE OR THE LOVE WAVE IS CONSIDERED ∴ THE EPICENTER IS @ THE SITE).

Form BR 8002-2

σ_{PR} = PRESSURE STRESS (PSI)
$= \frac{PD}{4t}$;

σ_T = THERMAL STRESS (PSI)
$= \alpha E \Delta T$

σ_W = BENDING STRESS (PSI)
= 100 psi (ASSUMED, FOR UNEVENESS OF SOIL SUPPORT)

σ_S = MAXIMUM COMBINED AXIAL STRESS (AXIAL + BENDING) DUE TO A SINGLE SHEAR WAVE AT AN ANGLE θ, (REF. 2.3)
$= (E \cos\theta / C_S^2)(C_S v_{S\theta} \sin\theta + R a_{S\theta} \cos^2\theta)$

σ_P = MAXIMUM COMBINED AXIAL STRESS (AXIAL + BENDING) DUE TO A SINGLE COMPRESSION WAVE AT AN ANGLE θ, (REF. 2.3)
$= (E \cos^2\theta / C_P^2)(C_P v_{P\theta} + R a_{P\theta} \sin\theta)$

S_h = BASIC MATERIAL ALLOWABLE STRESS AT MAXIMUM (HOT) TEMP., PSI = 15,000 psi FOR SA 106 GR.B.

S_A = ALLOWABLE STRESS RANGE, PSI = 22,500 PSI FOR SA 106 GR B AND TEMP. 106°F.

P = INTERNAL FLUID PRESSURE, PSI.

D = OUTSIDE PIPE DIAMETER, IN.

t = THICKNESS OF PIPE = NOMINAL PIPE THICKNESS MINUS CORROSION ALLOWANCE.

α = COEFFICIENT OF LINEAR THERMAL EXPANSION, in/in/°F

E = MODULUS OF ELASTICITY, PSI.

ΔT = TEMPERATURE CHANGE, °F (MINIMUM TEMP. AT WNP-2 SITE IS −20°F)

θ = ANGLE OF INCLINATION OF THE WAVES TO THE AXIS OF THE BURIED PIPE.

C_s = SHEAR WAVE VELOCITY = 900 ft/sec = 10800 in/sec

C_p = COMPRESSION (PRESSURE) WAVE VELOCITY, in/sec

$= C_s\sqrt{2(1-\nu)/(1-2\nu)}$ (REF. 2.3)

ν = POISSON'S RATIO = 0.35 FOR WNP-2 SITE

$v_{p\theta} = v_{s\theta}$ = MAXIMUM SOIL PARTICLE VELOCITY DUE TO EITHER A P-WAVE OR A S-WAVE (BOTH MAX. VALUES ASSUMED TO BE EQUAL, CONSERVATIVELY)

= 8.1 in/sec (REF. 2.4)

$a_{p\theta} = a_{s\theta}$ = MAXIMUM SOIL PARTICLE ACCELERATION DUE TO EITHER A P-WAVE OR A S-WAVE (BOTH MAX. VALUES ASSUMED TO BE EQUAL, CONSERVATIVELY)

= 68.31 in/sec^2 (REF. 2.4)

R = OUTSIDE RAD. OF PIPE = D/2, IN.

THE COMPRESSION WAVE VELOCITY IS DETERMINED BY:

$$C_p = C_s \sqrt{\frac{2(1-\nu)}{(1-2\nu)}} \quad \& \quad \nu = 0.35$$

$$= 10{,}800 \times \sqrt{\frac{2(1-0.35)}{(1-2\times 0.35)}}$$

$$= 22{,}482 \text{ IN/SEC.}$$

SINCE EARTH QUAKE LOADS ARE CLASSIFIED AS OCCASIONAL LOADS, THE LOADING COMBINATION OF ASME SEC. III CODE, ND-3652.2 EQ. (9) ARE TO BE MET.

THE ND-3652.2 STATES THAT THE EFFECTS OF PRESSURE, WEIGHT, OTHER SUSTAINED LOADS, AND OCCASIONAL LOADS, INCLUDING EARTH QUAKE, MUST MEET THE REQUIREMENTS OF EQ. (9)

$$S_{OL} = \frac{P_{MAX} D_o}{4 t_n} + 0.75 i \left(\frac{M_A + M_B}{Z} \right) \leq 1.2\, S_h$$

S_{OL} = STRESSES DUE TO OCCASIONAL LOADS COMBINATION.
P_{MAX} = MAX. INTERNAA FLUID PRESSURE, PSI.
D_o = OUTSIDE DIA. OF PIPE, IN
t_n = NOMINAL WALL THICKNESS, IN
i = STRESS INTENSIFICATION FACTOR = 1, FOR ST. PIPE; $(0.75 i)$ SHALL NEVER BE TAKEN AS LESS THAN 1.0.
M_A = RESULTANT MOMENT DUE TO WEIGHT & OTHER SUSTAINED LOADS, IN-LBS.
M_B = RESULTANT MOMENT DUE TO OCCASIONAL LOADS, IN-LBS.

FOR THE BURIED PIPING, THE EQ(9) LOADING COMBINATIONS WOULD BE AS FOLLOWS:

$$\sigma_{PR} + \sigma_{W} + \sqrt{\sigma_P^2 + \sigma_S^2} \leq 1.2\, S_h$$

AND THE MAX. STRESS FOR THE ABOVE EQ. IS DETERMINED FOR EACH PIPE FOR ANY ANGLE θ. THE MAX. STRESS IS DETERMINED BY ITERATION.

IT SHOULD BE NOTED THAT SINCE THE P-WAVE AND THE S-WAVE TRAVEL AT DIFFERENT SPEEDS, (THE FORMER BEING NEARLY TWICE AS FAST AS THE LATER), HENCE THE PEAKS OF THE TWO WAVES DO NOT ARRIVE AT THE SITE AT THE SAME TIME. HENCE, TO ACCOUNT FOR BOTH WAVES AND YET NOT BE TOO CONSERVATIVE, WE WILL TAKE THE SRSS OF THE CONTRIBUTIONS OF EACH WAVE. (ASSUMPTION 4.2) THE TAKING OF SRSS IS CONSISTENT WITH NRC POSITION ON EFFECTS OF X, Y & Z EARTHQUAKES AND THEIR PEAKS NOT OCCURING AT THE SAME TIME. HENCE COMBINED SEISMIC STRESS IS: $\sqrt{\sigma_P^2 + \sigma_S^2}$.

THE RESULTS OF THE ITERATION ARE OBTAINED ON A PROGRAMMABLE TI-59 CALCULATOR AND ARE SUMMARIZED ON THE NEXT PAGE.

ISSUE 34

BURNS AND ROE, INC.

W.O. No. 3900-10 Date 3/19/80 Book No. 8.50- 3 Page No.

Drawing No. NA Calc. No. 8.50.29 Sheet 10 of 10

By MOHIB.N. DURRANI Checked [illegible] Approved

Title BURIED PIPING WNP-2 (STRAIGHT PIPES)

PIPE SIZE AND DESIGNATION	STRESS (EQ. 9) PSI	WAVE ANGLE ($\theta°$)
30" SW (35)-2	17,641	35.8594
20" SW (1)-2	15,770	36.0156
20" SW (2)-2	15,770	36.0156
18" SW (21)-2	15,396	36.0645
18" SW (22)-2	15,396	36.0645
8" SW (70)-1	12,955	36.1523
8" SW (71)-1	12,955	36.1523
6" SW (15)-2	13,844	36.1926
6" SW (16)-2	13,844	36.1926
2" SW (56)-2	12,968	36.2109

THIS ANALYSIS HAS NOT INCLUDED ANY RELATIVE BUILDING-SOIL SEISMIC MOVEMENT BECAUSE THE PENETRATIONS ON ALL EXCEPT THE 30" ϕ LINE ARE ENCLOSED IN LONG SLEEVES AND HENCE THE EFFECT IS NEGLIGIBLE ON THE PIPE IN CONTACT WITH SOIL.

WHEN ANALYZING THE 30" ϕ LINE, THERE ARE FLEXIBLE BOOTS AND HENCE RELATIVE DISPL. IS GREATLY REDUCED. THE 30" ϕ LINE HAS A 90° ELBOW AND IN THE ELBOW ANALYSIS STRESS INTENSIFICATION SHOULD BE CONSIDERED AND ALSO THE OVERHANG OF THIS PIPING, WHEN NOT SUPPORTED BY THE SOIL.

NRC QUESTIONS*

* Draft FSAR page changes

Q130.050
(220.01)
(3.5.1)

You state in Section 3.5.1.3 of the FSAR that the reorientation of the turbine generator building to limit potential missile strike is not considered. Rather, the barrier capability of the massive radiation shielding structures, characteristic of BWR's, is utilized to control postulated turbine missile hazards, and probability studies provide the assurance that the chance of missile strike is remote.

Describe your probability studies with emphasis on the chance of turbine missile strike and penetration of the structural barrier. If in your analysis the value of P3 is assumed as 1.0, please so indicate.

RESPONSE

A revised turbine missile study is presently underway and consists of a probabilistic approach to missile strikes and damage. The study will be complete during the first quarter of 1982.

If this evaluation requires the use of the P_3 value less than 1.0, then the modified NDRC formula, among other ones, will be used or the justification of use of an alternate formula will be provided.

If the evaluation indicates that the probability of damage to safety-related equipment is greater than the NRC acceptance criteria, remedial measures will be taken to resolve the issue to the satisfaction of the staff.

Q130.051
(220.02)
(3.5.3)

You state in Section 3.5.3 of the FSAR that for the design of concrete missile barriers, a concrete thickness of twice the penetration thickness determined for an infinitely thick slab is provided to prevent perforation, spalling or scabbing. Compare your results with the minimum requirements contained in Table 1 (Attachment 1) and provide justification if deviations exist.

RESPONSE:

The WNP-2 Site is in Region III as shown on Fig. 1 of Regulatory Guide 1.76.

Our results are well within the limits set forth in Table 1 (Attachment 1).

ATTACHMENT # 1

TABLE 1 TO SRP SECTION 3.5.3

Minimum Acceptable Barrier Thickness Requirements
For Local Damage Prediction Against Tornado
Generated Missiles

Regions*	Concrete Strength (psi)	Wall Thickness (inches)	Roof Thickness (inches)
Region I	3000	23	18
	4000	20	16
	5000	18	14
Region II	3000	16	13
	4000	14	11
	5000	13	10
Region III	3000	<6	<6
	4000	<6	<6
	5000	<6	<6

*For definition of Region I, II, and III, refer to Regulatory Guide 1.76 (Ref. 8).

130.051-2

Q130.052
(220.03)
(3.5.3)

Indicate the allowable ductility values used in the overall damage prediction of structural barriers in Section 3.5.3 of the FSAR. Compare these values with those given in Attachment 2 and justify the deviations, if any.

RESPONSE

The ductility values utilized in the impact analysis for WNP-2 conform with Attachment #2 with the exception of 2a (Ductility Ratio for Steel Members for Tension due to Flexure) where a value of 13 was used.

Additional review of the WNP-2 design indicates that the design meets the above stated position.

Q130.053

The repsonse to Q130.053 is attached to Issue #3.

Q130.054
220.05
(3.7.2)

In your response to previous question (Q130.020) you stated that for the NSSS equipment where the response spectrum method of seismic analysis was used the closely-spaced modal responses were combined by the SRSS method. The staff position is that for closely-spaced modes, rules set forth in Regulatory Guide 1.92 should be used. Accordingly, state your intent to comply with the position or provide justification and assess the impact for the deviation.

RESPONSE

The design basis for WNP-2 with regard to the combination of closely-spaced modes is SRSS prior to the issuance of Reg. Guide 1.92. Subsequently, all NSSS scope of supply or analysis has been evaluated and shown to meet the requirements of Reg. Guide 1.92 (double sum with absolute sign). Accordingly, the FSAR is amended to reflect the satisfaction of these requirements.*

*Draft FSAR page changes attached.

The solution of the differential equation 3.7.2.1-2, for the case of at-rest initial conditions is:

$$Y_r(t) = \frac{\psi_r}{\omega_r\sqrt{1-\lambda_r^2}} \int_o^g (\tau)\ e^{-\lambda_r\omega_r(t-\tau)} \sin\left[\omega_r\sqrt{1-\lambda_r^2}(t-\tau)\right] d\tau \sin \qquad \text{(Eq. 3.7.2.1-5)}$$

For small damping ratios, λ_r, the above solution is approximated by:

$$Y_r(t) = \frac{\psi_r}{\psi_r} \int_o^t \ddot{v}_g\ (\tau) e^{-\lambda_r\omega_r(t-\tau)} \sin\left[\omega_r(t-\tau)\right] d\tau \cdot \sin \qquad \text{(Eq. 3.7.2.1-6)}$$

There are two methods of dynamic analysis that are used to solve the multi-degree-of-freedom problems; the response spectrum method and the time history method.

3.7.2.1.5 Response Spectrum Method of Analysis

If the design earthquake is specified in terms of a response velocity spectrum, Equation 3.7.2.1-6 becomes:

$$Y_r(t)_{max} = \frac{\psi_r S_{vr}}{\omega_r} \qquad \text{(Eq. 3.7.2.1-7)}$$

where: S_{vr} = Spectral velocity for the r^{th} mode:

$$S_{vr} = \left| \int_o^t \ddot{v}_g(\tau) e^{-\lambda_r\omega_r(t-\tau)} \sin\left[\omega_r(t-\tau)\right] d\tau \right|_{max} \qquad \text{(Eq. 3.7.2.1-8)}$$

Q130.054

The maximum modal displacements, $\underline{v}_{r_{max}}$, for the r^{th} mode is:

$$\underline{v}_{r_{max}} = \underline{\phi}_r \frac{\psi_r S_{vr}}{\omega_r} \qquad \text{(Eq. 3.7.2.1-9)}$$

If the design earthquake is specified in terms of a response acceleration spectrum instead of a velocity spectrum, the maximum modal displacements, $\underline{v}_{r_{max}}$, of the structure for the r^{th} mode are:

$$\underline{v}_{r_{max}} = \underline{\phi}_r \frac{\psi_r S_{ar}}{\omega_7^2} \qquad \text{(Eq. 3.7.2.1-10)}$$

Where: S_{ar} - Spectral acceleration for the r^{th} mode.

The maximum modal inertia forces, $\underline{F}_{r\ max}$, for the r^{th} mode are computed from:

$$\underline{F}_{r_{max}} = \underline{k}\ \underline{v}_{r_{max}} \qquad \text{(Eq. 3.7.2.1-11)}$$

With maximum modal displacements and modal inertia forces known, the other modal quantities such as shears and moments are computed for each mode by conventional structural analysis procedures.

~~The individual modal maxima are combined by the square root of the sum of the squares method. For example, the total displacements of the structure $\underline{v}_{tot}$ are computed from:~~

$$\cancel{\underline{v}_{tot} = \sqrt{\Sigma \underline{v}_{r_{max}}^2} = \sqrt{\underline{v}_{1_{max}}^2 + \underline{v}_{2_{max}}^2 \cdots + \underline{v}_{n_{max}}^2}} \qquad \text{(Eq. 3.7.2.1-12)}$$

~~The total internal forces, such as shears and moments, are computed in the same manner.~~

3.7.2.1.5.1 Combination of Modal Response

In a response spectrum modal dynamic analysis, if the modes are not closely spaced (i.e., if the frequencies differ from each other by more than 10 percent of the lower frequency), the modal responses are combined by the square root of the sum of the squares (SRSS) method as described in Subsection 3.7.2.1.5.1.1 If some or all of the modes are closely spaced, a double sum method, as described in Subsection 3.7.2.1.5.1.2 is used to evaluate the combined response. In a time-history method of dynamic analysis, the vector sum at every step is used to calculate the combined response. The use of the time-history analysis method precludes the need to consider closely spaced modes.

3.7.2.1.5.1.1 <u>Square Root of the Sum of the Squares Method</u>

Mathemetically, this SRSS method is expressed as follows:

$$R = \left(\sum_{i=1}^{n} (R_i)^2 \right)^{1/2} \qquad \text{(Eq. 3.7.2.1-12)}$$

where:

R = Combined Response

R_i = Response in the i^{th} mode

n = Number of Modes considered in the analysis.

3.7.2.1.5.1.2 Double Sum Method

This method is defined mathematically as:

$$R = \left(\sum_{k=1}^{N} \sum_{s=1}^{N} \left| R_k R_s \right| \epsilon_{ks} \right)^{1/2} \quad \text{(Eq. 3.7.2.1-13)}$$

where:

R = Representative maximum value of a particular response of a given element to a given component of excitation

R_k = Peak value of the response of the element due to the k^{th} mode

N = Number of significant modes considered in the modal response combination

R_s = Peak value of the response of the element attributed to s^{th} mode

where:

$$\epsilon_{ks} = \left[1 + \left\{ \frac{(\omega'_k - \omega'_s)}{(\beta'_k \omega_k + \beta'_s \omega_s)} \right\}^2 \right]^{-1}$$

in which:

$$\omega'_k = \omega_k \left[1 - \beta_k^2 \right]^{1/2}$$

$$\beta'_k = \beta_k + \frac{2}{t_d \omega_k}$$

where ω_k and β_k are the modal frequency and the damping ratio in the kth mode, respectively, and t_d is the duration of the earthquake.

If several controlling frequencies in an eigenvalue solution for non-NSSS piping, equipment, and structures are found to lie close together, their modal maxima are combined by direct summation (sum of absolute values method) and then combined by the square-root-of-the-sum-of-the-squares method with other individual modal maxima. For NSSS equipment and piping systems, responses for closely spaced modes were generally combined by the SRSS method, except that the double-sum method, approved by the NRC on the GESSAR 251 docket, was used to combine the responses for closely spaced modes for the main steam and reactor recirculation ASME Safety Class I piping. Close frequencies are considered those which satisfy the following relationship.

$$\omega_r \leq \omega_{r+1} \leq 1.10\omega_r \qquad \text{(Eq. 3.7.2.1-13)}$$

3.7.2.1.6 Time-History Method of Analysis

The time-history of ground acceleration, $v_g(t)$, is defined at discrete time intervals. The acceleration is approximated by a segmentally linear function and the solution to Duhamel's Integral (Equation 3.7.2.1-5) is obtained by using a step-by-step integration procedure (Reference 3.7-7).

Y_r (t) is computed as a function of time for r = 1,2,3,...,n, where n is the number of significant modes of the system. The modal displacements, $\underline{v_r}(t)$, at the time t for the r^{th} mode, are then calculated from:

$$\underline{v_r(t)} = \underline{\phi_r}Y_r(t) \qquad \text{(Eq. 3.7.2.1-14)}$$

The total displacements, $\underline{v(t)}$, of the structure at any time, t, are obtained by adding the individual modal displacements at time t:

$$\underline{v(t)} = \underline{v_1(t)} + \underline{v_2(t)} + \ldots + \underline{v_n(t)} \qquad \text{(Eq. 3.7.2.1-15)}$$

The inertia forces, $F_r(t)$, at time t, for the r^{th} mode are determined from:

$$\underline{F_r(t)} = \underline{k}\ \underline{v_r(t)} \qquad \text{(Eq. 3.7.2.1-16)}$$

Q. 130.055
220.06
(3.7.2)

In Section 3.7.2.4 of the FSAR, it is stated that the lumped mass spring method representing soil/structure interaction is obtained from a simplified mechanical analog to the model of a rigid mat resting on the surface of an elastic half-space.

The current position of the regulatory staff regarding the soil/structure interaction is described in Section 3.7.2.II.4 of the SRP (Attachment 3)* Note that this position, in addition to the use of elastic half-space approach, requires the use of finite element method. State your intent to comply with the position or justify the deviations. **

RESPONSE:

Based on studies performed in-house, it is found that the use of the elastic half-space/compliance function method and the finite element method for soil/structure interaction analysis yield comparable results. Therefore, either method is considered acceptable for seismic soil/structure interaction analysis.

To support this conclusion, acceleration floor response spectra are provided on Figures 130.055-1 through 130.055-4 for representative locations in the reactor building using both methods of analysis. The curves labelled "two-step analysis" (dashed lines) represent the building response obtained from a two step substructure approach using compliance functions to represent the equivalent soil stiffness. The curves labelled "one-step analysis" (solid lines) represent the building response obtained from a (one-pass) finite element dynamic analysis of the coupled soil/structure.

Inspection of the response spectra on the aforementioned figures shows that there is generally good agreement between the two methods.

In addition, NUREG/CR-1161 RD, "Recommended Revisions to Nuclear Regulatory Commission Design Criteria" (published May 1980), states: "Performing independent analyses with each technique and enveloping the results should not be required".

*Included as Attachment I to this question

**The response to Q130.048 has been revised to refer to this response.

Q.130.055 (Continued)

It is also noted that the response spectra used in the original design are very conservative because of the low damping value assigned for the soil in the original soil/structure interaction analysis. The conservatism in this analysis is evident by comparing these response spectra with a separate finite element soil/structure interaction analysis performed specifically for WNP-2 in accordance with the NRC regulatory guidelines. The comparison which is provided with the response to NRC Q.130.056 shows that the original seismic design loads are much higher than the loads obtained using the recently developed and more realistic finite element method.

A similar finite element soil/structure interaction analysis for the radwaste/control building is presently being performed. A comparison of this analysis with the original design basis for the radwaste/control building will be provided by January, 1982.

