SOUTH CAROLINA ELECTRIC & GAS COMPANY
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COLUMBIA, SOUTH CAROLINA 29218

T. C. NICHOLS, JR.
VICE PRESIDENT AND GROUP EXECUTIVE
NUCLEAR OPERATIONS

July 10, 1981

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

Subject: Virgil C. Summer Nuclear Station
Docket No. 50/395
SER Item 1.7.21
Seismic Qualification of Equipment

Dear Mr. Denton:

During the Seismic Qualification Review Team Audit (SQRT) of the Virgil C. Summer Nuclear Station documentation for the seismic qualification of accumulators was not available at the site due to insufficient notification. In order to complete the review of the seismic qualification of the accumulators a meeting was held on May 12, 1981, between Westinghouse and Brookhaven National Labs (NRC consultants). The purpose of this meeting was to discuss and review the seismic qualification of accumulators supplied by Westinghouse for the Virgil C. Summer Nuclear Station. A detailed summary of the meeting is provided in Westinghouse Trip Report NS-S&ESE-8177 (Attachment A).

As a result of the subject review the NRC consultant identified two areas of concern as follows:

1. The computer input and output for the modal analysis performed by Westinghouse was not available at the meeting.

2. There was no one document which tied together all the analyses and reports used to demonstrate qualification of the Virgil C. Summer accumulators.

In order to resolve these concerns Westinghouse has initiated the actions described below which were deemed acceptable by the NRC consultant. Relative to the first concern, a simplified model of the modal analysis is provided in Attachment B and the computer input and output for the modal analysis is provided in Attachment C. Relative to the second concern, Westinghouse has revised Calculation Note 34-17-1 to contain a summary statement identifying the analyses and reports used to demonstrate seismic qualificaton of the Virgil C. Summer Nuclear Station accumulators. The summary information contained in the calculation note is similar to the information described on the second page of Attachment A.

Based on the above information, the subject of seismic qualification of the Virgil C. Summer Nuclear Station accumulators is considered closed. If you have any questions or concerns please contact us.

A049
S1/1

Very truly yours,

T. C. Nichols, Jr.

RBC:TCN:lkb

cc: V. C. Summer
G. H. Fischer
H. N. Cyrus
T. C. Nichols, Jr.
Dr. J. Ruoff
D. A. Nauman
W. A. Williams, Jr.
R. B. Clary
O. S. Bradham
A. R. Koon
M. N. Browne
B. A. Bursey
J. L. Skolds
J. B. Knotts, Jr.
Dr. M. Reich
NPCF
File

ATTACHMENT A

TRIP/CONFERENCE REPORT
FORM 551148

Westinghouse Electric Corporation

REPORT/FILE NO. * NS-S&ESE-81177

DATE PREPARED 6-15-81

TRIP TO	LOCATION	DATE(S) OF TRIP
Brookhaven Labs	Long Island, NY	5/11-12/81

PURPOSE*

To review seismic qualification of accumulator vessels for Virgil Summer (CGE) plant

P.O./NEGOTIATION/CONTRACT

S.O./BUDGET NO. *

SUMMARY/ACTION*

1. As a follow-up to the SQRT audit of the Virgil Summer (CGE) site an NRC consultant (Brookhaven Labs) conducted a review of the seismic qualification of accumulators.

2. During the review the Westinghouse seismic qualification methods were discussed in deta and several reports were reviewed.

3. The seismic qualification was acceptable with the exception of the following two items:

   a. the consultant requested review of the computer run for the modal analysis.

   b. there was no one document which tied together all the analyses and reports used to demonstrate qualification of the CGE accumulators.

4. Westinghouse agreed to provide the computer input and results for the modal analysis along with a sketch of the accumulator model, and to pursue the concern raised relative to documentation.

PERSONS PRESENT (NAME/TITLE/ORG./DIV./DEPT./GROUP)*

J. J. McInerney, W
S. Hyde, W
J. Curreri, Brookhaven

NOTHING IN THIS REPORT SHALL BE CONSTRUED TO CHANGE ANY TERMS, CONDITIONS, REQUIREMENTS, SPECIFICATIONS, OR PRICE IN ANY WRITTEN AGREEMENT.

AUTHOR SIGNATURE * John McInerney (NAME & TITLE)

DATE 6/22/81

DISTRIBUTION*

J. J. McInerney

S. Hyde, 3
J. Reid, 3
J. Pandya, 3
F. Manger, 4
D. Rawlins, 4
G. Butterworth, 4
D. Alexander, PC 2
R. Kelly, PC 2
J. Cookingham, 5
J. Curreri, Brookhaven Labs
R. Clearly, SCE&G

Details of Trip

A. Background

During the SQRT audit at the Virgil Summer site the accumulators were identified as a component which would be audited. Since this component was not identified prior to the audit and seismic qualification documentation was not available at the site during the audit. Subsequent to the audit a SQRT Form was prepared for the accumulators and submitted to the NRC. After receipt of the SQRT Form the NRC requested copies of the seismic qualification documentation for review by their consultant, Brookhaven Labs. In lieu of submitting the proprietary documentation, Westinghouse arranged to meet with Brookhaven consultants to discuss the Westinghouse seismic qualification methods and review the appropriate seismic qualification documentation.

