STATIC METHOD

OF

SEISMIC ANALYSIS OF PIPING SYSTEMS

FOR

OCONEE 1, 2, 3

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ENGINEERING DEPARTMENT
MECHANICAL DESIGN GROUP, MECHANICAL SECTION
CHARLOTTE, NORTH CAROLINA

FILE NO. OS-27B

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PREFACE

The "Static Method of Seismic Analysis for Oconee 1, 2, 3" describes the philosophy and approach taken by Duke Power Company in the static seismic analysis of piping for the Oconee Station. The attached sample problem demonstrates the techniques used through the theoretical analysis of a portion of the Reactor Building Spray System. The analysis is considered as a sample only and is not intended to represent a final analysis on this system.

CONTENTS

A. DESIGN CRITERIA

Piping shall be designed in accordance with ANSI B31.1.0 (1967). For the Operating Basis Earthquake, seismic load shall be considered as an occasional load occurring less than one percent (1%) of the time, and designed for as provided in paragraphs 102.3.3 and 121.1.2(a) 1. Accordingly, the sum of the combined longitudinal stresses produced by concurrent values of maximum expected internal pressure, live and dead loads, plus loads corresponding to the Operating Basis Earthquake shall not exceed 1.20 times S_A, where S_A is the allowable stress at the concurrent maximum expected temperature. Thermal expansion stresses will be handled independently in accordance with the code. Loads will be checked for no loss of essential function under the Design Basis Earthquake in accordance with the following formula: the sum of the longitudinal stresses produced by concurrent values of the maximum expected internal operating pressure, live and dead loads, plus twice the loads corresponding to the Operating Basis Earthquake shall not exceed S_{yield} at the corresponding operating temperature as defined by Table A.3 of the ANSI B31.7 code.

B. INTRODUCTION AND ASSUMPTIONS

In order for a static analysis to be meaningful it must be relatively simple. The more complicated the analysis is the more doubtful the results are. Also, to be useful the analysis must be based on conservative assumptions. Usually, along with increased conservatism goes increased hardware costs. However, this is not always the case and it is engineering judgment that must decide the reasonable degree of conservatism. Certain assumptions are made in the analysis and are as follows:

1. Acceleration response spectra are available for the building.

2. The analysis is conservative enough and the effects are low enough so as to allow the engineer to ignore the effects of thermal insulation.

3. Piping spans will be designed rigid.

4. A piping span can be considered rigid if its fundamental frequency is twice the highest significant building frequency or if its fundamental frequency is above 20 hz.

5. Spring hangers are not considered restraints.

C. DESIGN SPAN

In developing an acceptable static analysis technique for seismic loading one would ideally select piping spans to avoid the resonant range of the structure or building supporting the piping. The resonant range is defined as that range of frequencies in which the building causes appreciable amplification of the earthquake input. This, of course, is determined by the characteristics of the building structure and mass distribution. The degree of response or magnitude of acceleration depends on the earthquake characteristics in relation to the structure. Having acceleration response spectra curves facilitates identification of the resonant range.

The designer can avoid the resonant range by either decreasing the span and increasing the frequency or by increasing the span and decreasing the frequency. However, in steel structures, especially the taller ones, the fundamental frequency may be so low that the second and third modes fall within the earthquake spectrum. Designing for a flexible span by keeping the fundamental frequency of the pipe span below the building fundamental may allow the second or third modes of the pipe span to fall within the range of the second and third building mode. If these fall within the earthquake spectrum, it would not be safe to analyze the pipe span for only the fundamental mode. Consequently, it follows that the safest approach is to design for a rigid span.

In designing for a rigid span, one's assumptions must always make the span more flexible or have a lower natural frequency than it really has. This leads to the selection of a simply supported beam as the design span. Obviously, few piping systems can be idealized wholly into segments of simple spans. However, a large portion of a given system can be restrained this way, and a simplified analysis for this portion of the piping will greatly reduce the task of evaluation. The simple beam lends itself to minimal analysis also in that the evaluation of modal effects are easily accomplished. Only the first and third modes need be considered for rigid beam because the second mode has no bending stress at the center of the beam where the first and third modes are highest. Also, the contribution of the third mode for stresses can be no greater than 11% of the first mode for the same acceleration level. Since the acceleration at the third mode will generally be less, it would be safe to assume that an addition of 10% to the stresses for the fundamental mode would be conservative.

D. OTHER SPANS

Having designed the major portion of a system as simple beams, there is left the problem of determining equivalent beams for the slightly more complicated cases and the final problem of either performing a dynamic analysis on the more complicated systems or providing more hydraulic snubbing devices, or both.

The development of equivalent spans for calculating frequency for the moderately complicated piping spans is left to the engineer. However, it is noted that it is usually sufficient to simulate the end conditions of one end of the span and assume that the other end offers only a shear restraint and mass.

