DUKE POWER COMPANY
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HAL B. TUCKER
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NUCLEAR PRODUCTION

TELEPHONE
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March 15, 1983

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Ms. E. G. Adensam, Chief
Licensing Branch No. 4

Re: Catawba Nuclear Station
Docket Nos. 50-413 and 50-414

Dear Mr. Denton:

On February 22, 1983 the NRC issued the Safety Evaluation Report (SER) related to the operation of Catawba. Section 1.8 identified a number of Confirmatory Issues which required additional information from Duke.

Attached is a response to the following Confirmatory Issues:

(6) SSI for buildings not founded on rock (SER Section 3.7.3).

(8) Vertical seismic response spectra (SER Section 3.9.2.2).

Very truly yours,

Hal B. Tucker

Hal B. Tucker

ROS/php
Attachment

cc: Mr. James P. O'Reilly, Regional Administrator
U. S. Nuclear Regulatory Commission
Region II
101 Marietta Street, NW, Suite 2900
Atlanta, Georgia 30303

B001

Mr. P. K. Van Doorn
NRC Resident Inspector
Catawba Nuclear Station

Mr. Robert Guild, Esq.
Attorney-at-Law
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cc: Palmetto Alliance
2135½ Devine Street
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Mr. Jesse L. Riley
Carolina Environmental Study Group
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Charlotte, North Carolina 28207

Mr. Henry A. Presler, Chairman
Charlotte-Mecklenburg Environmental Coalition
943 Henley Place
Charlotte, North Carolina 28207

Attachment 1

Confirmatory Issue (6)

SSI for buildings not founded on rock (SER Section 3.7.3)

Response:

Attached is an extract from Calculation File CNC-1144.09-01-0010. The lumped mass model used to generate seismic response spectra is shown on sheet 137. Properties of the model are shown on sheet 156. The methodology of using four separate base acceleration time histories is discussed on sheets 157 to 159. Sheets 160 to 167 present typical analysis input data, and sheets 168 to 171 discuss generation of horizontal spectra. Sheets 172 to 189 present the analysis for vertical amplification.

Previous submittals of additional information are discussed and explained on sheets 189.001 to 189.017. Sheets 189.018 to 189.022 address the relative magnitude of vertical and horizontal accelerations. It is shown that the computed acceleration levels are, in fact, in the proper relationship to each other.

Extracts of computer runs "R2TOTSTK","SPECTRA", and "COMPARE" are included as appropriate to support the calculations presented.

Extract from CNC-1144.09-01-0010

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FOR INFORMATION ONLY

1.0 Overview

A preliminary seismic analysis of the Catawba containment vessel was performed to produce the 'Catawba Containment Vessel Response Acceleration Spectra' for file CNS-1108.00-00-0002, Catawba Nuclear Station Specification For The Response Spectra Displacements For Category I Structures, Volume I. Details of this analysis are shown in calculation file CNC-1144.09-01-0001. Because the computer print out of the preliminary seismic analysis cannot be located and the 13th ring stiffner has been relocated since the original seismic analysis was performed, a verification of the response spectra used for the catawba containment vessel is necessary. This calculation investigates the validity of the 'Catawba Containment Vessel Response Acceleration Spectra' in published file CNC-1108.00-00-0002.

The model used for analysis will be analogous to the model used in the preliminary seismic analysis of 1974. The seismic analysis will adhere to NRG 1.92 and Catawba Nuclear Station FSAR section 3.7.

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Form 00184 (6-81)

DUKE POWER COMPANY

Dev./Station Catawba N.S. Unit All File No. CNC-1144.07-01-0010

Subject Stick Model

By JMK Date 6-16-82

Sheet No. 10 of ___ Problem No. Rev 3 Checked By DEB Date 7-1-82

1.1 Nuclear Safety Related

This analysis is a Q.A. Condition 1 item and deemed nuclear safety related.

1.2 Finite Element Model

The seismic analysis model is a one-dimensional linear elastic dynamic model analyzed using 'STRUDL'.

1.3 Applicable Codes, Standards, and References

1.3.1 Catawba FSAR, Section 3.7, 'Seismic Design'.

1.3.2 Nuclear Regulatory Guide, Section 1.92

1.3.3 MCAUTO STRUDL

1. STRUDL Users Manual Appendices - October 1980

2. STRUDL User Manual - April 1981

1.3.4 Calculation File CNC-1144.09-01-0001, "Preliminary Analysis"

1.3.5 Calculation File CNC-1144.09-01-0008, "Analysis of the Steel Containment Vessel for Non-Axisymmetric Localized Effects due to the Equipment Hatch and Personnel Lock"

1.3.6 Calculation File CNC-1144.09-01-0004, "Steel Containment Vessel Analysis for Static and Dynamic Loads"

1.3.7 Drawings CN-1042-1 to 5

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1.4 Assumptions

All assumptions will be stated in the body of the calculation.

1.5 Computer Programs

Referenced Computer Runs
(STRUDL)

Name	Date	Description
R2TOTSTK	7/28/82	Dynamic Modal Analysis (3-Modes) Transient Time History Analysis Computes and Stores Four individual Horizontal and Vertical Total Acceleration VS. Period Response Spectra per Specified Joint
SPECTRA	7/29/82	Restores Horizontal and Vertical Response Spectra from computer program "R2TOTSTK" and computes the total Horizontal and Vertical Response Spectra per Specified Joint
R2RELSTK	7/28/82	Dynamic Modal Analysis (3-Modes) Transient Time History Analysis ; Computes and Stores Four individual Horizontal and Vertical Relative Acceleration VS. Period Response Spectra per Specified Joint

1.5 continued **UNCONTROLLED**

Name	Date	Description
RELSPEC	7/29/82	Restores Horizontal and Vertical Response Spectra from computer program "R2RELSTK" and compute the relative Horizontal and Vertical Response Spectra per Specified Joint
COMPARE	8/23/82	Determines the acceleration amplifical between the generated response at specified joints and the generated ground response. Then calculates the percentage increase. Also determines the acceleration amplification between the adjusted response at specified joints and the FSAR vertical response spectra. Then calculat. the percentage increase.

Note: Computer output "R2TOTSTK", "SPECTRA", and "COMPARE" are included in Volume 7.

Computer output "R2RELSTK" and "RELSPEC" are included in Volume 8.

2.0 Model

A stick model of the containment vessel will be used to generate the building responce spectra. This model will be based on the original model used in the preliminary analysis calculation file CNC-1144.09-01-0001. The relocation of the 13th ring stiffener (which deviates from the original model) is incorporated in the stick model. The mass distribution in the original model implements a smearing technique. To avoid the smearing technique, mass and mass concentrations are applied to mass points with respective elevations so as to reasonably represent the containment vessel. Member properties including moment of inertia, cross-section area, and shear area are calculated in the same manner as the original model.

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Form 00184 (6-81)

Dev./Station Catawba N.S. Unit All File No. CNC-1144.09-01-001
Subject Stick Model
By JMK Date 6-17-82
Sheet No. 115 of Problem No. Rev 3 Checked By DEB Date 7-1-82

2.1 Containment Weight For Lumped Mass Points

The weight of the containment vessel, penetrations, equipment hatch, personnel locks, ice condensers, ring stiffeners, and vertical stiffeners are calculated and the mass distributed to mass points with respective location.

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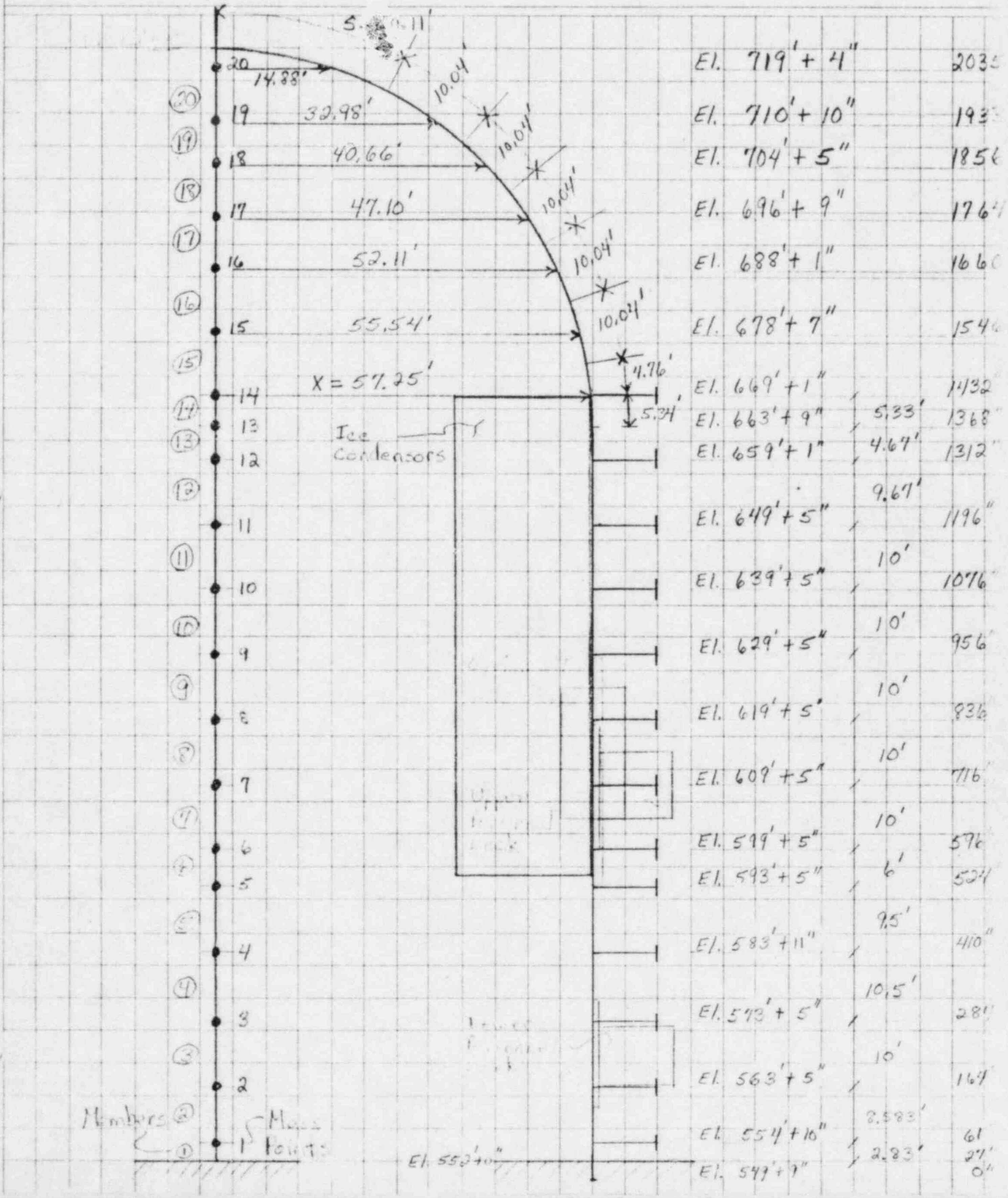
DUKE POWER COMPANY

Dev./Station *Catawba N.S.* Unit *All* File No. *CNC-1144.09-01-0010*

Subject *Stick Model*

By *JMK* Date *6-23-82*

Sheet No. *13* of Problem No. *Rev 3* Checked By *DEB* Date *7-22-82*



Form 00184 (6-81)

DUKE POWER COMPANY

Dev./Station Catawba N.S. Unit All File No. CNC-1148.09-01-001

Subject Stick Model

By JMK Date 6-24-82

Sheet No. 156 of Problem No. Rev 3 Checked By DEB Date 7-23-82

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2.3 Stick Model Data

The input data for computer program "JMKSTK" to generate response spectra for Catawba Nuclear Station Units 1 & 2 is tabulated below:

Joint No.	X Coord. (ft)	Y Coord. (ft)	Member No.	Weight (kips)	Area (ft^2)	Shear Area (ft^2)	Moment of Inertia (ft^4)
1	0	0.0					
2	0	2.83	1	160.44412	32.607	16.3035	53945.48
3	0	11.42	2	202.10272	32.607	16.3035	53945.48
4	0	21.42	3	212.57616	25.13	12.57	41585.138
5	0	31.92	4	205.97073	25.13	12.57	41585.138
6	0	41.42	5	163.23697	25.13	12.57	41585.138
7	0	47.42	6	224.45838	25.13	12.57	41585.138
8	0	57.42	7	284.66869	25.13	12.57	41585.138
9	0	67.42	8	275.13342	25.13	12.57	41585.138
10	0	77.42	9	254.52208	25.13	12.57	41585.138
11	0	87.42	10	243.71347	25.13	12.57	41585.138
12	0	97.42	11	243.34579	25.13	12.57	41585.138
13	0	107.08	12	188.02149	25.13	12.57	41585.138
14	0	111.75	13	96.57234	25.13	12.57	41585.138
15	0	117.08	14	138.51967	20.66	10.33	34011.2
16	0	126.63	15	98.35739	20.30	10.15	32286.7
17	0	136.05	16	92.28310	19.38	9.69	28078.1
18	0	144.73	17	84.79279	17.86	8.93	21978.1
19	0	152.42	18	73.38804	15.80	7.90	15211.1
20	0	158.85	19	58.40523	13.26	6.63	8988.4
21	0	167.29	20	77.02222	8.61	4.31	2468.1

$$E = 29 \times 10^6 \text{ PSI} = 29 \times 10^6 \left(\frac{144}{1000}\right) = 4{,}176{,}000 \text{ ksf}$$

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Form 00184 (6 81)

Dev./Station Catawba N. C. Unit All File No. CNC-1144.02-01-00

Subject Stick Model

By JMK Date 6-28-82

Sheet No. 158 Problem No. Rev 3 Checked By DEB Date 7-23-82

3.0 Seismic Analysis

The intent of the seismic analysis is to generate a response spectra for the Catawba containment vessel. A response spectrum can be defined as the representation of the maximum response of a single mass system for a varying frequency range to a defined base motion. The time history of the mass points is used as the base motion to obtain the response spectrum. The time history of the mass points is generated from transient loads, which are four synthetic earthquakes. The numerical average for the response of the four earthquake time-histories is used to generate the final response spectrum.

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3.1 <u>Input Data</u>

The input transient loads are four synthetic earthquakes noted as CATEQ1, CATEQ2, CATEQ3, and CATEQ4. Because each earthquake is assumed to have an equal contribution, each will be multiplied by a factor of .25. Through the STRUDL/DYNAL analysis the input transient loads are used to generate the corresponding time-histories (TH_{1-4}) and in turn the response spectra (RS_{1-4}). Since each response spectra only represents 25% of the response to the design input transients, the response spectra's are summed by absolute value to determine the total response (RS_{TOT}) for each given location. The following figure demonstrates the procedure above:

0.25 X CATEQ1 → TH1 → RS1 ↘
0.25 X CATEQ2 → TH2 → RS2 → RS_{TOT}
0.25 X CATEQ3 → TH3 → RS3 ↗
0.25 X CATEQ4 → TH4 → RS4 ↗

where: $RS_{TOT} = |RS1| + |RS2| + |RS3| + |RS4|$

Form 00184 (6-81)

DUKE POWER COMPANY

Dev./Station: Catawba N.S. | Unit: All | File No. CNC-1144.09-01-0010

Subject: Stick Model

By: JMK | Date: 6-29-82

Sheet No. 159 of ____ | Problem No. Rev 3 | Checked By: DEB | Date: 7-23-82

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3.1 continued

According to Catawba FSAR 3.7.2.6, an earthquake ground motion (CATEQ1, CATEQ2, CATEQ3, CATEQ4) is to be applied in a N-S and E-W horizontal direction simultaneously with motion applied in the vertical direction. Since the stick model is symmetric, an earthquake ground motion need only be applied in one horizontal direction simultoneously with motion applied in the vertical direction. Thus, 25% of CATEQ1, CATEQ2, CATEQ3, and CATEQ4 will be applied in both the horizontal and vertical directions. Because the horizontal response due to an earthquake ground motion applied in the vertical direction is negligable compared to the horizontal response due to an earthquake ground motion applied in the horizontal direction, the total horizontal response spectra will be calculated as stated on page 158 using only the horizontal response due to an earthquake ground motion applied in the horizontal direction. The same is true for the total vertical response spectra.

The following 8 pages are typical listings of the computer programs used in the STRUDL/DYNAL seismic analysis.

```
//R21UTST( JOB (8362CATA,D037,,99),2KELLYJK,MSGCLAS( A,CLASS=J,
//   TIME=60,NOTIFY=JMK8362
/*MESSAGE  OPERATOR...PLEASE ALLOW A CPU TIME OF 60 MINUTES
// EXEC STRUDL,CORE='900K',CLOCK=60
//DD1 DD DSN=TST.R030.C8362.TOT.SPECTRA,
//   DISP=(NEW,CATLG,DELETE),UNIT=3330V,MSVGP=TEST,
//   DCB=(LRECL=80,RECFM=FB,BLKSIZE=6080),
//   SPACE=(6144,(100,100),RLSE)
STRUDL 'CATAWBA' 'SEISMIC RESPONSE SPECTRA'
UNITS FEET LBM POUNDS CYCLES
TYPE PLANE FRAME
JOINT COORDINATES
1  0.    0.0   S
2  0.    2.83
3  0.   11.42
4  0.   21.42
5  0.   31.92
6  0.   41.42
7  0.   47.42
8  0.   57.42
9  0.   67.42
10 0.   77.42
11 0.   87.42
12 0.   97.42
13 0.  107.08
14 0.  111.75
15 0.  117.08
16 0.  126.63
17 0.  136.05
18 0.  144.73
19 0.  152.41
20 0.  158.85
21 0.  167.29
MEMBER INCIDENCES
1   1  2
2   2  3
3   3  4
4   4  5
5   5  6
6   6  7
7   7  8
8   8  9
9   9 10
10 10 11
11 11 12
12 12 13
13 13 14
14 14 15
15 15 16
16 16 17
17 17 18
18 18 19
19 19 20
20 20 21
MEMBER PROPERTIES PRISMATIC
1 2 AX 32.66 AY 16.33 IZ 58280.9
3 TO 13 AX 25.13 AY 12.57 IZ 45837.9
14 AX 20.66 AY 10.33 IZ 34011.2
15 AX 20.30 AY 10.15 IZ 32286.7
16 AX 19.38 AY  9.69 IZ 28078.4
17 AX 17.86 AY  8.93 IZ 21978.1
18 AX 15.80 AY  7.90 IZ 15211.1
[illegible]
```

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Stick Model
includes : 1. Joints
2. Members
3. Cross-section Area
4. Shear Area
5. Moment of Inertia
6. Mass Points
7. Lumped Mass

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```
UNITS INCHES
CONSTANTS
E 29000000. ALL
POISSON .3 ALL
INERTIA OF JOINTS ADD
2  LINEAR ALL 162909.7
3  LINEAR ALL 203048.9
4  LINEAR ALL 213707.5
5  LINEAR ALL 205842.6
6  LINEAR ALL 162264.2
7  LINEAR ALL 224514.4
8  LINEAR ALL 284668.7
9  LINEAR ALL 275139.3
10 LINEAR ALL 254630.0
11 LINEAR ALL 243893.0
12 LINEAR ALL 243632.2
13 LINEAR ALL 188218.4
14 LINEAR ALL  96592.3
15 LINEAR ALL 138519.7
16 LINEAR ALL  98357.4
17 LINEAR ALL  92283.1
18 LINEAR ALL  84229.6
19 LINEAR ALL  72824.8
20 LINEAR ALL  58405.2
21 LINEAR ALL  79028.0
UNITS FEET
DAMPING RATIO .01
TRANSIENT LOAD 1
SUPPORT ACCELERATIONS
TRANSLATION X FILE 'CATEQ1' FACTOR .25
INTEGRATE FROM 0. TO 20. AT DELTA .01
END
TRANSIENT LOAD 2
SUPPORT ACCELERATIONS
TRANSLATION X FILE 'CATEQ2' FACTOR .25
INTEGRATE FROM 0. TO 20. AT DELTA .01
END
TRANSIENT LOAD 3
SUPPORT ACCELERATIONS
TRANSLATION X FILE 'CATEQ3' FACTOR .25
INTEGRATE FROM 0. TO 20. AT DELTA .01
END
TRANSIENT LOAD 4
SUPPORT ACCELERATIONS
TRANSLATION X FILE 'CATEQ4' FACTOR .25
INTEGRATE FROM 0. TO 20. AT DELTA .01
END
TRANSIENT LOAD 5
SUPPORT ACCELERATIONS
TRANSLATION Y FILE 'CATEQ1' FACTOR .25
INTEGRATE FROM 0. TO 20. AT DELTA .01
END
TRANSIENT LOAD 6
SUPPORT ACCELERATIONS
TRANSLATION Y FILE 'CATEQ2' FACTOR .25
INTEGRATE FROM 0. TO 20. AT DELTA .01
END
TRANSIENT LOAD 7
SUPPORT ACCELERATIONS
TRANSLATION Y FILE 'CATEQ3' FACTOR .25
INTEGRATE FROM 0. TO 20. AT DELTA .01
END
TRANSIENT LOAD 8
```

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Reference Catawba FSAR 3.7.1.3

Note: Multiplication factor of 0.25 applied as stated on page 159.

CATEQ 1 applied in horizontal X-direction

CATEQ 2 " "

CATEQ 3 " "

CATEQ 4 " "

CATEQ 1 applied in the Vertical Direct.

CATEQ 2 "

CATEQ 3 "

JMK 6-29-8_

DEB 7-2-8_

CNC-1144.01-01-00_

```
TRANSLATI(  Y FILE 'CATEW4' FACTOR .25
INTEGRATE FROM 0. TO 20. AT DELTA .01
END
ASSEMBLE FOR DYNAMICS
INDEPENDENT DEGREES OF FREEDOM SELECT
CONDENSE DYNAMIC MATRICES
MODAL ANALYSIS HOW MAX 50.
LIST DYNAMIC PARTICIPATION FACTORS
LIST DYNAMIC NORMALIZED MODES
TRANSIENT ANALYSIS LOADS 1 2 3 4 5 6 7 8
STORE TRANSIENT 'HORIZ'
USE 1 2 3 4 FROM TIME 0. TO 20.
JOINT TOTAL ACCELERATIONS
6 9 14 17 20 TRANSLATION X
END
STORE TRANSIENT 'VERT'
USE 5 6 7 8 FROM TIME 0. TO 20.
JOINT TOTAL ACCELERATIONS
6 9 14 17 20 TRANSLATION Y
END
COMPUTE STORE TRANS 'HORIZ' 'VERT'
UNITS RADIANS
STORE SPECTRUM 1
RANGE FREQ LIN 1. 4. .15 4. 20. .3 20. 65. 1. 65. 210. 2.
OSCIL DAMP RATIO .005 .01 .02 .05
USE STORE 'HORIZ'
USE TRANS 1 2 3 4
JOI TOTAL ACCEL
6 TRANS X
END
STORE SPECTRUM 2
RANGE FREQ LIN 1. 4. .15 4. 20. .3 20. 65. 1. 65. 210. 2.
OSCIL DAMP RATIO .005 .01 .02 .05
USE STORE 'HORIZ'
USE TRANS 1 2 3 4
JOI TOTAL ACCEL
9 TRANS X
END
STORE SPECTRUM 3
RANGE FREQ LIN 1. 4. .15 4. 20. .3 20. 65. 1. 65. 210. 2.
OSCIL DAMP RATIO .005 .01 .02 .05
USE STORE 'HORIZ'
USE TRANS 1 2 3 4
JOI TOTAL ACCEL
14 TRANS X
END
STORE SPECTRUM 4
RANGE FREQ LIN 1. 4. .15 4. 20. .3 20. 65. 1. 65. 210. 2.
OSCIL DAMP RATIO .005 .01 .02 .05
USE STORE 'HORIZ'
USE TRANS 1 2 3 4
JOI TOTAL ACCEL
17 TRANS X
END
STORE SPECTRUM 5
RANGE FREQ LIN 1. 4. .15 4. 20. .3 20. 65. 1. 65. 210. 2.
OSCIL DAMP RATIO .005 .01 .02 .05
USE STORE 'HORIZ'
USE TRANS 1 2 3 4
JOI TOTAL ACCEL
20 TRANS X
END
STORE SPECTRUM 6
```

- (at MODAL ANALYSIS) Modal Analysis required for up coming transient analysis
- (at TRANSIENT ANALYSIS LOADS) Transient Analysis
- (at STORE TRANSIENT 'HORIZ') Horizontal Time-History Defined For Specified Joints
- (at STORE TRANSIENT 'VERT') Vertical Time-History Defined For Specified Joints
- (at COMPUTE STORE TRANS) Computes & Stores horizontal & Vertical Time-History
- (at STORE SPECTRUM 1) Defines input for [illegible] response spectra for joint 6 (response [illegible] synthetic earthquake).
- (at RANGE FREQ line) Reference Catawba FSAR 3.7.1.2
- (at STORE SPECTRUM 2) " Joint 9 "
- (at STORE SPECTRUM 3) " Joint 14 "
- (at STORE SPECTRUM 4) " Joint 17 "
- (at STORE SPECTRUM 5) " Joint 20 "

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DEB 7-23-84

JMK 6-29-82

CNC-1144.01-01-0010

```
OSCIL DAM( RATIO .005 .01 .02 .05
USE STORE 'VERT'
USE TRANS 5 6 7 8
JOI TOTAL ACCEL
6 TRANS Y
END
STORE SPECTRUM 7
RANGE FREQ LIN 1. 4. .15 4. 20. .3 20. 65. 1. 65. 210. 2.
OSCIL DAMP RATIO .005 .01 .02 .05
USE STORE 'VERT'
USE TRANS 5 6 7 8
JOI TOTAL ACCEL
9 TRANS Y
END
STORE SPECTRUM 8
RANGE FREQ LIN 1. 4. .15 4. 20. .3 20. 65. 1. 65. 210. 2.
OSCIL DAMP RATIO .005 .01 .02 .05
USE STORE 'VERT'
USE TRANS 5 6 7 8
JOI TOTAL ACCEL
14 TRANS Y
END
STORE SPECTRUM 9
RANGE FREQ LIN 1. 4. .15 4. 20. .3 20. 65. 1. 65. 210. 2.
OSCIL DAMP RATIO .005 .01 .02 .05
USE STORE 'VERT'
USE TRANS 5 6 7 8
JOI TOTAL ACCEL
17 TRANS Y
END
STORE SPECTRUM 10
RANGE FREQ LIN 1. 4. .15 4. 20. .3 20. 65. 1. 65. 210. 2.
OSCIL DAMP RATIO .005 .01 .02 .05
USE STORE 'VERT'
USE TRANS 5 6 7 8
JOI TOTAL ACCEL
20 TRANS Y
END
COMPUTE STORE SPECTRA 1 2 3 4 5 6 7 8 9 10
SAVE 'SPECTRA' SCAN CHECK
FINISH
/*
```

Response spectra for joint 6 (1 response per synthetic earthquake)

" joint 9 "

" joint 14 "

" joint 17 "

" joint 20 "

Computes and Stores all previously defined Response Spectra.

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```
//R2TOTSP  JOB (8362CATA,D037,,99),2KELLYJK,MSGCLASS=A,CLASS=F,
//   TIME=20,NOTIFY=JMK8362
/*MESSAGE  OPERATOR...PLEASE ALLOW A CPU TIME OF 20 MINUTES
//STEPA EXEC STRUDRAW,CORE='400K',CLOCK=20,
//   PLOTAPE='CNS.PLOT.TT1',PLOTPRO=SPECTEN
//DD1 DD DSN=TST.R030.C8362.TOT.SPECTRA,DISP=OLD,
//   DCB=(LRECL=80,RECFM=FB,BLKSIZE=6080)
STRUDL 'CATAWBA' 'CONTAINMENT RESPONSE SPECTRA'
RESTORE 'SPECTRA'
UNITS CYCLES
OUTPUT SPECTRUM
PUNCH ON
OUTPUT G TRUE ACCEL VS PERIOD
USE STORE 1
USE TRANS ANAL 1 2 3 4
USE DAMP ALL
COMBINE SPECTRA PEAK
JOINT TOTAL ACCE
6 TRANS X
END SUBSET
END
OUTPUT SPECTRUM
PUNCH ON
OUTPUT G TRUE ACCEL VS PERIOD
USE STORE 2
USE TRANS ANAL 1 2 3 4
USE DAMP ALL
COMBINE SPECTRA PEAK
JOINT TOTAL ACCE
9 TRANS X
END SUBSET
END
OUTPUT SPECTRUM
PUNCH ON
OUTPUT G TRUE ACCEL VS PERIOD
USE STORE 3
USE TRANS ANAL 1 2 3 4
USE DAMP ALL
COMBINE SPECTRA PEAK
JOINT TOTAL ACCE
14 TRANS X
END SUBSET
END
OUTPUT SPECTRUM
PUNCH ON
OUTPUT G TRUE ACCEL VS PERIOD
USE STORE 4
USE TRANS ANAL 1 2 3 4
USE DAMP ALL
COMBINE SPECTRA PEAK
JOINT TOTAL ACCE
17 TRANS X
END SUBSET
END
OUTPUT SPECTRUM
PUNCH ON
OUTPUT G TRUE ACCEL VS PERIOD
USE STORE 5
USE TRANS ANAL 1 2 3 4
USE DAMP ALL
COMBINE SPECTRA PEAK
JOINT TOTAL ACCEL
20 TRANS X
```

This program restores the horizontal and vertical response spectra. Then for each joint (6, 9, 14, 17, 20), the total response spectra per joint is calculated by summing the absolute values of the response spectra's calculated for each joint due to synthetic earthquakes CATEQ1, CATEQ2, CATEQ3, & CATEQ4.

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JMK 6-29-82
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```
END
FINISH
//STEP2.SYSIN DD *
CATAWBA CONTAINMENT VESSEL - SEISMIC
HORIZONTAL RESPONSE TO OBE (.08G) AT EL 593.42
HORIZONTAL RESPONSE TO OBE (.08G) AT EL 593.42
HORIZONTAL RESPONSE TO OBE (.08G) AT EL 593.42
HORIZONTAL RESPONSE TO OBE (.08G) AT EL 593.42
HORIZONTAL RESPONSE TO OBE (.08G) AT EL 619.42
HORIZONTAL RESPONSE TO OBE (.08G) AT EL 619.42
HORIZONTAL RESPONSE TO OBE (.08G) AT EL 619.42
HORIZONTAL RESPONSE TO OBE (.08G) AT EL 619.42
HORIZONTAL RESPONSE TO OBE (.08G) AT EL 663.75
HORIZONTAL RESPONSE TO OBE (.08G) AT EL 663.75
HORIZONTAL RESPONSE TO OBE (.08G) AT EL 663.75
HORIZONTAL RESPONSE TO OBE (.08G) AT EL 663.75
HORIZONTAL RESPONSE TO OBE (.08G) AT EL 688.05
HORIZONTAL RESPONSE TO OBE (.08G) AT EL 688.05
HORIZONTAL RESPONSE TO OBE (.08G) AT EL 688.05
HORIZONTAL RESPONSE TO OBE (.08G) AT EL 688.05
HORIZONTAL RESPONSE TO OBE (.08G) AT EL 710.85
HORIZONTAL RESPONSE TO OBE (.08G) AT EL 710.85
HORIZONTAL RESPONSE TO OBE (.08G) AT EL 710.85
HORIZONTAL RESPONSE TO OBE (.08G) AT EL 710.85
/*
```


Pg. 165

CNC-1144.09.01-0010
JWK 6-29-82
DEB 7-23-82

```
//R2TOTSP  JOB (8362CATA,0037,,99),2KELLYJK,MSGCLASS=A,CLASS=F,
//   TIME=20,NOTIFY=JMK8362,PRTY=12
/*MESSAGE  OPERATOR...PLEASE ALLOW A CPU TIME OF 20 MINUTES
/*AFTER R2JMKSP1
//STEPA EXEC STRUDRAW,CORE='400K',CLOCK=20,
//   PLOTAPE='CNS.PLOT.TT2',PLOTPRO=SPECTEN
//DD1 DD DSN=TST.R030.C8362.TOT.SPECTRA,DISP=OLD,
//   DCB=(LRECL=80,RECFM=FB,BLKSIZE=6080)
STRUDL 'CATAWBA' 'CONTAINMENT RESPONSE SPECTRA'
RESTORE 'SPECTRA'
UNITS CYCLES
OUTPUT SPECTRUM
PUNCH ON
OUTPUT G TRUE ACCEL VS PERIOD
USE STORE 6
USE TRANS ANAL 5 6 7 8
USE DAMP ALL
COMBINE SPECTRA PEAK
JOINT TOTAL ACCEL
6 TRANS Y
END SUBSET
END
OUTPUT SPECTRUM
PUNCH ON
OUTPUT G TRUE ACCEL VS PERIOD
USE STORE 7
USE TRANS ANAL 5 6 7 8
USE DAMP ALL
COMBINE SPECTRA PEAK
JOINT TOTAL ACCEL
9 TRANS Y
END SUBSET
END
OUTPUT SPECTRUM
PUNCH ON
OUTPUT G TRUE ACCEL VS PERIOD
USE STORE 8
USE TRANS ANAL 5 6 7 8
USE DAMP ALL
COMBINE SPECTRA PEAK
JOINT TOTAL ACCEL
14 TRANS Y
END SUBSET
END
OUTPUT SPECTRUM
PUNCH ON
OUTPUT G TRUE ACCEL VS PERIOD
USE STORE 9
USE TRANS ANAL 5 6 7 8
USE DAMP ALL
COMBINE SPECTRA PEAK
JOINT TOTAL ACCEL
17 TRANS Y
END SUBSET
END
OUTPUT SPECTRUM
PUNCH ON
OUTPUT G TRUE ACCEL VS PERIOD
USE STORE 10
USE TRANS ANAL 5 6 7 8
USE DAMP ALL
COMBINE SPECTRA PEAK
JOINT TOTAL ACCEL
```

This program restores the horizontal and vertical response spectra. Then for each joint (6, 9, 14, 17, 20), the total response spectra per joint is calculated by summing the absolute values of the response spectra's calculated for each joint due to synthetic earthquakes CATEQ1, CATEQ2, CATEQ3, & CATEQ4.

UNCONTROLLED

Pg-166

CNC-1114.09-01-06
JMK 6-29-82
DEB 7-23-82

```
END SUBSE
END
FINISH
//STEP2.SYSIN DD *
CATAWBA CONTAINMENT VESSEL - SEISMIC
VERTICAL RESPONSE TO OBE (.08G) AT EL 593.42
VERTICAL RESPONSE TO OBE (.08G) AT EL 593.42
VERTICAL RESPONSE TO OBE (.08G) AT EL 593.42
VERTICAL RESPONSE TO OBE (.08G) AT EL 593.42
VERTICAL RESPONSE TO OBE (.08G) AT EL 619.42
VERTICAL RESPONSE TO OBE (.08G) AT EL 619.42
VERTICAL RESPONSE TO OBE (.08G) AT EL 619.42
VERTICAL RESPONSE TO OBE (.08G) AT EL 619.42
VERTICAL RESPONSE TO OBE (.08G) AT EL 663.75
VERTICAL RESPONSE TO OBE (.08G) AT EL 663.75
VERTICAL RESPONSE TO OBE (.08G) AT EL 663.75
VERTICAL RESPONSE TO OBE (.08G) AT EL 663.75
VERTICAL RESPONSE TO OBE (.08G) AT EL 688.05
VERTICAL RESPONSE TO OBE (.08G) AT EL 688.05
VERTICAL RESPONSE TO OBE (.08G) AT EL 688.05
VERTICAL RESPONSE TO OBE (.08G) AT EL 688.05
VERTICAL RESPONSE TO OBE (.08G) AT EL 710.85
VERTICAL RESPONSE TO OBE (.08G) AT EL 710.85
VERTICAL RESPONSE TO OBE (.08G) AT EL 710.85
VERTICAL RESPONSE TO OBE (.08G) AT EL 710.85
/*
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UNCONTROLLED

Pg 16,7

CNC-1144.09-01-00
JMK 6-29-82
DEB 7-23-82

UNCONTROLLED

3.1 continued

Listings of the computer programs used in the STRUDL/DYNAL seismic analysis are shown in Appendix A.

The ground response spectra generated due to the four synthetic earthquake time histories used to simulate the horizontal ground motion will be compared to the Catawba FSAR specified ground response spectra shown in FSAR Figure 2.5.2-6. The figures in Appendix B show the generated ground response spectrum for oscillator damping values of .5, 1.0, 2.0, and 5.0 % as well as the Catawba FSAR ground response spectra plotted on these generated spectrum. In reviewing these figures, it is seen that the generated ground response spectrum, with the magnitudes of acceleration being slightly greater, reasonably represents the shape of the Catawba FSAR specified ground response spectrum.

Note: Appendices A thru K are included in Volume 6, "For Information Only".

Note: Section 3.7, Seismic Design, of the Catawba FSAR and FSAR Figure 2.5.2-6 are shown in Appendix K.

3.2 Results

The results of the seismic analysis will include modes with frequencies less than 33 hertz, time histories at specified joints, and horizontal total acceleration vs. period response spectra. In addition, action item number 10 of the NRC Structural Audit concerning the assumption of negligible amplification in the vertical seismic analysis will be addressed.

Three modes had frequencies less than 33 hertz. The first mode is a horizontal flexure mode, the second is a vertical axial mode, the third is the second horizontal flexure mode. These mode shapes are shown in Appendix C.

Time histories were generated for six joints from the transient analysis mentioned in section 3.1. The first joint was chosen to develope a time history at ground elevation. The five remaining joints were chosen so as to develope time histories at the same elevations as the response spectrum in published File CNS-1108.00-00-0002, Volume I, Appendix A "Containment Vessel Seismic

Form 00154 (6 81)

DUKE POWER COMPANY

Div./Station Catawba N.S. Unit All File No. CNC-1144.09-01-0016

Subject Stick Model

By JMK Date 6-30-82

Sheet No. 170 of Problem No. Rev 3 Checked By DEB Date 8-24-82

UNCONTROLLED

3.2 continued

Response Spectra (OBE)". These time histories incorporated the oscillating damping values stated in Catawba FSAR section 3.7.1.2 of .5, 1.0, 2.0, and 5.0% damping for OBE. The time history plots for each damping at each elevation are shown in Appendix D.

The horizontal total acceleration vs. period response spectrum, generated by this calculation, were calculated by adding rigid body support motions to those from modal contributions. This resulted in the total acceleration versus time history at each selected elevation. From these time histories, the response spectra for single degree of freedom oscillators were generated for the damping ratios required. These horizontal response spectrum, developed from computer programs "R2TOTSTK" and "SPECTRA", are shown in Appendix E. Data points from these horizontal response spectrum are plotted (shown in red) on the horizontal response spectra plots of

UNCONTROLLED

3.2 continued

File CNS-1108.00-00-0002, Volume I, Appendix A "Containment Vessel Seismic Response Spectra (OBE)". These plots are shown in Appendix F. The dashed line represents the horizontal response spectra used for design of Category I structures, systems, and components supported by the containment vessel. The dashed line has incorporated a safety factor in the vicinity of the maximum response acceleration by broadening the peak by 10% and increasing the amplitude of the peak by 10%. To verify the horizontal response spectra of File CNS-1108.00-00-0002 to be satisfactory, the data points (shown in red) from the horizontal response spectra derived in this calculation must be completely enveloped by the dashed line. The plots in Appendix F show that the data points (shown in red) from the horizontal response spectra developed in this calculation are completely enveloped by the dashed line. This indicates that the horizontal response spectra included in published File CNS-1108.00-00-0002, Volume I, Appendix A seems to adequately represent the containment vessel.

Form 00184 (6-81)

DUKE POWER COMPANY

Dev./Station Catawba N.S. Unit All File No. CNC-1144.09-01-001

Subject Stick Model

By JMK Date 8-6-82

Sheet No. 172i Problem No. Rev 3 Checked By DEB Date 9-1-82

UNCONTROLLED

3.2 continued

Action item 10 of NRC Structural Audit concerns the assumption of negligible amplification in the vertical seismic analysis. To illustrate negligible amplification in the vertical analysis, a synthetic ground motion will be applied in the vertical direction in a transient analysis to calculate time histories at specified locations. These time histories are used to generate both input time history response spectra and response spectra in the vertical direction at specified elevations. A simulated time history was used due to the lack of a reasonable vertical ground motion time history. For ease of use, the horizontal time history is utilized. It is noted that the vertical response spectra generated in this calculation do not represent actual vertical response spectra. The vertical response spectra generated are for the purpose of illustrating negligible amplification with altitude in the vertical seismic analysis only. The Catawba FSAR section 3.7.2.10 states that "The response spectra used for the design of vertical modes is equal to 2/3 of the horizontal spectra". The

3.2 continued **UNCONTROLLED**

horizontal spectra is the horizontal ground response spectra shown in FSAR Figure 2.5.2-6.

The vertical total acceleration vs. period response spectra obtained at each elevation specified in calculation File CNS-1108.00-00-0002, Appendix A can now be compared to the input response spectra to illustrate negligible amplification with altitude. The vertical acceleration vs. period response spectra plots are shown in Appendix G. A FORTRAN program, "COMPARE," was written to determine the acceleration amplification between the generated response spectra at each elevation and the generated ground response spectra. The percentage increase for each period was also calculated. *The figures in Appendix H are vertical response spectra plots showing the region, designated in blue, where the percentage increase is greater than 5%. The maximum percentage increase and its approximate location is noted. The maximum acceleration amplification and maximum percent increase for each damping value per specified joint is tabulated on page 175.

* Reference computer output "COMPARE"

3.2 continued **UNCONTROLLED**

It is noted that the Catawba FSAR section 3.7.1.3, Critical Damping Values states that the only system subject to a damping value of .5% for OBE is the 'Primary Coolant Loop System Components'. Since the 'Primary Coolant Loop System Components' are structurally independent of the steel containment vessel, a damping value of .5% will not be considered in the vertical seismic analysis of the steel containment vessel.

DUKE POWER COMPANY

Form 06184 (6-81)

Dev./Station: Catawba N.S. Unit: All File No.: CNC-1144.09-01-001
Subject: Stick Model
By: JMK Date: 8-6-82
Sheet No. 175 of Problem No.: Rev 3 Checked By: DEB Date: 9-3-82

UNCONTROLLED

The Maximum Acceleration Amplification and Maximum Percentage Increase Between the Generated Ground Response Spectrum and the Generated Response Spectrum at Specified Joints

Elevation	Period	1.0% Damping		2.0% Damping		5.0% Damping	
		Δ Acc	% Inc	Δ Acc	% Inc	Δ Acc	% Inc
593.42	.0795	.0394	17.064	.0322	15.972		
	.0706	.0348	19.551				
	.0757			.0279	16.053		
	.0776					.0208	13.065
619.42	.0795			.0508	25.198		
	.0706	.0568	31.910				
	.0757			.0440	25.316		
	.0776	.0624	27.771			.0332	20.854
663.75	.0795			.0710	35.218		
	.0706	.0808	45.393				
	.0670			.0560	35.760		
	.0776	.0876	38.985			.0468	29.397
688.05	.0795			.0769	38.145		
	.0706	.0878	49.326				
	.0690			.0608	38.825		
	.0776	.0950	42.279			.0508	31.910
710.85	.0795			.0802	39.782		
	.0706	.0917	51.517				
	.0690			.0635	40.549		
	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]

UNCONTROLLED

3.2 continued

To better represent the magnitude of the amplification with respect to the Catawba FSAR Vertical Response Spectrum, the generated response spectrum at each specified joint will be ratioed by:

$$\left(\frac{\text{Catawba FSAR Vertical Response Spectra}}{\text{Generated Ground Response Spectra}} \right)$$

This is intended only to get the amplification and the input ground response into the same range of values as the required FSAR Response Spectrum. The Catawba FSAR states that the vertical response spectrum will be 2/3 the specified horizontal ground response spectrum of FSAR Figure 2.5.2-6. It has been shown that the magnitude of the generated ground response spectrum is larger than the FSAR Ground Response Spectrum Figure 2.5.2-6. Thus, the multiplication factor above, applied to the generated respons spectrum, reduces to:

$$\frac{\text{2/3 FSAR Horizontal Ground Response Spectrum of Figure 2.5.2-6}}{\text{Generated Ground Response Spectrum}}$$

for the same period.

UNCONTROLLED

3.2 continued

The adjusted response acceleration that will be compared to 2/3 of the FSAR horizontal ground response acceleration with respect to the same period will be:

$$\text{Adjusted Acceleration} = (\text{Generated Acceleration}) * \left(\frac{2/3 \text{ FSAR Figure 2.5.2-6 Acceleration}}{\text{Generated Ground Response Acceleration}}\right)$$

To compare the adjusted response spectrum to 2/3 of the Catawba FSAR horizontal ground response spectrum, accelerations must be determined with respect to the same periods used to generate the vertical acceleration vs. period response spectrum. The equation of the Catawba FSAR response spectra plots of FSAR figure 2.5.2-6 are required. Since the plots are in a log-log scale, the equation of each respective line is:

$$Y = MX + B$$

where
- Y = Log (acceleration)
- M = multiplication factor
- X = Log (period)
- B = constant

3.2 continued

Given the end points of each line, M and B can be determined. The period (P) is known. Therefore, the acceleration (A) can be calculated:

Equation: $\text{Log}(A) = M\,\text{Log}(P) + B$

Given: P_1, A_1, P_2, A_2

$\text{Log}\,A_1 = M\,\text{Log}\,P_1 + B$

$\Rightarrow B = \text{Log}\,A_1 - M\,\text{Log}\,P_1$ ①

$\text{Log}\,A_2 = M\,\text{Log}\,P_2 + B$

$\Rightarrow B = \text{Log}\,A_2 - M\,\text{Log}\,P_2$ ②

① = ② $\Rightarrow$ $\text{Log}\,A_1 - M\,\text{Log}\,P_1 = \text{Log}\,A_2 - M\,\text{Log}\,P_2$

$\text{Log}\,A_1 - \text{Log}\,A_2 = M\,\text{Log}\,P_1 - M\,\text{Log}\,P_2$

$\text{Log}(A_1/A_2) = M\,\text{Log}(P_1/P_2)$

$$\Rightarrow M = \frac{\text{Log}(A_1/A_2)}{\text{Log}(P_1/P_2)}$$

$$\Rightarrow B = \text{Log}\,A_1 - \left[\frac{\text{Log}(A_1/A_2)}{\text{Log}(P_1/P_2)}\right]\text{Log}\,P_1$$

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3.2 continued

Given P_1, A_1, P_2, A_2 and determining M and B, the acceleration (A) now becomes:

$$\text{Log } A = M \text{ Log } P + B$$

$$\therefore A = 10^{(M \text{ Log} P + B)}$$

The end points chosen for each of the 3 lines per damping value .005, .01, .02, .05 for OBE are tabulated below:

	Line 1				Line 2				Line 3			
Damping	P_1	A_1	P_2	A_2	P_3	A_3	P_4	A_4	P_5	A_5	P_6	A_6
.5%	.05	.140	.166	.40	.166	.40	.50	.40	.50	.40	3.0	.065
1.0%	.05	.132	.166	.340	.166	.340	.50	.340	.50	.340	3.0	.054
2.0%	.05	.125	.166	.280	.166	.280	.50	.280	.50	.280	3.0	.045
5.0%	.05	.110	.166	.20	.166	.20	.50	.20	.50	.20	3.0	.033

Note: the acceleration values are 100% of the FSAR horizontal ground repsonse spectr

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3.2 continued

The following example problem will be used to verify computer output "COMPARE".

Given: Damping = 1.0% Joint 20 P = .0706

Line 1 ⇒ $P_1 = .05s$ $A_1 = .088g$ $P_2 = .166s$ $A_2 = .2266g$

Note: A_1 & A_2 are 2/3 of values shown in previous table

$$M = \frac{\log(.088/.2266)}{\log(.05/.166)}$$

$$M = .78847619$$

$$B = \log(.088) - \left[\frac{\log(.088/.2266)}{\log(.05/.166)}\right]\log(.05)$$

$$B = -.02968615$$

$$\Rightarrow \quad A = 10^{(.78847619 \log .0706 + (-.02968615))}$$

$$A = 10^{-.93737623}$$

$$\underline{A = .1155111 = .1155\ g}$$

Given: Generated Ground Response = .1780 g
Generated Response = .2697 g

3.2 continued

Adjusted Acceleration = $(.2697)\left[\frac{(.1155)}{(.1780)}\right]$ (calculated ok)

= .1750 g

Acceleration Amplification = .1750 − .1155

= .0595 g

Percentage Increase = $\frac{.0595\,g}{.1155\,g}$

= 51.52%

Percentages are same as previously calculated. OK

A comparison of these calculated values to those from output "COMPARE" reveals the same results.

FORTRAN program "COMPARE" also determines the acceleration amplification between the adjusted response spectra and the Catawba FSAR vertical response spectra given the same period. The percentage increase for each period was also calculated. *The figures in Appendix I are vertical response spectra plots showing the region, designated in green, where the acceleration

* Reference computer output "COMPARE"

DUKE POWER COMPANY

Plant/Station Catawba N.S. Unit All File No. CNC-1144.09-01-00
Subject Stick Model

By JMK Date 8-20-82

Sheet No. 182 of Problem No. Rev 3 Checked By LEB Date 9-3-82

UNCONTROLLED

3.2 continued

amplification is greater than 2%g. The maximum acceleration amplification and its approximate location is noted. The maximum acceleration amplification and maximum percent increase for each damping value .01, .02 & .05 per specified joint is tabulated on the following page.

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Form 00734 (6-81)

Div./Station: Catawba N.S. Unit: All File No. CNC-1144.09-01-001

Subject: Stick Model

By: JMK Date: 8-20-82

Sheet No. 183 of ___ Problem No. Rev 3 Checked By: DEB Date: 9-3-82

The Maximum Acceleration Amplification and Maximum Percentage Increase Between the Catawba FSAR Ground Response Spectrum and the Adjusted Response Spectrum at Specified Joints

Elevation	Period	1.0 % Damping		2.0 % Damping		5.0 % Damping	
		Δ Acc	% Inc	Δ Acc	% Inc	Δ Acc	% Inc
593.42	.0795			.0182	15.972		
	.0706	.0226	19.551				
	.0757			.0177	16.053		
	.0776					.0119	13.065
619.42	.0795			.0287	25.1983		
	.0706	.0369	31.910				
	.0757			.0279	25.317		
	.0776					.0190	20.854
663.75	.0795			.0401	35.218		
	.0706	.0524	45.393				
	.0690			.0370	35.7598		
	.0776					.0268	29.397
688.05	.0795			.0434	38.145		
	.0706	.0570	49.326				
	.0690			.0402	38.825		
	.0776					.0291	31.910
710.85	.0795			.0453	39.782		
	.0706	.0595	51.517				
	.0690			.0419	40.549		
	[illegible]					[illegible]	[illegible]

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Form 00184 (6-81)

DUKE POWER COMPANY

Dev./Station Catawba N.S. Unit All File No. CNC-1144.09-01-001

Subject Stick Model

By JMK Date 8-20-82

Sheet No. 184 of Problem No. Rev 3 Checked By DEB Date 9-3-82

3.2 continued

To show this amplification due to modal contributions, vertical relative acceleration vs. period response spectra was generated, again using 100% horizontal ground motion time history as the time history input, by computer programs "RELSTK" and "RELSPEC". These plots are shown in Appendix J.

Inspecting the figures in Appendix I, it is noted that:

A. At some points on the vertical response spectrum, it is possible to get out an acceleration 51% greater than that indicated by the input vertical spectrum!

B. The amplification is noted in a general range of frequency between 5 and 20 hertz. In this range, the generated vertical response is greater than the input vertical excitation.

C. The magnitude of the maximum acceleration amplification is approximately .16g at 14.16 hertz.

3.2 continued

D. The FSAR ground response spectrum (FSAR Figure 2.5.2 peak is between 2 and 6 hertz. Note: The amplification is noted at off peak frequencies.

Although vertical amplification is present, the magnitude of the vertical amplification is only approximately 6% g. The mass of all attachments experience a constant acceleration of 1.0g due to gravity. The amplification of 6% is deemed to be small relative to 1.0 and will be neglected.