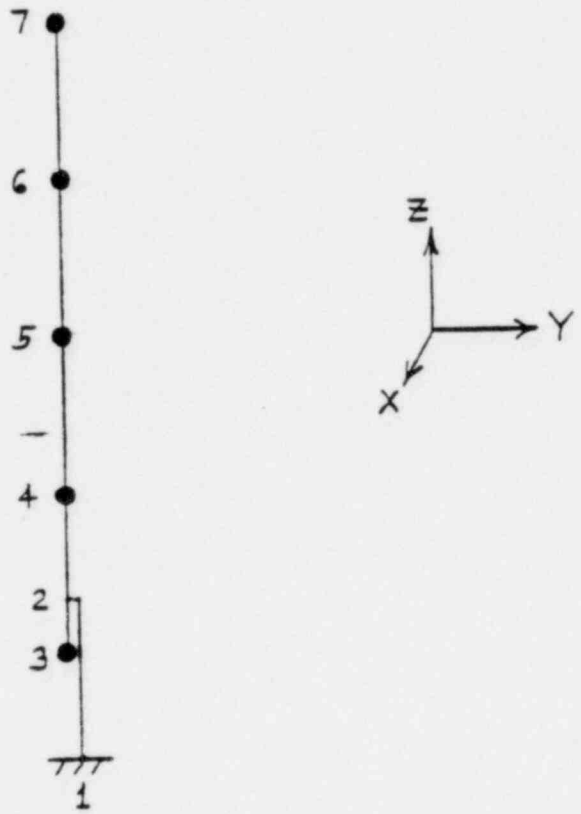
B. Discussion of Seismic Qualification

The seismic qualification methods were discussed in detail for the accumulators. The basic qualification consisted of a static analysis by the vendor (Delta Southern) to generic g levels identified in the equipment specification. The vendor analysis was documented in a design report and reviewed during the meeting. To supplement the vendor analysis Westinghouse performed a two dimensional modal analysis to determine the natural frequencies. The g valves at the predominent calculated natural frequency were then obtained from the appropriate Virgil Summer response spectra and compared with the generic qualification levels used by the vendor to demonstrate the acceptability of the vendor qualification. The consultant reviewed the results of this analysis as documented in Calculation Note 34-17-1 dated 1/3/77. The consultant was also interested in reviewing the computer run for this analysis. However, this information was not available at the meeting. To further demonstrate the accepability of the Westinghouse methods for determining natural frequencies the testing performed at Diablo Canyon (WCAP 9478) to verify analysis techniques was discussed and reviewed.

The last step in the qualification process was to demonstrate that the two dimensional analysis perform for the accumulators satisfied the requirement for three dimensional seismic analysis which was imposed on the Summer plant after the initial accumulator seismic analysis was completed. This was accomplished by comparing the g valves obtained in the two dimensional analysis with the information in WCAP 8230 which provides a generic method for making such a comparison.

Based on the above described review by the Brookhaven consultant, the seismic qualification of the Virgil Summer accumulators were deemed acceptable pending review of the computer run for the modal analysis. The consultant did express an additional concern which related to determining the applicability of all the documentation reviewed to the Virgil Summer accumulators. Westinghouse agreed to take action to resolve both of these concerns.

