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October 25, 1990

1CAN109004

U. S. Nuclear Regulatory Commission
Document Control Desk
Mail Station P1-137
Washington, D.C. 20555

SUBJECT: Arkansas Nuclear One - Unit 1
Docket No. 50-313
License No. DPR-51
Response to NRC Request for Additional Information -
QCST Seismic Qualification

Gentlemen:

NRC letter dated August 22, 1990 (1CNA089003) transmitted a request for additional information regarding our June 18, 1990 response (1CAN069008) to remaining NRC questions regarding the ANO-1 Seismically Qualified Condensate Storage Tank (QCST). Our letter dated July 10, 1989 (1CAN078903) had previously provided a response to your letter dated June 11, 1987 (1CNA068702), which originally transmitted the questions raised during an NRC site visit regarding the QCST.

A response to each item of your specific information request is attached. If you have additional questions regarding this issue, please contact my office.

Very truly yours,

James J. Fisiscaro

James J. Fisiscaro
Manager, Licensing

JJF/RBT/sgw
Attachments

A001
1/1

9011260226 901025
PDR ADOCK 05000313
P PDC

RESPONSE TO NRC QUESTIONS
REQUEST FOR ADDITIONAL INFORMATION
CONDENSATE STORAGE TANK SEISMIC QUALIFICATION

1. The geometrical configuration of the CST together with the dimensions and steel plate thickness of the cylinder and dome; the size and spacing of the bolts.

RESPONSE:

The configuration and materials construction of the QCST can be found in the attached sections of QCST design calculation 82-2086-60 (Attachment 2).

Anchor bolts for the QCST are 1-3/4" in diameter spaced at 15 degrees symmetrically about the tank as Shown on the "Plan" view of drawing C-2056, Sht. 1 (Attachment 4). The bolts are embedded 18" into the concrete base slab as shown in Section H-H of this drawing.

2. The elevation of the CST concrete base slab in relation to the plant finished grade elevation.

RESPONSE:

The nominal elevation of the top of the tank's base slab foundation is 354'-4" as shown on Section A-A of attached drawing C-2056, Sht.1. The nominal plant site elevation is 353' as noted in ANO-1 SAR Section 2.6.2.

3. The location of the 27 RC drilled piers and their lengths together with information on sizes and arrangement of rebars in the piers, if any.

RESPONSE:

The location and arrangement of the concrete drilled piers is shown on the "Plan" view of the attached drawing C-2056, Sht.1. The average length of the drilled piers is approximately 29'. The size, spacing and arrangement of the reinforcing steel used in the piers is shown in Section C-C and Section E-E of the attached drawing C-2056, Sht.1.

4. The thickness of the 5 ft. high concrete tornado missile shield wall and details of rebar size and spacing including connections to the base mat and spacing between the steel CST and the wall. Indicate if this wall is a seismic Category 1 structure.

RESPONSE:

The thickness of the tornado missile shield wall is 18". The size, spacing and arrangement of the reinforcing steel used in the missile shield wall is shown in Section A-A of the attached drawing C-2056, Sheet 1. The tornado missile shield wall, as part of the tank base mat, is a seismic Category I structure.

5. The results of the design control motion of a rock outcrop and the rock motion and free field surface motion as computed by SHAKE; and the results of the bedrock motion after deconvolution by FLUSH. Provide the response spectrum at each location.

RESPONSE:

The revised response spectra as generated by the FLUSH computer output in response to the NRC request for additional information of June 11, 1987 are provided on Figures 6 through 9 of design calculation 82D-2086-08 (Attachment 3). The revised design response spectra (peak broadened) also developed in response to the initial NRC request are attached (Figures 10 through 13 of the design calculation). The SHAKE free field motion results (plotted versus the SAR and synthetic time histories) are provided on Figures 1 and 2 of Appendix M of design calculation 82D-2086-08 (Attachment 3). A printout of the FLUSH bedrock motion is not available.

6. The mathematical model used in the soil-structure analysis using FLUSH.

RESPONSE:

The mathematical model used for the tank foundation analysis is provided on Figure 5 of the design calculation 82D-2086-08 (Attachment 3).

7. A summary of the calculation indicating how the steel tank, the concrete base slab, and the tornado missile shield wall were analyzed and designed. Provide the soil parameter values if used in the analysis.

RESPONSE:

Calculation details regarding the QCST steel tank can be found in the attached pages from Engineering design calculation 82-2086-60 (Attachment 2).

The base slab for the tank was designed to the requirements of ACI-318-83 utilizing seismic loads derived from the design response spectra noted above in response to question 5. The tornado missile shield wall was also designed to the requirements of ACI-318-83 with tornado missile shield design methodology as defined by Bechtel TOPICAL Report BC-TOP-9A, Rev.2, "Design of Structures for Missile Impact". Soil parameters used for the design of the tank foundation include:

Shear Wave Velocity: 0'- 10'= 580 FPS
10'- 20'= [illegible] FPS
20'- 30'= 700 FPS

Poisson's Ratio: Top of soil = .45, decreasing to .40 at 30'

Shear Modulus: 0'- 10'= 1,384,000 PSF
10'- 20'= 1,740,000 PSF
20'- 30'= 2,020,000 PSF

8. The CST design at ANO-1 is unique in that it is supported on drilled piers which are anchored into the unweathered bedrock at the bottom and rigidly connected with the CST concrete base slab at the top. Justify the use of SHAKE and FLUSH for the soil-structure interaction analysis, and also the application of the results of the Taiwan Power study to the ANO-1 CST design.

RESPONSE:

The design of the QCST is not considered unique given the existing arrangement of ANO site structures in the area where the tank had to be located and considering operational requirements for the tank as well as economics of construction. During the preliminary design phase for the foundation, several options were investigated with regard to the best approach to support the tank. The available data showed that a drilled pier foundation would provide the best solution to avoid any potential for differential settlement of the tank and would adequately address any issues which could have been raised relative to the question of adverse affects on the tank as a result of differential soil settlement.

The regulatory climate at the time of the foundation design did not lend itself to pursuing the option of a base mat foundation directly on the clay soil due to the potential for questions concerning soil settlement. In addition, excavation of the clay soil to the unweathered shale and replacement with engineered material was considered difficult and too costly due to the presence of many buried services in the area. Therefore, reinforced drilled piers, embedded into the bedrock to ensure adequate bearing capacity, were selected for the foundation.

In late 1987, Professor H. Bolton Seed was retained to perform a third party independent review of the original FLUSH analysis and to provide recommendations as to the best approach to respond to the NRC questions on the design of the QCST foundation. Professor Seed indicated that the original FLUSH analysis was reasonable and with appropriate corrections to the soil input parameters could be reapplied in the reanalysis. Professor Seed noted that in order to resolve the NRC comments in a timely manner, a more conservative approach should be utilized in the reanalysis of the QCST foundation. Based on his recommendations, the combined SHAKE and FLUSH programs were used in the reanalysis.

As part of the reanalysis effort, Professor J. Lysmer (co-author of the SHAKE and FLUSH programs) was consulted on the proper modelling and application of these programs to the QCST foundation design. The revised calculation packages were submitted to Professor Seed for his review. Professor Seed concluded that, "...the procedures you have used to make the analysis are in keeping with the best techniques available for this purpose". This conclusion was based on Professor Seed's knowledge and experience as a recognized expert in the area of the design of structures to resist seismic forces.

Professor Seed noted that the Taiwan Power studies have shown that the FLUSH program provides a reasonable representation of the seismic behavior of a structure with respect to soil-structure interaction during a seismic event. However, neither the data nor the results of the Taiwan Power study were utilized in the reanalysis effort associated with the resolution of the NRC comments on the design of the foundation of the QCST.

Design Calculation 82-2086-60
(Pages 20, 21, 28 through 52 of 83)

Table 3

Item	Material Specification	S (psi)	Fy (psi)
Plate Bottom Shell Roof	SA240 Type 304L(HRAP)	15700	25000
Piping ≤ 2" (Sch 40S) > 3" (Sch 10S)	SA312 Type 304L	15700	25000
Bolting	SA193B7/SA1932H	25000 7000	105000
External Structural	A36		36000
Anchor Bolts (By others)	A36		36000

Fy: Yield Stress
S : Allowable Stress Value

REFERENCE: ASME CODE SECTION III

DOCUMENT TYPE & NO. 82-208660
ATTACH A PAGE 20 OF 83

SUBJECT	Birmingham	REVISION 0		REFERENCE NO.
TABLE 3 CONDENSATE STORAGE TANK ARKANSAS POWER & LIGHT	MADE BY ORS	VERIFIED BY	MADE BY	VERIFIED BY	SHT B-7 OF ___
	DATE 4/11/90	DATE 4/11/90	DATE	DATE	853601

TABLE 4
FORCES and MOMENTS ON NOZZLES

	± Fx	± Fy	± Fz	± Mx	± My	± Mz
1" SCH 40S						
Normal	111	111	111	958	958	958
Upset	146	171	146	5,695	4,113	5,321
Emergency	223	223	223	6,111	4,204	5,443
4" SCH 40S (Bottom)						
Normal	120	660	20	690	290	2,545
Upset	225	790	40	1,480	510	4,000
Emergency	325	905	55	2,220	715	5,750
4" SCH 40S (Shell)						
Normal	0	368	0	0	0	5,102
Upset	4	424	26	55	513	5,992
Emergency	7	43[illegible]	46	97	902	6,239
6" SCH 40S						
Normal	690	1,45[illegible]	110	2,020	905	12,815
Upset	845	1,50[illegible]	130	2,370	990	15,475
Emergency	1,260	1,[illegible]00	140	2,625	1,080	23,965
12" SCH 40S						
Normal	1,000	2,310	310	5,820	8,335	17,910
Upset	1,447	2,761	902	17,397	25,043	25,839
Emergency	1,716	2,943	1,304	25,328	28,397	34,551

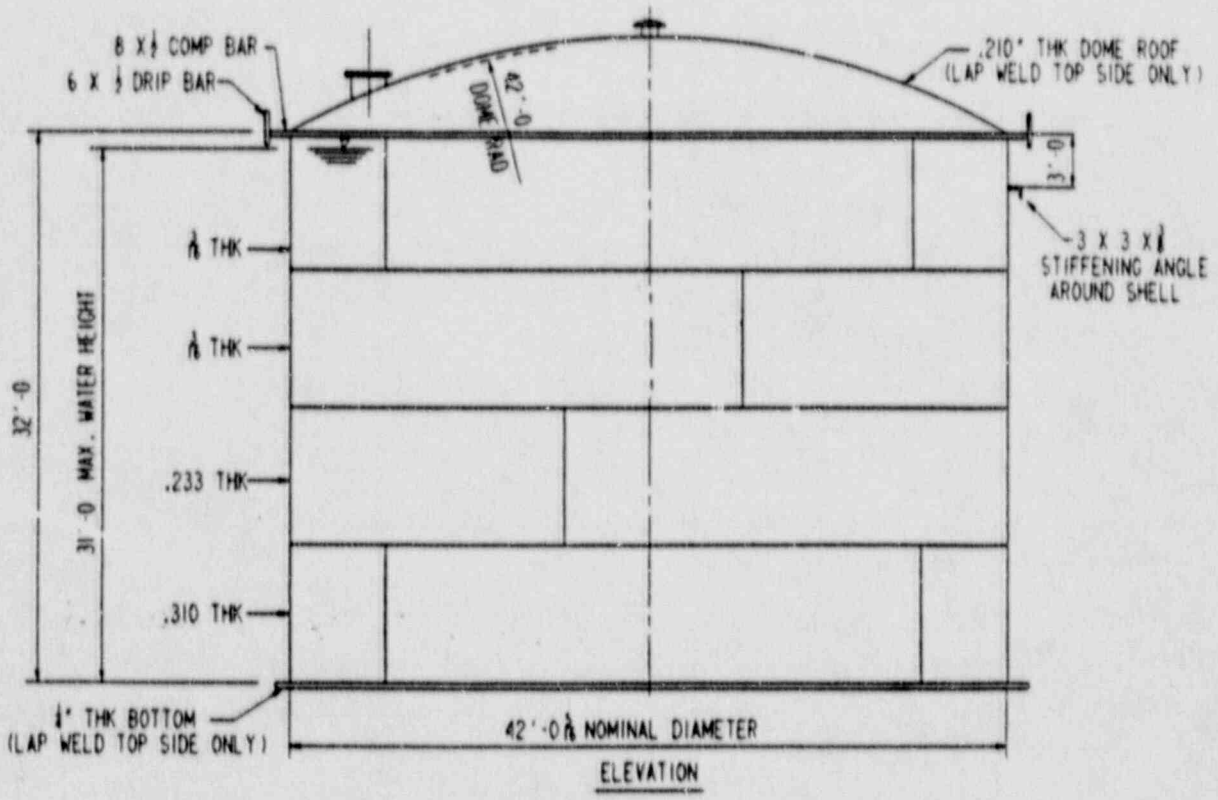
Reference: APL-M-2511 REV 6
TECHNICAL SPECIFICATION

DOCUMENT TYPE & NO.	82-1086 60
ATTACH. A	PAGE 21 OF 83

Notes for Table 1:

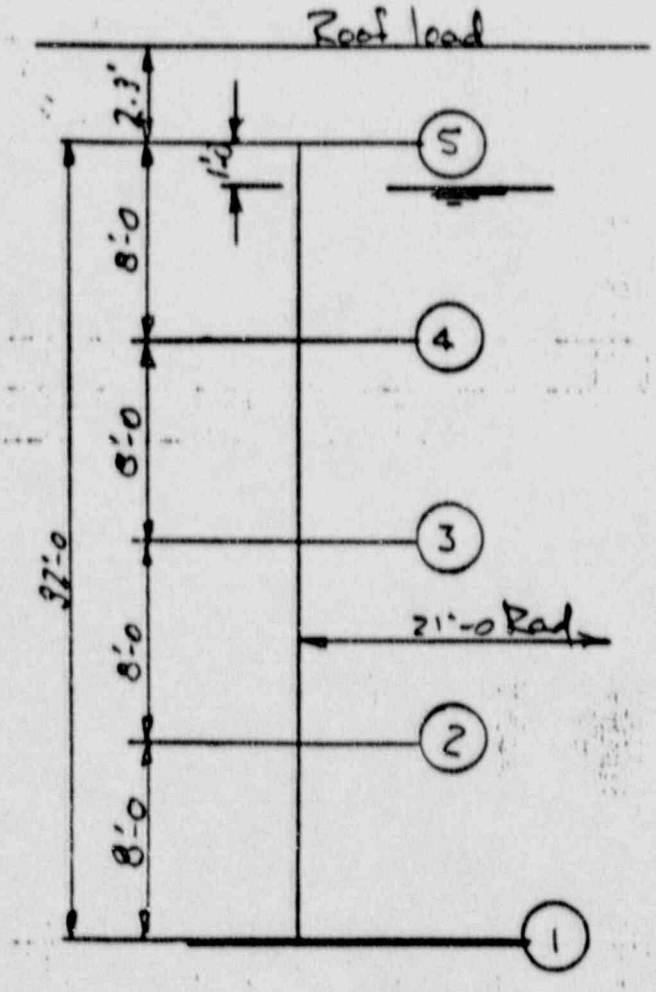
1. Local coordinate system, +Y direction is axial.
2. Definitions:
   a) Normal Condition, Service Level A- Gravity + Pressure + Thermal
   b) Upset Condition, Service Level B - Gravity + Pressure + Thermal + Operating Basis Earthquake (+ Plastic for N_2 Sparger)
   c) Emergency Condition, Service Level C - Gravity + Pressure + Thermal + Design Basis Earthquake (Safe Shutdown Earthquake) (+ Plastic for N_2 Sparger)
3. Forces in lbf, Moments in in-lbf.