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4.0 Conclusions

Calculation File CNC-1144.09-01-0001 includes the preliminary seismic analysis of the Catawba containment vessel which produced the "Catawba Containment Vessel Response Acceleration Spectra" of File CNS-1108.00-00-0002, Catawba Nuclear Station Specification for The Response Spectra Displacements For Category I Structures, Volume I. Because the computer print out of the preliminary seismic analysis could not be located and the 13th ring stiffener had been relocated since the original seismic analysis, a verification of the published response spectra was performed. The stick model used for analysis was analogous to the model used in the preliminary seismic analysis of 1974. The relocation of the 13th ring stiffener was incorporated in the stick model. A more refined smearing technique was utilized. Mass concentrations were applied to mass points with respective elevations. Member properties including moment of inertia, cross-section area, and shear area were calculated in the same manner as the original model. Using the stick

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4.0 continued

model, a seismic analysis was performed to generate horizontal response spectra. These response spectra were then compared to the response spectra of published File CNS-1108.00-00-0002 to verify that the published response spectra reasonably represented the containment vessel. In compliance with the Catawba FSAR section 3.7.2.6, a simulated horizontal time history was applied in the horizontal and vertical directions. Twenty-five percent of four synthetic earthquakes (CATEQ1, CATEQ2, CATEQ3, CATEQ4) were used to simulate the horizontal ground motion. The generated ground response spectra for oscillator damping values of .5, 1.0, 2.0, and 5.0 %, with magnitudes of acceleration being slightly greater, reasonably represented the shape of the Catawba FSAR specified ground response spectra. Horizontal response spectra were generated at 5 joints with the same elevations as those response spectra in published File CNS-1108.00-00-0002. The horizontal total acceleration vs. period response spectra were calculated by adding rigid body support motions to those from modal contributions. This resulted in the total acceleration time history at each selected elevation. From these time histories, the response spectra for single degree of freedom oscillators

DUKE POWER COMPANY

Form 00184 (6-81)

Div./Station Catawba N.S. Unit All File No. CNC-1144.09-01-001

Subject Stick Model

By JMK Date 8-24-82

Sheet No. 188 of ____ Problem No. Rev 3 Checked By DEB Date 9-3-82

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4.0 continued

were generated for the damping ratios required. Data points from these horizontal response spectrum were plotted on the horizontal response spectrum plots of File CNS-1108.00-00-000 The data points were completely enveloped by the dashed line of the published response spectrum. This indicates that the horizontal response spectra included in published File CNS-1108.00-00-0002 Volume I, Appendix A seems to adequately represent the containment vessel.

Action item 10 of the NRC Structural Audit concerning the assumption of negligible amplification in the vertical seismic analysis was also addressed. To illustrate negligible amplification in the vertical analysis, a synthetic ground motion was applied in the vertical direction in a transient analysis to calculate time histories and associated response spectra at specified locations. It is noted that the vertical response spectra generated in this calculation do not represent true containment vertical response spectra. The vertical response spectra generated are for the purpose of illustrating negligible amplification with altitude in the vertical seismic analysis only. To represent the magnitude of the amplification with respect to the Catawba FSAR vertical

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4.0 continued

response spectra, the generated response spectra at each specified joint was ratioed (see Results section 3.0) into the same range of values as the FSAR Vertical Response Spectra (2/3 of horizontal ground response spectra). Although vertical amplification is present, the magnitude of the vertical amplification is only approximately 6% g. The mass of all attachments experience a constant acceleration of 1.0 g due to gravity. The amplification of 6% g is deemed to be small relative to 1.0 and will be neglected.

Form 00184 (6-81)

DUKE POWER COMPANY

Div./Station CATAWBA Unit 1&2 File No. CNC-1144.09-01-0010

Subject VERTICAL AMPLIFICATION

By JMM Date 1-28-83

Sheet No. 189.001 Problem No. REV 6 Checked By DEB Date 1-31-83

STATEMENT OF THE PROBLEM

FOLLOWING THE ANALYSIS OF THE LUMPED MASS MODEL FOR VERTICAL EXCITATION, AS DESCRIBED ON THE PRECEDING PAGES, A REVISED SUBMITTAL WAS MADE TO THE USNRC S.E.B. DESCRIBING THE ANALYSIS AND EXPLAINING THE CONTENTION THAT AMPLIFICATION IN THE VERTICAL DIRECTION IS NEGLIGIBLE. THIS SUBMITTAL WAS MADE TO SRAL DURING SEPTEMBER 1982, AND A COPY OF THE SUBMITTAL IS INCLUDED ON THE FOLLOWING PAGES.

DURING JANUARY 1983, NRC REPRESENTATIVES REQUESTED CLARIFICATION AND DETAILED DATA SUPPORTING THE CONCLUSIONS OF THE ANALYSIS. A COPY OF THE INFORMATION PROVIDED IS ALSO INCLUDED ON THE FOLLOWING SHEETS.

THE PURPOSE OF THIS REVISION IS TO DOCUMENT THE SOURCES OF THE DATA SUBMITTED.

QA CONDITION 1 APPLIES

STANDARDS, FSAR REFERENCES, AND REFERENCES AS BEFORE.

COMPUTER RUNS USED

A. RZTOTSTK J 5543 28JUL82 _ STICK MODEL AND ACCELERATION TIME HISTORIES FOR BASE AND MASS POINTS (horiz & vert)
B. SPECTRA J6199 29Jul82 - Generation of response spectra from acceleration time histories above
C. COMPARE J1974 23AUG82 - PERFORMS ANALYSIS DESCRIBED IN SEPTEMBER SUBMITTAL ABOVE
D. DEB8362D J4431 17JAN83 } GENERATE PLOTS OF RESULTS
   DEB8362Z J 921 14JAN83 } OF RUN "COMPARE"

Form 00134 (6-81)

DUKE POWER COMPANY

Dev./Station CATAWBA Unit 1&2 File No. CNC-1144.09-01-0010

Subject VERTICAL AMPLIFICATION

By JMM Date 1-28-83

Sheet No. 189.002 of Problem No. Rev 6 Checked By DEB Date 1-31-83

SEPTEMBER SUBMITTAL

THIS SUBMITTAL, SHOWN ON THE FOLLOWING THREE PAGES, IS A SUMMARY OF THE ANALYSIS METHOD FOR DETERMINING VERTICAL AMPLIFICATION WHICH IS DESCRIBED IN THIS CALC, SHEETS 172 TO 185.

THE MAXIMUM AMPLIFICATION OF ACCELERATION, DETERMINED TO BE 0.06g, IS SHOWN ON SHEET 181, AS CALCULATED IN COMPUTER RUN "COMPARE"

10. Provide justification demonstrating negligible amplification assumed in vertical seismic analysis (interior structure, auxiliary building, and steel containment).

Revised Response (Steel Containment only)

During preparation of the design report for the steel containment vessel, a detailed review of all design calculations has been made. In the course of this review, it was found that the spectra submitted in the initial response to this action item had been generated using relative acceleration time histories from the lumped mass stick model. A time history of total accelerations is the appropriate input for generation of these spectra.

The use of spectra generated using relative accelerations results in the conclusion that the vertical ground response spectrum envelopes the vertical spectrum at each point. This, in fact, may not be true when total accelerations are considered. Because of this, the spectra previously submitted are somewhat misleading and should be deleted from Duke's response to this action item.

A reanalysis of the vertical response of the steel containment was made. The containment vessel stick model was analyzed for vertical excitation using an input vertical base acceleration time history identical to the horizontal base acceleration time history used in the horizontal seismic analysis. All containment frequencies up to 33 hz were considered in the analysis. Using total acceleration time histories from this analysis, vertical response spectra were generated at the base and at mass points of interest.

A review of the results of the analysis described above was conducted to quantify the amplification in the vertical direction. Figure 10.1 depicts the methodology used in this review. In this figure, Spectrum "A" represents the required vertical ground response spectrum, defined in the FSAR as two-thirds of the horizontal ground response spectrum. Spectrum "1" represents the vertical ground response spectrum resulting from the input vertical base acceleration time history. It should be noted that this spectrum envelopes the horizontal ground response spectrum shown in the FSAR. Spectrum "n" represents the vertical response spectrum obtained at mass point "n". At a given period $\underline{t}_i$, one point on each spectrum is defined.

For a given frequency or period, the magnification factor $\underline{H}$ was defined to be the ratio of the response acceleration to the excitation acceleration.

$$H = a_n/a_1$$

The digital response spectrum data was reviewed for all frequencies between 0 hz and 33.3 hz and for all applicable damping ratios. In the general frequency range of 5 hz to 20 hz, the magnification factor $\underline{H}$ was found to be greater than 1.05, indicating a 5% or greater amplification of the acceleration input at the base. At some points, the value of $\underline{H}$ reached a maximum of 1.51, indicating an amplification of the input acceleration by 51%.

Since this amplification was felt to be potentially significant, the spectrum data was further reviewed to quantify the magnitude of the acceleration increase. For an input vertical base excitation equal to the required vertical ground response (Spectrum "A"), the magnitude of the increase in acceleration is given by

$$\Delta a = (a_n - a_1)a_A/a_1 = (H-1)a_A$$

A pointwise review of spectrum data showed the maximum amplification of acceleration to be approximately 0.06 g. When this increase is compared to the constant gravitational acceleration of 1.0 g experienced by all attachments to the containment vessel, it is felt that the assumption of negligible amplification in the vertical direction is indeed justified.

It should be pointed out that the analysis in question pertains only to attachments to the steel containment, not the vessel itself. In the analysis of the containment, all vertical and horizontal modes below 30 hz were considered by modeling the entire vessel and applying shock spectra at the base in both directions.

sh 189.005

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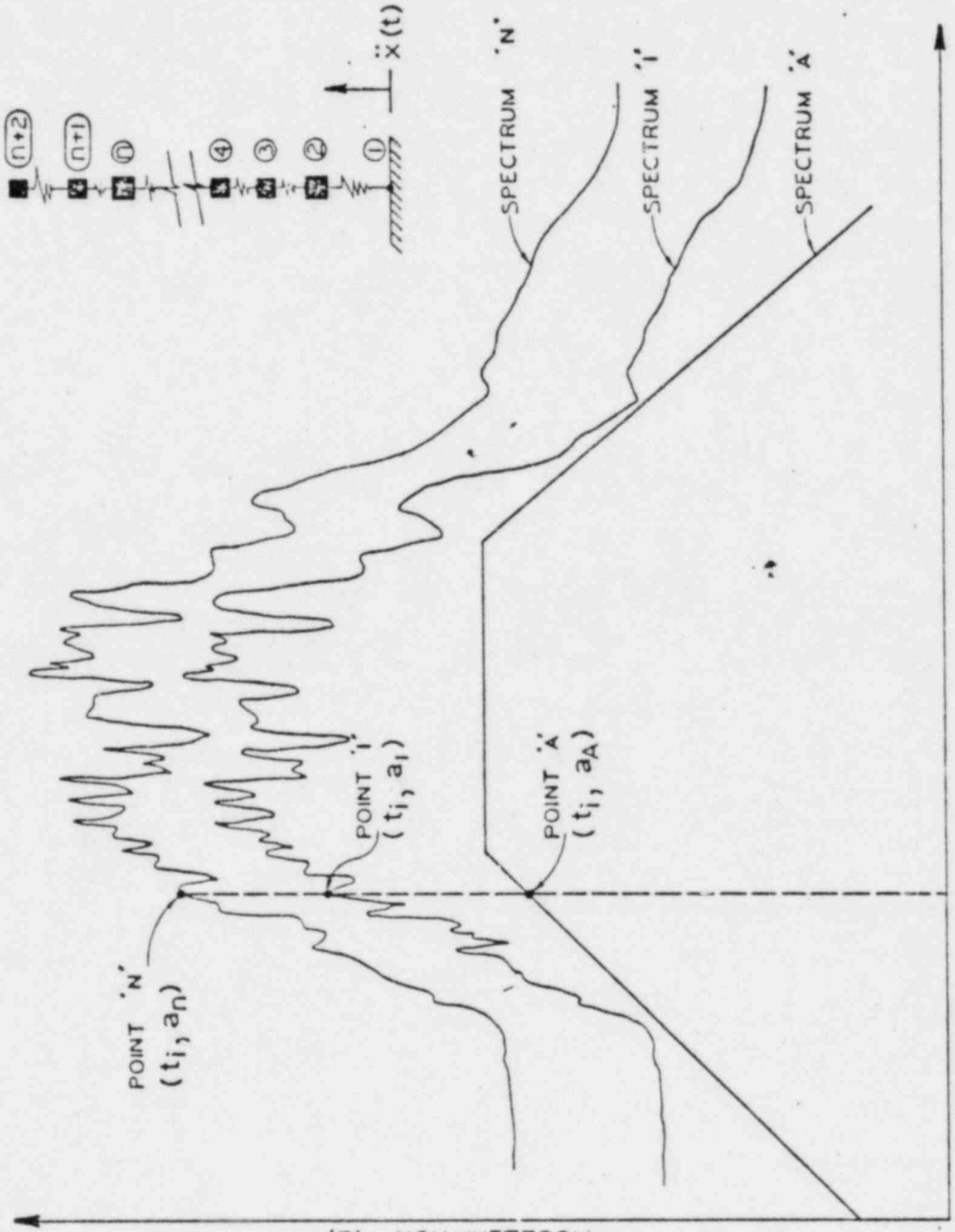

FIGURE 10.1 ANALYSIS OF VERTICAL AMPLIFICATION

JANUARY SUBMITTAL

THIS SUBMITTAL, SHOWN ON THE FOLLOWING SHEETS, PRESENTS ADDITIONAL DATA FROM THE ANALYSIS FOR VERTICAL AMPLIFICATION.

TABLE 10.1 CONTAINS DATA EXTRACTED FROM RUNS "SPECTRA" AND "COMPARE". SPECTRUM "I" IS THE RESPONSE SPECTRUM AT THE BASE OF THE STRUCTURE RESULTING FROM COMBINING THE SPECTRA GENERATED BY FOUR SYNTHETIC VERTICAL TIME HISTORIES APPLIED AT THE BASE. THIS CAN BE READ FROM RUN "SPECTRA", PAGES 129 TO 133, AS WELL AS IN RUN "COMPARE" WHICH USES THE RESULTS OF "SPECTRA".

SIMILARLY, SPECTRUM "N" IS THE RESPONSE SPECTRUM AT THE TOP OF THE CONTAINMENT DOME RESULTING FROM COMBINING THE SPECTRA GENERATED BY FOUR VERTICAL TIME HISTORIES AT THE BASE. THIS LOCATION WAS CHOSEN BECAUSE IT EXHIBITED THE GREATEST PERCENTAGE AMPLIFICATION AND THE GREATEST INCREASE IN "g" LEVEL. SPECTRUM "N" CAN BE FOUND IN RUN "SPECTRA", PAGES 229 TO 233, AS WELL AS IN THE POSTPROCESSOR "COMPARE".

THE AMPLIFICATION FACTOR "H" IS CALCULATED BY RUN "COMPARE", AS IS THE FSAR VERTICAL G.R.S. (SEE ALSO SH. 177-179), THE AMPLIFIED SPECTRUM, AND THE AMPLIFICATION.

COMPUTER RUNS DEB836ZD AND DEB836ZZ ARE USED TO GENERATE PLOTS OF THE AMPLIFICATION AND AMPLIFIED SPECTRUM FOR COMPARISON PURPOSES. FOR PLOTS, SEE SUBMITTAL AND THE FOLLOWING PAGES.

sh 189.007

ADDITIONAL INFORMATION FOR ACTION ITEM 10

10. Provide justification demonstrating negligible amplification assumed in vertical seismic analysis.

Steel Containment

Previous submittals have described the methodology used in assessing the amplification of input vertical seismic excitation for the containment vessel. The purpose of this additional information is to provide more detailed data at the request of NRC reviewers.

A review of the results of the analysis described in previous submittals showed the maximum amplification of input vertical excitation to occur at the top of the containment vessel. The stick model data point at elevation 710'+11" (Approximately 10' below the top of the containment dome) shows the greatest amplification of input excitation.

Table 10.1 presents digital data used in assessing the amplification in the vertical direction. Columns (1) and (2) present representative periods/frequencies on the spectra. Column (3) shows the input base vertical spectrum resulting from four synthetic time histories applied to the stick model (Spectrum "I" from previous submittals). Column (4) shows the calculated spectrum at elevation 710'+11" resulting from these time histories (Spectrum "N" from previous submittals). The structural amplification factor for a given frequency is the ratio of these two values and is shown in column (5). Column (6) shows the vertical ground response spectrum from the FSAR defined as 2/3 the horizontal ground response spectrum. The amplified spectrum at elevation 710'+11" is the product of the structural amplification factor and the FSAR vertical ground response spectrum and is shown in column (7). The magnitude of the amplification is shown in column (8).

Figure 10.2 graphically depicts the results of the analysis, showing a comparison of the FSAR vertical ground response spectrum, the amplified vertical spectrum at elevation 710'+11", and the amplification of the input vertical spectrum by the containment vessel. Figures 10.3 and 10.4 display the same information in tripartite format.

The frequency range of measurable vertical structural amplification is seen to be very narrow, and the maximum increase in acceleration of 0.06 g is negligible compared to the constant gravitational acceleration of 1.0 g experienced by all attachments to the containment vessel.

As a result of this analysis, it is concluded that the assumption of negligible amplification in the vertical direction is justified for all attachments to the containment vessel.

TABLE 10.1

CATAWBA NUCLEAR STATION
STEEL CONTAINMENT VESSEL
OBE VERTICAL RESPONSE AMPLIFICATION INVESTIGATION
ELEVATION 710'+11" 1% DAMPING

(1) PERIOD t_i (Sec)	(2) FREQUENCY f_i (hz)	(3) SPECTRUM "I" a_I (g)	(4) SPECTRUM "N" a_N (g)	(5) AMPLIFICATION FACTOR "H" (4)/(3)	(6) FSAR VERT. SPECTRUM (g) a_A (g)	(7) AMPLIFIED SPECTRUM (g) (5)·(6)	(8) AMPLIFICATION (g) (7)-(6)
1.0300	0.9709	0.1916	0.1920	1.00209	0.1079	0.108	0.000
0.4947	2.0214	0.4796	0.4846	1.01042	0.2266	0.229	0.002
0.3307	3.0239	0.4157	0.4250	1.02237	0.2266	0.232	0.005
0.2513	3.9793	0.3872	0.4006	1.03461	0.2266	0.234	0.008
0.2027	4.9334	0.4457	0.4743	1.06417	0.2266	0.241	0.015
0.1653	6.0496	0.4371	0.4752	1.08717	0.2266	0.246	0.020
0.1428	7.0028	0.4068	0.4593	1.12906	0.2012	0.227	0.026
0.1257	7.9554	0.3686	0.4265	1.15708	0.1820	0.211	0.029
0.1102	9.0744	0.3661	0.4437	1.21196	0.1641	0.199	0.035
0.0997	10.0301	0.2939	0.3703	1.25995	0.1516	0.191	0.039
0.0911	10.9769	0.2864	0.3744	1.30726	0.1412	0.185	0.043
0.0838	11.9332	0.2444	0.3348	1.36988	0.1322	0.181	0.049
0.0776	12.8866	0.2247	0.3238	1.44103	0.1244	0.179	0.055
0.0706	14.1643	0.1780	0.2697	1.51517	0.1155	0.175	0.060
0.0661	15.1286	0.1418	0.2087	1.47179	0.1097	0.161	0.052
0.0622	16.0772	0.1257	0.1534	1.22037	0.1045	0.128	0.023
0.0587	17.0358	0.1187	0.1349	1.13648	0.0999	0.114	0.014
0.0556	17.9856	0.1196	0.1401	1.17141	0.0957	0.112	0.016
0.0528	18.9394	0.1194	0.1583	1.32579	0.0919	0.122	0.030
0.0503	19.8807	0.1171	0.1580	1.34927	0.0884	0.119	0.031

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FIGURE 10.2

ELEVATION 710+11

CATAWBA NUCLEAR STATION

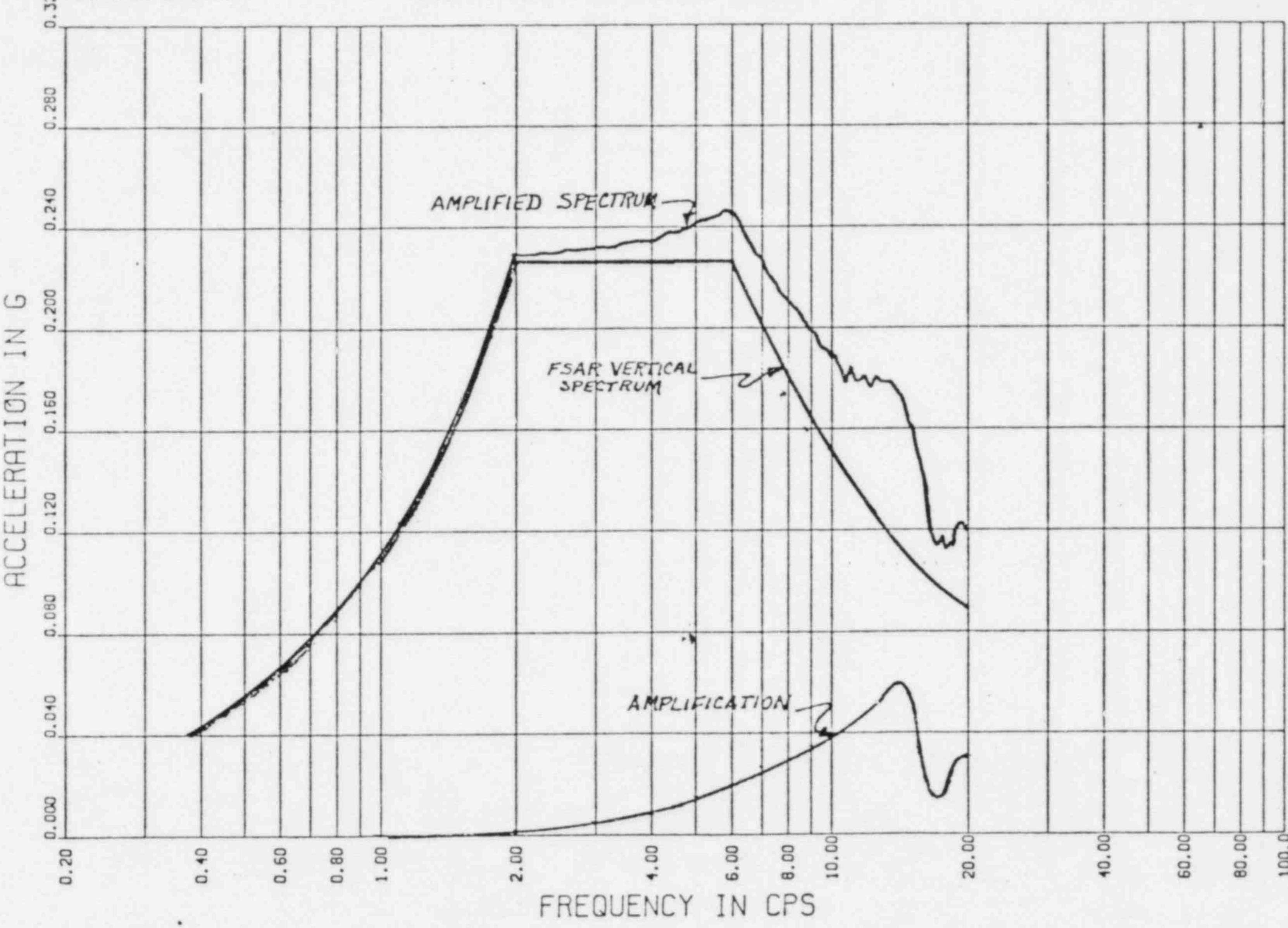
1-17-83

CONTAINMENT VESSEL

RESPONSE SPECTRUM

OBE VERTICAL RESPONSE AMPLIFICATION INVESTIGATION

DAMPING= 0.01



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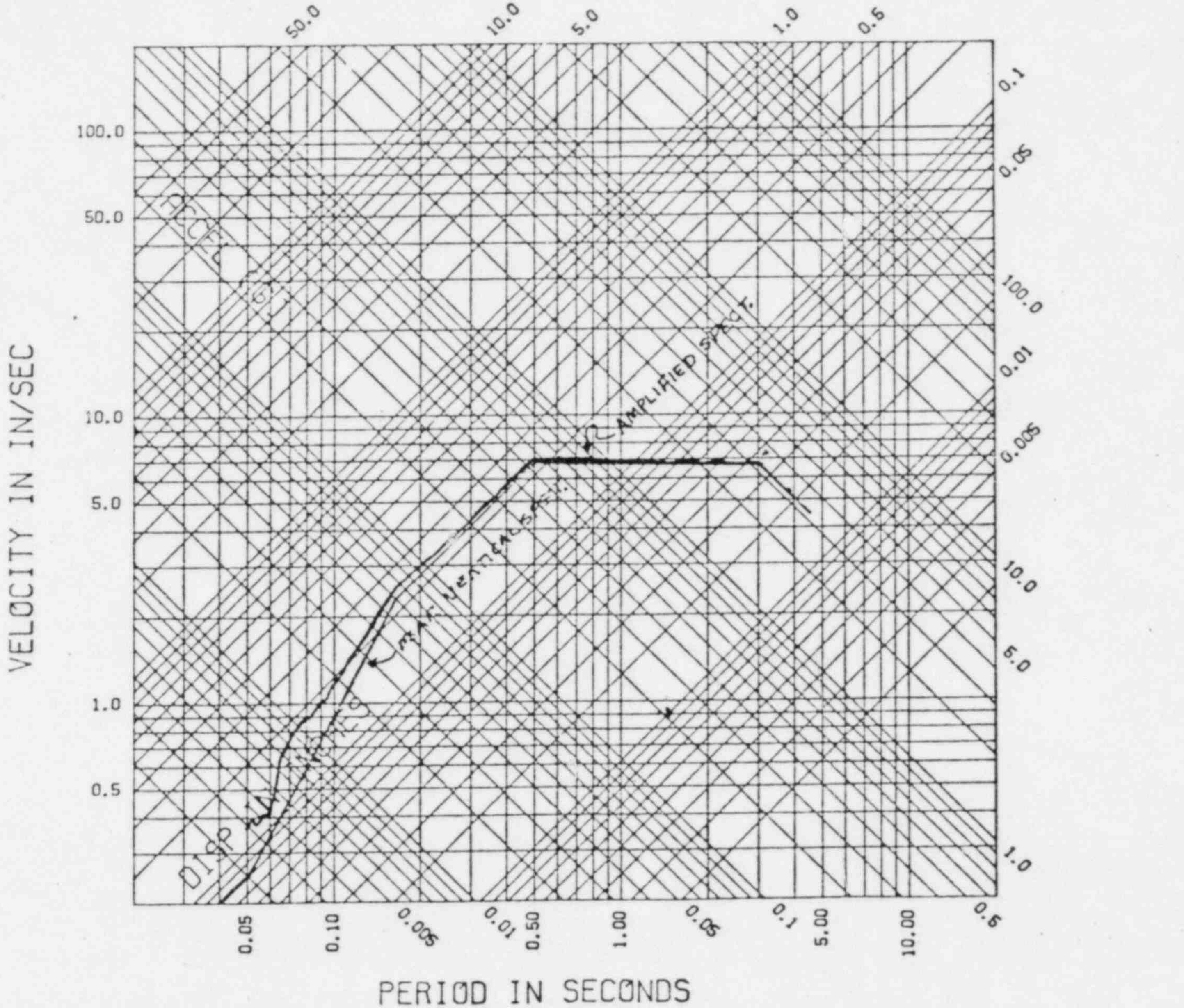
DEB 1-31-83
Sh 189.009

FIGURE

ELEVATION 710+11 — CATAWBA NUCLEAR STATION — 1-17-83

CONTAINMENT VESSEL

RESPONSE SPECTRUM — OBE VERTICAL RESPONSE AMPLIFICATION INVESTIGATION — DAMPING= 0.01



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Sh 189.010

FIGURE 10.4

ELEVATION 710+11

CATAWBA NUCLEAR STATION

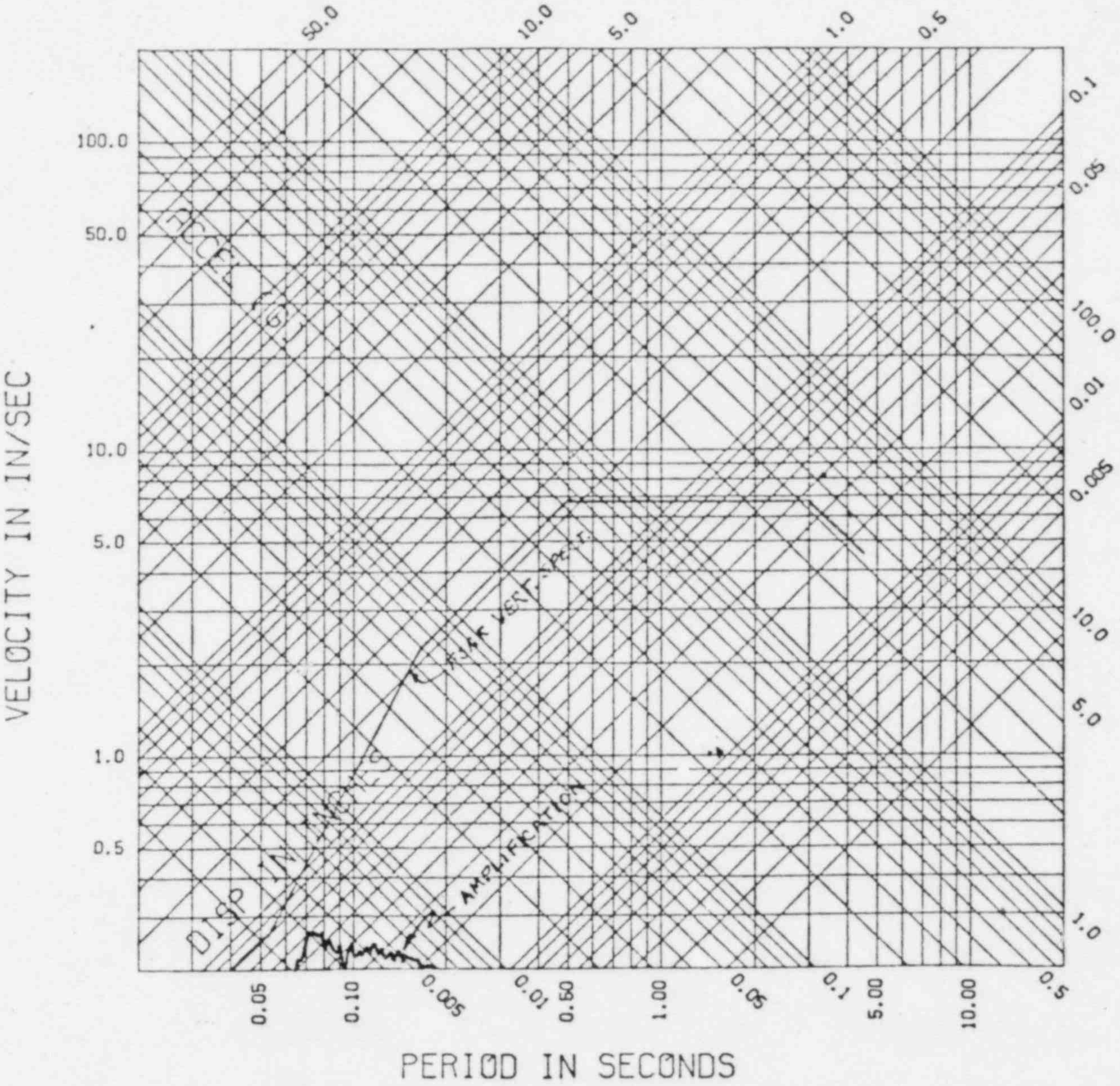
1-17-83

CONTAINMENT VESSEL

RESPONSE SPECTRUM

OBE VERTICAL RESPONSE AMPLIFICATION INVESTIGATION

DAMPING= 0.01



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sh 189.011

ELEVATION 710+11

CATAWBA NUCLEAR STATION

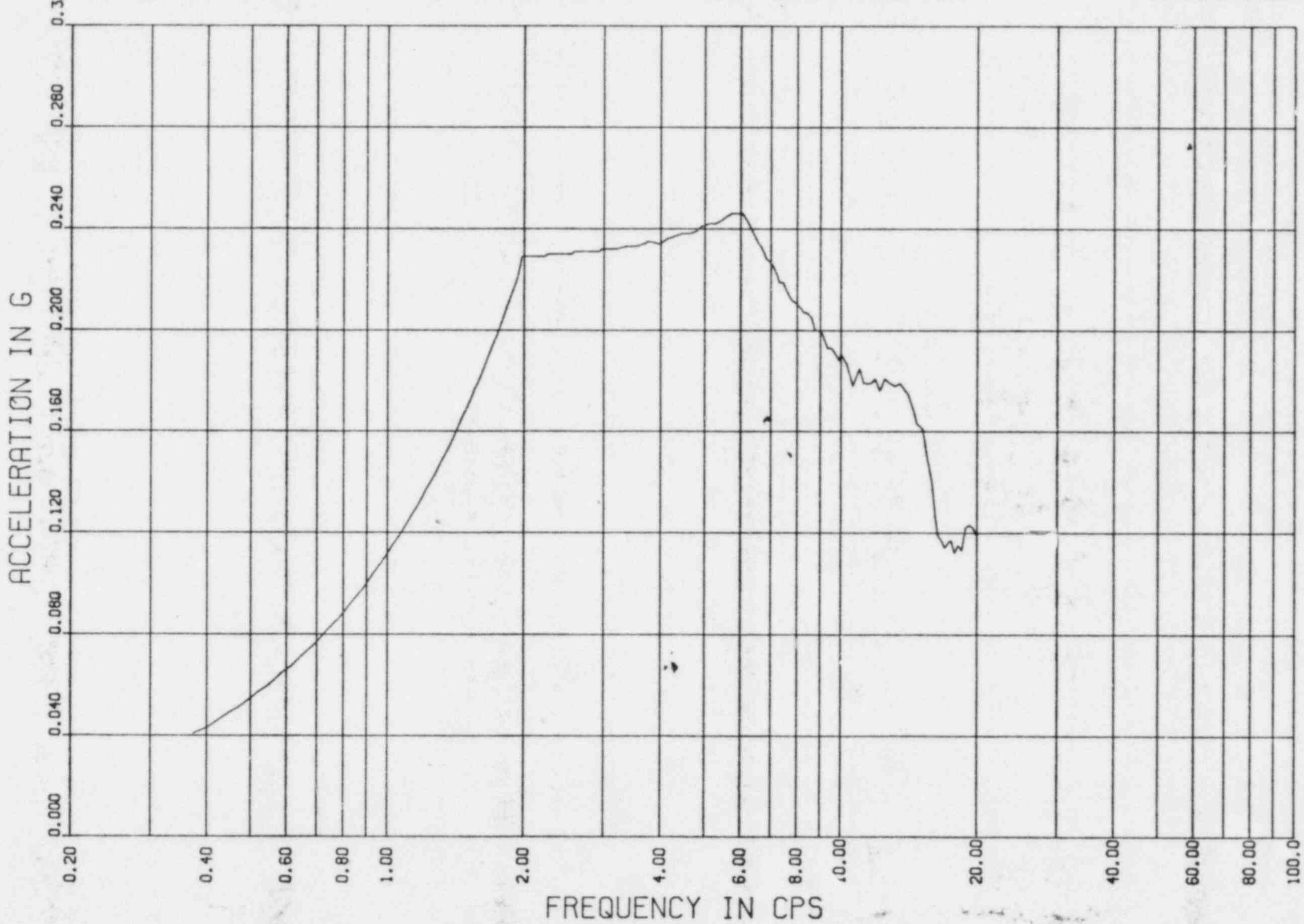
1-17-83

CONTAINMENT VESSEL

RESPONSE SPECTRUM

OBE VERTICAL RESPONSE AMPLIFICATION INVESTIGATION

DAMPING= 0.01



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CNC-1144.09-01-0010
Rev 6
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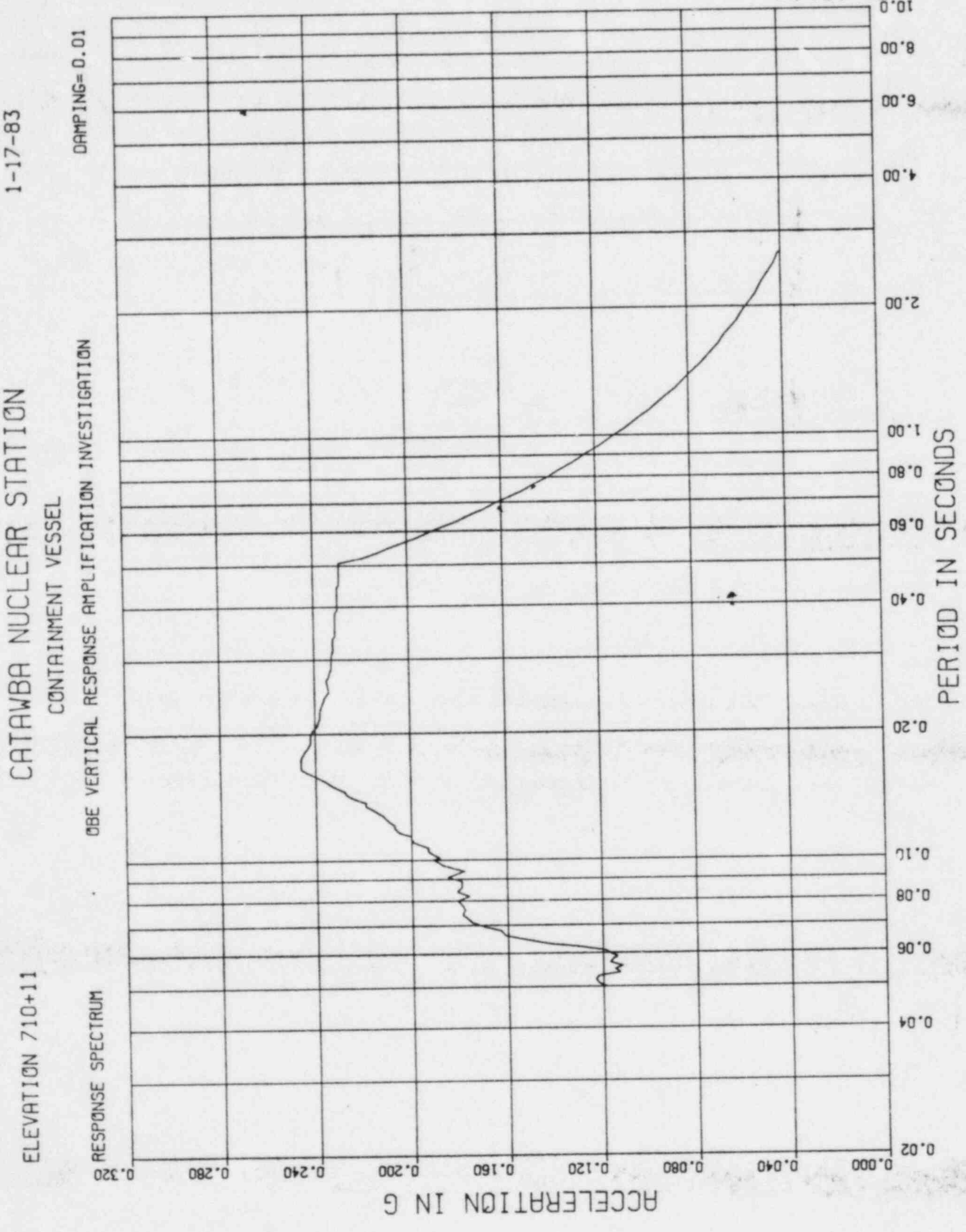
DEB 1-31-83
Sh 189.013



ELEVATION 710+11

CATAWBA NUCLEAR STATION

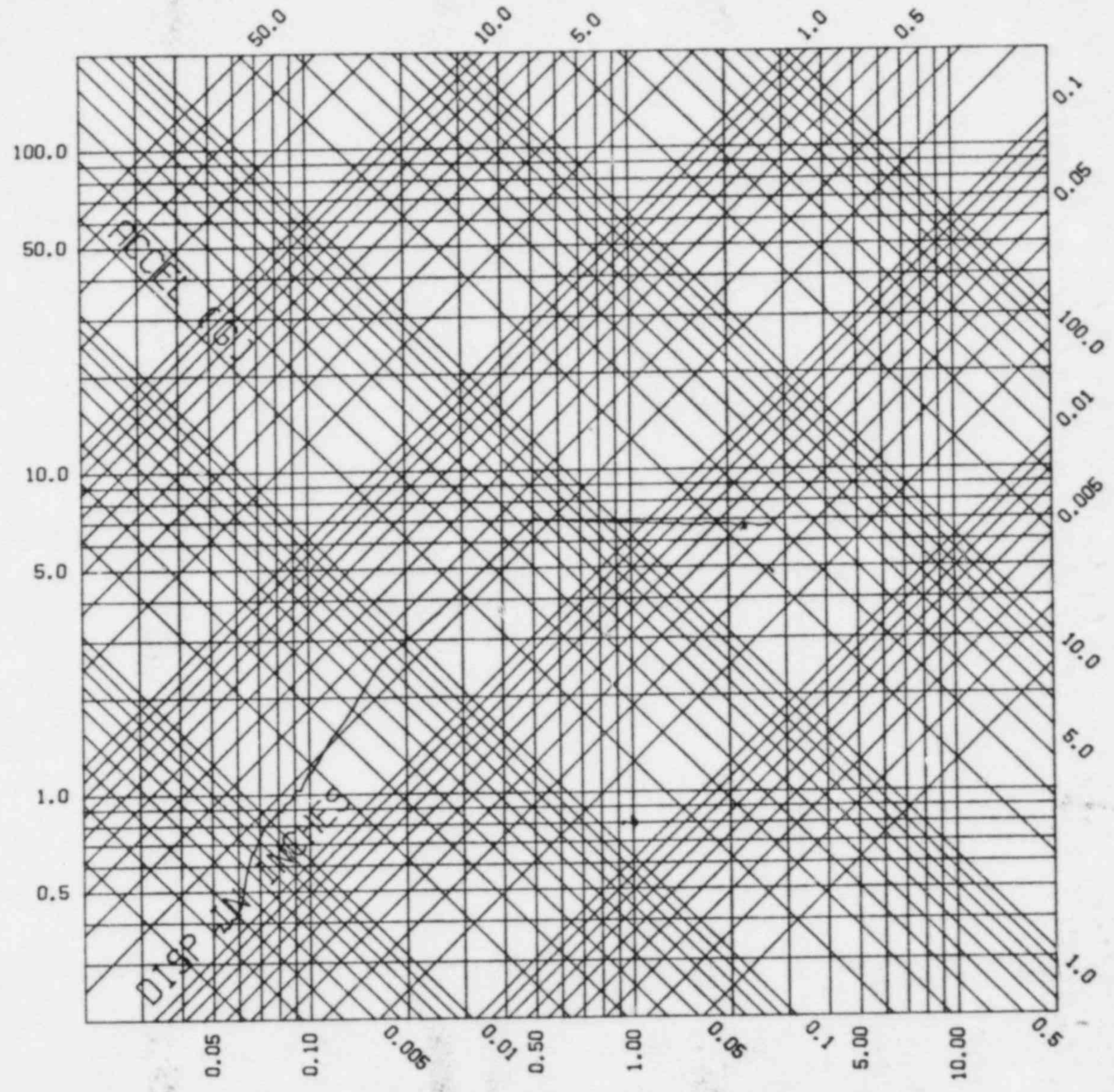
1-17-83

CONTAINMENT VESSEL

RESPONSE SPECTRUM

OBE VERTICAL RESPONSE AMPLIFICATION INVESTIGATION

DAMPING= 0.01



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Rev 6
JMM 1-28-83
DEB 1-31-83
Sh 189.015

ELEVATION 710+11

CATAWBA NUCLEAR STATION

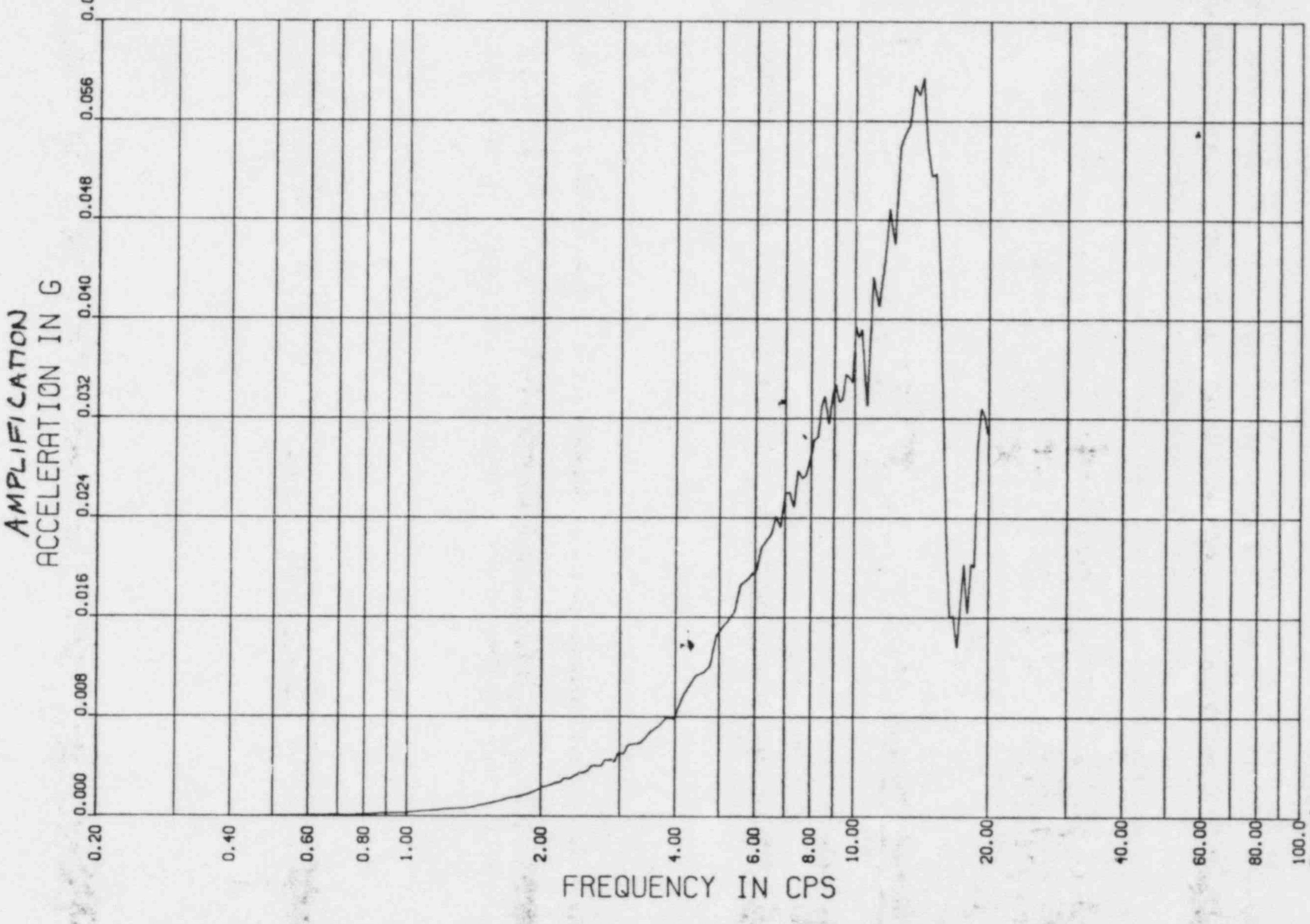
1-17-83

CONTAINMENT VESSEL

RESPONSE SPECTRUM

OBE VERTICAL RESPONSE AMPLIFICATION INVESTIGATION

DAMPING= 0.01



ELEVATION 710+11

CATAWBA NUCLEAR STATION

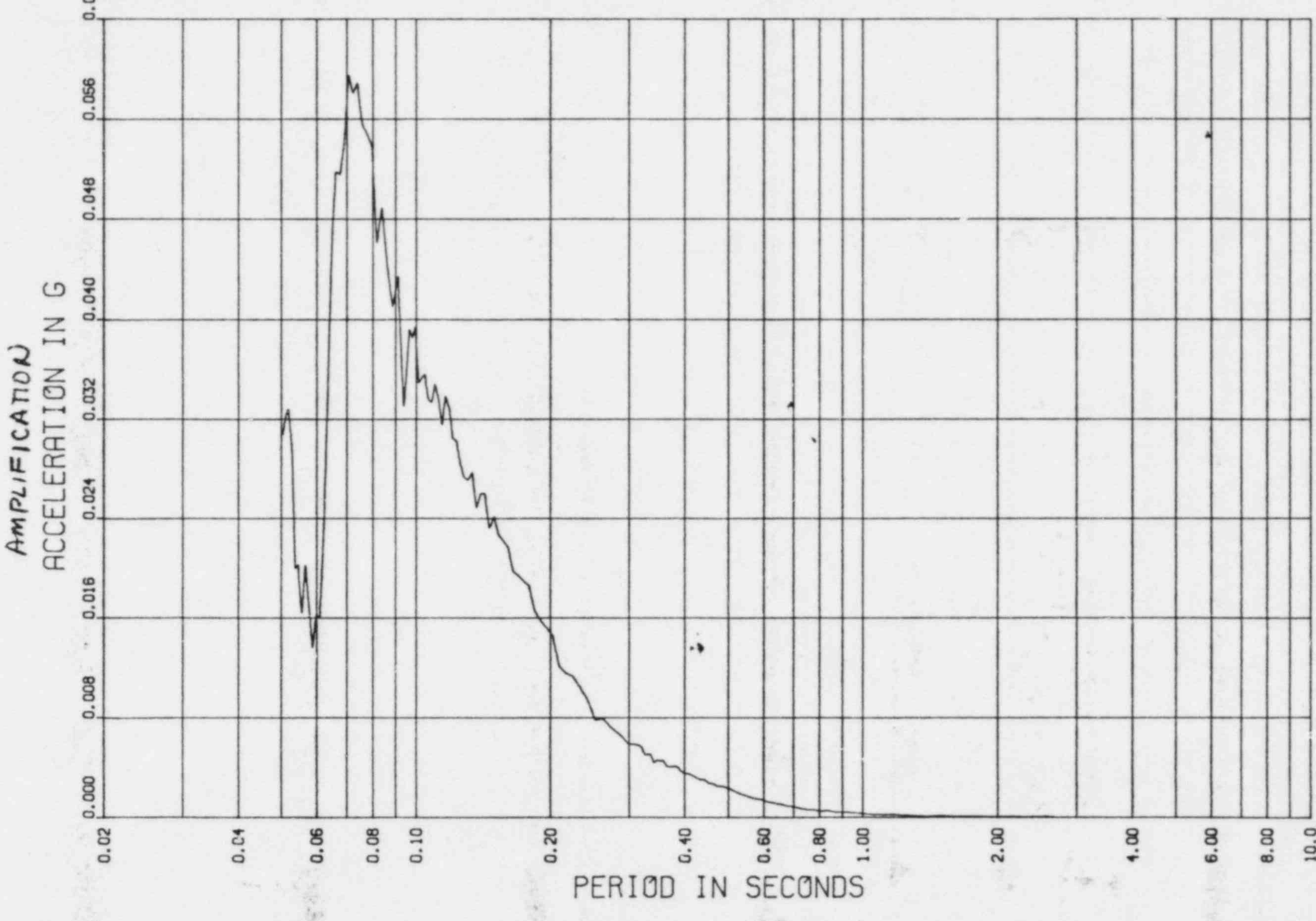
1-17-83

CONTAINMENT VESSEL

RESPONSE SPECTRUM

OBE VERTICAL RESPONSE AMPLIFICATION INVESTIGATION

DAMPING= 0.01



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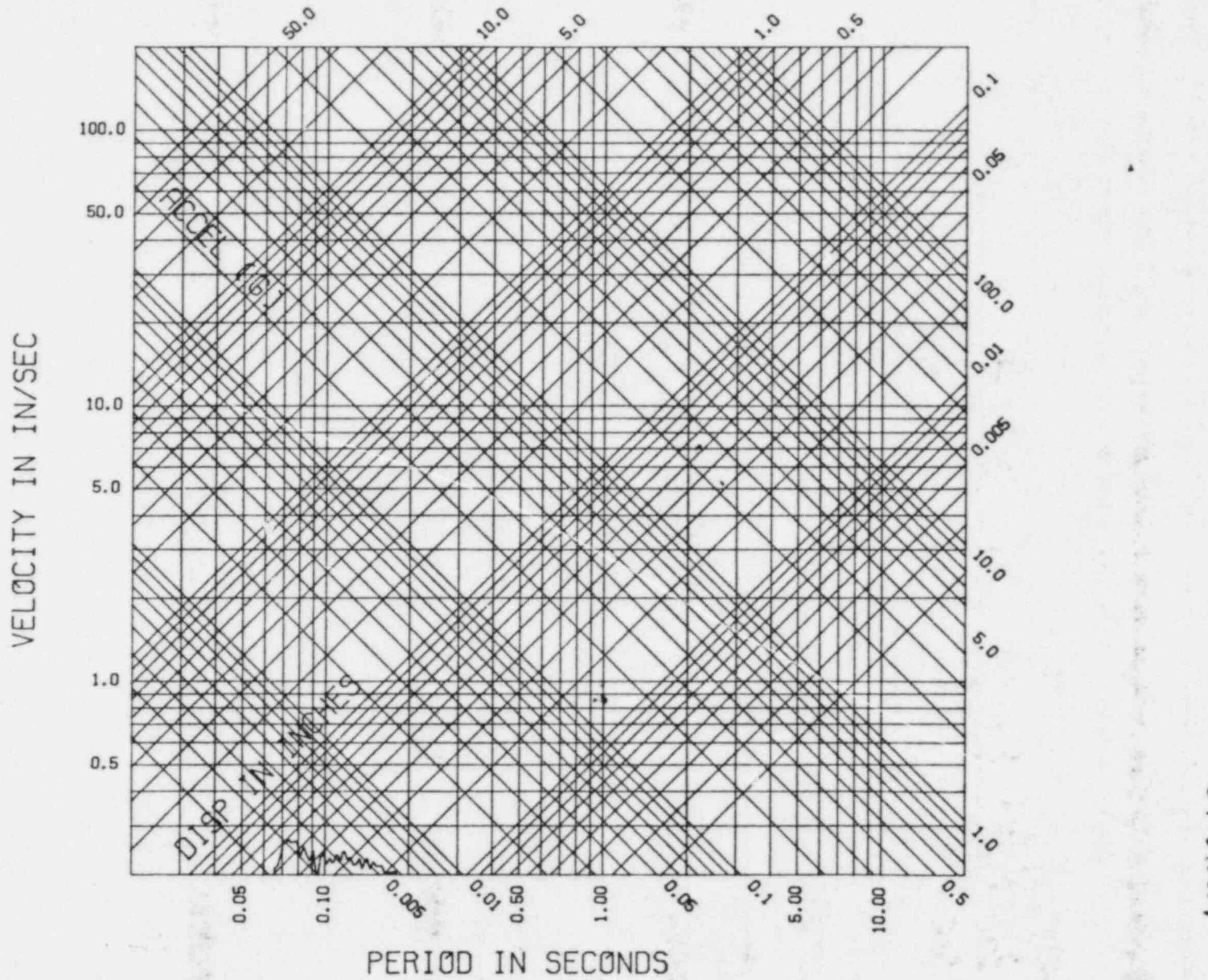
DEB 1-31-83
Sh 189.016

ELEVATION 710+11 | CATAWBA NUCLEAR STATION | 1-17-83

CONTAINMENT VESSEL
(AMPLIFICATION ONLY)

RESPONSE SPECTRUM | OBE VERTICAL RESPONSE AMPLIFICATION INVESTIGATION | DAMPING= 0.01



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Sh 189.017

RELATIVE MAGNITUDE OF VERTICAL AND HORIZONTAL SPECTRA.