E. DESIGN ACCELERATION

In agreement with the general philosophy of making the analysis technique simple, it follows that it would be desirable to use a constant design acceleration wherever practical. The design value would, of course, have to be conservative. This, then, would affect the design loads on restraints and may affect restraint costs. However, in a stiff system, the loads on lateral restraints are not expected to be large. Consequently, even doubling a design load may not affect a design of the restraint. In the axial direction, the loads can become appreciable and it would be wise to select a more representative design acceleration. This is easily done because it can be assumed that the support floor acceleration derived from the building modal analysis is adequate for the design acceleration for the axial direction of a run of pipe. This implies that the piping restraint is rigid and this must be verified. This assumption allows a much lower design acceleration to be used for the axial direction and should result in a savings in restraint costs.

In the vertical direction, the design acceleration can be lower than that used for the horizontal directions because of the generally assumed absence of building amplification in this direction. Design accelerations can be taken from the ground response spectra recommended for the site. Design values can be selected as a function of frequency or the maximum value can be used and the frequency disregarded. Either method is acceptable; the selection would be a matter of judgment based on economics.

F. CONCENTRATED MASSES

The effect of concentrated masses such as valves or branch lines must be considered. These effects are minimized by putting restraints near the mass concentrations where possible. The mass "M", Fig. 1, is treated as an effective mass "Meff" at the center of the span in the determination of frequency and bending stress. However, if the valve is restrained by a single restraint immediately adjacent to the valve, the effect of the valve on the span need not be considered because the small theoretical effect of the concentrated mass is counteracted by the added stiffness of the valve.

G. RESTRAINT LOADS

In the determination of restraint loads one must consider the loads from the spans on either side of the restraint. Valve loads can be distributed according to location in the span. When the distribution of loads is questionable, it will be conservative to assume that each restraint must resist the full load.

H. ANCHORS

True anchors should be avoided where it is possible to use X-Y-Z restraints. This eliminates the need for designing anchors for moment loadings.

I. THERMAL GROWTH

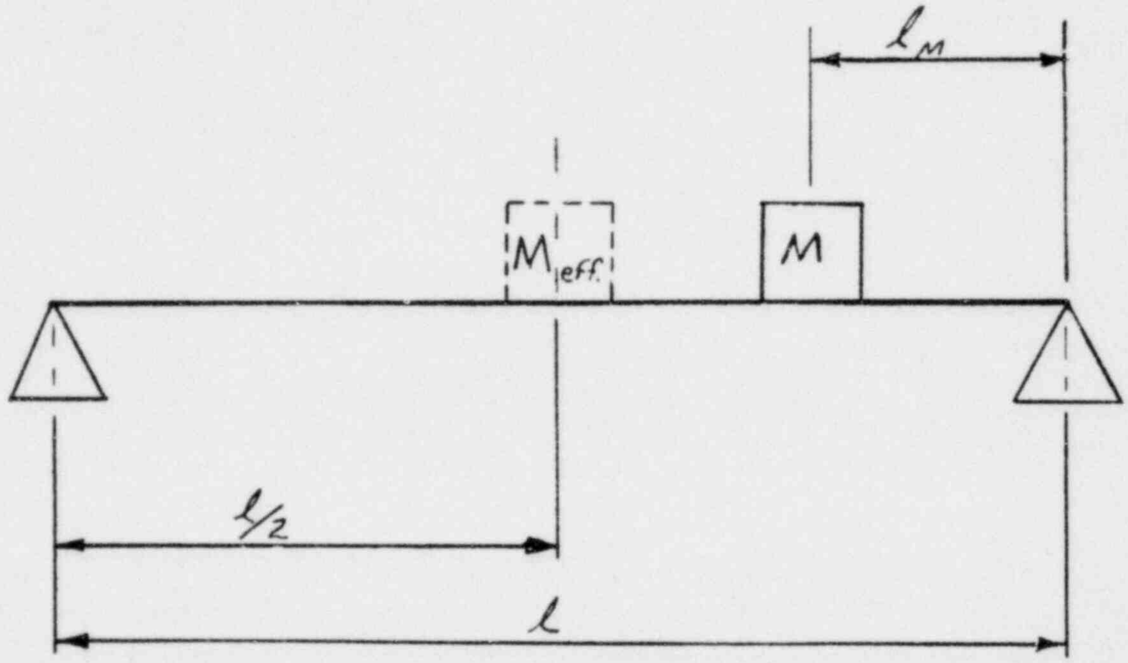
Thermal growth must be considered when determining the type and location of seismic restraints. Generally it is best to place rigid axial restraints near the center of the run to divide the growth between the two ends. However, this is not always true and each case must be evaluated individually. Long axial runs may produce large restraint forces. If additional support locations are required, hydraulic suppressors may be required to allow for thermal growth.

J. RELATIVE DISPLACEMENTS

Relative displacement of restraints due to seismic movement must also be considered if a run is anchored or restrained in two or more buildings. Relative displacements also occur between floors of the same building but are not considered important because of the relatively greater flexibility of the piping when compared to the building. The absolute sum of the restraint movements must be applied to the restraints in both X and Z directions, but not simultaneously, to determine the effects on piping and restraints.