SUBJECT	CBI Birmingham	REVISION 0		REFERENCE NO
TABLE 4				N81049
CONDENSATE STORAGE TANK	MADE BY CRS / VERIFIED BY	MADE BY	VERIFIED BY	SHT B-8 OF ___
ARKANSAS POWER & LIGHT	DATE 3/27/90 / DATE 3/27/90	DATE	DATE	853601



DOCUMENT TYPE & NO.	82-2086-60
ATTACH A	PAGE 28 OF 83

SUBJECT	OFFICE	REVISION	REFERENCE NO
SEISMIC ANALYSIS CONDENSATE STORAGE TANK ARKANSAS POWER & LIGHT	CBI BIRMINGHAM	0	NB1049
	MADE BY: CRS / VERIFIED BY:	MADE BY / VERIFIED BY	SHT C-1 OF ___
	DATE: 12/15/89 / DATE: 3/23/90	DATE / DATE	853601



SHELL MODEL

DOCUMENT TYPE & NO.	82-2086-60
ATTACH. A	PAGE 29 OF 83

SUBJECT: SHELL MODEL CONDENSATE STORAGE TANK ARKANSAS POWER & LIGHT	OFFICE: CBI BIRMINGHAM	REVISION 0		REFERENCE NO: N81049
	MADE BY: CRS / VERIFIED BY	MADE BY	VERIFIED BY	SHT C-2 OF ___
	DATE: 2/14/90 / DATE: 3/23/90	DATE	DATE	853601

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GO 64A AUG 87

SUMMARY OF SHELL STRESSES

POINT ON SHELL	TYPE STRESS	LOADING	LOAD COMBINATION 3	4	5	6
1	σ_θ	HYDROSTATIC	10,570	5,105	10,570	5,105
		SEISMIC	2,362	839	3,695	1,516
		TOTAL	12,932	5,944	14,265	6,621
	σ_ϕ	DL + LL	-189	-189	-189	-189
		SEISMIC	-1,428	-185	-2,152	-827
		TOTAL	-1,617	-374	-2,341	-516
		ALLOWABLE	-2,365	-2,365	-3,225	-3,225
2	σ_θ	HYDROSTATIC	10,310	3,050	10,310	3,050
		SEISMIC	2,915	712	4,495	1,275
		TOTAL	13,225	3,762	14,805	4,325
	σ_ϕ	DL + LL	-215	-215	-215	-215
		SEISMIC	-906	-91	-1,370	-161
		TOTAL	-1,121	-306	-1,585	-376
		ALLOWABLE	-1,780		-2,430	-2,430
3	σ_θ	HYDROSTATIC	8,160	0	8,160	0
		SEISMIC	2,805	389	4,288	741
		TOTAL	10,965	389	12,448	741
	σ_ϕ	DL + LL	-233	-233	-233	-233
		SEISMIC	-402	-53	-612	-106
		TOTAL	-635	-286	-845	-339
		ALLOWABLE	-1,430	-1,430	-1,950	-1,950
4	σ_θ	HYDROSTATIC	3,483	0	3,483	0
		SEISMIC	1,430	0	2,187	0
		TOTAL	4,923	0	5,680	0
	σ_ϕ	DL + LL	-205	-205	-205	-205
		SEISMIC	-92	-15	-141	-30
		TOTAL	-297	-220	-346	-235
		ALLOWABLE	-1,430	-1,430	-1,950	-1,950
ALLOWABLES		TENSION	14,680	14,680	20,020	20,020

ALL STRESSES WITHIN ALLOWABLE STRESSES, SHELL OK.

DOCUMENT TYPE & NO. 82-2086-60

ATTACH A PAGE 30 OF 83

SUBJECT	OFFICE	REVISION	REFERENCE NO.
STRESS SUMMARIES	DBE	0	N81049
	MADE BY / VERIFIED BY: CRS	MADE BY / VERIFIED BY	SHT C-3 OF ___
	DATE: 3/15/90 / DATE: 3/23/90	DATE / DATE	853601

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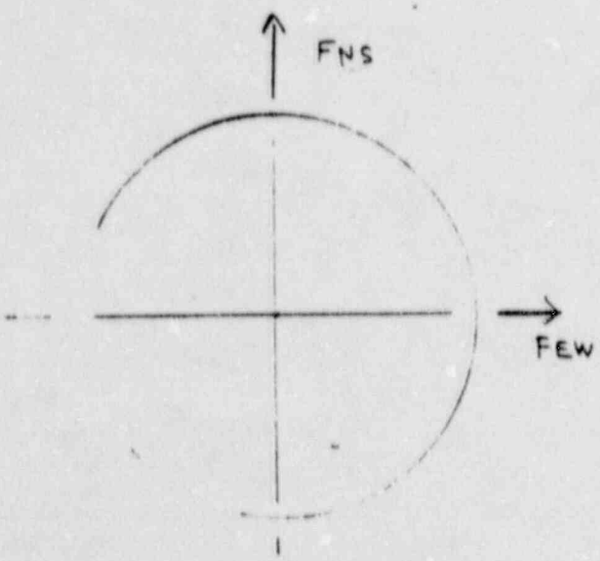
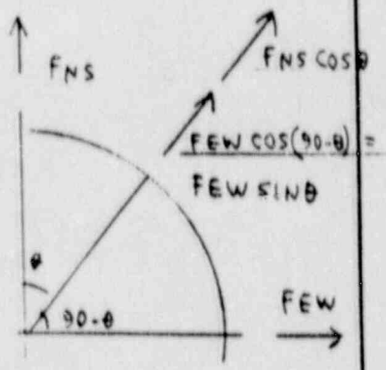
BIAXIAL HORIZONTAL SEISMIC RESPONSE

For a cylindrical tank structure subjected to concurrent biaxial seismic forces which are combined by SRSS.



PLAN OF TANK



AT AN INTERMEDIATE AZIMUTH LOCATION

Combining the effects by SRSS

$$\text{RESULTANT} = [(F_{EW}\,\text{SIN}\theta)^2 + (F_{NS}\text{COS}\theta)]^{1/2}$$

WHEN $F_{EW} = F_{NS} = F$

$$\text{RESULTANT} = [F^2(\text{SIN}^2\theta + \text{COS}^2\theta]^{1/2} = F$$

For Biaxial horizontal seismic combined by SRSS, the resultant at any azimuth is no larger than the specified response.

Additionally, vertical seismic effects are specified to be combined by SRSS

DOCUMENT TYPE & NO.	82-2086-60
ATTACH. A	PAGE 31 OF 83

SUBJECT	CBI Birmingham	REVISION 0		REFERENCE NO.
SHELL DESIGN CONDENSATE STORAGE TANK ARKANSAS POWER & LIGHT	MADE BY VERIFIED BY CRS	MADE BY	VERIFIED BY	N81049 SHT C-4 OF ___
	DATE DATE 3/28/90 3/29/90	DATE	DATE	853601

SHELL DESIGN

Variables

D = Diameter of tank = 42.0 (ft) R = Radius of tank = 21.0 (ft)

HI = Height of tank = 32.0 (ft)

FBD = Freeboard from top of shell to liquid = 1(FT) = 12 (IN)

ρ = Weight of product stored = 62.4 (pcf), G = 1.0

VP = Internal gas pressure = 0 (psi)

P_V = Negative internal pressure (vacuum) = 0 (psi)

E = Modulus of elasticity of shell material = 28×10^6 (psi)

S_m = Product allowable stress (w/o seismic) = 15700 (psi)

SI = Seismic stress increase factor (for tension & compression) = 1.1 OBE / 1.5 DBE

$\dot{u}_o$ = Horizontal Seismic Factor = OBE - 0.30g FULL / DBE - 0.15 ; 0.16g - ½ FULL / 1.28

$\dot{u}_V$ = Vertical seismic factor = OBE - 0.075 / DBE - 0.15 g

R_L = Projected roof dead load + live load = 38.0 (psf)

R_{LS} = Load on roof subjected to earthquake = 52500 (lbs)

H_{CG} = Height of C.G. of load on roof above shell-to-roof junction = 2.30 (ft)

g = Acceleration of gravity = 32.2 (ft/sec²)

w = Tank shell weight = 91.39 (FIRSS) (lb/ft²/in) (40.8 for steel)

Tank anchored X YES ____ NO

Corrosion allowance = 0 (in)

DOCUMENT TYPE & NO.	82-2086-60
ATTACH. A	PAGE 32 OF 83

t = Thickness of shell ring (exclusive of corrosion allowance)

Ring No.	Btm. Shl. Ring 1	2	3	4
Ring ht. (ft)	8	8	8	8
Ring thk. (in)	0.310	0.233	0.1875	0.1875

SUBJECT	OFFICE	REVISION	REFERENCE NO.
SHELL DESIGN CONDENSATE STORAGE TANK ARKANSAS POWER & LIGHT	CBI BIRMINGHAM	0	N81049
	MADE BY: CRS / VERIFIED BY:	MADE BY / VERIFIED BY	SHT C-5 OF ___
	DATE: 1/19/90 / DATE: 8/23/90	DATE / DATE	853601

Other Nomenclature

H = Total height of product, HI - FBD (ft)

y = Product height above point under consideration, for impulsive pressure, fluid depth (ft)

y_B = Elevation above bottom to point under consideration (h-y) (ft)

N_Θ = Circumferential load per unit length due to hydrostatic head and internal gas pressure (lb/in)

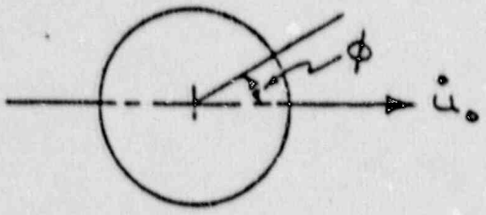
$N_{\Theta C}$ = Circumferential load per unit length due to convective forces (lb/in)

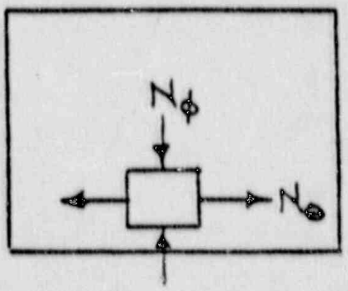
$N_{\phi I}$ = Axial load per unit length due to impulsive forces (lb/in)

$N_{\phi C}$ = Axial load per unit length due to convective forces (lb/in)

$N_{\phi\Theta}$ = Shear force per unit length (lb/in)

ϕ = Angle WRT direction of E.Q. (rad.)





DOCUMENT NO. & REV.	82-2086-60
ATTACH. A	PAGE 33 OF 83

SUBJECT: SHELL DESIGN CONDENSATE STORAGE TANK ARKANSAS POWER & LIGHT	CHI OFFICE: BIRMINGHAM	REVISION 0		REFERENCE NO: N8109
	MADE BY: CRS	VERIFIED BY: [illegible]	MADE BY	VERIFIED BY
	DATE: 1/19/90	DATE: 3/23/90	DATE	DATE

SHT C-6 OF ___

853601

SUBJECT
SHELL DESIGN - PERIOD
CONDENSATE STORAGE TANK
ARKANSAS POWER & LIGHT

PANEL LENGTH (IN)	WT (K)	BEND DEFL (IN)	SHEAR DEFL (IN)	TOTAL DEFL (IN)
	57.25	2.183×10^{-2}	1.25×10^{-1}	0.1468
	19.66	1.356×10^{-2}	1.210×10^{-1}	0.1346
	273.9	1.270×10^{-2}	1.204×10^{-1}	0.1331
	420.0	0.799×10^{-2}	1.056×10^{-1}	0.1136
	350.8	0.494×10^{-2}	8.702×10^{-2}	0.09196
	351.7	0.2391×10^{-2}	5.991×10^{-2}	0.06229
	352.5	0.06624×10^{-2}	3.316×10^{-2}	0.03382
	176.2	0	0	0

MODEL FULL

$\Sigma WX = 161.31$

$\Sigma WX^2 = 16.60$

$$T = 2\pi \left[\frac{16.60}{161.31 \times 386.4} \right]^{1/2} = 0.1026 \text{ SEC}$$

NOTE: TOTAL DEFLECTION MAY BE SCALED BY THE OBE OR SSE ACCELERATION IN g TO FIND THE SEISMIC MODE SHAPE

DOCUMENT ... & NO. 82-2086-60
ATTACH A
PAGE 35 OF 83

CBI OFFICE BIRMINGHAM	REVISION 0	REFERENCE NO. N81049	
MADE BY CRS	VERIFIED BY	MADE BY	VERIFIED BY
DATE 2/8/90	DATE 3/23/90	DATE	DATE
			SHT C-8 OF
			853601

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Natural Period of Tank

The Rayleigh-Ritz Method has been used to determine the natural fundamental period of vibration of the tank structure.

The basic assumptions made in the use of this method are:

1. Distributed mass of the structure can be lumped at a finite number of point masses along the length of the structure.

2. The dynamic mode shape of vibration is the same as the static deflection of the structure loaded under its own weight.

The weight W_o of the contained liquid which acts as if it were a solid mass in rigid contact with the tank walls is included in the period calculation.

A numerical integration technique is used to calculate forces, moments and deflections

$$T = 2\pi \sqrt{\frac{\sum_{i=1}^{n} w_i x_i^2}{g \sum_{i=1}^{n} w_i x_i}}$$

For a more complete description of the Rayleigh-Ritz Method refer to "Vibration Problems in Engineering" by S. Timoshenko and D. H. Young.

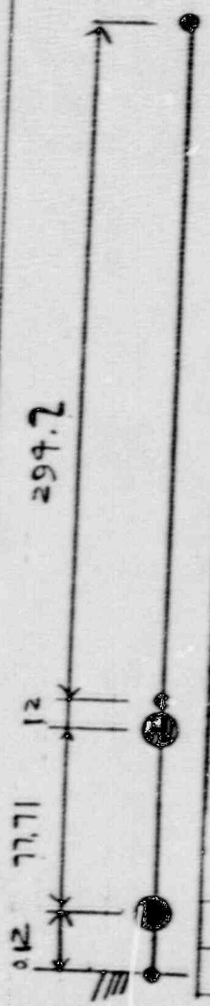
DOCUMENT TYPE & NO.	82-2086-60
ATTACH. A	PAGE 34 OF 83

T = period in seconds
N = No. of points
w_i = lumped weight at point i (lb)
x_i = static deflection at point i (inches)
g = 386.4 in/sec^2

SUBJECT	OFFICE	REVISION	REFERENCE NO.
SHELL DESIGN CONDENSATE STORAGE TANK ARKANSAS POWER & LIGHT	CBI BIRMINGHAM	0	N81049
	MADE BY: CRS / VERIFIED BY:	MADE BY / VERIFIED BY	SHT 67 OF ___
	DATE: 1/19/90 / DATE: 3/23/90	DATE / DATE	853601

SUBJECT
SHELL DESIGN-PERIOD
CONDENSATE STORAGE TANK
ARKANSAS POWER & LIGHT

PANEL LENGTH	WT (K)	BENDING DEFL (IN)	SHEAR DEFL (IN)	TOTAL DEFL (IN)
	67.87	4.282×10^{-3}	2.269×10^{-2}	2.697×10^{-2}
12	30.62	3.791×10^{-4}	1.269×10^{-2}	1.302×10^{-2}
11.11	315.00	2.956×10^{-4}	1.219×10^{-2}	1.249×10^{-2}
10	285.00	8.799×10^{-10}	3.175×10^{-5}	3.175×10^{-5}
	44.06	0	0	0



MODE: HALF FULL

$\Sigma WX = 6.173$
$\Sigma WX^2 = 0.1037$

$$T = 2\pi \left[\frac{0.1037}{6.173 \times 386.4} \right]^{1/2} = 0.0415 \text{ SEC}$$

NOTE: TOTAL DEFLECTION MAY BE SCALED BY THE OBE OR SSE ACCELERATION IN g TO FIND THE SEISMIC MODE SHAPE.

DOCUMENT NO.	82.2086.00
ATTACH A	PAGE 36 OF 83

OFFICE BIRMINGHAM	REVISION 0		REFERENCE NO. N81049
MADE BY CRS	VERIFIED BY hm	MADE BY	VERIFIED BY
DATE 2/8/90	DATE 2/23/90	DATE	DATE
			SHT C.9 OF

853601

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GD-94A AUG 87

Acceleration of Tank and Constrained Fluid

Acceleration of the tank and constrained fluid is obtained from the response spectrum curve provided for use with this tank.