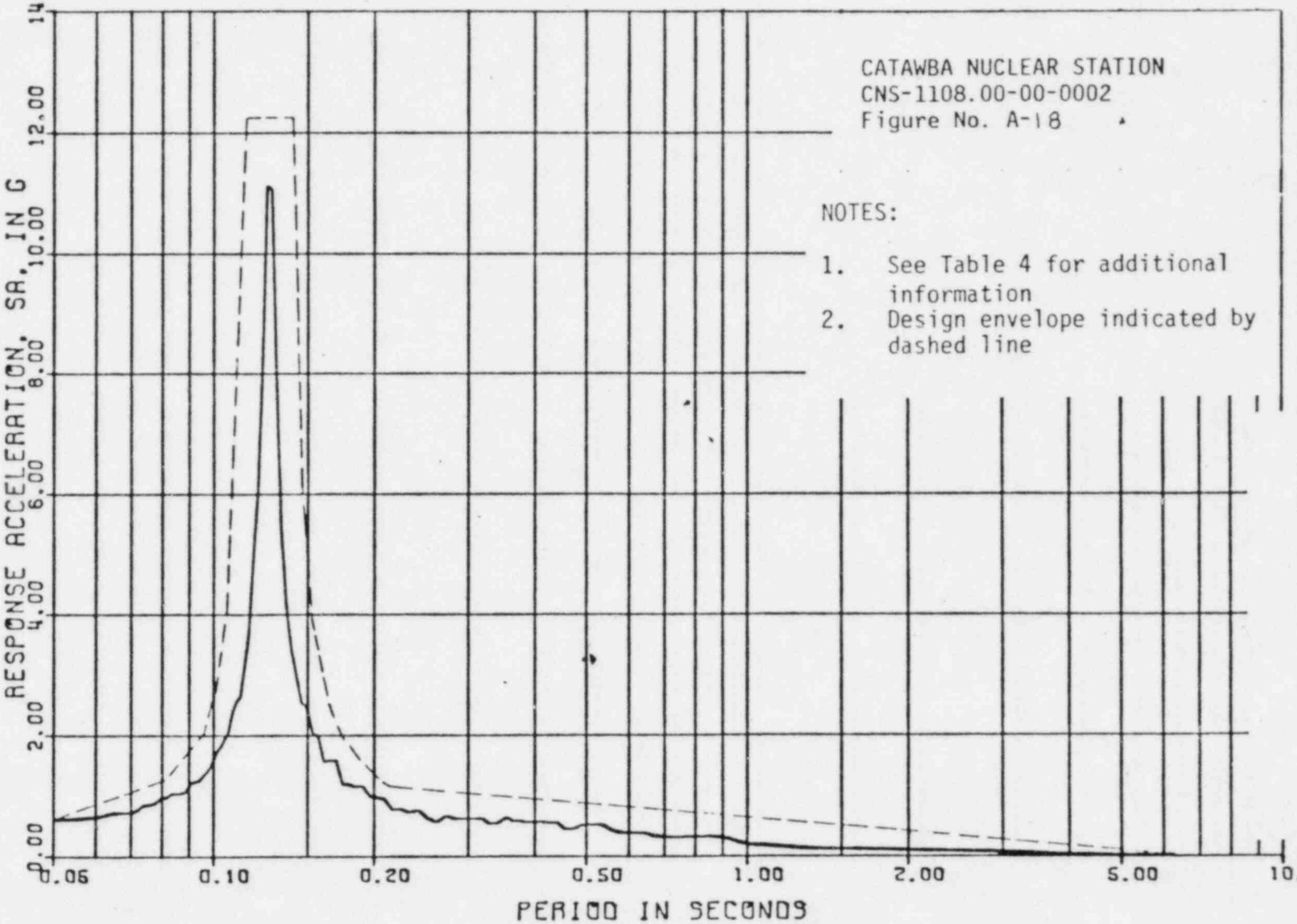
During the discussion of vertical amplification of seismic input, some discussion was raised over the relative magnitudes of horizontal and vertical response spectra at one point.

For example, at the top of the dome, Figure A-18 of Specification CNS-1108.00-00-0002 (see next sheet) shows a peak acceleration level on the design envelope (10% above calculated spectrum) of approximately 12.2g. At the same point, use of 2/3 of the horizontal ground response spectrum applied in the vertical direction gives a design vertical acceleration of 0.23g.

The purpose of this section is to address this apparent disparity and to show that it is in fact well founded.

As a starting point, it should be pointed out that the analysis of the lumped mass model shows very good comparison to the overall analysis of the steel containment model. In the table below, the results of the overall analysis are taken from Calc CNC-1144.09-01-0013, while the results of the lumped mass model are from computer run "RZ.TOTSTK". EXCELLENT CORRELATION IS noted, and the stick model may be taken to accurately reflect overall SCV behavior for these purposes

CATAWBA CONTAINMENT VESSEL - SEISMIC ANA
RESPONSE ACCELERATION SPECTRA, DAMPING= 0.010
CONTAINMENT VESSEL RESPONSE TO OBE (.08G) AT EL 710.85



Revision 3: July 1, 1982
Date: December 5, 1980

Sh 189.019
CNC-1144.09-01-0010
Rev 6
JWM 1-28-83
DEB 1-31-83

OVERALL SCV ANALYSIS	STICK MODEL ANALYSIS
Mode 1 6.73 hz overall cantilever mode	Mode 1 7.71 hz $\Gamma = 80.385$ horizontal cantilever mode
Mode 2 17.76 hz second cantilever mode	Mode 2 21.09 hz $\Gamma = 84.091$ vertical vibration
Mode 3 18.76 hz vertical dome vibration	Mode 3 21.96 hz $\Gamma = 34.187$ second cantilever mode NOTE: FOR ALL THREE MODES, MAXIMUM MODAL DISPLACEMENT OCCURS AT TOP OF DOME

TO PREDICT THE RELATIVE MAGNITUDES OF THE HORIZONTAL AND VERTICAL RESPONSES AT THE TOP OF THE DOME (WHERE ALL MODE SHAPES ARE A MAXIMUM), THE FOLLOWING APPROACH WILL BE FOLLOWED:

USING BIGGS, INTRODUCTION TO STRUCTURAL DYNAMICS, Chapter 6, The Maximum Modal amplitude is given by

$$C_n = \frac{\Gamma_n S_{a_n}}{\omega_n^2}$$

where Γ_n = participation factor, mode n
S_{a_n} = modal acceleration, mode n
ω_n = frequency, mode n

Form 00184 (6 81)

DUKE POWER COMPANY

Dev./Station CATAWBA Unit 1&2 File No. CNC-1144.09-01-0010

Subject HORIZ / VERT SPECTRA

By JMM Date 1-28-83

Sheet No. 189.021 of Problem No. Rev 6 Checked By DEB Date 1-31-83

AS INPUT, USE THE GROUND RESPONSE SPECTRUM FOR OBE & 1% DAMPING WHICH RESULTS FROM THE FOUR SYNTHETIC TIME HISTORIES (SEE FSAR FIGURE 2.5.2-5 (2 of 4)

for horizontal motion $f_h = 7.71 hz \rightarrow t = .13 sec \rightarrow Sa_h \cong .38g$

for vertical motion $f_v = 21.09 hz \rightarrow t = .047 sec \rightarrow Sa_v = .13g$

therefore the ratio of the horizontal response maximum to the vertical response maximum is given by

$$\frac{\Gamma_h \frac{Sa_h}{\omega_h^2}}{\Gamma_v \frac{Sa_v}{\omega_v^2}} = \frac{\frac{(80,385)(.38)}{(7.71)^2 (2\pi)^2}}{\frac{(84.091)(.13)}{(21.09)^2 (2\pi)^2}} = 20.91$$

WHEN THE STICK MODEL WAS ANALYZED IN THE VERTICAL DIRECTION FOR A VERTICAL ACCELERATION TIME HISTORY CORRESPONDING TO 100% OF THE HORIZONTAL GROUND RESPONSE SPECTRUM, THE MAXIMUM RESPONSE SPECTRUM ACCELERATION NOTED (FROM SPECTRUM "N", RUN "COMPARE" OR RUN "SPECTRA"), WAS 0.53g

THEREFORE, PREDICT A MAXIMUM IN THE HORIZONTAL DIRECTION OF

$$20.91 (0.53g) = 11.08g$$

TAKING THE 10% ENVELOPE OFF OF THE HORIZONTAL DESIGN SPECTRUM, GET A PEAK OF

$$\frac{12.2g}{1.1} = 11.09g$$

VERY GOOD COMPARISON IS NOTED FOR THIS PREDICTION.

DUKE POWER COMPANY

Form 00184 (6-81)

Div./Station CATAWBA Unit 1/2 File No. CNC-1144.09-01-0010

Subject HORIZ / VERT SPECTRA

By JMM Date 1-28-83

Sheet No. 189.022 of ___ Problem No. Rev 6 Checked By DEB Date 1-31-83

CONCLUSION:

THE RELATIVE MAGNITUDES OF HORIZONTAL AND VERTICAL RESPONSES ARE IN THE CORRECT PROPORTION TO ONE ANOTHER.

R2TOTSTK

** EXTRACT **

UNCONTROLLED

J5543A

FOR INFORMATION ONLY

```
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***A  START  JOB  5543  R2TOTSTK  2KELLYJK  FM  NORM  0037  5.48.36  PM  28  JUL  82  R2.PR1  SYS  3034  JOB  5543  START  A****
***A  START  JOB  5543  R2TOTSTK  2KELLYJK  FM  NORM  0037  5.48.36  PM  28  JUL  82  R2.PR1  SYS  3034  JOB  5543  START  A****
***A  START  JOB  5543  R2TOTSTK  2KELLYJK  FM  NORM  0037  5.48.36  PM  28  JUL  82  R2.PR1  SYS  3034  JOB  5543  START  A****
***A  START  JOB  5543  R2TOTSTK  2KELLYJK  FM  NORM  0037  5.48.36  PM  28  JUL  82  R2.PR1  SYS  3034  JOB  5543  START  A****
***A  START  JOB  5543  R2TOTSTK  2KELLYJK  FM  NORM  0037  5.48.36  PM  28  JUL  82  R2.PR1  SYS  3034  JOB  5543  START  A****
***A  START  JOB  5543  R2TOTSTK  2KELLYJK  FM  NORM  0037  5.48.36  PM  28  JUL  82  R2.PR1
```

```
J E S 2   J O B   L O G  --  S Y S T E M   3 0 3 4  --  N O D E   C H U R C H

2.01 JOB 5543  $HASP373 R2TOTSTK STARTED - INIT  9 - CLASS L - SYS 3034
2.02 JOB 5543  IEF403I R2TOTSTK - STARTED - TIME=14.32.02
4.05 JOB 5543  +MDC001I ---------------------------R=051 S=00000 E=00066
8.04 JOB 5543  +MDC001I ---------------------------R=102 S=00000 E=00122
8.09 JOB 5543  -                                        --TIMINGS (MINS.)--            ----PAGING COUNTS---              (APPROX.)
8.09 JOB 5543  -JOBNAME  STEPNAME PROGRAM    RC   EXCP    CPU    SRB  CLOCK   SERV  PG   PAGE   SWAP   VIO SWAPS       C O S T
8.09 JOB 5543  -R2TOTSTK STEP1    DFINT      00   8450   30.42   .06  166.1  6150K   1   4480      0     0     0    $   199.77
8.09 JOB 5543  IEF404I R2TOTSTK - ENDED - TIME=17.18.09
8.09 JOB 5543  -R2TOTSTK ENDED.  NAME-2KELLYJK              TOTAL CPU TIME= 30.49  TOTAL ELAPSED TIME= 166.1 JOB COST=$   199.77
8.10 JOB 5543  $HASP395 R2TOTSTK ENDED

-- JES2 JOB STATISTICS ------

JUL 82 JOB EXECUTION DATE

   201 CARDS READ

28,977 SYSOUT PRINT RECORDS

     0 SYSOUT PUNCH RECORDS

166.13 MINUTES EXECUTION TIME
```

THESE DESIGN CALCULATIONS COVER ITEMS RELATING TO NUCLEAR SAFETY IN ACCORDANCE WITH ESTABLISHED PROCEDURES. THE QUALITY HAS BEEN ASSURED.

Jeffrey M. Kelly 8/24/82
ORIGINATED BY — DATE

Doyle E. Byrd 9/1/82
CHECKED BY — DATE

APPROVED BY — DATE

FOR INFORMATION ONLY

MCAUTO ICES EXECUTIVE SYSTEM

RELEASE 3.5 - 14 AUG 1980

TIME= 14:32:53 DATE= JUL 28, 1982

MODEL 33 VS2 REL 3.8F

STRUDL 'CATAWBA' 'TRANSIENT ANALYSIS OF CATAWBA STICK MODEL'

```
*************************************************************
*                                                           *
*   MCAUTO STRUDL                  RELEASE 4.5  APR 1981    *
*   MCAUTO STRUDL DYNAL            RELEASE 6.5              *
*   MCAUTO STRUDL PLOTS            RELEASE 3.5              *
*                                                           *
*                  TIME 14.33.23.  7/28/82                  *
*                                                           *
*               DATA POOL SIZE   30640 BYTES                *
*                                                           *
*************************************************************
```

UNITS FEET LBM POUNDS CYCLES

TYPE PLANE FRAME

JOINT COORDINATES

```
1  0.   0.0  S
2  0.   2.83
3  0.   11.42
4  0.   21.42
5  0.   31.92
6  0.   41.42
7  0.   47.42
8  0.   57.42
9  0.   67.42
10 0.   77.42
11 0.   87.42
12 0.   97.42
13 0. 107.08
14 0. 111.75
```

FOR INFORMATION ONLY

15 0. 117.08
16 0. 126.63
17 0. 136.05
18 0. 144.73
19 0. 152.42
20 0. 158.85
21 0. 167.29
MEMBER INCIDENCES
1 1 2
2 2 3
3 3 4
4 4 5
5 5 6
6 6 7
7 7 8
8 8 9
9 9 10
10 10 11
11 11 12
12 12 13
13 13 14
14 14 15
15 15 16
16 16 17
17 17 18
18 18 19

```
19 19 20
20 20 21
MEMBER PROPERTIES PRISMATIC
1 2 AX 32.607 AY 16.3035 IZ 53945.5
3 TO 13 AX 25.13 AY 12.57 IZ 41585.1
14 AX 20.66 AY 10.33 IZ 34011.2
15 AX 20.30 AY 10.15 IZ 32286.7
16 AX 19.38 AY  9.69 IZ 28078.4
17 AX 17.86 AY  8.93 IZ 21978.1
18 AX 15.80 AY  7.90 IZ 15211.1
19 AX 13.26 AY  6.63 IZ  8988.4
20 AX  8.61 AY  4.31 IZ  2468.1
UNITS INCHES
CONSTANTS
E 29000000. ALL
POISSON .3 ALL
INERTIA OF JOINTS ADD
2  LINEAR ALL 160444.1
3  LINEAR ALL 202102.7
4  LINEAR ALL 212576.2
5  LINEAR ALL 205970.7
6  LINEAR ALL 163237.0
7  LINEAR ALL 224458.4
8  LINEAR ALL 284608.7
9  LINEAR ALL 275133.4
10 LINEAR ALL 254522.1
```

11 LINEAR ALL 293713.5

12 LINEAR ALL 293345.8

13 LINEAR ALL 186021.5

14 LINEAR ALL 96592.3

15 LINEAR ALL 138519.7

16 LINEAR ALL 98357.4

17 LINEAR ALL 92283.1

18 LINEAR ALL 84792.8

19 LINEAR ALL 73368.0

20 LINEAR ALL 58305.2

21 LINEAR ALL 79028.0

UNITS FEET

ASSEMBLE FOR DYNAMICS

**** STRUDL MESSAGE - BANDWIDTH STATISTICS ARE AS FOLLOWS :

THE MAXIMUM BANDWIDTH IS 1 AND OCCURS AT JOINT 3
THE AVERAGE BANDWIDTH IS 0.95
THE STANDARD DEVIATION IS 0.22

CORRESPONDENCE TABLE

JOINT ID	XT	YT	ZT	XR	YR	ZR	JOINT ID	XT	YT	ZT	XR	YR	ZR
1							2	1	2				3
3	4	5				6	4	7	8				9
5	10	11				12	6	13	14				15
7	16	17				18	8	19	20				21
9	22	23				24	10	25	26				27
11	28	29				30	12	31	32				33
13	34	35				36	14	37	38				39
15	40	41				42	16	43	44				45
17	46	47				48	18	49	50				51
19	52	53				54	20	55	56				57
21	58	59				60							

INDEPENDENT DEGREES OF FREEDOM SELECT

CONDENSE DYNAMIC MATRICES

CONDENSATION CORRESPONDENCE TABLE
INDEPENDENT COORDINATES

JOINT ID	XT	YT	ZT	XR	YR	ZR	JOINT ID	XT	YT	ZT	XR	YR	ZR
2	1	2					3	3	4				
4	5	6					5	7	8				
6	9	10					7	11	12				
8	13	14					9	15	16				
10	17	18					11	19	20				
12	21	22					13	23	24				
14	25	26					15	27	28				
16	29	30					17	31	32				
18	33	34					19	35	36				
20	37	38					21	39	40				

CONDENSATION CORRESPONDENCE TABLE
DEPENDENT COORDINATES

JOINT ID	XT	YT	ZT	XR	YR	ZR	JOINT ID	XT	YT	ZT	XR	YR	ZR
2						1	3						2
4						3	5						4
6						5	7						6
8						7	9						8
10						9	11						10
12						11	13						12
14						13	15						14
16						15	17						16
18						17	19						18
20						19	21						20

**** STRUDL MESSAGE - THE ICES SYSTEM WILL TEMPORARILY BE
ROLLED OUT WHILE CONDENSATION IS PERFORMED.

ROLL-OUT OF THE ICES SYSTEM COMPLETED : CONDENSATION INITIATED

MCAUTO ICES EXECUTIVE SYSTEM
RELEASE [illegible].5 - 14 AUG 1980
TIME= 14:34:25 DATE= JUL 28, 1982
MODEL 33 VS2 REL 3.8F

STRUDL

```
*****************************************************************************
*                                                                           *
*   MCAUTO STRUDL                      RELEASE 4.5  APR 1981                *
*   MCAUTO STRUDL DYNAL                RELEASE 6.5                          *
*   MCAUTO STRUDL PLOTS                RELEASE 3.5                          *
*                                                                           *
*                  TIME 14.34.34.  7/28/82                                  *
*                                                                           *
*               DATA POOL SIZE   30640 BYTES                                *
*                                                                           *
*****************************************************************************
```

ROLL-IN OF THE ICES SYSTEM COMPLETED ; CONDENSATION ACCOMPLISHED

FOR INFORMATION ONLY

MODAL ANALYSIS HOR MAX 33.

****
RESULTS OF LATEST ANALYSIS
****

PROBLEM - CATAWBA TITLE - TRANSIENT ANALYSIS OF CATAWBA STICK MODEL

ACTIVE UNITS FEET LB CYC. FAHR SEC LBM

EIGENVALUES

MODE	EIGENVALUE	FREQUENCY	PERIOD
1	0.594766D+02	0.771211D+01	0.129666D+00
2	0.444903D+03	0.210927D+02	0.474097D-01
3	0.482054D+03	0.219557D+02	0.455462D-01

LIST DYNAMIC PARTICIPATION FACTORS

FOR INFORMATION ONLY

****
RESULTS OF LATEST ANALYSIS
****

PROBLEM - CATAWBA TITLE - TRANSIENT ANALYSIS OF CATAWBA STICK MODEL
PARTICIPATION FACTORS -(OUTPUT IN INTERNAL UNITS)

MODE	DISPLACEMENT X DISP.	DISPLACEMENT Y DISP.	DISPLACEMENT Z DISP.	ROTATION X ROT.	ROTATION Y ROT.	ROTATION Z ROT.
1	-80.3849487	0.0000000	0.0	0.0	0.0	0.0
2	0.0000000	84.0906830	0.0	0.0	0.0	0.0
3	34.1869507	-0.0000000	0.0	0.0	0.0	0.0

LIST DYNAMIC NORMALIZED MODES

FOR INFORMATION ONLY

****
RESULTS OF LATEST ANALYSIS
****

PROBLEM - CATAWBA TITLE - TRANSIENT ANALYSIS OF CATAWBA STICK MODEL

ACTIVE UNITS FEET LB CYC. FAHR SEC LBM

NORMALIZED EIGENVECTORS

MODE 1 MAXIMUM VALUE (IN INTERNAL UNITS) IS -1.972451E-02 AT JOINT 21 IN DIRECTION DISP X

JOINT		DISPLACEMENT X DISP.	DISPLACEMENT Y DISP.	DISPLACEMENT Z DISP.	ROTATION X ROT.	ROTATION Y ROT.	ROTATION Z ROT.
1	GLOBAL	0.0	0.0				0.0
2	GLOBAL	0.0121339	-0.0000000				-0.0000225
3	GLOBAL	0.0512381	-0.0000000				-0.0000869
4	GLOBAL	0.1136106	0.0000000				-0.0001744
5	GLOBAL	0.1841283	0.0000000				-0.0002550
6	GLOBAL	0.2507845	0.0000000				-0.0003184
7	GLOBAL	0.2938735	0.0000000				-0.0003538
8	GLOBAL	0.3661537	0.0000000				-0.0004052
9	GLOBAL	0.4377564	-0.0000000				-0.0004477
10	GLOBAL	0.5075781	-0.0000000				-0.0004819
11	GLOBAL	0.5746246	-0.0000000				-0.0005088
12	GLOBAL	0.6386816	-0.0000000				-0.0005292
13	GLOBAL	0.6962001	-0.0000000				-0.0005437
14	GLOBAL	0.7221650	-0.0000000				-0.0005491
15	GLOBAL	0.7528820	-0.0000000				-0.0005555
16	GLOBAL	0.8044424	-0.0000000				-0.0005645
17	GLOBAL	0.8533472	-0.0000000				-0.0005713
18	GLOBAL	0.8965245	-0.0000000				-0.0005760
19	GLOBAL	0.9331077	-0.0000000				-0.0005793
20	GLOBAL	0.9622912	-0.0000000				-0.0005815
21	GLOBAL	1.0000000	-0.0000000				-0.0005846

MODE 2 MAXIMUM VALUE (IN INTERNAL UNITS) IS 1.6032186E-02 AT JOINT 21 IN DIRECTION DISP Y

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JOINT		DISPLACEMENT X DISP.	DISPLACEMENT Y DISP.	DISPLACEMENT Z DISP.	ROTATION X ROT.	ROTATION Y ROT.	ROTATION Z ROT.
1	GLOBAL	0.0	0.0				0.0
2	GLOBAL	0.0000000	0.0229761				0.0000000
3	GLOBAL	0.0000000	0.0925893				0.0000000
4	GLOBAL	0.0000000	0.1967675				0.0000000
5	GLOBAL	0.0000000	0.3038698				0.0000000
6	GLOBAL	0.0000000	0.3976785				0.0000000
7	GLOBAL	0.0000000	0.4548997				0.0000000
8	GLOBAL	0.0000000	0.5449562				0.0000000
9	GLOBAL	0.0000000	0.6269417				0.0000000
10	GLOBAL	0.0000000	0.6999531				0.0000000
11	GLOBAL	0.0000000	0.7636959				0.0000000
12	GLOBAL	0.0000000	0.8177555				0.0000000
13	GLOBAL	0.0000000	0.8549759				0.0000000
14	GLOBAL	0.0000000	0.8764584				0.0000000
15	GLOBAL	0.0000000	0.8964847				0.0000000
16	GLOBAL	-0.0000000	0.9253653				0.0000000
17	GLOBAL	-0.0000000	0.9494211				0.0000000
18	GLOBAL	-0.0000000	0.9679064				0.0000000
19	GLOBAL	-0.0000000	0.9811962				0.0000000
20	GLOBAL	-0.0000000	0.9898718				0.0000000
21	GLOBAL	-0.0000000	1.0000000				0.0000000

MODE 3 MAXIMUM VALUE (IN INTERNAL UNITS) IS -2.512604E-02 AT JOINT 21 IN DIRECTION DISP X

JOINT		DISPLACEMENT X DISP.	DISPLACEMENT Y DISP.	DISPLACEMENT Z DISP.	ROTATION X ROT.	ROTATION Y ROT.	ROTATION Z ROT.
1	GLOBAL	0.0	0.0				0.0
2	GLOBAL	-0.0322653	0.0000000				-0.0000030
3	GLOBAL	-0.1286854	0.0000000				-0.0000228
4	GLOBAL	-0.2648554	0.0000000				-0.0000781
5	GLOBAL	-0.3865364	0.0000000				-0.0001634
6	GLOBAL	-0.4698143	0.0000000				-0.0002611
7	GLOBAL	-0.5062466	0.0000000				-0.0003311
8	GLOBAL	-0.5288191	0.0000000				-0.0004570
9	GLOBAL	-0.5008729	0.0000000				-0.0005878
10	GLOBAL	-0.4259289	0.0000000				-0.0007158
11	GLOBAL	-0.3126637	0.0000000				-0.0008344
12	GLOBAL	-0.1709131	0.0000000				-0.0009385
13	GLOBAL	-0.0164558	0.0000000				-0.0010223
14	GLOBAL	0.0595911	0.0000000				-0.0010565
15	GLOBAL	0.1585731	0.0000000				-0.0010981
16	GLOBAL	0.3337659	0.0000000				-0.0011602

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JOINT		DISPLACEMENT X DISP.	Y DISP.	Z DISP.	ROTATION X ROT.	Y ROT.	Z ROT.
17	GLOBAL	0.5036133	0.0000000				-0.0012088
18	GLOBAL	0.6941995	0.0000000				-0.0012444
19	GLOBAL	0.7796087	0.0000000				-0.0012697
20	GLOBAL	0.8760223	0.0000000				-0.0012872
21	GLOBAL	1.0000000	0.0000000				-0.0013129

```
PLOT DEVICE PLOTTER
PLOT FORMAT NORMAL
TITLE 'CATAWBA STICK MODEL - MODE SHAPES'
TITLE BLOCK
  JOB 'CATAWBA NUCLEAR STATION'
  FOR 'STICK TRANSIENT ANALYSIS'
  BY 'DOYLE E. BYRD'
DISPLAY MODE SHAPE THREE DIMENSIONAL
PLOT FINISH
DAMPING RATIO .01 10
TRANSIENT LOAD 1 'SUPPORT ACCEL. IN HORZ. X-DIRECTION FOR EARTHQUAKE 1'
SUPPORT ACCELERATIONS
TRANSLATION X FILE 'CATEW1' FACTOR .25
INTEGRATE FROM 0. TO 20. AT DELTA .01
END
TRANSIENT LOAD 2 'SUPPORT ACCEL. IN HORZ. X-DIRECTION FOR EARTHQUAKE 2'
SUPPORT ACCELERATIONS
TRANSLATION X FILE 'CATEW2' FACTOR .25
INTEGRATE FROM 0. TO 20. AT DELTA .01
END
TRANSIENT LOAD 3 'SUPPORT ACCEL. IN HORZ. X-DIRECTION FOR EARTHQUAKE 3'
```

FOR INFORMATION ONLY

```
SUPPORT ACCELERATIONS
TRANSLATION X FILE 'CATEQ3' FACTOR .25
INTEGRATE FROM 0. TO 20. AT DELTA .01
END
TRANSIENT LOAD 4 'SUPPORT ACCEL. IN HORZ. X-DIRECTION FOR EARTHQUAKE 4'
SUPPORT ACCELERATIONS
TRANSLATION X FILE 'CATEQ4' FACTOR .25
INTEGRATE FROM 0. TO 20. AT DELTA .01
END
TRANSIENT LOAD 5 'SUPPORT ACCEL. IN VERT. Y-DIRECTION FOR EARTHQUAKE 1'
SUPPORT ACCELERATIONS
TRANSLATION Y FILE 'CATEQ1' FACTOR .25
INTEGRATE FROM 0. TO 20. AT DELTA .01
END
TRANSIENT LOAD 6 'SUPPORT ACCEL. IN VERT. Y-DIRECTION FOR EARTHQUAKE 2'
SUPPORT ACCELERATIONS
TRANSLATION Y FILE 'CATEQ2' FACTOR .25
INTEGRATE FROM 0. TO 20. AT DELTA .01
END
TRANSIENT LOAD 7 'SUPPORT ACCEL. IN VERT. Y-DIRECTION FOR EARTHQUAKE 3'
SUPPORT ACCELERATIONS
TRANSLATION Y FILE 'CATEQ3' FACTOR .25
INTEGRATE FROM 0. TO 20. AT DELTA .01
END
TRANSIENT LOAD 8 'SUPPORT ACCEL. IN VERT. Y-DIRECTION FOR EARTHQUAKE 4'
SUPPORT ACCELERATIONS
```

```
TRANSLATION Y FILE 'CATEQ4' FACTOR .25
INTEGRATE FROM 0. TO 20. AT DELTA .01
END
TRANSIENT ANALYSIS LOADS 1 2 3 4 5 6 7 8

**** STRUDL WARNING - NO INITIAL CONDITIONS SPECIFIED FOR TRANSIENT LOAD 1
                      ZEROES ASSUMED.

**** STRUDL WARNING - NO INITIAL CONDITIONS SPECIFIED FOR TRANSIENT LOAD 2
                      ZEROES ASSUMED.

**** STRUDL WARNING - NO INITIAL CONDITIONS SPECIFIED FOR TRANSIENT LOAD 3
                      ZEROES ASSUMED.

**** STRUDL WARNING - NO INITIAL CONDITIONS SPECIFIED FOR TRANSIENT LOAD 4
                      ZEROES ASSUMED.

**** STRUDL WARNING - NO INITIAL CONDITIONS SPECIFIED FOR TRANSIENT LOAD 5
                      ZEROES ASSUMED.

**** STRUDL WARNING - NO INITIAL CONDITIONS SPECIFIED FOR TRANSIENT LOAD 6
                      ZEROES ASSUMED.

**** STRUDL WARNING - NO INITIAL CONDITIONS SPECIFIED FOR TRANSIENT LOAD 7
                      ZEROES ASSUMED.
```

FOR INFORMATION ONLY

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**** STRUDL WARNING - NO INITIAL CONDITIONS SPECIFIED FOR TRANSIENT LOAD 8
          ZEROES ASSUMED.

STORE TRANSIENT 'TRANHORZ'
USE MODAL RESULTS OF TRANSIENT ANALYSIS 1 2 3 4 FROM TIME 0. TO 20.
JOINT TOTAL ACCELERATIONS
1 6 9 14 17 20 TRANSLATION X
END
STORE TRANSIENT 'TRANVERT'
USE MODAL RESULTS OF TRANSIENT ANALYSIS 5 6 7 8 FROM TIME 0. TO 20.
JOINT TOTAL ACCELERATIONS
1 6 9 14 17 20 TRANSLATION Y
END
COMPUTE STORE TRANS 'TRANHORZ' 'TRANVERT'
UNITS RADIANS
STORE SPECTRUM 'HORZEQ'
RANGE FREQ LIN 1. 4. .15 4. 20. .3 20. 65. 1. 65. 210. 2.
OSCIL DAMP RATIO .005 .01 .02 .05
USE STORE 'TRANHORZ'
USE TRANSIENT 1 2 3 4 FROM TIME 0. TO 20.
JOINT TOTAL ACCELERATIONS
1 6 9 14 17 20 TRANSLATION X
END
STORE SPECTRUM 'VERTEQ'
RANGE FREQ LIN 1. 4. .15 4. 20. .3 20. 65. 1. 65. 210. 2.
OSCIL DAMP RATIO .005 .01 .02 .05
```

FOR INFORMATION ONLY

```
USE STORE 'TRANVERT'
USE TRANSIENT 5 6 7 8
JOINT TOTAL ACCELERATION
1 6 9 14 17 20 TRANSLATION Y
END
COMPUTE AND STORE SPECTRA RESULTS 'HORZEQ' 'VERTEQ'
SAVE 'SPECTRA' SCAN CHECK
001        DSNAME=TST.R030.C8362.JMK.CEB.STICK              VOLSER=MSST02
****NON-DESTRUCTIVE SAVE SUCCESSFUL FOR FILE SPECTRA  USING MAP SAVESTRU
****ON JUL 28, 1982 AT 17.09.08 - THIS FILE HAS BEEN SAVED    1 TIME(S)
OUTPUT STORED TRANSIENT RESULTS
PLOT ON
ABSCISSA SCALE ON INDIVIDUAL BASIS
ORDINATE SCALE ON INDIVIDUAL BASIS
USE STORE TRANSIENT SET IDENT 'TRANHORZ'
USE TRANSIENT ANALYSIS 1 2 3 4
JOINT TOTAL ACCELERATION
1 6 9 14 17 20 TRANSLATION X
END SUBSET
```

FOR INFORMATION ONLY

****
RESULTS OF LATEST ANALYSIS
****

PROBLEM - CATAWBA TITLE - TRANSIENT ANALYSIS OF CATAWBA STICK MODEL

ACTIVE UNITS FEET LB RAD. FAHR SEC LBM

TRANSIENT LOAD 1

TIME HISTORY FOR JOINT 1 XT TOTAL ACCELERATION

TIME	VALUE	TIME	VALUE	TIME	VALUE	TIME	VALUE
0.0	0.0	9.999998E-03	-6.749995E-03	2.000000E-02	-8.874997E-03	3.000000E-02	-1.082500E-02
4.000000E-02	-1.207500E-02	5.000000E-02	-1.237500E-02	6.000000E-02	-1.167499E-02	6.999999E-02	-9.974975E-03
7.999998E-02	-7.024974E-03	8.999997E-02	-2.799970E-03	9.999996E-02	1.950022E-03	1.100000E-01	5.825002E-03
1.199999E-01	7.224984E-03	1.300000E-01	5.699951E-03	1.400000E-01	1.899944E-03	1.500000E-01	-2.650045E-03
1.600000E-01	-6.575026E-03	1.700000E-01	-9.000003E-03	1.799999E-01	-9.549974E-03	1.900000E-01	-8.349955E-03
2.000000E-01	-5.874936E-03	2.100000E-01	-2.624931E-03	2.200000E-01	1.150075E-03	2.300000E-01	5.350057E-03
2.399999E-01	-8.900009E-03	2.499999E-01	-9.624917E-03	2.600000E-01	-5.349774E-03	2.700000E-01	-3.850253E-03
2.800000E-01	-1.350016E-02	2.900000E-01	-2.139995E-02	3.000000E-01	-2.102480E-02	3.099999E-01	-1.384975E-02
3.200000E-01	-3.724751E-03	3.300000E-01			7.949937E-03	3.500000E-01	5.949847E-03
3.600000E-01	1.049916E-03	3.699999E-01			2.975505E-03	3.900000E-01	1.717570E-02
4.000000E-01	3.715000E-02	4.100000E-01			6.197484E-02	4.299999E-01	5.807463E-02
4.400000E-01	4.839963E-02	4.500000E-01			3.710004E-02	4.700000E-01	3.860014E-02
4.800000E-01	4.262516E-02	4.899999E-01			5.172503E-02	5.100000E-01	5.357480E-02
5.200000E-01	4.989940E-02	5.300000E-01			2.124897E-02	5.500000E-01	7.395927E-05
5.599999E-01	-2.175093E-02	5.700000E-01			-5.807547E-02	5.900000E-01	-6.732506E-02
6.000000E-01	-6.929988E-02	6.100000E-01			-6.832540E-02	6.300000E-01	-7.705098E-02
6.400000E-01	-4.490144E-02	6.500000E-01			-1.500518E-01	6.700000E-01	-1.818205E-01
6.799999E-01	-2.086756E-01	6.900000E-01			-2.071975E-01	7.100000E-01	-1.706468E-01
7.200000E-01	-1.224471E-01	7.300000E-01			-4.757359E-02	7.499999E-01	-2.624861E-02
7.600000E-01	-5.423147E-03	7.700000E-01			4.945187E-02	7.900000E-01	7.600141E-02
8.000000E-01	4.600075E-02	8.099999E-01			1.051484E-01	8.300000E-01	8.584702E-02
8.400000E-01	4.854633E-02	8.500000E-01			-4.227734E-02	8.699999E-01	-7.275134E-02
8.800000E-01	-4.600047E-02	8.900000E-01			-1.152757E-01	9.100000E-01	-1.249751E-01
9.200000E-01	-1.270095E-01	9.299999E-01			-1.162246E-01	9.500000E-01	-1.122994E-01
9.600000E-01	-1.064235E-01	9.700000E-01			-5.774017E-02	9.899999E-01	-1.507168E-02
9.999999E-01	2.207657E-02	1.009999E+00			3.204437E-02	1.030000E+00	2.612989E-03
1.040000E+00	-3.430501E-02	1.049999E+00			-1.039712E-01	1.070000E+00	-9.617645E-02
1.080000E+00	-5.513577E-02	1.089999E+00			5.264074E-02	1.110000E+00	7.329345E-02
1.120000E+00	6.579742E-02	1.129999E+00			3.968406E-02	1.150000E+00	4.834684E-02
1.160000E+00	6.745106E-02	1.169999E+00			1.111916E-01	1.190000E+00	1.424379E-01
1.200000E+00	1.004744E-01	1.209999E+00			2.674431E-01	1.230000E+00	2.637621E-01
1.240000E+00	2.125649E-01	1.249999E+00			2.371615E-02	1.270000E+00	-5.950022E-02
1.280000E+00	-1.044946E-01	1.290000E+00	-1.307517E-01	1.299999E+00	-1.429740E-01	1.309999E+00	-1.654105E-01
1.320000E+00	-2.027994E-01	1.330000E+00	-2.445025E-01	1.339999E+00	-2.757623E-01	1.349999E+00	-2.908661E-01
1.360000E+00	-2.471746E-01	1.370000E+00	-3.084230E-01	1.379999E+00	-3.349472E-01	1.389999E+00	-3.794419E-01

REMAINDER OF RUN CONSISTS OF ACCELERATION TIME HISTORIES FOR VARIOUS JOINTS

FOR INFORMATION ONLY

SPECTRA

EXTRACT

J6199A

FOR INFORMATION ONLY

UNCONTROLLED

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****A START JOB 6199 SPECTRA 2KELLYJK FM NORM D037 2.34.57 AM 29 JUL 82 PRINTER6 SYS AMD1 JOB 6199 START A****
****A START JOB 6199 SPECTRA 2KELLYJK FM NORM D037 2.34.57 AM 29 JUL 82 PRINTER6 SYS AMD1 JOB 6199 START A****
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                  J E S 2  J 0 B  L 0 G  --  S Y S T E M  3 0 3 4  --  N 0 D E  C H U R C H

17.34.35 J0B 6199  $HASP373 SPECTRA  STARTED - INIT 10 - CLASS L - SYS 3034
17.34.35 J0B 6199  IEF403I SPECTRA - STARTED - TIME=17.34.35
17.36.27 J0B 6199  +MDC001I -----------------------M=060 S=00000 E=00072
                                                        --TIMINGS (MINS.)--           ----PAGING COUNTS---          (APPR0X.)
17.36.31 J0B 6199  -
17.36.31 J0B 6199  -J0BNAME  STEPNAME PR0GRAM    RC   EXCP    CPU    SRB  CL0CK   SERV   PG   PAGE   SWAP   VI0  SWAPS      C 0 S T
17.36.31 J0B 6199  -SPECTRA  STEP1    DFINT      00   1459    .31    .01   1.9   106K    1    14     15     0     1     $    2.73
17.37.59 J0B 6199  -SPECTRA  STEP2    SPECTEN    00    368    .44    .00   1.4   95577   1    19     15     0     1     $    2.73
17.38.27 J0B 6199  IEF404I SPECTRA - ENDED - TIME=17.38.27
17.38.27 J0B 6199  -SPECTRA  ENDED.  NAME-2KELLYJK        T0TAL CPU TIME=   .77  T0TAL ELAPSED TIME=   3.8 J0B C0ST=$     5.46
17.38.27 J0B 6199  $HASP395 SPECTRA  ENDED

------ JES2 J0B STATISTICS ------

 28 JUL 82 J0B EXECUTI0N DATE

        97 CARDS READ

    22,252 SYS0UT PRINT REC0RDS

         0 SYS0UT PUNCH REC0RDS

      3.87 MINUTES EXECUTI0N TIME
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THESE DESIGN CALCULATIONS COVER ITEMS RELATING TO NUCLEAR SAFETY. IN ACCORDANCE WITH ESTABLISHED PROCEDURES, THE QUALITY HAS BEEN ASSURED.

Jeffrey M. Kelly — ORIGINATED BY — 8/24/82 — DATE

Doyle E. Byrd — CHECKED BY — 9/1/82 — DATE

APPROVED BY — DATE

FOR INFORMATION ONLY

MCAUTO ICES EXECUTIVE SYSTEM
RELEASE 3.5 - 14 AUG 1980
TIME- 17:35:11 DATE- JUL 28, 1982
MODEL 33 VS2 REL 3.8F

FOR INFORMATION ONLY

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STRUDL 'CATAWBA' 'RESPONSE SPECTRA FROM STICK TRANSIENT ANALYSIS'
*****************************************************************
*                                                               *
*   MCAUTO STRUDL                    RELEASE 4.4  OCT 1980      *
*   MCAUTO STRUDL DYNAL              RELEASE 6.4                *
*   MCAUTO STRUDL PLOTS              RELEASE 3.4                *
*                                                               *
*               TIME 17.35.14,  7/28/82                         *
*                                                               *
*             DATA POOL SIZE    30640 BYTES                     *
*                                                               *
*****************************************************************

RESTORE 'SPECTRA'

DD1      DSNAME=TST.R030.C8362.JMK.DEB.STICK                 VOLSER=MSST02

****NON-DESTRUCTIVE RESTORE SUCCESSFUL FOR FILE SPECTRA  USING MAP SAVESTRU
****THIS FILE HAS BEEN SAVED      1 TIME(S), THE MOST RECENT SAVE ON JUL 28, 1982 AT 17.09.08 USING MAP SAVESTRU
****THIS FILE HAS BEEN RESTORED    4 TIME(S) SINCE THEN
*   JOB STATUS AT TIME OF SAVE:
    ACTIVE UNITS ARE:  FEET LB   RAD. FAHR SEC  LBM
    IN ADDITIONS MODE

UNITS CYCLES

OUTPUT SPECTRUM

PUNCH ON

PLOT ON

ABSCISSA SCALE LOG ON INDIVIDUAL BASIS

ORDINATE SCALE ON INDIVIDUAL BASIS

DAMPING CURVES PER PLOT 1

OUTPUT G TRUE ACCEL VS PERIOD

USE STORE 'HORZEQ'

USE TRANSIENT ANALYSIS 1 2 3 4

USE DAMP ALL
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FOR INFORMATION ONLY

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COMBINE SPECTRA BY PEAK
JOINT TOTAL ACCELERATION
1 6 9 14 17 20 TRANSLATION X
END SUBSET
```

RESULTS OF LATEST ANALYSIS

PROBLEM - CATAWBA TITLE - TRANSIENT ANALYSIS OF CATAWBA STICK MODEL

ACTIVE UNITS FEET LB CYC. FAHR SEC LBM

INPUT HORIZONTAL SPECTRUM
AT BASE DUE TO 4-TIMEHIST.