ACHMENT 3

ATTACHMENT I to
Q130.055

x

Soil-Structure Interaction

An analytical model of a soil-structure interaction system is acceptable if both the structure model and the supporting soil model are properly coupled and the design motion is properly addressed. The coupled model is subjected to the design ground motion as specified in SRP Section 3.7.1 or to the regenerated excitation system described in Section II.4 (iii) below. A suitable dynamic analysis using the time history method is performed for the entire soil-structure system and the dynamic responses at various locations of the system are calculated. All assumptions to simplify the analysis should be justified and the resulting errors be studied. Any dynamic decoupling or condensation procedure should be substantiated by theoretical verification and mathematical proofs.

At present most commonly used methods are the half-space and the finite boundaries modeling methods and there is no indication as to which one is more reliable, especially when too many assumptions are involved. Therefore, modeling methods for implementing the soil-structure interaction analysis should include both the half-space and finite boundaries approaches. Category I structures, systems, and components should be designed to accommodate responses obtained by one of the following:

a. Envelope of results of the two methods,

b. Results of one method with conservative design considerations of effects from use of the other method,

c. Combination of a. and b. with provision of adequate conservatism in design.

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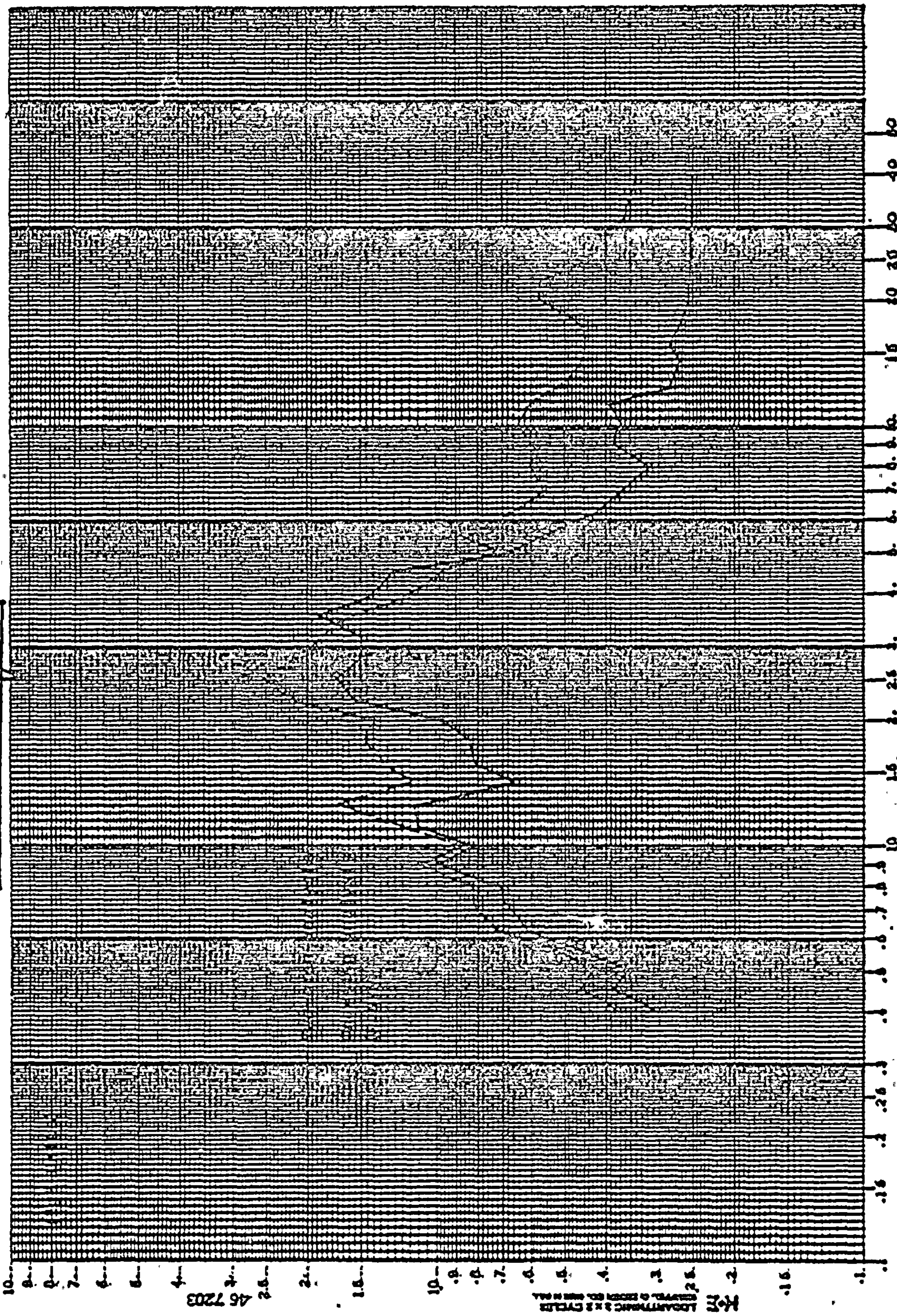

Fig. 5.1 Absolute Horizontal Acceleration Response Spectra - Node 129 (Bottom of Mat)

Figure 130.055-1

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Figure 130.055-2

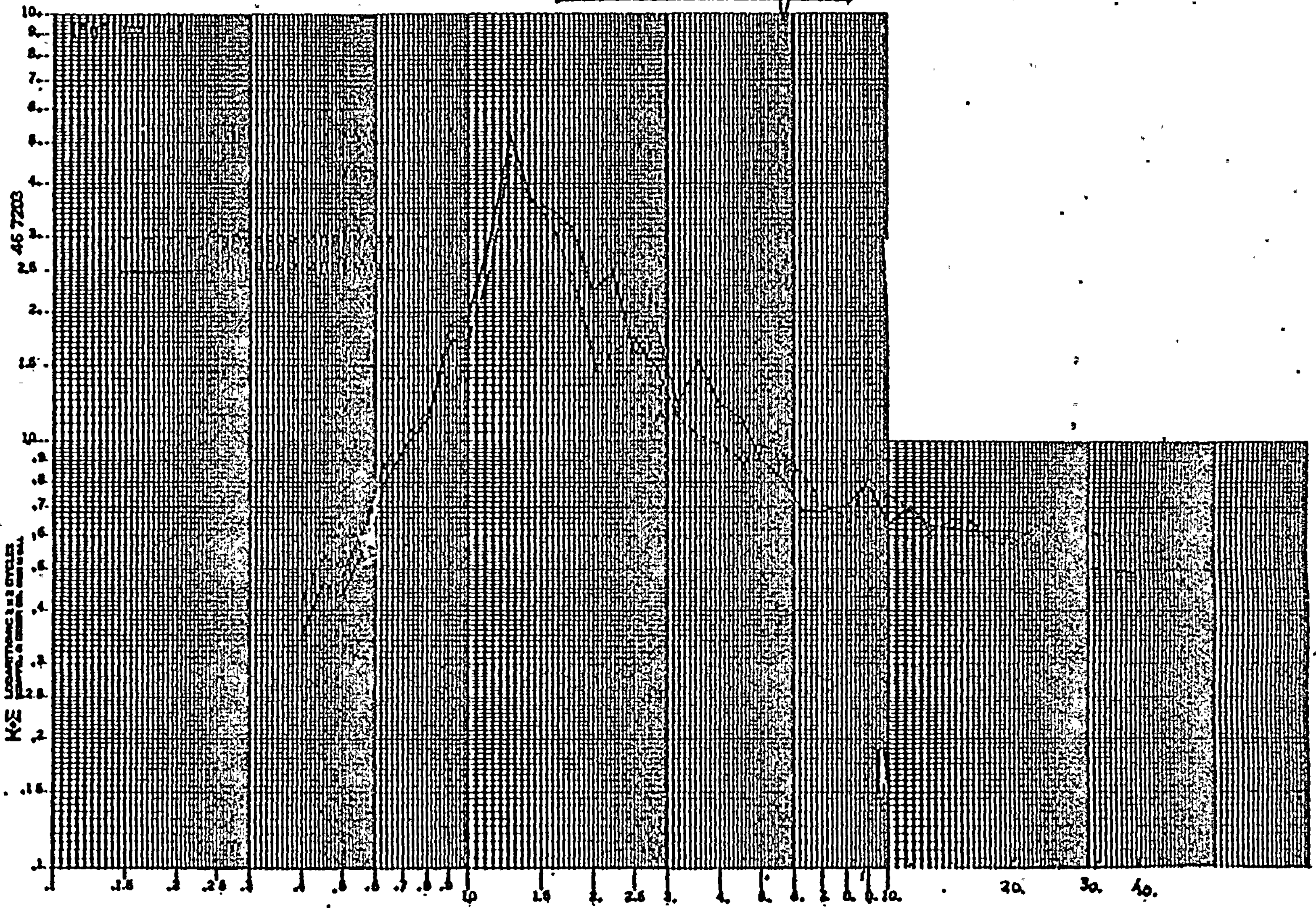

Fig. 5.2 Absolute Horizontal Response Spectra - Node 117
(Top of Structure)

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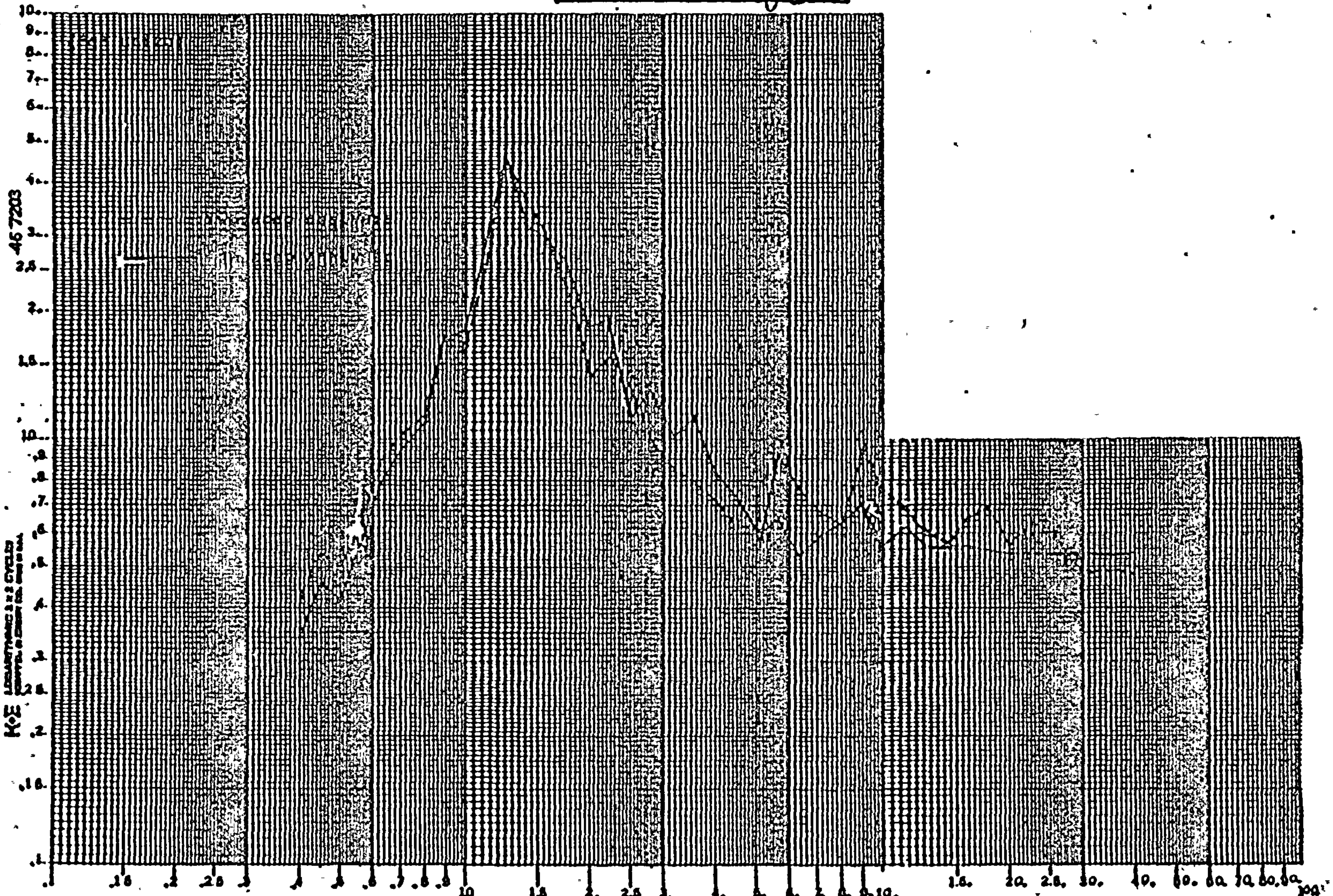

Freq. (Hz)

Fig. 5.3 Absolute Horizontal Acceleration Response Spectra - Node 140 (Stabilizer Truss)

Figure 130.055-3

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Figure 130.055-4

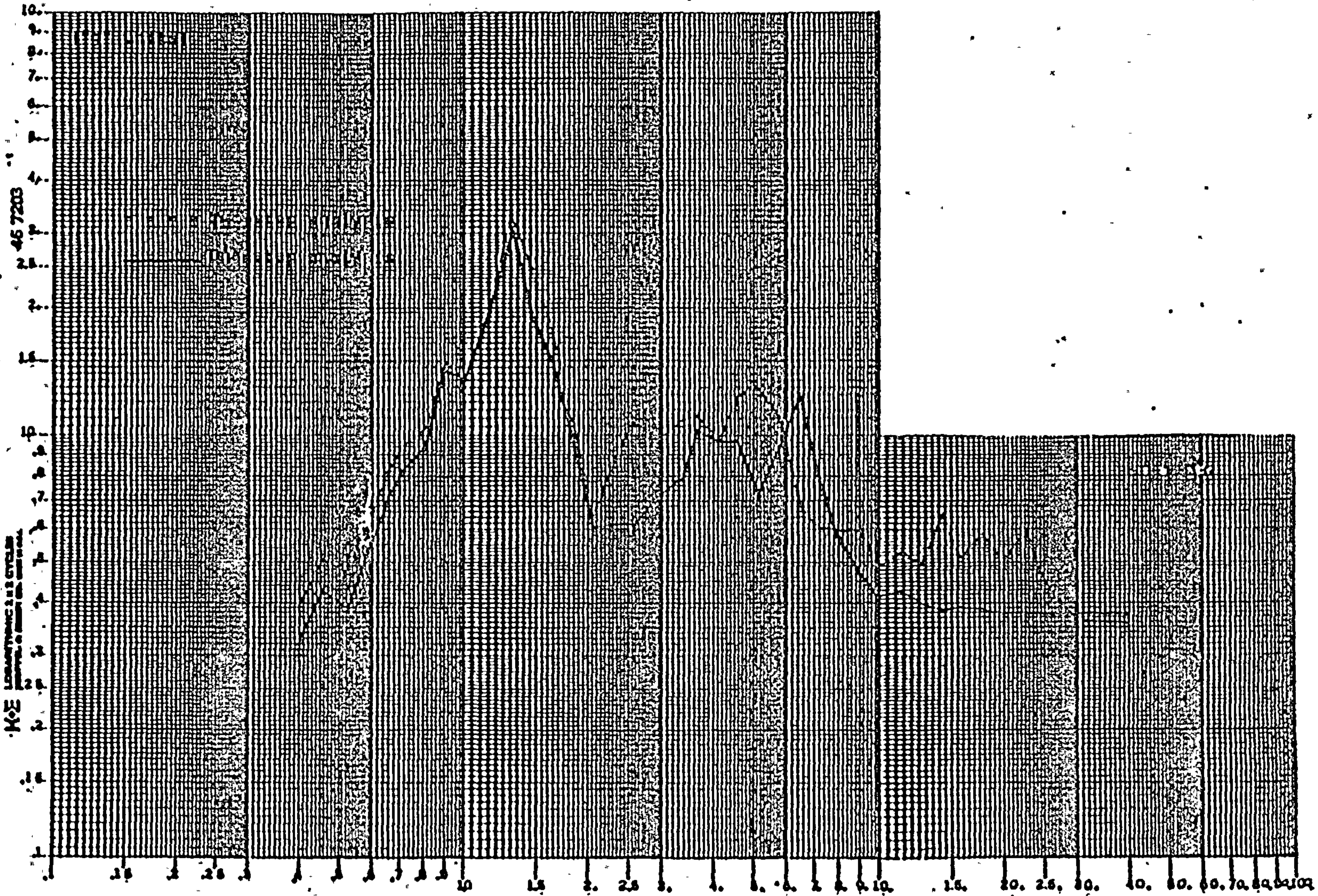

Fig. 5.4 Absolute Horizontal Acceleration Response Spectra - Node 150 (RPV Support)

Q. 130.048

In Technical Memorandum No. 1188, you state that the design response spectra at all mass point of your mathematical model of the reactor building were generated in your soil-structure interaction analysis. Our current licensing position requires that you analyze the soil-structure interaction using both the half-space (lumped spring-mass or compliance function) methodology and the shear beam, finite element representation of the soil foundation. Our concern in this matter is that the results obtained by the finite element approach using the deconvolution procedure and the FLUSH computer program, may not be acceptable. Accordingly, we require that all seismic loads and the corresponding design response spectra be recalculated by employing a half-space, soil spring model and that you adopt the higher values calculated by either of the two methods discussed above.

Reponse:

The original seismic analysis utilizes lumped spring mass damper representation for soil structure interaction effects. The soil spring constants are calculated using elastic half-space theory. However, the soil damping values are conservatively assumed to be low values as presented in Table 3.7-1 of the FSAR instead of those calculated from half-space theory as recommended in Section 3.7.2 of the Standard Review Plan. Consequently, the original seismic loads are substantially higher than those which would have been obtained from half-space methodology as suggested in this question.

In connection with the sacrificial shield wall correction weld addressed in the responses to Questions 130.045 through 130.047 and 130.049, analysis of the correction weld was made using, in turn, the results from each seismic method in the controlling combination of loads. Design margins are calculated which are equal to the ratio of the permissible stress in the correction weld to the maximum stress using the controlling load combination. With the current seismic definition based on finite element soil-structure interaction analysis the design margin afforded by the weld is 2.4. With the seismic loads as originally defined (lumped mass-spring model) the design margin in the correction weld is 2.1. Thus, relatively high design margins result with both methods of seismic analysis. This follows because the seismic loads are relatively small compared to other loads in the controlling load combination, namely, annulus pressures and pipe break reactions.

In connection with the structural design of the balance of the plant, the current regulatory position referred to in this question will be conformed with.

For a response to the NRC position on soil/structure interaction using both the half-space methodology and the shear beam, finite element representation of the soil foundation, refer to the response to Question 130.055.

Q.130.056

The response to Q.130.056 is attached to Issue #2.

Q.130.057

The response to Q.130.057 is attached to Issue #10.

Q.130.058
220.09
(3.7.2)

You state in 3.7.2.14 of the FSAR that determination of seismic Category I structure overturning, the sliding effects consist of two horizontal orthogonal and vertical components of earthquake motions. Each horizontal component is taken separately and is applied concurrently with the vertical component. Demonstrate that the requirements of Section 3.7.2.II.14 of the SRP are met or justify your deviations from the staff requirements.

RESPONSE

Although two component earthquake loads (one horizontal and one vertical) have been considered acting simultaneously for evaluation of overturning and sliding effects of Seismic Category I structures, the following elements in the analysis indicate that this approach is sufficiently conservative when compared to the three component earthquake loads:

a) The two component earthquake loads are much higher than the three component earthquake loads. This is evident by the comparison of response spectra provided with the response to Question 130.056.

b) The horizontal earthquake component, which is considered to act separately in each horizontal direction is applied concurrently to the vertical earthquake component rather than using the SRSS of each response.

Q.130.059

The response to Q.130.059 is attached to Issue #6.

Q.130.060

The response to Q.130.060 is attached to Issue #1.

Q.130.061
220.12
(3.8.2)

You state in Section 3.8.2.5.4 of the FSAR that to assure safety against buckling, the rules set forth in the ASME Code, Section III, NE 3133 are utilized. However, the ASME Code are applicable to unstiffened continuous steel containment shell without significant openings. Assess the effects of shell stiffening and openings on the applicability of the NE 3133 for buckling analysis and discuss remedial analyses you can perform to address this issue.

RESPONSE

1. An external pressure of 4 psig has been evaluated in the Final Stress Report (FSR). An external pressure of 15 psig has been evaluated in the Final Stress Report for the Containment Vessel Retrofit (CVR FSR) on the lower part of the vessel only. In both reports the acceptable criteria is the ASME Code Section NE 3133. The vessel has been evaluated as if the vertical stiffeners do not exist since they do not unconservatively affect the capacity of the vessel to carry external pressure.

2. Two methods have been used in the FSR to evaluate vertical compressive stress on the areas of the shell with vertical stiffening:

   a) The vertical compressive force has been assumed to be resisted by the vertical stiffeners. A conservative assumption that a stiffener and a portion of the shell acts as a column pinned at the nearest ring stiffeners has been used. Based on the Certified Mill Test Reports, actual properties of the vertical tees exceed the minimum specified properties, which provides an additional margin of safety.

   b) An equivalent unstiffened shell wall has been computed based on the bending stiffness of the composite shell and stiffener section. This equivalent unstiffened shell has been evaluated using the ASME Code Section NE 3133.

3. It is not felt that the large openings in the vessel such as the Equipment Hatch and Air Lock reduce the buckling capacity of the vessel. These openings have been reinforced in accordance with the ASME rules and, therefore, the shell wall in these areas has a relatively high bending stiffness compared to the surrounding unstiffened area even if the great stiffening effect of the penetration barrel is neglected. In addition, the two major openings are located in the drywell where the vertical compressive forces are significantly lower than near the base of the vessel.