Period of Sloshing Water - T

From TID-7024 eq. 6.19

$$\omega^2 = \frac{1.84g}{R} \tanh\left(1.84 \frac{h}{R}\right)$$

and $T = \frac{2\pi}{\omega}$

DOCUMENT TYPE & NO.	82-2086-60
ATTACH. A	PAGE 37 OF 83

Spectral Velocity of Sloshing Water - S_v

$$S_v = \frac{T\,a}{2\pi}$$

T = period of sloshing wave

a = spectral acceleration in ft/sec², at period of sloshing wave

SEISMIC LOAD	FILL COND.	TANK PERIOD	DAMPING (%)	HORIZ ACC. U_0 (g)	T (SEC)	SV (FT/SEC	REMARKS
OBE	FULL	0.1026	2	0.300	3.757	0.83	
↓	50%	0.0415	↓	0.160	3.997	0.84	
DBE	FULL	0.1026	4	0.450	3.757	1.64	
↓	50%	0.0415	↓	0.280	3.997	1.64	

SUBJECT	OFFICE	REVISION		REFERENCE NO.
SHELL DESIGN CONDENSATE STORAGE TANK ARKANSAS POWER & LIGHT	CBI BIRMINGHAM	0		N81049
	MADE BY CRS / VERIFIED BY [signature]	MADE BY	VERIFIED BY	SHT C-10 OF ___
	DATE 1/19/90 / DATE 3/23/90	DATE	DATE	853601

Wave Depth d_{max}

From the basic properties of the wave, the maximum amplitude $A_1 = S_v/\omega$

From TID-7024 eq. 6.20

$$\theta_h = 1.534 \frac{A_1}{R} \tanh\left(1.84 \frac{h}{R}\right)$$

and from eq. 6.22 the wave depth is

$$d_{max} = \frac{.408\ R \coth\left(1.84 \frac{h}{R}\right)}{\frac{g}{\omega^2 \theta_h R} - 1}$$

DOCUMENT TYPE & NO.	82-2086.60
ATTACH A	PAGE 38 OF 83

SEISMIC LOAD	FILL CONDITION	d_{MAX} (Ft)
OBE	FULL	0.606
↓	50%	0.592
DBE	FULL	1.286
↓	50%	1.212

Circumferential Stress in Each Shell Ring

The circumferential membrane stress in each ring excluding earthquake is

$$\sigma_\theta = \frac{N\theta}{t} = \frac{PR}{t}$$

where P = hydrostatic head

NOTE: CHECK POINT IS ONE FOOT ABOVE CIRCUMFERENTIAL JOINT (IN ACCORDANCE WITH ASME CODE RULES)

	TANK FULL				TANK 50% FULL			
Ring	1	2	3	4	1	2	3	4
N_θ	3276	2402	1529	655	1582	710	0	0
t	0.310	0.233	0.1875	0.1875	0.310	0.233	0.1875	0.1875
σ_θ	10568	10310	8155	3493	5103	3047	0	0

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SHELL DESIGN CONDENSATE STORAGE TANK ARKANSAS POWER & LIGHT	CBI BIRMINGHAM	0	N81049
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DATE 1/19/90 / DATE 3/23/90	DATE / DATE		853601

The circumferential stress in each ring due to impulsive plus convective plus vertical seismic forces is:

$$\sigma_{\theta s} = \frac{\left[N_{\theta I}^2 + N_{\theta C}^2 + (N_\theta \times \dot{u}_v/g)^2\right]^{1/2}}{t} \quad \text{(COMBINED BY SRSS)}$$

where from TID-7024 eq. F.79, pressure due to the impulsive force is

$$\text{(for } y \leq 1.35R) \qquad P = \rho \dot{u}_o h \left[\frac{y}{h} - 1/2\left(\frac{y}{h}\right)^2\right]\sqrt{3} \tanh\left(\sqrt{3}\,\frac{R}{h}\right)$$

For $y \geq 1.35R$, the paper, "Earthquake Pressures on Fluid Containers", by G. W. Housner, page 7 states that $P = \frac{\rho}{g} \dot{u}_o R$

$$N_{\theta I} = PR$$

From TID-7024 eq. F.96 pressure due to the convective force is

$$P_w = \sqrt{3/8}\ \rho R^2 \theta_h \left[1 - 1/3\cos^2\phi - 1/2\sin^2\phi\right]\cos\phi \frac{\cosh\left(\frac{1.84y_s}{R}\right)}{\sinh\left(\frac{1.84h}{R}\right)} \omega^2 \sin$$

For $\phi = 0$ and $\sin \omega t = 1$

$$P_w = .409\ \rho R^2 \theta_h\ \omega^2 \left[\frac{\cosh\left(\frac{1.84y_s}{R}\right)}{\sinh\left(\frac{1.84h}{R}\right)}\right]$$

$$N_{\theta C} = P_w R$$

DOCUMENT TYPE & NO.	82-2086-60
ATTACH. A	PAGE 39 OF 83

SEISMIC CONDITION	FILL CONDITION	$\sigma_{\theta s}$ RING 1	RING 2	RING 3	RING 4	REMARKS
OBE	FULL	2362	2915	2805	1930	
↓	50%	839	712	389	0	
SSE	FULL	3695	4495	4298	2187	
↓	50%	1516	1275	741	0	

SUBJECT	OFFICE	REVISION	REFERENCE NO.
SHELL DESIGN CONDENSATE STORAGE TANK ARKANSAS POWER & LIGHT	CBI BIRMINGHAM	0	N81099
MADE BY CRS / VERIFIED BY		MADE BY / VERIFIED BY	SHT C-12 OF
DATE 2/8/90 / DATE 3/23/90		DATE / DATE	853601

The axial stress in the shell due to horizontal earthquake is the sum of the axial stresses caused by overturning moment. The overturning moment is caused by unsymmetrical convective and impulsive pressures on the shell and the weight on the roof subject to earthquake times the horizontal acceleration times the distance to the bottom of the shell ring.

$$N_{\phi s} = \left[N_{\phi C}^2 + \left(N_{\phi I} + \frac{R_{LS}(y + H_{CG} + FBD)}{\pi R^2} \times \ddot{u}_o / g \right)^2 \right]^{1/2}$$

COMBINED BY SRSS

From TID-7024, eq. F.79 pressure due to impulsive force

$$P_I = \rho \ddot{u}_o h \left[\frac{y}{h} - 0.5\left(\frac{y}{h}\right)^2 \right] \sqrt{3} \tanh \left(\sqrt{3} \frac{R}{h} \right) \cos\theta \quad (\text{for } y \leq 1.35R)$$

and

$$P_I = \rho \ddot{u}_o R \quad (\text{for } y > 1.35R)$$

These two values will be substituted in the basic shells equations for cylindrical shells based on the membrane theory which are represented in the following form:

$$\frac{\partial N_\phi}{\partial \phi} + \frac{1}{R} \frac{\partial N_{\phi\theta}}{\partial \theta} = 0$$

$$\frac{\partial N_{\phi\theta}}{\partial \phi} + \frac{1}{R} \frac{\partial N_\theta}{\partial \theta} = 0$$

$$N_\theta = -pR$$

DOCUMENT TYPE & NO. 82-2086-60
ATTACH. A PAGE 40 OF 83

SUBJECT	OFFICE	REVISION	REFERENCE NO.
SHELL DESIGN CONDENSATE STORAGE TANK ARKANSAS POWER & LIGHT	CB BIRMINGHAM	0	N81049
MADE BY: CRS	VERIFIED BY:	MADE BY:	VERIFIED BY:
DATE: 11/19/90	DATE: 3/29/90	DATE:	DATE:
			SHT C-13 OF ___
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(Refer Chapter 14, page 458 of "Theory of Plates and Shells" by S. Timoshenko & Woinowsky-Krieger).

Now $N_\theta = p_I R$

Substituting this value in the second of the above equations one then obtains $N_{\phi\theta}$ by integration. Using the value of $N_{\phi\theta}$ thus obtained one finds N_ϕ by integrating the first equation.

$$N_{\phi I} = \rho \dot{u}_o h \sqrt{3} \tanh \left(\frac{\sqrt{3}R}{h}\right) \left[\frac{y^3}{6h} - \frac{y^5}{24h^2}\right] \frac{1}{R} \quad \text{(for } y \leq 1.35R\text{)}$$

$$N_{\phi I} = \frac{\rho \dot{u}_o}{2} \left[y^2 - .9yR + .3038R^2\right] \quad \text{(for } y > 1.35R\text{)}$$

Also in the same manner the value of the convective pressure as given in TID Eq. F.96 is substituted in the above equations to give the value of convective force in each shell ring.

$$N_{\phi C} = .182\, \rho R^3 \theta_h \omega^2 \left[\frac{\cosh\left(\frac{1.84(h-y)}{R}\right) - \cosh\left(\frac{1.84h}{R}\right)}{\sinh\left(\frac{1.84h}{R}\right)} + \frac{1.84y}{R}\right]$$

SEISMIC CONDITION	FILL CONDITION	$\sigma_{\phi S} = N_{\phi S}/T$ RING 1	RING 2	RING 3	RING 4	REMARKS
OBE	FULL	±1428	±906	±402	±90	
↓	50%	± 184	± 90	± 58	–	
SSE	FULL	±2152	±1370	± 612	±138	
↓	50%	± 326	± 158	± 101	–	

SUBJECT	OFFICE	REVISION	REFERENCE NO
SHELL DESIGN CONDENSATE STORAGE TANK ARKANSAS POWER & LIGHT	CBI BIRMINGHAM	0	N81049
MADE BY CRS / VERIFIED BY		MADE BY / VERIFIED BY	C-19 SHT ___ OF ___
DATE 1/19/90 / DATE 3/23/90		DATE / DATE	853601

Axial Compressive Stress in Each Ring

The axial compressive stress at the bottom of each shell ring excluding effects of horizontal earthquake is the sum of the stress due to external gas pressure and the roof dead load plus live load reactions at the shell and the weight of shell above the bottom of the ring.

$$N_\phi = -\frac{P_v R}{2} - \left[\frac{R_L R}{2} + \Sigma \text{ shell wt. above bottom or ring (lb/in)}\right]$$

Ring	1	2	3	4
N_ϕ	-52	-50	-44	-38
t	0.310	0.233	0.1875	0.1875
σ_ϕ	-189	-215	-233	-205

$$N_{\phi s} = N_\phi (\dot{u}_v/g)$$

DOCUMENT TYPE & NO.	82-208660
ATTACH. A	PAGE 42 OF 83

OBE (FULL AND 50% FULL)

Ring	1	2	3	4
$N_{\phi s}$	± 5	± 4	± 3	± 3
t	0.310	0.233	0.1875	0.1875
σ_ϕ	± 14	± 17	± 13	± 15

DBE (FULL AND 50% FULL)

Ring	1	2	3	4
$N_{\phi s}$	± 9	± 8	± 6	± 6
t	0.310	0.233	0.1875	0.1875
σ_ϕ	± 27	± 34	± 32	± 30

SUBJECT	OFFICE	REVISION	REFERENCE NO
SHELL DESIGN CONDENSATE STORAGE TANK ARKANSAS POWER & LIGHT	CBI BIRMINGHAM	0	N81049
MADE BY: ORS	VERIFIED BY: [illegible]	MADE BY	VERIFIED BY
DATE: 1/19/90	DATE: 3/23/90	DATE	DATE
			C-15 SHT ___ OF ___
			853601

SUMMATION of SEISMIC STRESSES.

The meridional stress due to vertical acceleration are combined by SRSS with the meridional stresses due to horizontal acceleration. (overturning)

	RING	1	2	3	4
DBE FULL	Vert	14	17	18	15
	horz	1428	906	402	90
	ΣSRSS	1428	906	402	92
DBE 50%	Vert	14	17	18	15
	horz	184	90	50	0
	ΣSRSS	185	91	53	15
					0
DBE FULL	Vert	27	34	32	30
	horz	2152	1370	612	138
	ΣSRSS	2152	1370	612	141
DBE 50%	Vert	27	34	32	30
	horz	326	158	101	0
	ΣSRSS	327	161	106	30

DOCUMENT TYPE & NO.	82-2086-60
ATTACH. A	PAGE 43 OF 83

SUBJECT	OFFICE	REVISION	REFERENCE NO.
SHELL DESIGN	CBI DBE	0	N 81096
	MADE BY: [signature] / VERIFIED BY: CRS	MADE BY / VERIFIED BY	C-16 SHT ___ OF ___
	DATE: 3/15/90 / DATE: 3/19/90	DATE / DATE	853601

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DETERMINATION OF MAXIMUM VALUE OF HOUSNER BENDING MOMENT

In this section the equations of Chapter 6 in TID-7024 are utilized to calculate the maximum value of the Housner bending moment M_o. All the assumptions and limitations of this chapter are applicable with one exception pertaining to calculation of impulsive force. In TID-7024, for tanks with h/R ratios greater than 1.5, the upper portion of the liquid with a depth of 1.5 x radius from the top is considered to be in motion. The liquid in the remaining lower region is assumed to behave as a completely constrained mass of fluid. In calculating the impulsive force our analysis limits this ratio of h/R to 1.35. This is necessitated by the fact that an inconsistency arises if this limitation is not imposed.

The equations for convective forces are applicable regardless of the h/R ratio.

CALCULATION OF BENDING MOMENT M_1 DUE TO CONVECTIVE FORCE

h = height of tank HI - Freeboard FBD

DOCUMENT TYPE & NO.	82-2086-60
ATTACH. A	PAGE 44 OF 88

Total Weight of Liquid

$W = \pi R^2 h \times W =$ 2680000 LB-FULL 1340000 LB 50% FULL

From eq. 6.16 $W_1 = W \times \left\{ .318 \times \frac{R}{h} \times \tanh\left(\frac{1.84h}{R}\right) \right\}$

From eq. 6.21 $P_1 = 1.2 \times W_1 \times \theta_h \times \sin(\omega t)$

SUBJECT	OFFICE	REVISION	REFERENCE NO.
SHELL DESIGN CONDENSATE STORAGE TANK ARKANSAS POWER & LIGHT	CBI BIRMINGHAM	0	N81049
MADE BY ORS / VERIFIED BY		MADE BY / VERIFIED BY	C-17 SHT ___ OF ___
DATE 1/19/90 / DATE 3/23/90		DATE / DATE	853601

For values of $\sin(\omega t) = 1$ and θ_h from

$$P_1 = 1.2\, W_1 \times \theta_h$$

From eq. 6.17 $$h_1 = h\left\{1 - \left[\frac{\cosh\left(1.84\,\frac{h}{R}\right) - 1}{1.84\,\frac{h}{R}\sinh\left(1.84\frac{h}{R}\right)}\right]\right\}$$

Bending Moment M_1 due to convective force

$$M_1 = P_1 \times h_1$$

DOCUMENT & NO.	82-2086-60
ATTACH A	PAGE 45 OF 83

SUBJECT: SHELL DESIGN CONDENSATE STORAGE TANK ARKANSAS POWER & LIGHT	OFFICE: BIRMINGHAM	REVISION 0		REFERENCE NO: N81049
	MADE BY: CRS	VERIFIED BY: [illegible]	MADE BY	VERIFIED BY
	DATE: 1/19/90	DATE: 8/23/90	DATE	DATE

C-18 SHT ___ OF ___

853601

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CALCULATION OF BENDING MOMENT M_2 DUE TO IMPULSIVE FORCE

Case 1 For values of h/R less than or equal to 1.35

From eq. 6.12 $$W_o = W \left\{ \frac{\tanh\left(\sqrt{3}\,\frac{R}{h}\right)}{\sqrt{3}\,\frac{R}{h}} \right\}$$

From eq. 6.13 $$h_o = \frac{3}{8} h$$

From eq. 6.15 $$P_o = W_o \times \dot{u}_o / g$$

DOCUMENT TYPE & NO.	82-2086-60
ATTACH. A	PAGE 46 OF 93

Bending Moment M_2 due to impulsive force

$$P_o \times h_o$$

Case 2 For values of h/R greater than 1.35

Bending Moment M_2 = (Moment due to constrained water) + (Moment due to column of liquid of height 1.35R from top)

$$M_2 = \left\{ \pi R^2 (h-1.35R)\, \rho \times \dot{u}_o \times \left(\frac{h-1.35R}{2} \right) \right\} + \left\{ \pi R^2 (1.35R)\, \rho \times \frac{\tanh\left(\frac{\sqrt{3}}{1.35}\right)}{\frac{\sqrt{3}}{1.35}} \times \dot{u}_o \times [.375(1.35R) + (h-1.35R)] \right\}$$