SPECTRUM IDENT HORZEQ
SPECTRUM FROM JOINT 1 XT TOT
COMBINED TRANSIENTS PEAK
DAMPING = 0.010

FREQUENCY	PSEUDO DISPLACEMENT	PSEUDO VELOCITY	TRUE ACCELERATION	TRUE G	PERIOD
0.159155E+00	0.281422E+00	0.281422E+00	0.281422E+00	0.873983E-02	0.628319E+01
0.183028E+00	0.306694E+00	0.352697E+00	0.405602E+00	0.125963E-01	0.546364E+01
0.206901E+00	0.371002E+00	0.482302E+00	0.626992E+00	0.194718E-01	0.483322E+01
0.230775E+00	0.431834E+00	0.626160E+00	0.907932E+00	0.281966E-01	0.433323E+01
0.254648E+00	0.449438E+00	0.719100E+00	0.115056E+01	0.357317E-01	0.392699E+01
0.278521E+00	0.470967E+00	0.824192E+00	0.144234E+01	0.447930E-01	0.359039E+01
0.302394E+00	0.557722E+00	0.105967E+01	0.201338E+01	0.625272E-01	0.330694E+01
0.326267E+00	0.576718E+00	0.118104E+01	0.242113E+01	0.751905E-01	0.306497E+01
0.350141E+00	0.549028E+00	0.123786E+01	0.265729E+01	0.825247E-01	0.285599E+01
0.374014E+00	0.498084E+00	0.117238E+01	0.275538E+01	0.855616E-01	0.267370E+01
0.397887E+00	0.478652E+00	0.119663E+01	0.299157E+01	0.929060E-01	0.251327E+01
0.421760E+00	0.4[illegible]7065E+00	0.115828E+01	0.306943E+01	0.953240E-01	0.237101E+01
0.445634E+00	0.402815E+00	0.112788E+01	0.315807E+01	0.980768E-01	0.224399E+01
0.469507E+00	0.3[illegible]3660E+00	0.113160E+01	0.333280E+01	0.103689E+00	0.212989E+01
0.493380E+00	0.369745E+00	0.114621E+01	0.355325E+01	0.110350E+00	0.202683E+01
0.517253E+00	0.351832E+00	0.114345E+01	0.371623E+01	0.115411E+00	0.193329E+01
0.541127E+00	0.325342E+00	0.113616E+01	0.376096E+01	0.116800E+00	0.184800E+01
0.565000E+00	0.303104E+00	0.107602E+01	0.381986E+01	0.118629E+00	0.176991E+01
0.588873E+00	0.281322E+00	0.104089E+01	0.385130E+01	0.119606E+00	0.169816E+01
0.612746E+00	0.273084E+00	0.105137E+01	0.404779E+01	0.125706E+00	0.163200E+01
0.636620E+00	0.264179E+00	0.105672E+01	0.422687E+01	0.131269E+00	0.157080E+01
0.684366E+00	0.222662E+00	0.957445E+00	0.411701E+01	0.127858E+00	0.146121E+01
0.732113E+00	0.189852E+00	0.873319E+00	0.401727E+01	0.124760E+00	0.136591E+01
0.779859E+00	0.188232E+00	0.922337E+00	0.451945E+01	0.140356E+00	0.128228E+01
0.827606E+00	0.190550E+00	0.993859E+00	0.515247E+01	0.160014E+00	0.120830E+01
0.875352E+00	0.180640E+00	0.993522E+00	0.546437E+01	0.169701E+00	0.114240E+01
0.923099E+00	0.178780E+00	0.103693E+01	0.601417E+01	0.186776E+00	0.108331E+01
0.970845E+00	0.165806E+00	0.101141E+01	0.661963E+01	0.191603E+00	0.103003E+01
0.101859E+01	0.173302E+00	0.110913E+01	0.709845E+01	0.220449E+00	0.981748E+00
0.106634E+01	0.196259E+00	0.136896E+01	0.883701E+01	0.274441E+00	0.937789E+00
0.111408E+01	0.191311E+00	0.133917E+01	0.937422E+01	0.291125E+00	0.897598E+00
0.116183E+01	0.194[illegible]3E+00	0.142199E+01	0.103805E+02	0.322376E+00	0.860710E+00
0.120958E+01	0.183[illegible]E+00	0.139622E+01	0.106113E+02	0.329544E+00	0.826735E+00
0.125732E+01	0.1699[illegible]+00	0.134296E+01	0.106094E+02	0.329484E+00	0.795340E+00

FOR INFORMATION ONLY

FREQUENCY	PSEUDO DISPLACEMENT	PSEUDO VELOCITY	TRUE ACCELERATION	TRUE G	PERIOD
0.130507E+01	0.144089E+00	0.118153E+01	0.968852E+01	0.300886E+00	0.766242E+00
0.135282E+01	0.133[illegible]48E+00	0.113261E+01	0.962718E+01	0.298981E+00	0.739[illegible]98E+00
0.140056E+01	0.120[illegible]88E+00	0.106205E+01	0.934609E+01	0.290251E+00	0.713[illegible]98E+00
0.144831E+01	0.120196E+00	0.109378E+01	0.995341E+01	0.309112E+00	0.690[illegible]60E+00
0.149606E+01	0.119670E+00	0.112490E+01	0.105740E+02	0.328386E+00	0.668424E+00
0.154380E+01	0.124953E+00	0.121204E+01	0.117568E+02	0.365118E+00	0.647751E+00
0.159155E+01	0.116650E+00	0.116650E+01	0.116650E+02	0.362266E+00	0.628317E+00
0.163930E+01	0.110455E+00	0.113769E+01	0.117182E+02	0.363919E+00	0.610018E+00
0.168704E+01	0.103919E+00	0.113154E+01	0.116763E+02	0.362619E+00	0.592753E+00
0.173479E+01	0.985022E-01	0.107367E+01	0.117031E+02	0.363449E+00	0.576439E+00
0.178253E+01	0.104155E+00	0.116654E+01	0.130653E+02	0.405753E+00	0.560999E+00
0.183028E+01	0.106812E+00	0.122833E+01	0.141258E+02	0.438691E+00	0.546364E+00
0.187803E+01	0.112182E+00	0.132374E+01	0.156202E+02	0.485099E+00	0.532473E+00
0.192577E+01	0.107604E+00	0.133201E+01	0.157543E+02	0.489264E+00	0.519272E+00
0.197352E+01	0.102100E+00	0.126604E+01	0.156989E+02	0.487545E+00	0.506709E+00
0.202127E+01	0.957513E-01	0.121604E+01	0.154438E+02	0.479620E+00	0.494739E+00
0.206901E+01	0.859507E-01	0.111736E+01	0.145257E+02	0.451108E+00	0.483322E+00
0.211676E+01	0.732109E-01	0.973705E+00	0.129503E+02	0.402183E+00	0.472420E+00
0.216451E+01	0.675805E-01	0.919094E+00	0.124997E+02	0.388189E+00	0.461999E+00
0.221225E+01	0.689588E-01	0.955527E+00	0.133235E+02	0.413774E+00	0.452028E+00
0.226000E+01	0.769999E-01	0.112180E+01	0.159295E+02	0.494706E+00	0.442478E+00
0.230775E+01	0.756350E-01	0.109671E+01	0.159023E+02	0.493860E+00	0.433323E+00
0.235549E+01	0.696978E-01	0.103153E+01	0.152166E+02	0.474119E+00	0.424540E+00
0.240324E+01	0.687469E-01	0.103808E+01	0.156750E+02	0.486801E+00	0.416105E+00
0.245098E+01	0.670043E-01	0.103187E+01	0.158908E+02	0.493502E+00	0.407999E+00
0.249873E+01	0.630074E-01	0.989215E+00	0.155307E+02	0.482320E+00	0.400203E+00
0.254648E+01	0.596541E-01	0.954466E+00	0.152715E+02	0.474269E+00	0.392699E+00
0.259422E+01	0.564703E-01	0.920464E+00	0.150036E+02	0.465949E+00	0.385472E+00
0.264197E+01	0.560776E-01	0.930887E+00	0.154527E+02	0.479898E+00	0.378505E+00
0.268972E+01	0.571543E-01	0.965907E+00	0.163238E+02	0.506951E+00	0.371786E+00
0.273746E+01	0.525697E-01	0.904199E+00	0.155522E+02	0.482988E+00	0.365301E+00
0.278521E+01	0.540222E-01	0.945387E+00	0.165443E+02	0.513797E+00	0.359039E+00
0.283296E+01	0.529896E-01	0.943213E+00	0.167892E+02	0.521403E+00	0.352988E+00
0.288070E+01	0.478342E-01	0.865798E+00	0.156709E+02	0.486675E+00	0.347137E+00
0.292845E+01	0.427018E-01	0.785713E+00	0.144571E+02	0.448979E+00	0.341478E+00
0.297620E+01	0.384239E-01	0.718527E+00	0.134364E+02	0.417281E+00	0.335999E+00
0.302394E+01	0.370821E-01	0.704559E+00	0.133866E+02	0.415734E+00	0.330694E+00
0.307169E+01	0.371789E-01	0.717552E+00	0.138488E+02	0.430086E+00	0.325554E+00
0.311944E+01	0.378913E-01	0.742669E+00	0.145563E+02	0.452059E+00	0.320571E+00
0.316718E+01	0.385973E-01	0.765085E+00	0.152849E+02	0.474686E+00	0.315738E+00
0.318310E+01	0.377310E-01	0.754621E+00	0.150524E+02	0.468709E+00	0.314159E+00
0.334225E+01	0.332824E-01	0.699930E+00	0.146775E+02	0.455824E+00	0.299199E+00
0.350141E+01	0.291257E-01	0.643765E+00	0.140968E+02	0.437790E+00	0.285599E+00
0.366056E+01	0.281856E-01	0.648270E+00	0.149102E+02	0.463050E+00	0.273182E+00
0.381972E+01	0.205032E-01	0.492077E+00	0.116099E+02	0.366766E+00	0.261799E+00
0.397887E+01	0.194492E-01	0.499731E+00	0.124683E+02	0.387214E+00	0.251327E+00
0.413803E+01	0.221413E-01	0.575674E+00	0.149675E+02	0.464830E+00	0.241661E+00

FOR INFORMATION ONLY

FREQUENCY	PSEUDO DISPLACEMENT	PSEUDO VELOCITY	TRUE ACCELERATION	TRUE G	PERIOD
0.429718E+01	0.178001E-01	0.483603E+00	0.129763E+02	0.402990E+00	0.232711E+00
0.445634E+01	0.174739E-01	0.494869E+00	0.138563E+02	0.430321E+00	0.224399E+00
0.461549E+01	0.154184E-01	0.447134E+00	0.129669E+02	0.402698E+00	0.216662E+00
0.477463E+01	0.180245E-01	0.540736E+00	0.162221E+02	0.503792E+00	0.209439E+00
0.493380E+01	0.149354E-01	0.462996E+00	0.143529E+02	0.445742E+00	0.202683E+00
0.509296E+01	0.136667E-01	0.437333E+00	0.139947E+02	0.434617E+00	0.196350E+00
0.525211E+01	0.145480E-01	0.480083E+00	0.158428E+02	0.492011E+00	0.190400E+00
0.541127E+01	0.125357E-01	0.426213E+00	0.144912E+02	0.450038E+00	0.184800E+00
0.557042E+01	0.107902E-01	0.377657E+00	0.132180E+02	0.410497E+00	0.179520E+00
0.572958E+01	0.107900E-01	0.388442E+00	0.139839E+02	0.434283E+00	0.174533E+00
0.588873E+01	0.115465E-01	0.427222E+00	0.158072E+02	0.490907E+00	0.169816E+00
0.604789E+01	0.974735E-02	0.373399E+00	0.140752E+02	0.437117E+00	0.165347E+00
0.620704E+01	0.844909E-02	0.329515E+00	0.128511E+02	0.399102E+00	0.161107E+00
0.636620E+01	0.921695E-02	0.368678E+00	0.147471E+02	0.457986E+00	0.157080E+00
0.652535E+01	0.795374E-02	0.326103E+00	0.133702E+02	0.415225E+00	0.153248E+00
0.668451E+01	0.768341E-02	0.322703E+00	0.135535E+02	0.420918E+00	0.149600E+00
0.684366E+01	0.779610E-02	0.335233E+00	0.144150E+02	0.447671E+00	0.146121E+00
0.700282E+01	0.676614E-02	0.297710E+00	0.130993E+02	0.406809E+00	0.142800E+00
0.716197E+01	0.655902E-02	0.295156E+00	0.132620E+02	0.412486E+00	0.139626E+00
0.732113E+01	0.623693E-02	0.286899E+00	0.131974E+02	0.409856E+00	0.136591E+00
0.748028E+01	0.613165E-02	0.288188E+00	0.135448E+02	0.420647E+00	0.133685E+00
0.763944E+01	0.488861E-02	0.234653E+00	0.112633E+02	0.349793E+00	0.130900E+00
0.779859E+01	0.448144E-02	0.219591E+00	0.107599E+02	0.334160E+00	0.128228E+00
0.795775E+01	0.474739E-02	0.237370E+00	0.118685E+02	0.368586E+00	0.125664E+00
0.811690E+01	0.485283E-02	0.247494E+00	0.126222E+02	0.391994E+00	0.123200E+00
0.827606E+01	0.476242E-02	0.247646E+00	0.128776E+02	0.399925E+00	0.120830E+00
0.843521E+01	0.442593E-02	0.234574E+00	0.124324E+02	0.386101E+00	0.118551E+00
0.859437E+01	0.396917E-02	0.214335E+00	0.115741E+02	0.359445E+00	0.116355E+00
0.875352E+01	0.346706E-02	0.190688E+00	0.104879E+02	0.325710E+00	0.114240E+00
0.891268E+01	0.355274E-02	0.199953E+00	0.111414E+02	0.346006E+00	0.112200E+00
0.907183E+01	0.362840E-02	0.206818E+00	0.117887E+02	0.366108E+00	0.110231E+00
0.923099E+01	0.336622E-02	0.195241E+00	0.113240E+02	0.351676E+00	0.108331E+00
0.939014E+01	0.275895E-02	0.162778E+00	0.960390E+01	0.298258E+00	0.106495E+00
0.954930E+01	0.259835E-02	0.155901E+00	0.935405E+01	0.290498E+00	0.104720E+00
0.970845E+01	0.240122E-02	0.146474E+00	0.893493E+01	0.277483E+00	0.103003E+00
0.986761E+01	0.241507E-02	0.149734E+00	0.928353E+01	0.288308E+00	0.101342E+00
0.100268E+02	0.238460E-02	0.150230E+00	0.946447E+01	0.293928E+00	0.997331E-01
0.101859E+02	0.211070E-02	0.135085E+00	0.864545E+01	0.268492E+00	0.981748E-01
0.103451E+02	0.210750E-02	0.136988E+00	0.890421E+01	0.276526E+00	0.966644E-01
0.106634E+02	0.167655E-02	0.112329E+00	0.752604E+01	0.233728E+00	0.937788E-01
0.109817E+02	0.193701E-02	0.133654E+00	0.922211E+01	0.286401E+00	0.910606E-01
0.113000E+02	0.162593E-02	0.115441E+00	0.819631E+01	0.254544E+00	0.884956E-01
0.116183E+02	0.147139E-02	0.107412E+00	0.784106E+01	0.243511E+00	0.860710E-01
0.119366E+02	0.139903E-02	0.104927E+00	0.786952E+01	0.244395E+00	0.837758E-01
0.122549E+02	0.126315E-02	0.972624E-01	0.748921E+01	0.232584E+00	0.815998E-01
0.125732E+02	0.119148E-02	0.941271E-01	0.743604E+01	0.230933E+00	0.795339E-01
0.128916E+02	0.110294E-02	0.393379E-01	0.723638E+01	0.224732E+00	0.775701E-01

FOR INFORMATION ONLY

FREQUENCY	PSEUDO DISPLACEMENT	PSEUDO VELOCITY	TRUE ACCELERATION	TRUE G	PERIOD
0.132099E+02	0.973336E-03	0.307869E-01	0.670531E+01	0.208240E+00	0.757010E-01
0.135282E+02	0.863231E-03	0.735872E-01	0.625491E+01	0.194252E+00	0.739198E-01
0.138465E+02	0.776[illegible]80E-03	0.675929E-01	0.588058E+01	0.182627E+00	0.722[illegible]05E-01
0.141648E+02	0.723[illegible]33E-03	0.643945E-01	0.573111E+01	0.177985E+00	0.705[illegible]75E-01
0.144831E+02	0.707[illegible]96E-03	0.643548E-01	0.585629E+01	0.181872E+00	0.690[illegible]0E-01
0.148014E+02	0.584204E-03	0.543310E-01	0.505278E+01	0.156919E+00	0.675611E-01
0.151197E+02	0.506045E-03	0.483743E-01	0.456706E+01	0.141834E+00	0.661387E-01
0.154380E+02	0.477050E-03	0.462739E-01	0.448857E+01	0.139397E+00	0.647750E-01
0.157563E+02	0.427369E-03	0.423096E-01	0.418865E+01	0.130082E+00	0.634665E-01
0.160746E+02	0.396891E-03	0.400860E-01	0.404869E+01	0.125736E+00	0.622098E-01
0.163930E+02	0.368105E-03	0.379148E-01	0.390523E+01	0.121280E+00	0.610018E-01
0.167113E+02	0.351038E-03	0.368591E-01	0.387020E+01	0.120193E+00	0.598399E-01
0.170296E+02	0.333841E-03	0.357211E-01	0.382215E+01	0.118700E+00	0.587214E-01
0.173479E+02	0.317775E-03	0.346375E-01	0.377549E+01	0.117251E+00	0.576439E-01
0.176662E+02	0.315342E-03	0.353030E-01	0.388533E+01	0.120662E+00	0.566053E-01
0.179845E+02	0.301559E-03	0.340762E-01	0.385061E+01	0.119584E+00	0.556034E-01
0.183028E+02	0.288530E-03	0.331809E-01	0.381581E+01	0.118503E+00	0.546364E-01
0.186211E+02	0.277491E-03	0.324664E-01	0.379857E+01	0.117968E+00	0.537024E-01
0.189394E+02	0.271478E-03	0.323059E-01	0.384440E+01	0.119391E+00	0.527999E-01
0.192577E+02	0.259381E-03	0.313851E-01	0.379760E+01	0.117938E+00	0.519271E-01
0.195760E+02	0.252354E-03	0.310395E-01	0.381786E+01	0.118567E+00	0.510828E-01
0.198944E+02	0.241266E-03	0.301583E-01	0.376478E+01	0.117074E+00	0.502655E-01
0.202127E+02	0.230610E-03	0.292875E-01	0.371951E+01	0.115513E+00	0.494739E-01
0.205310E+02	0.221037E-03	0.285138E-01	0.367828E+01	0.114232E+00	0.487069E-01
0.208493E+02	0.213500E-03	0.279685E-01	0.366388E+01	0.113785E+00	0.479632E-01
0.211676E+02	0.206662E-03	0.274861E-01	0.365565E+01	0.113530E+00	0.472420E-01
0.214859E+02	0.200223E-03	0.270301E-01	0.364907E+01	0.113325E+00	0.465421E-01
0.218042E+02	0.194153E-03	0.265989E-01	0.364406E+01	0.113169E+00	0.458627E-01
0.221225E+02	0.188363E-03	0.261824E-01	0.363936E+01	0.113024E+00	0.452028E-01
0.224408E+02	0.182821E-03	0.257777E-01	0.363466E+01	0.112878E+00	0.445616E-01
0.227592E+02	0.177512E-03	0.253842E-01	0.362794E+01	0.112731E+00	0.439384E-01
0.230775E+02	0.172426E-03	0.250018E-01	0.362526E+01	0.112586E+00	0.433323E-01
0.233958E+02	0.167565E-03	0.246320E-01	0.362091E+01	0.112451E+00	0.427428E-01
0.237141E+02	0.162924E-03	0.242756E-01	0.361707E+01	0.112331E+00	0.421690E-01
0.240324E+02	0.158466E-03	0.239264E-01	0.361319E+01	0.112211E+00	0.416105E-01
0.243507E+02	0.154188E-03	0.235908E-01	0.360939E+01	0.112093E+00	0.410666E-01
0.246690E+02	0.150097E-03	0.232651E-01	0.360609E+01	0.111990E+00	0.405367E-01
0.249873E+02	0.146172E-03	0.229490E-01	0.360300E+01	0.111894E+00	0.400203E-01
0.253056E+02	0.142394E-03	0.226407E-01	0.359987E+01	0.111797E+00	0.395169E-01
0.256239E+02	0.138766E-03	0.223412E-01	0.359694E+01	0.111706E+00	0.390260E-01
0.259422E+02	0.135276E-03	0.220500E-01	0.359415E+01	0.111620E+00	0.385471E-01
0.262606E+02	0.131903E-03	0.217639E-01	0.359105E+01	0.111523E+00	0.380799E-01
0.265789E+02	0.128661E-03	0.214864E-01	0.358824E+01	0.111436E+00	0.376239E-01
0.268972E+02	0.125551E-03	0.212182E-01	0.358588E+01	0.111363E+00	0.371786E-01
0.272155E+02	0.122551E-03	0.209562E-01	0.358351E+01	0.111289E+00	0.867438E-01
0.275338E+02	0.119646E-03	0.206987E-01	0.358087E+01	0.111207E+00	0.363190E-01
0.278521E+02	0.116855E-03	0.204497E-01	0.357870E+01	0.111140E+00	0.359039E-01

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FREQUENCY	PSEUDO DISPLACEMENT	PSEUDO VELOCITY	TRUE ACCELERATION	TRUE G	PERIOD
0.281704E+02	0.114159E-03	0.202062E-01	0.357650E+01	0.111072E+00	0.354982E-01
0.284887E+02	0.1115[illegible]E-03	0.199709E-01	0.357479E+01	0.111018E+00	0.351016E-01
0.288070E+02	0.10906[illegible]E-03	0.197400E-01	0.357294E+01	0.110961E+00	0.34713[illegible]E-01
0.291254E+02	0.106632E-03	0.195137E-01	0.357100E+01	0.110901E+00	0.343349E-01
0.294437E+02	0.104282E-03	0.192922E-01	0.356905E+01	0.110840E+00	0.339632E-01
0.297620E+02	0.102010E-03	0.190758E-01	0.356718E+01	0.110782E+00	0.335999E-01
0.300803E+02	0.998407E-04	0.188699E-01	0.356641E+01	0.110758E+00	0.332444E-01
0.303986E+02	0.977120E-04	0.186630E-01	0.356463E+01	0.110703E+00	0.328963E-01
0.307169E+02	0.956556E-04	0.184615E-01	0.356308E+01	0.110655E+00	0.325554E-01
0.310352E+02	0.936645E-04	0.182646E-01	0.356159E+01	0.110608E+00	0.322215E-01
0.313535E+02	0.917359E-04	0.180720E-01	0.356018E+01	0.110565E+00	0.318943E-01
0.316718E+02	0.898698E-04	0.178841E-01	0.355893E+01	0.110526E+00	0.315738E-01
0.319901E+02	0.880608E-04	0.177002E-01	0.355774E+01	0.110489E+00	0.312596E-01
0.323084E+02	0.862985E-04	0.175186E-01	0.355627E+01	0.110443E+00	0.309516E-01
0.326268E+02	0.845885E-04	0.173406E-01	0.355483E+01	0.110399E+00	0.306497E-01
0.329451E+02	0.829314E-04	0.171668E-01	0.355353E+01	0.110358E+00	0.303535E-01
0.332634E+02	0.813233E-04	0.169966E-01	0.355228E+01	0.110319E+00	0.300631E-01

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****
RESULTS OF LATEST ANALYSIS
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PROBLEM - CATAWBA   TITLE - TRANSIENT ANALYSIS OF CATAWBA STICK MODEL

ACTIVE UNITS FEET LB   CYC. FAHR SEC LB4

HORIZONTAL SPECTRUM AT TOP OF DOME DUE TO 4-TIME HISTORIES

SPECTRUM IDENT HORZEQ
SPECTRUM FROM JOINT 20 XT TOT
COMBINED TRANSIENTS PEAK
DAMPING = 0.010

FREQUENCY	PSEUDO DISPLACEMENT	PSEUDO VELOCITY	TRUE ACCELERATION	TRUE G	PERIOD
0.159155E+00	0.285308E+00	0.285308E+00	0.285308E+00	0.886049E-02	0.628319E+01
0.183028E+00	0.311413E+00	0.358124E+00	0.411843E+00	0.127901E-01	0.546364E+01
0.206901E+00	0.374129E+00	0.486368E+00	0.632278E+00	0.196360E-01	0.483322E+01
0.230775E+00	0.433992E+00	0.629288E+00	0.912467E+00	0.283375E-01	0.433323E+01
0.254648E+00	0.453451E+00	0.725522E+00	0.116083E+01	0.360508E-01	0.392699E+01
0.278521E+00	0.473712E+00	0.829996E+00	0.145074E+01	0.450541E-01	0.359039E+01
0.302394E+00	0.560602E+00	0.106514E+01	0.202377E+01	0.628501E-01	0.330694E+01
0.326267E+00	0.581033E+00	0.119112E+01	0.244179E+01	0.758319E-01	0.306497E+01
0.350141E+00	0.554543E+00	0.121999E+01	0.268399E+01	0.833536E-01	0.285599E+01
0.374014E+00	0.503911E+00	0.118419E+01	0.278285E+01	0.864238E-01	0.267370E+01
0.397887E+00	0.481789E+00	0.123447E+01	0.301118E+01	0.935149E-01	0.251327E+01
0.421760E+00	0.439931E+00	0.116582E+01	0.308941E+01	0.959446E-01	0.237101E+01
0.445634E+00	0.404982E+00	0.113395E+01	0.317506E+01	0.986044E-01	0.224399E+01
0.469507E+00	0.386902E+00	0.114136E+01	0.336701E+01	0.104566E+00	0.212989E+01
0.493380E+00	0.373732E+00	0.115857E+01	0.359156E+01	0.111539E+00	0.202683E+01
0.517253E+00	0.356523E+00	0.115870E+01	0.376577E+01	0.116949E+00	0.193329E+01
0.541127E+00	0.330619E+00	0.112411E+01	0.382196E+01	0.118694E+00	0.184800E+01
0.565000E+00	0.306473E+00	0.109798E+01	0.386233E+01	0.119948E+00	0.176991E+01
0.588873E+00	0.285097E+00	0.105486E+01	0.390298E+01	0.121211E+00	0.169816E+01
0.612746E+00	0.277355E+00	0.106781E+01	0.411109E+01	0.127674E+00	0.163200E+01
0.636620E+00	0.267590E+00	0.107036E+01	0.428144E+01	0.132964E+00	0.157080E+01
0.684366E+00	0.227524E+00	0.978352E+00	0.420691E+01	0.130649E+00	0.146121E+01
0.732113E+00	0.193237E+00	0.888892E+00	0.408890E+01	0.126985E+00	0.136591E+01
0.779859E+00	0.192728E+00	0.944368E+00	0.462740E+01	0.143708E+00	0.128228E+01
0.827606E+00	0.195201E+00	0.101504E+01	0.527823E+01	0.163920E+00	0.120830E+01
0.875352E+00	0.165179E+00	0.101849E+01	0.560167E+01	0.173965E+00	0.114240E+01
0.923099E+00	0.184713E+00	0.107133E+01	0.621373E+01	0.192973E+00	0.108331E+01
0.970845E+00	0.170672E+00	0.104110E+01	0.635069E+01	0.197226E+00	0.103003E+01
0.101859E+01	0.179133E+00	0.114645E+01	0.733729E+01	0.227866E+00	0.951748E+00
0.106634E+01	0.204553E+00	0.137051E+01	0.918240E+01	0.285168E+00	0.937789E+00
0.111408E+01	0.188409E+00	0.138886E+01	0.972203E+01	0.301926E+00	0.897598E+00
0.116183E+01	0.203294E+00	0.148405E+01	0.108335E+02	0.336446E+00	0.860710E+00
0.120958E+01	0.192917E+00	0.146617E+01	0.111429E+02	0.346052E+00	0.826735E+00
0.125732E+01	0.177687E+00	0.143373E+01	0.110895E+02	0.344393E+00	0.795340E+00

FOR INFORMATION ONLY

FREQUENCY	PSEUDO DISPLACEMENT	PSEUDO VELOCITY	TRUE ACCELERATION	TRUE G	PERIOD
0.130507E+01	0.152962E+00	0.125429E+01	0.102852E+02	0.319415E+00	0.766242E+00
0.135282E+01	0.138639E+00	0.117843E+01	0.100167E+02	0.311076E+00	0.739198E+00
0.140056E+01	0.127237E+00	0.111968E+01	0.985323E+01	0.306001E+00	0.713998E+00
0.144831E+01	0.128016E+00	0.116494E+01	0.106010E+02	0.329224E+00	0.690460E+00
0.149606E+01	0.126000E+00	0.115440E+01	0.111334E+02	0.345757E+00	0.668424E+00
0.154380E+01	0.132776E+00	0.128793E+01	0.124929E+02	0.387978E+00	0.647751E+00
0.159155E+01	0.123586E+00	0.123586E+01	0.123587E+02	0.383809E+00	0.628319E+00
0.163930E+01	0.118813E+00	0.122377E+01	0.126049E+02	0.391456E+00	0.610018E+00
0.168704E+01	0.112313E+00	0.117051E+01	0.126195E+02	0.391909E+00	0.592753E+00
0.173479E+01	0.106483E+00	0.116066E+01	0.126512E+02	0.392895E+00	0.576439E+00
0.178253E+01	0.112065E+00	0.125513E+01	0.140575E+02	0.436567E+00	0.560999E+00
0.183028E+01	0.117875E+00	0.135556E+01	0.155889E+02	0.484128E+00	0.546369E+00
0.187803E+01	0.124207E+00	0.146565E+01	0.172946E+02	0.537100E+00	0.532473E+00
0.192577E+01	0.118004E+00	0.142785E+01	0.172770E+02	0.536553E+00	0.519272E+00
0.197352E+01	0.114444E+00	0.141910E+01	0.175968E+02	0.546486E+00	0.506709E+00
0.202127E+01	0.106458E+00	0.135202E+01	0.171707E+02	0.533251E+00	0.494739E+00
0.206901E+01	0.959897E-01	0.124787E+01	0.162223E+02	0.503797E+00	0.483322E+00
0.211676E+01	0.816109E-01	0.108542E+01	0.144362E+02	0.448328E+00	0.472420E+00
0.216451E+01	0.762060E-01	0.103640E+01	0.140951E+02	0.437735E+00	0.461999E+00
0.221225E+01	0.788840E-01	0.109649E+01	0.152412E+02	0.473329E+00	0.452028E+00
0.226000E+01	0.902236E-01	0.128117E+01	0.181927E+02	0.564990E+00	0.442478E+00
0.230775E+01	0.857561E-01	0.124346E+01	0.180302E+02	0.559945E+00	0.433323E+00
0.235549E+01	0.818188E-01	0.121092E+01	0.179216E+02	0.556571E+00	0.424540E+00
0.240324E+01	0.827838E-01	0.125004E+01	0.188755E+02	0.586197E+00	0.416105E+00
0.245098E+01	0.812267E-01	0.125069E+01	0.192637E+02	0.598253E+00	0.407999E+00
0.249873E+01	0.749528E-01	0.117676E+01	0.184751E+02	0.573762E+00	0.400203E+00
0.254648E+01	0.705422E-01	0.112868E+01	0.180588E+02	0.560833E+00	0.392699E+00
0.259422E+01	0.668075E-01	0.108896E+01	0.177500E+02	0.551244E+00	0.385472E+00
0.264197E+01	0.671867E-01	0.111530E+01	0.185139E+02	0.574967E+00	0.378505E+00
0.268972E+01	0.687839E-01	0.116245E+01	0.196454E+02	0.610104E+00	0.371786E+00
0.273746E+01	0.638780E-01	0.109870E+01	0.188977E+02	0.586884E+00	0.365301E+00
0.278521E+01	0.667145E-01	0.116750E+01	0.204313E+02	0.634512E+00	0.359039E+00
0.283296E+01	0.665707E-01	0.118496E+01	0.210922E+02	0.655038E+00	0.352988E+00
0.288070E+01	0.599419E-01	0.108495E+01	0.196375E+02	0.609862E+00	0.347137E+00
0.292845E+01	0.528991E-01	0.973343E+00	0.179095E+02	0.556196E+00	0.341478E+00
0.297620E+01	0.499237E-01	0.933572E+00	0.174578E+02	0.542168E+00	0.335999E+00
0.302394E+01	0.480237E-01	0.912450E+00	0.173365E+02	0.538402E+00	0.330694E+00
0.307169E+01	0.488828E-01	0.943437E+00	0.182083E+02	0.565476E+00	0.325554E+00
0.311944E+01	0.506472E-01	0.992684E+00	0.194566E+02	0.604242E+00	0.320571E+00
0.316718E+01	0.530664E-01	0.105602E+01	0.210148E+02	0.652633E+00	0.315738E+00
0.318310E+01	0.521386E-01	0.104277E+01	0.208554E+02	0.647685E+00	0.314159E+00
0.334225E+01	0.464999E-01	0.976498E+00	0.205065E+02	0.636847E+00	0.299199E+00
0.350141E+01	0.418166E-01	0.919966E+00	0.202392E+02	0.628548E+00	0.285599E+00
0.366056E+01	0.416037E-01	0.956885E+00	0.220084E+02	0.683490E+00	0.273182E+00
0.381972E+01	0.335527E-01	0.805265E+00	0.193264E+02	0.600198E+00	0.261799E+00
0.397887E+01	0.340424E-01	0.851061E+00	0.212765E+02	0.660762E+00	0.251327E+00
0.413803E+01	0.375365E-01	0.975948E+00	0.253746E+02	0.788033E+00	0.241661E+00

FOR INFORMATION ONLY

FREQUENCY	PSEUDO DISPLACEMENT	PSEUDO VELOCITY	TRUE ACCELERATION	TRUE G	PERIOD
0.429718E+01	0.331680E-01	0.895536E+00	0.241795E+02	0.750916E+00	0.232711E+00
0.445634E+01	0.33512[illegible]E-01	0.938336E+00	0.262734E+02	0.815945E+00	0.22439[illegible]E+00
0.461549E+01	0.30524[illegible]E-01	0.885216E+00	0.256713E+02	0.797244E+00	0.21666[illegible]E+00
0.477465E+01	0.35995[illegible]E-01	0.107987E+01	0.323961E+02	0.100609E+01	0.209439E+00
0.493380E+01	0.345358E-01	0.107061E+01	0.331689E+02	0.103071E+01	0.202683E+00
0.509296E+01	0.335284E-01	0.107291E+01	0.343331E+02	0.106624E+01	0.196350E+00
0.525211E+01	0.372627E-01	0.122967E+01	0.403791E+02	0.126022E+01	0.190400E+00
0.541127E+01	0.343383E-01	0.116750E+01	0.396950E+02	0.123277E+01	0.184800E+00
0.557042E+01	0.345173E-01	0.120811E+01	0.422837E+02	0.131316E+01	0.179520E+00
0.572958E+01	0.327632E-01	0.117947E+01	0.424611E+02	0.131867E+01	0.174533E+00
0.588873E+01	0.385865E-01	0.142770E+01	0.528250E+02	0.164053E+01	0.169816E+00
0.604789E+01	0.366891E-01	0.139419E+01	0.529791E+02	0.164531E+01	0.165347E+00
0.620704E+01	0.344045E-01	0.134178E+01	0.523293E+02	0.162513E+01	0.161107E+00
0.636620E+01	0.423442E-01	0.169377E+01	0.677507E+02	0.210406E+01	0.157080E+00
0.652535E+01	0.425696E-01	0.174535E+01	0.715594E+02	0.222234E+01	0.153248E+00
0.668451E+01	0.474605E-01	0.199334E+01	0.837203E+02	0.260001E+01	0.149600E+00
0.684366E+01	0.513760E-01	0.220917E+01	0.949942E+02	0.295013E+01	0.146121E+00
0.700282E+01	0.561326E-01	0.246983E+01	0.108673E+03	0.337493E+01	0.142800E+00
0.716197E+01	0.713066E-01	0.323880E+01	0.144396E+03	0.448435E+01	0.139626E+00
0.732113E+01	0.890334E-01	0.409554E+01	0.188395E+03	0.585077E+01	0.136591E+00
0.748028E+01	0.119848E+00	0.563288E+01	0.264745E+03	0.822191E+01	0.133685E+00
0.763944E+01	0.159385E+00	0.765048E+01	0.367223E+03	0.114044E+02	0.130900E+00
0.779859E+01	0.144103E+00	0.706106E+01	0.345992E+03	0.107451E+02	0.128228E+00
0.795775E+01	0.961738E-01	0.483869E+01	0.240435E+03	0.746692E+01	0.125664E+00
0.811690E+01	0.770147E-01	0.392775E+01	0.200315E+03	0.622098E+01	0.123200E+00
0.827606E+01	0.546197E-01	0.284282E+01	0.147827E+03	0.459090E+01	0.120830E+00
0.843521E+01	0.420761E-01	0.223003E+01	0.118192E+03	0.367055E+01	0.118551E+00
0.859437E+01	0.334121E-01	0.183425E+01	0.974297E+02	0.302577E+01	0.116355E+00
0.87535[illegible]E+01	0.264696E-01	0.145333E+01	0.815829E+02	0.253363E+01	0.114240E+00
0.891268E+01	0.233555E-01	0.133791E+01	0.732430E+02	0.227463E+01	0.112200E+00
0.907183E+01	0.223488E-01	0.127388E+01	0.726113E+02	0.225501E+01	0.110231E+00
0.923099E+01	0.200559E-01	0.116324E+01	0.674682E+02	0.209529E+01	0.108331E+00
0.939014E+01	0.162811E-01	0.960583E+00	0.566744E+02	0.176007E+01	0.106495E+00
0.954930E+01	0.151818E-01	0.910911E+00	0.546547E+02	0.169735E+01	0.104720E+00
0.970845E+01	0.136228E-01	0.833990E+00	0.506904E+02	0.157424E+01	0.103003E+00
0.986761E+01	0.120818E-01	0.749072E+00	0.464424E+02	0.144231E+01	0.101342E+00
0.100268E+02	0.107281E-01	0.679651E+00	0.428180E+02	0.132975E+01	0.997331E-01
0.101859E+02	0.103005E-01	0.659230E+00	0.421907E+02	0.131027E+01	0.981748E-01
0.103451E+02	0.914124E-02	0.594181E+00	0.386217E+02	0.119943E+01	0.966644E-01
0.106634E+02	0.779687E-02	0.522390E+00	0.350002E+02	0.108696E+01	0.937788E-01
0.109817E+02	0.728159E-02	0.502430E+00	0.346677E+02	0.107664E+01	0.910606E-01
0.113000E+02	0.603371E-02	0.429393E+00	0.304159E+02	0.944594E+00	0.884956E-01
0.116183E+02	0.564182E-02	0.411853E+00	0.300653E+02	0.933704E+00	0.860710E-01
0.119366E+02	0.522310E-02	0.391733E+00	0.293800E+02	0.912422E+00	0.837758E-0[illegible]
0.122549E+02	0.456395E-02	0.351578E+00	0.270715E+02	0.840732E+00	0.815998E-01
0.125732E+02	0.422430E-02	0.333720E+00	0.263638E+02	0.818753E+00	0.795339E-01
0.128916E+02	0.384949E-02	0.311809E+00	0.252565E+02	0.784364E+00	0.775701E-01

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FREQUENCY	PSEUDO DISPLACEMENT	PSEUDO VELOCITY	TRUE ACCELERATION	TRUE G	PERIOD
0.132099E+02	0.345291E-02	0.286592E+00	0.237871E+02	0.738731E+00	0.757010E-01
0.135282E+02	0.321300E-02	0.273105E+00	0.232139E+02	0.720930E+00	0.739[illegible]98E-01
0.138465E+02	0.282[illegible]67E-02	0.246007E+00	0.214026E+02	0.664678E+00	0.722[illegible]05E-01
0.141648E+02	0.266[illegible]65E-02	0.237065E+00	0.210988E+02	0.655242E+00	0.705[illegible]75E-01
0.144831E+02	0.250617E-02	0.228061E+00	0.207536E+02	0.644521E+00	0.690460E-01
0.148014E+02	0.230369E-02	0.214243E+00	0.199246E+02	0.618778E+00	0.675611E-01
0.151197E+02	0.221963E-02	0.213865E+00	0.200321E+02	0.622116E+00	0.661387E-01
0.154380E+02	0.204987E-02	0.198837E+00	0.192872E+02	0.598983E+00	0.647750E-01
0.157563E+02	0.196324E-02	0.194361E+00	0.192417E+02	0.597569E+00	0.634665E-01
0.160746E+02	0.183861E-02	0.185700E+00	0.187557E+02	0.582474E+00	0.622098E-01
0.163930E+02	0.172715E-02	0.177897E+00	0.183234E+02	0.569049E+00	0.610018E-01
0.167113E+02	0.165103E-02	0.173358E+00	0.182026E+02	0.565299E+00	0.598399E-01
0.170296E+02	0.156760E-02	0.167733E+00	0.179475E+02	0.557375E+00	0.587214E-01
0.173479E+02	0.148814E-02	0.162207E+00	0.176806E+02	0.549086E+00	0.576439E-01
0.176662E+02	0.143686E-02	0.159491E+00	0.177035E+02	0.549798E+00	0.566053E-01
0.179845E+02	0.139138E-02	0.157226E+00	0.177665E+02	0.551756E+00	0.556034E-01
0.183028E+02	0.133973E-02	0.154069E+00	0.177179E+02	0.550246E+00	0.546364E-01
0.186211E+02	0.128433E-02	0.150266E+00	0.175812E+02	0.545999E+00	0.537024E-01
0.189394E+02	0.121836E-02	0.144985E+00	0.172533E+02	0.535815E+00	0.527999E-01
0.192577E+02	0.117298E-02	0.141931E+00	0.171737E+02	0.533344E+00	0.519271E-01
0.195760E+02	0.113181E-02	0.139213E+00	0.171232E+02	0.531775E+00	0.510828E-01
0.198944E+02	0.110617E-02	0.135271E+00	0.172838E+02	0.536766E+00	0.502655E-01
0.202127E+02	0.104586E-02	0.132824E+00	0.168686E+02	0.523870E+00	0.494739E-01
0.205310E+02	0.100382E-02	0.129493E+00	0.167046E+02	0.518778E+00	0.487069E-01
0.208493E+02	0.968358E-03	0.12[illegible]855E+00	0.166180E+02	0.516087E+00	0.479632E-01
0.211676E+02	0.934930E-03	0.124346E+00	0.165380E+02	0.513602E+00	0.472420E-01
0.214859E+02	0.903639E-03	0.121991E+00	0.164688E+02	0.511454E+00	0.465421E-01
0.218042E+02	0.873875E-03	0.119721E+00	0.164017E+02	0.509372E+00	0.458627E-01
0.221225E+02	0.845985E-03	0.117592E+00	0.163453E+02	0.507617E+00	0.452028E-01
0.224408E+02	0.818486E-03	0.115406E+00	0.162723E+02	0.505352E+00	0.445616E-01
0.227592E+02	0.793009E-03	0.113400E+00	0.162162E+02	0.503611E+00	0.439384E-01
0.230775E+02	0.768733E-03	0.111466E+00	0.161626E+02	0.501944E+00	0.433323E-01
0.233958E+02	0.745534E-03	0.109594E+00	0.161103E+02	0.500319E+00	0.427428E-01
0.237141E+02	0.723468E-03	0.107797E+00	0.160617E+02	0.498811E+00	0.421690E-01
0.240324E+02	0.702346E-03	0.106054E+00	0.160142E+02	0.497336E+00	0.416105E-01
0.243507E+02	0.682160E-03	0.104370E+00	0.159687E+02	0.495922E+00	0.410666E-01
0.246690E+02	0.662987E-03	0.102763E+00	0.159283E+02	0.494667E+00	0.405367E-01
0.249873E+02	0.644644E-03	0.101209E+00	0.158898E+02	0.493474E+00	0.400203E-01
0.253056E+02	0.627069E-03	0.997039E-01	0.158529E+02	0.492327E+00	0.395169E-01
0.256239E+02	0.610234E-03	0.982476E-01	0.158179E+02	0.491238E+00	0.390260E-01
0.259422E+02	0.594077E-03	0.968345E-01	0.1578[illegible]0E+02	0.490188E+00	0.385471E-01
0.262606E+02	0.578605E-03	0.954698E-01	0.157525E+02	0.489209E+00	0.380799E-01
0.265789E+02	0.563729E-03	0.941427E-01	0.157218E+02	0.488256E+00	0.376239E-01
0.268972E+02	0.549428E-03	0.928533E-01	0.156922E+02	0.487336E+00	0.371786E-01
0.272155E+02	0.535691E-03	0.916032E-01	0.156642E+02	0.486465E+00	0.367438E-01
0.275338E+02	0.522456E-03	0.903848E-01	0.156366E+02	0.485609E+00	0.363190E-01
0.278521E+02	0.509722E-03	0.892013E-01	0.156103E+02	0.484791E+00	0.359039E-01

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FREQUENCY	PSEUDO DISPLACEMENT	PSEUDO VELOCITY	TRUE ACCELERATION	TRUE G	PERIOD
0.281704E+02	0.497460E-03	0.883504E-01	0.155649E+02	0.484004E+00	0.354982E-01
0.284887E+02	0.485640E-03	0.869296E-01	0.155604E+02	0.483243E+00	0.351016E-01
0.288070E+02	0.474252E-03	0.858395E-01	0.155370E+02	0.482515E+00	0.347137E-01
0.291254E+02	0.463269E-03	0.847782E-01	0.155144E+02	0.481815E+00	0.343343E-01
0.294437E+02	0.452665E-03	0.837429E-01	0.154925E+02	0.481132E+00	0.339632E-01
0.297620E+02	0.442431E-03	0.827345E-01	0.154714E+02	0.480478E+00	0.335999E-01
0.300803E+02	0.432641E-03	0.817690E-01	0.154544E+02	0.479949E+00	0.332444E-01
0.303986E+02	0.423088E-03	0.808098E-01	0.154347E+02	0.479338E+00	0.328963E-01
0.307169E+02	0.413856E-03	0.798742E-01	0.154157E+02	0.478750E+00	0.325554E-01
0.310352E+02	0.404925E-03	0.789604E-01	0.153973E+02	0.478177E+00	0.322215E-01
0.313535E+02	0.396287E-03	0.780686E-01	0.153795E+02	0.477625E+00	0.318943E-01
0.316718E+02	0.387927E-03	0.771974E-01	0.153623E+02	0.477090E+00	0.315738E-01
0.319901E+02	0.379830E-03	0.763457E-01	0.153455E+02	0.476569E+00	0.312596E-01
0.323084E+02	0.371994E-03	0.755147E-01	0.153295E+02	0.476071E+00	0.309516E-01
0.326268E+02	0.364398E-03	0.747016E-01	0.153138E+02	0.475585E+00	0.306497E-01
0.329451E+02	0.357034E-03	0.739061E-01	0.152986E+02	0.475111E+00	0.303535E-01
0.332634E+02	0.349898E-03	0.731287E-01	0.152839E+02	0.474656E+00	0.300631E-01

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RESULTS OF LATEST ANALYSIS

PROBLEM - CATAWBA   TITLE - TRANSIENT ANALYSIS OF CATAWBA STICK MODEL

ACTIVE UNITS FEET LB CYC. FAHR SEC LBM

VERTICAL SPECTRUM AT BASE
DUE TO 4-TIME HISTORIES
" SPECTRUM I "

SPECTRUM IDENT VERTEQ
SPECTRUM FROM JOINT 1 YT TOT
COMBINED TRANSIENTS PEAK
DAMPING = 0.010

FREQUENCY	PSEUDO DISPLACEMENT	PSEUDO VELOCITY	TRUE ACCELERATION	TRUE G	PERIOD
0.159155E+00	0.281422E+00	0.281422E+00	0.281422E+00	0.873983E-02	0.628319E+01
0.183026E+00	0.306694E+00	0.351697E+00	0.405602E+00	0.125963E-01	0.546364E+01
0.206901E+00	0.371002E+00	0.482302E+00	0.626992E+00	0.194718E-01	0.483322E+01
0.230775E+00	0.431234E+00	0.626160E+00	0.907932E+00	0.281966E-01	0.433323E+01
0.254648E+00	0.449438E+00	0.719100E+00	0.115056E+01	0.357317E-01	0.392699E+01
0.278521E+00	0.470967E+00	0.824192E+00	0.144234E+01	0.447930E-01	0.359039E+01
0.302399E+00	0.557722E+00	0.105967E+01	0.201338E+01	0.625272E-01	0.330694E+01
0.326267E+00	0.576118E+00	0.111104E+01	0.242113E+01	0.751905E-01	0.306497E+01
0.350141E+00	0.549028E+00	0.120786E+01	0.265729E+01	0.825247E-01	0.285599E+01
0.374014E+00	0.498884E+00	0.117238E+01	0.275508E+01	0.855616E-01	0.267370E+01
0.397887E+00	0.478652E+00	0.119663E+01	0.299157E+01	0.929060E-01	0.251327E+01
0.421760E+00	0.437085E+00	0.115828E+01	0.306943E+01	0.953240E-01	0.237101E+01
0.445634E+00	0.402215E+00	0.112788E+01	0.315807E+01	0.980768E-01	0.224399E+01
0.469507E+00	0.383660E+00	0.113180E+01	0.333880E+01	0.103689E+00	0.212989E+01
0.493380E+00	0.369745E+00	0.114621E+01	0.355325E+01	0.110350E+00	0.202683E+01
0.517253E+00	0.351832E+00	0.114345E+01	0.371623E+01	0.115411E+00	0.193329E+01
0.541127E+00	0.325342E+00	0.110616E+01	0.376096E+01	0.116800E+00	0.184800E+01
0.565000E+00	0.303104E+00	0.107602E+01	0.381986E+01	0.118629E+00	0.176991E+01
0.588873E+00	0.281322E+00	0.104089E+01	0.385130E+01	0.119606E+00	0.169816E+01
0.612746E+00	0.273084E+00	0.105137E+01	0.404779E+01	0.125708E+00	0.163200E+01
0.636620E+00	0.264179E+00	0.105672E+01	0.422687E+01	0.131269E+00	0.157080E+01
0.684366E+00	0.222662E+00	0.957445E+00	0.411701E+01	0.127858E+00	0.146121E+01
0.732113E+00	0.189852E+00	0.873319E+00	0.401727E+01	0.124760E+00	0.136591E+01
0.779859E+00	0.188232E+00	0.922337E+00	0.451945E+01	0.140356E+00	0.128228E+01
0.827606E+00	0.190550E+00	0.990859E+00	0.515247E+01	0.160014E+00	0.120830E+01
0.875352E+00	0.180640E+00	0.993522E+00	0.546437E+01	0.169701E+00	0.114240E+01
0.923099E+00	0.178780E+00	0.103693E+01	0.601417E+01	0.186776E+00	0.108331E+01
0.970845E+00	0.165806E+00	0.101141E+01	0.616963E+01	0.191603E+00	0.103003E+01
0.101859E+01	0.173302E+00	0.110913E+01	0.709845E+01	0.220449E+00	0.981748E+00
0.106634E+01	0.196859E+00	0.131896E+01	0.883701E+01	0.274441E+00	0.937789E+00
0.111408E+01	0.191311E+00	0.133917E+01	0.937422E+01	0.291125E+00	0.897598E+00
0.116183E+01	0.194793E+00	0.142199E+01	0.103805E+02	0.322376E+00	0.860710E+00
0.120958E+01	0.183714E+00	0.139622E+01	0.106113E+02	0.329544E+00	0.826735E+00
0.125732E+01	0.169995E+00	0.134296E+01	0.106094E+02	0.329484E+00	0.795340E+00

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FREQUENCY	PSEUDO DISPLACEMENT	PSEUDO VELOCITY	TRUE ACCELERATION	TRUE G	PERIOD
0.130507E+01	0.144089E+00	0.111153E+01	0.968852E+01	0.300886E+00	0.766242E+00
0.135282E+01	0.133248E+00	0.113261E+01	0.962718E+01	0.298981E+00	0.739198E+00
0.140056E+01	0.120[illegible]8E+00	0.10[illegible]205E+01	0.934609E+01	0.290251E+00	0.713[illegible]8E+00
0.144831E+01	0.120196E+00	0.109378E+01	0.995341E+01	0.309112E+00	0.690[illegible]0E+00
0.149606E+01	0.119670E+00	0.112490E+01	0.105740E+02	0.328386E+00	0.668424E+00
0.154380E+01	0.124953E+00	0.121204E+01	0.117568E+02	0.365118E+00	0.647751E+00
0.159155E+01	0.116650E+00	0.116650E+01	0.116650E+02	0.362266E+00	0.628319E+00
0.163930E+01	0.110455E+00	0.113769E+01	0.117182E+02	0.363919E+00	0.610018E+00
0.168704E+01	0.103919E+00	0.111154E+01	0.116763E+02	0.362619E+00	0.592753E+00
0.173479E+01	0.985022E-01	0.107367E+01	0.117031E+02	0.363449E+00	0.576439E+00
0.178253E+01	0.104155E+00	0.116654E+01	0.130653E+02	0.405753E+00	0.560999E+00
0.183028E+01	0.106812E+00	0.122833E+01	0.141258E+02	0.438691E+00	0.546364E+00
0.187803E+01	0.112182E+00	0.132374E+01	0.156202E+02	0.485099E+00	0.532473E+00
0.192577E+01	0.107604E+00	0.133201E+01	0.157543E+02	0.489264E+00	0.519272E+00
0.197352E+01	0.102100E+00	0.126604E+01	0.156989E+02	0.487545E+00	0.506709E+00
0.202127E+01	0.957513E-01	0.121604E+01	0.154438E+02	0.479620E+00	0.499739E+00
0.206901E+01	0.859507E-01	0.111736E+01	0.145257E+02	0.451108E+00	0.483322E+00
0.211676E+01	0.732109E-01	0.973705E+00	0.129513E+02	0.402183E+00	0.472420E+00
0.216451E+01	0.675805E-01	0.919094E+00	0.124997E+02	0.388189E+00	0.461999E+00
0.221225E+01	0.689588E-01	0.955527E+00	0.133235E+02	0.413774E+00	0.452028E+00
0.226000E+01	0.789999E-01	0.112180E+01	0.159295E+02	0.494706E+00	0.442478E+00
0.230775E+01	0.756350E-01	0.109671E+01	0.159023E+02	0.493860E+00	0.433323E+00
0.235549E+01	0.696978E-01	0.103153E+01	0.152666E+02	0.474119E+00	0.424540E+00
0.240324E+01	0.687469E-01	0.103808E+01	0.156750E+02	0.486801E+00	0.416105E+00
0.245098E+01	0.670043E-01	0.103187E+01	0.158908E+02	0.493502E+00	0.407999E+00
0.249873E+01	0.630074E-01	0.989215E+00	0.155307E+02	0.482320E+00	0.400203E+00
0.254648E+01	0.596541E-01	0.954466E+00	0.152715E+02	0.474269E+00	0.392699E+00
0.259422E+01	0.564701E-01	0.920464E+00	0.150036E+02	0.465949E+00	0.385472E+00
0.264197E+01	0.560776E-01	0.930887E+00	0.154527E+02	0.479898E+00	0.378505E+00
0.268972E+01	0.571543E-01	0.965907E+00	0.163238E+02	0.506951E+00	0.371786E+00
0.273746E+01	0.525697E-01	0.904199E+00	0.155522E+02	0.482988E+00	0.365301E+00
0.278521E+01	0.540222E-01	0.945387E+00	0.165443E+02	0.513797E+00	0.359039E+00
0.283296E+01	0.529896E-01	0.943213E+00	0.167892E+02	0.521403E+00	0.352988E+00
0.288070E+01	0.478342E-01	0.865798E+00	0.156709E+02	0.486675E+00	0.347137E+00
0.292845E+01	0.427018E-01	0.785713E+00	0.144571E+02	0.448979E+00	0.341478E+00
0.297620E+01	0.384239E-01	0.718527E+00	0.134364E+02	0.417281E+00	0.335999E+00
0.302394E+01	0.370821E-01	0.704559E+00	0.133866E+02	0.415734E+00	0.330694E+00
0.307169E+01	0.371789E-01	0.717552E+00	0.138488E+02	0.430086E+00	0.325554E+00
0.311944E+01	0.378913E-01	0.742669E+00	0.145563E+02	0.452059E+00	0.320571E+00
0.316718E+01	0.385973E-01	0.765085E+00	0.152849E+02	0.474686E+00	0.315738E+00
0.318310E+01	0.377310E-01	0.754621E+00	0.150924E+02	0.468709E+00	0.314159E+00
0.334225E+01	0.332824E-01	0.695930E+00	0.146775E+02	0.455824E+00	0.299199E+00
0.350141E+01	0.291257E-01	0.640765E+00	0.140968E+02	0.437790E+00	0.285599E+00
0.366056E+01	0.281856E-01	0.648273E+00	0.149102E+02	0.463050E+00	0.273182E+00
0.381972E+01	0.205032E-01	0.492077E+00	0.118099E+02	0.366766E+00	0.261799E+00
0.397887E+01	0.199492E-01	0.498731E+00	0.124683E+02	0.387214E+00	0.251327E+00
0.413803E+01	0.221413E-01	0.575674E+00	0.149675E+02	0.464830E+00	0.241661E+00