ATTACHMENT B

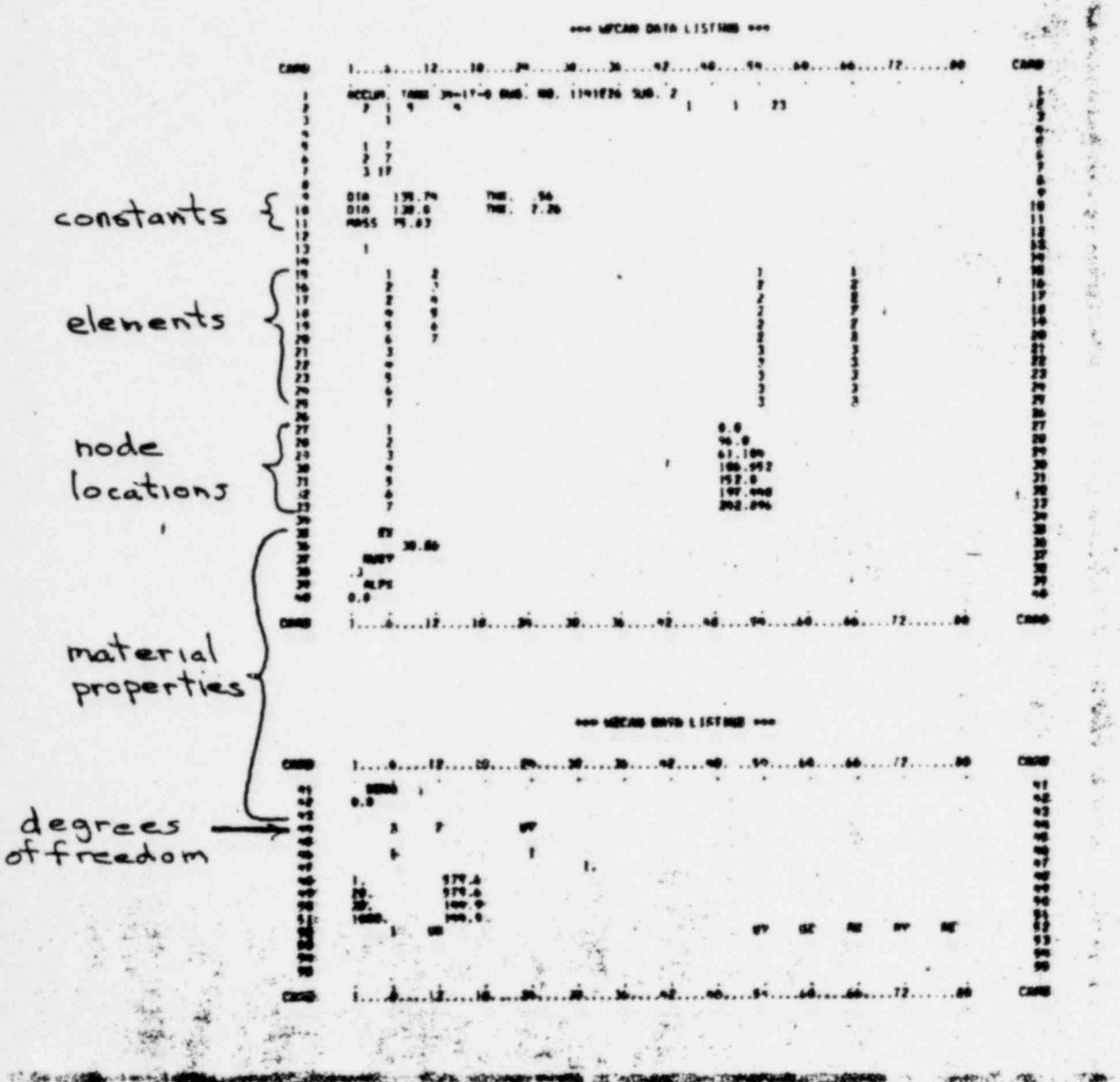


Mathematical Model for Summer Plant
SIS Accumulator Tank

ATTACHMENT C

Modal Analysis of Sumner Plant SIS Accumulator Tank

Horizontal Shock (Y-direction)



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******************************************************************************************************************
******************************************************************************************************************

             WECAN - WESTINGHOUSE ELECTRIC CORP. SM ANALYSIS          VERSION DATE  4/10/73

                      A PROPRIETARY GENERAL PURPOSE FINITE ELEMENT CODE

******************************************************************************************************************
******************************************************************************************************************

                    14.8850   8/20/74                      CP=     1.746     PP=     0.000

ACCUM. TANK 34-17-0 DWG. NO. 1141E26 SUB. 2

SOLUTION TYPE...............K20     2    MODE/FREQ ANALYSIS
SOLUTION KEYS...............KAY     1     4   -0    4   -0    1   -0   -0   -0   -0
NODE ROTATION ANGLE KEY.....K6     -0
RESTART KEY.................K9     -0
ELAST-PLAST KEY.............K13    -0
NODE FORCE OUTPUT KEY.......K15     1
NO OF EXTRA MATL PROP.......K16    -0
BOUND COND CHANGE KEY.......K17     1
ELEM MATRIX OUTPUT KEY......K19    -0
NO OF VALUES ON TAPE10......K21    23
GEOMETRY PLOT KEY...........K22    -0
COUPLED NODE KEY............K23    -0
MESH PRINTOUT KEY...........K24    -0
COORD SYSTEM OUTPUT KEY.....K25    -0
POST PLOTTING KEY...........K26    -0

NUMBER OF LOAD STEPS...NSTEPS       1
DATA FILE - ELEMENTS...INELEM       5
DATA FILE - NODES......INNODE       5
DATA FILE - BOUND COND...INBC       5
DATA FILE - TEMP.......INTEMP       5
REFERENCE TEMPERATURE....TREF        -0.0
MATL TEMP DEPENDENCE.....TMIN        -0.0
MATL TEMP DEPENDENCE.....TMAX       400.0
MATL TEMP DEPENDENCE...TDELTA       100.0

BLOCK SIZES...........BLKSIZ        500       500       36       100      1000



...ELEMENT LIBRARY USED...