SUBJECT	OFFICE	REVISION		REFERENCE NO
SHELL DESIGN CONDENSATE STORAGE TANK ARKANSAS POWER & LIGHT	CBI BIRMINGHAM	0		N81049
MADE BY: CRS	VERIFIED BY:	MADE BY	VERIFIED BY	C-19 SHT ___ OF ___
DATE: 1/19/90	DATE: 3/23/90	DATE	DATE	853601

Total Bending Moment M_o to be resisted at bottom of tank
(COMBINED BY SRSS)

$$\left[M_1^2 + \left(M_2 + \frac{\dot{u}_o}{g}\sum(\text{wt. of each shell ring}) \times (\text{height of C.G. of shell ring above tank bottom})\right)^2\right]^{1/2}$$

$$+ R_{LS} \times \frac{\dot{u}_o}{g} \times (HI + H_{CG})$$

DOCUMENT TYPE & NO.	82-2086-60
ATTACH A	PAGE 47 OF 83

SUBJECT	OFFICE	REVISION	REFERENCE NO.
SHELL DESIGN CONDENSATE STORAGE TANK ARKANSAS POWER & LIGHT	CBI BIRMINGHAM	0	N81049
MADE BY: CRS	VERIFIED BY:	MADE BY:	VERIFIED BY: C-20 SHT ___ OF ___
DATE: 2/8/90	DATE: 3/23/90	DATE:	DATE: 853601

FOUNDATION LOAD SUMMARY

LOAD	LOAD COMBINATION			
	3	4	5	6
DEAD LOAD + LIVE LOAD + SEISMIC	100.4 K 63 LB/IN	100.4 K 63 LB/IN	107.4 K 68 LB/IN	107.4 K 68 LB/IN
MO	739.6 FT-K	919.9 FT-K	1103.9 FT-K	1617.2 FT-K
UPLIFT	38.9 LB/IN	3 LB/IN	61.8 LB/IN	51.4 LB/IN
SLAB MOMENT BASE SHEAR	1083.0 FT-K 58.9 K	1894.9 FT-K 106.7 K	1621.5 FT-K 88.3.1 K	3326.8 FT-K 187.6 K
ANCHOR BOLT LOAD	25.6 K	0.198	40.7 K	3.39 K

DOCUMENT TYPE & NO. 82-2086.60
ATTACH. A PAGE 48 OF 83

SUBJECT	OFFICE	REVISION	REFERENCE NO
FOUNDATION LOAD SUMMARY CONDENSATE STORAGE TANK ARKANSAS POWER & LIGHT	CBI BIRMINGHAM	0	N8109
	MADE BY ORS / VERIFIED BY	MADE BY / VERIFIED BY	C-2 SHT ___ OF ___
	DATE 3/19/90 / DATE 3/23/90	DATE / DA..	853601

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CHECK FOR SHEAR BARS.

Weight tank	64,000 #
product	2,678,000 #
Total weight	2,742,000 #

Base shear	OBE	588.3 K
	DBE	883.1 K

Ratio shear to download

$$OBE = \frac{588.3}{2742(1-.075)} = 1.23$$

$$DBE = \frac{883.1}{2742(1-.15)} = 0.38$$

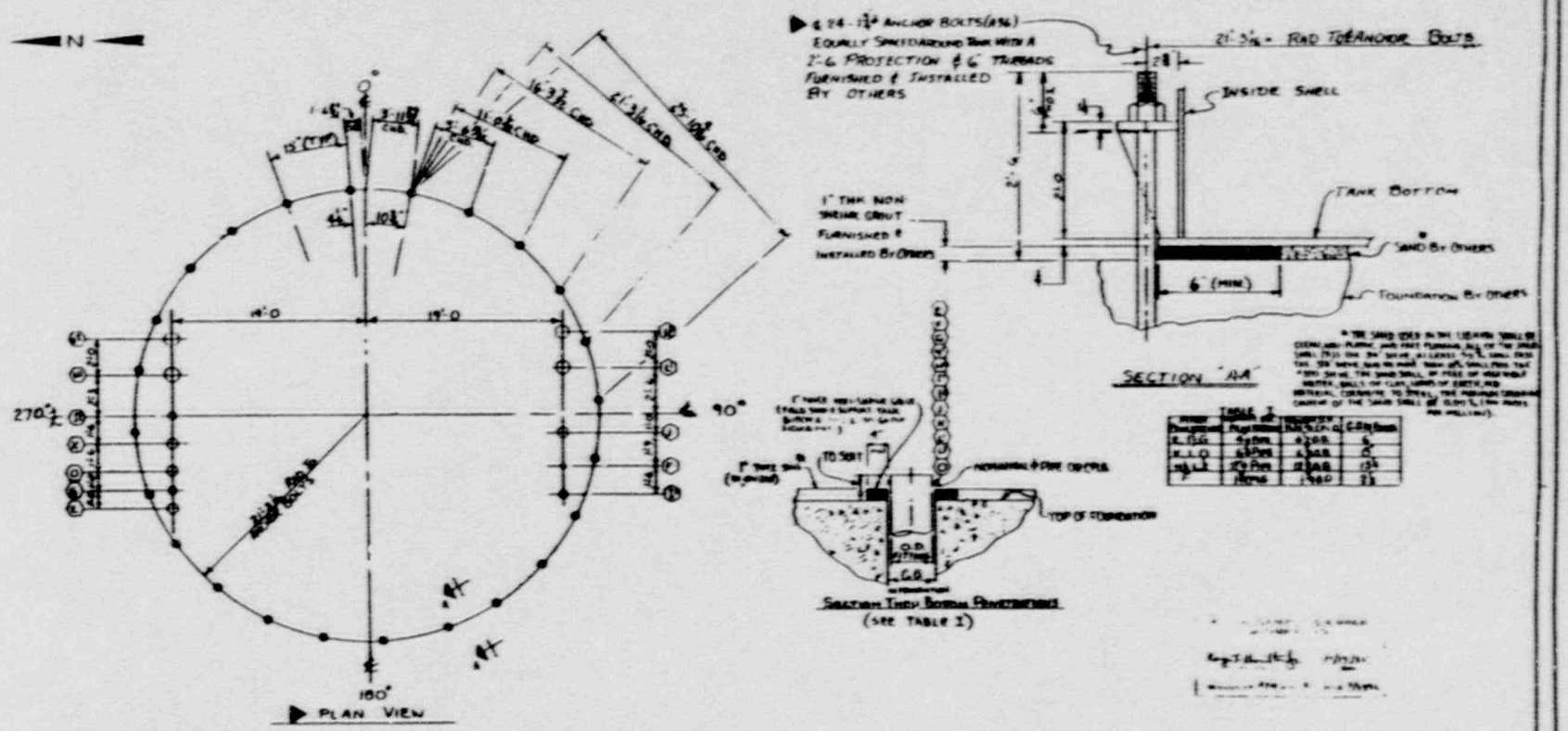
Ratios less than .5 ~ shear bars not required

DOCUMENT TYPE & NO.	82-2086-60
ATTACH A	PAGE 49 OF 83

SUBJECT: ANCHORAGE CONDENSATE STORAGE TANK ARKANSAS POWER & LIGHT	CBI OFFICE: BIRMINGHAM	REVISION 0		REFERENCE NO: N81949
	MADE BY: CRS	VERIFIED BY:	MADE BY	VERIFIED BY
	DATE: 2/11/90	DATE: 8/23/90	DATE	DATE
				C-22 SHT___ OF___
				853601

SUBJECT
ANCHOR BOLTS
CONDENSATE STORAGE TANK
ARKANSAS POWER & LIGHT

OFFICE BIRMINGHAM	REVISION 0	REFERENCE NO. N81049	
MADE BY CRS	VERIFIED BY	MADE BY	VERIFIED BY
DATE 3/19/90	DATE 3/23/90	DATE	DATE
			SHT 023 OF
			853601



ANCHOR BOLT TOLERANCES:
1. ANCHOR BOLT HEIGHT OF ± ½" FROM THEOR. HEIGHT OF CONCRETE.
2. LATERAL LOCATION OF THE ANCHOR BOLTS TO BE WITHIN ¼" FROM ITS THEORETICAL POSITION.
3. ANCHOR BOLTS TO BE PLUMB WITHIN ⅛" : 12".

FOUNDATION TOLERANCES:
1. TOP OF FOUNDATION SHALL BE LEVEL WITHIN ± ⅛" WITHIN ANY 30.0 ARC & ± ¼" AROUND THE ENTIRE RING

FOUNDATION LOADS	OBE	DBE	TORNADO
WEIGHT OF TANK & SNOW	93.4 KIPS	93.4 KIPS	93.4 KIPS
VERTICAL SEISMIC	± 7.9 KIPS	± 11.1 KIPS	—
WT. PRODUCT (FULL)	2680 KIPS	2680 KIPS	2680 KIPS
SLAB MOMENT	12250 FT-KIPS	19325 FT-KIPS	5073 FT-KIPS
BASE SHEAR	660 KIPS	1040 KIPS	290 KIPS

OBE - OPERATING BASIS EARTHQUAKE
DBE - DESIGN BASIS EARTHQUAKE

ARKANSAS NUCLEAR ONE
ARKANSAS POWER & LIGHT COMPANY
RUSSELLVILLE ARKANSAS

Chicago Bridge & Iron Company
CONDENSATE STORAGE TANK
ANCHOR BOLT SETTING PLAN
FOR 42'-0 to 52'-0 HIGH D.R.T.
853601

DOCUMENT CODE & NO. 82-2086-60
SEARCH A PAGE 50 OF 83

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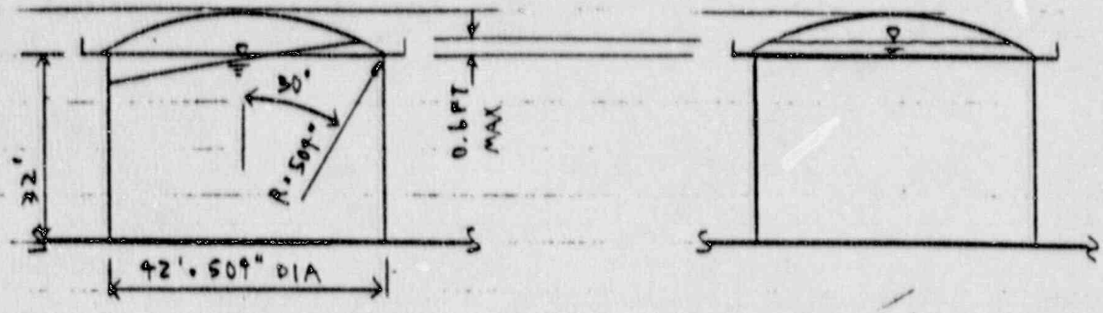
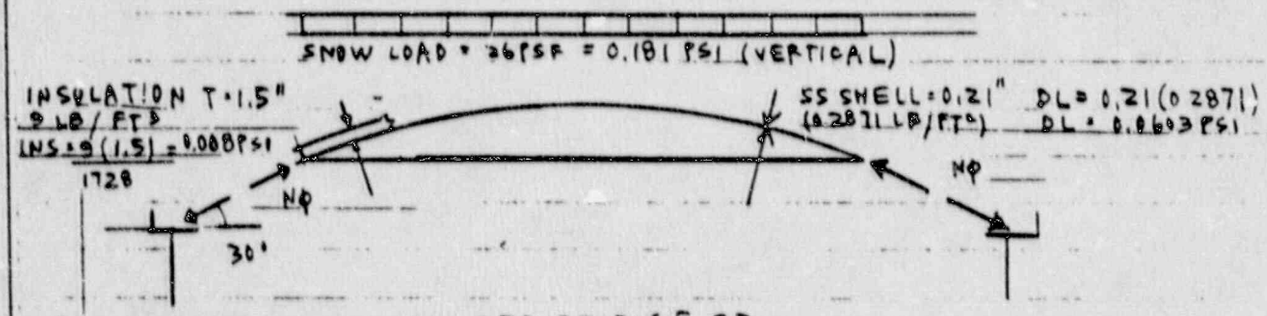
ROOF TO SHELL JUNCTION - FOR EFFECTS OF SSE WAVE



SSE WAVE

MODEL ANALYZED
(UNIFORM PRODUCT HEAD 0.6FT ABOVE TL)

THE IDEALIZED MODEL WILL BE ANALYZED FOR LOAD CASE 5(A+B+C+F)
THE AREA OF INTEREST IS THE ROOF TO SHELL JUNCTION.



FROM ORIGINAL DESIGN REPORT PAGE C3

SNOW $N\phi = WR/2 = 0.181(509)/2 =$ 46 LB/IN

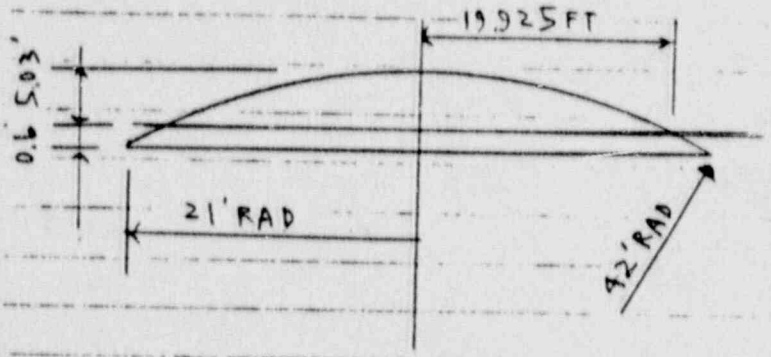
STEEL $N\phi = WR/(1+\cos\phi) = 0.06(509)/(1+\cos 30) =$ 17 LB/IN

INS. $N\phi = WR/(1+\cos\phi) = 0.008(509)/(1+\cos 30) =$ 2 LB/IN

DOCUMENT CODE & NO.	82-2086-60
ATTACH. A	PAGE 51 OF 83

SUBJECT	OFFICE	REVISION	REFERENCE NO.
ROOF TO SHELL JUNCTION CONDENSATE STORAGE TANK ARKANSAS POWER & LIGHT	CBI BIRMINGHAM	O	N81079
MADE BY: CRS	VERIFIED BY: mm	MADE BY:	VERIFIED BY:
DATE: 6/20/88	DATE: 7/1/88	DATE:	DATE:
			SHT C-24 OF
			853601

VERTICALLY UPWARD LOAD DUE TO WATER IN THE ROOF IS EQUAL TO THE WEIGHT OF WATER DISPLACED.