K. SUMMARY

The analysis procedure in Appendix A is intended to serve as a guide for the engineer in the static analyses of piping systems for seismic conditions. The simplified but conservative nature of this analysis technique is intended to expedite the review of a system. In the event that certain elements do not meet the criteria herein, the engineer has the option of a more detailed analysis to verify the adequacy of the elements.



$$M_{eff.} = 2M \frac{\ell_m}{\ell}$$

FIGURE 1

APPENDIX A

PROCEDURE FOR STATIC SEISMIC ANALYSIS

1. Review response spectra for entire building to determine if it is practical to establish a single horizontal design acceleration for lateral direction of pipe regardless of elevation by limiting the design span length such that its fundamental frequency is twice the highest significant building frequency. It is considered practical when the span so determined is approximately equal to or is greater than the normal support span for hangers. If a single design acceleration for the entire building cannot be established, then an effort should be made to establish one for a group of several floors or each floor elevation as required.

2. Select a vertical design acceleration to be used for horizontal runs. This is equal to the acceleration corresponding to the frequency of the design span (or the maximum acceleration) as shown on the recommended ground response spectra.

3. Review the building modal analysis results to determine the design acceleration to be used for axial runs for each floor of the building. These will be the same as the floor accelerations.

4. The vertical design acceleration for axial runs is established as equal to the ground acceleration at the site.

5. Having the design span lengths for given pipe sizes, and having the design accelerations, the maximum bending stresses for the span can be calculated as a simply supported beam with uniform load. It will be seen after adding the stresses due to a combined horizontal and vertical earthquake (with 10% added for modal effects) to the longitudinal pressure stresses and the dead load weight stress that the stresses are well below the allowable stress of 1.2S as defined previously. Having established this fact, it will be necessary to calculate stresses only for spans that have variations from the assumed design span. Such variations include but are not necessarily limited to:

   a. Spans of length greater than the design span length.

   b. Spans with concentrated masses other than at the very end of the span.

   c. Spans with a change in section properties occurring somewhere in the span.

   d. Spans with a change in material properties somewhere in the span.

   e. Spans with appreciable offsets occurring somewhere in the span.

   f. Spans that are affected by differential movements of buildings.

   g. Spans with stress intensifiers such as tees and elbows.

6. The lateral restraint reactions are calculated by statics for the simply supported beam. Concentrated masses such as valves are distributed as follows:

   a. The lateral restraint reaction at the end of the span nearest the valve should be based on the full weight of the valve.

   b. The lateral restraint reaction at the other end should be based on one-half the weight of the valve.

7. In a straight run, usually there is only one axial restraint and it must resist the full force developed by the run plus forces produced by adjacent lateral spans at either end of the axial run. However, if there is more than one axial restraint, the load distribution should be based on the relative flexibility of the resisting structural attachment points if such flexibility exists. For instance, two separate restraints located on two separate columns may be unable to share the load equally because of the difference in flexibility of the columns. To the contrary, two such restraints located on a beam running axially parallel to the pipe could be assumed to share the load equally.

8. Having calculated the restraint reactions due to pipe loads and valve loads for the individual spans, the summary of reactions must be made to determine the total load on a given restraint.

9. In progressing through the system being evaluated, the piping spans containing variations (see paragraph 5) can be noted and earmarked for further detailed analysis and justification.

10. After completing all analyses on the above spans, a stress summary sheet is made showing the highest stressed points in the system. One point will be shown for the highest thermal stress and another point will be shown for the highest stress due to the combined effect of pressure, dead weight and seismic loading.

11. Any changes in the existing design that were made as a result of the analysis review must be reported to the proper designers for incorporation on the drawings.

12. All design loads for restraints and anchors must also be transmitted to the structural designer for approval and to the restraint designer for use in design.

13. A file containing all of the analyses, summary sheets, marked drawings and communications will be made and kept current in the Engineering files.

SAMPLE PROBLEM

The following analysis is performed on a portion of the Reactor Building Spray System from the discharge nozzle of the pump 1A to the Reactor Building. All of the piping is in the Auxiliary Building, but one end is anchored to the Reactor Building.

The analysis begins with the stress calculations necessary to establish the acceptability of the design span and continues through a series of tabular sheets to document the classification and acceptability of each span. Identification numbers refer to span boundaries and computer data points used in the thermal analysis as shown on page A-45. The system has been divided into four problems. Only two of these problems, A and C, are presented here. The analysis is not complete in that a portion of the line must be analyzed dynamically. The purpose of this analysis is to demonstrate overall procedure and manual techniques.

Form 184

SYS. 54A(3) Development OCONEE 1 See Dwg. ______ File No. ______

RUN A+C Subject PIPING SEISMIC ANALYSIS ______ Sheet No. ______ of ______

AUX BUILDING — DIRECTION OF EXCITATION By WHS Date 5-20-70

SYSTEM NAME R.B. SPRAY

STRESSES IN DESIGN SPAN

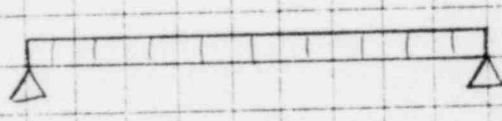
DESIGN FREQUENCY = 20 HZ

PIPE SIZE = 8" SCH 20 MAT'L = A376 304H

S_H = 15,500 @ 300°F

MAXIMUM PIPE SPAN = 15.2 FT.