  TYPE STIF          DESCRIPTION                   KEYSUBS    CORRELATION ARRAY

    1    7    3-DIMENSIONAL P...   12/6/71          -0   -0     1  2  3  4  5  6  7  8  9 10 11 12
                                                                0  0  0  0  0  0  0  0  0  0  0  0
    2    7    3-DIMENSIONAL PIPE   12/6/71          -0   -0     1  2  3  4  5  6  7  8  9 10 11 12
                                                                0  0  0  0  0  0  0  0  0  0  0  0
    3   17    LUMPED MASS  3-DIM.  4/30/70          -0   -0     1  2  3  0  0  0  0  0  0  0  0  0
                                                                0  0  0  0  0  0  0  0  0  0  0  0

ASSIGNMENT OF D.O.F. FOR CORRELATION ARRAY AS FOLLOWS... ANY USER ASSIGNED ARRAYS CANNOT ADD DIFFERENT D.O.F.

                   UX INDEX IS      1
                   UY INDEX IS      2
                   UZ INDEX IS      3
                   RX INDEX IS      4
                   RY INDEX IS      5
                   RZ INDEX IS      6



ELEMENT REAL CONSTANT TABLE                                        MAX NO. OF REAL CONSTANTS REQD =  2

TBL   CONSTANTS    LABEL          VALUE  LABEL          VALUE  LABEL          VALUE  LABEL          VALUE

  1     1 TO  2    DIA      .13574E+03   THK.      .56000E+00

  2     1 TO  2    DIA      .12000E+03   THK.      .22600E-01

  3     1 TO  1    MASS     .75830E+02

LOCAL COORDINATE SYSTEM DEFINITIONS

NO.      TYPE         X0          Y0          Z0          01          02          03

  1      CART       -0.00       -0.00       -0.00       -0.00       -0.00       -0.00
```

ELEMENT DESCRIPTION CPU 1.772 PPU 0.000

ELEMENT TYPE MAT1 TBL ....NODES....

1	1	1	1	1	2
2	1	1	2	2	3
3	1	1	2	3	4
4	1	1	2	4	5
5	1	1	2	5	6
6	1	1	2	6	7
7	1	1	3	1	
8	1	1	3	4	
9	1	1	3	5	
10	1	1	3	6	
11	1	1	3	7	

NO OF ELEMENTS... NUMELM= 11

NODE DESCRIPTION CPU 1.789 PPU 0.000

	NODE	X(1)	X(2)	X(3)			
1	1	-0.0000	-0.0000	0.0000	COORD SYSTEM NO	0	CART
2	2	-0.0000	-0.0000	96.0000	COORD SYSTEM NO	0	CART
3	3	-0.0000	-0.0000	61.1040	COORD SYSTEM NO	0	CART
	4	-0.0000	-0.0000	106.5520	COORD SYSTEM NO	0	CART
	5	-0.0000	-0.0000	152.0000	COORD SYSTEM NO	0	CART
	6	-0.0000	-0.0000	197.4480	COORD SYSTEM NO	0	CART
	7	-0.0000	-0.0000	242.8960	COORD SYSTEM NO	0	CART

NO OF NODES.....NUMNOD= 7

THE NUMBER OF WORDS IN EACH OF BLOCKS 1 AND 2 = 60