FOR INFORMATION ONLY

FREQUENCY	PSEUDO DISPLACEMENT	PSEUDO VELOCITY	TRUE ACCELERATION	TRUE G	PERIOD
0.429718E+01	0.178001E-01	0.480603E+00	0.129763E+02	0.402990E+00	0.232711E+00
0.445634E+01	0.176729E-01	0.494869E+00	0.138563E+02	0.430321E+00	0.224389E+00
0.461549E+01	0.154144E-01	0.447134E+00	0.129669E+02	0.402698E+00	0.216662E+00
0.477465E+01	0.180245E-01	0.543736E+00	0.162221E+02	0.503792E+00	0.209449E+00
0.493380E+01	0.149354E-01	0.462996E+00	0.143529E+02	0.445742E+00	0.202683E+00
0.509296E+01	0.136667E-01	0.437333E+00	0.139947E+02	0.434617E+00	0.196350E+00
0.525211E+01	0.145480E-01	0.463083E+00	0.158428E+02	0.492011E+00	0.190400E+00
0.541127E+01	0.125357E-01	0.426213E+00	0.144912E+02	0.450038E+00	0.184800E+00
0.557042E+01	0.107902E-01	0.377657E+00	0.132180E+02	0.410497E+00	0.179520E+00
0.572958E+01	0.107400E-01	0.385442E+00	0.139839E+02	0.434283E+00	0.174533E+00
0.588873E+01	0.115465E-01	0.422222E+00	0.158072E+02	0.490907E+00	0.169816E+00
0.604789E+01	0.974735E-02	0.373399E+00	0.140752E+02	0.437117E+00	0.165347E+00
0.620704E+01	0.844909E-02	0.329515E+00	0.128511E+02	0.399102E+00	0.161107E+00
0.636620E+01	0.921695E-02	0.365678E+00	0.147471E+02	0.457986E+00	0.157080E+00
0.652535E+01	0.795374E-02	0.326103E+00	0.133702E+02	0.415225E+00	0.153248E+00
0.668451E+01	0.768341E-02	0.322703E+00	0.135535E+02	0.420918E+00	0.149600E+00
0.684366E+01	0.779610E-02	0.335233E+00	0.144350E+02	0.447671E+00	0.146121E+00
0.700282E+01	0.676614E-02	0.297710E+00	0.130993E+02	0.406809E+00	0.142800E+00
0.716197E+01	0.655902E-02	0.295156E+00	0.132620E+02	0.412486E+00	0.139626E+00
0.732113E+01	0.623693E-02	0.286899E+00	0.131974E+02	0.409856E+00	0.136591E+00
0.748028E+01	0.613165E-02	0.285188E+00	0.135448E+02	0.420647E+00	0.133685E+00
0.763944E+01	0.488861E-02	0.234653E+00	0.112633E+02	0.349793E+00	0.130900E+00
0.779859E+01	0.448144E-02	0.219591E+00	0.107599E+02	0.334160E+00	0.128228E+00
0.795775E+01	0.474739E-02	0.237370E+00	0.118685E+02	0.368586E+00	0.125664E+00
0.811690E+01	0.485283E-02	0.247494E+00	0.126222E+02	0.391994E+00	0.123200E+00
0.827606E+01	0.476242E-02	0.247646E+00	0.128776E+02	0.399925E+00	0.120830E+00
0.843521E+01	0.442593E-02	0.234574E+00	0.124324E+02	0.386101E+00	0.118551E+00
0.859437E+01	0.396917E-02	0.214335E+00	0.115741E+02	0.359945E+00	0.116355E+00
0.875352E+01	0.346706E-02	0.193686E+00	0.104879E+02	0.325710E+00	0.114240E+00
0.891268E+01	0.355274E-02	0.199953E+00	0.111414E+02	0.346006E+00	0.112200E+00
0.907183E+01	0.362840E-02	0.20[illegible]818E+00	0.117887E+02	0.366108E+00	0.110231E+00
0.923099E+01	0.336622E-02	0.195241E+00	0.113240E+02	0.351676E+00	0.108331E+00
0.939014E+01	0.275895E-02	0.162778E+00	0.960390E+01	0.298258E+00	0.106495E+00
0.954930E+01	0.259835E-02	0.155901E+00	0.935405E+01	0.290498E+00	0.104720E+00
0.970845E+01	0.240122E-02	0.146474E+00	0.893493E+01	0.277483E+00	0.103003E+00
0.986761E+01	0.241507E-02	0.149734E+00	0.928353E+01	0.288308E+00	0.101342E+00
0.100268E+02	0.238460E-02	0.150230E+00	0.946447E+01	0.293928E+00	0.997331E-01
0.101859E+02	0.211070E-02	0.135085E+00	0.864545E+01	0.268492E+00	0.981748E-01
0.103451E+02	0.210750E-02	0.136988E+00	0.890421E+01	0.276528E+00	0.966644E-01
0.106634E+02	0.167655E-02	0.112329E+00	0.752604E+01	0.233728E+00	0.937788E-01
0.109817E+02	0.193701E-02	0.133654E+00	0.922211E+01	0.286401E+00	0.910606E-01
0.113000E+02	0.162593E-02	0.115441E+00	0.819631E+01	0.254544E+00	0.884956E-01
0.116183E+02	0.147139E-02	0.107412E+00	0.784106E+01	0.243511E+00	0.860710E-01
0.119366E+02	0.139903E-02	0.104927E+00	0.786952E+01	0.244395E+00	0.837758E-01
0.122549E+02	0.126315E-02	0.972624E-01	0.748921E+01	0.232584E+00	0.815998E-01
0.125732E+02	0.119148E-02	0.941271E-01	0.743604E+01	0.230933E+00	0.795339E-01
0.128916E+02	0.110294E-02	0.593379E-01	0.723638E+01	0.224732E+00	0.775701E-01

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FREQUENCY	PSEUDO DISPLACEMENT	PSEUDO VELOCITY	TRUE ACCELERATION	TRUE G	PERIOD
0.132099E+02	0.973336E-03	0.807869E-01	0.670531E+01	0.208240E+00	0.757010E-01
0.135282E+02	0.865731E-03	0.735872E-01	0.625491E+01	0.194252E+00	0.739198E-01
0.138465E+02	0.77[illegible]930E-03	0.675929E-01	0.588058E+01	0.182627E+00	0.722205E-01
0.141648E+02	0.72[illegible]533E-03	0.643945E-01	0.573111E+01	0.177985E+00	0.705975E-01
0.144831E+02	0.707196E-03	0.643548E-01	0.585629E+01	0.181872E+00	0.690460E-01
0.148014E+02	0.584204E-03	0.543310E-01	0.505278E+01	0.156919E+00	0.675611E-01
0.151197E+02	0.506045E-03	0.480743E-01	0.456706E+01	0.141834E+00	0.661387E-01
0.154380E+02	0.477050E-03	0.462739E-01	0.448857E+01	0.139397E+00	0.647750E-01
0.157563E+02	0.427369E-03	0.423096E-01	0.418865E+01	0.130082E+00	0.634665E-01
0.160746E+02	0.396891E-03	0.403660E-01	0.404869E+01	0.125736E+00	0.622098E-01
0.163930E+02	0.368105E-03	0.379140E-01	0.390523E+01	0.121280E+00	0.610018E-01
0.167113E+02	0.351038E-03	0.368591E-01	0.387020E+01	0.120193E+00	0.598397E-01
0.170296E+02	0.333841E-03	0.357211E-01	0.382215E+01	0.118700E+00	0.587264E-01
0.173479E+02	0.317775E-03	0.346375E-01	0.377549E+01	0.117251E+00	0.576439E-01
0.176662E+02	0.313342E-03	0.353030E-01	0.388533E+01	0.120662E+00	0.566053E-01
0.179845E+02	0.303559E-03	0.340762E-01	0.385061E+01	0.119584E+00	0.556034E-01
0.183028E+02	0.288530E-03	0.331809E-01	0.381581E+01	0.118503E+00	0.546364E-01
0.186211E+02	0.277491E-03	0.324654E-01	0.374857E+01	0.117968E+00	0.537023E-01
0.189394E+02	0.271478E-03	0.323059E-01	0.384440E+01	0.119391E+00	0.527994E-01
0.192577E+02	0.259361E-03	0.313851E-01	0.379760E+01	0.117938E+00	0.519271E-01
0.195760E+02	0.252354E-03	0.313395E-01	0.381786E+01	0.118567E+00	0.510828E-01
0.198944E+02	0.241266E-03	0.301583E-01	0.376978E+01	0.117074E+00	0.502655E-01
0.202127E+02	0.230610E-03	0.292875E-01	0.371951E+01	0.115513E+00	0.494739E-01
0.205310E+02	0.221037E-03	0.285138E-01	0.367828E+01	0.114232E+00	0.487069E-01
0.208493E+02	0.213500E-03	0.279685E-01	0.366388E+01	0.113785E+00	0.479632E-01
0.211676E+02	0.206662E-03	0.274861E-01	0.365565E+01	0.113530E+00	0.472420E-01
0.214859E+02	0.200223E-03	0.273301E-01	0.364907E+01	0.113325E+00	0.465421E-01
0.218042E+02	0.194153E-03	0.265989E-01	0.364406E+01	0.113169E+00	0.458627E-01
0.221225E+02	0.188363E-03	0.261824E-01	0.363936E+01	0.113024E+00	0.452028E-01
0.224408E+02	0.182821E-03	0.257777E-01	0.363466E+01	0.112878E+00	0.445616E-01
0.227592E+02	0.177562E-03	0.253642E-01	0.362994E+01	0.112731E+00	0.439384E-01
0.230775E+02	0.172426E-03	0.250018E-01	0.362524E+01	0.112586E+00	0.433323E-01
0.233958E+02	0.167545E-03	0.246320E-01	0.362093E+01	0.112451E+00	0.427428E-01
0.237141E+02	0.162924E-03	0.242756E-01	0.361707E+01	0.112331E+00	0.421690E-01
0.240324E+02	0.158466E-03	0.239084E-01	0.361319E+01	0.112211E+00	0.416105E-01
0.243507E+02	0.154188E-03	0.235906E-01	0.360939E+01	0.112093E+00	0.410666E-01
0.246690E+02	0.150097E-03	0.232651E-01	0.360609E+01	0.111990E+00	0.405367E-01
0.249873E+02	0.146172E-03	0.229430E-01	0.360300E+01	0.111894E+00	0.400203E-01
0.253056E+02	0.142394E-03	0.226407E-01	0.359987E+01	0.111797E+00	0.395169E-01
0.256239E+02	0.138766E-03	0.223412E-01	0.359694E+01	0.111706E+00	0.390260E-01
0.259422E+02	0.135276E-03	0.220500E-01	0.359415E+01	0.111620E+00	0.385471E-01
0.262606E+02	0.131903E-03	0.217639E-01	0.359105E+01	0.111523E+00	0.380799E-01
0.265789E+02	0.128661E-03	0.214864E-01	0.358824E+01	0.111436E+00	0.376239E-01
0.268972E+02	0.125551E-03	0.212182E-01	0.358588E+01	0.111363E+00	0.371786E-01
0.272155E+02	0.122555E-03	0.209562E-01	0.358351E+01	0.111289E+00	0.367438E-01
0.275338E+02	0.119646E-03	0.206983E-01	0.358087E+01	0.111207E+00	0.363190E-01
0.278521E+02	0.116855E-03	0.204437E-01	0.357870E+01	0.111140E+00	0.359039E-01

FOR INFORMATION ONLY

FREQUENCY	PSEUDO DISPLACEMENT	PSEUDO VELOCITY	TRUE ACCELERATION	TRUE G	PERIOD
0.281704E+02	0.114159E-03	0.202062E-01	0.357650E+01	0.111072E+00	0.354982E-01
0.284887E+02	0.1115[illegible]9E-03	0.199709E-01	0.357479E+01	0.111018E+00	0.3510[illegible]6E-01
0.288070E+02	0.1090[illegible]1E-03	0.197400E-01	0.357294E+01	0.110961E+00	0.3471[illegible]7E-01
0.291254E+02	0.106632E-03	0.195137E-01	0.357100E+01	0.110901E+00	0.3433[illegible]3E-01
0.294437E+02	0.104282E-03	0.192922E-01	0.356905E+01	0.110840E+00	0.339632E-01
0.297620E+02	0.102010E-03	0.190758E-01	0.356718E+01	0.110782E+00	0.335999E-01
0.300803E+02	0.998407E-04	0.188699E-01	0.356641E+01	0.110758E+00	0.332444E-01
0.303986E+02	0.977120E-04	0.186630E-01	0.356963E+01	0.110703E+00	0.328963E-01
0.307169E+02	0.956556E-04	0.184615E-01	0.356308E+01	0.110655E+00	0.325559E-01
0.310352E+02	0.936645E-04	0.182646E-01	0.356159E+01	0.110608E+00	0.322215E-01
0.313535E+02	0.917359E-04	0.180720E-01	0.356[illegible]18E+01	0.110565E+00	0.318943E-01
0.316718E+02	0.898698E-04	0.178841E-01	0.355893E+01	0.110526E+00	0.315738E-01
0.319901E+02	0.880608E-04	0.177002E-01	0.355774E+01	0.110489E+00	0.312596E-01
0.323084E+02	0.862985E-04	0.175186E-01	0.355627E+01	0.110443E+00	0.309516E-01
0.326268E+02	0.845885E-04	0.173406E-01	0.355483E+01	0.110399E+00	0.306497E-01
0.329451E+02	0.829314E-04	0.171668E-01	0.355353E+01	0.110358E+00	0.303535E-01
0.332634E+02	0.813233E-04	0.169966E-01	0.355228E+01	0.110319E+00	0.300631E-01

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RESULTS OF LATEST ANALYSIS

PROBLEM - CATAWBA   TITLE - TRANSIENT ANALYSIS OF CATAWBA STICK MODEL

ACTIVE UNITS FEET LB CYC. FAHR SEC LBM

VERTICAL SPECTRUM AT TOP OF DOME DUE TO TIME HISTORIES

"SPECTRUM N"

SPECTRUM IDENT VERTEQ
SPECTRUM FROM JOINT 20 YT TOT
COMBINED TRANSIENTS PEAK
DAMPING = 0.010

FREQUENCY	PSEUDO DISPLACEMENT	PSEUDO VELOCITY	TRUE ACCELERATION	TRUE G	PERIOD
0.159155E+00	0.281608E+00	0.281608E+00	0.281608E+00	0.874559E-02	0.628319E+01
0.183028E+00	0.306793E+00	0.352812E+00	0.405733E+00	0.126004E-01	0.546364E+01
0.206901E+00	0.371097E+00	0.482426E+00	0.627154E+00	0.194768E-01	0.483322E+01
0.230775E+00	0.432000E+00	0.626399E+00	0.906279E+00	0.282074E-01	0.433323E+01
0.254648E+00	0.449595E+00	0.719351E+00	0.115096E+01	0.357442E-01	0.392699E+01
0.278521E+00	0.471117E+00	0.824455E+00	0.144279E+01	0.448073E-01	0.359039E+01
0.302394E+00	0.557900E+00	0.106001E+01	0.201402E+01	0.625471E-01	0.330694E+01
0.326267E+00	0.576319E+00	0.115145E+01	0.242198E+01	0.752167E-01	0.306497E+01
0.350141E+00	0.549226E+00	0.120830E+01	0.265825E+01	0.825594E-01	0.285599E+01
0.374014E+00	0.499123E+00	0.117294E+01	0.275640E+01	0.856026E-01	0.267370E+01
0.397887E+00	0.478923E+00	0.119731E+01	0.299327E+01	0.929586E-01	0.251327E+01
0.421760E+00	0.437301E+00	0.115665E+01	0.307094E+01	0.953709E-01	0.237101E+01
0.445634E+00	0.403046E+00	0.112853E+01	0.315988E+01	0.981328E-01	0.224399E+01
0.469507E+00	0.383919E+00	0.113256E+01	0.334105E+01	0.103759E+00	0.212989E+01
0.493380E+00	0.370004E+00	0.114701E+01	0.355574E+01	0.110427E+00	0.202683E+01
0.517253E+00	0.352088E+00	0.114428E+01	0.371893E+01	0.115495E+00	0.193329E+01
0.541127E+00	0.325588E+00	0.113700E+01	0.376380E+01	0.116888E+00	0.184800E+01
0.565000E+00	0.303355E+00	0.107691E+01	0.382303E+01	0.118728E+00	0.176991E+01
0.588873E+00	0.281610E+00	0.104196E+01	0.385524E+01	0.119728E+00	0.169816E+01
0.612746E+00	0.273353E+00	0.105241E+01	0.405178E+01	0.125832E+00	0.163200E+01
0.636620E+00	0.264460E+00	0.105784E+01	0.423136E+01	0.131409E+00	0.157080E+01
0.664366E+00	0.223008E+00	0.955933E+00	0.412341E+01	0.128056E+00	0.146121E+01
0.732113E+00	0.190111E+00	0.874508E+00	0.402274E+01	0.124930E+00	0.136591E+01
0.779859E+00	0.182554E+00	0.923914E+00	0.452718E+01	0.140596E+00	0.128228E+01
0.827606E+00	0.190905E+00	0.992707E+00	0.516208E+01	0.160313E+00	0.120830E+01
0.875352E+00	0.181021E+00	0.995614E+00	0.547588E+01	0.170058E+00	0.114240E+01
0.923099E+00	0.179219E+00	0.103947E+01	0.602892E+01	0.187234E+00	0.108331E+01
0.970845E+00	0.166191E+00	0.101377E+01	0.618397E+01	0.192049E+00	0.103003E+01
0.101859E+01	0.173771E+00	0.111213E+01	0.711767E+01	0.221046E+00	0.981748E+00
0.106634E+01	0.197473E+00	0.132307E+01	0.886457E+01	0.275297E+00	0.937789E+00
0.111408E+01	0.191966E+00	0.134376E+01	0.940632E+01	0.292122E+00	0.897598E+00
0.116183E+01	0.195477E+00	0.142698E+01	0.104170E+02	0.323508E+00	0.860710E+00
0.120958E+01	0.184487E+00	0.143210E+01	0.106560E+02	0.330931E+00	0.826735E+00
0.125732E+01	0.170674E+00	0.134832E+01	0.106518E+02	0.330800E+00	0.795340E+00

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FREQUENCY	PSEUDO DISPLACEMENT	PSEUDO VELOCITY	TRUE ACCELERATION	TRUE G	PERIOD
0.130507E+01	0.144709E+00	0.115661E+01	0.973024E+01	0.302181E+00	0.766242E+00
0.135282E+01	0.133[illegible]39E+00	0.113763E+01	0.966988E+01	0.300307E+00	0.739[illegible]98E+00
0.140056E+01	0.121[illegible]79E+00	0.106725E+01	0.939184E+01	0.291672E+00	0.713[illegible]98E+00
0.144831E+01	0.120857E+00	0.109980E+01	0.100082E+02	0.310813E+00	0.690460E+00
0.149606E+01	0.120373E+00	0.113150E+01	0.106361E+02	0.330315E+00	0.668424E+00
0.154380E+01	0.125724E+00	0.121952E+01	0.118294E+02	0.367371E+00	0.647751E+00
0.159155E+01	0.117419E+00	0.117419E+01	0.117419E+02	0.364656E+00	0.628319E+00
0.163930E+01	0.111213E+00	0.114549E+01	0.117986E+02	0.366416E+00	0.610018E+00
0.168704E+01	0.104713E+00	0.110995E+01	0.117655E+02	0.365389E+00	0.592753E+00
0.173479E+01	0.992377E-01	0.108169E+01	0.117904E+02	0.366163E+00	0.576439E+00
0.178253E+01	0.104998E+00	0.117598E+01	0.131710E+02	0.409037E+00	0.560999E+00
0.183028E+01	0.107715E+00	0.123872E+01	0.142453E+02	0.442400E+00	0.546364E+00
0.187803E+01	0.113154E+00	0.133521E+01	0.157555E+02	0.489302E+00	0.532473E+00
0.192577E+01	0.108607E+00	0.131414E+01	0.159011E+02	0.493824E+00	0.519272E+00
0.197352E+01	0.103081E+00	0.127820E+01	0.158497E+02	0.492228E+00	0.506709E+00
0.202127E+01	0.967493E-01	0.122872E+01	0.156047E+02	0.484618E+00	0.494737E+00
0.206901E+01	0.868752E-01	0.112938E+01	0.146619E+02	0.455960E+00	0.483322E+00
0.211676E+01	0.740129E-01	0.984372E+00	0.130922E+02	0.406589E+00	0.472420E+00
0.216451E+01	0.683780E-01	0.929941E+00	0.126472E+02	0.392770E+00	0.461999E+00
0.221225E+01	0.697985E-01	0.970199E+00	0.134858E+02	0.418813E+00	0.452028E+00
0.226000E+01	0.800636E-01	0.113690E+01	0.161443E+02	0.501368E+00	0.442478E+00
0.230775E+01	0.766550E-01	0.111150E+01	0.161167E+02	0.500519E+00	0.433323E+00
0.235549E+01	0.706664E-01	0.104586E+01	0.154788E+02	0.480707E+00	0.424540E+00
0.240324E+01	0.697633E-01	0.105343E+01	0.159067E+02	0.493998E+00	0.416105E+00
0.245098E+01	0.680391E-01	0.104780E+01	0.161362E+02	0.501123E+00	0.407999E+00
0.249873E+01	0.639824E-01	0.100452E+01	0.157710E+02	0.489784E+00	0.400203E+00
0.254648E+01	0.606260E-01	0.970016E+00	0.155203E+02	0.481996E+00	0.392699E+00
0.259422E+01	0.574757E-01	0.936853E+00	0.152707E+02	0.474245E+00	0.385472E+00
0.264197E+01	0.570900E-01	0.947693E+00	0.157317E+02	0.488562E+00	0.378505E+00
0.268972E+01	0.581844E-01	0.983316E+00	0.166180E+02	0.516088E+00	0.371786E+00
0.273746E+01	0.535212E-01	0.920565E+00	0.158337E+02	0.491730E+00	0.365301E+00
0.278521E+01	0.551204E-01	0.964605E+00	0.168806E+02	0.524241E+00	0.359039E+00
0.283296E+01	0.540512E-01	0.962110E+00	0.171255E+02	0.531849E+00	0.352968E+00
0.288070E+01	0.488112E-01	0.883483E+00	0.159910E+02	0.496616E+00	0.347137E+00
0.292845E+01	0.435279E-01	0.803913E+00	0.147368E+02	0.457664E+00	0.341478E+00
0.297620E+01	0.392213E-01	0.733438E+00	0.137153E+02	0.425941E+00	0.335999E+00
0.302394E+01	0.379088E-01	0.720266E+00	0.136853E+02	0.425002E+00	0.330694E+00
0.307169E+01	0.380086E-01	0.733566E+00	0.141578E+02	0.439684E+00	0.325554E+00
0.311944E+01	0.388421E-01	0.761303E+00	0.149215E+02	0.463402E+00	0.320571E+00
0.316718E+01	0.395906E-01	0.787852E+00	0.156783E+02	0.486902E+00	0.315738E+00
0.318310E+01	0.386956E-01	0.773912E+00	0.154783E+02	0.480691E+00	0.314159E+00
0.334225E+01	0.341520E-01	0.717192E+00	0.150610E+02	0.467734E+00	0.299199E+00
0.350141E+01	0.299898E-01	0.659775E+00	0.145151E+02	0.450778E+00	0.285599E+00
0.366056E+01	0.290926E-01	0.669129E+00	0.153900E+02	0.477949E+00	0.273182E+00
0.381972E+01	0.212268E-01	0.509443E+00	0.122266E+02	0.379709E+00	0.261799E+00
0.397887E+01	0.206405E-01	0.516011E+00	0.129003E+02	0.400630E+00	0.251327E+00
0.413803E+01	0.230120E-01	0.599613E+00	0.155899E+02	0.484159E+00	0.241661E+00

FREQUENCY	PSEUDO DISPLACEMENT	PSEUDO VELOCITY	TRUE ACCELERATION	TRUE G	PERIOD
0.429718E+01	0.186216E-01	0.502782E+00	0.135751E+02	0.421588E+00	0.232711E+00
0.445634E+01	0.185563E-01	0.519583E+00	0.145483E+02	0.451811E+00	0.224399E+00
0.461549E+01	0.162024E-01	0.469876E+00	0.136264E+02	0.423180E+00	0.216662E+00
0.477465E+01	0.189886E-01	0.569658E+00	0.170897E+02	0.530737E+00	0.209439E+00
0.493380E+01	0.158918E-01	0.492645E+00	0.152720E+02	0.474285E+00	0.202683E+00
0.509296E+01	0.145836E-01	0.466677E+00	0.149337E+02	0.463778E+00	0.196350E+00
0.525211E+01	0.155612E-01	0.513519E+00	0.169461E+02	0.526278E+00	0.190400E+00
0.541127E+01	0.134443E-01	0.457106E+00	0.155416E+02	0.482650E+00	0.184800E+00
0.557042E+01	0.116771E-01	0.409698E+00	0.143044E+02	0.444237E+00	0.179520E+00
0.572958E+01	0.116926E-01	0.420933E+00	0.151536E+02	0.470608E+00	0.174533E+00
0.588873E+01	0.125363E-01	0.463843E+00	0.171622E+02	0.532987E+00	0.169816E+00
0.604789E+01	0.105967E-01	0.402674E+00	0.153016E+02	0.475206E+00	0.165347E+00
0.620704E+01	0.927387E-02	0.361681E+00	0.141056E+02	0.438061E+00	0.161107E+00
0.636620E+01	0.101595E-01	0.406380E+00	0.162552E+02	0.504820E+00	0.157080E+00
0.652535E+01	0.880236E-02	0.360897E+00	0.147968E+02	0.459528E+00	0.153248E+00
0.668451E+01	0.857241E-02	0.360042E+00	0.151217E+02	0.469620E+00	0.149600E+00
0.684366E+01	0.868060E-02	0.373266E+00	0.160504E+02	0.498461E+00	0.146121E+00
0.700282E+01	0.763857E-02	0.336097E+00	0.147883E+02	0.459264E+00	0.142800E+00
0.716197E+01	0.742197E-02	0.333989E+00	0.150295E+02	0.466755E+00	0.139626E+00
0.732113E+01	0.703611E-02	0.323661E+00	0.148884E+02	0.462379E+00	0.136591E+00
0.748028E+01	0.702092E-02	0.329984E+00	0.155092E+02	0.481653E+00	0.133685E+00
0.763944E+01	0.559381E-02	0.268503E+00	0.128881E+02	0.400253E+00	0.130900E+00
0.779859E+01	0.564602E-02	0.252155E+00	0.123556E+02	0.383714E+00	0.128228E+00
0.795775E+01	0.549296E-02	0.274648E+00	0.137324E+02	0.426473E+00	0.125664E+00
0.811690E+01	0.567359E-02	0.289353E+00	0.147570E+02	0.458293E+00	0.123200E+00
0.827606E+01	0.558445E-02	0.293391E+00	0.151004E+02	0.468955E+00	0.120830E+00
0.843521E+01	0.526406E-02	0.279995E+00	0.147268E+02	0.459216E+00	0.118551E+00
0.859437E+01	0.475239E-02	0.256629E+00	0.138580E+02	0.430372E+00	0.116355E+00
0.875352E+01	0.411625E-02	0.226394E+00	0.124517E+02	0.386698E+00	0.114240E+00
0.891268E+01	0.427186E-02	0.239224E+00	0.133966E+02	0.416043E+00	0.112200E+00
0.907183E+01	0.439717E-02	0.250638E+00	0.142664E+02	0.443677E+00	0.110231E+00
0.923099E+01	0.406020E-02	0.235492E+00	0.136585E+02	0.424178E+00	0.108331E+00
0.939014E+01	0.333964E-02	0.197039E+00	0.116253E+02	0.361034E+00	0.106495E+00
0.954930E+01	0.318494E-02	0.196097E+00	0.114658E+02	0.356081E+00	0.104720E+00
0.970845E+01	0.294630E-02	0.179725E+00	0.109632E+02	0.340472E+00	0.103003E+00
0.986761E+01	0.296484E-02	0.183820E+00	0.113969E+02	0.353940E+00	0.101342E+00
0.100268E+02	0.300374E-02	0.189239E+00	0.119220E+02	0.370250E+00	0.997331E-01
0.101859E+02	0.265381E-02	0.169844E+00	0.108700E+02	0.337577E+00	0.981748E-01
0.103451E+02	0.266543E-02	0.173253E+00	0.112614E+02	0.349734E+00	0.966644E-01
0.106634E+02	0.206017E-02	0.138031E+00	0.924810E+01	0.287208E+00	0.937788E-01
0.109817E+02	0.253244E-02	0.174738E+00	0.120569E+02	0.374439E+00	0.910606E-01
0.113000E+02	0.210891E-02	0.149733E+00	0.106310E+02	0.330156E+00	0.884956E-01
0.116183E+02	0.195492E-02	0.142709E+00	0.104178E+02	0.323533E+00	0.860710E-01
0.119366E+02	0.191635E-02	0.143726E+00	0.107795E+02	0.334767E+00	0.837758E-01
0.122549E+02	0.171277E-02	0.131883E+00	0.101550E+02	0.315373E+00	0.815998E-01
0.125732E+02	0.169702E-02	0.134064E+00	0.105911E+02	0.328916E+00	0.795339E-01
0.128916E+02	0.158903E-02	0.125711E+00	0.104256E+02	0.323777E+00	0.775701E-01

FOR INFORMATION ONLY

FREQUENCY	PSEUDO DISPLACEMENT	PSEUDO VELOCITY	TRUE ACCELERATION	TRUE G	PERIOD
0.132099E+02	0.141707E-02	0.117617E+00	0.976221E+01	0.303174E+00	0.757010E-01
0.135282E+02	0.129193E-02	0.108814E+00	0.933420E+01	0.289882E+00	0.739198E-01
0.138465E+02	0.116[illegible]51E-02	0.103964E+00	0.878387E+01	0.272791E+00	0.72[illegible]05E-01
0.141648E+02	0.109645E-02	0.975838E-01	0.868497E+01	0.269720E+00	0.705975E-01
0.144831E+02	0.104496E-02	0.953918E-01	0.865336E+01	0.268738E+00	0.690460E-01
0.148014E+02	0.854048E-03	0.794265E-01	0.738667E+01	0.229400E+00	0.675611E-01
0.151197E+02	0.744788E-03	0.707548E-01	0.672171E+01	0.208749E+00	0.661387E-01
0.154380E+02	0.680096E-03	0.659693E-01	0.639903E+01	0.198728E+00	0.647750E-01
0.157563E+02	0.566634E-03	0.560968E-01	0.555358E+01	0.172471E+00	0.634665E-01
0.160746E+02	0.484360E-03	0.489203E-01	0.494096E+01	0.153446E+00	0.622098E-01
0.163930E+02	0.425503E-03	0.438269E-01	0.451417E+01	0.140192E+00	0.610018E-01
0.167113E+02	0.407069E-03	0.427422E-01	0.448793E+01	0.139377E+00	0.598399E-01
0.170296E+02	0.379464E-03	0.406026E-01	0.434448E+01	0.134922E+00	0.587214E-01
0.173479E+02	0.373685E-03	0.407317E-01	0.443975E+01	0.137881E+00	0.576439E-01
0.176662E+02	0.381353E-03	0.423302E-01	0.469866E+01	0.145921E+00	0.566053E-01
0.179845E+02	0.353194E-03	0.399109E-01	0.450993E+01	0.140060E+00	0.556034E-01
0.183028E+02	0.350551E-03	0.403133E-01	0.463604E+01	0.143976E+00	0.546364E-01
0.186211E+02	0.337392E-03	0.394749E-01	0.461857E+01	0.143435E+00	0.537024E-01
0.189394E+02	0.360020E-03	0.429423E-01	0.509824E+01	0.158330E+00	0.527999E-01
0.192577E+02	0.353182E-03	0.427350E-01	0.517094E+01	0.160588E+00	0.519271E-01
0.195760E+02	0.343260E-03	0.422210E-01	0.519318E+01	0.161279E+00	0.510828E-01
0.198944E+02	0.325622E-03	0.407028E-01	0.508785E+01	0.158008E+00	0.502655E-01
0.202127E+02	0.288769E-03	0.366737E-01	0.465756E+01	0.144645E+00	0.494739E-01
0.205310E+02	0.267095E-03	0.344553E-01	0.444474E+01	0.138035E+00	0.487069E-01
0.208493E+02	0.252065E-03	0.330206E-01	0.432570E+01	0.134338E+00	0.479632E-01
0.211676E+02	0.236046E-03	0.313941E-01	0.417542E+01	0.129671E+00	0.472420E-01
0.214859E+02	0.227115E-03	0.306605E-01	0.413917E+01	0.128546E+00	0.465421E-01
0.218042E+02	0.217235E-03	0.297612E-01	0.407728E+01	0.126624E+00	0.458627E-01
0.221225E+02	0.208804E-03	0.290237E-01	0.403430E+01	0.125289E+00	0.452028E-01
0.224408E+02	0.201333E-03	0.283880E-01	0.400271E+01	0.124308E+00	0.445616E-01
0.227592E+02	0.194403E-03	0.277996E-01	0.397535E+01	0.123458E+00	0.439384E-01
0.230775E+02	0.188005E-03	0.272608E-01	0.395281E+01	0.122758E+00	0.433323E-01
0.233958E+02	0.182139E-03	0.267745E-01	0.393585E+01	0.122231E+00	0.427428E-01
0.237141E+02	0.176526E-03	0.263024E-01	0.391906E+01	0.121710E+00	0.421690E-01
0.240324E+02	0.171195E-03	0.258504E-01	0.390342E+01	0.121224E+00	0.416105E-01
0.243507E+02	0.166187E-03	0.254265E-01	0.389026E+01	0.120816E+00	0.410666E-01
0.246690E+02	0.161426E-03	0.250210E-01	0.387826E+01	0.120443E+00	0.405367E-01
0.249873E+02	0.156882E-03	0.246305E-01	0.386699E+01	0.120093E+00	0.400203E-01
0.253056E+02	0.152561E-03	0.242573E-01	0.385690E+01	0.119780E+00	0.395169E-01
0.256239E+02	0.148439E-03	0.238986E-01	0.384768E+01	0.119493E+00	0.390260E-01
0.259422E+02	0.144495E-03	0.235526E-01	0.383908E+01	0.119226E+00	0.385471E-01
0.262606E+02	0.140727E-03	0.232199E-01	0.383124E+01	0.118984E+00	0.380799E-01
0.265789E+02	0.137116E-03	0.228983E-01	0.382402E+01	0.118758E+00	0.376239E-01
0.268972E+02	0.133648E-03	0.225865E-01	0.381762E+01	0.118544E+00	0.371786E-01
0.272155E+02	0.130307E-03	0.222825E-01	0.381031E+01	0.118333E+00	0.367438E-01
0.275338E+02	0.127194E-03	0.220046E-01	0.380680E+01	0.118224E+00	0.363190E-01
0.278521E+02	0.124183E-03	0.217321E-01	0.380311E+01	0.118109E+00	0.359039E-01

FREQUENCY	PSEUDO DISPLACEMENT	PSEUDO VELOCITY	TRUE ACCELERATION	TRUE G	PERIOD
0.281704E+02	0.121279E-03	0.214665E-01	0.379956E+01	0.117999E+00	0.354[illegible]2E-01
0.284887E+02	0.118[illegible]1E-03	0.213063E-01	0.379593E+01	0.117886E+00	0.351[illegible]6E-01
0.288070E+02	0.1157[illegible]6E-03	0.209536E-01	0.379261E+01	0.117783E+00	0.347[illegible]7E-01
0.291254E+02	0.113164E-03	0.207090E-01	0.378974E+01	0.117694E+00	0.343343E-01
0.294437E+02	0.110652E-03	0.204707E-01	0.378708E+01	0.117611E+00	0.339632E-01
0.297620E+02	0.108227E-03	0.202384E-01	0.378458E+01	0.117533E+00	0.335999E-01
0.300803E+02	0.105906E-03	0.201163E-01	0.378308E+01	0.117487E+00	0.332444E-01
0.303986E+02	0.103632E-03	0.197937E-01	0.378059E+01	0.117410E+00	0.328963E-01
0.307169E+02	0.101429E-03	0.195759E-01	0.377814E+01	0.117334E+00	0.325554E-01
0.310352E+02	0.992991E-04	0.193633E-01	0.377585E+01	0.117262E+00	0.322215E-01
0.313535E+02	0.972335E-04	0.191550E-01	0.377354E+01	0.117191E+00	0.318943E-01
0.316718E+02	0.952299E-04	0.189507E-01	0.377120E+01	0.117118E+00	0.315738E-01
0.319901E+02	0.932857E-04	0.187504E-01	0.376884E+01	0.117045E+00	0.312596E-01
0.323084E+02	0.914086E-04	0.185560E-01	0.376686E+01	0.116983E+00	0.309516E-01
0.326268E+02	0.895894E-04	0.183658E-01	0.376500E+01	0.116925E+00	0.306497E-01
0.329451E+02	0.878237E-04	0.181795E-01	0.376316E+01	0.116868E+00	0.303535E-01
0.332634E+02	0.861127E-04	0.179975E-01	0.376149E+01	0.116816E+00	0.300631E-01

FOR INFORMATION ONLY

COMPARE

EXTRACT

J1974A

START	JOB	1974	COMPARE	2KELLYJK	FM	NORM	D037	5.12.29	PM	23	AUG	82	R2.PR1	SYS	3034	JOB	1974	START A****
START	JOB	1974	COMPARE	2KELLYJK	FM	NORM	D037	5.12.29	PM	23	AUG	82	R2.PR1	SYS	3034	JOB	1974	START A****
START	JOB	1974	COMPARE	2KELLYJK	FM	NORM	D037	5.12.29	PM	23	AUG	82	R2.PR1	SYS	3034	JOB	1974	START A****
START	JOB	1974	COMPARE	2KELLYJK	FM	NORM	D037	5.12.29	PM	23	AUG	82	R2.PR1	SYS	3034	JOB	1974	START A****
START	JOB	1974	COMPARE	2KELLYJK	FM	NORM	D037	5.12.29	PM	23	AUG	82	R2.PR1	SYS	3034	JOB	1974	START A****
START	JOB	1974	COMPARE	2KELLYJK	FM	NORM	D037	5.12.29	PM	23	AUG	82	R2.PR1	SYS	3034	JOB	1974	START A****
START	JOB	1974	COMPARE	2KELLYJK	FM	NORM	D037	5.12.29	PM	23	AUG	82	R2.PR1	SYS	3034	JOB	1974	START A****
START	JOB	1974	COMPARE	2KELLYJK	FM	NORM	D037	5.12.29	PM	23	AUG	82	R2.PR1	SYS	3034	JOB	1974	START A****
START	JOB	1974	COMPARE	2KELLYJK	FM	NORM	D037	5.12.29	PM	23	AUG	82	R2.PR1	SYS	3034	JOB	1974	START A****
START	JOB	1974	COMPARE	2KELLYJK	FM	NORM	D037	5.12.29	PM	23	AUG	82	R2.PR1	SYS	3034	JOB	1974	START A****
START	JOB	1974	COMPARE	2KELLYJK	FM	NORM	D037	5.12.29	PM	23	AUG	82	R2.PR1	SYS	3034	JOB	1974	START A****
START	JOB	1974	COMPARE	2KELLYJK	FM	NORM	D037	5.12.29	PM	23	AUG	82	R2.PR1	SYS	3034	JOB	1974	START A****
START	JOB	1974	COMPARE	2KELLYJK	FM	NORM	D037	5.12.29	PM	23	AUG	82	R2.PR1	SYS	3034	JOB	1974	START A****
START	JOB	1974	COMPARE	2KELLYJK	FM	NORM	D037	5.12.29	PM	23	AUG	82	R2.PR1	SYS	3034	JOB	1974	START A****
START	JOB	1974	COMPARE	2KELLYJK	FM	NORM	D037	5.12.29	PM	23	AUG	82	R2.PR1	SYS	3034	JOB	1974	START A****
START	JOB	1974	COMPARE	2KELLYJK	FM	NORM	D037	5.12.29	PM	23	AUG	82	R2.PR1	SYS	3034	JOB	1974	START A****
START	JOB	1974	COMPARE	2KELLYJK	FM	NORM	D037	5.12.29	PM	23	AUG	82	R2.PR1	SYS	3034	JOB	1974	START A****
START	JOB	1974	COMPARE	2KELLYJK	FM	NORM	D037	5.12.29	PM	23	AUG	82	R2.PR1	SYS	3034	JOB	1974	START A****
START	JOB	1974	COMPARE	2KELLYJK	FM	NORM	D037	5.12.29	PM	23	AUG	82	R2.PR1	SYS	3034	JOB	1974	START A****
START	JOB	1974	COMPARE	2KELLYJK	FM	NORM	D037	5.12.29	PM	23	AUG	82	R2.PR1	SYS	3034	JOB	1974	START A****
START	JOB	1974	COMPARE	2KELLYJK	FM	NORM	D037	5.12.29	PM	23	AUG	82	R2.PR1	SYS	3034	JOB	1974	START A****
START	JOB	1974	COMPARE	2KELLYJK	FM	NORM	D037	5.12.29	PM	23	AUG	82	R2.PR1	SYS	3034	JOB	1974	START A****
START	JOB	1974	COMPARE	2KELLYJK	FM	NORM	D037	5.12.29	PM	23	AUG	82	R2.PR1	SYS	3034	JOB	1974	START A****
START	JOB	1974	COMPARE	2KELLYJK	FM	NORM	D037	5.12.29	PM	23	AUG	82	R2.PR1	SYS	3034	JOB	1974	START A****
START	JOB	1974	COMPARE	2KELLYJK	FM	NORM	D037	5.12.29	PM	23	AUG	82	R2.PR1	SYS	3034	JOB	1974	START A****
START	JOB	1974	COMPARE	2KELLYJK	FM	NORM	D037	5.12.29	PM	23	AUG	82	R2.PR1	SYS	3034	JOB	1974	START A****
START	JOB	1974	COMPARE	2KELLYJK	FM	NORM	D037	5.12.29	PM	23	AUG	82	R2.PR1	SYS	3034	JOB	1974	START A****
START	JOB	1974	COMPARE	2KELLYJK	FM	NORM	D037	5.12.29	PM	23	AUG	82	R2.PR1	SYS	3034	JOB	1974	START A****
START	JOB	1974	COMPARE	2KELLYJK	FM	NORM	D037	5.12.29	PM	23	AUG	82	R2.PR1	SYS	3034	JOB	1974	START A****
START	JOB	1974	COMPARE	2KELLYJK	FM	NORM	D037	5.12.29	PM	23	AUG	82	R2.PR1	SYS	3034	JOB	1974	START A****
START	JOB	1974	COMPARE	2KELLYJK	FM	NORM	D037	5.12.29	PM	23	AUG	82	R2.PR1	SYS	3034	JOB	1974	START A****
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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                    J E S 2  J O B  L O G  --  S Y S T E M  3 0 3 4  --  N O D E  C H U R C H

7.09.10 JOB 1974  IEF677I WARNING MESSAGE(S) FOR JOB COMPARE  ISSUED
7.09.10 JOB 1974  $HASP373 COMPARE  STARTED - INIT 15 - CLASS L - SYS 3034
7.09.10 JOB 1974  IEF403I COMPARE - STARTED - TIME=17.09.10
7.09.16 JOB 1974  -                                     --TIMINGS (MINS.)--            ----PAGING COUNTS---          (APPROX.)
7.09.16 JOB 1974  -JOBNAME  STEPNAME PROGRAM    RC   EXCP    CPU    SRB  CLOCK   SERV  PG   PAGE   SWAP   VIO SWAPS     C O S T
7.09.16 JOB 1974  -COMPARE  FORT     IGIFORT    00    348    .02    .00     .1   5076   1      0      0     7     0  $    0.17
7.09.36 JOB 1974  -COMPARE  LKED     IEWL       00    214    .00    .00     .3   2587   1      0     72    68     2  $    0.10
7.12.07 JOB 1974  -COMPARE  GO       PGM=*.DD   00     57    .08    .00    2.4  24245   1     22    176    24     5  $    0.38
7.12.24 JOB 1974  IEF404I COMPARE - ENDED - TIME=17.12.24
7.12.24 JOB 1974  -COMPARE  ENDED.  NAME-2KELLYJK        TOTAL CPU TIME=   .11  TOTAL ELAPSED TIME=   3.2 JOB COST=$     0.65
7.12.24 JOB 1974  $HASP395 COMPARE  ENDED
------ JES2 JOB STATISTICS ------

23 AUG 82 JOB EXECUTION DATE

      375 CARDS READ

   12,374 SYSOUT PRINT RECORDS

        0 SYSOUT PUNCH RECORDS

     3.23 MINUTES EXECUTION TIME
```

THESE DESIGN CALCULATIONS COVER ITEMS RELATING TO NUCLEAR SAFETY. IN ACCORDANCE WITH ESTABLISHED PROCEDURES, THE QUALITY HAS BEEN ASSURED:

Jeffrey M. Kelly 8/24/82
ORIGINATED BY — DATE

Doyle E. Byrd 9/1/82
CHECKED BY — DATE

APPROVED BY — DATE

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```
   1    //COMPARE JOB (8362MCGU,0037,,90),2KELLYJK,MSGCLASS=A,CLASS=L,       JOB 1974
        // NOTIFY=JMK8362                                                    00000020
        ***ROUTE PRINT RMT2                                                   0000003
   2    //STEP1  EXEC  FTG1CLG                                                00000040
        *** REFER IP021,PPROCLIB(FTG1CLG                                      00010000
        *** COMPID PPF02                                                      00020000
        *** DOC THIS IS  THE FORTRAN IV G1  PROCEDURE THAT                    00030000
        ***        IS A COMPILE, LINK EDIT AND EXECUTE.                       00040000
   3    XXFORT     EXEC PGM=IGIFORT                                           00050000
   4    XXSYSPRINT DD   SYSOUT=A                                              00060000
   5    XXSYSLIN   DD   DSN=&OBJ,SPACE=(3040,(40,40),,,ROUND),UNIT=VIO,       00070000
        XX              DISP=(MOD,PASS),                                      00080000
        XX              DCB=(BLKSIZE=3040,LRECL=80,RECFM=FBS,BUFNO=1)        00090000
   6    //FORT.SYSIN DD *                                                     00000050
   7    XXLKED     EXEC PGM=IEWL,COND=(5,LT,FORT),PARM='LIST,LET,XREF,MAP'    00100000
   8    XXSYSPRINT DD   SYSOUT=A                                              00110000
   9    XXSYSLMOD  DD   SPACE=(CYL,(1,1,1)),DSN=&LOD(X),DISP=(,PASS),         00120000
        XX              UNIT=VIO,DCB=BUFNO=1                                  00130000
  10    XXSYSUT1   DD   DSN=&SYSUT1,SPACE=(1024,(120,120),,,ROUND),UNIT=VIO,  00140000
        XX              DCB=BUFNO=1                                           00150000
  11    XXSYSLIN   DD   DSN=&OBJ,DISP=(OLD,DELETE)                            00160000
  12    XX         DD   DDNAME=SYSIN                                          00170000
  13    XXSYSLIB   DD   DSN=SYS1.FORTLIB,DISP=(SHR,PASS)                      00180000
  14    XXGO       EXEC PGM=*.LKED.SYSLMOD,COND=((5,LT,LKED),(5,LT,FORT))     00190000
  15    XXFT05F001 DD   DDNAME=SYSIN                                          00200000
  16    XXFT06F001 DD   SYSOUT=A                                              00210000
  17    XXFT07F001 DD   SYSOUT=P                                              00220000
  18    //GO.FT08F001  DD DSN=TST.R010.C8362.DATA.JOINT1,DISP=SHR             00003260
  19    //GO.FT09F001  DD DSN=TST.R010.C8362.DATA.JOINT6,DISP=SHR             00003270
  20    //GO.FT10F001  DD DSN=TST.R010.C8362.DATA.JOINT9,DISP=SHR             00003280
  21    //GO.FT11F001  DD DSN=TST.R010.C8362.DATA.JOINT14,DISP=SHR            00003290
  22    //GO.FT12F001  DD DSN=TST.R010.C8362.DATA.JOINT17,DISP=SHR            00003300
  23    //GO.FT13F001  DD DSN=TST.R010.C8362.DATA.JOINT20,DISP=SHR            00003310
  24    //GO.SYSIN  DD  *                                                     00003320
```

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```
0001                DIMENSION A1(6,300),AP1(6,300),B1(6,300),BP1(6,300),C1(6,300),
                   1CP1(6,300),B2(6,300),BP2(6,300),C2(6,300),CP2(6,300),ADELT(6,300),
                   1BDELT(6,300),CDELT(6,300),APER(6,300),BPER(6,300),CPER(6,300),
                   1A2(6,300),AP2(6,300),A3(6,300),AAP1(6,300)
0002                DO 9 JJ=1,5
0003                IF(JJ.EQ.1)JOINT=6
0004                IF(JJ.EQ.2)JOINT=9
0005                IF(JJ.EQ.3)JOINT=14
0006                IF(JJ.EQ.4)JOINT=17
0007                IF(JJ.EQ.5)JOINT=20
0008                IF(JJ.EQ.1)ELEV=593.42
0009                IF(JJ.EQ.2)ELEV=619.42
0010                IF(JJ.EQ.3)ELEV=663.75
0011                IF(JJ.EQ.4)ELEV=688.05
0012                IF(JJ.EQ.5)ELEV=710.85
0013                IF(JJ.GT.1)GO TO 99
0014                DO 10 J=1,4
0015                IF(J.EQ.1)DAMP=0.005
0016                IF(J.EQ.2)DAMP=0.010
0017                IF(J.EQ.3)DAMP=0.020
0018                IF(J.EQ.4)DAMP=0.050
0019                WRITE(6,40)
0020                WRITE(6,61)DAMP
0021             61 FORMAT(//,27X,'RESPONSE ACCELERATION DATA FOR JOINT 1',//,27X,
                   1'GROUND ELEVATION',//,27X,'OSCILLATING DAMPING VALUE OF   ',F5.3)
0022                WRITE(6,82)
0023             82 FORMAT(///,10X,'RESPONSE',17X,'RESPONSE',18X,'RESPONSE',/,8X,
                   1'ACCELERATION',3X,'PERIOD',4X,'ACCELERATION',4X,'PERIOD',
                   14X,'ACCELERATION',4X,'PERIOD')
            C
            C   READ AND PRINT THE GENERATED GROUND RESPONSE DATA
            C
0024                DO 11 I=1,64
0025                READ(8,20)A1(J,I),AP1(J,I),B1(J,I),BP1(J,I),C1(J,I),CP1(J,I)
0026                IF(I.EQ.1)WRITE(6,22)
0027                WRITE(6,21)A1(J,I),AP1(J,I),B1(J,I),BP1(J,I),C1(J,I),CP1(J,I)
0028             11 CONTINUE
            C
            C   COMBINES AP1,BP1,CP1 TO ONE ARRAY FOR USE LATER
            C
0029                II=1
0030                DO 18 I=1,64
0031                AAP1(J,II)=AP1(J,I)
0032                II=II+1
0033                AAP1(J,II)=BP1(J,I)
0034                II=II+1
0035                AAP1(J,II)=CP1(J,I)
0036                II=II+1
```

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```
0037          18 CONTINUE
0038          10 CONTINUE
0039          20 FORMAT(6F13.4)
0040          21 FORMAT(3X,6F13.4)
0041          22 FORMAT(/)
0042          99 DO 12 J=1,4
0043             WRITE(6,40)
0044             IF(J.EQ.1)DAMP=0.005
0045             IF(J.EQ.2)DAMP=0.010
0046             IF(J.EQ.3)DAMP=0.020
0047             IF(J.EQ.4)DAMP=0.050
0048             WRITE(6,51)JOINT,ELEV,DAMP
0049          51 FORMAT(//,27X,'RESPONSE ACCELERATION DATA FOR JOINT ',I2,//,27X,
               1'ELEVATION ',F6.2,//,27X,'OSCILLATING DAMPING VALUE OF  ',F5.3)
0050             WRITE(6,82)
           C
           C  READS AND PRINTS GENERATED RESPONSE SPECTUM DATA FOR SPECIFIED JOINTS
           C
0051             DO 13 I=1,64
0052             JK=JJ+8
0053             READ(JK,20)A2(J,I),AP2(J,I),B2(J,I),BP2(J,I),C2(J,I),CP2(J,I)
0054             IF(I.EQ.1)WRITE(6,22)
0055             WRITE(6,21)A2(J,I),AP2(J,I),B2(J,I),BP2(J,I),C2(J,I),CP2(J,I)
0056          13 CONTINUE
0057          12 CONTINUE
           C
           C  THIS SECTION CALCULATES THE ACCELERATION SHOWN IN CATAWBA FSAR
           C  FIGURE 2.5.2-6  WHICH CORRESPONDS TO A GIVEN PERIOD (P) OF ARRAY AAP1
           C  THE PERIOD RANGE IS .05 TO 3.0 SECONDS.  THE DATA READ IN ARE THE END
           C  POINTS OF EACH LINEAR LINE SHOWN IN FSAR FIGURE 2.5.2-6 .  THE
           C  EQUATION USED TO CALCULATE THE ACCELERATION GIVEN THE PERIOD (P) IS :
           C
           C                    LOG(A) = M * LOG(P) + B
           C
           C  GIVEN THE TWO END POINTS OF THE LINEAR LINE, M AND B ARE KNOWN.  THE
           C  PERIOD (P) IS GIVEN.  THUS, ACCELERATION (A) EQUALS 10 RAISED TO THE
           C  POWER OF (M*LOG(P)+B).
           C
           C                    A = 10 ** (M * LOG(P) + B)
           C
0058             DO 14 J=1,4
0059             IF(J.EQ.1)DAMP=0.005
0060             IF(J.EQ.2)DAMP=0.010
0061             IF(J.EQ.3)DAMP=0.020
0062             IF(J.EQ.4)DAMP=0.050
0063             READ(5,500)SARP1,SARA1,SARP2,SARA2,SARP3,SARA3,SARP4,SARA4
0064         500 FORMAT(8F5.4)
0065             DO 15 I=10,48
```