$\sigma_{\substack{BENDING \\ MAX.}} = \dfrac{MC}{I}$



$M_{MAX} = \dfrac{wl^2}{8} = \dfrac{44.84(15.2)^2}{8}$

$= 1293$ FT-LB.

$I = 57.7 \text{ IN}^4$

$w = 44.84$ #/FT (INCL. WATER)

$C = \dfrac{O.D.}{2} = \dfrac{8.625}{2}$

$= 4.313$

$= \dfrac{(1293)(12)(4.313)}{57.7}$

= 1160 PSI FOR 1 G ACCELERATION

= 580 PSI FOR 0.5 G ACCELERATION

= 226 PSI FOR .2 G ACCELERATION

$\sigma_{\substack{LONG. \\ PRESS.}} = \dfrac{P\,A_{INSIDE}}{A_{METAL}} = \dfrac{500 \; 51.8}{6.58}$

P = 500 PSIG

$A_{INSIDE} = 51.8$

$A_{METAL} = 6.58$

$TEMP_{MAX} = 300°F$

= 3940 PSI

Sys. 54A(3) Development Oconee 1 See Dwg ______ File No. ______
Run A+C Subject Piping Seismic Analysis Sheet No. ______
Aux Building — Direction of Excitation By WHS Date 5-20-70
System Name R.B Spray

THE MAXIMUM STRESS IS DETERMINED BY ADDING ABSOLUTELY THE SEISMIC STRESSES DUE TO EITHER AN X-EARTHQUAKE OR A Z EARTHQUAKE COMBINED WITH A Y-EARTHQUAKE TO THE STRESS DUE TO DEAD WEIGHT AND THE LONGITUDINAL STRESS DUE TO INTERNAL PRESSURE.

$$\sigma_{MAX} = K_M(\sigma_{XEQ} + \sigma_{YEQ}) + \sigma_{WGT} + \sigma_{LONG.\,PRESS.}$$

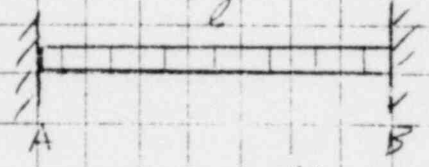
$K_M = 1.1$ (FOR MODAL EFFECTS)

$$= 1.1(580 + 226) + 1160 + 3940$$
$$= 886 + 1160 + 3940$$
$$= 5986$$

$$S_{ALLOWABLE} = 1.2\,S_H = 1.2(15500) = 18{,}600 \text{ PSI}$$

THE PORTION OF THE STRESS THAT IS AFFECTED BY THE LENGTH OF THE SPAN IS ONLY 2046 PSI. IF THE LENGTH OF THE SPAN WERE DOUBLED THIS STRESS WOULD ONLY BE 4 × 2046 = 8184 WHICH WHEN ADDED TO THE PRESSURE STRESS OF 3940 WOULD GIVE 12,124 < 18600. THIS SAYS THAT THE LENGTH IS OF CONCERN ONLY AS IT AFFECTS THE FREQUENCY WHICH IN TURN AFFECTS THE DESIGN ACCELERATION. CONSEQUENTLY, IF A SPAN IS LONGER THAN THE DESIGN SPAN BUT LESS THAN TWICE AS LONG, IT IS NECESSARY ONLY TO CHECK TO SEE IF THE RESULTING CHANGE IN FREQUENCY CAUSES A GREATER ACCELERATION FACTOR TO BE REQUIRED AS DETERMINED FROM THE FLOOR RESPONSE SPECTRA. IF A SPAN IS NO GREATER THAN 10% LONGER THAN THE DESIGN SPAN, IT IS CONSIDERED ACCEPTABLE WITHOUT REFERENCE TO THE SPECTRA.

THE STRESSES CALCULATED ABOVE EXIST AT THE CENTER OF THE ASSUMED SIMPLY SUPPORTED BEAM. THE ANALYSIS THUS FAR HAS NOT CONSIDERED THE STRESSES AT THE END OF THE BEAM. FOR THE MODEL USED, THESE STRESSES ARE ZERO. HOWEVER, FOR THE ACTUAL PIPE SPAN SOME STRESS WILL EXIST BECAUSE THE SPAN WILL NOT ACT EXACTLY AS A SIMPLE SPAN. THE APPROPRIATE SPAN MODEL FOR CONSIDERATION OF THESE STRESSES IS A FIXED-FIXED BEAM.



SINCE THE $M_A = M_B$ IS $\frac{Wl}{12}$ AND THE MAX. MOMENT FOR THE SIMPLY SUPPORTED BEAM IS $\frac{Wl}{8}$ IT CAN BE ASSUMED THAT FOR THE SAME ACCELERATION AND THE SAME SECTION PROPERTIES THE LOADS AT THE END OF THE BEAM WILL BE NO GREATER THAN $\frac{8}{12} = \frac{2}{3}$ OF THE STRESS AS CALCULATED ABOVE. CONSEQUENTLY ONE NEED NOT BE CONCERNED ABOUT THE STRESS IN THE PIPE AT THE RESTRAINTS UNLESS THERE IS A LOWER SECTION MODULUS AT SUCH A POINT. THIS IS ESPECIALLY POSSIBLE AT PUMP NOZZLES.