PRINT ALL PROPERTIE, ON.

MAT1, NO 1

E1= .3000E+08

ALPHA= 0.

RHO= .3000E+08

DENS= 0.

ACTIVE D.O.F. FOR DYNAMIC REDUCTION

NO.	NODE	D.O.F.
1	1	UY
2	4	UY
3	5	UY
4	6	UY
5	7	UY

3=0
1 01
2 01

FORC
FORC

STEP NUMBER.....ITIPS	1			CPs 1.817 PPs 0.000	
CONSTRAINT/LOAD KEY.....KDIS	1				
TEMPERATURE KEY.....KTEMP	-0				
SUBSTEPS KEY.....NITTER	1				
PRINTOUT KEY.....NPRINT	1				
MATRIX FORMULATION KEY....KIB	-0				
UNIFORM TEMP.....TUNIF	-0.0000				
END TIME OF STEP.....TIME	-0.0000				
ACCELERATIONS.....ACEL	-0.0000	1.0000	-0.0000		
ROTATIONS.....OMEGA	-0.0000	-0.0000	-0.0000		

SEISMIC RESPONSE SPECTRUM

FREQUENCY(HERTZ)	ACCELERATION
1.0000	579.60
20.000	579.60
25.000	144.90
1000.0	144.90

NODE CONSTRAINTS

NO.	NODE	DIRECTION	NEW VALUE	OLD VALUE	ALPHA 1	ALPHA 2	ALPHA 3
1	1	UX	-0.	-0.	0.	0.	0.
2	1	UY	-0.	-0.	0.	0.	0.
3	1	UZ	-0.	-0.	0.	0.	0.
4	1	RX	-0.	-0.	0.	0.	0.
5	1	RY	-0.	-0.	0.	0.	0.
6	1	RZ	-0.	-0.	0.	0.	0.

BEGIN FRONTAL SOLUTION AT CPs 1.827

ESTIMATE OF TIME AT FINISH OF ITERATION CPs 2.113 DONE AT .1 THRU SOLVER VS. TIME LIMIT= 23.000

ESTIMATE OF TIME AT FINISH OF ITERATION CPs 2.076 DONE AT .5 THRU SOLVER VS. TIME LIMIT= 23.000

END FRONTAL SOLUTION AT CPs 1.956

MAXIMUM EQUATIONS USED 30

MAXIMUM EQUATIONS ALLOWED FOR IN-CORE SOLUTION 64

THE DATA BLOCK SIZES SHOULD BE 864 864 1272 64 0 FOR MAXIMUM EFFICIENCY

TOTAL SPACE FOR BLOCKS IS 6719

TOTAL FIELD LENGTH REQUIRED IS 147910 (OCT)

TIMES AT START OF BACK SUBSTITUTION CPs 1.955 PPs 0.000

BACKSPACE AND READ COMPLETE CPs 1.965 PPs 0.000

COMPLETE SET OF EIGENVALUES

MODE	FREQUENCY (HERTZ)
1	20.310
2	66.768
3	214.98
4	312.52
5	361.14

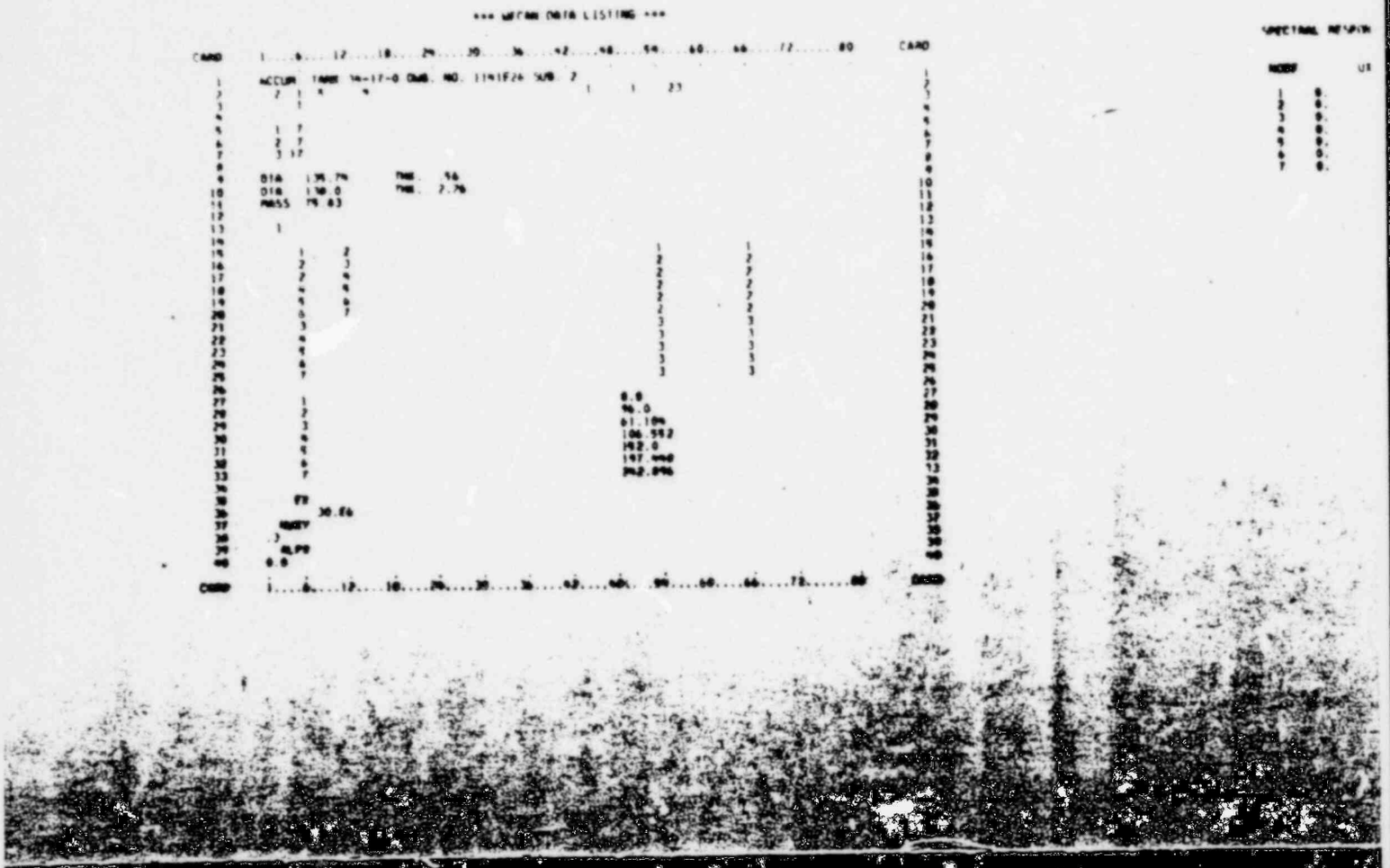
← 1st horizontal frequency

MODE	PARTICIPATION FACTOR	EFFECTIVE MASS	FRACTION EFF. MASS
1	1.3327	338.64	.89317
2	9.3180	+0.+82	.10677
3	-.997006E-02	.720618E-02	.190066E-04
4	.701726E-02	.496318E-02	.246966E-04
5	-.630936E-02	.718188E-02	.189608E-04

EXPANDED MODE SHAPE FOR MODE 1 FREQUENCY .203106E+02 HERTZ (CYCLES/SECOND)

NODE	UX	UY	UZ	RX	RY	RZ
1	0.	0.	0.	0.	0.	0.
2	0.	.449995	0.	-.307668E-02	0.	0.
3	0.	.951387	0.	-.307271E-02	0.	0.
4	0.	.699702	0.	-.112726E-02	0.	0.
5	0.	.667029	0.	-.128138E-02	0.	0.
6	0.	.836744	0.	-.195729E-02	0.	0.
7	0.	1.000000	0.	-.137644E-02	0.	0.

Vertical Shock (Z-direction)



*** WECAN DATA LISTING ***