Refer to the Los Alamos Scientific Laboratory Study, entitled "An Investigation of Buckling of Steel Cylinders with Circular Cutouts Reinforced in Accordance with ASME Rules", NUREG/CR-2165, for additional information on this topic. The containment openings fall well within the scope of this research which indicates that openings of this type, particularly when reinforced, have little effect on the buckling capacity of a fabricated shell.

Q.130.062
(220.13)
(3.8.2)

Revision 2 of WNP-2 Design Assessment Report (DAR) was completed in August, 1979. Since then more information has been generated from the Mark II Generic Program. Indicate if further assessment of WNP-2 containment and its internal structures has been made or needs to be made and what is your commitment, if any, to the further findings of the Mark II Generic Program.

RESPONSE

The attached Table 130.062-1 titled "WNP-2 Hydrodynamic Load Definition Summary" shows the WNP-2 position with regard to the Mark II Generic Program. An assessment of WNP-2 containment and internal structures is being made to evaluate the effect of revisions to load definitions that have been made since the writing of DAR Revision 2. It is anticipated that this assessment should not result in changes to existing structures or containment but will be performed to determine margins or safety based on these revised loads. New assessment will be submitted prior to fuel load. If the new assessment shows that physical changes are required to any structures, they will be made to the satisfaction of the staff.

13[?]2-1

TABLE ~~130.62-1~~

WNP-2 HYDRODYNAMIC LOAD DEFINITION SUMMARY

Item	NRC Item Number (From LER Table IV-1)	Subject/Load	Basis/Status of Licensing	Source of NRC Evaluation*
LOCA				
1	I.A	Submerged Boundary Vent Clearing Load	NRC criteria given in LER, no additional NRC review for WNP-2 anticipated	(2)
2	I.B.1	Pool Swell Analytical Model	NRC criteria given in LER, no additional review for WNP-2 anticipated	(1)
3	I.B.2	Submerged Boundary Pool Swell Load	NRC criteria given in LER, no additional NRC review for WNP-2 anticipated	(1)
4	I.B.3	Pool Swell Impact Load	NRC criteria given in LER, no additional NRC review for WNP-2 anticipated	(1)
5	I.B.4	Wetwell Air Compression	NRC criteria given in NUREG-0808 draft, no additional NRC review for WNP-2 anticipated	(3)
6	I.B.5	Asymmetric Load	NRC criteria given in LER, no additional NRC review for WNP-2 anticipated	(2)
7	I.C.1	Downcomer Lateral Load	NRC criteria given in NUREG-0808 draft, no additional NRC review for WNP-2 anticipated	(3)
8	I.C.2	Submerged Boundary Steam Condensation Loads		
		a. C.O.	WNP-2 position that chugging bounds C.O. and that the plant does not need to be assessed for C.O. was transmitted to the NRC via letter G02-81-239 dated August 13, 1981	
		b. Chugging	WNP-2 chugging report submitted July 81 NRC review required	
SRV				
9	II.A	Pool Temperature Limits	NRC criteria given in NUREG-0783 draft, no additional NRC review for WNP-2 anticipated	(1) additional
10	II.B	Air Clearing Loads	Plant unique SRV report submitted August 1980 Completion of NRC review required	
11	II.C.1	Quencher Arm Loads	NRC criteria given in LER, no additional NRC review for WNP-2 anticipated	(1)
12	II.C.2	Quencher Tie Down Loads	NRC criteria given in LER, no additional review for WNP-2 anticipated	(1)

*(1) NUREG-0487 (LER)
(2) NUREG-0487 (Supplement 1)
(3) NUREG-0808 (Draft)

130.062-2

Page 2 of 3

130.062-3

TABLE 130.062-1 (Continued)

Item	NRC Item Number (From LDR Table IV-1)	Subject/Load		Basis/Status of Licensing	Source of NRC Evaluation*
Submerged Structures					
13	III.B	Water Jet Loads	SRV Jets	NRC criteria given in LDR, no additional NRC review for WNP-2 anticipated	(1)
			LOCA Jets	NRC criteria given in NUREG-0808 draft, no additional NRC review for WNP-2 anticipated.	(3)
14	III.D	Air Bubble Drag Loads			
		a. SRV		Loads verified by CAORSO data on submerged structures. Definition consistent with 13 above.	(2)
		b. LOCA		NRC criteria given in LDR, no additional NRC review for WNP-2 anticipated.	(2)
15	III.C	Steam Condensation Loads		Generic "drag load" methodology and plant unique flow field are being used for WNP-2.	(2)

*(1) NUREG-0487 (LDR)
(2) NUREG-0487 (Supplement 1)
(3) NUREG-0808 (Draft)

Q.130.063
220.14
(3.8.2)

Provide a more detailed description of your analysis of fatigue for the steel containment shell and indicate the assumptions you made.

RESPONSE

1. In the Final Stress Report (FSR) it is shown that the penetrations do not require analysis for cyclic operation per the rules of NB 3222.4 (d), Summer 1972 Addenda. These rules are currently contained in the 1980 Edition of the ASME Code Section NE 3221.5.

2. In the Final Stress Report for the Containment Vessel Retrofit (CVR FSR) a fatigue analysis is performed of the structural discontinuity in the suppression chamber ring girders at cut-outs in the web. A detailed finite element analysis is performed to determine the actual stress at the discontinuity and a stress concentration factor of 4.0 is applied to compute the peak stress in the fillet weld.

Q.130.064
(220.15)
(3.8.2)

In Section 4.1.1.1.1.4 of the DAR, it is stated that additional considerations relating to effects of subsequent actuation will be covered in a subsequent revision of DAR. Provide the status of these additional considerations.

RESPONSE

In Section 4.1.1.1.1.4 of the DAR Rev. 2 it was stated that additional considerations relating to effects of subsequent actuation of low-set valves will be covered later.

The design basis operational SRV actuation events were investigated for WNP-2 and are listed in Table I attached. As indicated in this table a maximum of six lower pressure set point valves may discharge at subsequent actuation conditions. These valves correspond to quenchers which are all located adjacent to the RPV pedestal. In view of the pressure attenuation with distance (approx. 55%) this design condition is less critical than the all valves at initial actuation case for which the containment vessel was already analyzed and designed (See Section 4.1.1.1.1.1 of DAR Rev. 2) since the design pressure corresponding to subsequent actuation is only 35% larger than the design pressure corresponding to initial actuation. (See SRV Report).

TABLE I

WNP-2 DESIGN BASIS OPERATIONAL SRV ACTUATIONS

ITEM	FSAR SECTION	EVENT	NO. OF SRVs ACTUATED 1st BLOWDOWN	NO. OF SRVs ACTUATED 2nd BLOWDOWN
1	15.1.2	Feedwater Controller Failure	18	2
2	15.1.3	Pressure Regulator Failure-Open	2	2
3	15.1.4	Inadvertent SRV Opening	1	-
4	15.2.1	Pressure Regulator Failure-Closed	18	2
5	15.2.2	Generator Load Rejection-Bypass On	18	2
6	15.2.2	Generator Load Rejection-Bypass Off	18	2
7	15.2.3	Turbine Trip-Bypass On	18	2
8	15.2.3	Turbine Trip-Bypass Off	18	2
9	15.2.4	MSIV Closures	18	6
10	15.2.5	Loss of Condenser Vacuum	18	6
11	15.2.6	Loss of Auxiliary Power Transformers	2	2
12	15.2.6	Loss of All Grid Connections	18	2
13	15.2.7	Loss of Feedwater Flow	2	2
14	15.3.1	Trip of Both Recirculation Pumps (One Main Valve)	6	2
15	15.3.2	Recirculation Flow Control Failure (Both Main Valves)	2	2
16	15.3.2	Recirculation Flow Control Failure	6	2

130.064-2

Q.130.065
(220.16)
(3.8.2)

In Section 4.1.1.1.3 of the DAR under Item C (p. 4.1-6), the staff cannot understand the second sentence in the paragraph. An explanation should be provided.

RESPONSE

For the purpose of clarity, the last sentence in Section 4.1.1.1.3 Item C of the DAR is revised to read as follows*:

> "When external pressure governs the design, an additional external pressure of 2 psi due to the reaction of the compressible foam between the containment and the biological shield wall is used. This reaction results from the thermal expansion of the containment shell".

*See attached DAR revised page 4.1-6.

b. Hydrostatic Pressure

The hydrostatic pressure due to the suppression pool is included in the dead load.

c. Design External Pressure

An external pressure of 2 psi resulting from atmospheric conditions inside and outside the drywell is used. ~~Where critical, an additional~~ When external pressure governs the design, an additional external pressure of 2 psi due to the reaction of the compressible foam between the containment and the biological shield wall is used. This reaction results from the thermal expansion of the containment shell.

4.1.1.2 Controlling Load Combinations

The applicable load combinations for the pressure-suppression chamber portion of the steel containment structure are defined in Section 3.5.1.2. Load combination (3), stated below, is found to control the design of the steel containment shell.

Load Combination (3): $D+L+E_O+T_A+R_A+P_B+P_V+P_{SR}$

The interpretation and contribution of each of the terms depends on the event being considered. In considering the overall steel containment structure, the controlling combination of events involves ADS actuation during an intermediate break LOCA with chugging. Consequently, P_B and T_A refer to the intermediate break accident. The term P_{SR} refers to ADS pool boundary pressure loading. R_A in the load combination does not create general membrane stress which controls the design. Thus, the effective controlling load combination involves:

$$D+L+E_O+P_B+P_{SR}+P_C$$

The load combinations for the suppression chamber portion of the steel containment as listed in Section 3.5.1.2 are also applicable to the vertical and horizontal tees. The stresses in the tees are calculated for each applicable loads. The combined stress intensity corresponding to each load combination is evaluated. It is found that the following load combination (3) controls the design:

$$D+L+E_O+T_A+R_A+P_A+P_V+P_{SR}$$

In the preceding combination, T_A and R_A are relatively insignificant and P_A does not occur concurrently with P_V. Only P_{SR} single valve is considered with P_A. For both vertical

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W.O. No. 3900-03 Date 10-14-81 Book No. SV-470 Page No. 126

Drawing No. S1079 Calc. No. 6.19.52 Sheet 4 of 8

By AHA Checked LN Approved

Title WPPSS - HANFORD NO-2 - CONT, VERT. + HORIZ. TBE ASSESSMENT

ATTACHMENT TO QUESTION 130.066

(1) CONTAINMENT - general membrane - these critical stresses occur in the shell at elev. 458 FT

CONTROLLING LOAD COMB.

$$D + L + E_o + P_{SRV} + P_C$$

$$\sigma_\phi = \underset{\text{DEAD \& LIVE}}{-2.87} + \underset{\text{HYDRO}}{0.154} \pm \left(\underset{\text{CHUG}}{0.039^2} + \underset{\text{CHUG (B.R)}}{0.400^2} + \underset{\text{SRV}}{0.33^2} + \underset{\text{SRV (B.R)}}{1.286^2} + \underset{\text{OBE}}{3.539^2}\right)^{1/2}$$

$$\sigma_\phi = 1.085,\ -6.517$$

$$\sigma_\theta = \underset{\text{HYDRO}}{-0.744} \pm \left(\underset{\text{SRV}}{4.51^2} + \underset{\text{CHUG}}{0.476^2}\right)^{1/2}$$

$$\sigma_\theta = -3.791,\ 5.279$$

$$\sigma_{INT} = 5.279 - (-6.517) = 11.796$$

$$\sigma_{ALLOW} = 19.3$$

$$\text{DESIGN MARGIN} = \frac{19.3}{11.796} = 1.64$$

Form BR 8002-2

Q. 130.066
220.17
(3.8.2)

In Section 4.1.1.5.2 of the DAR, design margins for the containment structure and containment tees under various load combinations are given without indicating the contribution of stresses from each of the loads in the load combination. Provide a table to indicate the stress contributions from each of the loads indicated in the governing load combinations.

RESPONSE

The stress contributions for each of the loads in the governing load combination in DAR, Rev. 2 is provided on the attached three sheets for the containment shell and containment tees. The stress intensities for each structural element represent the critical values.

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W.O. No. 3900-03 Date 10-14-81 Book No. 51-470 Page No. 127
Drawing No. 51079 Calc. No. 619-52 Sheet 5 of 8
By AAN Checked LN Approved
Title: WPPSS - HANFORD No. 2 - CONT. VERT + HORIZ T'S ASSESSMENT

ATTACHMENT TO QUESTION 130.066

(2) Vertical T's - These critical stresses occur in the vertical T at elev. 458 FT

Controlling Load Combination:

$D + L + E_0 + P_{LOCA} + P_{SRV} + P_{CHUG}$

REF: SECTION 4.1.1.2 OF DAR REV. 2

$\sigma_\phi = -3.436 - 0.273 - 0.316 - 0.649 + 3.168 - 1.602$

GRAVITY, FILLER MAT'L, 2 PSI, HYDRO-STATIC, LOCA (BOUNDARY), SRV (BOUNDARY)

$\pm (3.018^2 + 0.229^2 + 1.428^2)^{1/2} = 0.239, -6.455$

OBE (B.R.), LOCA, SRV

$\sigma_\theta = \pm (6.650 + 1.518) = \pm 8.17$

LOCA (DIRECT), SRV (DIRECT)

$\sigma_r = (-0.842 \pm 0.193) = -0.649, -1.035$

LOCA (DIRECT), SRV (DIRECT)

$\tau = (2.703^2 + 1.802^2)^{1/2} = \pm 3.249$

LOCA (DIRECT), SRV (DIRECT)

$\sigma_1 = -7.976$ $\sigma_{INT.} = 16.144$ ALLOW = 20.85

$\sigma_2 = 8.168$

$\sigma_3 = 0.486$ DESIGN MARGIN = 1.29

130.066-3

Form BR 8002-2

ATTACHMENT TO QUESTION 130.066

③ HORIZONTAL T's - These critical stresses occur in the ring at elev 453.5'

Controlling load Combination

$D + L + E_o + P_{LOCA} + P_{SRV} + P_{CHUG}$

$$\sigma_\theta = \underset{\text{LOCA MEMBRANE}}{10.195} + \underset{\text{HYDRO}}{1.304} \pm \left(\underset{\text{LOCA PV}}{4.716^2} + \underset{\text{SRV PV}}{3.144^2} + \underset{\text{SRV MEMBRANE}}{(2(1.658))^2} + \underset{\text{BLDG RESP.}}{1.00^2} \right)^{1/2}$$

$\sigma_\theta = 4.857,\ 18.141$

$$\sigma_r = \underset{\text{LOCA MEMB}}{-0.78} - \underset{\text{HYDRO}}{0.10} \pm \underset{\text{SRV MEMB}}{0.25} - \underset{\text{LOCA DIRECT}}{0.432} \pm \underset{\text{SRV DIRECT}}{0.099}$$

$\sigma_r = -0.099,\ -1.661$

$\sigma_{INT} = 18.141 - (-1.661) = 19.802$

$\sigma_{ALLOW} = 28.95$

$$\text{DESIGN MARGIN} = \frac{28.95}{19.802} = 1.46$$

Q.130.067
(220.18)
(3.8.2)

In Section 4.1.1.4.1, it is stated that for assessing the stresses in the containment shell due to chugging, building model in Chapter 5 is used. It appears that the building model shown in Fig. 5.1-1 does not contain the fluid. Indicate that with such a mathematical model how the fluid shell structure interaction can be considered. Furthermore, the bottom part of the model appears to be different from the actual. Explain this model discrepancy or provide justification for the discrepancy.

RESPONSE

Figure 5.1-1 of DAR Rev. 2 will be revised. The building and hydrodynamic models used in the analysis are shown in References 130.067.1 and 130.067.2 (copies of the figures 130.067-1 and 130.067-2 are attached). The fluid masses were accounted for as explained in the same references.

References:

130.67.1 B&R, Inc., Chugging Loads - Revised Definition and Application Methodology for Mark II Containments (based on 4TCO test results), July 1981.

130.67.2 B&R, Inc., SRV Loads - Definition and Application Methodology for Mark II Containments, - 1980.

X

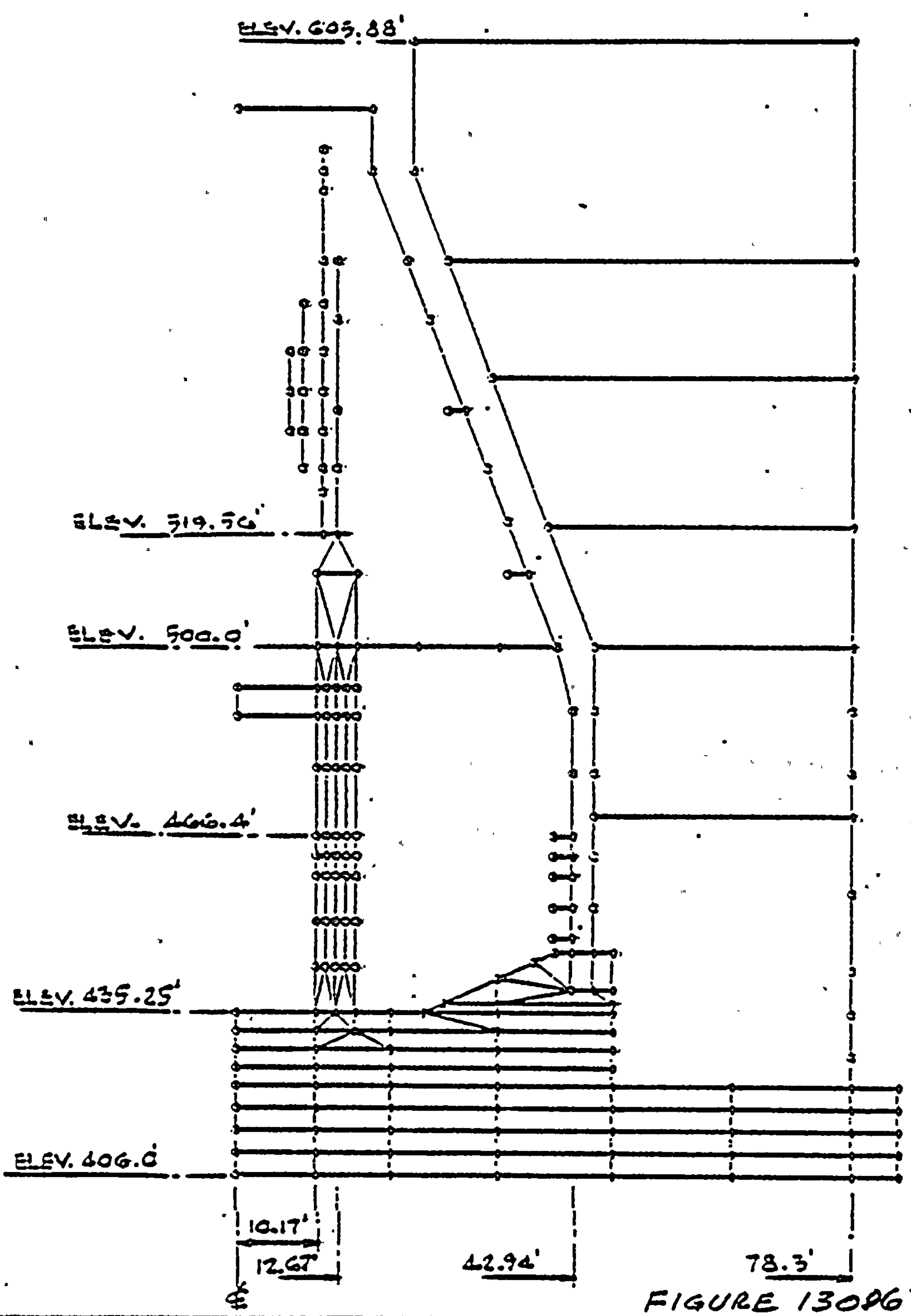


FIGURE 130067-1.

WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT NO. 2	WNP-2 REACTOR BUILDING MODEL	FIGURE 8.1

X

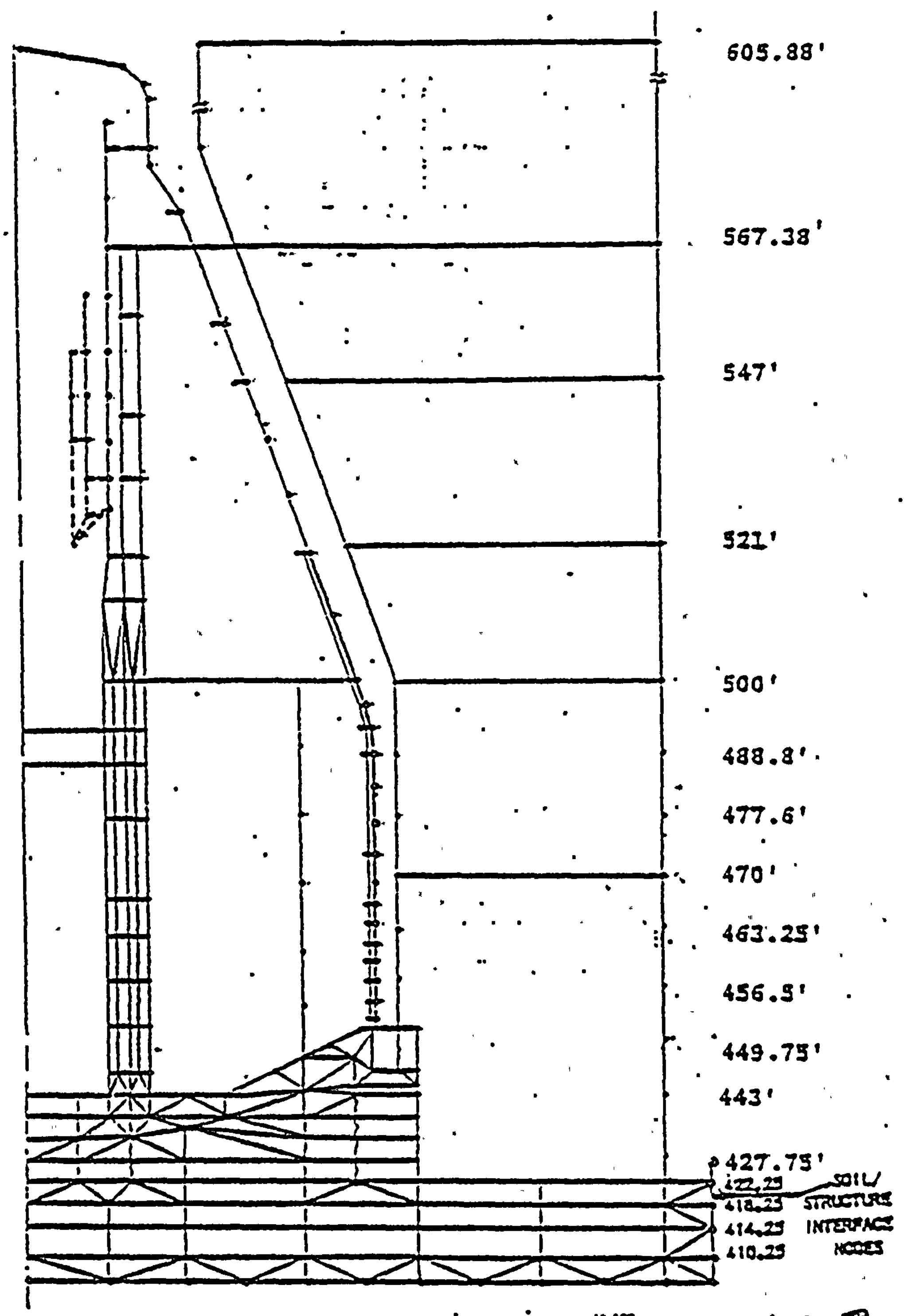


FIGURE 130.067-2

WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT NO. 2	REACTOR BUILDING MODEL	FIGURE 3-5

Q.130.068
220.19
(3.8.2)

In the assessment of the base mat indicate what structural functions are assumed for the portions of concrete above and below the steel containment bottom head, and how these portions are designed.

RESPONSE

The structural functions served by the portions of concrete above and below the steel containment bottom head and the associated methods of design are described below. The significant loads introduced into the concrete fill are the reactions from the RPV pedestal, the wetwell columns and the containment vessel. The pertinent structures are illustrated in Figures 3.8-1, 3.8-18, 3.8-40, and 3.8-45.

a. RPV Pedestal Base Reactions

(1) Tension due to Pedestal Moment and Axial Force - no function is served by the concrete with respect to tension due to the base bending moment. The tension is transmitted from the pedestal to the base mat by way of intermediate structural steel components. From the pedestal the vertical pedestal reinforcement continues through the upper concrete fill to cadwelds connected to the inner ring assembly. The inner ring assembly, in turn, is connected through weldments to the inner steel skirt which is anchored to the base mat.

(2) Compression Due to Pedestal Moment and Axial Load - This compression is transmitted directly into the upper concrete fill, through the steel bottom head (by normal compression and tangential bond) and then via the lower concrete fill to the base mat. Compression and bond stresses are checked against permissible values.

(3) Base Shear - The horizontal base shear is transmitted into the upper concrete fill by shear friction and then into the inner ring by bond. The shear is carried by the inner ring, through the bottom head and into the inner skirt by shear in steel. From the inner skirt, the shear is transmitted to the lower concrete fill by bond and then into the base mat by shear friction. Shear and bond stresses are checked against permissible values.

b. Wetwell Column Reactions

(1) Moment and Axial Load (Compression) - The base moment and compressive axial load is transmitted into the upper concrete fill by dowel reinforcement and direct bearing.

WVP-2

The fill acts as a beam (footing) in equilibrating these column base loads by vertical compressive reactions against the steel bottom head. The vertical compressive forces are carried across the bottom head via normal compressive stresses and tangential bond stresses into the lower concrete fill. From the lower concrete fill, the compressive forces are transmitted directly to the base mat.

(2) Base Shear — The horizontal base shear is transmitted into the upper concrete fill by shear friction. The shear is carried by the concrete fill to the bottom head. It passes through the bottom head via bond to the lower concrete fill. The lower concrete fill in turn passes the shear load to the base mat via concrete shear.

(3) Axial Load (Tension) — Axial tensile loads are transmitted into the upper concrete fill by dowel reinforcement. The upper concrete fill is designed as a two-way slab to provide weight to counteract the column upward load.

c. <u>Containment Vessel Reactions</u>

(1) Tension — No function is served by the concrete with respect to tensile forces at the bottom of the containment. These forces are transmitted directly into the skirts beneath the containment and then to the anchor bolts embedded in the base mat.

(2) Compression Due to Containment Moments and Axial Loads — This compression is transmitted directly into the lower concrete fill by normal compression and tangential bond and friction, and down through the fill to the base mat.

(3) Containment Shear — Containment shear is transmitted from the bottom of the containment into the outer skirt beneath the containment. It is transferred from the outer skirt to the concrete fill by bond and then transmitted from the concrete fill into the base mat by shear friction.

Q.130.069
(220.20)
(3.8.2)

In Section 5.1.2 of the DAR, it is stated that damping is applied as a material dependant property so that specific damping values may be imposed for each of the different structural elements. Express in mathematical term the formulation of this material dependant damping used in the actual analysis. What damping values are used for fluid and the soil? In all floor spectra provided, the applicable structural damping values for the floor response spectra should be indicated.

RESPONSE

For mathematical formulation of the material dependent damping, please refer to response to Question 130.73.. The damping values of fluid soil and structural materials are as follows.

Type of Loading	% of Critical Damping			
	Fluid	Soil	Concrete Elements	Steel Elements
Chugging	See Ref. 130.69.1	1. Axi-Symmetric Modes 4% at 10 Hz.	4%*	2%*
All other Hydro-dynamic Loads	0.0	2. Other Modes 4% at 30 Hz.		

Reference 130.69.1: Burns and Roe Technical Report, "Chugging Loads - Revised Definition and Application Methodology for Mark II Containments (Based on 4TCO Test Results," July, 1981.

*These values were selected to conservatively meet the intent of the requirements of RG 1.61, Rev. 0.

Q.130.070
(220.21)
(3.8.2)

Provide the figues which are missing in Section 5.1 of the DAR.

RESPONSE

Please refer to Figures 130.070-1 through 130.070-6. These correspond to Figures 8.3a,-b and 8.4a-d of the SRV Report, Reference 130.070.1.

References:

130.070.1 B&R, Inc., SRV Loads - Definition and Application Methodology for Mark II Containments, - July 1980.

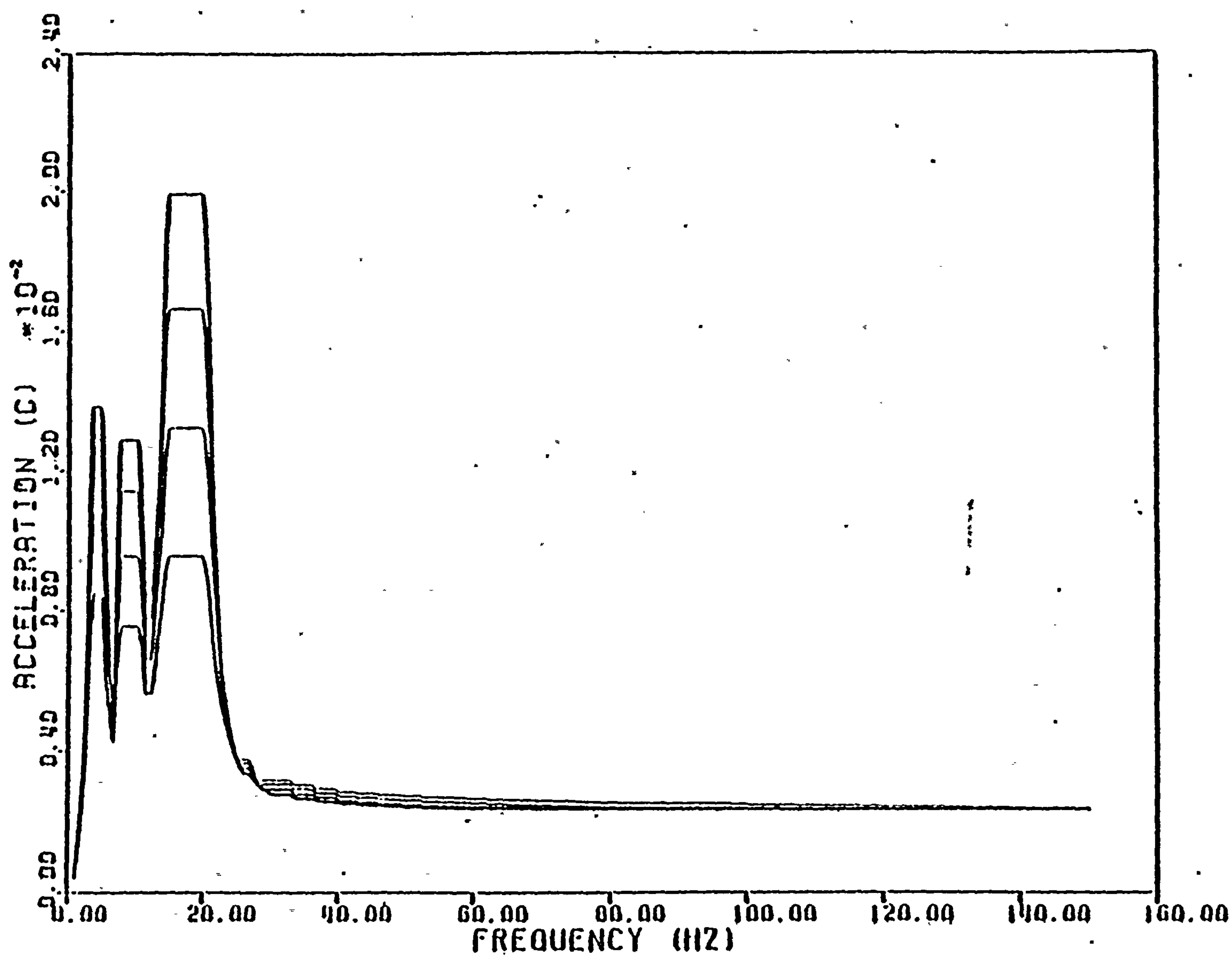
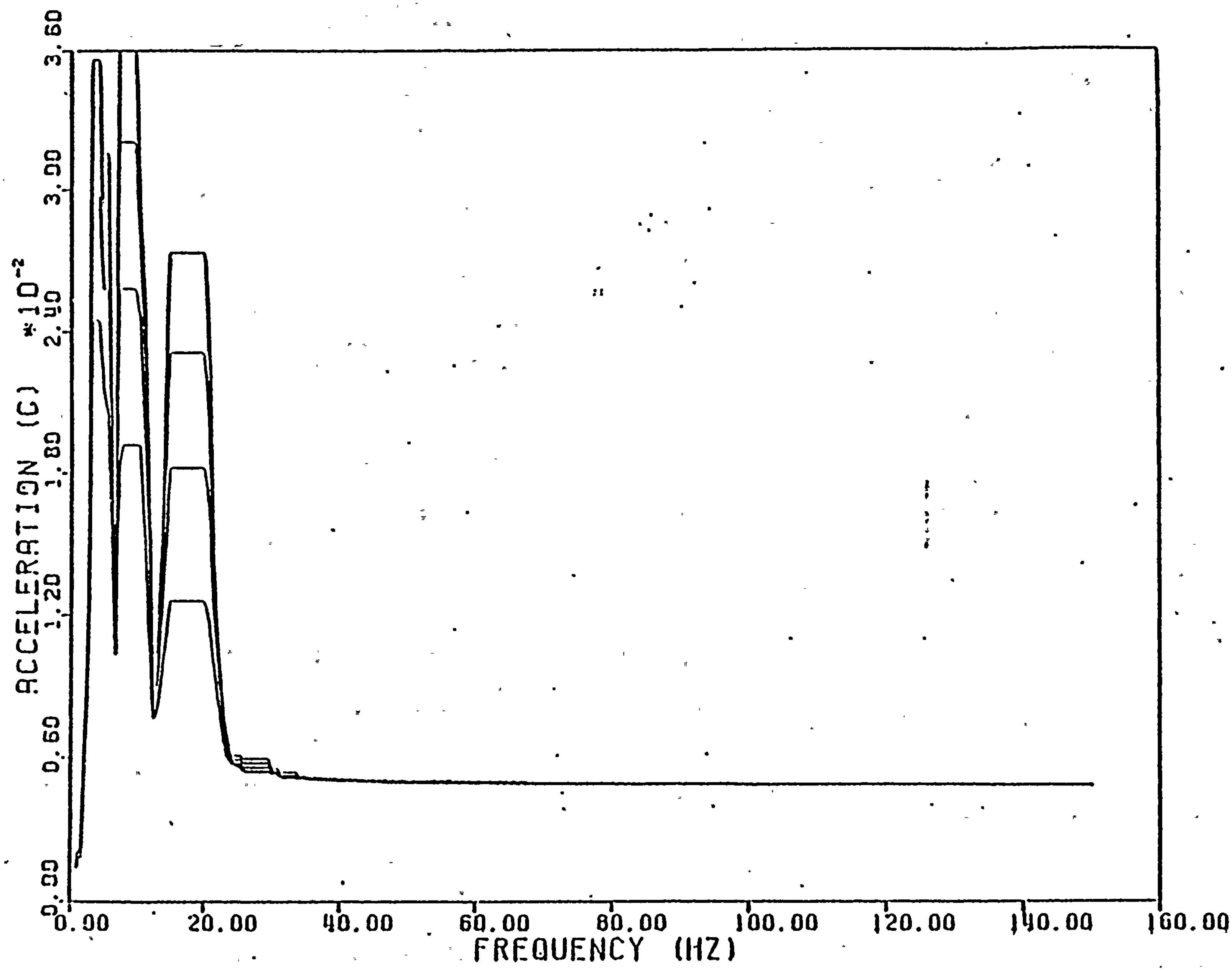


Figure 130.70-1

WASHINGTON PUBLIC POWER SUPPLY SYSTEM
NUCLEAR PROJECT NO. 2

VERTICAL RESPONSE AT RPV SUPPORT
ALL VALVES-APP

FIGURE 8.3a



HINGTON PUBLIC POWER SUPPLY SYSTEM
NUCLEAR PROJECT NO. 2

VERTICAL RESPONSE AT RPV SUPPORT
ALL VALVES - SFP

FIGURE 8.3b

Figure 130.70-2

WASHINGTON PUBLIC POWER SUPPLY SYSTEM
NUCLEAR PROJECT NO. 2

HORIZONTAL RESPONSE AT RPV SUPPORT
SINGLE VALVE (INNER) - MFP -

FIGURE 8.4a

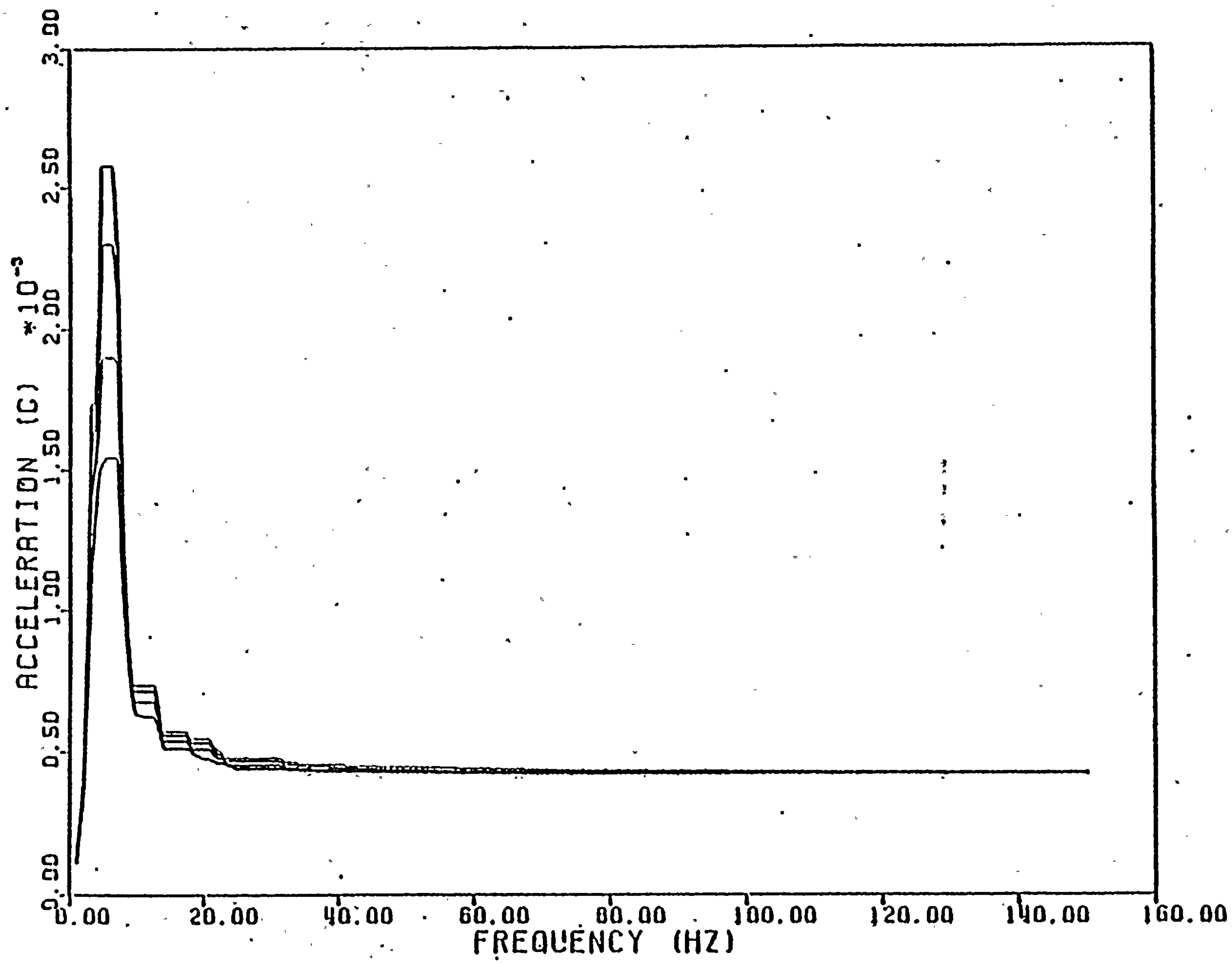


Figure 130.70-3

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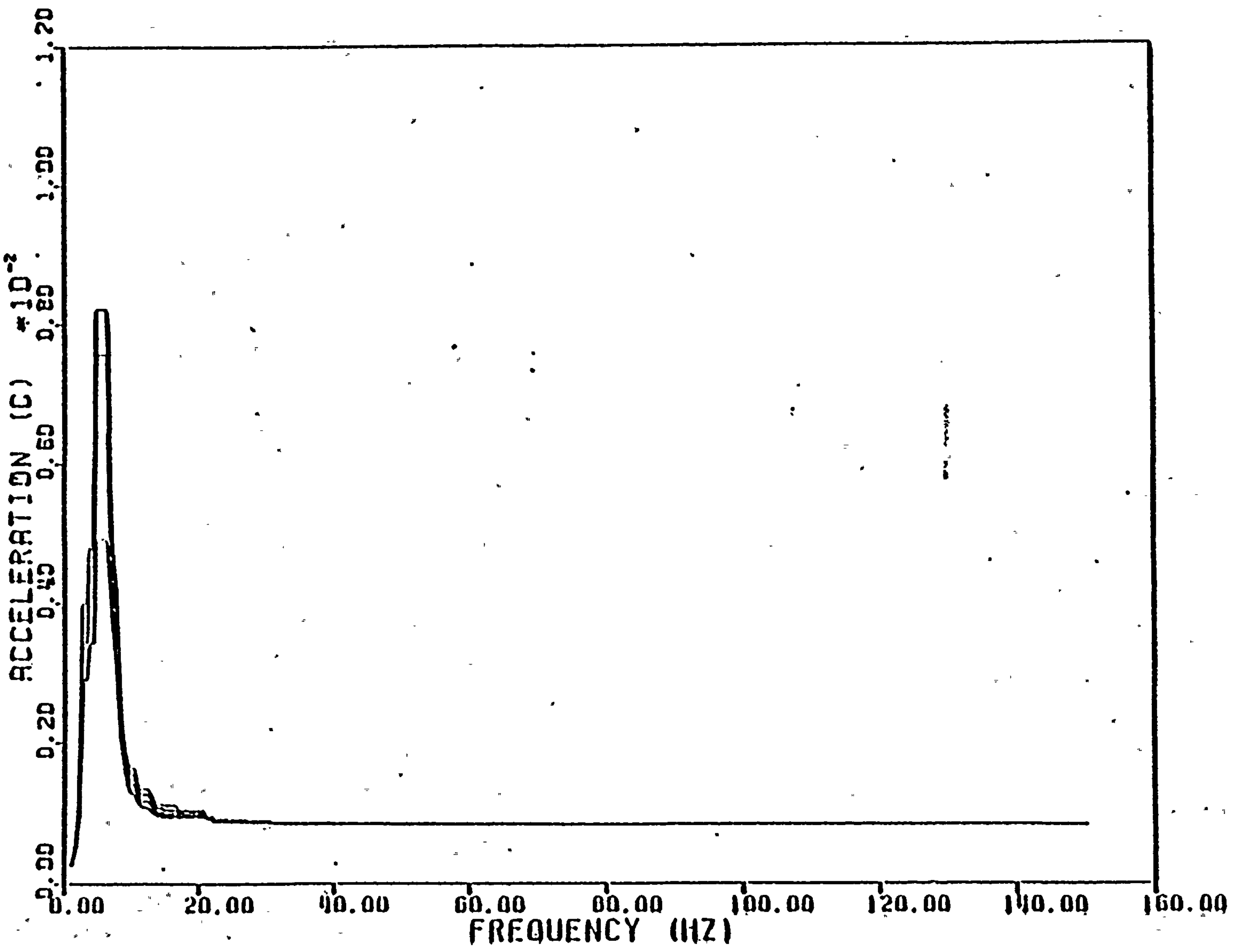
WASHINGTON PUBLIC POWER SUPPLY SYSTEM
NUCLEAR PROJECT NO. 2