IT CAN BE SHOWN THAT THE ANALYSIS TECHNIQUE IS SUFFICIENTLY CONSERVATIVE TO ACCOUNT FOR STRESS INTENSIFICATION FACTORS FOR UNREINFORCED TEES AND ELBOWS OF THIS PIPE SIZE IN THE DESIGN SPAN. HOWEVER SPANS WITH OTHER VARIATIONS IN ADDITION TO STRESS INTENSIFIERS MUST BE CHECKED.

Form 184

Sys. 54A(3) Development OCONEE I See Dwg ______ File No

RUN A Subject PIPING SEISMIC ANALYSIS Sheet No 1 of 3

AUX. BUILDING X DIRECTION OF EXCITATION By WHS Date 5-20-70

MATERIAL A-376 304H SYSTEM NAME R.B. SPRAY

A-X

DESIGN PERIOD ≦ .05 SEC.

LATERAL ACCELERATION .5

AXIAL ACCELERATION = (APPROPRIATE FLOOR ACCELERATION OR VERTICAL ACCELERATION - SEE TABLE ____)

LINE NO.	PIPE SIZE	SPAN (FT)	DESIGN SPAN (FT)	MEETS SPAN CRITERIA	DESIGN ACCEL.	ONE "G" PIPE REACTION	LENGTH FACTOR	PIPING RESTRAINT REACTION	ELEV. OF RSNT.
Δ5-25	8" SCH 20	16.5	15.25	YES	.5	342	-	171	
25-30		5.0		AXIAL	.05	684	-	34	771
30-38		15.67		YES	.5	342	1.03	35	
*38-60		21.75		AXIAL	.05	684	1.43	49	771
60-70		10.0		YES	.5	342	-	171	
70-100		52.2		AXIAL	.05	684	3.42	116	783'-9"
100-125		35.6		AXIAL	.05	684	2.33	79	783'-9"
125-132		16.5		YES	.5	342	1.08	185	
132-140Δ		16.25		YES	.5	342	1.07	183	

* OFFSET BETWEEN (50) AND (55) IS ONLY 3' (SEE ISOMETRIC)

Form 184

SYS. ______ Development OCONEE 1 ______ See Dwg. ______ File No. ______

RUN ______ Subject PIPING SEISMIC ANALYSIS ______ Sheet No. 2 of 3

______ BUILDING ______ DIRECTION OF EXCITATION ______ By ______ Date 5-20-70

SYSTEM NAME ______

LINE NO.	VALVE NO.	VALVE WGT	DESIGN ACCEL.	VALVE REACTION
-25	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]

POOR ORIGINAL

SYS. [illegible] Development OCONEE 1 See Dwg ______ File No. ______

RUN A Subject PIPING SEISMIC ANALYSIS Sheet No. 3 of 3

[illegible] BUILDING X DIRECTION OF EXCITATION By WHS Date 5-20-70

SYSTEM NAME [illegible]

RESTRAINT NO.	PIPING REACTION	VALVE REACTION	TOTAL SEISMIC REACTION
30	205	468	673
38	255	—	255
100	551	—	551
132	368	—	368
Δ 5	171	468	639
Δ 140	183	—	183

POOR ORIGINAL

SYS 54(2) Development OCONEE I See Dwg. File No.

CALC 4 Subject PIPING SEISMIC ANALYSIS Sheet No. of

4-x BUILDING X DIRECTION OF EXCITATION By WHS Date 5-20-70

SYSTEM NAME RB SPRAY

ANCHOR NO.	PIPING REACTION	VALVE REACTION	TOTAL SEISMIC REACTION
A-5	171	468	639
A-140, C-5	183 + *	—	

* DEPENDENT ON RESULTS OF DYNAMIC ANALYSIS

Form 184

Sys. 3A(3) Development OCONEE I   See Dwg ______ File No. ______

RUN A Subject PIPING SEISMIC ANALYSIS   Sheet No. 1 of 3

AUX BUILDING Y DIRECTION OF EXCITATION   By [illegible]   Date 5-20-70

MATERIAL A376-304H   SYSTEM NAME [illegible]

AY

DESIGN PERIOD ≤ .05 SEC.

LATERAL ACCELERATION .2 *

AXIAL ACCELERATION = (APPROPRIATE FLOOR ACCELERATION OR VERTICAL ACCELERATION - SEE TABLE Y-1)

LINE NO.	PIPE SIZE	SPAN (FT)	DESIGN SPAN (FT)	MEETS SPAN CRITERIA	DESIGN ACCEL.	ONE "G" PIPE REACTION	LENGTH FACTOR	PIPING RESTRAINT REACTION	
Δ 5-25	8 SCH 20	5.5	15.25	AXIAL	.15	684	—	34 #	PUMP NOZZ.
25-30		5	~	NA	.2	342	—	68	
30-35		15.67		NA	.2	342	1.03	70	
35-45		13.5		NA	.2	342	—	68	
45-60		SEE SHEET AY-1		NA	.2	342		68	
60-65		5.67	15.25	AXIAL	.15	684	—	34	
65-70		4.33 APPROX	~	AXIAL	.15	684	—	34	
70-80		20		NA	.2	342	1.31	90	
80-85		18.5		NA	.2	~	1.21	83	
85-95		10		NA	.2		—	68	
95-105		17		NA	.2		1.12	77	
105-117		12.5		NA	.2		—	68	
117-125 Δ		14		NA	.2	342	—	68	
125-140		32.75		AXIAL	.15	684	2.15	73	