```
CARD    1....6....12....18....24....30....36....42....48....54....60....66....72......80     CARD

  41      DEN'                                                                                41
  42    0.0                                                                                   42
  43                                                                                          43
  44          1    2                    UZ                                                    44
  45                                                                                          45
  46          1                  1                                                            46
  47                                          1.                                              47
1 48    1.           388.1                                                                    48
1 49    20.          388.1                                                                    49
1 50    28.          47.1                                                                     50
  51    1000.        47.1                                                                     51
  52          1    UX                                        UY    UZ    RX    RY    RZ       52
  53                                                                                          53
  54                                                                                          54
  55                                                                                          55

CARD    1....6....12....18....24....30....36....42....48....54....60....66....72......80     CARD
```

```
TIME

3-D PIPE   1
1 DIM      +
2 DIM      +

FORCES ON NOD
FORCES ON NOD

3-D PIPE   2
1 DIM      -+
2 DIM      -+

FORCES ON NOD
FORCES ON NOD

3-D PIPE   3
1 DIM      -+
2 DIM      -+

FORCES ON NOD
FORCES ON NOD

3-D PIPE   4
1 DIM      -+
2 DIM      +

FORCES ON NOD
FORCES ON NOD

3-D PIPE   5
1 DIM      --
2 DIM      --

FORCES ON NOD
FORCES ON NOD
```

TUNED FOR LARGER PROBLEM CAPACITY AND OTHER FEATURES TO BE ANNOUNCED SOON

WECAN - WESTINGHOUSE ELECTRIC COMPUTER ANALYSIS   VERSION DATE 9/10/73

A PROPRIETARY GENERAL PURPOSE FINITE ELEMENT CODE

14.41.28   8/20/74   CP= 3.880   PP= 0.000

ACCUM. TANK 14-17-0 DWG. NO. 1141E26 SUB. 2

SOLUTION TYPE	K20	2	MODE/FREQ ANALYSIS
SOLUTION KEYS	KAY	1	5 -0 4 -0 1 -0 -0 -0
NODE ROTATION ANGLE KEY	K6	-0	
RESTART KEY	K9	-0	
ELAST-PLAST KEY	K13	-0	
NODE FORCE OUTPUT KEY	K15	1	
NO OF EXTRA MATL PROP	K16	-0	
BOUND COND CHANGE KEY	K17	1	
ELEM MATRIX OUTPUT KEY	K19	-0	
NO OF VALUES ON TAPE10	K21	23	
GEOMETRY OUT KEY	K22	-0	
COUPLED NODE KEY	K23	-0	
MESH PRINTOUT KEY	K24	-0	
COORD SYSTEM OUTPUT KEY	K25	-0	
POST PLOTTING KEY	K26	-0	