FOR SPHERICAL SEGMENT OF TWO BASES

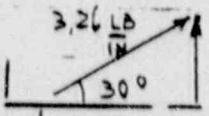
$V = \frac{\pi H}{6}(3r^2 + 3R^2 + H^2)$

VOL IN CYLINDER = $\pi(21)^2(0.6)$ = 831.27 FT^3
92'DIA X 0.6'HIGH

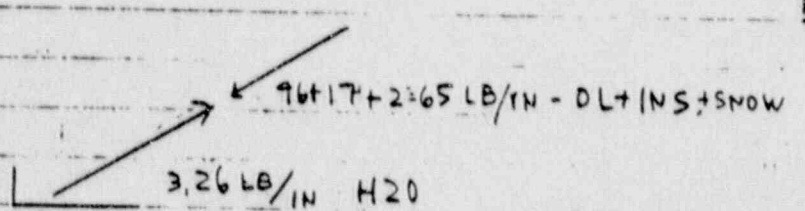
VOL IN SPHERICAL SEGMENT = $\frac{\pi(0.6)}{6}[3(19.925)^2 + 3(21)^2 + (0.6)^2]$ = 789.90 FT^3

VOLUME DISPLACED = 41.37 FT^3

UPLIFT = 62.4(91.37) = 2581.5 LB

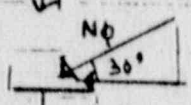


$\frac{2581.5}{\pi(50)^2}$ = 1.63 LB/IN

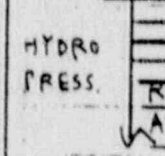


ROOF TO SHELL
FOR PROPERTIES SEE SHEET C5
A = 9.07 SQ IN

NO FORCES AT ROOF TO SHELL



61.79 LB/IN $(1 + \dot{U}v/g)$ = 61.79(1+0.15) = 71 LB/IN
(INCREASED BY COMPONENT OF VERTICAL SEISMIC)



STRESS = $\frac{NR}{A}\left[\frac{71(\cos 30) + 12(0.433/2)}{9.07}\right]$ 452 = 1780 PSI

ALLOWABLE = 1.15(15700) = 18055 PSI

DOCUMENT NO. & NO. 82-2086-60
ATTACH. A PAGE 52 OF 83

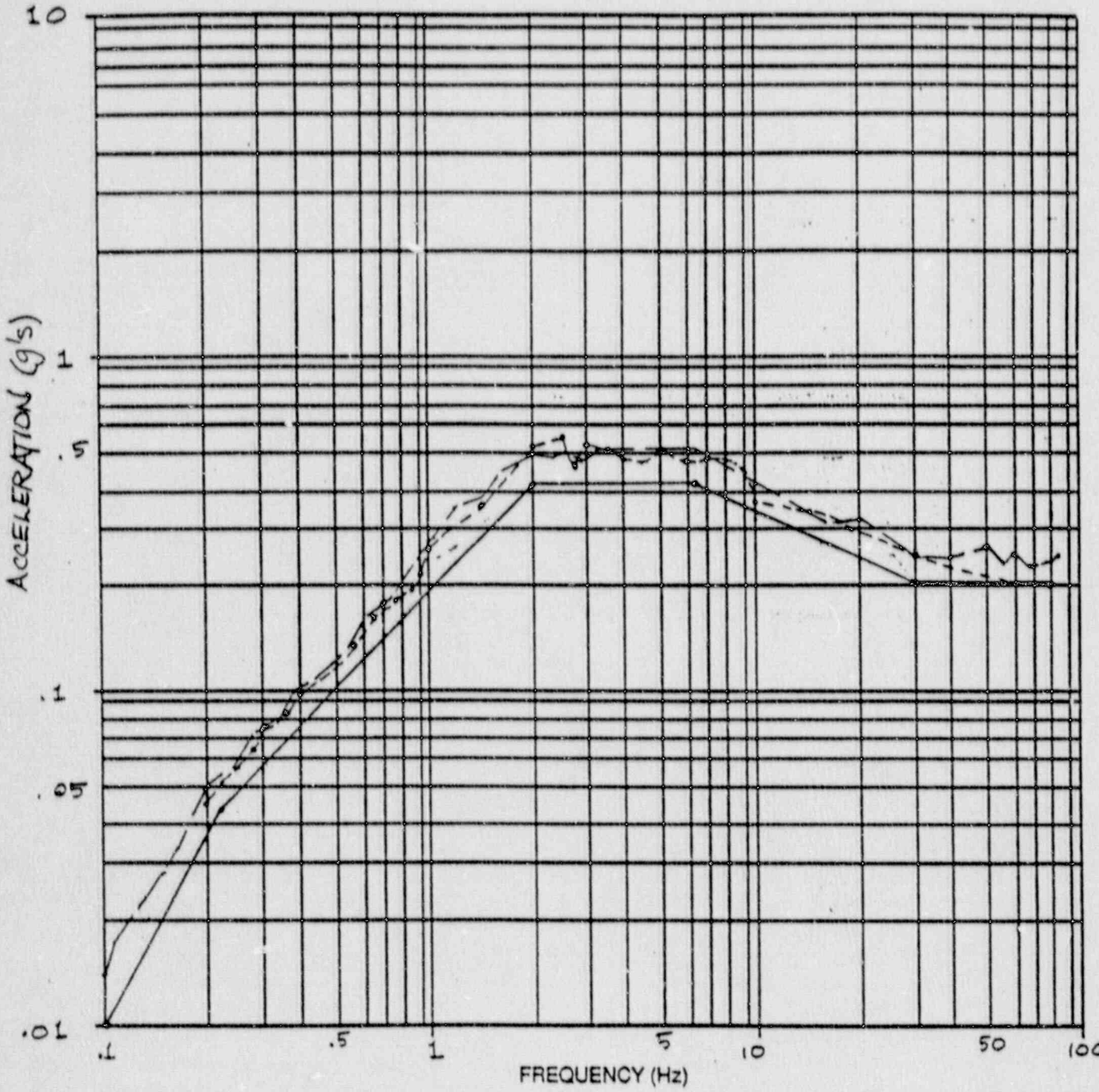
SUBJECT	OFFICE	REVISION	REFERENCE NO.
ROOF TO SHELL JUNCTION CONDENSATE STORAGE TANK ARKANSAS POWER & LIGHT	CBI BIRMINGHAM	0	N81049
MADE BY CRS / VERIFIED BY		MADE BY / VERIFIED BY	C-25 SHT ___ OF ___
DATE 6/20/88 / DATE 7/1/88		DATE / DATE	853601

Printed in USA

GO 64A AUG 87

Design Calculation 82D-2086-08
(Figures 5 through 13 and Figures
1 and 2 of Appendix M)

FREE - FIELD RESPONSE SPECTRA



HORIZONTAL SSE 5% DAMPING
AT EL. 354'-5"

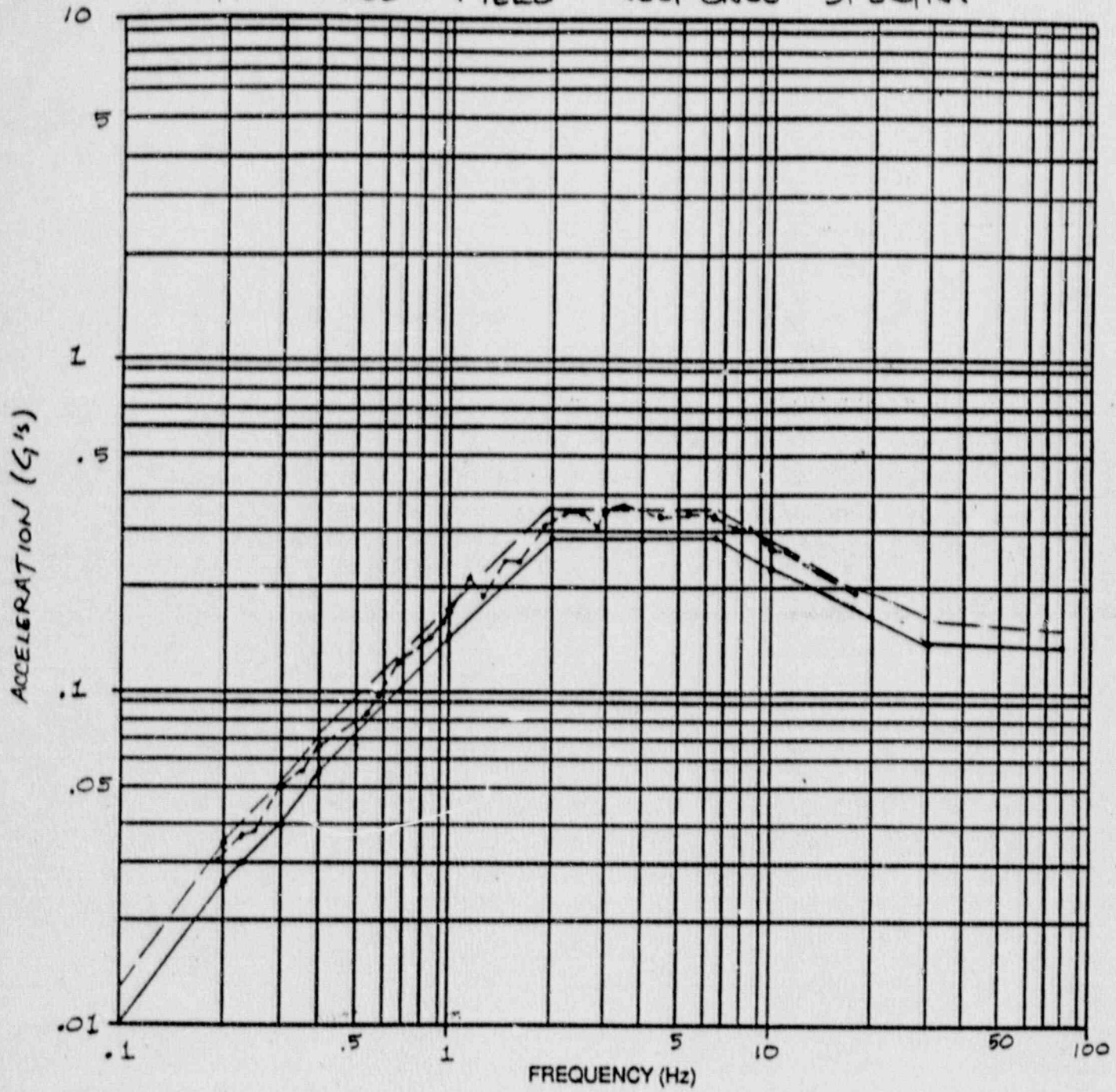
FSAR
SYNTHETIC
SHAKE FREE FIELD MOTION

82D 2086 · · 08

FIGURE 1

M7

FREE - FIELD RESPONSE SPECTRA



VERTICAL SSE @ 5% DAMPING
@ EL 354'-5"

——— FSAR
— — SYNTHETIC
- - - - SHAKE FREE-FIELD MOTION

82D 2086 08

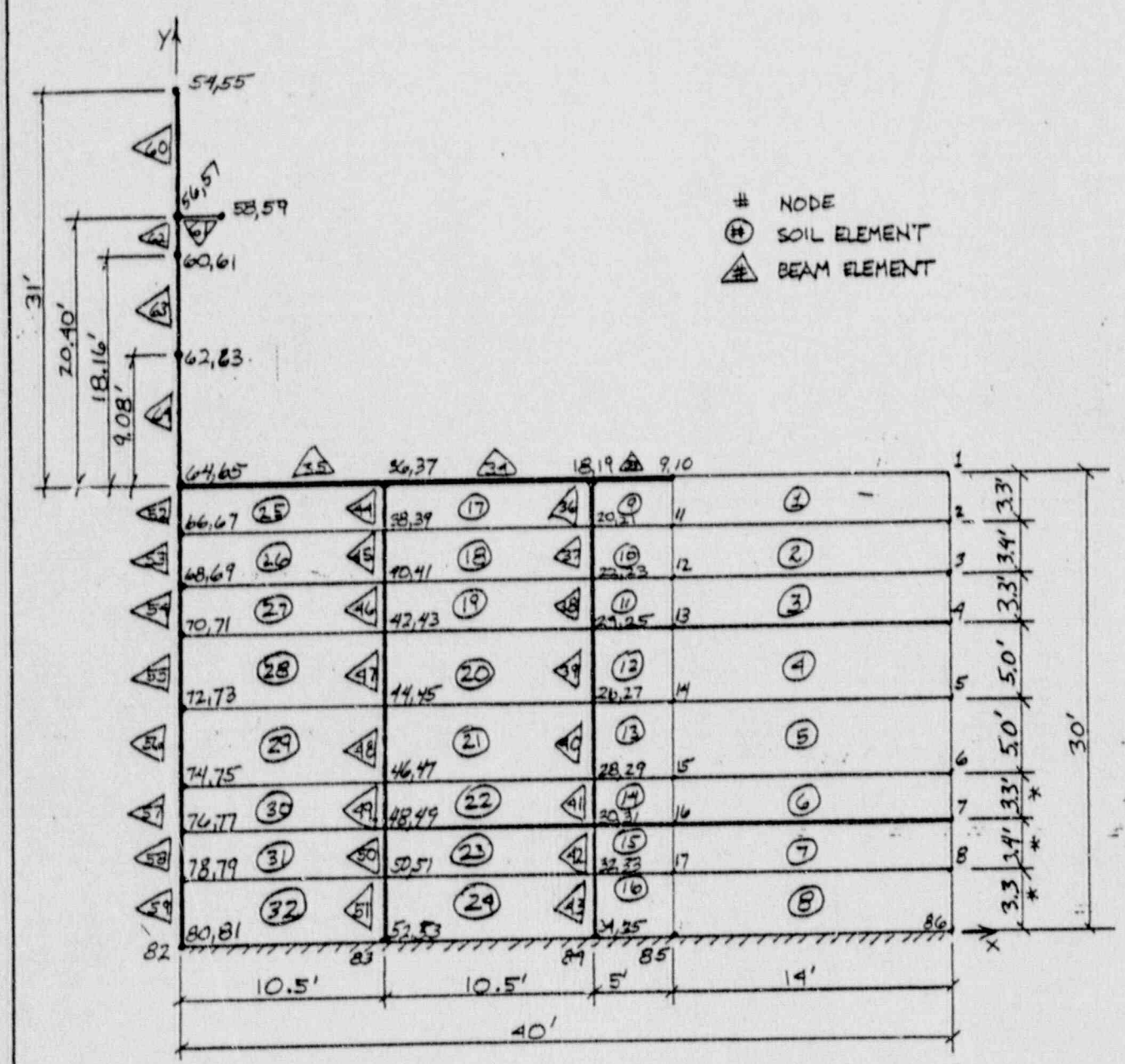
FIGURE 2

MB

PROJECT Arkansas Nuclear One - Unit 2&1 FILE NO.

OWNER Arkansas Power and Light Company

CLIENT Arkansas Power and Light Company 82D-2086-08



* THREE LAYERS HAVE BEEN USED HERE TO MINIMIZE CHANGES MADE TO PREVIOUSLY CHECKED & VERIFIED FLUSH MODEL.