HORIZONTAL RESPONSE AT RPV SUPPORT
SINGLE VALVE (INNER) - SET

FIGURE 3.4b

Figure 13a70-4



WASHINGTON PUBLIC POWER SUPPLY SYSTEM
NUCLEAR PROJECT NO. 2

HORIZONTAL RESPONSE AT RPV SUPPORT
SINGLE VALVE (OUTER) - NTP

FIGURE 8.4c

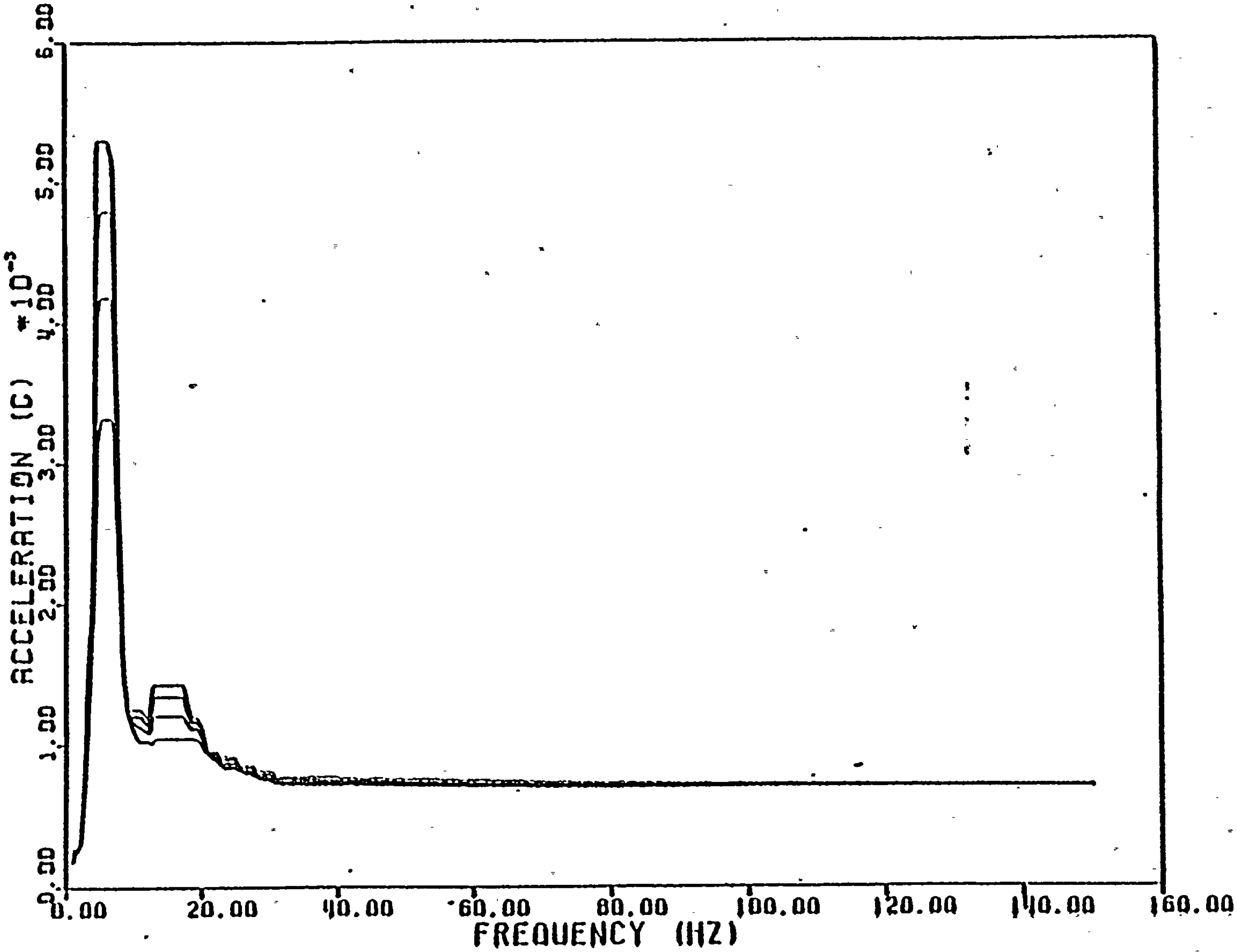


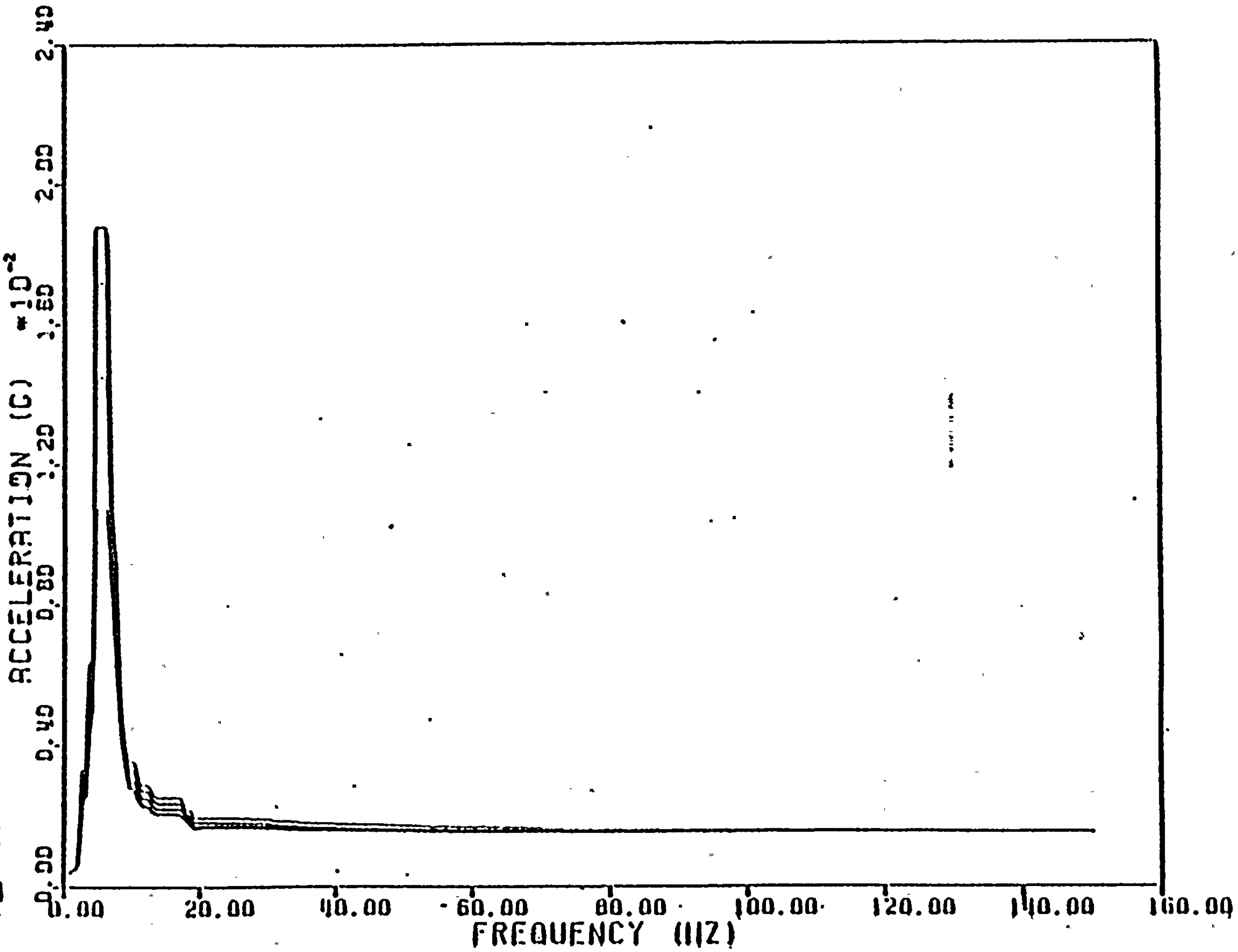
Figure 130070-5

WASHINGTON PUBLIC POWER SUPPLY SYSTEM
NUCLEAR PROJECT NO. 2

HORIZONTAL RESPONSE AT RPV SUPPORT
SINGLE VALVE (OUTER) - SF2

FIGURE 8.4d

Figure 13080-6

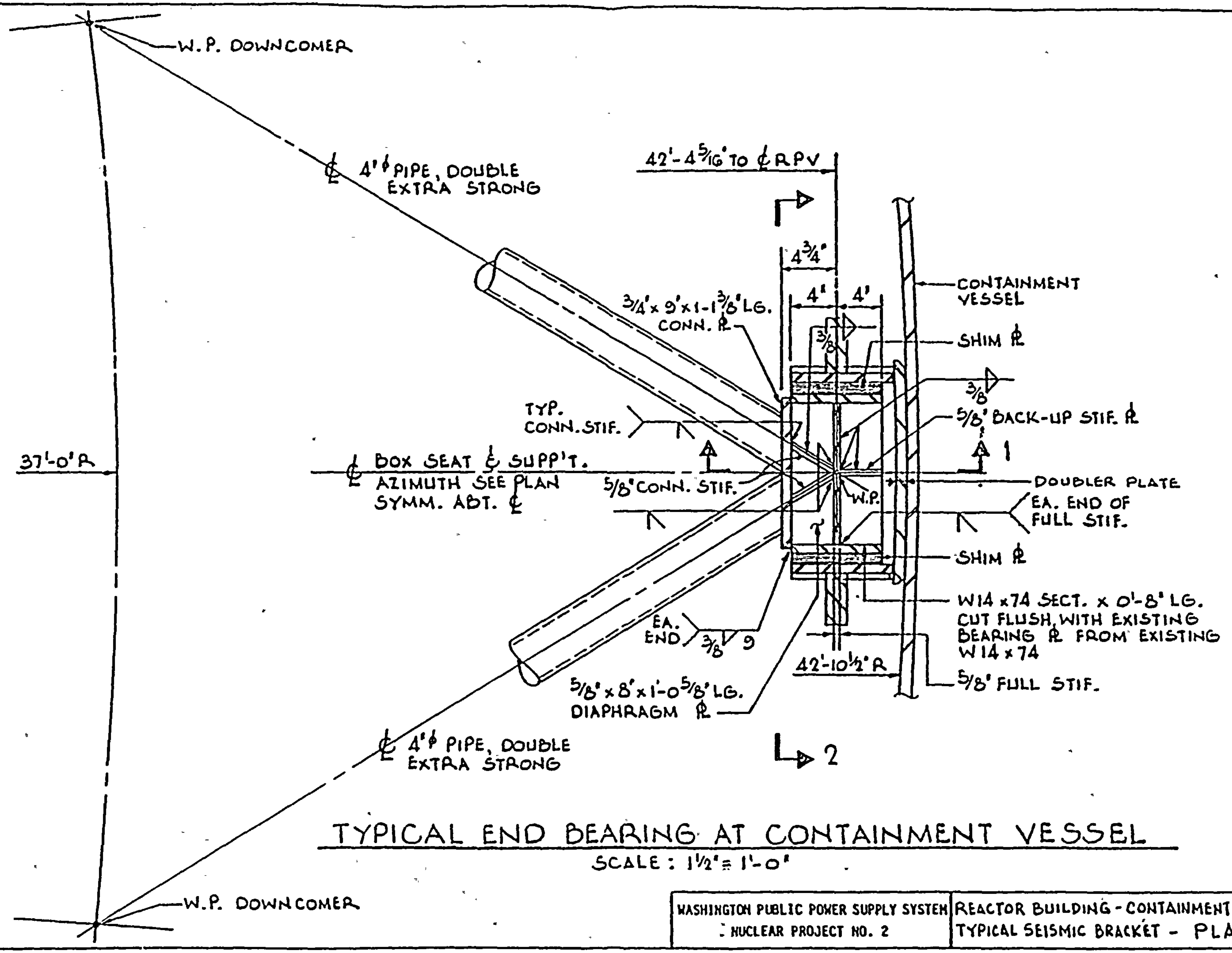


Q.130.071
(220.22)
(3.8.2)

In Figure 4.1-20 of the DAR, a seismic bracket to provide lateral support of the downcomers is indicated. Provide a drawing showing the details and its attachment to the containment shell. Indicate what are the effects on stresses and behavior of the containment shell as a result of such attachments under the action of LOCA and SRV loads.

RESPONSE

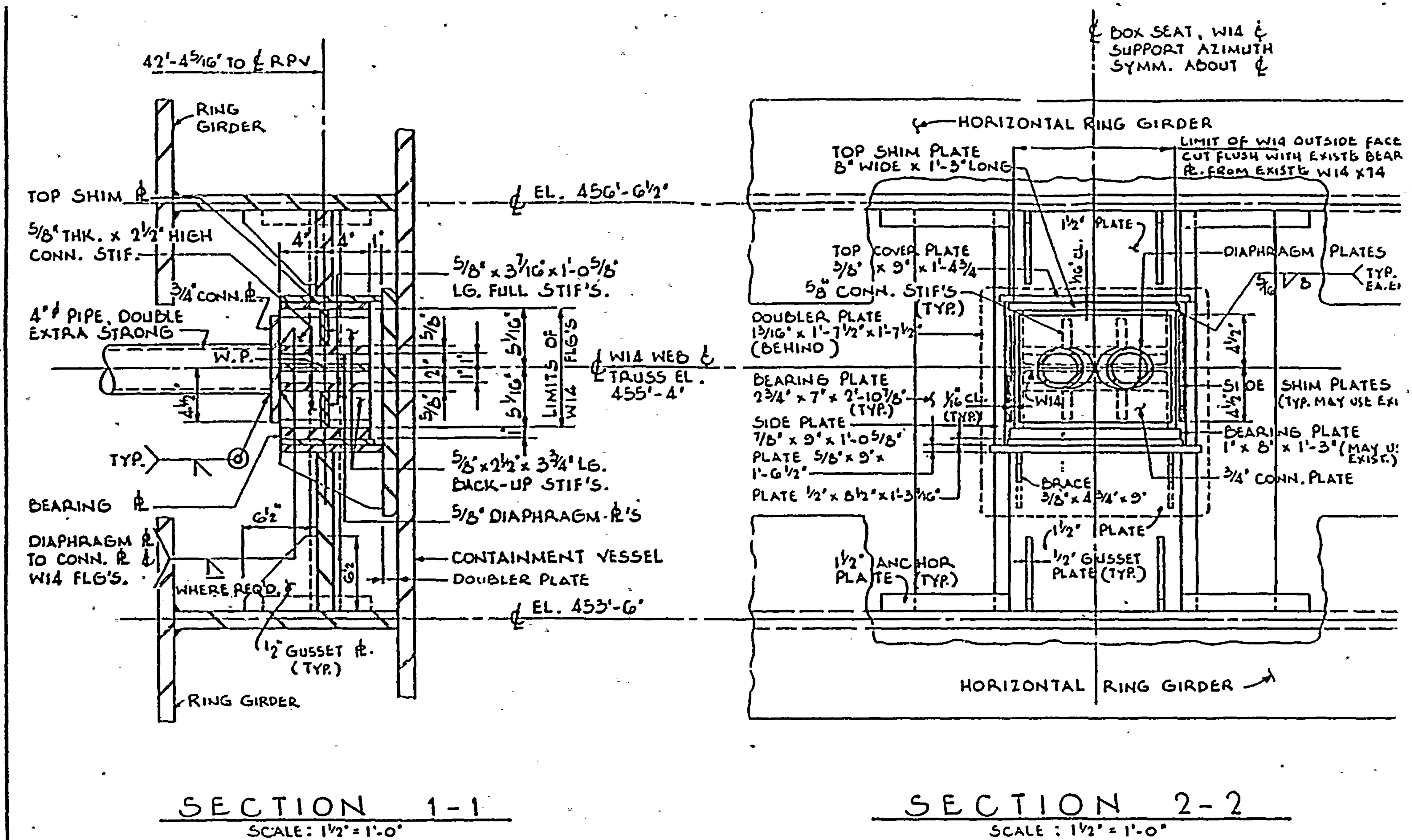
The seismic bracket referred to in Figures 4.1-20 and 4.2-3 of the DAR, Rev. 2, is the downcomer bracing system at Elev. 455'-4". The drawings describing the downcomer bracing system are figures 4.2-1 and 4.2-2 of the DAR. As indicated in Figure 4.2-1, the detail of the attachment of the downcomer bracing to the containment shell is shown on Figures 130.071-1 and 130.071-2. The controlling design margin for the vessel connection are tabulated in Table 4.2-1 of the DAR. A description of the bracing system and discussion of the loads and assessment are in Section 4.2.1 of the DAR. As indicated in Section 4.1.1.1.2.3 and 4.2.1.1 of the DAR, all concentrated loads from the downcomer bracing system are carried by the containment structure and are evaluated by the containment vessel contractor.



TYPICAL END BEARING AT CONTAINMENT VESSEL

SCALE: 1 1/2" = 1'-0"

WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT NO. 2	REACTOR BUILDING - CONTAINMENT VESSEL TYPICAL SEISMIC BRACKET - PLAN	FIG. 13?



WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT NO. 2	REACTOR BUILDING - CONTAINMENT VESSEL TYPICAL SEISMIC BRACKET - SECTIONS

The following questions (220.23 and 220.24) pertain to the report titled "Chugging Loads - Revised Definition and Application Methodology for Mark II Containments.

Q.130.072
(220.23)
(3.8.2)

It is noted in Section 3.3.3 on Page 32 of the above referenced report, that viscous damping coefficients Dw and Ds are represented in the form of dashpots connecting the water elements and steam elements respectively. However, in the model shown in Figure 3-17a there is no identification of water or steam elements not is there any representation of viscous damping in the form of dashpots. Provide in a figure a model incorporating the various elements as described. In your evaluation of Dw and Ds by a trial and error method, how the effects of the structural damping of the tank can be isolated? Are the damping values thus determined considered in the theoretical formulation of the fluid-structure interaction analysis as discussed in the following question? How are they considered?

RESPONSE

Refer to Figures 130.072-1 through 130.072-4. The structural damping values of the tanks were not isolated, however, the method used of treating the structural damping in the 4T tanks and the WNP-2 building can be shown to be conservative as follows.

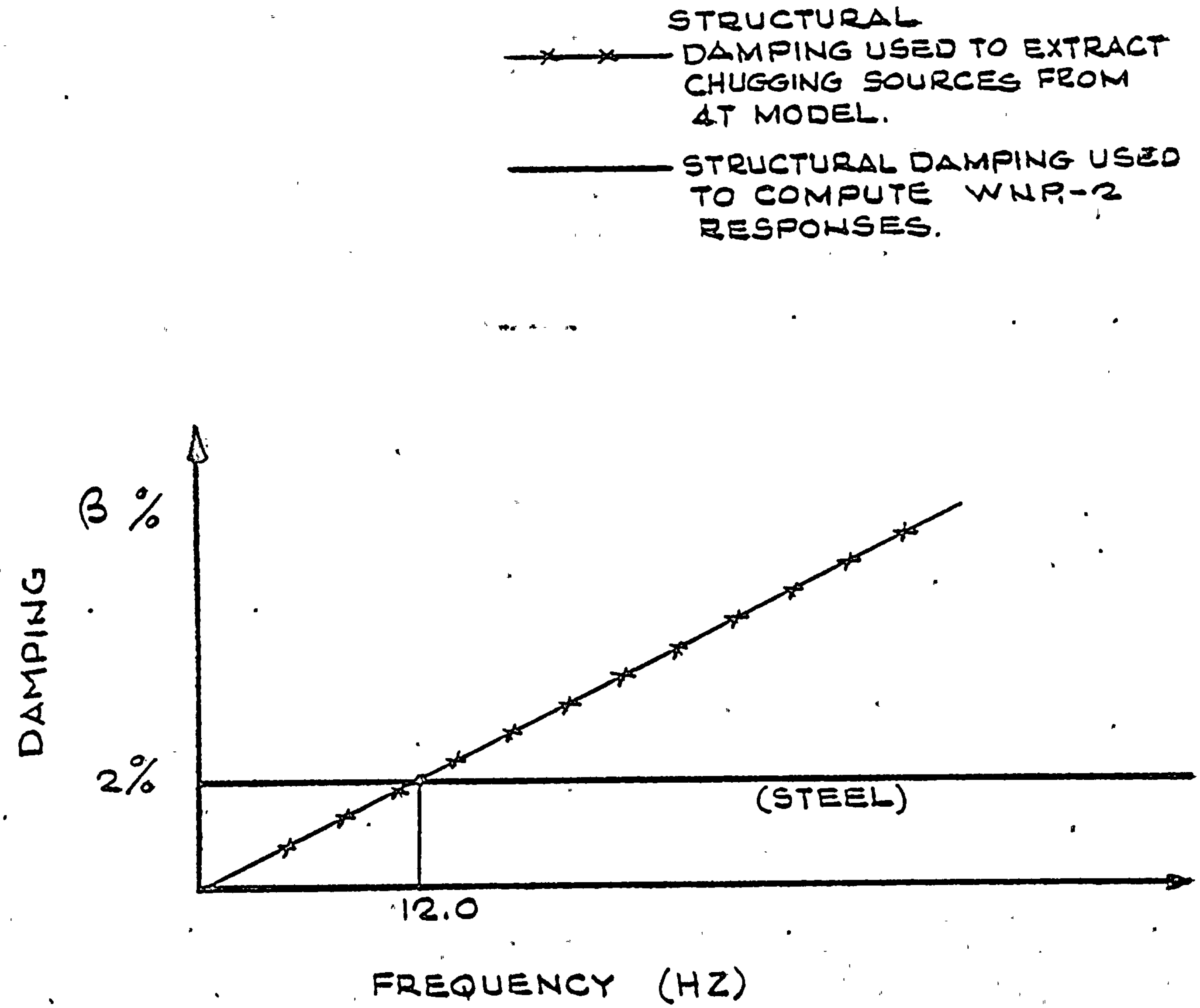
The structural damping in the 4T tank finite elements model is of Rayleigh type which increases linearly with the frequency of excitation, Fig. 130.072-1. A 2% critical damping value at 12.0 Hz was used for the structural steel elements. The 12.0 Hz was chosen since it is lower than the fluid-structure interaction frequencies observed in the tests. The structural steel damping, on the other hand, of the WNP-2 finite element model was chosen to be 2% at all frequencies (4% for concrete), as shown in the next question. The damping properties in steam and water were similar in both models. This way of treating damping in the two models insures conservatism of the results since:

i. The calculated response of the 4T model is lower in the higher frequency zone, since the structural damping is more than 2%.