NUMBER OF LOAD STEPS	NSTEPS	1
DATA FILE - ELEMENTS	INELEM	5
DATA FILE - NODES	INNODE	5
DATA FILE - BOUND COND	INBC	5
DATA FILE - TEMP	INTEMP	5
REFERENCE TEMPERATURE	TREF	-0.0
MATL TEMP DEPENDENCE	TMIN	-0.0
MATL TEMP DEPENDENCE	TMAX	900.0
MATL TEMP DEPENDENCE	TDELTA	100.0

BLOCK SIZES ....BLKSIZ   500   500   1000   100   1000

...ELEMENT LIBRARY USED...

TYPE	STIF	DESCRIPTION		KEYSUBS		CORRELATION ARRAY
1	7	3-DIMENSIONAL PIPE	12/6/71	-0	-0	1 2 3 4 5 6 7 8 9 10 11 12 0 0 0 0 0 0 0 0 0 0 0 0
2	7	3-DIMENSIONAL PIPE	12/6/71	-0	-0	1 2 3 4 5 6 7 8 9 10 11 12 0 0 0 0 0 0 0 0 0 0 0 0
3	17	LUMPED MASS 3-DIM.	4/30/70	-0	-0	1 2 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

ASSIGNMENT OF D.O.F. FOR CORRELATION ARRAY AS FOLLOWS .. ANY USER ASSIGNED ARRAYS CANNOT ADD DIFFERENT D.O.F.

UX INDEX IS 1
UY INDEX IS 2
UZ INDEX IS 3
RX INDEX IS 4
RY INDEX IS 5
RZ INDEX IS 6

ELEMENT REAL CONSTANT TABLE   MAX NO. OF REAL CONSTANTS REQD = 2

TBL	CONSTANTS	LABEL	VALUE	LABEL	VALUE	LABEL	VALUE	LABEL	VALUE
1	1 TO 2	DIA	.13974E+03	THK.	.56000E+00				
2	1 TO 2	DIA	.13800E+03	THK.	.22600E+01				
3	1 TO 1	MASS	.75830E+02						

LOCAL COORDINATE SYSTEM DEFINITIONS

NO.	TYPE	X0	Y0	Z0	Θ1	Θ2	Θ3
1	CART	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00

SPECTRAL RESP

MODE
1 -0
2 -0
3 -0
4 -0
5 -0
6 -0
7 -0.

TIME =

3-D PIPE 1
1 DIR
2 DIR
FORCES ON NODE
FORCES ON NODE

3-D PIPE 2
1 DIR
2 DIR
FORCES ON NODE
FORCES ON NODE

3-D PIPE 3
1 DIR
2 DIR
FORCES ON NODE
FORCES ON NODE

3-D PIPE 4
1 DIR
2 DIR
FORCES ON NODE
FORCES ON NODE

3-D PIPE 5
1 DIR
2 DIR
FORCES ON NODE
FORCES ON NODE

TIME =

3-D PIPE 6
1 DIR
2 DIR
FORCES ON NODE
FORCES ON NODE

ELEMENT DESCRIPTION CPs 3.467 PPs 0.000

ELEMENT	TYPE	MAT	TBL	NODES		
1	2	1	1	1	2
2	2	1	2	2	3
3	2	1	2	3	4
4	2	1	2	4	5
5	2	1	2	5	6
6	2	1	2	6	7
7	1	1	1	1	
8	1	1	1	4	
9	1	1	1	5	
10	1	1	3	6	
11	1	1	3	7	

NO OF ELEMENTS... NUMEL= 11

EXPANDED NO

NODE	
1	0.
2	0.
3	0.
4	0.
5	0.
6	0.
7	0.

NODE DESCRIPTION CPs 3.923 PPs 0.000

NODE	X(1)	X(2)	X(3)			
1	-0.0000	-0.0000	.0 0000	COORD	SYSTEM NO	0 CART
2	-0.0000	[illegible]	96.0000	COORD	SYSTEM NO	0 CART
3	-0.0000	-0.[illegible]	61.1094	COORD	SYSTEM NO	0 CART
4	-0.0000	-0.0000	106.9520	COORD	SYSTEM NO	0 CART
5	-0.0000	-0.0000	152.0000	COORD	SYSTEM NO	0 CART
6	-0.0000	-0.0000	197.0480	COORD	SYSTEM NO	0 CART
7	-0.0000	-0.0000	242.8906	COORD	SYSTEM NO	0 CART

NO OF NODES..... NUMNP= 7

THE NUMBER OF WORDS IN EACH OF BLOCKS 1 AND 2 = 884

SPECTRAL R

NODE	
1	0.
2	0.
3	0.
4	0.
5	0.
6	0.
7	0.

MATERIAL PROPERTIES DATA

MATL NO 1

E2= .3000E+08

ALPH= 0.

NUE= .2000E+00

DENS= 0.

TIME

1=0 PIPE
1 DIR=
2 DIR=

FORCES ON =
FORCES ON =

1=0 PIPE
1 DIR=
2 DIR=

FORCES ON =
FORCES ON =

1=0 PIPE
1 DIR=
2 DIR=

FORCES ON =
FORCES ON =

1=0 PIPE
1 DIR=

FORCES ON NODE