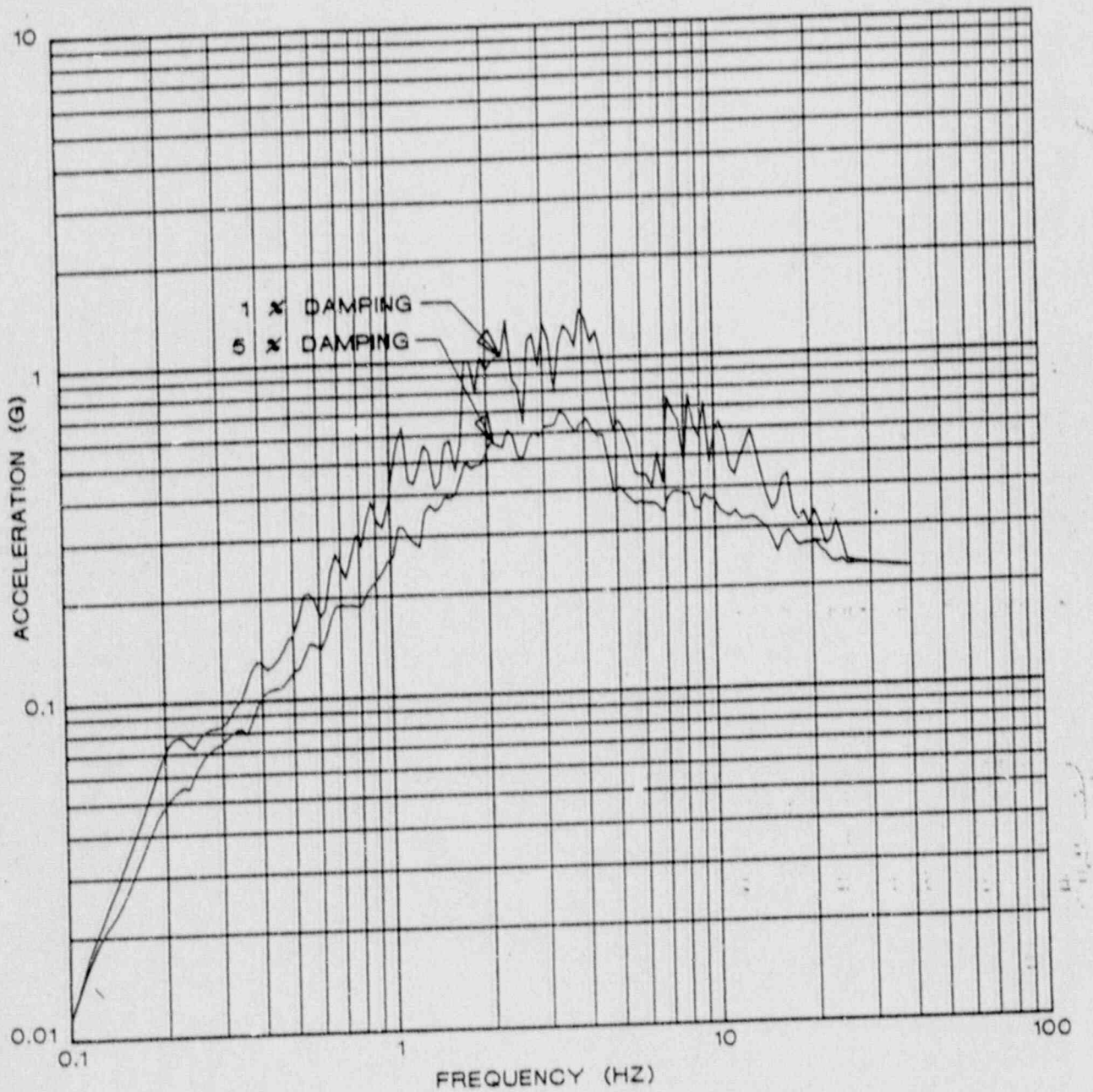
FIGURE 5. FLUSH MODEL

REVISION	5					PAGE 34
PREPARED BY/DATE	RW 1/25/88					OF 53
CHECKED BY/DATE	[illegible] 1/26/88					

PROJECT Arkansas Nuclear One - Unit 2 &1 FILE NO. ARK003.0302

OWNER Arkansas Power and Light Company

CLIENT Arkansas Power and Light Company 820-2086-08



QCST DESIGN RESPONSE SPECTRA EL. 354'-5"
HORIZONTAL SSE

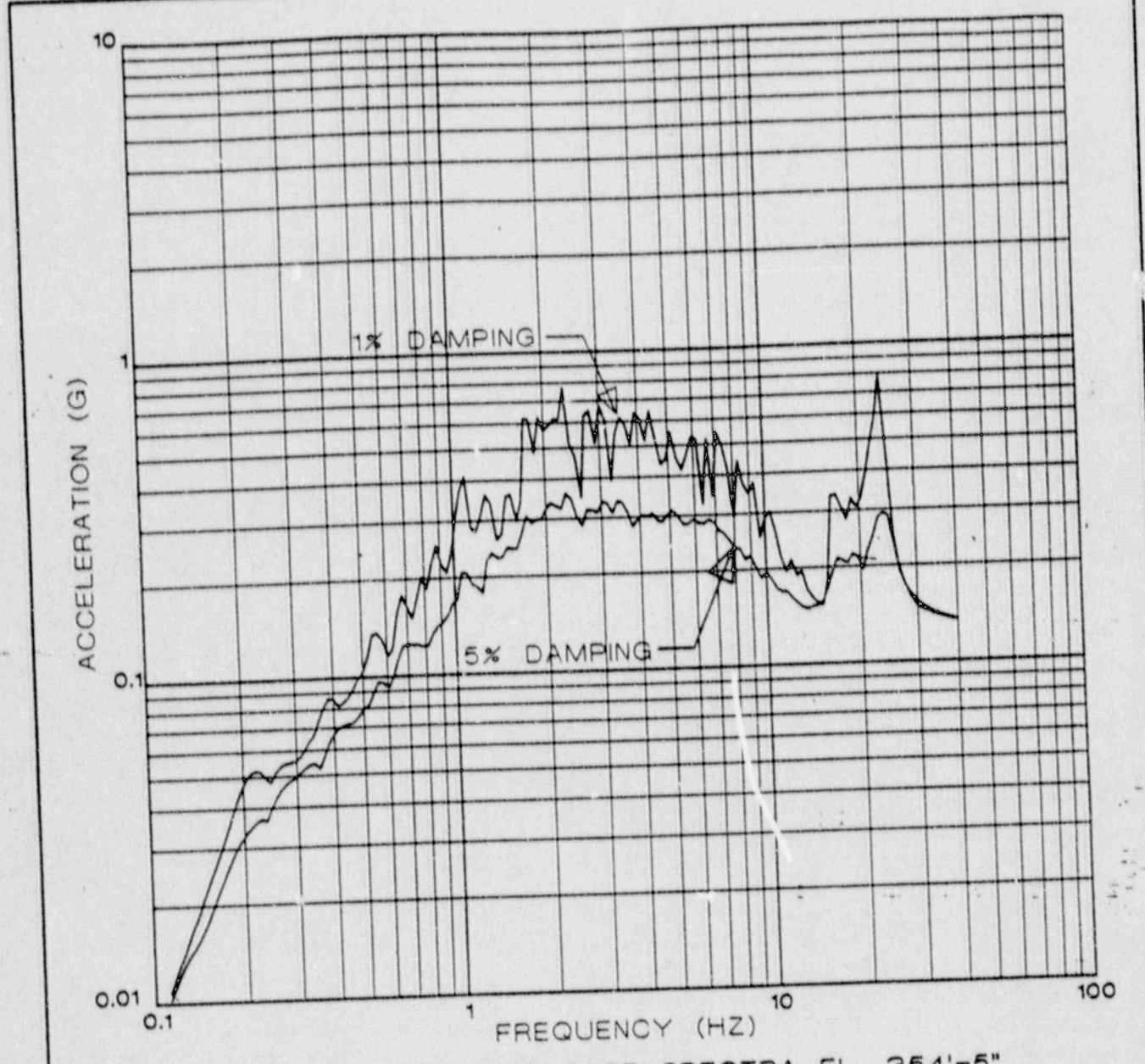
FIGURE 6.

REVISION	5					PAGE 44
PREPARED BY/DATE	RW/1-26-88					OF 53
CHECKED BY/DATE	[illegible] 10/6/88					

PROJECT Arkansas Nuclear One - Unit 1 & 2 FILE NO. ARK003.0302

OWNER Arkansas Power and Light Company

CLIENT Arkansas Power and Light Company CALC. NO. 82D-2086-08



QCST DESIGN RESPONSE SPECTRA EL. 354'-5"
VERTICAL SSE

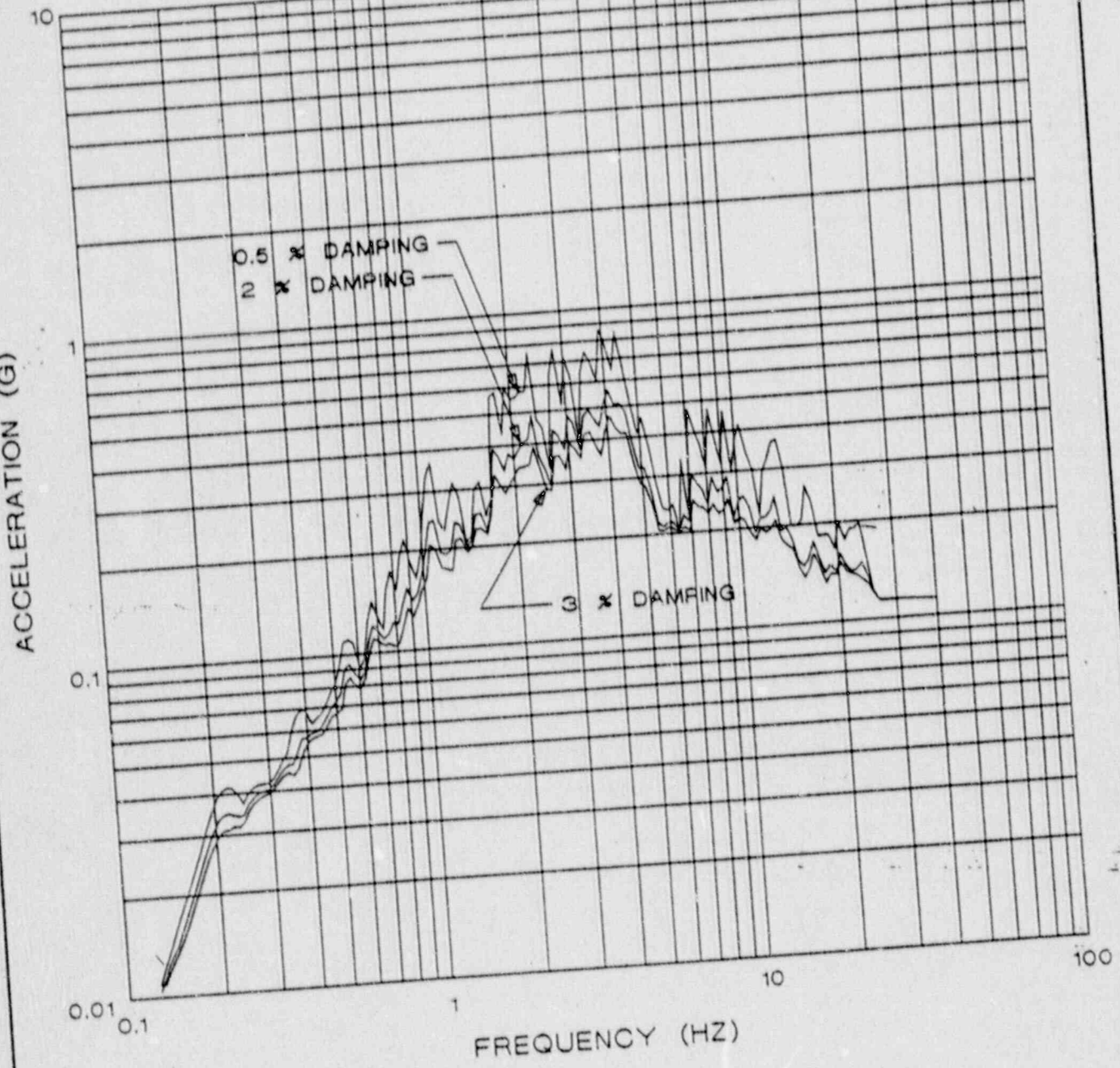
FIGURE 7.

REVISION	5					PAGE 45
PREPARED BY/DATE	RW/7-5-88					OF 53
CHECKED BY/DATE	DMH 10/6/88					

PROJECT Arkansas Nuclear One - Unit 2 & 1 FILE NO. ARK003.0302

OWNER Arkansas Power and Light Company 820-2086-08

CLIENT Arkansas Power and Light Company



QCST DESIGN RESPONSE SPECTRA EL. 354'-5"
HORIZONTAL OBE

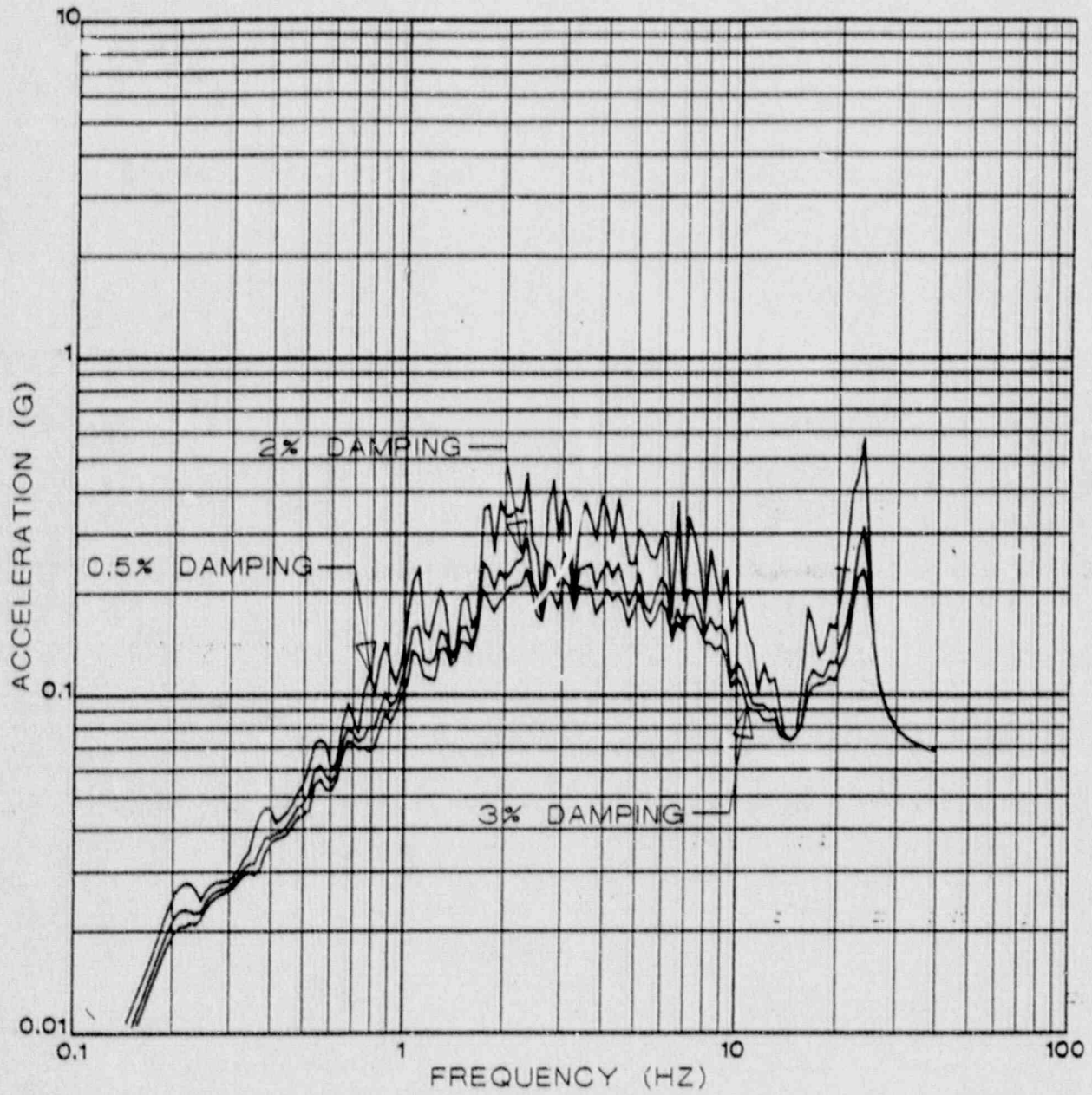
FIGURE 8

REVISION	5					PAGE 46 OF 53
PREPARED BY/DATE	RW/1-25-88					
REVIEWED BY/DATE	[illegible] 1/26/88					

PROJECT Arkansas Nuclear One - Unit 1 FILE NO. ARK003.0302

OWNER Arkansas Power and Light Company

CLIENT Arkansas Power and Light Company CALC. No. 82D-2086-08



QCST DESIGN RESPONSE SPECTRA EL. 354'-5"
VERTICAL OBE

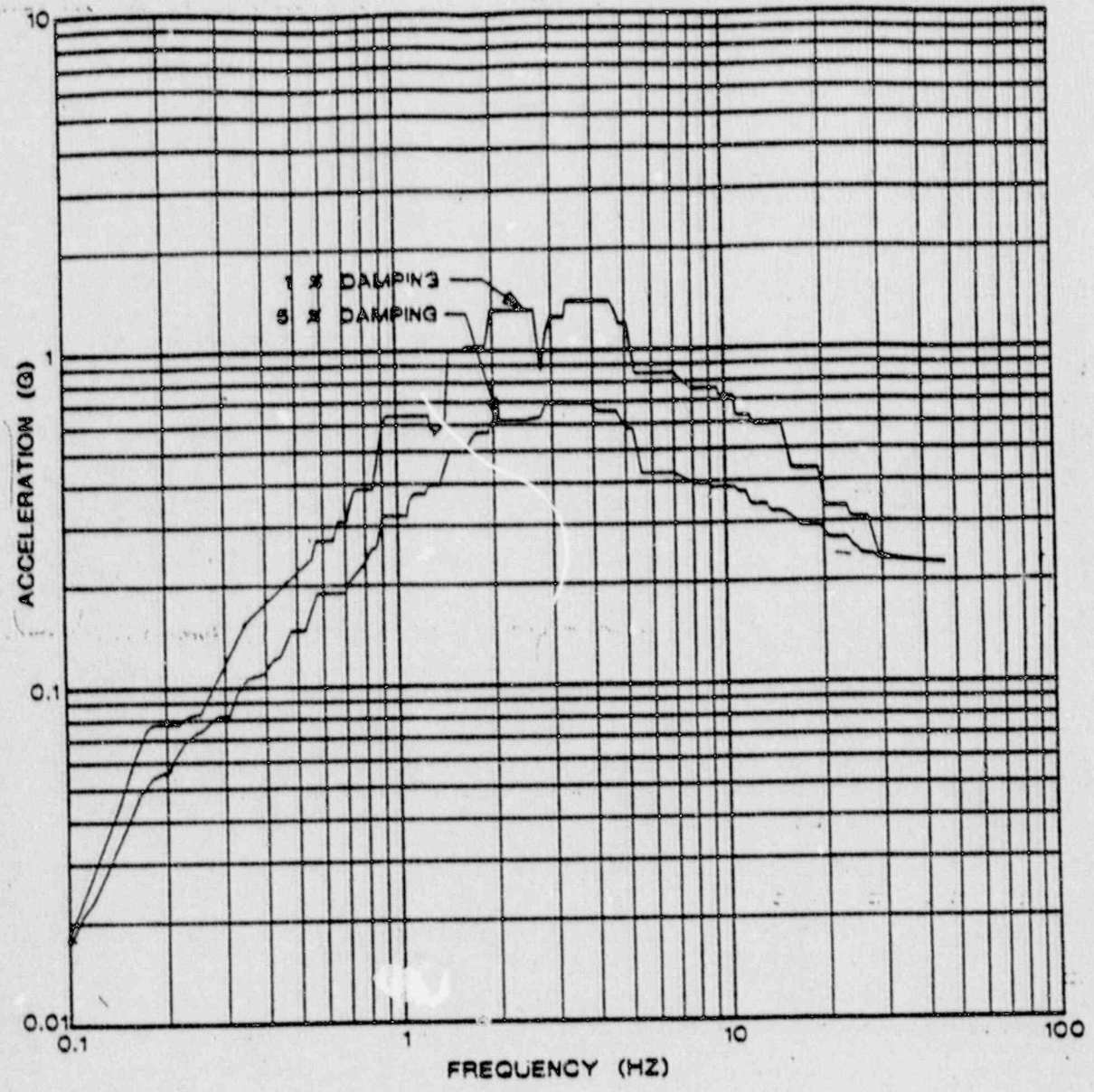
FIGURE 9

REVISION	5					PAGE 47
PREPARED BY/DATE	RW/7-5-88					OF 53
CHECKED BY/DATE	[illegible] 10/6/88					

PROJECT Arkansas Nuclear One - Unit 1 FILE NO. ARK003.0302

OWNER Arkansas Power and Light Company

CLIENT Arkansas Power and Light Company CALC 82-2086-08



QCST ENVELOPE DESIGN RESPONSE SPECTRA EL. 354'-5"

HORIZONTAL SSE

FIGURE 10.