* DESIGN ACCELERATION IS EQUAL TO MAXIMUM ACCELERATION FOR ½% DAMPING [illegible] AS GIVEN BY THE GROUND RESPONSE SPECTRA [illegible]

Form 184

SYS. 54(3) Development OCONEE 1 See Dwg. ______ File No. ______

RUN A Subject PIPING SEISMIC ANALYSIS Sheet No. 2 of 3

AUX BUILDING Y DIRECTION OF EXCITATION By [illegible] Date 5-20-70

SYSTEM NAME RB SPRAY

LINE NO.	VALVE NO.	VALVE WGT	DESIGN ACCEL.	VALVE REACTION
5-X5	1/54/3	345	.05	17
	1/54/4	600	.05	30

Form 184

SYS. 54A 3 Development OCONEE 1 See Dwg File No.

RUN A Subject PIPING SEISMIC ANALYSIS Sheet No. 3 of 3

AUX BUILDING Y DIRECTION OF EXCITATION By [illegible] Date 5-20-70

SYSTEM NAME RB SPRAY

	RESTRAINT NO.	PIPING REACTION	VALVE REACTION	TOTAL SEISMIC REACTION
	30	138	—	138
	35	138	—	138
	45	136	—	136
	65	226	—	226
	80	178	—	[illegible]
	85	151	—	151
	95	145	—	145
	105	145	—	145
	117	136	—	136
*	140 △	141	—	141
	5 △	102	47	149

* △ - INDICATES ANCHOR

SYS. 24 A(3) Development UCONEC 1 See Dwg. File No.

RUN A Subject PIPING SEISMIC ANALYSIS Sheet No. of

AUX BUILDING Y DIRECTION OF EXCITATION By Date 5-20-70

SYSTEM NAME RB SPRAY

ANCHOR NO.	PIPING REACTION	VALVE REACTION	TOTAL SEISMIC REACTION
A-5	102	47	149
A-140, C-5	141+104	—	245

Form 184

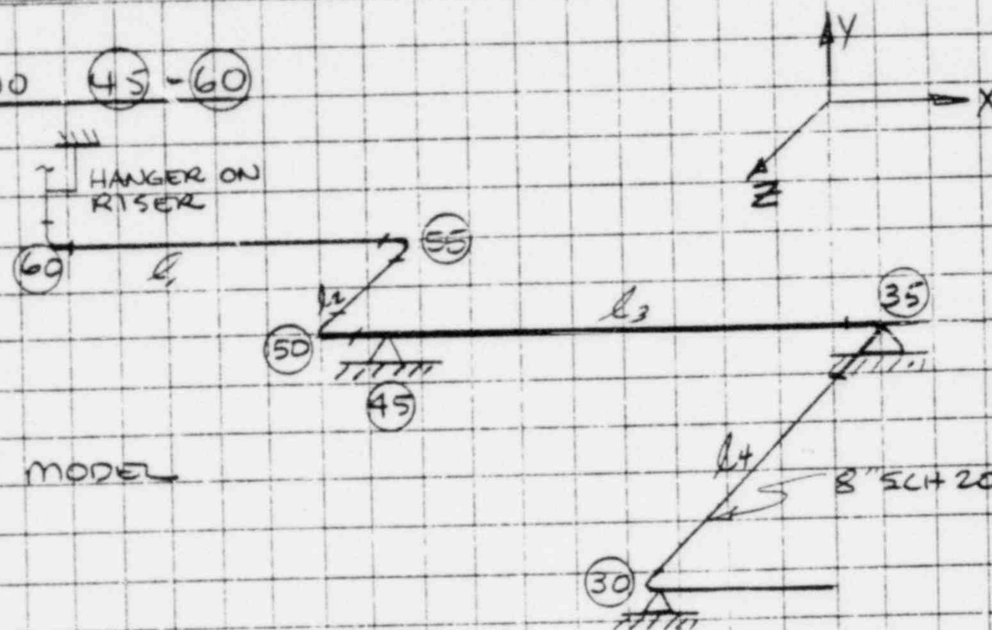
SYS. 54A(3) Development OCONEE ·1 See Dwg. File No.