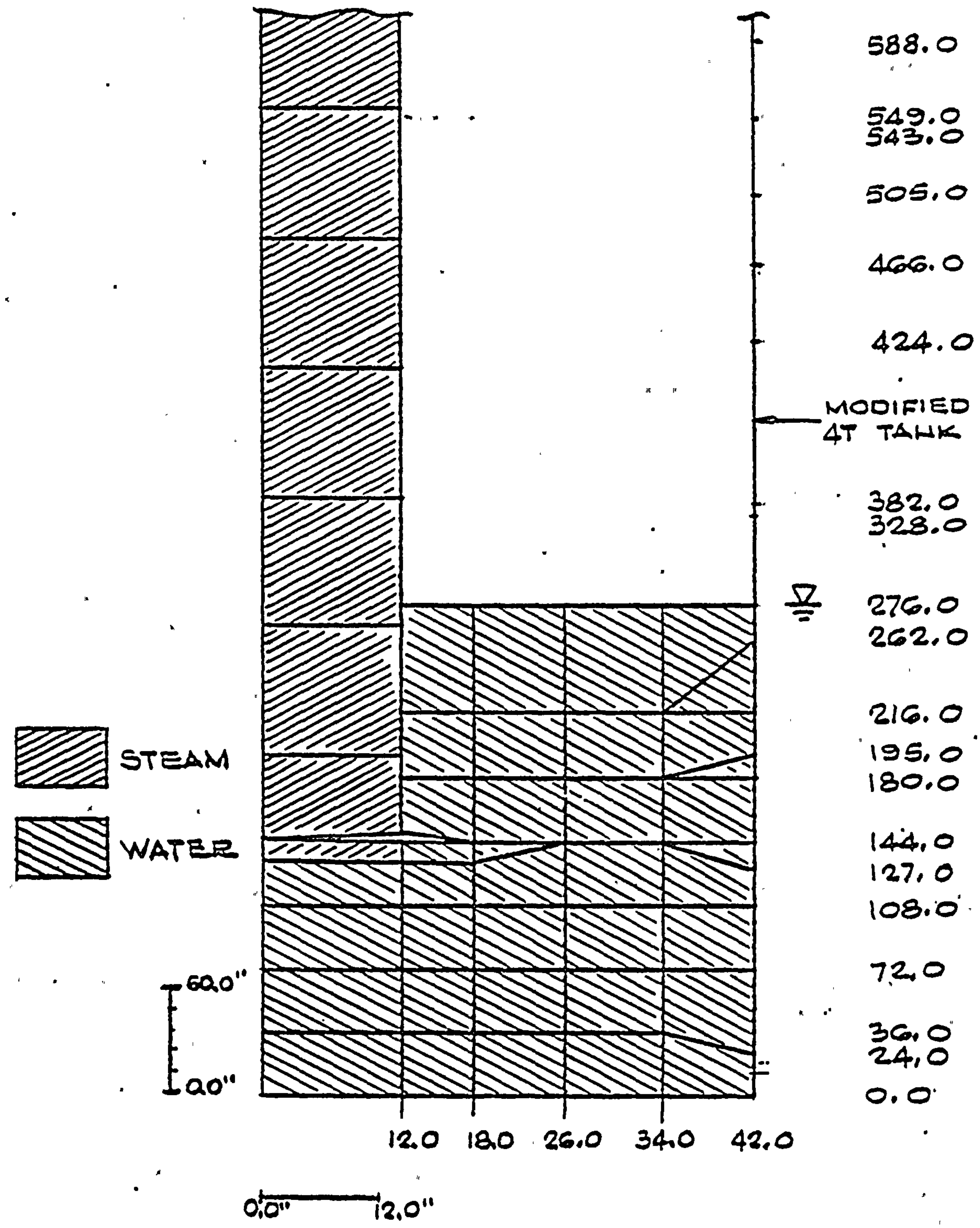
ii. This means that the seven chugging sources that were evaluated in the B&R chugging report are conservative at frequencies higher than 12Hz, since the calculated responses of these sources were required to envelope the test results at all frequencies.

iii. Since the danping properties of the steam and fluid were kept constant during the sources evaluation phase (4T tank model) and the sources apllication phase (WNP-2 model), and since during the calculation of the WNP-2 responses, both the applied chugging sources and the structural damping were conservative, it is concluded

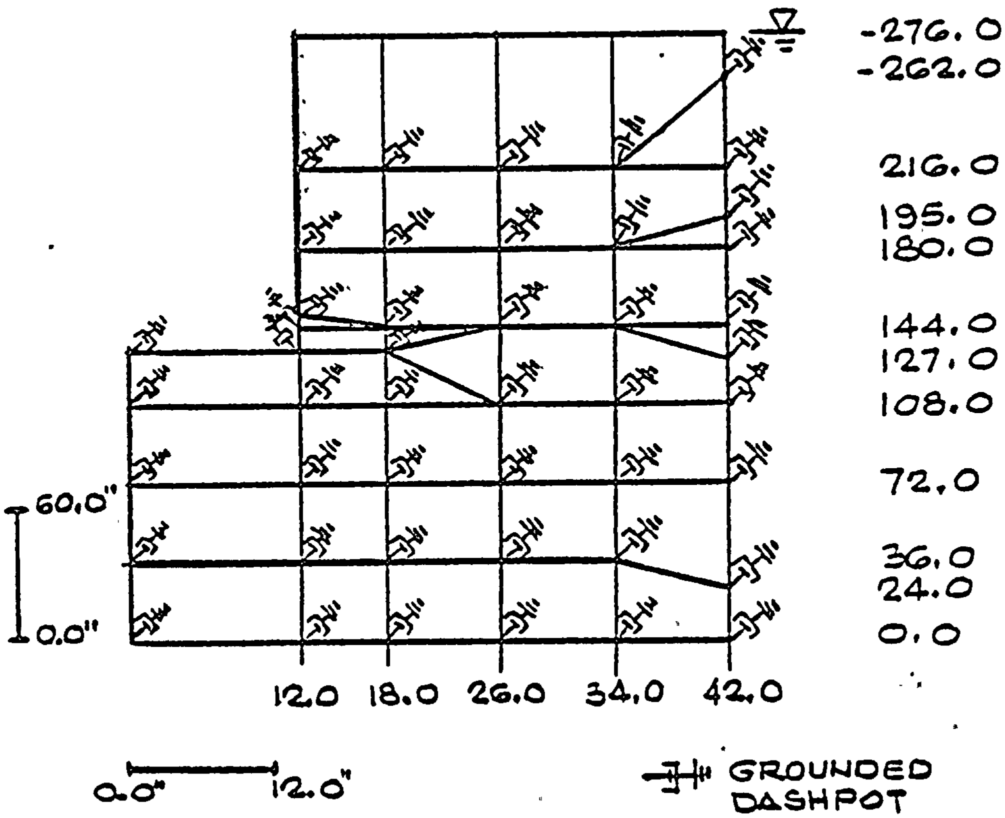
that the calculated WNP-2 responses to chugging load are conservative.



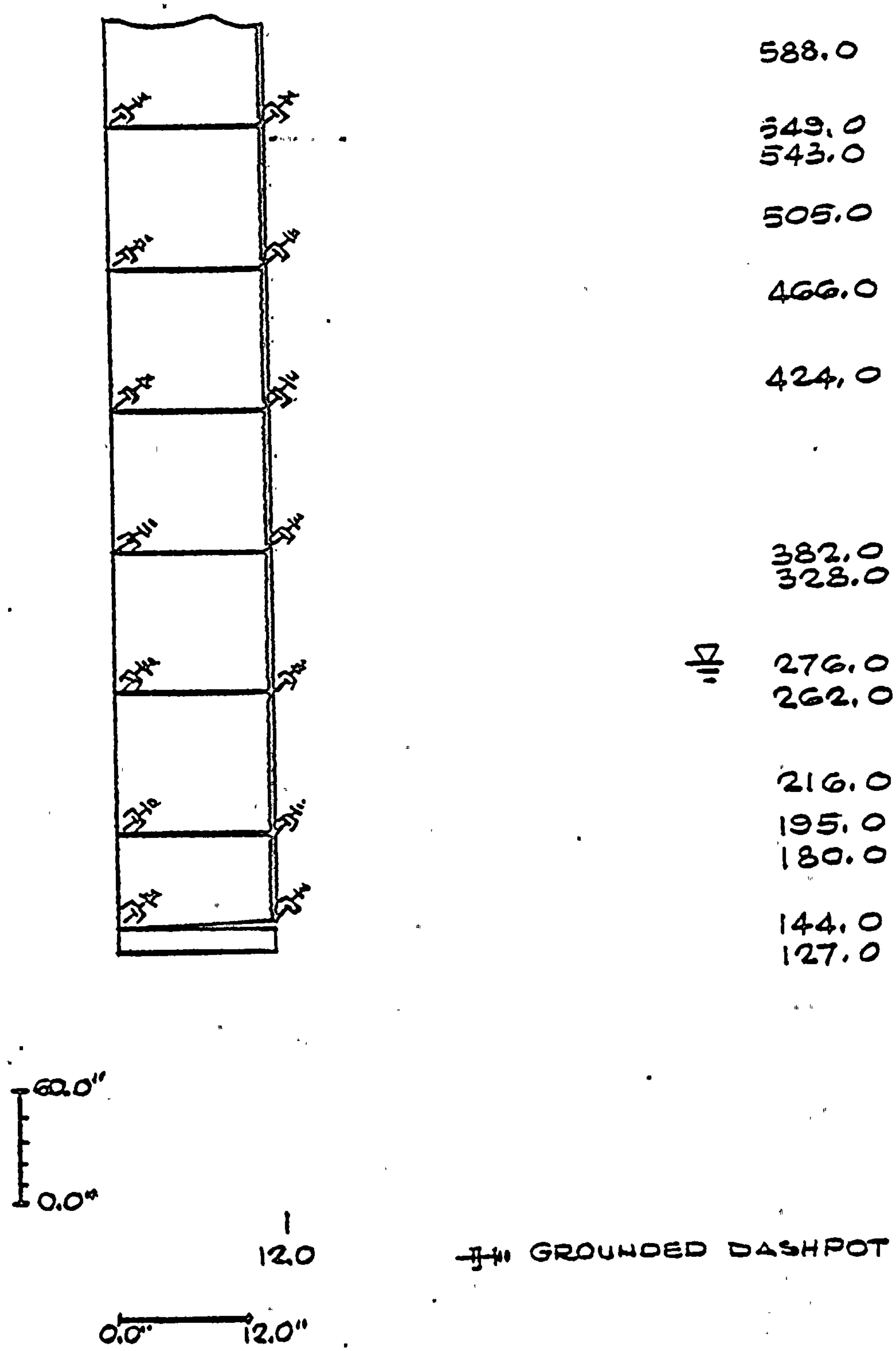
WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT NO. 2	COMPARISON OF STRUCTURAL DAMPING IN CHUGGING LOAD METHODALOGY	FIGURE 130.072-1



WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT NO. 2	VENT-POOL MODEL (FLUID ELEMENTS)	FIGURE 130.072-2



WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT NO. 2	VENT-POOL MODEL WATER DASHPOTS	FIGURE 3.9-072-3



WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT NO. 2	VENT-POOL MODEL STEAM DASHPOTS	FIGURE ~~130.72-4~~

Q.130.073
(220.24)
(3.8.2)

In the theoretical formulation of the equation for the fluid-structure interaction analysis as indicated in Section 5.2 of the report, a so called dynamic stiffness matrix is defined in terms of Ms, Ma, Cs and Ks materices. Provide a discussion how the structural damping matrix Cs is established, and why the natural frequency of the structure is not involved in the formulation. In the model shown in Figure 5-4, no water is indicated, therefore, how Ma is considered? Provide a model used in the analysis which includes all the physical elements as contained in equation 5.3 of the report. How do you verify the validity of your theoretical formulation?

RESPONSE

Refer to Figures 130.073-1 through 130.073-11.

The structural damping matrix $\underset{\sim}{C}_s$ is a non-proportional damping matrix which is assembled from the individual element damping matrices $\underset{\sim}{C}_s^n$, where

$$\underset{\sim}{C}_s^n = (2\beta_n/\Omega)\ \underset{\sim}{K}_s^n$$

$\underset{\sim}{K}_s^n$ = Structural Element Stiffness Matrix

β_n = Percentage of critical damping assigned to the element.

Ω = Forcing frequency

Different element damping matrices $\underset{\sim}{C}_s^n$ can be assembled using the conventional assembling finite element method technique to form the total structural damping matrix $\underset{\sim}{C}_s$. Since $\underset{\sim}{C}_s$ is formed for each individual element, it is non-proportional damping matrix thus it is independent from the structural natural frequencies. It insures that the loss of energy due to damping in each individual element is constant over all frequencies, Ref. 130.073.1.

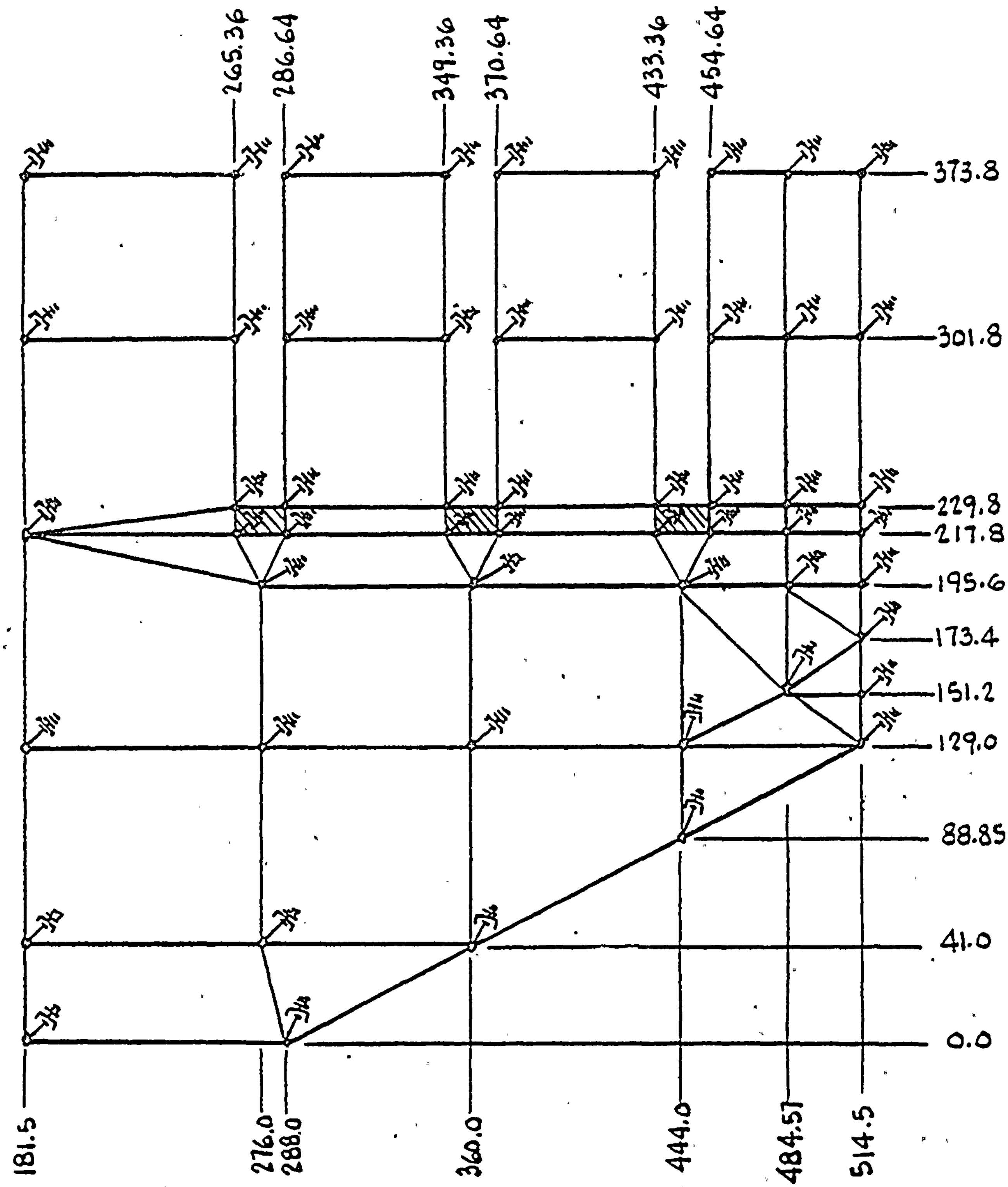
The hydrodynamic added mass matrix $\underset{\sim}{M}_a$ was computed using the hydrodynamic finite element model of Figs. 5.3 and 5.4 of B&R chugging report. The theoretical formulation of the model is described in detail in Appendix 5.1 of Ref. 130.073.2 The theoretical formulation was verified against the program NASTRAN, Ref. 130.073.3 Also, in Ref. 130.073.2 it was shown that this formulation can predict quite well the general behavior of the 4T test facility during chugging tests.

References

130.073.1 Roesset, J.M., Whitman, R.V. and Dobry, R., "Modal Analysis for Structures with Foundation Interaction," Dept. of Civil Engineering, M.I.T., Structures Publication No. 329, Dec. 1972.

130.073.2 B&R, Inc. Report, "Chugging Loads - Improved Definition and Application Methodology to Mark II Containments," June 1979.

130.073.3 Bedrosian, B., "Analysis of a Mark II Containment Structure for Hydrodynamic Loads in Suppression Pool," presented at the Conference on Structural Analysis, Design and Construction in Nuclear Power Plants, Porto Alegre, Brazil, 1978.