REVISION	6					PAGE 119
PREPARED BY/DATE	RW 5/29/89					OF 53
CHECKED BY/DATE	DWM 5/24/89					

PROJECT Arkansas Nuclear One - Unit 1 FILE NO. ARK003.03102

OWNER Arkansas Power and Light Company

CLIENT Arkansas Power and Light Company CALC 82-2086-08

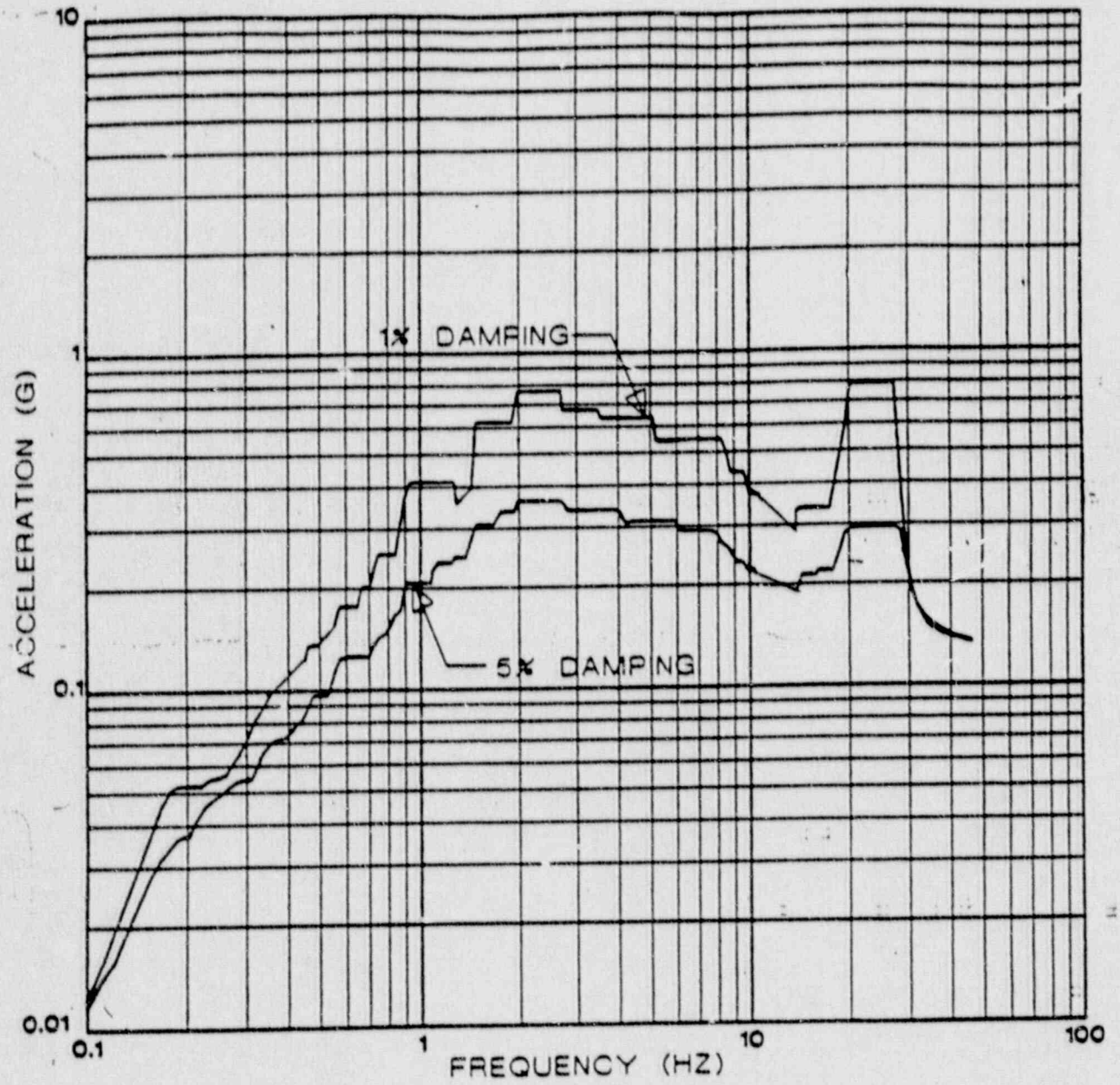


FIGURE 11

QCST ENVELOPE DESIGN RESPONSE SPECTRA EL. 354'-5"

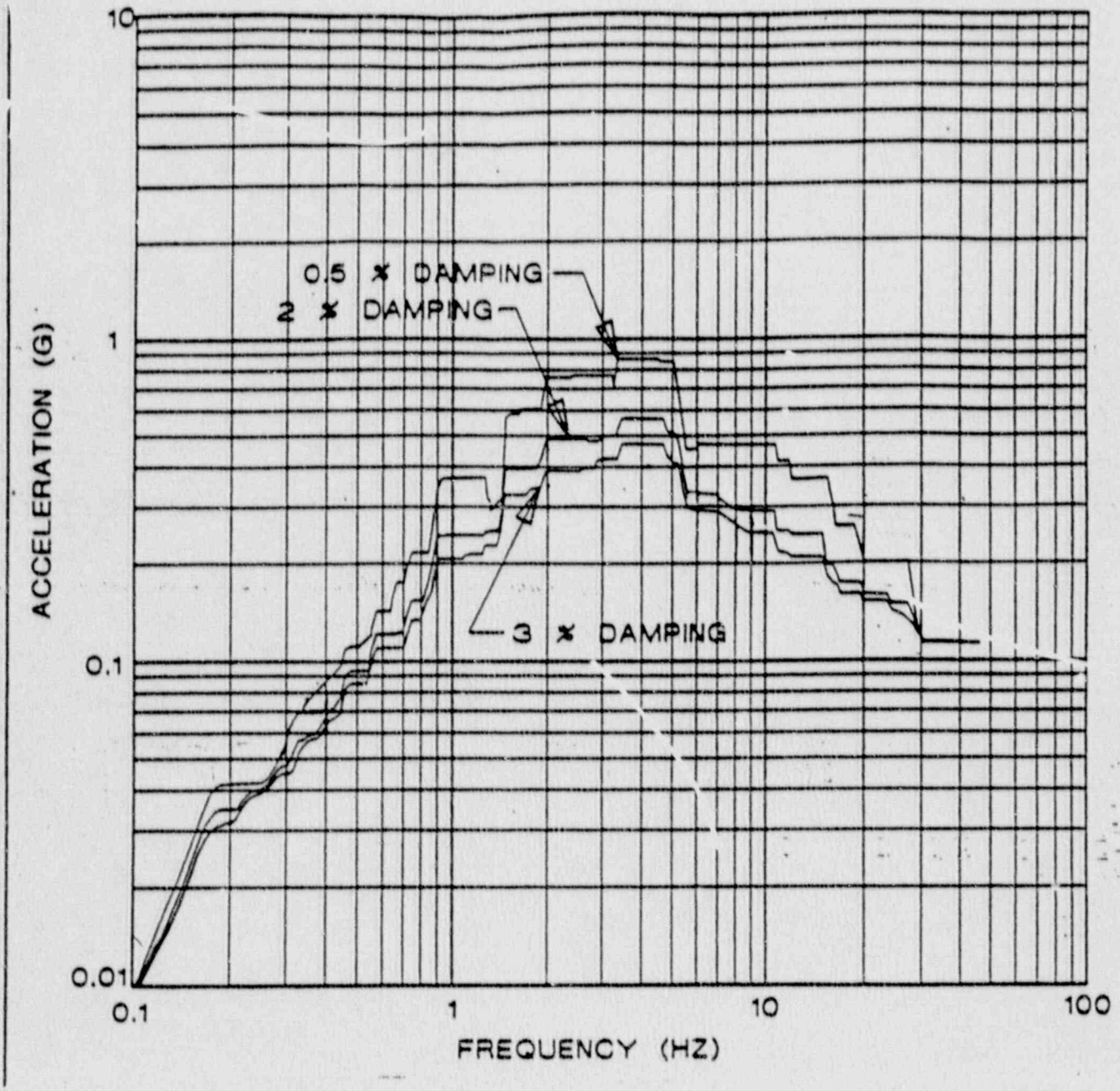
VERTICAL SSE

REVISION	6					PAGE 50
PREPARED BY/DATE	RW 5/23/89					OF 53
CHECKED BY/DATE	DMM 5/24/89					

PROJECT Arkansas Nuclear One - Unit 1 FILE NO. ARK003.0302

OWNER Arkansas Power and Light Company

CLIENT Arkansas Power and Light Company CALC 82-2086-08



QCST ENVELOPE DESIGN RESPONSE SPECTRA EL. 354'-5"

HORIZONTAL OBE

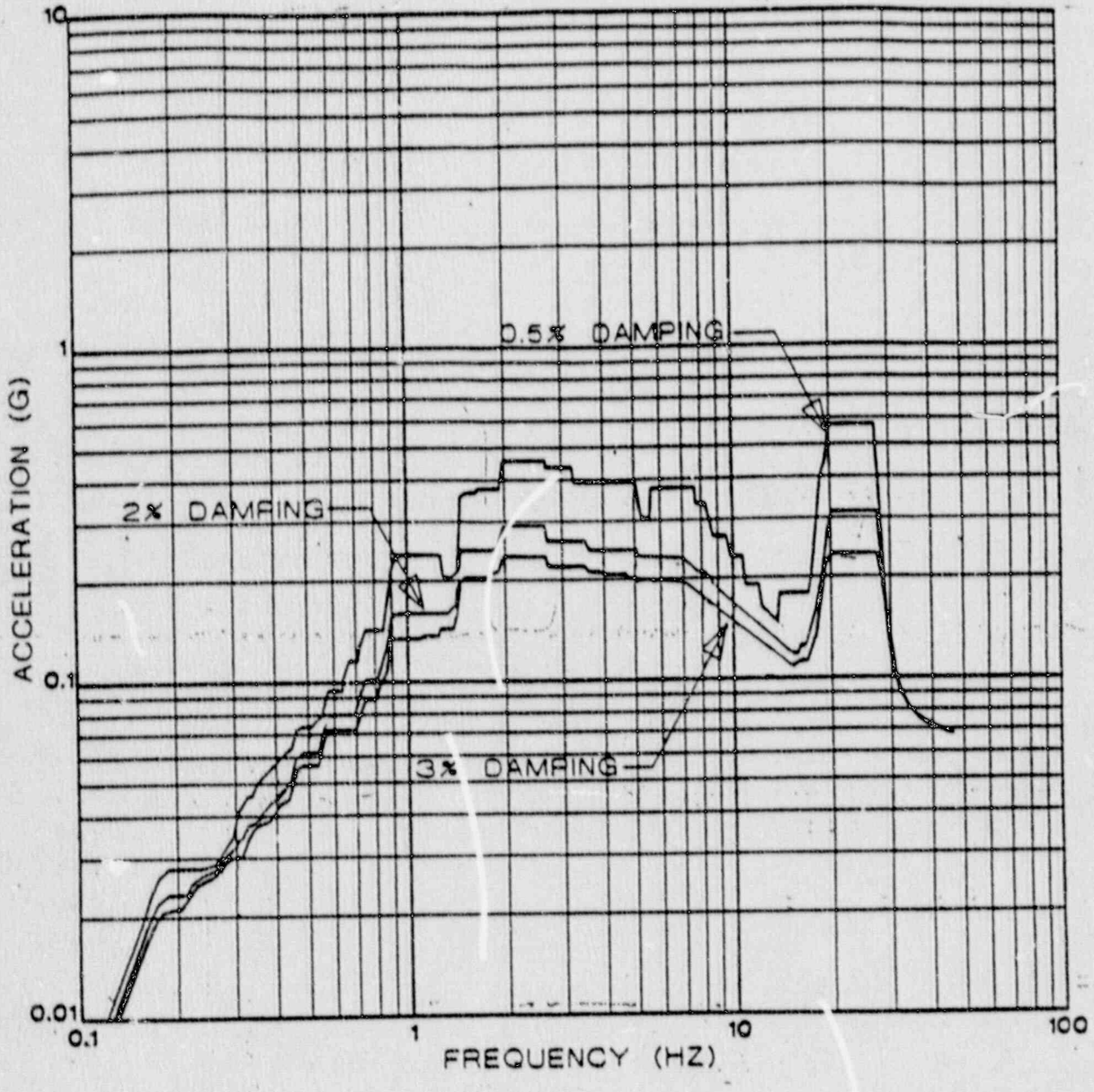
FIGURE 12.