RUN A Subject PIPING SEISMIC ANALYSIS Sheet No. AY-1 of

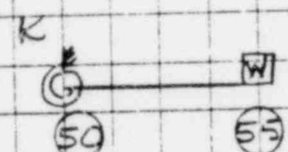
AUX BUILDING Y DIRECTION OF EXCITATION By WHS Date 5-20-70

SYSTEM NAME R.B. SPRAY

LINE NO 45-60



ASSUMED MODEL



$l_1 = 6.75$

$l_2 = 3.17$

$l_3 = 13.5$

$l_4 = 15.67$

$w = 153$ #/FT

$I = 57.7$

$$W = \frac{w l_1}{2} + .236\, w l_2 = w(.5 l_1 + .236 l_2)$$

$$= 153\left[(.5)(6.75) + .236(3.17)\right] = 632$$

$$f_n = \frac{3.14}{\sqrt{\delta_{ST}}}$$

$$\delta_{ST} = \frac{W l_2^3}{3EI} + \theta l_2$$

$$\theta = \frac{M l_3}{JG} + \frac{M l_4}{3EI} = \frac{M l_3}{2I\frac{E}{2.6}} + \frac{M l_4}{3EI}$$

$$= \frac{M}{EI}\left(1.3 l_3 + .33 l_4\right)$$

$$= \frac{W l_2}{EI}\left(1.3 l_3 + .33 l_4\right)$$

Form 184

SYS. ______ Development OCONEE ·1 ______ See Dwg. ______ File No. ______

RUN ______ Subject PIPING SEISMIC ANALYSIS ______ Sheet No. AY-2 of ______

______ BUILDING ______ DIRECTION OF EXCITATION By WHS Date 5-20-70

SYSTEM NAME ______

LINE NO. (45) - (60)

$$\Theta = \frac{W l_2}{EI}\left(1.3 l_2 + .33 l_4\right) = \frac{632(3.17)(144)}{30\times10^6(57.7)}\left[1.3(13.5)+.33(15.67)\right]$$

$$= 1665\left[17.5 + 5.2\right]\times10^{-6}$$ (22.7)

$$= .003780$$

$$\delta_{ST} = \frac{W l_2^3}{3EI} + \Theta l_2 = \frac{632(3.17)^3(1728)}{3(30)(10)^6(57.7)} + .00378(3.17)(12)$$

$$= .0067$$

$$f_n = \frac{3.14}{\sqrt{.0067}} = \frac{3.14}{.082} = 37.3 \text{ hz}$$

$f_n = 37.3 > 20$ ∴ DESIGN ACCELERATIONS ARE ACCEPTABLE FOR LINE 45-60

Form 184

Sys. 54A(3) Development: OCONEE 1 See Dwg. ______ File No. ______

RUN 4 Subject: PIPING SEISMIC ANALYSIS Sheet No. 1 3

AUX BUILDING Z DIRECTION OF EXCITATION By Jrw Date 5-20-70

MATERIAL A376-304 SYSTEM NAME RB SPRAY

AZ

DESIGN PERIOD ≤ .05 SEC.

LATERAL ACCELERATION .5

AXIAL ACCELERATION = (APPROPRIATE FLOOR ACCELERATION OR VERTICAL ACCELERATION - SEE TABLE ____)

LINE NO.	PIPE SIZE	SPAN (FT)	DESIGN SPAN (FT)	MEETS SPAN CRITERIA	DESIGN ACCEL.	ONE "G" PIPE REACTION	LENGTH FACTOR	PIPING RESTRAINT REACTION	
Δ 5-30	[illegible]	10.42	SEE SHEET	AZ-1	.5	342	—	171	SEE SHEET AZ-4
30-40		17.0	15.25	AXIAL	.05	684	1.12	38	
40-45		13.75		YES	.5	342	—	171	
45-55		3.17		AXIAL	.05	684	—	34	
55-60		8.25		YES	.5	342	—	171	
60-70		10.0		YES	.5		—	171	
70-82		APPROX 20		NO	* .5		1.31	224	
82-87		18.5		NO	* .5		1.21	207	
87-97		10		YES	.5		—	171	
97-107		17		NO	* .5		1.12	192	
107-118		12.5		YES	.5		—	171	
118-125		14		YES	.5		—	171	
125-132		16.5		YES	.5		1.08	185	
Δ 132-140		16.25		YES	.5	342	1.07	183	

A-17

* SEE SHEET AZ-[illegible]

Form 184

Sys. [illegible] Development OCONEE 1 See Dwg. ______ File No. ______

RUN [illegible] Subject PIPING SEISMIC ANALYSIS Sheet No. 2 3

[illegible] BUILDING Z DIRECTION OF EXCITATION By [illegible] Date 5-20-70

SYSTEM NAME [illegible] SPRAY

LINE NO.	VALVE NO.	VALVE WGT	DESIGN ACCEL.	VALVE REACTION
5-20	1/54/3	[illegible]	.5	[illegible]
	1/54/4	[illegible]	[illegible]	300

SYS. 5413 Development OCONEE I See Dwg. File No.
RUN 1 Subject PIPING SEISMIC ANALYSIS Sheet No. 3 3
AUX BUILDING Z DIRECTION OF EXCITATION By [signature] Date 5-20-70
SYSTEM NAME RB SPRAY

RESTRAINT NO.	PIPING REACTION	VALVE REACTION	TOTAL SEISMIC REACTION
40	380	234	614
45	376	—	376
60	376	—	376
70	395	—	395
82	431	—	431
87	378	—	378
97	363	—	363
107	363	—	363
118	342	—	342
125	356	—	356
133	368	—	368
△ 5	171	468	639
△ 140	183	—	183

SYS. 54A(3) Development OCONEE I See Dwg. File No.
RUN A Subject PIPING SEISMIC ANALYSIS Sheet No. of
AUX BUILDING Z DIRECTION OF EXCITATION By [illegible] Date 5-20-70