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```
      X=SARA1/SARA2
      Y=SARP1/SARP2
      XX=ALOG10(X)
      YY=ALOG10(Y)
      XY=XX/YY
      CONST=ALOG10(SARA1)-(XY*ALOG10(SARP1))
      Z=XY*ALOG10(AAP1(J,I))+CONST
      A3(J,I)=10.**Z
   15 CONTINUE
      DO 16 I=49,93
      X=SARA3/SARA1
      Y=SARP3/SARP1
      XX=ALOG10(X)
      YY=ALOG10(Y)
      XY=XX/YY
      CONST=ALOG10(SARA3)-(XY*ALOG10(SARP3))
      Z=XY*ALOG10(AAP1(J,I))+CONST
      A3(J,I)=10.**Z
   16 CONTINUE
      DO 17 I=94,150
      X=SARA4/SARA3
      Y=SARP4/SARP3
      XX=ALOG10(X)
      YY=ALOG10(Y)
      XY=XX/YY
      CONST=ALOG10(SARA4)-(XY*ALOG10(SARP4))
      Z=XY*ALOG10(AAP1(J,I))+CONST
      A3(J,I)=10.**Z
   17 CONTINUE
      WRITE(6,40)
      WRITE(6,52)JOINT,ELEV,DAMP
   52 FORMAT(//,27X,'CATAWBA FSAR RESPONSE ACCELERATION DATA FOR JOINT
     1',I2,//,27X,'ELEVATION ',F6.2,//,27X,'OSCILLATING DAMPING VALUE OF
     1 ',F5.3)
      WRITE(6,83)
   83 FORMAT(///,10X,'CATAWBA',19X,'CATAWBA',19X,'CATAWBA',/,11X,
     1'FSAR',22X,'FSAR',22X,'FSAR',/,
     19X,'RESPONSE',18X,'RESPONSE',18X,'RESPONSE',/,7X,
     1'ACCELERATION',4X,'PERIOD',4X,'ACCELERATION',4X,'PERIOD',
     14X,'ACCELERATION',4X,'PERIOD')
      II=10
C
C     PRINTS THE CALCULATED CATAWBA FSAR RESPONSE ACCELERATION
C
      DO 19 I=1,47
      IF(I.EQ.1)WRITE(6,22)
      III=II+1
      IIII=III+1
```

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```
0105          WRITE(6,21)A3(J,II),AAP1(J,II),A3(J,III),AAP1(J,III),A3(J,IIII),
             1AAP1(J,IIII)
0106          II=II+3
0107       19 CONTINUE
0108       14 CONTINUE
      C
      C  THIS SECTION DETERMINES THE ACCELERATION AMPLIFICATION BETWEEN THE
      C  GENERATED GROUND RESPONSE ACCELERATION AND THE GENERATED RESPONSE
      C  ACCELERATIONS OF SPECIFIED JOINTS.  THE PERCENTAGE INCREASE IS
      C  ALSO CALCULATED.
      C
0109           DO 30 J=1,4
0110          AMAX=0.0
0111          PERMAX=0.0
0112          WRITE(6,40)
0113          IF(J.EQ.1)DAMP=0.005
0114          IF(J.EQ.2)DAMP=0.010
0115          IF(J.EQ.3)DAMP=0.020
0116          IF(J.EQ.4)DAMP=0.050
0117          WRITE(6,51)JOINT,ELEV,DAMP
0118          DO 31 I=1,64
0119          ADELTA=A2(J,I)-A1(J,I)
0120          BDELTA=B2(J,I)-B1(J,I)
0121          CDELTA=C2(J,I)-C1(J,I)
0122          ADELT(J,I)=A2(J,I)-A1(J,I)
0123          BDELT(J,I)=B2(J,I)-B1(J,I)
0124          CDELT(J,I)=C2(J,I)-C1(J,I)
0125          APER(J,I)=(ADELT(J,I)/A1(J,I))*100.
0126          BPER(J,I)=(BDELT(J,I)/B1(J,I))*100.
0127          CPER(J,I)=(CDELT(J,I)/C1(J,I))*100.
0128          IF(I.EQ.1)WRITE(6,60)
0129       60 FORMAT(//,40X,'GENERATED',/,10X,14X,'GENERATED',9X,'GROUND',/,10X,
             115X,'RESPONSE',8X,'RESPONSE',6X,'ACCELERATION',9X,'PERCENT',/,
             110X,'PERIOD',7X,'ACCELERATION',4X,'ACCELERATION',4X,'AMPLIFICATION
             1',11X,'INCREASE',//)
0130          WRITE(6,71)AP1(J,I),A2(J,I),A1(J,I),ADELT(J,I),APER(J,I)
0131          WRITE(6,71)BP1(J,I),B2(J,I),B1(J,I),BDELT(J,I),BPER(J,I)
0132          WRITE(6,71)CP1(J,I),C2(J,I),C1(J,I),CDELT(J,I),CPER(J,I)
0133       71 FORMAT(10X,4(F6.4,10X),F10.4)
0134          IF(ADELTA.GT.AMAX)IAD=I
0135          IF(ADELTA.GT.AMAX)NUMBER=1
0136          IF(ADELTA.GT.AMAX)AMAX=ADELTA
0137          IF(BDELTA.GT.AMAX)IAD=I
0138          IF(BDELTA.GT.AMAX)NUMBER=2
0139          IF(BDELTA.GT.AMAX)AMAX=BDELTA
0140          IF(CDELTA.GT.AMAX)IAD=I
0141          IF(CDELTA.GT.AMAX)NUMBER=3
0142          IF(CDELTA.GT.AMAX)AMAX=CDELTA
```

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```
0143        IF(APER(J,I).GT.PERMAX)IPID=I
0144        IF(APER(J,I).GT.PERMAX)NUM=1
0145        IF(APER(J,I).GT.PERMAX)PERMAX=APER(J,I)
0146        IF(BPER(J,I).GT.PERMAX)IPID=I
0147        IF(BPER(J,I).GT.PERMAX)NUM=2
0148        IF(BPER(J,I).GT.PERMAX)PERMAX=BPER(J,I)
0149        IF(CPER(J,I).GT.PERMAX)IPID=I
0150        IF(CPER(J,I).GT.PERMAX)NUM=3
0151        IF(CPER(J,I).GT.PERMAX)PERMAX=CPER(J,I)
0152     31 CONTINUE
0153        WRITE(6,40)
0154        IF(J.EQ.1)DAMP=0.005
0155        IF(J.EQ.2)DAMP=0.010
0156        IF(J.EQ.3)DAMP=0.020
0157        IF(J.EQ.4)DAMP=0.050
0158        WRITE(6,51)JOINT,ELEV,DAMP
0159        WRITE(6,72)
0160     72 FORMAT(//,10X,'THE FOLLOWING IS A LIST OF THOSE RESPONSE ACCELERAT
           1ION GREATER THAN 5%',/,10X,'OF THE GROUND RESPONSE ACCELERATION :
           1')
0161        WRITE(6,60)
0162        DO 32 I=1,64
0163        IF(APER(J,I).GT.5.0)WRITE(6,71)AP1(J,I),A2(J,I),A1(J,I),
           1ADELT(J,I),APER(J,I)
0164        IF(BPER(J,I).GT.5.0)WRITE(6,71)BP1(J,I),B2(J,I),B1(J,I),
           1BDELT(J,I),BPER(J,I)
0165        IF(CPER(J,I).GT.5.0)WRITE(6,71)CP1(J,I),C2(J,I),C1(J,I),
           1CDELT(J,I),CPER(J,I)
0166     32 CONTINUE
0167        WRITE(6,40)
0168        WRITE(6,51)JOINT,ELEV,DAMP
0169        WRITE(6,601)
0170    601 FORMAT(//,10X,'THE FOLLOWING IS A LIST OF THOSE RESPONSE ACCELERAT
           1ION GREATER THAN 5%',/,10X,'2/3 OF THE CATAWBA FSAR GROUND RESPONS
           1E ACCELERATION :')
0171        WRITE(6,600)
0172    600 FORMAT(///,10X,14X,'GENERATED',8X,'ADJUSTED',9X,'CATAWBA',/,10X,
           115X,'RESPONSE',8X,'RESPONSE',10X,'FSAR',8X,'ACCELERATION',10X,'PER
           1CENT',/,10X,'PERIOD',7X,'ACCELERATION',4X,'ACCELERATION',4X,
           1'ACCELERATION',4X,'AMPLIFICATION',9X,'INCREASE',//)
0173        II=9
      C
      C   THIS SECTION ADJUSTS THE GENERATED RESPONSE ACCELERATIONS AT
      C   SPECIFIED JOINTS TO COMPARE TO TWO-THIRDS THE CATAWBA FSAR GROUND
      C   RESPONSE SPECTRUM.  THE CATAWBA FSAR STATES THAT 2/3 OF THE
      C   HORIZONTAL GROUND RESPONSE SPECTRUM WILL BE USED AS THE VERTICAL
      C   RESPONSE SPECTRUM.  SINCE THE RESPONSE SPECTRUM GENERATED USED
      C   100% OF THE GROUND MOTION, A FACTOR OF 2/3 WILL BE APPLIED TO THE
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                 C  GENERATED RESPONSE SPECTRUM.  IT IS SHOWN THAT THE GENERATED           00002420
                 C  GROUND RESPONSE SPECTRUM IS LARGER THAN THE CATAWBA FSAR GROUND        00002421
                 C  RESPONSE SPECTRUM.  THUS, A REDUCTION FACTOR OF :                      00002422
                 C                                                                         00002423
                 C   (CATAWBA FSAR GROUND RESPONSE / (2./3.)*(GENERATED GROUND RESPONSE))  00002424
                 C                                                                         00002425
                 C  WILL ALSO BE APPLIED TO THE GENERATED RESPONSE SPECTRUM AT SPECIFIED   00002426
                 C  JOINTS.  THE ADJUSTED RESPONSE SPECTRUM AT SPECIFIED JOINTS IS :       00002427
                 C                                                                         00002428
                 C     ADJ RES SPEC = 2/3*(GEN RES SPEC)*(FSAR GRND RES / GEN GRND RES)    00002429
                 C                                                                         00002430
                 C  THE ACCELERATION AMPLIFICATION BETWEEN THE ADJUSTED RESPONSE SPECTRUM  00002432
                 C  AND FSAR RESPONSE SPECTRUM WILL BE DETERMINED.  THE PERCENTAGE         00002434
                 C  INCREASE WILL ALSO BE CALCULATED.                                      00002436
                 C                                                                         00002438
0174                   DO 510 I=4,50                                                       00002440
0175                   II=II+1                                                             00002450
0176                   Z=(2./3.)*A2(J,I)                                                   00002460
0177                   Y=A3(J,II)/((2./3.)*(A1(J,I)))                                      00002470
0178                   ADJACC=Z*Y                                                          00002480
0179                   DDELT=ADJACC-A3(J,II)                                               00002490
0180                   DPRCNT=(DDELT/A3(J,II))*100.                                        00002500
0181                   IF(DPRCNT.GT.5.0)WRITE(6,602)AP1(J,I),A2(J,I),ADJACC,A3(J,II),      00002510
                      1DDELT,DPRCNT                                                        00002520
0182               602 FORMAT(10X,5(F6.4,10X),F10.4)                                       00002530
0183                   II=II+1                                                             00002540
0184                   Z=(2./3.)*B2(J,I)                                                   00002550
0185                   Y=A3(J,II)/((2./3.)*(B1(J.I)))                                      00002560
0186                   ADJACC=Z*Y                                                          00002570
0187                   DDELT=ADJACC-A3(J,II)                                               00002580
0188                   DPRCNT=(DDELT/A3(J,II))*100.                                        00002590
0189                   IF(DPRCNT.GT.5.0)WRITE(6,602)BP1(J,I),B2(J,I),ADJACC,A3(J,II),      00002600
                      1DDELT,DPRCNT                                                        00002610
0190                   II=II+1                                                             00002620
0191                   Z=(2./3.)*C2(J,I)                                                   00002630
0192                   Y=A3(J,II)/((2./3.)*(C1(J,I)))                                      00002640
0193                   ADJACC=Z*Y                                                          00002650
0194                   DDELT=ADJACC-A3(J,II)                                               00002660
0195                   DPRCNT=(DDELT/A3(J,II))*100.                                        00002670
0196                   IF(DPRCNT.GT.5.0)WRITE(6,602)CP1(J,I),C2(J,I),ADJACC,A3(J,II),      00002680
                      1DDELT,DPRCNT                                                        00002690
0197               510 CONTINUE                                                            00002700
                 C                                                                         00002701
                 C  THIS SECTION DETERMINES THE MAXIMUM ACCELERATION AMPLIFICATION AND     00002702
                 C  MAXIMUM PERCENTAGE INCREASE BETWEEN THE GENERATED RESPONSE SPECTRUM    00002703
                 C  AT SPECIFIED JOINTS AND THE GENERATED GROUND RESPONSE SPECTRUM.        00002704
                 C                                                                         00002705
0198                   WRITE(6,40)                                                         00002770
```

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```
   40 FORMAT(1H1)                                                        00002780
      IF(J.EQ.1)DAMP=0.005                                               00002790
      IF(J.EQ.2)DAMP=0.010                                               00002800
      IF(J.EQ.3)DAMP=0.020                                               00002810
      IF(J.EQ.4)DAMP=0.050                                               00002820
      IF(NUMBER.EQ.1)PERIOD=AP1(J,IAD)                                   00002880
      IF(NUMBER.EQ.1)ACC=A2(J,IAD)                                       00002890
      IF(NUMBER.EQ.1)PERCNT=APER(J,IAD)                                  00002900
      IF(NUMBER.EQ.1)GRNDAC=A1(J,IAD)                                    00002920
      IF(NUMBER.EQ.2)PERIOD=BP1(J,IAD)                                   00002930
      IF(NUMBER.EQ.2)ACC=B2(J,IAD)                                       00002940
      IF(NUMBER.EQ.2)PERCNT=BPER(J,IAD)                                  00002950
      IF(NUMBER.EQ.2)GRNDAC=B1(J,IAD)                                    00002960
      IF(NUMBER.EQ.3)PERIOD=CP1(J,IAD)                                   00002961
      IF(NUMBER.EQ.3)ACC=C2(J,IAD)                                       00002962
      IF(NUMBER.EQ.3)PERCNT=CPER(J,IAD)                                  00002963
      IF(NUMBER.EQ.3)GRNDAC=C1(J,IAD)                                    00002964
      WRITE(6,41)JOINT,ELEV,DAMP,PERIOD,ACC,GRNDAC,AMAX,PERCNT           00002980
   41 FORMAT(/////,10X,'FOR JOINT ',I2,'  ELEVATION ',F6.2,'  OSCILLATIN00002990
     1G DAMPING VALUE  ',F5.3,' :',//,10X,'THE MAXIMUM RESPONSE ACCELERA00003000
     1TION AMPLIFICATION BETWEEN THE',/,10X,'GENERATED GROUND RESPONSE S00003010
     1PECTRUM AND THE GENERATED RESPONSE',/,10X,'SPECTRUM AT SPECIFIED J00003011
     1OINTS OCCURS AT PERIOD ',F6.4,'          ',//,10X,'WHICH HAS A RESPON00003020
     1SE ACCELERATION OF  ',F6.4,' .',//,10X,'THE GROUND RESPONSE ACCELE00003021
     1RATION IS  ',F6.4,' .',//,10X,'THUS, THE AMPLIFICATION IS  ',     00003030
     1F6.4,' .',//,10X,'THE PERCENTAGE INCREASE IS  ',F6.3,'%.')        00003040
C                                                                        00003041
C     THIS SECTION DETERMINES THE MAXIMUM ACCELERATION AMPLIFICATION AND 00003042
C     MAXIMUM PERCENTAGE INCREASE BETWEEN THE GENERATED RESPONSE SPECTRUM 00003043
C     AT SPECIFIED JOINTS AND THE CATAWBA FSAR RESPONSE SPECTRUM.        00003044
C                                                                        00003045
      IF(NUM.EQ.1)PERIOD=AP1(J,IPID)                                     00003080
      IF(NUM.EQ.1)GRNDAC=A1(J,IPID)                                      00003090
      IF(NUM.EQ.1)ACC=A2(J,IPID)                                         00003100
      IF(NUM.EQ.2)PERIOD=BP1(J,IPID)                                     00003110
      IF(NUM.EQ.2)GRNDAC=B1(J,IPID)                                      00003120
      IF(NUM.EQ.2)ACC=B2(J,IPID)                                         00003130
      IF(NUM.EQ.3)PERIOD=CP1(J,IPID)                                     00003131
      IF(NUM.EQ.3)GRNDAC=C1(J,IPID)                                      00003132
      IF(NUM.EQ.3)ACC=C2(J,IPID)                                         00003133
      WRITE(6,81)JOINT,ELEV,DAMP,PERIOD,ACC,GRNDAC,PERMAX                00003151
   81 FORMAT(/////,10X,'FOR JOINT ',I2,'  ELEVATION ',F6.2,'  OSCILLATIN00003152
     1G DAMPING VALUE  ',F5.3,' :',//,10X,'THE MAXIMUM RESPONSE ACCELERA00003160
     1TION PERCENTAGE INCREASE BETWEEN THE',/,10X,'GENERATED GROUND RESP00003170
     1ONSE SPECTRUM AND THE GENERATED RESPONSE',/,10X,'SPECTRUM AT SPECI00003171
     1FIED JOINTS OCCURS AT PERIOD  ',F6.4,'          ',//,10X,'WHICH HAS00003172
     1 A RESPONSE ACCELERATION OF  ',F6.4,' .',//,10X,'THE GROUND RESPON00003180
     1SE ACCELERATION IS  ',F6.4,' .',//,10X,'THUS, THE PERCENTAGE INCRE00003190
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                 1ASE IS ',F6.3,'%.')                    00003200
0229          30 CONTINUE                                00003210
0230           9 CONTINUE                                00003220
0231             STOP                                    00003230
0232             END                                     00003240
```

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RESPONSE ACCELERATION DATA FOR JOINT 1

GROUND ELEVATION

OSCILLATING DAMPING VALUE OF 0.010

SPECTRUM "I"

RESPONSE ACCELERATION	PERIOD	RESPONSE ACCELERATION	PERIOD	RESPONSE ACCELERATION	PERIOD
0.0087	6.2832	0.0126	5.4636	0.0195	4.8332
0.0282	4.3332	0.0357	3.9270	0.0448	3.5904
0.0625	3.3069	0.0752	3.0650	0.0825	2.8560
0.0856	2.6737	0.0929	2.5133	0.0953	2.3710
0.0981	2.2440	0.1037	2.1299	0.1163	2.0266
0.1154	1.9333	0.1168	1.8480	0.1186	1.7699
0.1196	1.6982	0.1257	1.6320	0.1313	1.5708
0.1279	1.4612	0.1248	1.3659	0.1404	1.2823
0.1600	1.2083	0.1697	1.1424	0.1868	1.0833
0.1916	1.0300	0.2204	0.9817	0.2744	0.9378
0.2911	0.8976	0.3224	0.8607	0.3295	0.8267
0.3295	0.7953	0.3009	0.7662	0.2990	0.7392
0.2903	0.7140	0.3091	0.6905	0.3284	0.6684
0.3651	0.6476	0.3623	0.6283	0.3639	0.6100
0.3626	0.5928	0.3634	0.5764	0.4058	0.5610
0.4387	0.5464	0.4851	0.5325	0.4893	0.5193
0.4875	0.5067	0.4796	0.4947	0.4511	0.4833
0.4022	0.4[illegible]24	0.3882	0.4620	0.4138	0.4520
0.4947	0.4425	0.4939	0.4333	0.4741	0.4245
0.4868	0.4161	0.4935	0.4080	0.4823	0.4002
0.4743	0.3927	0.4659	0.3855	0.4799	0.3785
0.5070	0.3718	0.4830	0.3653	0.5138	0.3590
0.5214	0.3530	0.4867	0.3471	0.4490	0.3415
0.4173	0.3360	0.4157	0.3307	0.4361	0.3256
0.4521	0.3206	0.4747	0.3157	0.4667	0.3142
0.4558	0.2992	0.4378	0.2856	0.4631	0.2732
0.3668	0.2618	0.3872	0.2513	0.4648	0.2417
0.4030	0.2327	0.4303	0.2244	0.4027	0.2167
0.5038	0.2094	0.4457	0.2027	0.4346	0.1963
0.4920	0.1904	0.4500	0.1848	0.4105	0.1795
0.4343	0.1745	0.4909	0.1698	0.4371	0.1653
0.3991	0.1611	0.4580	0.1571	0.4152	0.1532
0.4209	0.1496	0.4477	0.1461	0.4068	0.1426
0.4125	0.1396	0.4099	0.1366	0.4206	0.1337
0.3498	0.1309	0.3342	0.1282	0.3686	0.1257
0.3920	0.1232	0.3999	0.1208	0.3861	0.1186
0.3594	0.1164	0.3257	0.1142	0.3460	0.1122
0.3661	0.1102	0.3517	0.1083	0.2983	0.1065
0.2905	0.1047	0.2775	0.1030	0.2883	0.1013
0.2939	0.0997	0.2685	0.0982	0.2765	0.0967
0.2337	0.0938	0.2864	0.0911	0.2545	0.0885
0.2435	0.0861	0.2448	0.0838	0.2326	0.0816
0.2304	0.0795	0.2247	0.0776	0.2082	0.0757
0.1943	0.0739	0.1826	0.0722	0.1780	0.0706
0.1419	0.0690	0.1569	0.0676	0.1418	0.0661
0.1394	0.0648	0.1301	0.0635	0.1257	0.0622
0.1213	0.0610	0.1202	0.0598	0.1167	0.0587

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0.1179	0.0519	0.1186	0.0511	0.1171	0.0503
0.1155	0.0495	0.1142	0.0487	0.1138	0.0480
0.1135	0.0472	0.1133	0.0465	0.1132	0.0459
0.1130	0.0452	0.1129	0.0446	0.1127	0.0439
0.1126	0.0433	0.1125	0.0427	0.1123	0.0422
0.1122	0.0416	0.1121	0.0411	0.1120	0.0405
0.1119	0.0400	0.1118	0.0395	0.1117	0.0390
0.1116	0.0385	0.1115	0.0381	0.1114	0.0376
0.1114	0.0372	0.1113	0.0367	0.1112	0.0363
0.1111	0.0359	0.1111	0.0355	0.1110	0.0351
0.1110	0.0347	0.1109	0.0343	0.1108	0.0340
0.1108	0.0336	0.1108	0.0332	0.1107	0.0329
0.1107	0.0326	0.1106	0.0322	0.1106	0.0319
0.1105	0.0316	0.1105	0.0313	0.1104	0.0310
0.1104	0.0306	0.1104	0.0304	0.1103	0.0301

RESPONSE ACCELERATION DATA FOR JOINT 20

ELEVATION 710.85

OSCILLATING DAMPING VALUE OF 0.010 SPECTRUM "N"

RESPONSE ACCELERATION	PERIOD	RESPONSE ACCELERATION	PERIOD	RESPONSE ACCELERATION	PERIOD
0.0087	6.2832	0.0126	5.4636	0.0195	4.8332
0.0282	4.3332	0.0357	3.9270	0.0448	3.5904
0.0625	3.3069	0.0752	3.0650	0.0826	2.8560
0.0856	2.6737	0.0930	2.5133	0.0954	2.3710
0.0981	2.2440	0.1038	2.1299	0.1104	2.0268
0.1155	1.9333	0.1169	1.8480	0.1187	1.7699
0.1197	1.6482	0.1258	1.6320	0.1314	1.5708
0.1281	1.4612	0.1249	1.3659	0.1406	1.2823
0.1603	1.2083	0.1701	1.1424	0.1872	1.0833
0.1920	1.0300	0.2210	0.9817	0.2753	0.9378
0.2921	0.8976	0.3235	0.8607	0.3309	0.8267
0.3308	0.7953	0.3022	0.7662	0.3003	0.7392
0.2917	0.7140	0.3108	0.6905	0.3303	0.6684
0.3674	0.6478	0.3647	0.6283	0.3664	0.6100
0.3654	0.5928	0.3602	0.5764	0.4090	0.5610
0.4424	0.5464	0.4893	0.5325	0.4938	0.5193
0.4922	0.5067	0.4846	0.4947	0.4560	0.4833
0.4066	0.4724	0.3928	0.4620	0.4188	0.4520
0.5014	0.4425	0.5005	0.4333	0.4807	0.4245
0.4940	0.4161	0.5011	0.4080	0.4898	0.4002
0.4820	0.3927	0.4742	0.3855	0.4886	0.3785
0.5161	0.3718	0.4917	0.3653	0.5242	0.3590
0.5318	0.3530	0.4966	0.3471	0.4577	0.3415
0.4259	0.3360	0.4250	0.3307	0.4397	0.3256
0.4634	0.3206	0.4869	0.3157	0.4807	0.3142
0.4677	0.2992	0.4508	0.2856	0.4779	0.2732
0.3797	0.2618	0.4006	0.2513	0.4842	0.2417
0.4216	0.2327	0.4518	0.2244	0.4232	0.2167
0.5307	0.2094	0.4783	0.2027	0.4638	0.1963
0.5263	0.1904	0.4827	0.1848	0.4442	0.1795
0.4706	0.1745	0.5330	0.1698	0.4752	0.1653
0.4381	0.1611	0.5048	0.1571	0.4595	0.1532
0.4696	0.1496	0.4985	0.1461	0.4593	0.1428
0.4668	0.1396	0.4624	0.1366	0.4817	0.1337
0.4003	0.1309	0.3837	0.1282	0.4265	0.1257
0.4583	0.1232	0.4690	0.1208	0.4592	0.1186
0.4304	0.1164	0.3867	0.1142	0.4160	0.1122
0.4437	0.1102	0.4242	0.1083	0.3610	0.1065
0.3561	0.1047	0.3405	0.1030	0.3539	0.1013
0.3703	0.0997	0.3376	0.0982	0.3497	0.0967
0.2872	0.0938	0.3744	0.0911	0.3302	0.0885
0.3235	0.0861	0.3348	0.0838	0.3154	0.0816
0.3289	0.0795	0.3238	0.0776	0.3032	0.0757
0.2899	0.0739	0.2728	0.0722	0.2697	0.0706
0.2687	0.0690	0.2294	0.0676	0.2067	0.0661
0.1987	0.0648	0.1725	0.0635	0.1534	0.0622

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0.1606	0.0519	0.1613	0.0511	0.1580	0.0503
0.1446	0.0495	0.1360	0.0487	0.1343	0.0480
0.1297	0.0472	0.1285	0.0465	0.1266	0.0459
0.1253	0.0452	0.1243	0.0446	0.1235	0.0439
0.1228	0.0433	0.1222	0.0427	0.1217	0.0422
0.1212	0.0416	0.1208	0.0411	0.1204	0.0405
0.1201	0.0400	0.1198	0.0395	0.1195	0.0390
0.1192	0.0385	0.1190	0.0381	0.1188	0.0376
0.1185	0.0372	0.1183	0.0367	0.1182	0.0363
0.1181	0.0359	0.1180	0.0355	0.1179	0.0351
0.1178	0.0347	0.1177	0.0343	0.1176	0.0340
0.1175	0.0336	0.1175	0.0332	0.1174	0.0329
0.1173	0.0326	0.1173	0.0322	0.1172	0.0319
0.1171	0.0316	0.1170	0.0313	0.1170	0.0310
0.1169	0.0306	0.1169	0.0304	0.1168	0.0301

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CATAWBA FSAR RESPONSE ACCELERATION DATA FOR JOINT 20

ELEVATION 710.85

OSCILLATING DAMPING VALUE OF 0.010

FSAR VERTICAL SPECTRUM

∂_A

(2/3 x HORIZ GROUND RESP. SPECTRUM)

CATAWBA FSAR RESPONSE ACCELERATION	PERIOD	CATAWBA FSAR RESPONSE ACCELERATION	PERIOD	CATAWBA FSAR RESPONSE ACCELERATION	PERIOD
0.0405	2.6737	0.0432	2.5133	0.0458	2.3710
0.0485	2.2440	0.0512	2.1299	0.0538	2.0268
0.0565	1.9333	0.0592	1.8480	0.0619	1.7699
0.0646	1.6982	0.0673	1.6320	0.0700	1.5708
0.0753	1.4612	0.0808	1.3659	0.0862	1.2623
0.0916	1.2083	0.0970	1.1424	0.1024	1.0833
0.1079	1.0300	0.1133	0.9817	0.1188	0.9378
0.1243	0.8976	0.1297	0.8607	0.1352	0.8267
0.1407	0.7953	0.1462	0.7662	0.1517	0.7392
0.1572	0.7140	0.1627	0.6905	0.1682	0.6684
0.1737	0.6478	0.1792	0.6283	0.1848	0.6100
0.1903	0.5928	0.1958	0.5764	0.2013	0.5610
0.2069	0.5464	0.2124	0.5325	0.2180	0.5193
0.2266	0.5067	0.2266	0.4947	0.2266	0.4833
0.2266	0.4724	0.2266	0.4620	0.2266	0.4520
0.2266	0.4425	0.2266	0.4333	0.2266	0.4245
0.2266	0.4161	0.2266	0.4080	0.2266	0.4002
0.2266	0.3927	0.2266	0.3855	0.2266	0.3785
0.2266	0.3716	0.2266	0.3653	0.2266	0.3590
0.2266	0.3530	0.2266	0.3471	0.2266	0.3415
0.2266	0.3360	0.2266	0.3307	0.2266	0.3256
0.2266	0.3206	0.2266	0.3157	0.2266	0.3142
0.2266	0.2492	0.2266	0.2856	0.2266	0.2732
0.2266	0.2618	0.2266	0.2513	0.2266	0.2417
0.2266	0.2327	0.2266	0.2244	0.2266	0.2167
0.2266	0.2094	0.2266	0.2027	0.2266	0.1963
0.2266	0.1904	0.2266	0.1848	0.2266	0.1795
0.2266	0.1745	0.2266	0.1698	0.2266	0.1653
0.2213	0.1611	0.2170	0.1571	0.2127	0.1532
0.2088	0.1496	0.2049	0.1461	0.2012	0.1428
0.1977	0.1396	0.1943	0.1366	0.1911	0.1337
0.1879	0.1309	0.1848	0.1282	0.1820	0.1257
0.1791	0.1232	0.1769	0.1208	0.1738	0.1186
0.1713	0.1164	0.1687	0.1142	0.1664	0.1122
0.1641	0.1102	0.1618	0.1083	0.1597	0.1065
0.1576	0.1047	0.1556	0.1030	0.1535	0.1013
0.1516	0.0997	0.1498	0.0982	0.1480	0.0967
0.1445	0.0938	0.1412	0.0911	0.1380	0.0885
0.1351	0.0861	0.1322	0.0838	0.1295	0.0816
0.1268	0.0795	0.1244	0.0776	0.1220	0.0757
0.1197	0.0734	0.1176	0.0722	0.1155	0.0706
0.1134	0.0690	0.1116	0.0676	0.1097	0.0661
0.1060	0.0648	0.1062	0.0635	0.1045	0.0622
0.1029	0.0610	0.1013	0.0598	0.0999	0.0587
[illegible]	0.0576	[illegible]	0.0566	0.0957	0.0556

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RESPONSE ACCELERATION DATA FOR JOINT 20

ELEVATION 710.85

OSCILLATING DAMPING VALUE OF 0.010

PERIOD	SPECT."N" GENERATED RESPONSE ACCELERATION	SPECT"I" GENERATED GROUND RESPONSE ACCELERATION	"N"-"I" ACCELERATION AMPLIFICATION	(H-1)*100 PERCENT INCREASE
6.2832	0.0087	0.0087	0.0	0.0
5.4636	0.0126	0.0126	0.0	0.0
4.8332	0.0195	0.0195	0.0	0.0
4.3332	0.0282	0.0282	0.0	0.0
3.9270	0.0357	0.0357	0.0	0.0
3.5904	0.0448	0.0448	0.0	0.0
3.3069	0.0625	0.0625	0.0	0.0
3.0650	0.0752	0.0752	0.0	0.0
2.8560	0.0826	0.0825	0.0001	0.1212
2.6737	0.0856	0.0856	0.0	0.0
2.5133	0.0930	0.0929	0.0001	0.1077
2.3710	0.0954	0.0953	0.0001	0.1049
2.2440	0.0981	0.0981	0.0	0.0
2.1299	0.1038	0.1037	0.0001	0.0964
2.0268	0.1104	0.1103	0.0001	0.0907
1.9333	0.1155	0.1154	0.0001	0.0866
1.8480	0.1169	0.1168	0.0001	0.0856
1.7699	0.1187	0.1186	0.0001	0.0843
1.6982	0.1197	0.1196	0.0001	0.0836
1.6320	0.1258	0.1257	0.0001	0.0796
1.5708	0.1314	0.1313	0.0001	0.0762
1.4612	0.1281	0.1279	0.0002	0.1564
1.3659	0.1249	0.1248	0.0001	0.0801
1.2823	0.1406	0.1404	0.0002	0.1425
1.2083	0.1603	0.1600	0.0003	0.1875
1.1424	0.1701	0.1697	0.0004	0.2357
1.0833	0.1872	0.1868	0.0004	0.2141
1.0300	0.1920	0.1916	0.0004	0.2087
0.9817	0.2210	0.2204	0.0006	0.2723
0.9378	0.2753	0.2744	0.0009	0.3280
0.8976	0.2921	0.2911	0.0010	0.3435
0.8607	0.3235	0.3224	0.0011	0.3412
0.8267	0.3309	0.3295	0.0014	0.4249
0.7953	0.3308	0.3295	0.0013	0.3945
0.7662	0.3022	0.3009	0.0013	0.4320
0.7392	0.3003	0.2990	0.0013	0.4348
0.7140	0.2917	0.2903	0.0014	0.4823
0.6905	0.3108	0.3091	0.0017	0.5500
0.6684	0.3303	0.3284	0.0019	0.5785
0.6478	0.3674	0.3651	0.0023	0.6300
0.6283	0.3647	0.3623	0.0024	0.6624
0.6100	0.3664	0.3639	0.0025	0.6870
0.5928	0.3654	0.3626	0.0028	0.7722
0.5764	0.3662	0.3634	0.0028	0.7705
0.5610	0.4090	0.4058	0.0032	0.7886

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0.5067	0.4922	0.4875	0.0047	0.9641
0.4947	0.4846	0.4796	0.0050	1.0425
0.4833	0.4560	0.4511	0.0049	1.0862
0.4724	0.4066	0.4022	0.0044	1.0940
0.4620	0.3928	0.3882	0.0046	1.1850
0.4520	0.4188	0.4138	0.0050	1.2083
0.4425	0.5014	0.4947	0.0067	1.3544
0.4333	0.5005	0.4939	0.0066	1.3363
0.4245	0.4807	0.4741	0.0066	1.3921
0.4161	0.4940	0.4868	0.0072	1.4790
0.4080	0.5011	0.4935	0.0076	1.5400
0.4002	0.4898	0.4823	0.0075	1.5550
0.3927	0.4820	0.4743	0.0077	1.6234
0.3855	0.4742	0.4659	0.0083	1.7815
0.3785	0.4886	0.4799	0.0087	1.8129
0.3718	0.5161	0.5070	0.0091	1.7949
0.3653	0.4917	0.4830	0.0087	1.8012
0.3590	0.5242	0.5138	0.0104	2.0241
0.3530	0.5318	0.5214	0.0104	1.9946
0.3471	0.4966	0.4867	0.0099	2.0341
0.3415	0.4577	0.4490	0.0087	1.9376
0.3360	0.4259	0.4173	0.0086	2.0609
0.3307	0.4250	0.4157	0.0093	2.2372
0.3256	0.4397	0.4301	0.0096	2.2320
0.3206	0.4634	0.4521	0.0113	2.4995
0.3157	0.4869	0.4747	0.0122	2.5700
0.3142	0.4807	0.4687	0.0120	2.5603
0.2992	0.4677	0.4558	0.0119	2.6108
0.2856	0.4508	0.4378	0.0130	2.9694
0.2732	0.4779	0.4631	0.0148	3.1959
0.2618	0.3797	0.3668	0.0129	3.5169
0.2513	0.4006	0.3872	0.0134	3.4607
0.2417	0.4842	0.4648	0.0194	4.1738
0.2327	0.4216	0.4030	0.0186	4.6154
0.2244	0.4518	0.4303	0.0215	4.9965
0.2167	0.4232	0.4027	0.0205	5.0906
0.2094	0.5307	0.5038	0.0269	5.3394
0.2027	0.4743	0.4457	0.0286	6.4169
0.1963	0.4638	0.4346	0.0292	6.7188
0.1904	0.5263	0.4920	0.0343	6.9715
0.1848	0.4827	0.4500	0.0327	7.2667
0.1795	0.4442	0.4105	0.0337	8.2095
0.1745	0.4706	0.4343	0.0363	8.3583
0.1698	0.5330	0.4909	0.0421	8.5761
0.1653	0.4752	0.4371	0.0381	8.7165
0.1611	0.4381	0.3991	0.0390	9.7720
0.1571	0.5048	0.4580	0.0468	10.2183
0.1532	0.4595	0.4152	0.0443	10.6696
0.1496	0.4696	0.4209	0.0487	11.5704
0.1461	0.4985	0.4477	0.0508	11.3469
0.1428	0.4593	0.4068	0.0525	12.9056
0.1396	0.4668	0.4125	0.0543	13.1636
0.1366	0.4624	0.4099	0.0525	12.8080
0.1337	0.4817	0.4206	0.0611	14.5269
0.1309	0.4003	0.3498	0.0505	14.4368
0.1282	0.3837	0.3342	0.0495	14.8115
0.1257	0.4265	0.3686	0.0579	15.7081
0.1232	0.4583	0.3920	0.0663	16.9132
0.1208	0.4690	0.3999	0.0691	17.2793
0.1185	0.4592	0.3861	0.0731	18.9324
0.1164	0.4304	0.3594	0.0710	19.7551
0.1142	[illegible]	0.3257	[illegible]	[illegible]

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0.1083	0.4242	0.3517	0.0725	20.6142
0.1065	0.3610	0.2983	0.0627	21.0191
0.1047	0.3561	0.2905	0.0656	22.5818
0.1030	0.3405	0.2775	0.0630	22.7027
0.1013	0.3539	0.2883	0.0656	22.7541
0.0997	0.3703	0.2939	0.0764	25.9952
0.0982	0.3376	0.2685	0.0691	25.7356
0.0967	0.3497	0.2765	0.0732	26.4738
0.0938	0.2872	0.2337	0.0535	22.8926
0.0911	0.3744	0.2864	0.0880	30.7262
0.0885	0.3302	0.2545	0.0757	29.7446
0.0861	0.3235	0.2435	0.0800	32.8502
0.0838	0.3348	0.2444	0.0904	36.9885
0.0816	0.3154	0.2326	0.0828	35.5976
0.0795	0.3289	0.2309	0.0980	42.4426
0.0776	0.3238	0.2247	0.0991	44.1033
0.0757	0.3032	0.2082	0.0950	45.6292
0.0739	0.2899	0.1943	0.0956	49.2023
0.0722	0.2728	0.1826	0.0902	49.3976
0.0706	0.2697	0.1780	0.0917	51.5169
0.0690	0.2687	0.1819	0.0868	47.7185
0.0676	0.2294	0.1569	0.0725	46.2078
0.0661	0.2087	0.1418	0.0669	47.1791
0.0648	0.1987	0.1394	0.0593	42.5394
0.0635	0.1725	0.1301	0.0424	32.5903
0.0622	0.1534	0.1257	0.0277	22.0366
0.0610	0.1402	0.1213	0.0189	15.5812
0.0598	0.1394	0.1202	0.0192	15.9734
0.0587	0.1349	0.1187	0.0162	13.6478
0.0576	0.1379	0.1173	0.0206	17.5618
0.0566	0.1459	0.1207	0.0252	20.8782
0.0556	0.1401	0.1196	0.0205	17.1405
0.0546	0.1440	0.1185	0.0255	21.5190
0.0537	0.1434	0.1180	0.0254	21.5255
0.0528	0.1583	0.1194	0.0389	32.5795
0.0519	0.1606	0.1179	0.0427	36.2171
0.0511	0.1613	0.1186	0.0427	36.0034
0.0503	0.1580	0.1171	0.0409	34.9274
0.0495	0.1446	0.1155	0.0291	25.1948
0.0487	0.1380	0.1142	0.0238	20.8406
0.0480	0.1343	0.1138	0.0205	18.0141
0.0472	0.1297	0.1135	0.0162	14.2731
0.0465	0.1285	0.1133	0.0152	13.4157
0.0459	0.1266	0.1132	0.0134	11.8375
0.0452	0.1253	0.1130	0.0123	10.8850
0.0446	0.1243	0.1129	0.0114	10.0974
0.0439	0.1235	0.1127	0.0108	9.5830
0.0433	0.1228	0.1126	0.0102	9.0586
0.0427	0.1222	0.1125	0.0097	8.6222
0.0422	0.1217	0.1123	0.0094	8.3704
0.0416	0.1212	0.1122	0.0090	8.0214
0.0411	0.1208	0.1121	0.0087	7.7609
0.0405	0.1204	0.1120	0.0084	7.5000
0.0400	0.1201	0.1119	0.0082	7.3280
0.0395	0.1198	0.1118	0.0080	7.1556
0.0390	0.1195	0.1117	0.0078	6.9830
0.0385	0.1192	0.1116	0.0076	6.8100
0.0381	0.1190	0.1115	0.0075	6.7268
0.0376	0.1188	0.1114	0.0074	6.6427
0.0372	0.1185	0.1114	0.0071	6.3734
0.0367	0.1183	0.1113	0.0070	6.2843
0.0363	[illegible]	[illegible]	[illegible]	[illegible]

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0.0351	0.1179	0.1110	0.0069	6.2162
0.0347	0.1178	0.1110	0.0068	6.1261
0.0343	0.1177	0.1109	0.0068	6.1316
0.0340	0.1176	0.1108	0.0068	6.1372
0.0336	0.1175	0.1108	0.0067	6.0469
0.0332	0.1175	0.1108	0.0067	6.0469
0.0329	0.1174	0.1107	0.0067	6.0524
0.0326	0.1173	0.1107	0.0066	5.9620
0.0322	0.1173	0.1106	0.0067	6.0578
0.0319	0.1172	0.1106	0.0066	5.4675
0.0316	0.1171	0.1105	0.0066	5.9729
0.0313	0.1170	0.1105	0.0065	5.8824
0.0310	0.1170	0.1104	0.0066	5.9782
0.0306	0.1169	0.1104	0.0065	5.8877
0.0304	0.1169	0.1104	0.0065	5.8877
0.0301	0.1168	0.1103	0.0065	5.8930

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RESPONSE ACCELERATION DATA FOR JOINT 20

ELEVATION 710.85

OSCILLATING DAMPING VALUE OF 0.010

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THE FOLLOWING IS A LIST OF THOSE RESPONSE ACCELERATION GREATER THAN 5%
2/3 OF THE CATAWBA FSAR GROUND RESPONSE ACCELERATION :

PERIOD	SPECTRUM "N" GENERATED RESPONSE ACCELERATION	(AMPLIFIED SPECTRUM) ADJUSTED RESPONSE ACCELERATION	a_A CATAWBA FSAR ACCELERATION	AMPLIFICATION ACCELERATION AMPLIFICATION	(H-1)*100 PERCENT INCREASE
4Hz 0.2167	0.4232	0.2381	0.2266	0.0115	5.0906
0.2094	0.5307	0.2387	0.2266	0.0121	5.3394
0.2027	0.4743	0.2411	0.2266	0.0145	6.4169
0.1963	0.4638	0.2418	0.2266	0.0152	6.7188
0.1904	0.5263	0.2424	0.2266	0.0158	6.9715
0.1848	0.4827	0.2431	0.2266	0.0165	7.2667
0.1795	0.4442	0.2452	0.2266	0.0186	8.2095
0.1745	0.4706	0.2455	0.2266	0.0189	8.3582
0.1698	0.5330	0.2460	0.2266	0.0194	8.5761
0.1653	0.4752	0.2464	0.2266	0.0198	8.7165
6Hz 0.1611	0.4381	0.2429	0.2213	0.0216	9.7720
0.1571	0.5048	0.2391	0.2170	0.0222	10.2183
0.1532	0.4595	0.2354	0.2127	0.0227	10.6695
0.1496	0.4696	0.2329	0.2088	0.0242	11.5704
0.1461	0.4985	0.2282	0.2049	0.0232	11.3469
0.1428	0.4593	0.2272	0.2012	0.0260	12.9056
0.1396	0.4668	0.2237	0.1977	0.0260	13.1636
0.1366	0.4624	0.2192	0.1943	0.0249	12.8080
0.1337	0.4817	0.2188	0.1911	0.0278	14.5268
0.1309	0.4003	0.2150	0.1879	0.0271	14.4368
0.1282	0.3837	0.2122	0.1848	0.0274	14.8115
0.1257	0.4265	0.2106	0.1820	0.0286	15.7080
8Hz 0.1232	0.4583	0.2094	0.1791	0.0303	16.9132
0.1208	0.4690	0.2069	0.1764	0.0305	17.2793
0.1186	0.4592	0.2068	0.1738	0.0329	18.9329
0.1164	0.4309	0.2051	0.1713	0.0338	19.7551
0.1142	0.3867	0.2003	0.1687	0.0316	18.7289
9Hz 0.1122	0.4160	0.2001	0.1664	0.0337	20.2312
0.1102	0.4437	0.1988	0.1641	0.0348	21.1963
0.1083	0.4242	0.1952	0.1618	0.0334	20.6141
0.1065	0.3610	0.1933	0.1597	0.0336	21.0191
0.1047	0.3561	0.1932	0.1576	0.0356	22.5817
0.1[illegible]	0.3405	0.1909	0.1556	0.0353	22.7027
0.1[illegible]	0.3539	0.1885	0.1535	0.0349	22.7541
0.0997	0.3703	0.1910	0.1516	0.0394	25.9852
0.0982	0.3376	0.1884	0.1498	0.0386	25.7355
0.0967	0.3447	0.1872	0.1480	0.0392	26.4738
11Hz 0.0938	0.2872	0.1776	0.1445	0.0331	22.8926
0.0911	0.3744	0.1846	0.1412	0.0434	30.7262
0.0885	0.3302	0.1791	0.1380	0.0411	29.7846
0.0861	0.3235	0.1794	0.1351	0.0444	32.8541
0.0838	0.3398	0.1811	0.1322	[illegible]	[illegible]

0.0776	[illegible]	0.1793	0.1244	0.0549	44.1032
0.0757	[illegible]	0.1777	0.1220	0.0557	45.6292
0.0739	[illegible]	0.1786	0.1197	0.0589	49.2023
0.0722	[illegible]	0.1756	0.1176	0.0581	49.3976
0.0706	[illegible]	0.1750	0.1155	0.0595	51.5167
0.0690	[illegible]	0.1676	0.1134	0.0541	47.7185
0.0675	0.2276	0.1632	0.1116	0.0516	46.2076
0.0661	0.2087	0.1614	0.1097	0.0517	47.1790
0.0648	0.1989	0.1539	0.1080	0.0459	42.5394
0.0635	0.1725	0.1409	0.1062	0.0346	32.5902
0.0622	0.1534	0.1276	0.1045	0.0230	22.0365
0.0610	0.1402	0.1190	0.1029	0.0160	15.5811
0.0598	0.1394	0.1175	0.1013	0.0162	15.9733
0.0587	0.1349	0.1135	0.0999	0.0136	13.6478
0.0576	0.1379	0.1157	0.0984	0.0173	17.5618
0.0566	0.1459	0.1173	0.0970	0.0203	20.8782
0.0556	0.1401	0.1121	0.0957	0.0164	17.1403
0.0546	0.1440	0.1146	0.0943	0.0203	21.5190
0.0537	0.1434	0.1131	0.0931	0.0200	21.5253
0.0528	0.1583	0.1218	0.0919	0.0249	32.5794
0.0519	0.1606	0.1234	0.0906	0.0328	36.2171
0.0511	0.1613	0.1218	0.0895	0.0322	36.0032
0.0503	0.1580	0.1193	0.0884	0.0309	34.9273

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Attachment 2

Confirmatory Issue (8)

Vertical seismic response spectra (SER Section 3.9.2.2)

Response:

Attached is a copy of the stress report for the Refueling Water Storage Tanks.

ME - 311

SEISMIC - STRESS ANALYSIS

OF

ASME SECTION III, CLASS 2 TANKS

FOR

DUKE POWER COMPANY

CATAWBA NUCLEAR STATION UNITS 1and 2

MILL POWER P. O. NO. C - 39969

TANK	SPECIFICATION	DUKE DRAWING
Refueling Water Storage	CNS – 1148.00–03	CN – 1325 – 02

MANUFACTURED BY

RICHMOND ENGINEERING COMPANY, INC.

Analysis By

McDONALD ENGINEERING ANALYSIS COMPANY

BIRMINGHAM, ALABAMA

REVISED 1/14/77 CKM

ME-311

CERTIFICATION STATEMENT

This tank and foundation has been analyzed in accordance with Duke Power Company Specification CNS-1148.00-03, the ASME Boiler and Pressure Vessel Code, Section III, Class 2, ACI-318-71 and accepted good practice in seismic stress analysis.

The tank and foundation meets all requirements of the specification and is structurally adequate to withstand Normal, Upset, Faulted, and Tornado Loading conditions.