REVISION	6					PAGE 51
PREPARED BY/DATE	RW 5/29/89					OF 53
CHECKED BY/DATE	[illegible] 5/29/89					

PROJECT Arkansas Nuclear One - Unit 1 FILE NO. ARK003.0302

OWNER Arkansas Power and Light Company

CLIENT Arkansas Power and Light Company CALC 82-2086-08



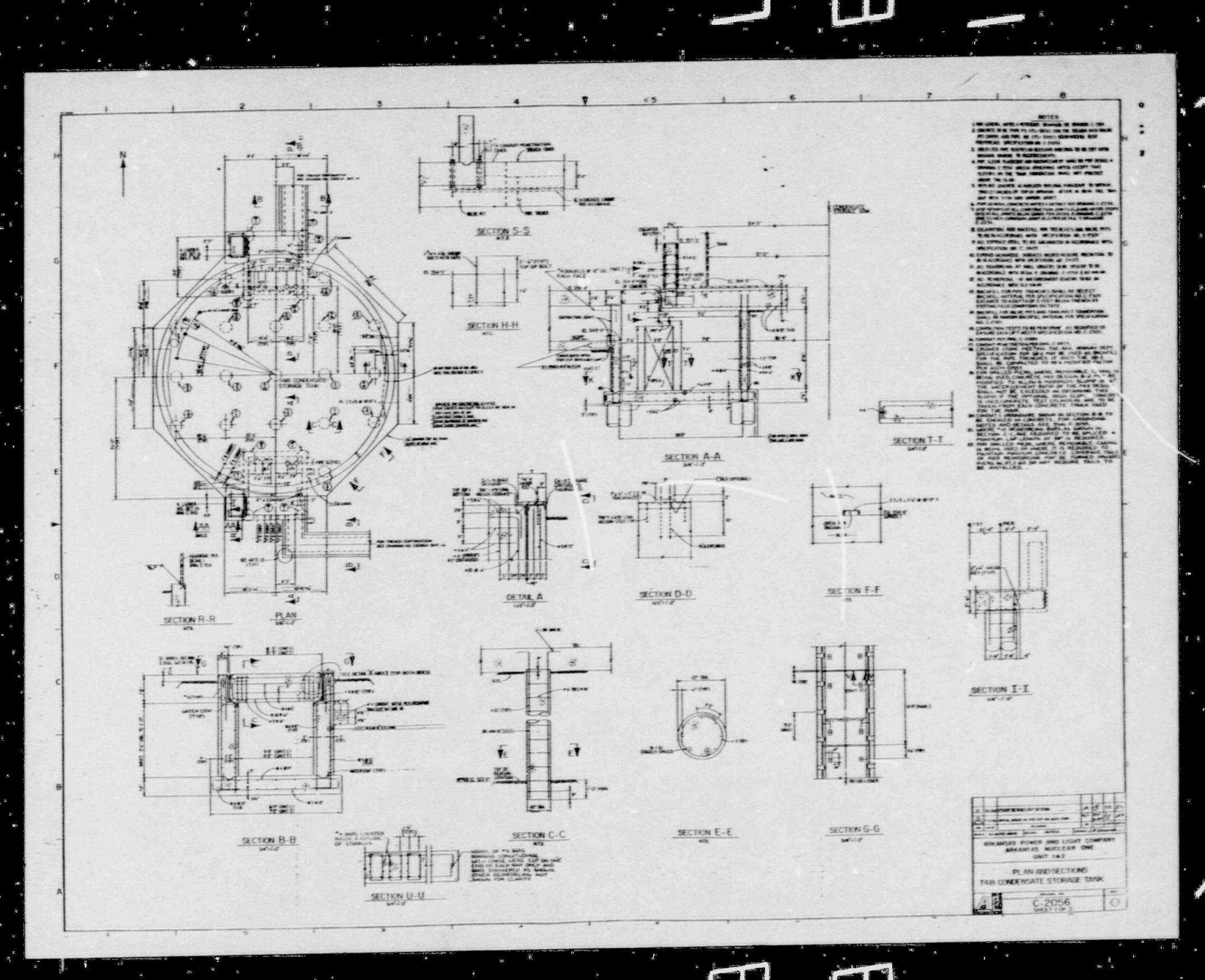
QCST ENVELOPE DESIGN RESPONSE SPECTRA EL. 354'-5"

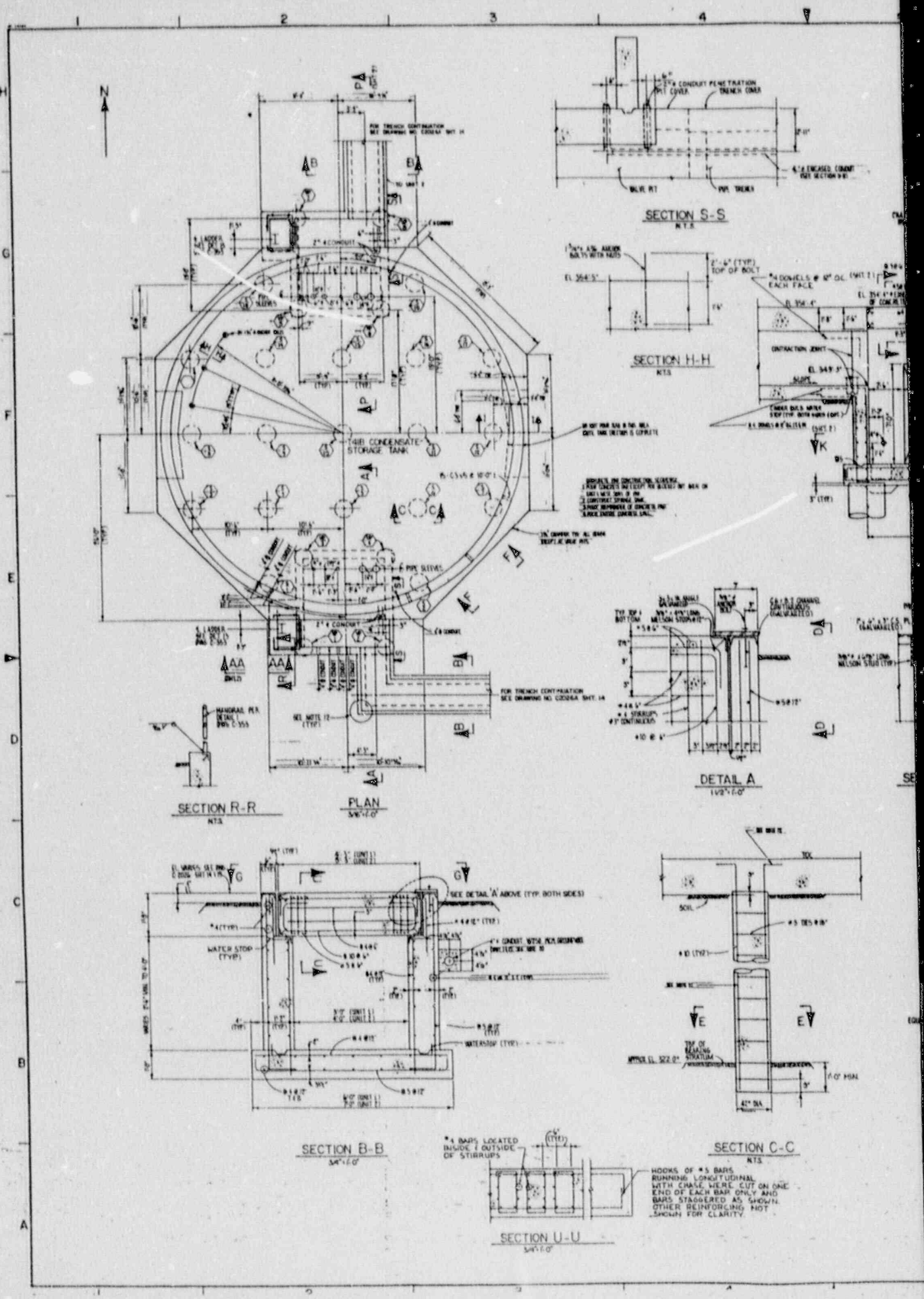
VERTICAL OBE

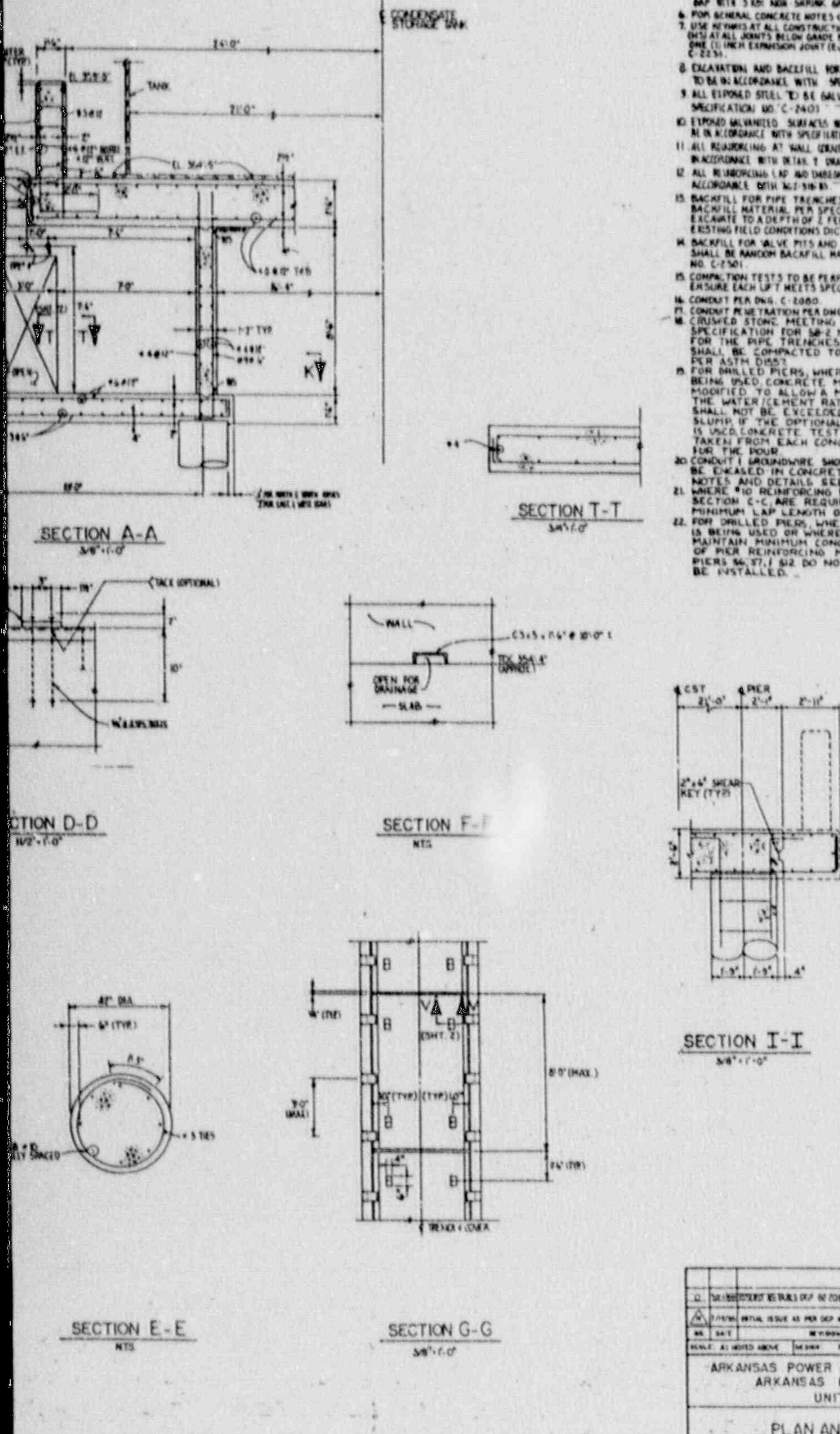
FIGURE 13

REVISION	6					PAGE 52
PREPARED BY/DATE	RW 5/25/89					OF 53
CHECKED BY/DATE	DWM 5/24/89					

(Drawing C-2056 SH 1 of 3)


SECTION S-S
SECTION H-H
SECTION A-A
SECTION T-T
T418 CONDENSATE STORAGE TANK
SECTION R-R
PLAN
DETAIL A
SECTION D-D
SECTION F-F
SECTION I-I
SECTION B-B
SECTION C-C
SECTION E-E
SECTION G-G
SECTION U-U
NOTES
ARKANSAS POWER AND LIGHT COMPANY
ARKANSAS NUCLEAR ONE
UNIT 1&2
PLAN AND SECTIONS
T418 CONDENSATE STORAGE TANK
C-2056
SHEET 1 OF 3
0


SECTION S-S
N.T.S.
SECTION H-H
N.T.S.
T41B CONDENSATE STORAGE TANK
SECTION R-R
N.T.S.
PLAN
DETAIL A
SECTION B-B
SECTION C-C
N.T.S.
SECTION U-U
HOOKS OF #5 BARS RUNNING LONGITUDINAL WITH CHASE WERE CUT ON ONE END OF EACH BAR ONLY AND BARS STAGGERED AS SHOWN. OTHER REINFORCING NOT SHOWN FOR CLARITY.



NOTES

1. FOR GENERAL NOTES & REFERENCE DRAWINGS SEE DRAWING C-2201
2. CONCRETE TO BE TYPE F3 (f'c=5KSI) FOR THE TRENCH AND VALVE PIT COVERS AND TYPE B2 (f'c=3KSI) EVERYWHERE ELSE. REFERENCE SPECIFICATION NO. C-2405A
3. HOLES FOR PIPE SLEEVES IN AUXILIARY BUILDING TO BE CUT WITH MINIMUM DAMAGE TO REINFORCEMENTS.
4. PIPE SLEEVE PLACEMENT AND REINFORCEMENT SHALL BE PER DETAIL 4 DRAWING C-2254 UNLESS OTHERWISE NOTED EXCEPT THAT SLEEVES IN THE TANK FOUNDATION SHALL NOT PROJECT ABOVE THE SLAB.
5. REPLACE CONCRETE IN AUXILIARY BUILDING KNOCKOUT TO WITHIN TWO (2) INCHES OF TOP OF OPENING. AFTER 14 DAYS FILL THIS GAP WITH 3 KSI NON-SHRINK GROUT.
6. FOR GENERAL CONCRETE NOTES & DETAILS SEE DRAWING C-2234
7. USE KEYWAYS AT ALL CONSTRUCTION JOINTS (CJ) AND WATER STOPS (WS) AT ALL JOINTS BELOW GRADE PER DETAIL 8 DRAWING C-2234. ONE (1) INCH EXPANSION JOINT (EJ) PER DETAIL 7 DRAWING C-2234.
8. EXCAVATION AND BACKFILL FOR TRENCHES AND VALVE PITS TO BE IN ACCORDANCE WITH SPECIFICATION NO. C-2501
9. ALL EXPOSED STEEL TO BE GALVANIZED IN ACCORDANCE WITH SPECIFICATION NO. C-2403
10. EXPOSED GALVANIZED SURFACES WELDED REQUIRE RECOATING TO BE IN ACCORDANCE WITH SPECIFICATION NO. 2403
11. ALL REINFORCING AT WALL CORNERS TO BE SPLICED TO BE IN ACCORDANCE WITH DETAIL 7 DRAWING C-2254 & ACI-318-83
12. ALL REINFORCING LAP AND EMBEDMENT LENGTHS TO BE IN ACCORDANCE WITH ACI-318-83.
13. BACKFILL FOR PIPE TRENCHES SHALL BE SELECT BACKFILL MATERIAL PER SPECIFICATION NO. C-2501. EXCAVATE TO A DEPTH OF 2 FEET BELOW TRENCH AS EXISTING FIELD CONDITIONS DICTATE.
14. BACKFILL FOR VALVE PITS AND TANK MATT FOUNDATION SHALL BE RANDOM BACKFILL MATERIAL PER SPECIFICATION NO. C-2501.
15. COMPACTION TESTS TO BE PERFORMED AS REQUIRED TO ENSURE EACH LIFT MEETS SPECIFICATION NO. C-2301.
16. CONDUIT PER DWG. C-2080.
17. CONDUIT PENETRATION PER DWG. C-2073.
18. CRUSHED STONE MEETING THE ARK. HIGHWAY DEPT. SPECIFICATION FOR SB-2 MAY BE USED AS BACKFILL FOR THE PIPE TRENCHES. IF USED THE SB-2 SHALL BE COMPACTED TO 95% MODIFIED FACTOR PER ASTM D1557.
19. FOR DRILLED PIERS, WHERE REMOVABLE CASING IS BEING USED CONCRETE MIX DESIGN B-2 MAY BE MODIFIED TO ALLOW A MAXIMUM SLUMP OF 6". THE WATER/CEMENT RATIO OF THE MIX DESIGN SHALL NOT BE EXCEEDED IN OBTAINING THIS SLUMP. IF THE OPTIONAL HIGH SLUMP CONCRETE IS USED, CONCRETE TEST CYLINDERS ARE TO BE TAKEN FROM EACH CONCRETE TRUCK USED FOR THE POUR.
20. CONDUIT & GROUNDWIRE SHOWN IN SECTION B-B TO BE ENCASED IN CONCRETE. FOR GROUNDING NOTES AND DETAILS SEE DWG. E-2055.
21. WHERE #10 REINFORCING BARS AS SHOWN IN SECTION C-C ARE REQUIRED TO BE SPLICED A MINIMUM LAP LENGTH OF 30" IS REQUIRED.
22. FOR DRILLED PIERS, WHERE REMOVABLE CASING IS BEING USED OR WHERE IT IS REQUIRED TO MAINTAIN MINIMUM CONCRETE COVERAGE TAILS OF PIER REINFORCING MAY BE TURNED INWARD. PIERS 56, 57, & 62 DO NOT REQUIRE TAILS TO BE INSTALLED.

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