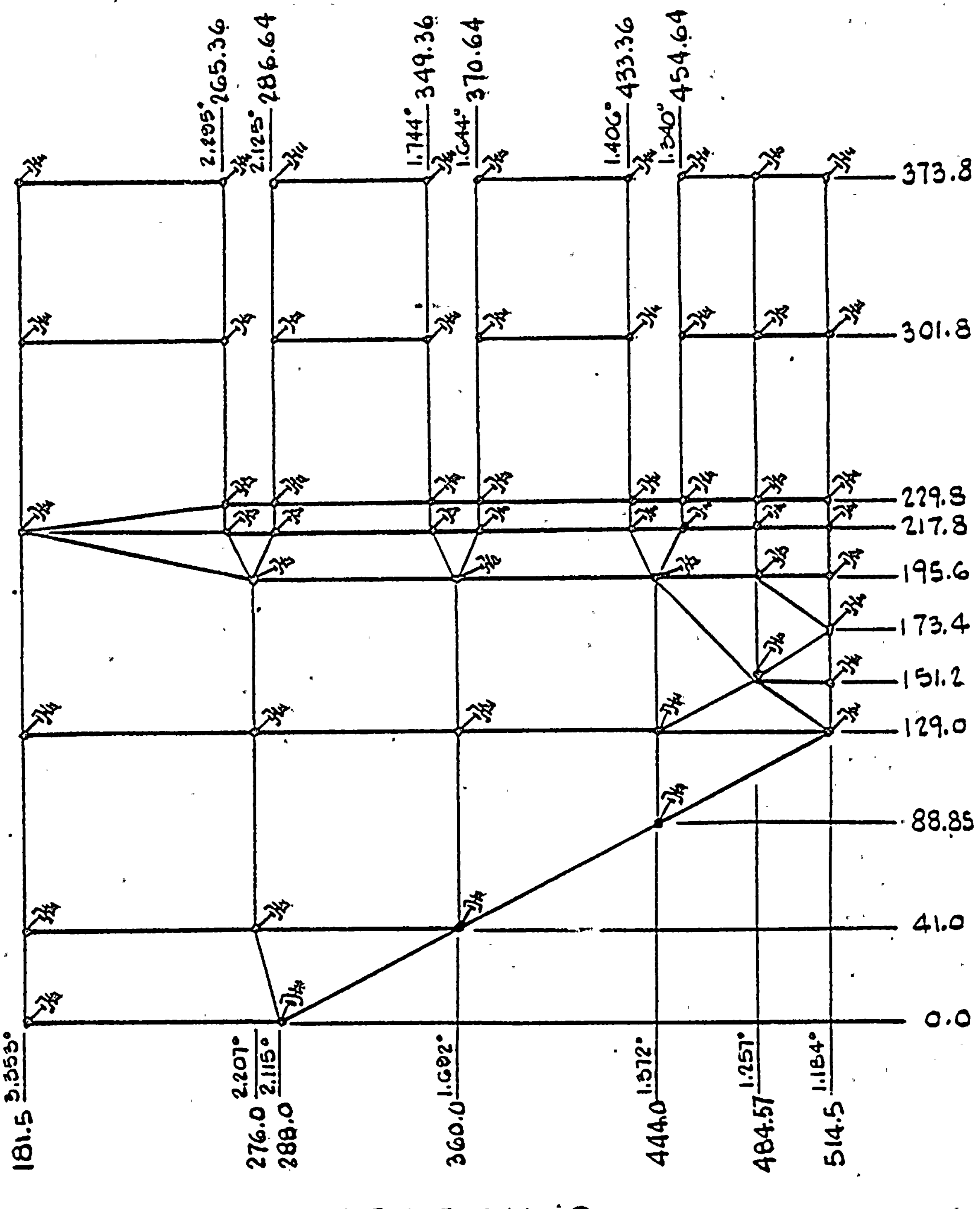


SECTION 1 @ 0°

GROUNDED DAMPER

NOTE: ALL ELEMENTS ARE WATER EXCEPT THOSE CROSS-HATCHED (STEAM)

WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT NO. 2	HYDRODYNAMIC FINITE ELEMENT MODEL OF WETWELL	FIGURE 130.073-1

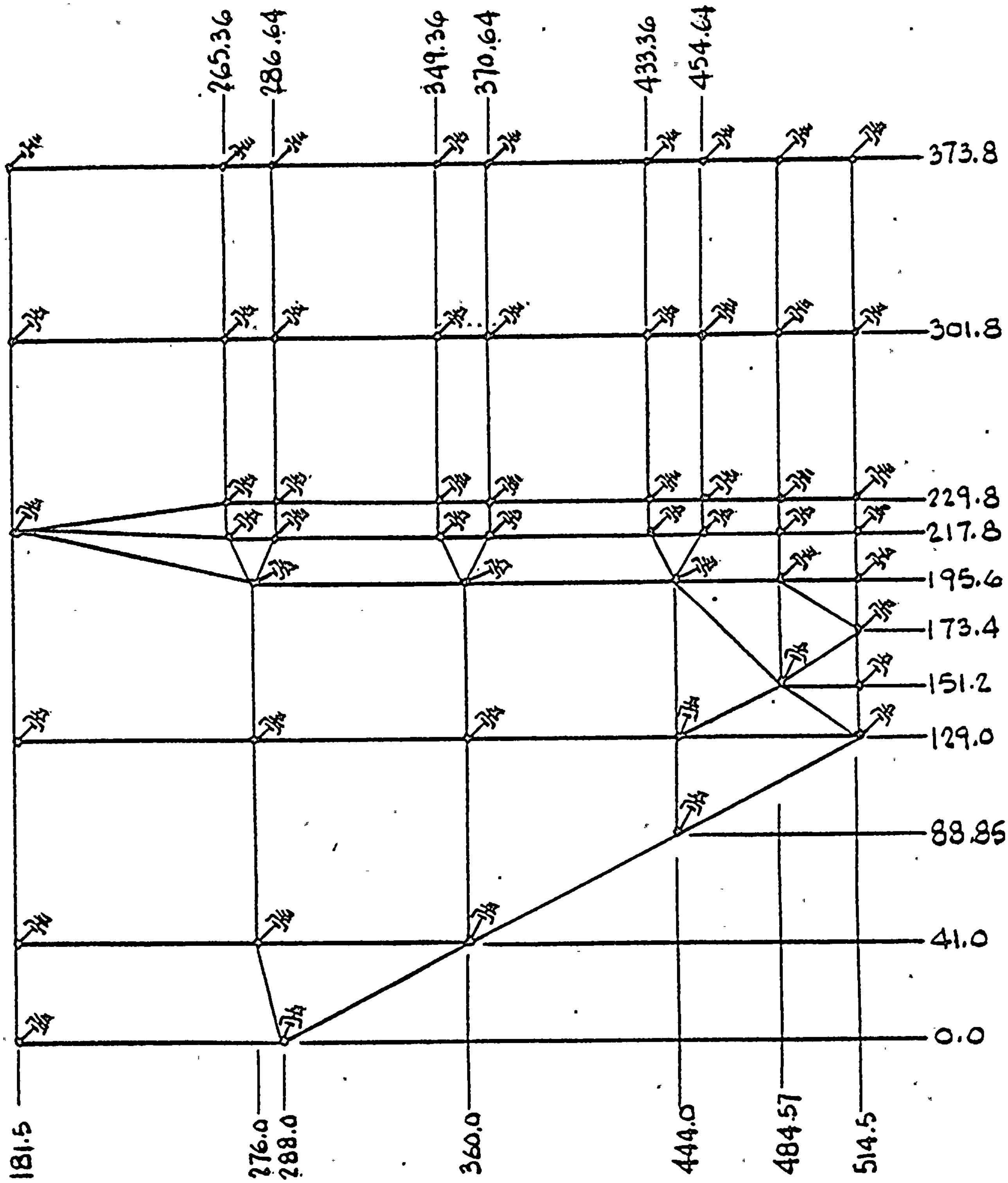


SECTION 2

GROUNDED DAMPER

NOTE: ALL ELEMENTS ARE WATER

WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT NO. 2	HYDRODYNAMIC FINITE ELEMENT MODEL OF WETWELL	FIGURE 130.073-2

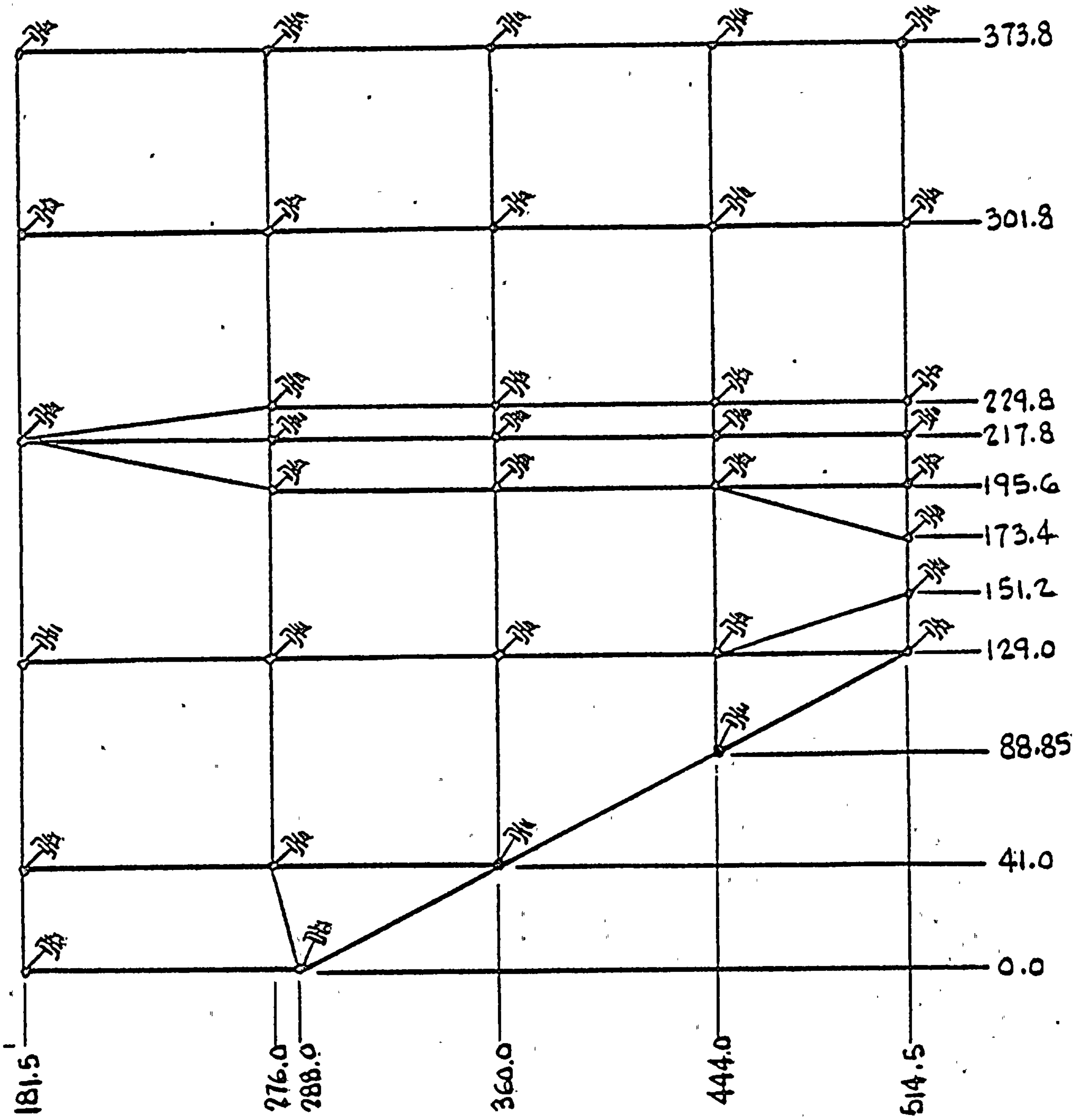


SECTION 3 @ 5°-15°

GROUNDED DAMPER

NOTE: ALL ELEMENTS ARE WATER

WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT NO. 2	HYDRODYNAMIC FINITE ELEMENT MODEL OF WETWELL	FIGURE 130.073-3

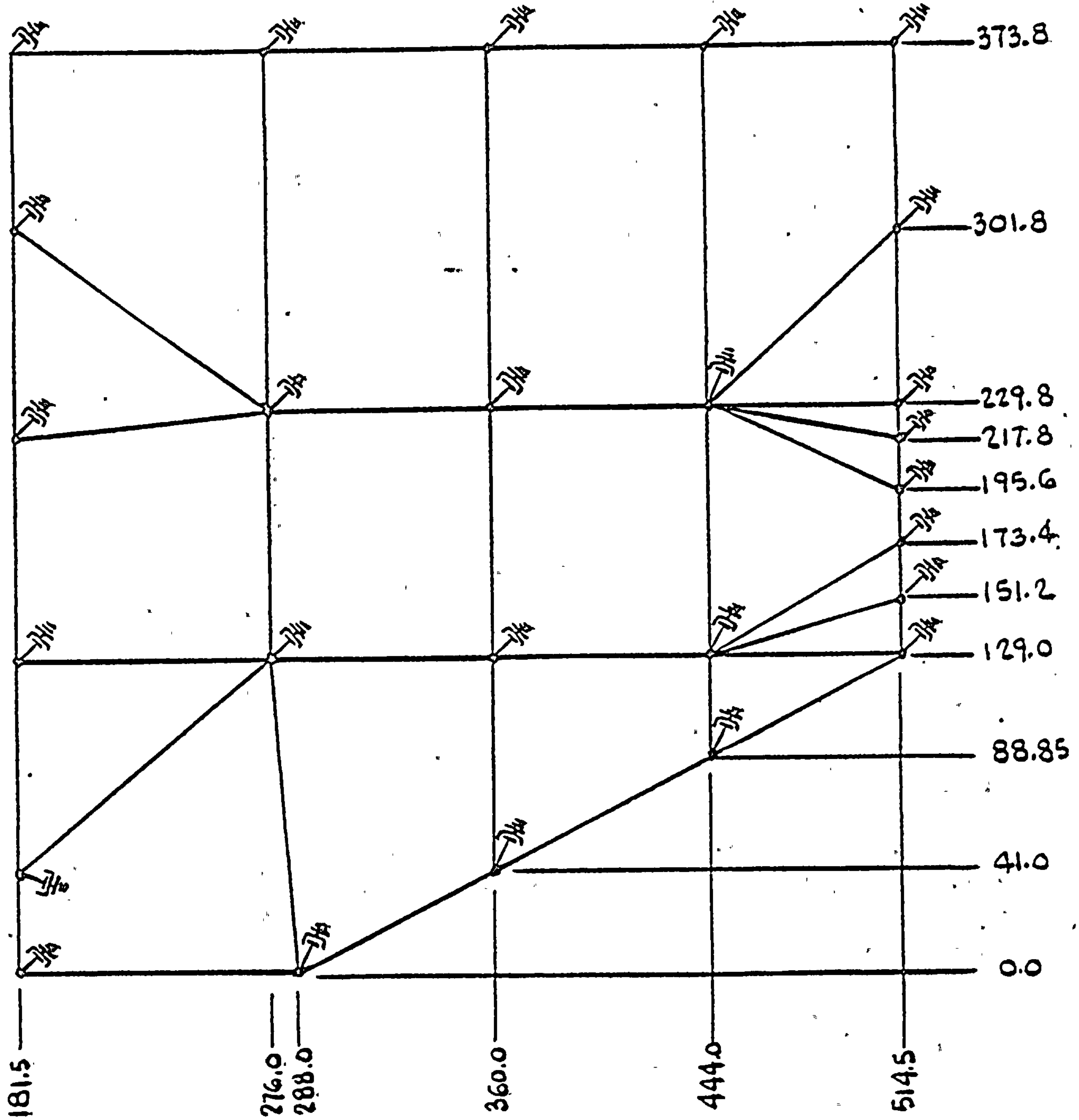


SECTION 4 @ 15°-30°

GROUNDED DAMPER

NOTE: ALL ELEMENTS ARE WATER

WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT NO. 2	HYDRODYNAMIC FINITE ELEMENT MODEL OF WETWELL	FIGURE 130.073-4

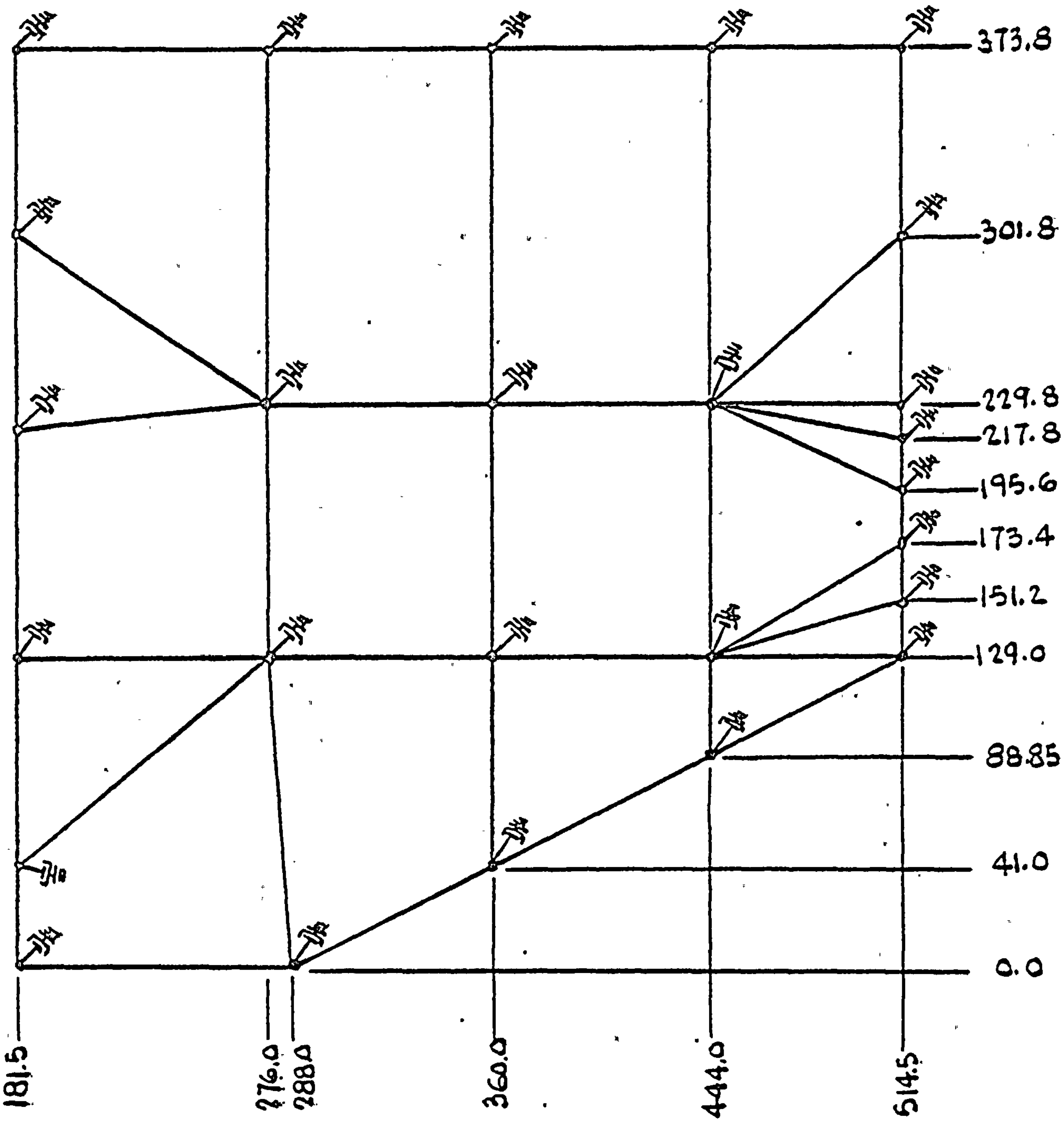


SECTION 5 @ 30°-60°

GROUNDED DAMPER

NOTE:...ALL ELEMENTS ARE WATER

WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT NO. 2	HYDRODYNAMIC FINITE ELEMENT MODEL OF WETWELL	FIGURE 130.073-5

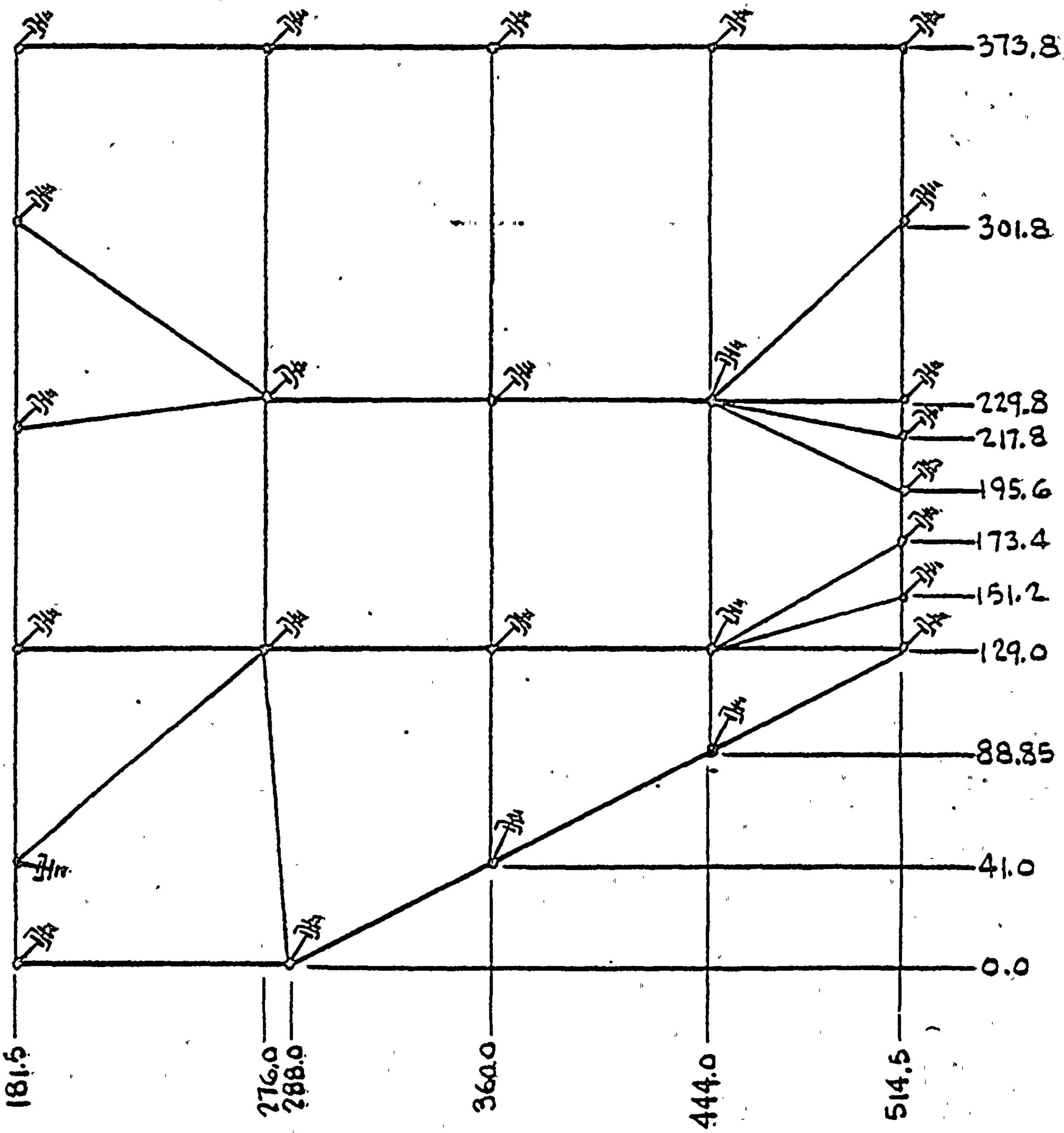


SECTION 6 @ 60°-90°

GROUNDED DAMPER

NOTE: ALL ELEMENTS ARE WATER

WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT NO. 2	HYDRODYNAMIC FINITE ELEMENT MODEL OF WETWELL	FIGURE 130.073-6