Prepared by:	J. H. Appleton (Foundation, App. E) P.E.	5/10/76 Date
	C. K. McDonald (Tank), P.E.	1/14/77 R1 Date
Checked by:	T. K. Hicks, P.E.	1/14/77 R1 Date
Approved by:	C. K. McDonald McDonald Engineering Analysis Co.	1/14/77 R1 Date
Approved by:	Grayson A. Harding, P. E. Richmond Engineering Company	6-1-77 R1 Date

2. SUMMARY OF RESULTS

2.1 Normal

Component	Actual	Allowable
Anchor Bolts Stress, PSI - Tensile	276	40,000
- Shear	376	12,320
Concrete Compressive Stress, PSI	342	1,250
Support Ring Stress, PSI	16,104	27,900
Anchor Chair Stress, PSI		
Top Plate	192	21,750
Shell	111	27,900
Vertical Plates	176	21,750
Bearing in Bottom Plate	472	27,000
Roof Pressure, PSIG	.21	.443
Shell Compressive Stress, PSI		
Ring #1	322	4,688
Ring #2	243	4,219
Ring #3	226	3,281
Ring #4	223	2,344
Ring #5	196	1,875
Shell Tensile Stress, PSI	7,085	18,600
Nozzle Stresses, PSI		
Mark A (4" Nozzle)	19,564	55,800
Mark B (24" Nozzle)	27,694	55,800
Mark C (6" Nozzle)	20,872	55,800
Mark D (4" Nozzle)	19,564	55,800
Mark E (3" Nozzle)	13,042	55,800
Mark G (8" Nozzle)	27,685	55,800
Mark H and J (1" Nozzle)	8,575	55,800

2.2 Upset

Component	Actual	Allowable
Anchor Bolts Stress, PSI - Tensile	15,718	40,000
- Shear	5,736	12,320
Concrete Compressive Stress, PSI	342	1,250
Support Ring Stress, PSI	16,104	27,900
Anchor Chair Stress, PSI		
Top Plate	10,933	21,750
Shell	6,321	27,900
Vertical Plates	10,004	21,750
Bearing in Bottom Plate	7,208	27,000
Roof Pressure, PSIG	.23	.443
Shell Compressive Stress, PSI		
Ring #1	2,818	4,688
Ring #2	2,186	4,219
Ring #3	1,786	3,281
Ring #4	1,319	2,344
Ring #5	617	1,875
Shell Tensile Stress, PSI	10,856	18,600
Nozzle Stresses, PSI		
Mark A	44,124	55,800
Mark B	52,075	55,800
Mark C	41,744	55,800
Mark D	44,124	55,800
Mark E	31,077	55,800
Mark G	52,041	55,800
Mark H and J	13,842	55,800

2.3 Faulted

Component	Actual	Allowable
Anchor Bolts Stress, PSI - Tensile	31,008	38,749
- Shear	11,068	14,784
Concrete Compressive Stress, PSI	642	1,666
Support Ring Stress, PSI	30,177	33,480
Anchor Chair Stress, PSI		
Top Plate	21,568	26,100
Shell	12,469	33,480
Vertical Plates	19,736	26,100
Bearing in Bottom Plate	13,908	32,400
Roof Pressure,	.25	.53
Shell Compressive Stress, PSI		
Ring #1	5,290	5,625
Ring #2	4.119	5,063
Ring #3	3,335	3,937
Ring #4	2,401	2,813
Ring #5	1,023	2,250
Shell Tensile Stress, PSI	14,630	22,320
Nozzle Stresses, PSI		
Mark A	58,902	66,960
Mark B	66,154	66,960
Mark C	52,180	66,960
Mark D	58,902	66,960
Mark E	42,594	66,960
Mark G	66,134	66,960
Mark H and J	18,361	66,960

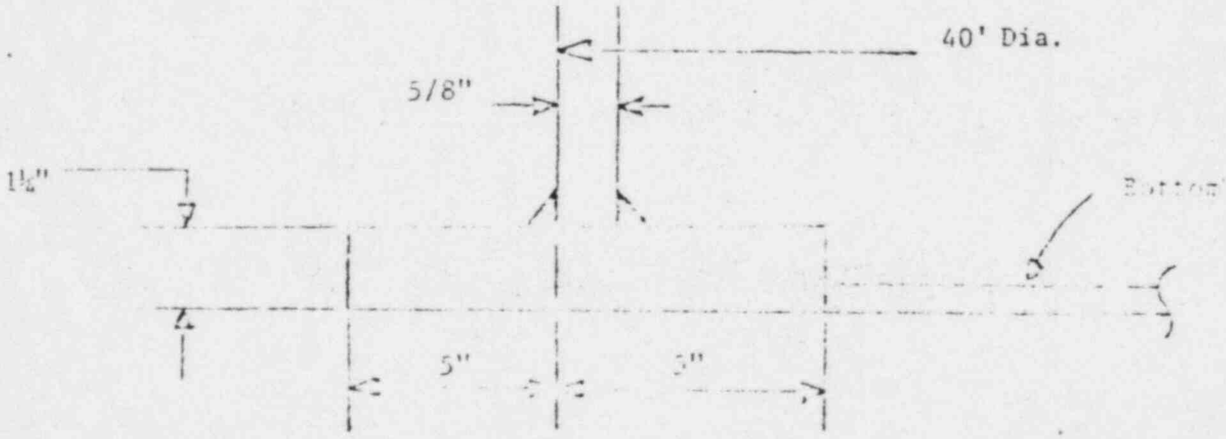
$$S = \frac{4(574305326)}{48(485)(3.1416)} - \frac{60598}{48(3.1416)} = 31{,}008 \text{ psi tensile}$$

$$V = \frac{1669072}{48(3.1416)} = 11{,}068 \text{ psi shear}$$

The allowable stresses are 38,749 psi tensile and 14,784 psi shear.

5.2 Concrete Compressive Stress

The tank has a support ring as shown below which transfers the overturning moment into the foundation.



The loads are the same as in Section 5.1 except the nozzle loads and seismic act downward and snow is added.

The concrete compressive stresses are obtained by the method of Brownell and Young, "Process Equipment Design", John Wiley & Sons, First Corrected Printing, Chapter 10. The anchor bolt stresses are also obtained, but since the method of Section 5.1 is more conservative for the anchor bolts, it is recommended that the stresses of Section 5.1 be used for the bolts.

The nomenclature is that of the Reference. Some of the parameters are:

$$n = 6 \qquad t_3 = 10'' \qquad t_1 = \frac{48(3.1416)}{3.1416(485)} = .099''$$

The normal case is not given since it is trivial.

(a) Upset

$K = .15; \quad C_c = 1.049; \quad C_t = 2.772; \quad Z = .469; \quad j = .771$

$$P_t = \frac{297046998 - 180427(.469)(485)}{(.771)(485)} = 684{,}621 \text{ lbs.}$$

$$f_s = \frac{684627}{(.099)(242.5)(2.772)} = 10{,}288 \text{ psi}$$

$$F_c = 684627 + 180427 = 865{,}054 \text{ lbs.}$$

$$f_c = \frac{865054}{(10 + 6(.099))(242.5)(1.049)} = 321 \text{ psi}$$

Check: $k = \frac{1}{1 + \frac{10288}{6(321)}} = .157$ O.K. $\quad f_{cmax} = 321(162.29/152.29) = 342$ psi

(b) <u>Faulted</u>

$k = .15; \quad C_c = 1.049; \quad C_t = 2.772; \quad Z = .469; \quad j = .771$

$$F_t = \frac{574305326 - 199455(.469)(485)}{(.771)(485)} = 1{,}414{,}514 \text{ lbs.}$$

$$f_s = \frac{1414514}{(.099)(242.5)(2.772)} = 21{,}255 \text{ psi}$$

$$F_c = 1414514 + 199455 = 1{,}613{,}969 \text{ lbs.}$$

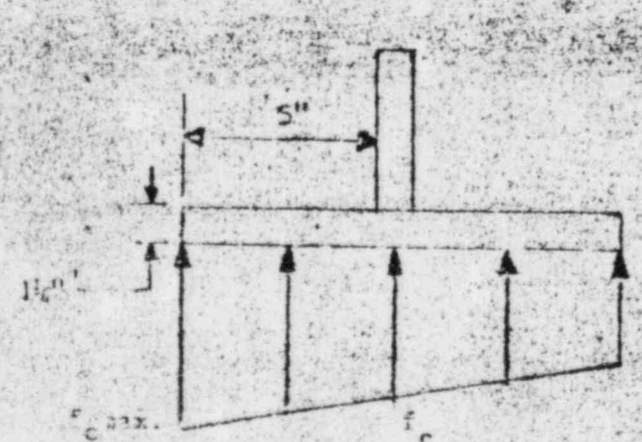
$$f_c = \frac{1613969}{(10 + 6(.099))(242.5)(1.049)} = 599 \text{ psi}$$

Check: $k = \frac{1}{1 + \frac{21255}{6(599)}} = .145$ O.K. $\quad f_{cmax} = 599(150.65/140.65) = 642$ psi

The allowable concrete compressive stresses for 5,000 psi concrete are 1,250 psi Normal and Upset and 1,666 psi Faulted per the AISC Code.

5.3 Support Ring Stress

The ring of Section 5.2 is subjected to bending stress due to the concrete compression. The stresses act as shown below.



Thus, the bending moment in the plate per inch of width is:

$M = 5(f_c)(2.5) + (f_c max - f_c)(2.5)(5)(2/3)$ where f_c and $f_c max$ are the stresses from Section 5.2. Thus the moments are:

$$M = 5(321)(2.5) + (342 - 321)(2.5)(5)(2/3) = 4,187 \text{ in-lbs.}$$

$$M = 5(599)(2.5) + (642 - 599)(2.5)(5)(2/3) = 7,846 \text{ in-lbs.}$$

The section modulus of the plate is:

$$Z = \frac{1.25^2}{6} = .260 \quad \text{in.}^3/\text{in.}$$

and the stress is:

$$S = \frac{4187}{.26} = 16,104 \text{ psi Upset}$$
$$= 30,177 \text{ psi Faulted}$$

The allowable stresses are 1.5(18,600) = 27,900 psi Normal and Upset and 33,480 Faulted.

5.4 Anchor Bolt Chairs

The anchor bolt loads can be obtained by multiplying the stress in Section 5.1 by the bolt area. Thus the loads are:

Thus, the stress is:

$$S = \frac{2.5(867)}{12.34} \begin{array}{l} = 176 \text{ psi Normal} \\ = 10{,}004 \text{ psi Upset} \\ = 19{,}736 \text{ psi Faulted} \end{array}$$

The allowable stress is 1.5(14500) = 21,750 psi Normal and Upset and 26,100 psi Faulted

(d) Bearing in Bottom Plate

The shearing load in the bolt imposes bearing stress in the 1¼" bottom plate. This stress is:

$$V = \frac{R}{1.25(2.0)} = \frac{R}{2.5}$$

Thus V = 472 psi Normal
= 7,208 psi Upset
= 13,908 psi Faulted

The allowable bearing stress per Appendix XVII - 2216 is .9(30,000) = 27,000 psi Normal and Upset and 32,400 psi Faulted.

5.5 Roof Stresses

The roof must be checked for the compressive stresses due to snow, deadweight, and seismic, and the tensile stress due to the 3 psi tornado induced vacuum.

The allowable compressive stress is obtained from ASME Code Section NC-3133.4.

$$\frac{R}{T} = \frac{480}{.25} = 1,920$$

From Figure VII-1102-4:

B = 850

$$\text{Thus } P_a = \frac{850}{1920} \begin{array}{l} = .443 \text{ psig Normal \& Upset} \\ = .53 \text{ psig Faulted} \end{array}$$

(a) Normal

ME-311

CERTIFICATION STATEMENT

This tank and foundation has been analyzed in accordance with Duke Power Company Specification CNS-1148.00-03, the ASME Boiler and Pressure Vessel Code, Section III, Class 2, ACI-318-71 and accepted good practice in seismic stress analysis.

The tank and foundation meets all requirements of the specification and is structurally adequate to withstand Normal, Upset, Faulted, and Tornado Loading conditions.

Prepared by:	J. H. Appleton J. H. Appleton (Foundation, App. E) P.E.	5/10/76 Date
	C K McDonald C. K. McDonald (Tank), P.E.	6/24/76 Date
Checked by:	T. K. Hicks T. K. Hicks, P.E.	6/24/76 Date
Approved by:	C K McDonald C. K. McDonald McDonald Engineering Analysis Co.	6/24/76 Date
Approved by:	Jerry L. Dawson J. L. Dawson, V. P. Engineering Richmond Engineering Company	6/25/76 Date

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1. INTRODUCTION

This report covers the structural and seismic analysis of the Refueling Water Storage Tank and its foundation. The tank is shown on Duke Power Company Drawing CN-1325-02, Revision 2. A dimensional sketch of the tank and foundation is shown on page 2 of this report.

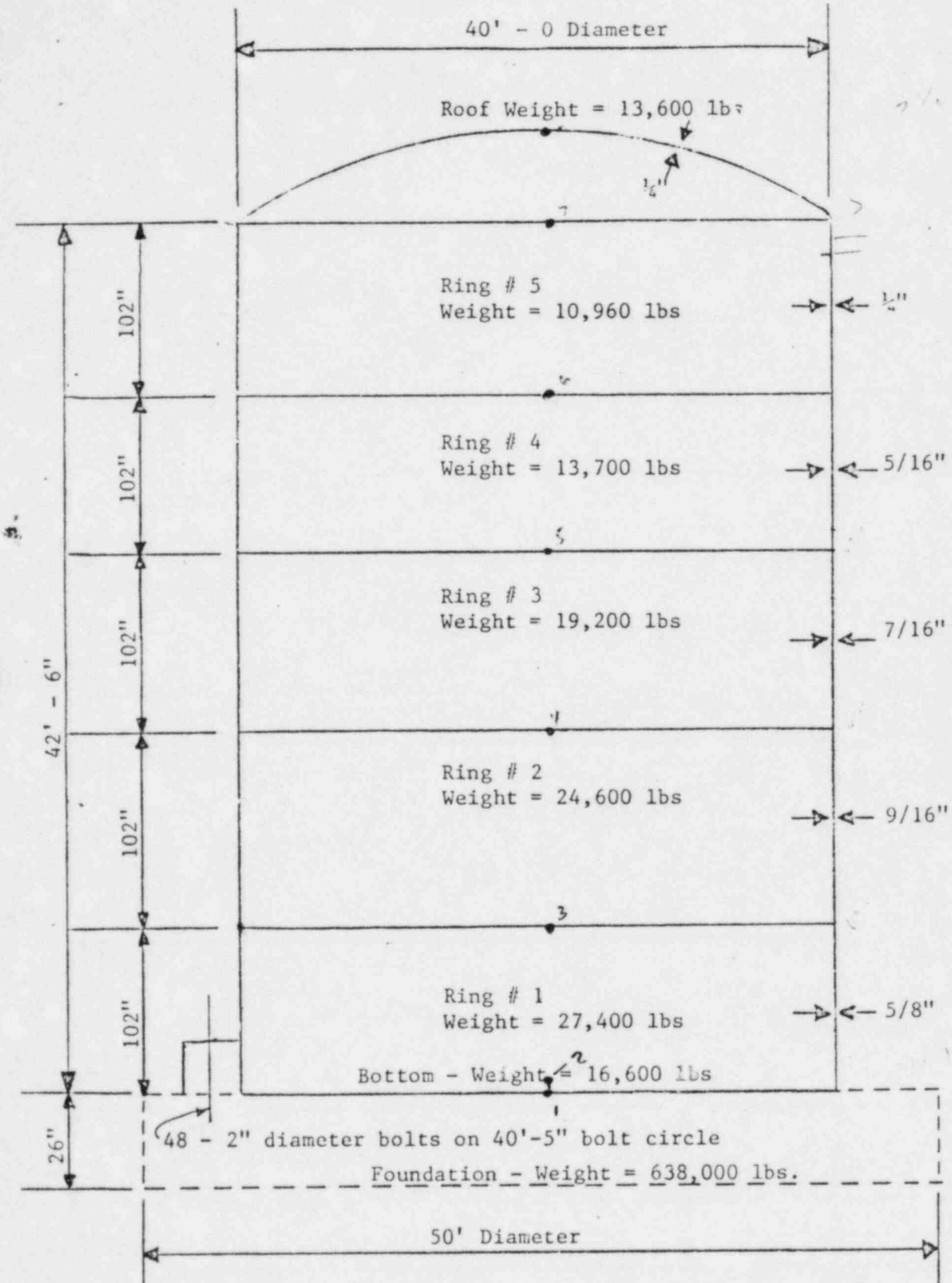
The lateral frequency of the tank was checked for both the sloshing and no sloshing conditions. The no sloshing condition was the worst case.

The localized nozzle stresses are treated as nozzles in a flat plate by use of Roark's Formulas for Stress and Strain (Ref. 1). This was done because the tank parameters are not within the range of Welding Research Council Bulletin 107, the usual technique used. The flat plate approach is believed to be very conservative.

The soil structure interaction was included by the use of soil springs. The soil springs were calculated by use of equations given by Richart, Hall, and Woods (Ref. 5), page 350, Table 10-13. The Poissons ratio of the soil (.33) and damping of the combined soil/shell first mode (5%), not given in the specification, was obtained by direct communication with Duke Power.

There are two Faulted conditions for this tank. These are the Normal + SSE and Normal + Tornado conditions. From the loadings given in Section 4, it is obvious that the Normal + SSE case governs for most of the stress calculations. For those conditions where it is not obvious that the Normal + SSE case governs, the Normal + Tornado case is also calculated.

FIGURE 1 - TANK OUTLINE SKETCH



1) See page E-9 for foundation reinforcing steel
2) See pages 25-30 for reinforcing pad sizes required

2. SUMMARY OF RESULTS

2.1 Normal

Component	Actual	Allowable
Anchor Bolts Stress, PSI - Tensile	276	40,000
- Shear	376	12,320
Concrete Compressive Stress, PSI	20	750
Support Ring Stress, PSI	1,500	27,900
Anchor Chair Stress, PSI		
Top Plate	192	21,750
Shell	111	27,900
Vertical Plates	176	21,750
Bearing in Bottom Plate	591	27,000
Roof Pressure, PSIG	.21	.443
Shell Compressive Stress, PSI		
Ring #1	322	4,688
Ring #2	243	4,219
Ring #3	226	3,281
Ring #4	223	2,344
Ring #5	196	1,875
Shell Tensile Stress, PSI	7,085	18,600
Nozzle Stresses, PSI		
Mark A (4" Nozzle)	19, [illegible]4	55,800
Mark B (24" Nozzle)	27,694	55,800
Mark C (6" Nozzle)	20,872	55,800
Mark D (4" Nozzle)	19,564	55,800
Mark E (3" Nozzle)	13,042	55,800
Mark G (8" Nozzle)	27,685	55,800
Mark H and J (1" Nozzle)	8,575	55,800

2.2 Upset

Component	Actual	Allowable
Anchor Bolts Stress, PSI - Tensile	15,718	40,000
- Shear	5,736	12,320
Concrete Compressive Stress, PSI	179	750
Support Ring Stress, PSI	13,428	27,900
Anchor Chair Stress, PSI		
Top Plate	10,933	21,750
Shell	6,321	27,900
Vertical Plates	10,004	21,750
Bearing in Bottom Plate	9,010	27,000
Roof Pressure , PSIG	.23	.443
Shell Compressive Stress, PSI		
Ring #1	2,818	4,688
Ring #2	2,186	4,219
Ring #3	1,786	3,281
Ring #4	1,319	2,344
Ring #5	617	1,875
Shell Tensile Stress, PSI	10,856	18,600
Nozzle Stresses, PSI		
Mark A	44,124	55,800
Mark B	52,075	55,800
Mark C	41,744	55,800
Mark D	44,124	55,800
Mark E	31,077	55,800
Mark G	52,041	55,800
Mark H and J	13,842	55,800

2.3 Faulted

Component	Actual	Allowable
Anchor Bolts Stress, PSI - Tensile	31,008	38,749
- Shear	11,068	14,784
Concrete Compressive Stress, PSI	337	1,000
Support Ring Stress, PSI	25,278	33,480
Anchor Chair Stress, PSI		
Top Plate	21,568	26,100
Shell	12,469	33,480
Vertical Plates	19,736	26,100
Bearing in Bottom Plate	17,386	32,400
Roof Pressure ,	.25	.53
Shell Compressive Stress, PSI		
Ring #1	5,290	5,625
Ring #2	4.119	5,063
Ring #3	3,335	3,937
Ring #4	2,401	2,813
Ring #5	1,023	2,250
Shell Tensile Stress, PSI	14,630	22,320
Nozzle Stresses, PSI		
Mark A	58,902	66,960
Mark B	66,154	66,960
Mark C	52,180	66,960
Mark D	58,902	66,960
Mark E	42,594	66,960
Mark G	66,134	66,960
Mark H and J	18,361	66,960

3. FREQUENCY ANALYSIS

3.1 Lateral Frequencies

(a) Completely Filled Condition

The completely filled condition is analyzed by use of the stick model shown on page 8 and the ICES-STRUDL code. The soil spring constants are calculated by use of Table 10-13, page 350, of Reference 5. These are:

$G = 70{,}000$ psi $\qquad \upsilon = .33 \qquad r_o = 25' = 300''$

Vertical

$$K_y = \frac{4(70000)(300)}{1 - .33} = 125{,}373{,}134 \text{ lb/in.}$$

Lateral

$$K_x = \frac{32(1 - .33)(70000)(300)}{7 - 8(.33)} = 103{,}266{,}055 \text{ lb/in.}$$

Rocking

$$K_{MZ} = \frac{8(70000)(300)^3}{3(1 - .33)} = 7{,}522{,}388{,}059{,}701 \text{ in-lbs./radians}$$

The weights are based upon the tank being filled to the overflow nozzle, see page 2 for dimensions. Additional weight was included for nozzles, chairs, etc.

No soil weight was included at Joint 1 for lateral motion but since it is believed that some soil will move with the foundation vertically, a conservative amount of soil was included at Joint 1 for vertical motion.

The computer input data is included on pages A-1 & A-2. The frequencies are given below. The lowest frequency is seen to be 5.99 cps.

```
FIGENVALLES
MODE-------EIGENVALUE-------FREQUENCY--------PERICD---/
  1      3.5344720 C1
  2      4.0737410 C2       5.9870460 CC       1.6702730-01
  3      1.5222210 03       2.0183510 C1       4.9545350-C2
  4      1.9480270 C3       3.3945800 C1       2.9458670-02
  5      2.3009080 C3       4.4136400 01       2.2657010-02
  6      4.2270770 C3       5.3487400 C1       1.8695970-C2
  7      1.0303990 C5       6.5015980 01       1.53808[illegible]
  [illegible]
```

The mode shapes are given in Appendix D.

(b) Sloshing Condition

Sloshing is checked per A.E.C. T.I.D. 7024 (Ref. 2). The nomenclature is per T.I.D. 7024.

$$1.84\frac{(h)}{R} = (1.84)\frac{42.5}{20} = 3.91$$

$$\text{Tanh}(3.91) = .992$$

$$\omega^2 = \frac{1.84(32.2)(.992)}{20} = 2.94$$

$$f = .27 \text{ cps}$$

The spectra curve shows that this low frequency gives a much lower seismic load than is obtained by use of the no sloshing case. Thus the no sloshing case is the worst and is used henceforth in the analysis.

3.2 Vertical Frequencies

The model, page 8, used for the lateral frequency analysis is also used for the vertical analysis. However, the roof much be checked for its frequency. The equation for the lowest mode of the roof is given by Kraus, Ref. 6, pages 316-319. Thus:

$$R/a = 2$$

$$\omega^2 = \frac{.97121E}{\rho R^2}$$

$$E = 29 \times 10^6 \text{ psi}$$

$$\rho = .285/386 = .0007383$$

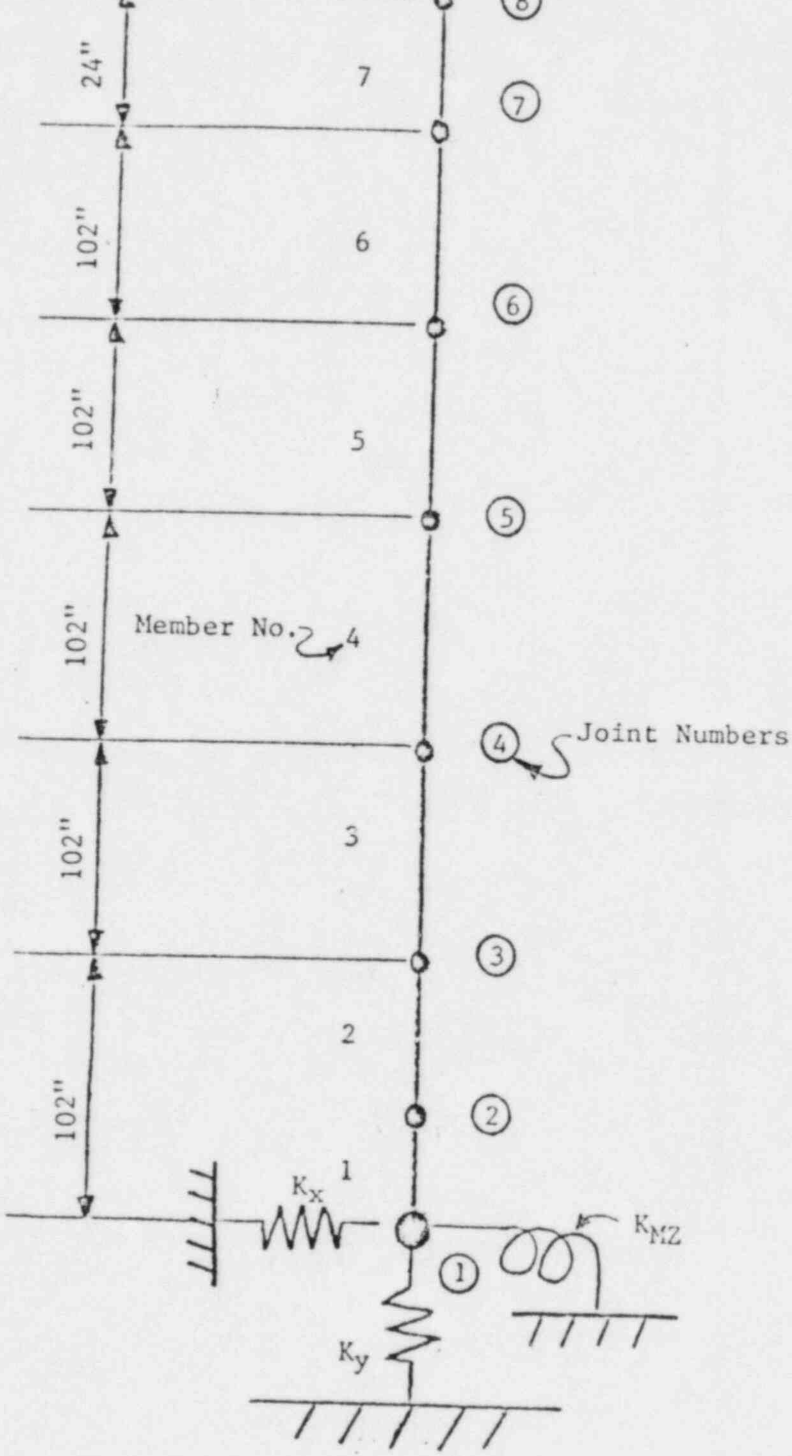
$$R = 40' = 480''$$

Thus:

$$f = \frac{\omega}{2\pi} = 64.76 \text{ cps}$$

and the roof is rigid and can be included in the stick model.

As mentioned previously, an amount of soil is included at Joint 1 for


24"
102"
102"
102"
102"
102"
7
6
5
Member No.
4
3
2
1
8
7
6
5
4
Joint Numbers
3
2
1
K_x
K_MZ
K_y

the vertical analysis. The weight of soil was selected conservatively since some authors do not include any soil weight in the model and other authors include various amounts.

The computer input is given on pages A-3 and A-4 and the frequencies are given below:

EIGENVALUES

MODE	EIGENVALUE	FREQUENCY	PERIOD
1	2.535438D 02	1.592306D 01	6.280200D-02
2	7.617490D 03	8.727324D 01	1.145761D-02
3	4.704019D 04	2.168875D 02	4.610655D-03
4	1.368962D 05	3.699949D 02	2.702740D-03
5	2.385752D 05	4.884416D 02	2.047327D-03
6	3.393807D 05	5.825639D 02	1.716550D-03
7	1.108370D 06	1.052792D 03	9.498558D-04
8	1.385110D 06	1.176907D 03	8.496948D-04

The mode shapes are given in Appendix D.

4. LOADING CRITERIA

4.1 Seismic Loading

The seismic loadings obtained from the spectra curves are:

Lateral OBE

Mode	Frequency	Loading
1	5.99	.3g
2	20.2	.13g
3	33.95	.13g
4	44.13	.13g
5	53.5	.13g

Vertical OBE

Mode	Frequency	Loading
1	15.9	.12g
2	87.3	.09g

The SSE loads are twice the OBE loads.

The computer input for the ICES-STRUDL analysis (IBM 370/158 computer) is given in Appendix A and the output in Appendix B.

4.2 Individual Nozzle Loadings

The nozzle loads are calculated in accordance with the specification. The attached piping is assumed to be of the same schedule and size as the nozzle pipe. The loads are:

Nozzle	Normal	Upset	Faulted
1" Size			
F_x, F_y, F_z, lbs.	128	256	320
M_x, M_y, M_z, in-lbs.	322	644	805
3" Size			
F_x, F_y, F_z, lbs.	446	892	1115
Mx, My, Mz, lbs.	3448	6896	8620

Nozzle	Normal	Upset	Faulted
4" Size			
F_x, F_y, F_z, lbs.	634	1268	1585
M_x, M_y, M_z, in-lbs.	6440	12880	16100
6" Size			
F_x, F_y, F_z, lbs.	1116	2232	2790
M_x, M_y, M_z, in-lbs.	17000	34000	42500
8" Size			
F_x, F_y, F_z, lbs.	1680	3360	4200
M_x, M_y, M_z, in-lbs.	33620	67240	84050
24" Size			
F_x, F_y, F_z, lbs.	5560	11120	13900
M_x, M_y, M_z, in-lbs.	323800	647600	809500

4.3 Nozzle Loads on Tank and Support

Since Unit 1 and Unit 2 has different nozzle orientations, the worst case orientations for resultant overturning of the tank are assumed. The resultant shear on the nozzle is assumed to act upward (downward) for the worst case.

(a) Loads on the Support

The Normal loads are tabulated below:

Mark	Resultant Shear, Lbs.	Axial Load, Lbs.	Result. Bending Mom., in-lbs
A	634	897	546,921
B	5560	7862	2,627,028
C	1578	1116	1,095,795
D	634	897	230,397
E	446	631	382,753
G	6720	9502	2,757,006
H	384	543	139,673
J	384	543	143,513
SRSS	8867	12,537	4,030,128

Upset and Faulted are 2 and 2.5 times the Normal loads.

(b) Loads on the Upper Portion of Tank

Nozzles A, C, and E impose loads in the shell above the first shell ring. All other nozzles are located in the first ring. The bending moment is as follows:

$M = 674,860 + 2658\ X$ in-lbs.

$P = 2644$ lbs. axial load

X is distance from roof/shell intersection, inches.

4.4 Tornado Loads

The tornado loads are 60 mph translational and 300 mph rotational for a total wind load of 360 mph. This is equal to 324 pounds per square foot of projected area (using a .60 shape factor). Thus the tornado wind loads are as follows:

(a) Loads at the Support

$V = 324(40)(47.86) = 620,266$ lbs. Shear

$M = 620266\left(\frac{47.86}{2}\right)(12) = 178,115,585$ in-lbs.

(b) Loads on Upper Portion of Tank

$M = 2,234,014 + 540\ X^2 + 69466\ X$ in-lbs.

X = distance in inches from shell/roof intersection.

In addition to the above loads, the tornado induces a 3 psi vacuum.

4.5 Other Normal Loads

(a) Atmospheric pressure at 120^{o} F.

(b) Snow load of 20 PSF on projected roof area.

Total snow load = $20(.785)(40)^2 = 25,120$ lbs.

(c) Wind load of 95 mph at 30 ft. above ground. For simplicity a conservative 25 PSF is used for the length of the tank. Thus the loads at the base are: $V = 25(40)(47.86) = 47,860$ lbs. shear

$$M = 47,860\frac{(47.86)}{2}(12) = 13,743,478 \text{ in-lbs.}$$

$$M = 172378 + 41.67 X^2 + 5360 X \quad (\text{X as in Section 4.4})$$

5. DETAILED STRESS ANALYSIS

5.1 Anchor Bolts

The anchor bolts are checked by Equation 43, page 26, of Reference 3. The loads on the support are given in Section 4 and Appendix B. There are 48 - 2" diameter A-325 bolts on a 40' - 5" bolt circle.

(a) Normal (Wind + Nozzles + Deadweight)

$$M = 13{,}743{,}478 + 4{,}030{,}128 = 17{,}773{,}606 \text{ in-lbs.}$$

$$R = 8867 + 47860 = 56{,}727 \text{ lbs. shear}$$

$$P = 117{,}460 - 12{,}537 = 104{,}923 \text{ lbs. Down}$$

$$S = \frac{4(17773606)}{48(485)(3.1416)} - \frac{104923}{48(3.1416)} = 276 \text{ psi tensile}$$

$$V = \frac{56727}{48(3.1416)} = 376 \text{ psi shear}$$

The allowable stresses are 40,000 psi tensile and 12,320 psi shear per Appendix XVII.

(b) Upset (Normal + OBE)

$$M = 2(4030128) + 13743478 + 275{,}243{,}264 = 297{,}046{,}998 \text{ in-lbs.}$$

$$R = 2(8867) + 47860 + 799522 = 865{,}116 \text{ lbs.}$$

$$P = 117{,}460 - 2(12537) - 12760 = 79{,}626 \text{ lbs.}$$

$$S = \frac{4(297046998)}{48(485)(3.1416)} - \frac{79626}{48(3.1416)} = 15{,}718 \text{ psi tensile}$$

$$V = \frac{865116}{48(3.1416)} = 5{,}736 \text{ psi shear}$$

The allowable stresses are 40,000 psi tensile and 12,320 psi shear.

(c) Faulted (Normal + SSE)

$$M = 13743478 + 2.5(4030128) + 2(275243264) = 574{,}305{,}326 \text{ in-lbs.}$$

$$R = 2.5(8867) + 47860 + 2(799522) = 1{,}669{,}072 \text{ lbs.}$$

$$P = 117{,}460 - 2.5(12537) - 2(12760) = 60{,}598 \text{ lbs.}$$

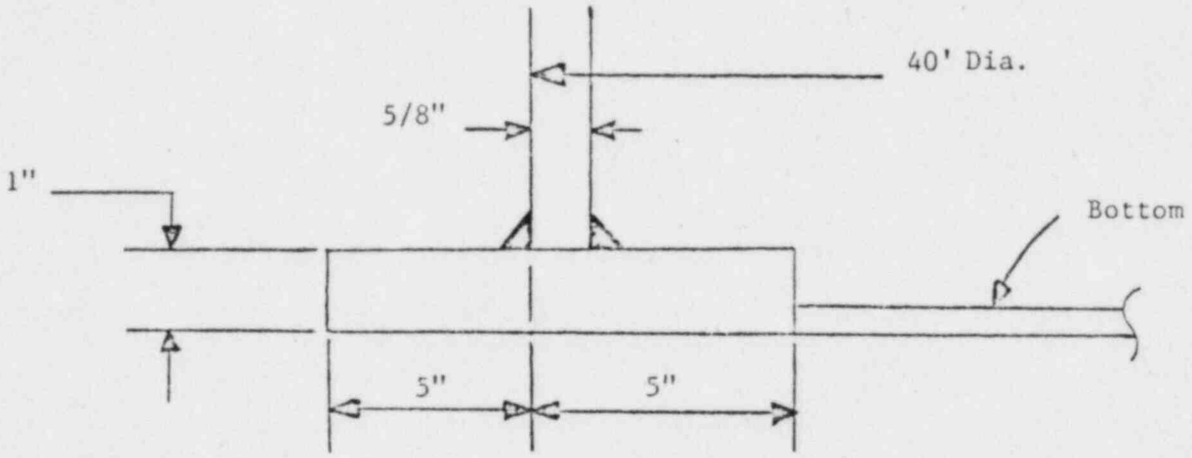
$$S = \frac{4(574305326)}{48(485)(3.1416)} - \frac{60598}{48(3.1416)} = 31{,}008 \text{ psi tensile}$$

$$V = \frac{1669072}{48(3.1416)} = 11{,}068 \text{ psi shear}$$

The allowable stresses are 38,749 psi tensile and 14,784 psi shear.

5.2 Concrete Compressive Stress

The tank has a support ring as shown below which transfers the overturning moment into the foundation.



The properties of the ring which imposes stress into the concrete are:

$$A = .785(490^2 - 470^2) = 15{,}072 \text{ in.}^2$$

$$Z = \frac{3.1416(490^4 - 470^4)}{64(245)} = 1{,}773{,}397 \text{ in.}^3$$

The loads are the same as in Section 5.1 except the nozzle loads and seismic act downward and snow is added. Thus the compressive stresses are:

$$S = \frac{17773606}{1773397} + \frac{155130}{15072} = 20 \text{ psi Normal}$$

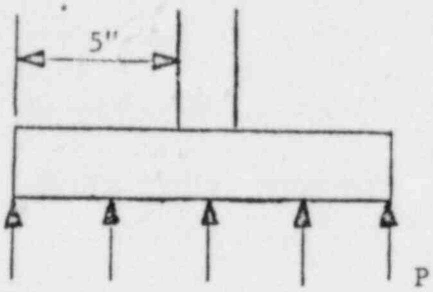
$$S = \frac{297046998}{1773397} + \frac{180427}{15072} = 179 \text{ psi Upset (Normal + OBE)}$$

$$S = \frac{574305326}{1773397} + \frac{199455}{15072} = 337 \text{ psi Faulted (Normal + SSE)}$$

The allowable stresses for 3,000 psi concrete are 750 psi Normal and Upset and 1,000 psi Faulted per the A.I.S.C. Code.

5.3 Support Ring Stress

The ring of section 5.2 is subjected to bending stress due to the concrete compression. The stresses act as shown below:



Thus the bending moment in the plate per inch of width is:

M = 5(P)(2.5) = 12.5 P where P is the stress from Section 5.2.

Thus the moments are:

M = 12.5(20) = 250 in-lbs. Normal

= 12.5(179) = 2,238 in-lbs. Upset

= 12.5(337) = 4,213 in-lbs. Faulted (Normal plus SSE)

The section modulus of the plate is:

$Z = \frac{(1)^2}{6}$ in.^{3}/in.

and the stress is:

S = 250(6) = 1,500 psi Normal

= 2238(6) = 13,428 psi Upset (Normal + OBE)

= 4213(6) = 25,278 psi Faulted (Normal + SSE)

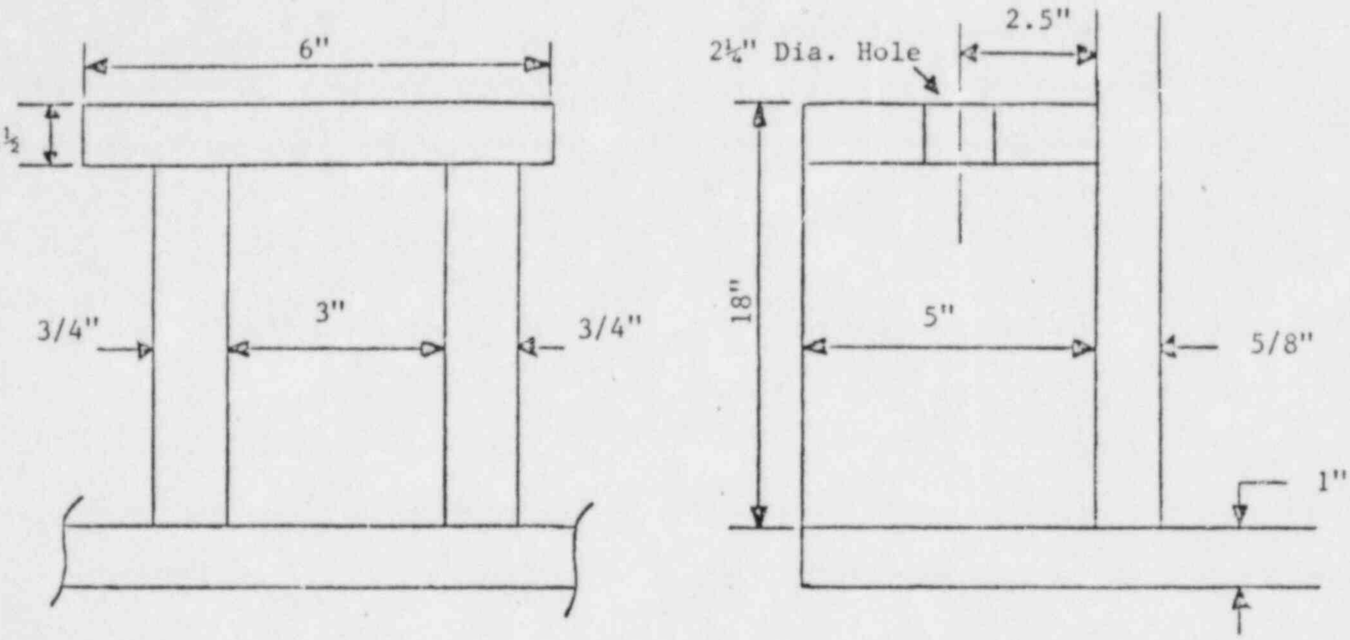
The allowable stresses are 1.5(18600) = 27,900 psi Normal and Upset and 33,480 psi Faulted.

5.4 Anchor Bolt Chairs

The anchor bolt loads can be obtained by multiplying the stress in Section 5.1 by the bolt area. Thus the loads are:

	Normal	Upset	Faulted (Normal plus SSE)
P (uplift), Lbs.	867	49,380	97,415
R (shear), Lbs.	1,181	18,020	34,771

The chair is as shown below:



(a) Top Plate

The stress in the top plate is given by:

$$S = \frac{P((.375)(3) - .22(2))}{1.375(1.5)^2} = .2214\ P$$

Thus, the stress is:

S = 192 psi Normal

= 10,933 psi Upset

= 21,568 psi Faulted

The allowable stress is 1.5(14500) = 21,750 psi Normal and Upset and 26,100 psi Faulted.

(b) Shell

The stress in the shell is given Equation 46 of Reference 3.

$$S = \frac{.9P(2.5)\sqrt[4]{240(.625)}}{18\sqrt{6}\,(1^2 + .625)^2} = .128\ P$$

Thus, the stress is:

S = 111 psi Normal; 6,321 psi Upset; 12,469 psi Faulted

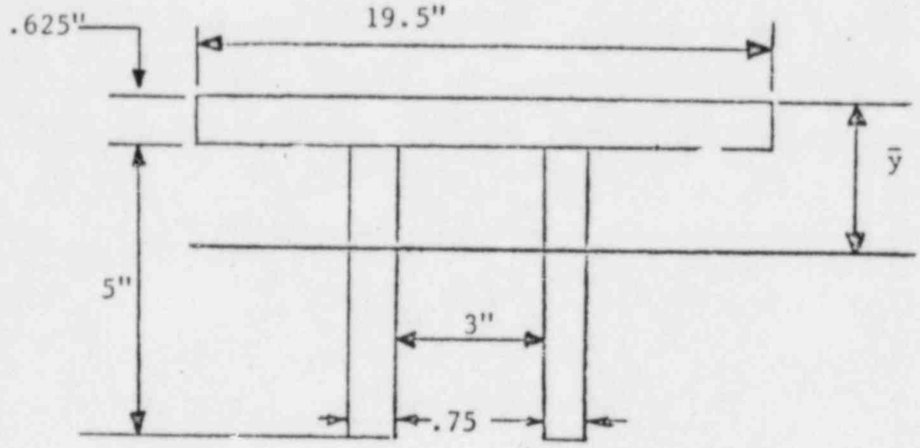
The allowable stress is 1.5(18600) = 27,900 psi Normal and Upset and 33,480 psi Faulted.

(c) Bending in Vertical Plate

The bending moment in the plates is:

$$M = 2.5\ P$$

The section modulus of the plates/shell composite is:



$$\bar{y} = \frac{19.5(.625)(.3125) + 2(.75)(5)(3.125)}{12.1875 + 7.5} = 1.384"$$

$$I = \frac{2(.75)(5)^3}{12} + 7.5(3.125 - 1.384)^2 + 12.1875(1.384 - .312)^2$$

$$= 52.36 \text{ in.}^4$$

$$Z = \frac{52.36}{4.241} = 12.34 \text{ in.}^3$$

Thus, the stress is:

$$S = \frac{2.5(867)}{12.34} \begin{array}{l} = \quad 176 \text{ psi Normal} \\ = 10{,}004 \text{ psi Upset} \\ = 19{,}736 \text{ psi Faulted} \end{array}$$

The allowable stress is 1.5(14500) = 21,750 psi Normal and Upset and 26,100 psi Faulted

(d) Bearing in Bottom Plate

The shearing load in the bolt imposes bearing stress in the 1" bottom plate. This stress is:

$$V = \frac{R}{1(2.0)} = \frac{R}{2.0}$$

Thus V = 591 psi Normal
= 9,010 psi Upset
= 17,386 psi Faulted

The allowable bearing stress per Appendix XVII - 2216 is .9(30,000) = 27,000 psi Normal and Upset and 32,400 psi Faulted.

5.5 Roof Stresses

The roof must be checked for the compressive stresses due to snow, deadweight, and seismic, and the tensile stress due to the 3 psi tornado induced vacuum.

The allowable compressive stress is obtained from ASME Code Section NC-3133.4.

$$\frac{R}{T} = \frac{480}{.25} = 1{,}920$$

From Figure VII-1102-4:

B = 850

$$\text{Thus } P_a = \frac{850}{1920} \begin{array}{l} = \ .443 \text{ psig Normal \& Upset} \\ = \ .53 \text{ psig Faulted} \end{array}$$

(a) Normal

$$\text{Snow} = \frac{20}{144} = .14 \text{ psig}$$

Deadweight	=	.07 psi
Total	=	.21 psi

(b) Upset

Seismic (.25 g)	.02 psi
Normal	.21 psi
	.23 psi

(c) Faulted

Seismic (.5 g)	.04 psi
Normal	.21 psi
	.25 psi

In addition, the tensile stress due to the 3 psi negative tornado pressure must be checked.

$$S = \frac{PR}{2t} = \frac{3(480)}{2(.25)} = 2{,}880 \text{ psi}$$

The allowable tensile stress is 18,600(1.2) = 22,320 psi.

5.6 Shell Compressive Stresses

The seismic, nozzles, and wind overturning moments produce compressive buckling stress in the shell. This stress must be computed for each shell section since the thickness is not the same.

The overturning moments due to seismic are obtained from Appendix B, those due to wind from Section 4.5, and those due to nozzles from Section 4.3. The seismic axial loads are obtained from Appendix B and the deadweight is obtained from data given on page 2.

The shell ring numbers are given on page 2.

Ring No. 1

(a) Normal

$$M = 13{,}743{,}478 + 4{,}030{,}128 = 17{,}773{,}606 \text{ in-lbs.}$$

$$P = 117460 + 12537 + 25120 = 155{,}117 \text{ lbs.}$$

$$S = \frac{17773606}{113097} + \frac{155117}{942} = 322 \text{ psi}$$

The allowable compressive stress is $S_a = \frac{1800000(.625)}{240} = 4,688$ psi

from NC-3922.3.

(b) Upset

$M = 2(4030128) + 13743478 + 275243264 = 297,046,998$ in-lbs.

$P = 117460 + 2(12537) + 25120 + 12760 = 180,414$ lbs.

$$S = \frac{297046998}{113097} + \frac{180414}{942} = 2,818 \text{ psi}$$

The allowable is 4,688 psi.

(c) Faulted (Normal plus SSE)

$M = 2.5(4030128) + 13743478 + 2(275243264) = 574,305,326$ in-lbs.

$P = 117460 + 2.5(12537) + 25120 + 2(12760) = 199,443$ lbs.

$$S = \frac{574305326}{113097} + \frac{199443}{942} = 5,290 \text{ psi}$$

The allowable is 1.2(4688) = 5,625 psi.

Ring No. 2

(a) Normal

$M = 674860 + 2658(408) + 172378 + 41.67(408)^2 + 5360(408)$

$= 11,055,137$ in-lbs.

$P = 86060 + 2644 + 25120 = 113,824$ lbs.

$$S = \frac{11055137}{101788} + \frac{113824}{848} = 243 \text{ psi}$$

The allowable is 4,219 psi (Note: ½" plate was used in computer analysis but had to be increased to 9/16" here.)

(b) Upset

$M = 11055137 + (674860 + (2658)(408)) + 194535680 = 207,350,141$ in-lbs.

$P = 86060 + 2644(2) + 25120 + 9766 = 126,234$ lbs.

$$S = \frac{207350141}{101788} + \frac{126234}{848} = 2,186 \text{ psi}$$

The allowable stress is 4,219 psi.

(c) Faulted (Normal plus SSE)

$$M = 11055137 + 1.5(674860) + 1.5(2658)(408) + 2(194535680)$$

$$= 402{,}765{,}483 \text{ in-lbs.}$$

$$P = 86060 + 2644(2.5) + 25120 + 9766(2) = 137{,}322 \text{ lbs.}$$

$$S = \frac{402765483}{101788} + \frac{137322}{848} = 4{,}119 \text{ psi}$$

The allowable stress is 5,063 psi.

Ring No. 3

(a) Normal

$$M = 674860 + 2658(306) + 172378 + 41.67(306)^2 + 5360(306)$$

$$= 7{,}202{,}558 \text{ in-lbs.}$$

$$P = 61460 + 2644 + 25120 = 89{,}224 \text{ lbs.}$$

$$S = \frac{7202558}{79168} + \frac{89224}{660} = 226 \text{ psi}$$

The allowable stress is 3,281 psi.

(b) Upset

$$M = 7202558 + (2658)(306) + 674860 + 120837184 = 129{,}527{,}950 \text{ in-lbs.}$$

$$P = 61460 + 2(2644) + 25120 + 7215 = 99{,}083 \text{ lbs.}$$

$$S = \frac{129527950}{79168} + \frac{99083}{660} = 1{,}786 \text{ psi}$$

The allowable stress is 3,281 psi.

(c) Faulted (Normal plus SSE)

$$M = 7202558 + 1.5(2658)(306) + 1.5(674860) + 2(120837184)$$

$$= 251{,}109{,}238 \text{ in-lbs.}$$

$$P = 61460 + 2.5(2644) + 25120 + 2(7215) = 107{,}620 \text{ lbs.}$$

$$S = \frac{251109238}{79168} + \frac{107620}{660} = 3{,}335 \text{ psi}$$

The allowable stress is 3,937 psi.

Ring No. 4

(a) Normal

$$M = 674860 + 2658(204) + 172378 + 41.67(204)^2 + 5360(204)$$

$$= 4,217,049 \text{ in-lbs.}$$

$$P = 42260 + 2644 + 25120 = 70,024 \text{ lbs.}$$

$$S = \frac{4217049}{56549} + \frac{70024}{471} = 223 \text{ psi}$$

The allowable stress is 2,344 psi.

(b) Upset

$$M = 4217049 + 2658(204) + 674860 + 59807776 = 65,241,917 \text{ in-lbs.}$$

$$P = 42260 + 2(2644) + 25120 + 5166 = 77,834 \text{ lbs.}$$

$$S = \frac{65241917}{56549} + \frac{77834}{471} = 1,319 \text{ psi}$$

The allowable stress is 2,344 psi.

(c) Faulted (Normal plus SSE)

$$M = 4217049 + 1.5(2658)(204) + 1.5(674860) + 2(59807776)$$

$$= 125,658,239 \text{ in-lbs.}$$

$$P = 42260 + 2.5(2644) + 25120 + 2(5166) = 84,322 \text{ lbs.}$$

$$S = \frac{125658239}{56549} + \frac{84322}{471} = 2,401 \text{ psi}$$

The allowable stress is 2,813 psi.

Ring No. 5

(a) Normal

$$M = 674860 + 2658(102) + 172378 + 41.67(102)^2 + 5360(102)$$

$$= 2,098,609 \text{ in-lbs.}$$

$$P = 28560 + 2644 + 25120 = 56,324 \text{ lbs.}$$

$$S = \frac{2098609}{45239} + \frac{56324}{377} = 196 \text{ psi}$$

The allowable stress is 1,875 psi.

(b) Upset

$$M = 2098609 + 2658(102) + 674860 + 17352448 = 20{,}397{,}033 \text{ in-lbs.}$$

$$P = 28560 + 2(2644) + 25120 + 3485 = 62453 \text{ lbs.}$$

$$S = \frac{20397033}{45239} + \frac{62453}{377} = 617 \text{ psi}$$

The allowable stress is 1,875 psi.

(c) Faulted (Normal plus SSE)

$$M = 2098609 + 1.5(2658)(102) + 1.5(674860) + 2(17352448)$$

$$= 38{,}222{,}469 \text{ in-lbs.}$$

$$P = 28560 + 2.5(2644) + 25120 + 2(3485) = 67{,}260 \text{ lbs.}$$

$$S = \frac{38222469}{45239} + \frac{67260}{377} = 1{,}023 \text{ psi}$$

The allowable stress is 2,250 psi.

5.7 Tensile Stress in Shell

The maximum tensile stress in the shell (Ring no. 1) is checked here.

(a) Normal

$$P = \frac{42.5(62.5)}{144} = 18.45 \text{ psig}$$

$$S = \frac{PR}{t} = \frac{18.45(240)}{.625} = 7{,}085 \text{ psi}$$

The allowable stress is 18,600 psi.

(b) Upset

$$P = 18.45(1.25) + \frac{40(62.5)(.3)}{144} = 28.27 \text{ psig}$$

$$S = \frac{28.27(240)}{.625} = 10{,}856 \text{ psi}$$

The allowable stress is 18,600 psi.