FORCES ON NODE

ACTIVE D.O.F. FOR DYNAMIC REDUCTION

NO.	NODE	D.O.F.
1	1	UZ
2	4	UZ
3	5	UZ
4	6	UZ
5	7	UZ

TIME =

>=0 PIPE 6
1 DIR= *
2 DIR= *

FORCES ON NODE
FORCES ON NODE

STEP NUMBER.....ITIME	1		CPU 3.790	PPU 0.000
CONSTRAINT/LOAD KEY.....KDIS	1			
TEMPERATURE KEY.....ATEMP	=0			
SUBSTEPS KEY.....NITTER	1			
PRINTOUT KEY.....NPRINT	1			
MATRIX FORMULATION KEY...KIB	=0			
UNIFORM TEMP.....TUNIF	=0.0000			
END TIME OF STEP.....TIME	=0.0000			
ACCELERATIONS.....ACEL	=0.0000	=0.0000	1.0000	
ROTATIONS.....OMEGA	=0.0000	=0.0000	=0.0000	

EXPANDED FOR

NODE

1	0.
2	0.
3	0.
4	0.
5	0.
6	0.
7	0.

SEISMIC RESPONSE SPECTRUM

FREQUENCY(HERTZ)	ACCELERATION
1.0000	388.38
20.000	388.38
25.000	97.100
1000.0	97.100

NODE CONSTRAINTS

NO.	NODE	DIRECTION	NEW VALUE	OLD VALUE	ALPHA 1	ALPHA 2	ALPHA 3
1	1	UX	=0.	=0.	0.	0.	0.
2	1	UY	=0.	=0.	0.	0.	0.
3	1	UZ	=0.	=0.	0.	0.	0.
4	1	RX	=0.	=0.	0.	0.	0.
5	1	RY	=0.	=0.	0.	0.	0.
6	1	RZ	=0.	=0.	0.	0.	0.

BEGIN FRONTAL SOLUTION AT CPU 3.961

ESTIMATE OF TIME AT FINISH OF ITERATION CPU 4.247 DONE AT .1 THRU SOLVER VS. TIME LIMIT= 23.000

ESTIMATE OF TIME AT FINISH OF ITERATION CPU 4.217 DONE AT .5 THRU SOLVER VS. TIME LIMIT= 23.000

END FRONTAL SOLUTION AT CPU 4.006

SPECTRAL R

NODE

1	0.
2	0.
3	0.
4	0.
5	0.
6	0.
7	0.

NUMBER OF EQUATIONS USED 30

NUMBER OF EQUATIONS ALLOWED FOR IN-CORE SOLUTION 60

THE DATA BLOCK SIZES SHOULD BE 600 600 1272 60 5 FOR MAXIMUM EFFICIENCY

TOTAL SPACE FOR BLOCKS IS 6719

TOTAL FIELD LENGTH REQUIRED IS 147510 (OCTAL)

TIMES AT START OF BACK SUBSTITUTION CPU 4.090 PPU 0.000

BACKSPACE AND READ COMPLETE CPU 4.100 PPU 6.000

COMPLETE SET OF EIGENVALUES

MODE	FREQUENCY (HERTZ)
1	67.900 ← 1st vertical frequency
2	292.67
3	541.96
4	748.14
5	878.97

TIME = 0.0

3-D PIPE 1. NO
1 DIR= = BEND
2 DIR= = BEND

FORCES ON NODE
FORCES ON NODE

3-D PIPE 2. NO
1 DIR= = BEND
2 DIR= = BEND

FORCES ON NODE
FORCES ON NODE

3-D PIPE 3. NO
1 DIR= = BEND
2 DIR= = BEND

FORCES ON NODE
FORCES ON NODE

3-D PIPE 4. NO
1 DIR= -= BEND
2 DIR= -= BEND

FORCES ON NODE
FORCES ON NODE

3-D PIPE 5. NO
1 DIR= = BEND
2 DIR= = BEND

FORCES ON NODE
FORCES ON NODE

MODE	PARTICIPATION FACTOR	EFFECTIVE MASS	FRACTION EFF. MASS
1	1701	377.92	.99674
2	.79404E-01	1.2039	.31752E-02
3	-.16497E-02	.5[illegible]32E-03	.13900E-05
4	.9968[illegible]E-02	.20335E-01	.53632E-04
5	.70934E-02	.96302E-02	.25399E-04

TIME = 0.

3-D PIPE 6. NO
1 DIR= -= BEN
2 DIR= -= BEN

FORCES ON NODE
FORCES ON NODE

EXPANDED MODE SHAPE FOR MODE 1 FREQUENCY .67900E+02 HERTZ (CYCLES/SECOND)

NODE	UX	UY	UZ	RX	RY	RZ
1	0.	0.	0.	0.	0.	0.
2	0.	0.	.854786	0.	0.	0.
3	0.	0.	.869094	0.	0.	0.
4	0.	0.	.873644	0.	0.	0.
5	0.	0.	.936138	0.	0.	0.
6	0.	0.	.978959	0.	0.	0.
7	0.	0.	1.000000	0.	0.	0.

COMBINED SPE

NODE	
1	0.
2	0.
3	0.
4	0.
5	0.
6	0.
7	0.