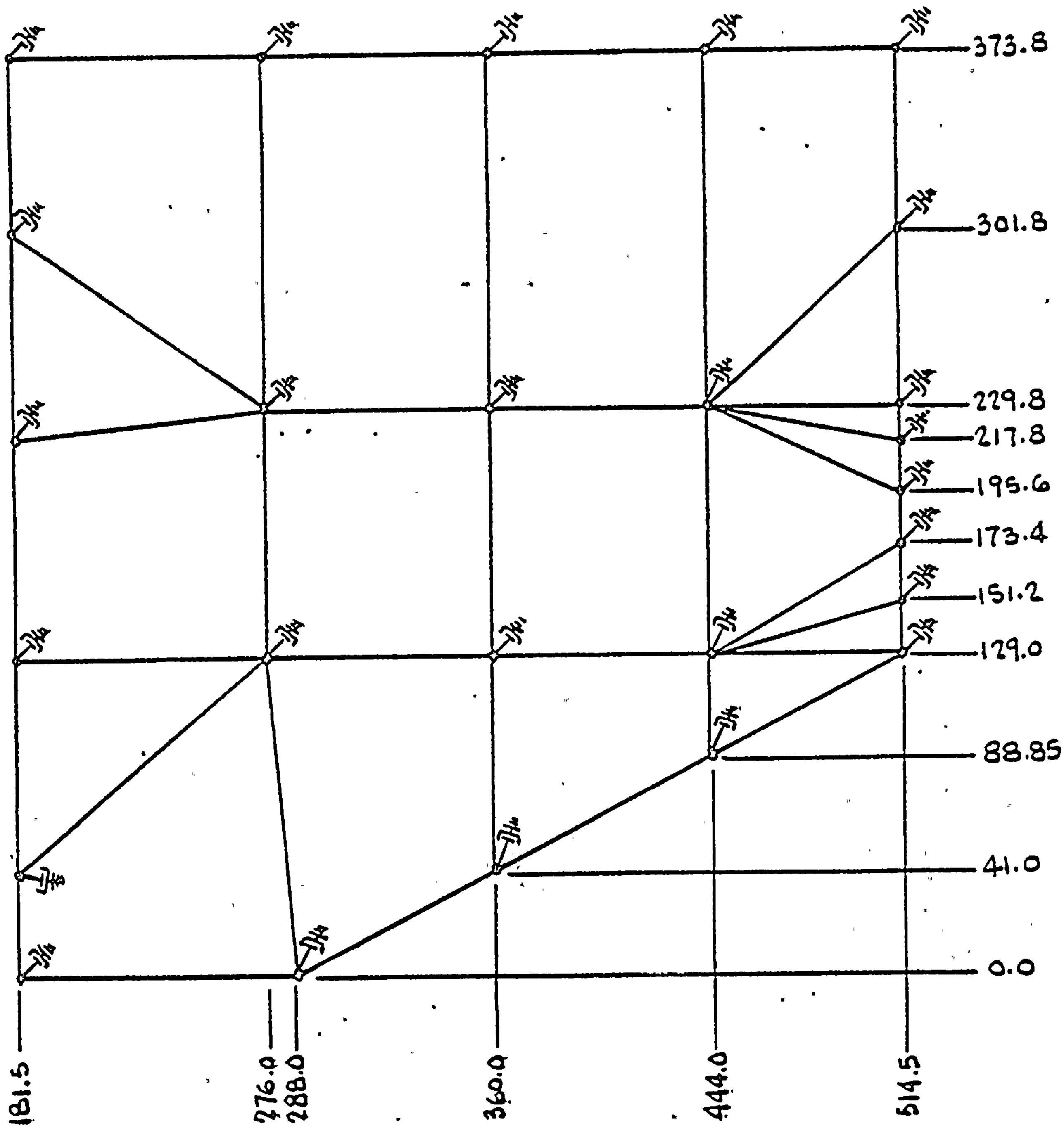


SECTION 7 @ 90°-120°

GROUNDED DAMPER

NOTE: ALL ELEMENTS ARE WATER

WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT NO. 2	HYDRODYNAMIC FINITE ELEMENT MODEL OF WETWELL	FIGURE 130.073-7

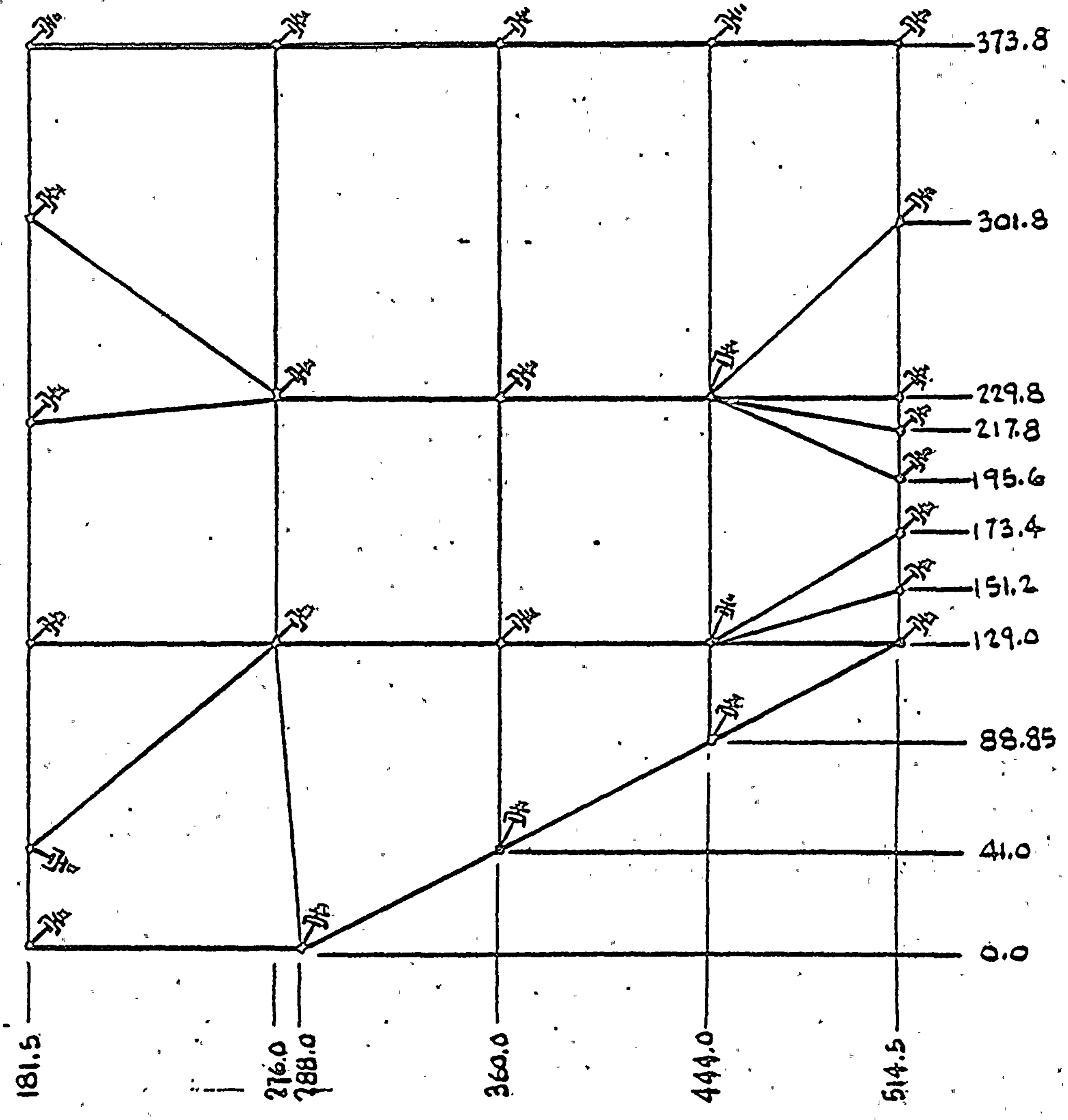


SECTION 8 @ 120°-150°

GROUNDED DAMPER

NOTE: ALL ELEMENTS ARE WATER

WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT NO. 2	HYDRODYNAMIC FINITE ELEMENT MODEL OF WETWELL	FIGURE 130.073-8

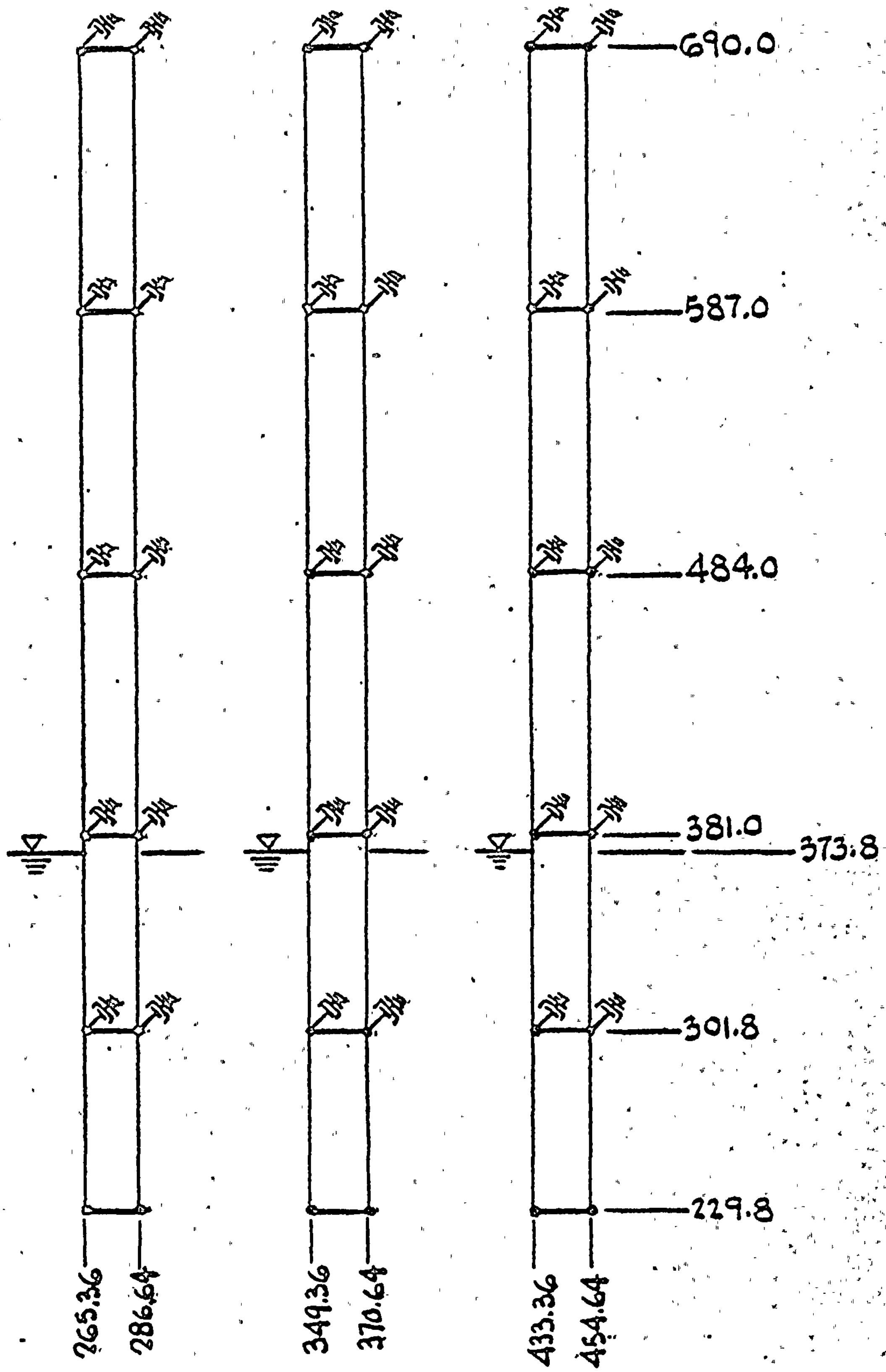


SECTION 9 @150° - 180°

GROUNDED DAMPER

NOTE: ALL ELEMENTS ARE WATER...

WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT NO. 2	HYDRODYNAMIC FINITE ELEMENT MODEL OF WETWELL	FIGURE 130.073-9

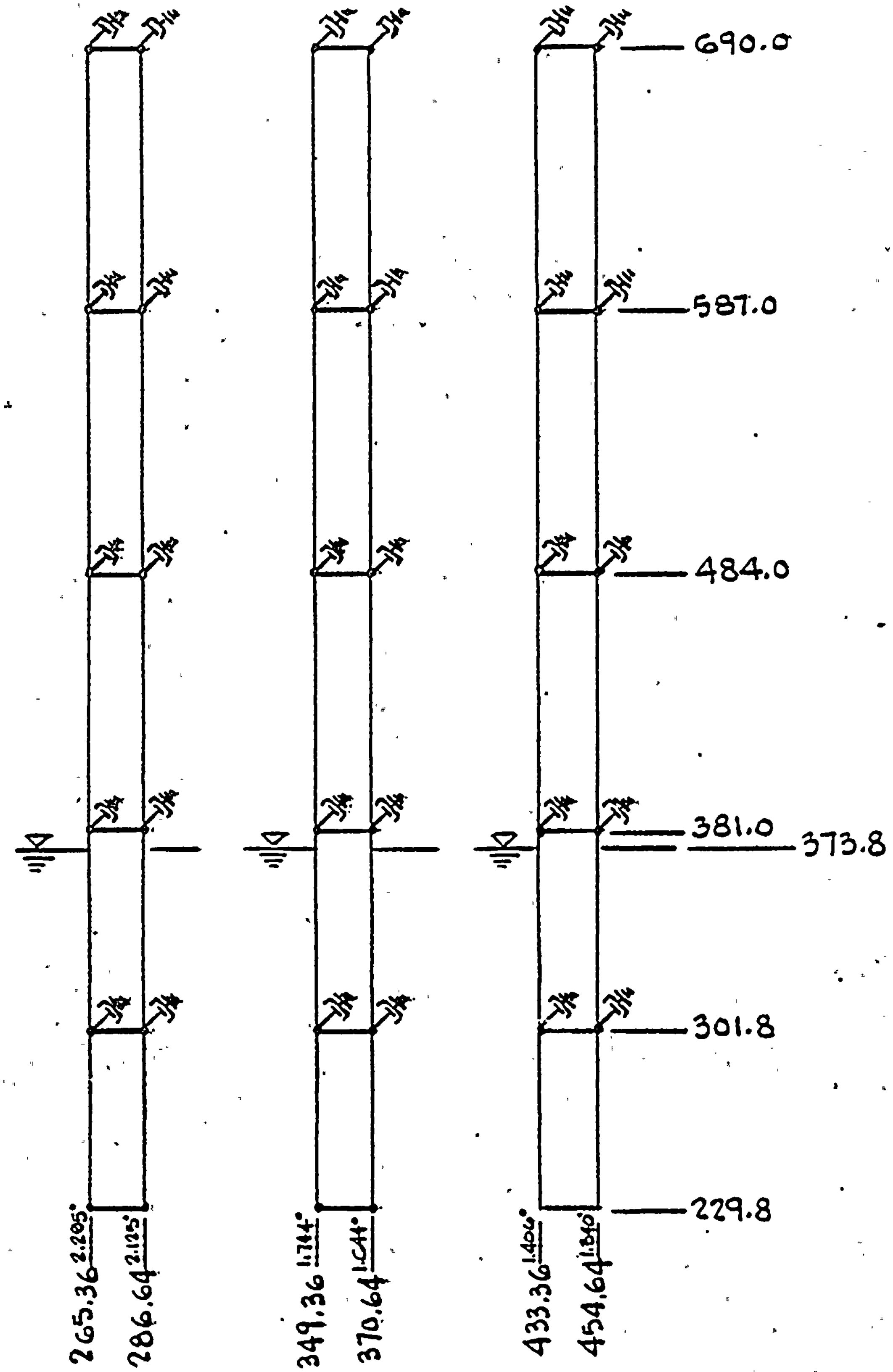


SECTION 1 VENTS @ 0°

GROUNDED DAMPER

NOTE: ALL ELEMENTS ARE STEAM

WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT NO. 2	HYDRODYNAMIC FINITE ELEMENT MODEL OF WETWELL	FIGURE 130.073-1[illegible]



SECTION 2 VENTS

GROUNDED DAMPER

NOTE: ALL ELEMENTS ARE STEAM

WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT NO. 2	HYDRODYNAMIC FINITE ELEMENT MODEL OF WETWELL	FIGURE 130.073-11

Q. 130.074
(Q220.25)
(3.8.3)
(RSP)

With regard to Table 3.8-10 of the FSAR where the abnormal/ severe environmental loads for internal concrete structures were not considered, and to Table 3.8-11 of the FSAR where live loads were not considered in some load combinations for the internal steel structures, provide overall assessment on the impact of such omissions and demonstrate that the corresponding requirements of Section 3.8.3 of the SRP are complied with.

Response:

The load combinations and acceptance criteria defined in the SRP Section 3.8.3 are accounted for in the WNP-2 design and calculations show that the structures internal to containment have enough capacity to meet the requirements.

Q. 130.075
(Q220.26)
(3.8.4)

The loads and load combinations used in Tables 3.8-15 and 3.8-16 of Section 3.8.4 of the FSAR are different from those presented in Section 3.8.4 of the SRP. Demonstrate that the applicable requirements are met in the design or justify the deviations from the SRP.

Response:

The design of WNP-2 structures was done before SRP 3.8.4 was issued. The design of WNP-2 has been reevaluated and the findings indicate that the load combinations and acceptance criteria specified in Section 3.8.4 of the SRP are satisfied.

Q. 130.076
(Q220.27)
(3.8.4)

Are there any spent fuel pool structures used in WNP-2. If so, describe key dimensions, structure modeling, static and seismic analysis criteria, procedures, assumption and computer codes used, and the key results. A copy of "Minimum Requirements for Design of Spent Fuel Pool Racks" is enclosed (Attachment 5).*

Response:

The spent fuel storage racks are described in detail including key dimensions, structure modeling, static and seismic analysis criteria, assumptions, computer codes used and key results in 9.1.2 of the FSAR.

Key dimensions of the spent fuel storage racks are specified in Figures 9.1-2 and 9.1-3. The structural modeling and analysis, including assumptions, computer codes, and results, are in NUS Reports 2061, Structural Analysis of the Spent Fuel Racks for WNP-2, November 1977, and 2060, Fuel-Can Interaction Analysis, October 17, 1977 which was submitted to the NRC on ~~________.**~~ Supply System (Renberger) to NRC (Varga) letter G02-77-396, dated Oct. 24, 1977.

Conformance of the design, fabrication, and installation of the spent fuel storage racks with Appendix D of NRC SRP 3.8.4 is presently being investigated. No unjustifiable deviations are expected; however, the results of the investigation will be forwarded to NRC in December 1981.

* Attachment not included in FSAR

~~** Supply System to insert letter reference.~~

Q. 130.077
(Q220.28)
(3.8.4)

Confirm if safety-related concrete masonry walls are used in WNP-2 buildings. If so, the criteria contained in Attachment 6* should be followed.

Response:

A review of the WNP-2 safety-related structure was made per the request of IE Bulletin 80-11 and it has been determined that there are no safety-related masonry walls in this plant, See also the letter response attached.

*Attachment not included in FSAR.

Washington Public Power Supply System
A JOINT OPERATING AGENCY

P. O. BOX 968 3000 GEO. WASHINGTON WAY RICHLAND, WASHINGTON 99352 PHONE (509) 375-5000

G02-81-07
January 8, 1981

Docket No. 50-397

Mr. R. L. Tedesco, Assistant Director, Licensing
Division of Licensing
U. S. Nuclear Regulatory Commision
Washington, D. C. 20555

Dear Mr. Tedesco:

Subject: WPPSS NUCLEAR PROJECT NO. 2
CATEGORY I MASONRY WALLS

Reference: Letter, S. A. Varga (NRC) to All Construction Permit and Operating License Applicants, same subject, dated April 21, 1980.

The referenced letter requested information on the use of Category I Masonry walls. There are no Category I Masonry walls at WNP-2. Some removable concrete block walls are to be installed in Class I areas for shielding purposes; but these are stacked loose and enclosed by a metal framework. As such, they do not constitute concrete masonry walls as per the request.

Very truly yours,

G. D. Bouchey
G. D. Bouchey
Director, Nuclear Safety

GDB:OKE:tj

cc: NS Reynolds - Debevoise & Liberman
MD Lynch - NRC
BJ Youngblood - NRC
B. Wood - NUS/LIS
JJ Verderber - B&R NY
ND Lewis - EFSEC, Olympia
JR Lewis - BPA
WNP-2 Files

130077-2

Q. 130.078

The response to Question 130.078 is attached to Issue #11.