(c) Faulted (Normal + SSE)

$$P = 18.45(1.5) + \frac{40(62.5)(.6)}{144} = 38.1 \text{ psig}$$

$$S = \frac{38.1(240)}{.625} = 14{,}630 \text{ psi}$$

The allowable stress is 22,320 psi.

5.8 Stresses in Nozzles

The nozzles in the tank are treated by Cases 5 and 4, page 217 of Reference 1. The nomenclature is that of Reference 1.

In this case $a >> r$. Thus the equations reduce to:

Case 5

$$S_3 = \frac{.454M}{t^2 r}$$

Case 4

$$S_4 = \frac{.1434W}{t^2}\left(3.33 + 4.33 L_n \frac{d}{r}\right) \qquad S_1 = S_3 + S_4$$

$S_b = S_1 + S_2$; W = Axial Force; t = plate thickness

S_2 = Internal pressure stress

M = Resultant Bending Moment

b = r = outside radius of nozzle

d = distance from edge of shell/head or shell/bottom junction.

The shearing stresses are:

$$V = \frac{M_t}{2\pi r^2 t} + \frac{R}{\pi r t}$$

M_t = torsional moment

R = Resultant shearing force

The stresses are combined by the maximum shearing stress theory.

$$S = \sqrt{(2V)^2 + S_b^2}$$

The nozzle loads are given in Section 4.2.

The nozzles in the shell should be analyzed by Welding Research Council Bulletin 107. However, the shell parameter exceeds those covered by WRC 107. Therefore, since it is known that the flat plate is more severe than the curved shell (for stresses) the nozzles in the shell are treated as being in a flat plate. This is believed to be conservative. Note that the bending stress is independent of a for $a >> r$.

1" Nozzle

$d = 30''$ $r = .875''$ $t = .625''$

$$S_1 = \frac{.454\sqrt{322^2 + 322^2}}{(.625)2(.875)} + \frac{.1434(128)}{(.625)^2}\left(3.33 + 4.33\,Ln\,\frac{30}{.875}\right)$$

= 1,480 psi Normal

= 2,960 psi Upset

= 3,700 psi Faulted

S_2 = 7,085 psi Normal; 10,856 psi Upset, and 14,630 psi Faulted due to internal pressure.

Thus:

S_b = 1480 + 7085 = 8,565 psi Normal

= 13,816 psi Upset

= 18,330 psi Faulted

$$V = \frac{322}{2(3.142)(.875)^2(.625)} + \frac{\sqrt{128^2 + 128^2}}{3.142(.875)(.625)}$$

= 212 psi Normal
= 424 psi Upset
= 530 psi Faulted

$$S = \sqrt{(2(212))^2 + (8565)^2}$$ = 8,575 psi Normal

= 13,842 psi Upset

= 18,361 psi Faulted

The allowable stress per Appendix XIII is 3(18600) = 55,800 psi for the total localized stress for Normal and Upset and 66,960 psi Faulted.

3" Nozzle (in shell)

An 8" O.D. x ¼" reinforcing pad is used.

$r_o = 1.75''$ $d = 4.75''$ $t = .5''$

$$S_1 = \frac{.454\sqrt{3448^2 + 3448^2}}{(.5)^2(1.75)} + \frac{.1434(446)}{(.5)^2}\left(3.33 + 4.33\,Ln\,\frac{4.75}{1.75}\right)$$

= 7018 psi Normal; 14,036 psi Upset; and 17,545 psi Faulted

The pressure stress is 0 psi Normal, 5000 psi Upset, and 10,000 psi Faulted for this nozzle. Thus:

S_b = 7018 psi Normal; 19,036 psi Upset, and 27,545 Faulted

$$V = \frac{3448}{2(3.142)(1.75)^2(.5)} + \frac{\sqrt{446^2 + 446^2}}{3.142(1.75)(.5)}$$ = 588 psi Normal
= 1176 psi Upset
= 1470 psi Faulted

$$S = \sqrt{(2(588))^2 + (7018)^2}$$ = 7,116 psi Normal
= 19,181 psi Upset
= 27,701 psi Faulted

At edge of Pad

$$S_l = \frac{.454\sqrt{3448^2 + 3448^2}}{(.25)^2\ (4)} + \frac{.1434(446)}{(.25)^2}\left(3.33 + 4.33\ Ln\frac{4.75}{4}\right)$$

= 13,024 psi Normal; 26,048 psi Upset; and 32,560 psi Faulted

S_b = 13,024 psi Normal
= 31,048 psi Upset
= 42,560 psi Faulted

$$V = \frac{3448}{2(3.142)(4)^2(.25)} + \frac{\sqrt{446^2 + 446^2}}{3.142(4)(.25)}$$ = 338 psi Normal

$$S = \sqrt{(2(338))^2 + (13024)^2}$$ = 13,042 psi Normal
= 31,077 psi Upset
= 42,594 psi Faulted

4" Nozzle (Mark A - Mark D does not require a pad)

This nozzle has a 9" O.D. x ¼" reinforcing pad.

r_o = 2.25" d = 4.5" t = .5"

$$S_l = \frac{.454\sqrt{6440^2 + 6440^2}}{(.5)^2(2.25)} + \frac{.1434(634)}{(.5)^2}\left(3.33 + 4.33\ Ln\frac{4.5}{2.25}\right)$$ = 9,652 psi Norma

S_p = 0 psi Normal, 5,000 psi Upset, and 10,000 psi Faulted.

S_b = 9,652 psi Normal; 24,304 psi Upset; 34,130 psi Faulted

$$V = \frac{6440}{2(3.142)(2.25)^2(.5)} + \frac{\sqrt{634^2 + 634^2}}{3.142(2.25)(.5)}$$ = 659 psi Normal; 1,318 psi Upset; 1,648 psi Faulted

$$S = \sqrt{(2(659))^2 + (9652)^2}$$ = 9,742 psi Normal; 24,446 Upset; and 34,289 Faulted

At Edge of Pad

r = 4.5" t = .25"

$$S_l = \frac{.454\sqrt{6440^2 + 6440^2}}{(.25)^2\ (4.5)} + .1434(634)\left(3.33 + 4.33\ L_n\frac{4.5}{4.5}\right)$$ = 19,543 psi Norma

S_b = 19,543 Normal
= 44,086 Upset
= 58,858 Faulted

$$V = \frac{6440}{2(3.142)(4.5)^2(.25)} + \frac{\sqrt{634^2 + 634^2}}{3.142(4.5)(.25)} = 456 \text{ psi Normal,}$$

$$S = \sqrt{(2(456))^2 + (19543)^2} = 19{,}564 \text{ psi Normal}$$
= 44,124 psi Upset
= 58,902 psi Faulted

6" Nozzle

This nozzle has a 40" O.D. x ½" pad.

r_o = 3.31"   d = 24"   t = .5"

$$S_1 = \frac{.454\sqrt{17000^2 + 17000^2}}{(.5)^2\ (3.31)} + \frac{.1434(1116)}{(.5)^2}(3.33 + 4.33\text{Ln}\ \frac{24}{3.31})$$

= 20,811 psi Normal; 41,622 psi Upset; 52,028 psi Faulted

The pressure stress is zero. Thus:

S_b = 20,811 psi Normal
= 41,622 psi Upset
= 52,028 psi Faulted

$$V = \frac{17000}{2(3.142)(3.31)^2(.5)} + \frac{\sqrt{1116^2 + 1116^2}}{3.142(3.31)(.5)} < 797 \text{ psi Normal}$$

$$S = \sqrt{(2(797))^2 + (20811)^2} = 20{,}872 \text{ psi Normal}$$
= 41,744 psi Upset
= 52,180 psi Faulted

At edge of pad

r_o = 20"   t = .25"

$$S_1 = \frac{.454\sqrt{17000^2 + 17000^2}}{(.25)^2\ (20)} + \frac{.1434(1116)}{(.25)^2}(3.33 + 4.33\text{Ln}\ \frac{24}{20})$$

= 19,279 psi Normal; 38,558 psi Upset; and 48,198 psi Faulted

The pressure stress is zero, thus S_b = 19,279 psi Normal.

$$V = \frac{17000}{2(3.142)(20)^2(.25)} + \frac{\sqrt{1116^2 + 1116^2}}{3.142(20)(.25)} = 128 \text{ psi Normal}$$
356 psi Upset
320 psi Faulted

$$S = \sqrt{(2(128))^2 + (19279)^2} = 19{,}281 \text{ psi Normal}$$
= 38,561 psi Upset
= 48,203 psi Faulted

8" Nozzle

d = 36.25 $\qquad r_o = 4.31 \qquad t = .625"$

$$S_1 = \frac{.454\sqrt{33620^2 + 33620^2}}{(.625)^2\,(4.31)} + \frac{.1434(1680)}{(.625)^2}(3.33 + 4.33 \text{ Ln } \frac{36.25}{4.31})$$

= 20,560 psi Normal ; 41,120 psi Upset; and 51,400 psi Faulted

The pressure stress is 7,085 psi Normal, 10,856 psi Upset, and 14,630 psi Faulted, Thus:

S_b = 27,645 psi Normal
= 51,936 psi Upset
= 66,030 psi Faulted

$$V = \frac{33620}{2(3.142)(4.31)^2(.625)} + \frac{\sqrt{1680^2 + 1680^2}}{3.142(4.31)(.625)}$$ = 742 psi Normal
= 1484 psi Upset
= 1855 psi Faulted

$$S = \sqrt{(2(742))^2 + (27645)^2}$$ = 27,685 psi Normal
= 52,041 psi Upset
= 66,134 psi Faulted

24" Nozzle 72" O.D. pad ½" thick

d = 32.25" $\qquad r = 12" \qquad t = 1.125"$

$$S_1 = \frac{.454\sqrt{323800^2 + 323800^2}}{(1.125)^2(12)} + \frac{.1434(5560)}{(1.125)^2}(3.33 + 4.33 \text{ Ln } \frac{32.25}{12})$$

= 18,481 psi Normal; 36,962 psi Upset; and 46,203 psi Faulted

The pressure stress is 7,085 psi Normal; 10,856 psi Upset; and 14,630 psi Faulted Thus:

S_b = 25,566 psi Normal
= 47,818 psi Upset
= 60,833 psi Faulted

$$V = \frac{323800}{2(3.142)(12)^2(1.125)} + \frac{\sqrt{5560^2 + 5560^2}}{3.142(12)(1.125)}$$ = 503 psi Normal

$$S = \sqrt{(2(503))^2 + (25566)^2}$$ = 25,586 psi Normal
= 47,860 psi Upset
= 60,885 psi Faulted

At edge of pad

r = 36" $\qquad t = .625"$

$$S_1 = \frac{.454\sqrt{323800^2 + 323800^2}}{(.625)^2(36)} + \frac{.1434(5560)}{(.625)^2}(3.33 + 4.33 \text{ Ln } \frac{32.25}{36})$$

= 20,607 psi Normal; 41,214 psi Upset; and 51,518 psi Faulted

S_b = 27,692 psi Normal
= 52,070 psi Upset
= 66,148 psi Faulted

$$V = \frac{323800}{2(3.142)(36)^2(.625)} + \frac{\sqrt{5560^2 + 5560^2}}{3.142(36)(.625)} = 175 \text{ psi Normal}$$

$$S = \sqrt{(2(175))^2 + (27692)^2}$$

= 27,694 psi Normal
= 52,075 psi Upset
= 66,154 psi Faulted

LATERAL

```
STRUDL 'MF-311' 'REFUELING WATER STORAGE TANK'
***********************************************************
*                                                         *
*                    ICES STRUDL-II                       *
*            THE STRUCTURAL DESIGN LANGUAGE               *
*                                                         *
*          CIVIL ENGINEERING SYSTEMS LABORATORY           *
*         MASSACHUSETTS INSTITUTE OF TECHNOLOGY           *
*             CAMBRIDGE, MASSACHUSETTS                    *
*               V2 M2          JUNE, 1972                 *
*               23:29:22        4/23/75                   *
*                                                         *
***********************************************************
UNITS INCHES POUNDS SECONDS
TYPE PLANE FRAME
JOINT COORDINATES
1   0.   0.        SUPPORT
2    0.   0.2
3   0.   102.
4   0.   204.
5   0.   305.
6   0.   403.
7   0.   510.
8   0.   534.
JOINT RELEASE
1 FORCE KFY 125377134.
1 FORCE KFX 133266055.
1 MOMENT KMZ 752239303970J1.
MEMBER INCIDENCES
1   1   2
2   2   3
3   3   4
4   4   5
5   5   6
6   6   7
7   7   8
CONSTANTS
E 29000000. ALL
MEMBER PROPERTIES
1 2 PRIS AX 942. AY 942. IZ 27143361.   SZ 113057.
3   PRIS AX 754. AY 754. IZ 21714053.   SZ 93743.
4 PRIS AX 660. AY 660. IZ 19000352.   SZ 79169.
5 7   PRIS AX 471. AY 471. IZ 13571640. SZ 56549.
6 PRIS AX 377. AY 377. IZ 10357344. SZ 43237.
DYNAMIC DEGREES OF FREEDOM
JOINTS 1 TO 8 DISP X
[illegible]
```

APPENDIX A - COMPUTER INPUT

```
INERTIA OF JOINTS 2 LINEAR ALL 936.
INERTIA OF JOINTS 3 LINEAR ALL 1793.
INERTIA OF JOINTS 4 LINEAR ALL 1783.
INERTIA OF JOINTS 5   LINEAR ALL 1772.
INERTIA OF JOINTS 6 LINEAR ALL 1761.
INERTIA OF JOINTS 7 LINEAR ALL 879.
INERTIA OF JOINTS 9 LINEAR ALL 52.
DAMPING .01  5
UNITS CYCLES
STORE RESPONSE SPECTRA ACCELERATION VS FREQUENCY 'OBE'
DAMPING .01 FACTOR 386.
.4 5.  .3 5.79  .13 20.  .13 33.9  .13 44.1  .13 53.5  .13 70.
DYNAMIC LOADING 1 'OBE LATERAL'
SUPPORT ACCELERATION
DISK X FILE 'OBE'
DYNAMIC ANALYSIS MODAL
OUTPUT DECIMAL 5
LIST DYNAMIC EIGENVALUES EIGENVECTORS
```

STRUDL 'ME-311' 'REFUELING WATER STORAGE TANK'   VERTICAL

```
*****************************************************
*                                                   *
*                ICES STRUDL-II                     *
*        THE STRUCTURAL DESIGN LANGUAGE             *
*                                                   *
*     CIVIL ENGINEERING SYSTEMS LABORATORY          *
*    MASSACHUSETTS INSTITUTE OF TECHNOLOGY          *
*         CAMBRIDGE, MASSACHUSETTS                  *
*          V2 M2          JUNE, 1972                *
*          20144157         4/23/76                 *
*                                                   *
*****************************************************
UNITS INCHES POUNDS SECONDS
TYPE PLANE FRAME
JOINT COORDINATES
1   0.   0.        SUPPORT
2   0.   0.2
3   0.   102.
4   0.   204.
5   0.   306.
6   0.   408.
7   0.   510.
9   0.   534.
JOINT RELEASE
1 FORCE KFY 125373134.
1 FORCE KFX 103266055.
1 MOMENT KMZ 12238800597014.
MEMBER INCIDENCES
1   1   2
2   2   3
3   3   4
4   4   5
5   5   6
6   6   7
7   7   9
CONSTANTS
E 29000000. ALL
MEMBER PROPERTIES
1 2 PRIS AX 942. AY 942. IZ 27143161.  SZ 113057.
3   PRIS AX 754. AY 754. IZ 21714693.  SZ 53749.
4 PRIS AX 660. AY 660. IZ 19000352.  SZ 79153.
5 7   PRIS AX 471. AY 471. IZ 13571630. SZ 56549.
6 PRIS AX 377. AY 377. IZ 10857344. SZ 45224.
DYNAMIC DEGREES OF FREEDOM
JOINTS 1 TO 9 DISP Y
[illegible]
```

8500

```
INERTIA OF JOINTS 2 LINEAR ALL 3744.
INERTIA OF JOINTS 3 LINEAR ALL 64.
INERTIA OF JOINTS 4 LINEAR ALL 54.
INERTIA OF JOINTS 5 LINEAR ALL.43.
INERTIA OF JOINTS 6 LINEAR ALL 35.
INERTIA OF JOINTS 7 LINEAR ALL 20.
INERTIA OF JOINTS 8 LINEAR ALL 52.
DAMPING .01 3
UNITS CYCLES
STORE RESPONSE SPECTRA ACCELERATION VS FREQUENCY 'OBE'
DAMPING .01 FACTOR 386.
.12 15. .12 15.92 .09 37.3 .09 216.9 .09 500.
DYNAMIC LOADING 2 'OBE VERTICAL'
SUPPORT ACCELERATION
DISP Y FILE 'OBE'
DYNAMIC ANALYSIS MODAL
OUTPUT DECIMAL 5
LIST DYNAMIC EIGENVALUES EIGENVECTORS
```

```
LOADING 2 'DEAD WEIGHT'
JOINT LOADS
2 FOR Y 3375184.
3 FOR Y 24205.
4 FOR Y 20944.
5 FOR Y 16600.
6 FOR Y 13600.
7 FOR Y 7750.
8 FOR Y 20100.
LOADING LIST ALL
STIFFNESS ANALYSIS
OUTPUT DECIMAL 5
LIST FORCES DISPLACEMENTS
```

DEAD Weight

GEOMETRIC DATA SAME AS PAGE A-1

LOADING - 1 OBE LATERAL

MEMBER FORCES

MEMBER	JOINT	RESPONSE TYPE	FORCE AXIAL	FORCE SHEAR-Y	FORCE SHEAR-Z	MOMENT TORSIONAL	MOMENT BENDING-Y	MOMENT BENDING-Z
1	1	RMS	0.0	612517.12500				275407516.00000
		ABS SUM	0.0	620405.31250				279959552.00000
1	2	RMS	0.0	612517.12500				275246557.00000
		ABS SUM	0.0	620405.31250				279419[illegible].00000
2	2	RMS	0.0	755521.59000				275243264.00000
		ABS SUM	0.0	696040.37500				277315660.00000
2	3	RMS	0.0	779521.53000				195535552.00000
		ABS SUM	0.0	694049.37500				206346096.00000
3	3	RMS	0.0	727516.93750				195735650.00000
		ABS SUM	0.0	783516.81250				206340128.00000
3	4	RMS	0.0	727616.53750				130837408.00000
		ABS SUM	0.0	783516.81250				135959392.00000
4	4	RMS	0.0	661372.43750				123537184.00000
		ABS SUM	0.0	663523.56250				133593735.00000
4	5	RMS	0.0	661372.43750				55907552.00000
		ABS SUM	0.0	663523.56250				72574768.00000
5	5	RMS	0.0	417250.73750				55907776.00000
		ABS SUM	0.0	457115.25000				72594576.00000
5	6	RMS	0.0	417350.93750				17352416.00000
		ABS SUM	0.0	457115.25000				23695024.00000
6	6	RMS	0.0	167835.43750				17352448.00000
		ABS SUM	0.0	229154.50000				23695056.00000
6	7	RMS	0.0	167925.43750				233267.43750
		ABS SUM	0.0	229154.50000				321315.62500
7	7	RMS	0.0	9714.70312				233264.57500
		ABS SUM	0.0	13353.09375				321406.68750
7	8	RMS	0.0	9714.70312				222.24918
		ABS SUM	0.0	13343.09375				231.77106

RESULTANT JOINT DISPLACEMENTS- SUPPORTS

JOINT		RESPONSE TYPE	DISPLACEMENT X DISP.	DISPLACEMENT Y DISP.	DISPLACEMENT Z DISP.	ROTATION X ROT.	ROTATION Y ROT.	ROTATION Z ROT.
1	GLOBAL	RMS	0.00910	0.0				0.00002
		ABS SUM	0.00972	0.0				0.00002

RESULTANT JOINT DISPLACEMENTS- FREE JOINTS

JOINT		RESPONSE TYPE	DISPLACEMENT X DISP.	DISPLACEMENT Y DISP.	DISPLACEMENT Z DISP.	ROTATION X ROT.	ROTATION Y ROT.	ROTATION Z ROT.
2	GLOBAL	RMS	0.00914	0.0				0.00002
		ABS SUM	0.00976	0.0				0.00002
3	GLOBAL	RMS	0.02716	0.0				0.00002
		ABS SUM	0.02930	0.0				0.00002
4	GLOBAL	RMS	0.04515	0.0				0.00002
		ABS SUM	0.05276	0.0				0.00003
5	GLOBAL	RMS	0.07410	0.0				0.00003
		ABS SUM	0.07673	0.0				[illegible]
6	GLOBAL	RMS	0.10153	0.0				0.00003
		ABS SUM	0.10154	0.0				0.00003
7	GLOBAL	RMS	0.1[illegible]	0.0				[illegible]
		ABS SUM	0.1[illegible]	0.0				[illegible]
8	GLOBAL	RMS	0.12740	0.0				0.00003
		ABS SUM	0.13063	0.0				[illegible]

LOADING - 2   URE VERTICAL

MEMBER FORCES

MEMBER	JOINT	RESPONSE TYPE	FORCE AXIAL	FORCE SHEAR-Y	FORCE SHEAR-Z	MOMENT TORSIONAL	MOMENT BENDING-Y	MOMENT BENDING-Z
1	1	RMS	417755.56250	0.0				0.0
		ABS SUM	417823.50000	0.0				0.0
1	2	RMS	417755.56250	0.0				0.0
		ABS SUM	417823.50000	0.0				0.0
2	2	RMS	12760.33594	0.0				0.0
		ABS SUM	13016.17137	0.0				0.0
2	3	RMS	12760.33594	0.0				0.0
		ABS SUM	13016.17137	0.0				0.0
3	3	RMS	9765.61719	0.0				0.0
		ABS SUM	9959.77734	0.0				0.0
3	4	RMS	9765.61719	0.0				0.0
		ABS SUM	9959.77734	0.0				0.0
4	4	RMS	7214.75391	0.0				0.0
		ABS SUM	7413.51406	0.0				0.0
4	5	RMS	7214.75391	0.0				0.0
		ABS SUM	7413.51406	0.0				0.0
5	5	RMS	5166.26703	0.0				0.0
		ABS SUM	5330.33203	0.0				0.0
5	6	RMS	5166.26703	0.0				0.0
		ABS SUM	5330.33203	0.0				0.0
6	6	RMS	3495.05786	0.0				0.0
		ABS SUM	3607.92293	0.0				0.0
6	7	RMS	3495.05786	0.0				0.0
		ABS SUM	3607.92293	0.0				0.0
7	7	RMS	2519.06445	0.0				0.0
		ABS SUM	2607.13574	0.0				0.0
7	8	RMS	2519.06445	0.0				0.0
		ABS SUM	2607.13574	0.0				0.0

RESULTANT JOINT DISPLACEMENTS- SUPPORTS

JOINT		RESPONSE TYPE	DISPLACEMENT X DISP.	DISPLACEMENT Y DISP.	DISPLACEMENT Z DISP.	ROTATION X ROT.	ROTATION Y ROT.	ROTATION Z ROT.
1	GLOBAL	RMS	0.0	0.00462				0.0
		ABS SUM	0.0	0.00462				0.0

RESULTANT JOINT DISPLACEMENTS- FREE JOINTS

JOINT		RESPONSE TYPE	DISPLACEMENT X DISP.	DISPLACEMENT Y DISP.	DISPLACEMENT Z DISP.	ROTATION X ROT.	ROTATION Y ROT.	ROTATION Z ROT.
2	GLOBAL	RMS	0.0	0.00461				0.0
		ABS SUM	0.0	0.00463				0.0
3	GLOBAL	RMS	0.0	0.00467				0.0
		ABS SUM	0.0	0.00469				0.0
4	GLOBAL	RMS	0.0	0.00472				0.0
		ABS SUM	0.0	0.00472				0.0
5	GLOBAL	RMS	0.0	0.00476				0.0
		ABS SUM	0.0	0.00476				0.0
6	GLOBAL	RMS	0.0	0.00479				0.0
		ABS SUM	0.0	0.00481				0.0
7	GLOBAL	RMS	0.0	0.00483				0.0
		ABS SUM	0.0	0.00486				0.0
8	GLOBAL	RMS	0.0	0.00483				0.0
		ABS SUM	0.0	0.00484				0.0

LOADING - 3 DEAD WEIGHT

MEMBER FORCES

MEMBER	JOINT	FORCE AXIAL	FORCE SHEAR Y	FORCE SHEAR Z	MOMENT TORSIONAL	MOMENT BENDING Y	MOMENT BENDING Z
1	1	-3473793.00000	0.0				0.0
1	2	3473793.00000	0.0				0.0
2	2	-103599.00000	0.0				0.0
2	3	103599.00000	0.0				0.0
3	3	-79893.93750	0.0				0.0
3	4	79893.93750	0.0				0.0
4	4	-58050.00000	0.0				0.0
4	5	58050.00000	0.0				0.0
5	5	-41450.00000	0.0				0.0
5	6	41450.00000	0.0				0.0
6	6	-27850.00000	0.0				0.0
6	7	27950.00000	0.0				0.0
7	7	-20099.99609	0.0				0.0
7	9	20099.99609	0.0				0.0
							0.0

RESULTANT JOINT DISPLACEMENTS - SUPPORTS

JOINT		DISPLACEMENT X DISP.	DISPLACEMENT Y DISP.	DISPLACEMENT Z DISP.	ROTATION X ROT.	ROTATION Y ROT.	ROTATION Z ROT.
1	GLOBAL	0.0	0.02775				0.0

RESULTANT JOINT DISPLACEMENTS - FREE JOINTS

JOINT		DISPLACEMENT X DISP.	DISPLACEMENT Y DISP.	DISPLACEMENT Z DISP.	ROTATION X ROT.	ROTATION Y ROT.	ROTATION Z ROT.
2	GLOBAL	0.0	0.02777				0.0
3	GLOBAL	0.0	0.02818				0.0
4	GLOBAL	0.0	0.02353				0.0
5	GLOBAL	0.0	0.02554				0.0
6	GLOBAL	0.0	0.02511				0.0
7	GLOBAL	0.0	0.02941				0.0
9	GLOBAL	0.0	0.02544				0.0
							0.0

RESULTS OF LATEST ANALYSES

PROBLEM - ME-311   TITLE - REFUELING WATER STORAGE TANK

LATERAL

ACTIVE UNITS INCH LB CYC DEGF SEC

ACTIVE STRUCTURE TYPE PLANE FRAME

ACTIVE COORDINATE AXES X Y

EIGENVALUES

MODE	EIGENVALUE	FREQUENCY	PERIOD
1	3.5944720 01	5.9872640 00	1.6702770-01
2	4.0737410 02	2.0183591D 01	4.9545350-02
3	1.1522210 03	3.3945360 01	2.9459670-02
4	1.9450270 03	4.4136460 01	2.2657010-02
5	2.[illegible] 03	5.3487400 01	1.8695970-02
6	4.2270770 03	6.5015930 01	1.5380830-02
7	1.0503790 05	3.2367460 02	3.0423430-03
8	2.2054950 06	1.5122810 03	6.6125260-04

EIGENVECTORS

MODE 1

JOINT		X DISP.	Y DISP.	Z DISP.	X ROT.	Y ROT.	Z ROT.
1	GLOBAL	0.06273	0.0				-0.00077
2	GLOBAL	0.06300	0.0				-0.00077
3	GLOBAL	0.21274	0.0				-0.00101
4	GLOBAL	0.37347	0.0				-0.00121
5	GLOBAL	0.53723	0.0				-0.00134
6	GLOBAL	0.73724	0.0				-0.00142
7	GLOBAL	0.95511	0.0				-0.00144
8	GLOBAL	1.00000	0.0				-0.00144

MODE 2

JOINT		X DISP.	Y DISP.	Z DISP.	X ROT.	Y ROT.	Z ROT.
1	GLOBAL	-0.48120	0.0				-0.00034
2	GLOBAL	-0.48151	0.0				-0.00034
3	GLOBAL	-0.70953	0.0				-0.00055
4	GLOBAL	-0.71525	0.0				-0.00147
5	GLOBAL	-0.37942	0.0				-0.00216
6	GLOBAL	0.29472	0.0				-0.00293
7	GLOBAL	0.92294	0.0				-0.00306
8	GLOBAL	1.00000	0.0				-0.00306

MODE 3

JOINT		X DISP.	Y DISP.	Z DISP.	X ROT.	Y ROT.	Z ROT.
1	GLOBAL	0.70727	0.0				0.00074
2	GLOBAL	0.70744	0.0				0.00074
3	GLOBAL	0.44056	0.0				0.00126
4	GLOBAL	-0.23111	0.0				0.00110
5	GLOBAL	-0.77147	0.0				0.00014
6	GLOBAL	-0.16563	0.0				-0.00124
7	GLOBAL	0.74243	0.0				-0.00156
8	GLOBAL	1.00000	0.0				[illegible]

RESULTS OF LATEST ANALYSES

PROBLEM - ME-311   TITLE - REFUELING WATER STORAGE TANK

VERTICAL

ACTIVE UNITS INCH LB CYC DEGF SEC

ACTIVE STRUCTURE TYPE PLANE FRAME

ACTIVE COORDINATE AXES X Y

EIGENVALUES

MODE	EIGENVALUE	FREQUENCY	PERIOD
1	6.5354390 02	1.5923060 01	6.2802000-02
2	7.6174900 03	8.7276240 01	1.1457610-02
3	4.7040190 04	2.1659750 02	4.6104550-03
4	1.3639620 05	3.6499490 02	2.7027460-03
5	2.3557520 05	4.3944100 02	2.0472270-03
6	5.3533670 05	5.3656430 02	1.7165300-03
7	1.1032730 06	1.0527920 03	9.4565560-04
8	1.3351100 06	1.1765070 03	8.4997480-04

EIGENVECTORS

MODE 1

JOINT		DISPLACEMENT X DISP.	DISPLACEMENT Y DISP.	DISPLACEMENT Z DISP.	ROTATION X ROT.	ROTATION Y ROT.	ROTATION Z ROT.
1	GLOBAL	0.0	0.93655				0.0
2	GLOBAL	0.0	0.95719				0.0
3	GLOBAL	0.0	0.96702				0.0
4	GLOBAL	0.0	0.97644				0.0
5	GLOBAL	0.0	0.98439				0.0
6	GLOBAL	0.0	0.99232				0.0
7	GLOBAL	0.0	0.99569				0.0
8	GLOBAL	0.0	1.00000				0.0

MODE 2

JOINT		DISPLACEMENT X DISP.	DISPLACEMENT Y DISP.	DISPLACEMENT Z DISP.	ROTATION X ROT.	ROTATION Y ROT.	ROTATION Z ROT.
1	GLOBAL	0.0	-0.01286				0.0
2	GLOBAL	0.0	-0.01279				0.0
3	GLOBAL	0.0	0.15057				0.0
4	GLOBAL	0.0	0.35514				0.0
5	GLOBAL	0.0	0.57292				0.0
6	GLOBAL	0.0	0.77202				0.0
7	GLOBAL	0.0	0.91252				0.0
8	GLOBAL	0.0	1.00000				0.0

MODE 3

JOINT		DISPLACEMENT X DISP.	DISPLACEMENT Y DISP.	DISPLACEMENT Z DISP.	ROTATION X ROT.	ROTATION Y ROT.	ROTATION Z ROT.
1	GLOBAL	0.0	-0.00726				0.0
2	GLOBAL	0.0	-0.00659				0.0
3	GLOBAL	0.0	0.58463				0.0
4	GLOBAL	0.0	1.00000				0.0
5	GLOBAL	0.0	0.86672				0.0
6	GLOBAL	0.0	0.30675				0.0
7	GLOBAL	0.0	-0.59774				0.0
8	GLOBAL	0.0	-0.12924				0.0

APPENDIX C - REFERENCES

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2. U. S. Atomic Energy Commission, T. I. D. 7024, Nuclear Reactors and Earthquakes.
3. A. I. S. C. Steel Plate Engineering Data - Volume 2, "Design of Plate Structures".
4. Blodgett, Omer W., "Design of Welded Structures", The James F. Lincoln ARC Welding Foundation
5. Richart, Hall, and Woods, "Vibration of Soils and Foundations", Prentice Hall, New York
6. Kraus, Harry, "Thin Elastic Shells", John Wiley & Sons, Inc.

APPENDIX E - FOUNDATION ANALYSIS

BY

J.H. APPLETON
PHD., P.E.

5/3/7-

ANALYSIS & DESIGN OF FOUNDATION
REFUELING WATER STORAGE TANK

Normal capacity 400,000 gal

Tank 40'-0" OD, 42'-6" high, Roof Domed 5.36'

Foundation Allowable Bearing Pressure = 15,000 psf (service loads)

Reinforced Concrete Design - ACI 318-71
f'_c = 3000 psi, Grade 60 reinforcement

Tank Weights & Loads

Tank (not inc. bottom)	=	117.5^k ↓
Tank vertical seismic	=	12.8^k ↑ or ↓
Tank Bottom	=	16.6^k ↓
Tank bottom vertical seismic	=	1.8^k ↑ or ↓
Nozzle horizontal	=	8.9^k ← or →
Wind horizontal	=	47.9^k ← or →
Nozzle overturning	=	335.8$^{'k}$
Wind overturning	=	1145.3$^{'k}$
Tank horizontal seismic	=	799.5^k ← or →
Seismic overturning	=	22,937$^{'k}$
Normal water wt	=	3337^k ↓ (400,000 gal)
Min water wt	=	2920^k ↓ (350,000 gal)
Foundation wt	=	638^k ↓
Water vert seismic	=	300.3^k ↑ or ↓
Foundation vert seismic	=	57.4^k
Snow	=	25.1^k ↓
Nozzle vertical	=	12.5^k ↑ or ↓

5/3/

(a) Normal Foundation Pressures
(Wind + nozzles + Dead weight + snow)

$$\frac{P}{A} = \frac{(117.5+16.6+3337+638+25.1+12.5)}{\pi(50)^2/4} = \frac{4146.7}{1963.5} = 2.11^{k}/\square' = 2110\ psf$$

$$\frac{Mc}{I} = \frac{(335.8+1145.3)(25)}{\pi(50)^4/64} = \frac{(1481.1)(25)}{306,796\ ft^4} = 0.12^{k}/\square' = 120\ psf$$

No uplift

Max pressure = 2110 + 120 = 2230 psf ↓ < 15,000

(b) Upset (Normal + OBE)

Max down

$$\frac{P}{A} = \frac{(117.5+12.8+16.6+1.8+3337+300.3+638+57.4+25.1+2\times12.5)}{1963.5}$$

$$= \frac{4531.5}{1963.5} = 2.31^{k}/\square' = 2310\ psf$$

$$\frac{Mc}{I} = \frac{(2\times335.8+1145.3+22,937)(25)}{306,796} = \frac{24753.9(25)}{306,796} = 2.02^{k}/\square' = 2020^{k}/\square' \downarrow$$

Max down = 2310 + 2020 = 4330 ↓ < 15,000

Siesmic up & no snow

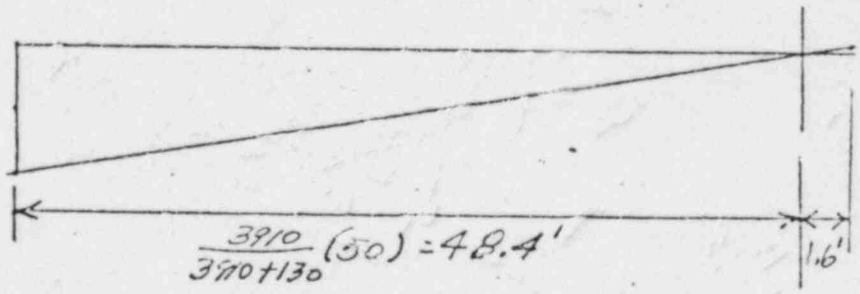
$$\frac{P}{A} = \frac{(117.5-12.8+16.6-1.8+3337-300.3+638-57.4-2\times12.5)}{1963.5}$$

$$= \frac{3711.8}{1963.5} = 1.89^{k}/\square' = 1890\ psf$$

$$\frac{Mc}{I} = 2020\ psf \uparrow$$

1890	1890
2020	2020
3910	130

Uplift area negligible with stresses far below (3910 < 15,000) allowable



Make check for next loading condition)

c) Faulted (Normal + SSE)

Max down

$$\frac{P}{A} = \frac{(117.5+2\times12.8+16.6+2\times1.8+3337+2\times300.3+638+2\times57.4+25.1+2.5\times12.5)}{1963.5}$$

$$= \frac{4910}{1963.5} = 2.50 \text{ k/}\square' = 2500 \text{ psf}$$

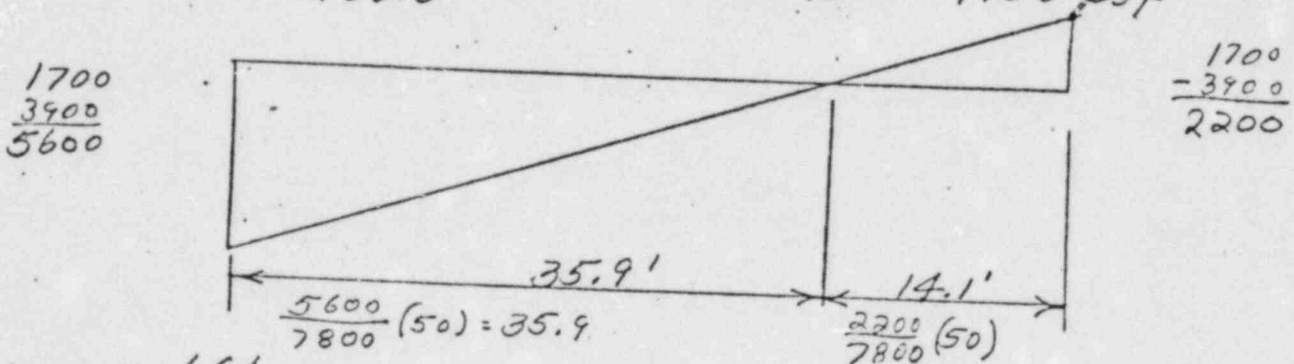
$$\frac{Mc}{I} = \frac{(335.8\times2.5+1145.3+2\times22{,}937)(25)}{306{,}796} = 3.90 \text{ k/}\square' = 3900 \text{ psf}$$

Max down = 2500 + 3900 = 6400 psf < 15,000 psf

Seismic up with no snow

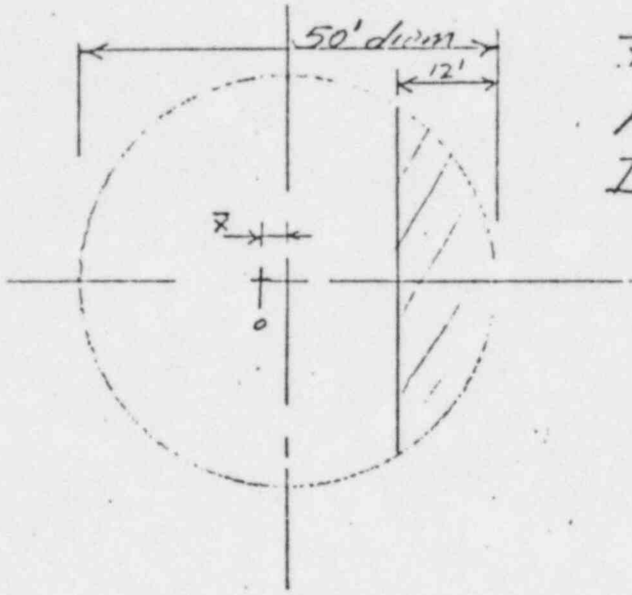
$$\frac{P}{A} = \frac{(117.5-2\times12.8+16.6-2\times1.8+3337-2\times300.3+638-2\times57.4-2.5\times12.5)}{1963.5}$$

$$= \frac{3333.2}{1963.5} = 1.70 \text{ k/}\square' = 1700 \text{ psf}$$



uplift occurs on 14.1'± distance from one side
check for uplift on 12'

$\frac{38}{50} = 0.74$



$\bar{x} = 0.193(25) = 4.82'$

$A = 0.622(50)^2 = 1555$

$I_o = 0.378(25)^4 = 147{,}656$

(coefficients from chart, p.703, Reinforced Concrete Fundamentals, Ferguson Second Edition, Wiley)

For seismic up & no snow

$$\frac{P}{A} = \frac{3333.2}{1555} = 2.14^{k/\square'} = 2140 \text{ psf}$$

$$\frac{Mc}{I} = \frac{(47859 - 3333.2 \times 4.82)(25 - 4.82)}{147{,}656} = 4.35^{k/\square'}$$

$$\text{or } \frac{(31{,}793)(25 + 4.82 - 12)}{147{,}656} = 3.84^{k/\square'}$$

Try uplift over 15' $35/50 = 0.7$

$\bar{x} = 0.22 \times 25 = 5.5$

$A = 0.59(50)^2 = 1475$

$I_o = 0.32(25)^4 = 125{,}000$

$$P/A = \frac{3333.2}{1475} = 2.26^{k/\square'}$$

$$\frac{Mc}{I} = \frac{(47{,}859 - 3333.2 \times 5.5)(25 + 5.5 - 15)}{125{,}000}$$

$$= 3.66^{k/\square'}$$

12
JH
5/3/72

Try uplift over 20' $\bar{x} = 0.31(25) = 7.75$

$30/50 = 0.6$ $A = 0.49(50)^2 = 1225$

$I = 0.2(25)^4 = 78,125$

$$P/A = \frac{3333.2}{1225} = 2.72^{k/\square'}$$

$$\frac{Mc}{I} = \frac{(47,959 - 3333.2 \times 7.75)(25 + 7.75 - 20)}{78,125}$$

$= 3.59^{k/\square'}$

Try uplift over 25' $\bar{x} = 0.42(25) = 10.5$

$A = 0.395(50)^2 = 987.5$

$I = 0.105(25)^4 = 41,016$

$$\frac{P}{A} = \frac{3333.2}{987.5} = 3.38^{k/\square'}$$

$$\frac{Mc}{I} = \frac{(47,959 - 3333.2 \times 10.5)(25 + 10.5 - 25)}{41,016}$$

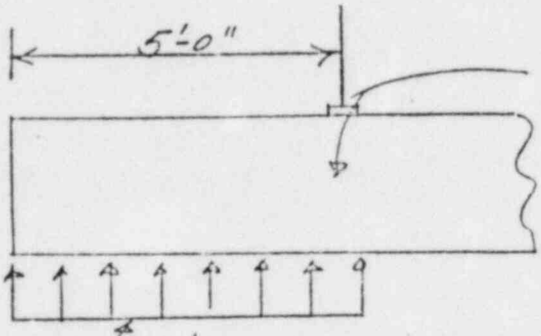
$= 3.29^{\prime k}$ ok use these values } uplift occurs over 25' of slab

$$\& \frac{Mc}{I} = \frac{(47,959 - 3333.2 \times 10.5)(25 - 10.5)}{41,016}$$

$= 4.55^{\prime k}$

Max pressure = 4550 + 3380 = 7930 psf < 15,000

Max slab bending outside tank wall



$M = \frac{7.67(5)^2}{2} = 95.9^{1k}$

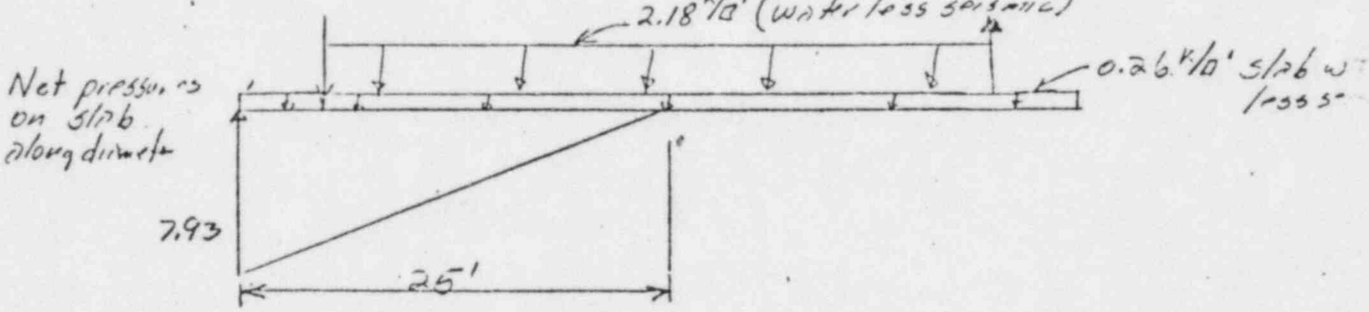
$V \cong 7.67(5 - \frac{22}{12}) = 24.3^k$

see below for controlling moment

C design pressure

$7.93^k/\square' - \frac{26}{12}(.15)(1-0.18) = 7.67^k/\square'$

slab wt



ULT $M_{across\ center\ diameter} = 47{,}859(1/2) - 2.18(1/2)(\pi)(20)^2(6.42)(20) - 0.26(1/2)(\pi)(25)^2(6.42)(25)$

1.4 $= 9744^{1k}$

$M/_1 = \frac{9744}{50} = 194.9^{1k}/_1$

Design bottom reinforcement for 194.9^{1k} service

bott $A_s = \frac{194.9(1.7)(0.75)(12)}{0.9(60)(0.9)(26-4.4)}$ (1.7 = load factor; 0.75 = reduction factor when seismic loads are included, ACI 318-71 Sec 9.3)

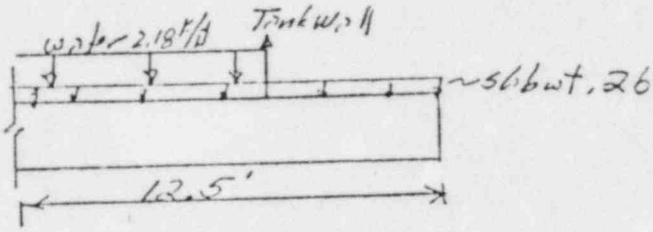
$= 2.84\ \square''/ft$ use #11 @ 6½" each way bottom

do not splice, use full length bars

top A_s = #8 @ 6½" each way

14
JTl
5/7/7?

M across chord
12.5' from diameter
uplift side

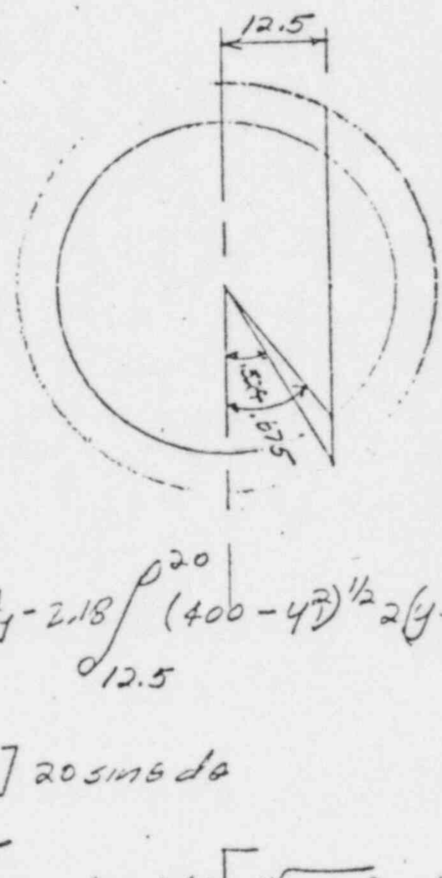


Tank wall forces

$$F = \frac{(117.5 - 2\times 12.8 - 2.5\times 12.5)}{\pi(40)} + \frac{(335.8\times 2.5 + 1145.3 + 2\times 22{,}937)\,y}{\pi(40)^3/16}$$

(y measured from diameter)

$$= 0.48\ ^{k}/_{ft} \downarrow + 3.81\,y$$



$$M_{12.5} = -0.26\int_{12.5}^{25}(625-y^2)^{1/2}(2)(y-12.5)\,dy - 2.18\int_{12.5}^{20}(400-y^2)^{1/2}\,2(y-12.5)\,dy$$

$$+\,2\int_{0.675}^{1.571}\left[0.48+3.91(20\sin\theta)\right]20\sin\theta\,d\theta$$

$$= -0.26\left[-2\frac{(625-y^2)^{3/2}}{3}\right]_{12.5}^{25} - 0.26(-12.5)(2)\left[\frac{y\sqrt{625-y^2}}{2} + \frac{625}{2}\sin^{-1}\frac{y}{25}\right]_{12.5}^{25}$$

$$+\,2\left[\left(-0.48(20)\cos\theta\right)_{.675}^{1.571} + \left(3.81(20)(20)\left(-\tfrac{1}{2}\sin\theta\cos\theta + \tfrac{1}{2}\theta\right)\right)_{.675}^{1.571}\right]$$

$$-2.18(2)\left[-\frac{(400-y^2)^{3/2}}{3}\right]_{12.5}^{20} - 2.18(2)(-12.5)\left[\frac{y\sqrt{400-y^2}}{2} + \frac{400}{2}\sin^{-1}\frac{y}{20}\right]_{12.5}^{20}$$

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$M_{12.5}$ uplift end $= -1759 + 1248 - 5531 + 4445 + 15 + 372 + 1197 - 514 = -527 < 9744$ at center diameter

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$M_{12.5}$ pressure end $= -1759 + 1248 - 5531 + 4445 - 15 - 372 + 1197 + 514$

$$+ 2\int_{0.524}^{1.571} [3.38 + 0.314(25\sin\theta - 10.5)][25\sin\theta - 10.5] \cdot [2(25)(\cos\theta)]\, d\theta$$

$$= -2667 + 2\int_{0.524}^{1.571} [4225\sin\theta\cos\theta - 1774.5\cos\theta + 9812.5\sin^2\theta\cos\theta - 4121.2\sin\theta\cos\theta - 4121.2\sin\theta\cos\theta + 1731\cos\theta]\, d\theta$$

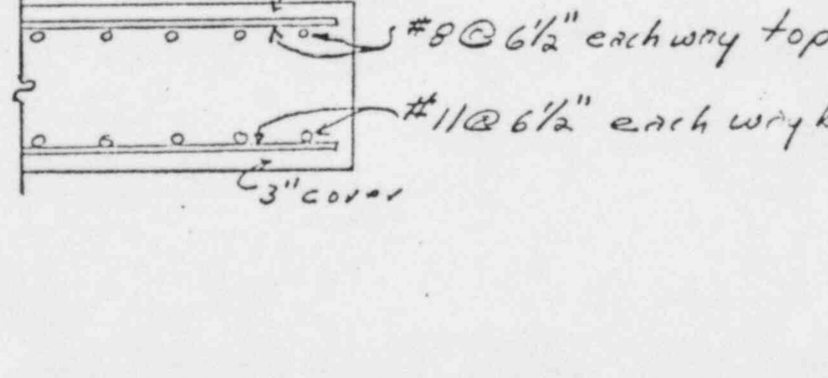
$$= -2667 + \left[2\left[4225\frac{\sin^2\theta}{2}\right]_{0.524}^{1.571} + 2\left[1774.5\sin\theta\right]_{0.524}^{1.571} + \left[2(9812.5)\frac{\sin^3\theta}{3}\right]_{0.524}^{1.571} - \left[4121.2(4)\frac{\sin^2\theta}{2}\right]_{.524}^{1.571} + \left[2(1731)\sin\theta\right]_{0.524}^{1.571}\right]$$

$$= -2667 + 3167 + 1773 + 5722 - 6179 + 1730$$

$$= 3546^{1k} \div 2(25\cos .524) = 81.9\ ^{ftk}/_{ft}$$

9744 at center diameter

M at center diameter governs



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ADDENDUM NO. 1 to REPORT ME-311

July 11, 1977

This addendum is issued to cover the change in anchor bolt material from SA-325 to Specification SA-320 with SA-193 Grade B7 bolts.

The SA-320 Spec with SA-193 Grade B7 bolts is acceptable based on either/or the following two criteria:

1) The SA-320 with SA-193 Grade B7 bolts is a higher grade material than the SA-325 and it has higher yield and ultimate strengths. The mechanical properties are at least equivalent to the SA-325 bolts.

2) The SA-320 with SA-193 Grade B7 bolts has a higher allowable stress than the SA-325 bolts when the criteria of ASME Code Case 1644-5 is applied to both bolts. The SA-320 with SA-193 Grade B7 bolts has allowable stresses(for both shear and tensile stresses) given by ASME Code Case 1644-5 which exceeds the actual stresses in the bolts.

Prepared by: C K McDonald 7/11/77
C. K. McDonald, P.E. Date