SYSTEM NAME RB SPRAY

ANCHOR NO.	PIPING REACTION	VALVE REACTION	TOTAL SEISMIC REACTION
A-5	171	468	639
A-110, C-5	183+171	—	354

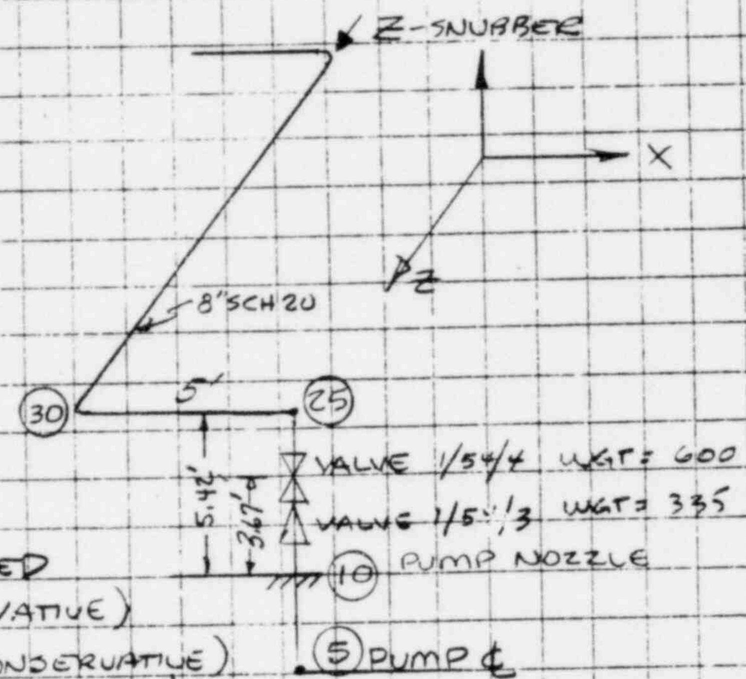
Form 184

SYS. 54A(3) Development OCONEE 1 See Dwg. File No.

RUN A Subject PIPING SEISMIC ANALYSIS Sheet No. AZ-1 of

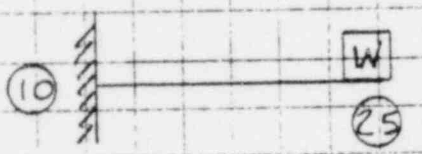
AUX. BUILDING Z DIRECTION OF EXCITATION By WHS Date 5-20-70

SYSTEM NAME R.B. SPRAY



LINE NO. 5-30

ASSUMED MODEL



1. DISREGARD EFFECT OF INCREASED STIFFNESS OF VALVES (CONSERVATIVE)
2. ASSUME JOINT 30 IS PINNED (CONSERVATIVE)
3. ASSUME ALL MASS CONCENTRATED AT POINT 25
4. SPAN 25-30 < DESIGN SPAN (OK)

$w = 44.84$ #/FT

TOTAL VALVE LENGTH = 3'

$I = 57.7$

$$W = W_{VALVES} + W_{PIPE}$$

$$W_{VALVES} = 600 + 335 = 935^{\#}$$

$$W_{PIPE} = w(5.42) + \tfrac{1}{2}w(5) = w(5.42 + 2.5) = 355^{\#}$$

(44.84) (7.92)

$$W = 935 + 355 = \underline{1290^{\#}}$$

$$\delta_{ST} = \frac{Wl^3}{3EI} = \frac{1290\,(5.42)^3\,(1728)}{3(30)(10)^6(57.7)} = .0683$$

$$f_n = \frac{3.14}{\sqrt{\delta_{ST}}} = \frac{3.14}{\sqrt{.0683}} = \frac{3.14}{.261} = 12\text{ HZ} < 20\text{ HZ} = \text{DESIGN FREQ}$$

CHECK RESPONSE SPECTRUM FOR ELEV. 771'-0" @ 12 HZ

ACCELERATION = .134 < .5 = DESIGN ACCEL. (OK)

NOTE! THIS CALCULATION WAS UNNECESSARY BECAUSE THE MAX. ACCEL. RESPONSE FOR THIS ELEV. IS .28 < .5. CALC. MADE TO DEMONSTRATE METHODS.

SYS 54A(3) Development OCONEE 1 See Dwg. File No.
RUN A+C Subject PIPING SEISMIC ANALYSIS Sheet No. AZ-2 of
AUX BUILDING — DIRECTION OF EXCITATION By WHS Date 5-20-70

SYSTEM NAME R.B. SPRAY

LINE NO. 70-82 ELEV. 776'-6" SUPPORTED FROM EL. 783'-9"

SPAN LENGTH = 20' > DESIGN SPAN = 15.25'

ELBOWS ARE LOCATED NEAR MID-SPAN AND A END. MID-SPAN IS WORST CASE.

CHECK RESPONSE SPECTRA TO SEE IF DESIGN ACCELERATION FOR THIS SPAN LENGTH IS BELOW 0.5g

ALSO DETERMINE MAX. STRESS RESULTING FROM ELBOW STRESS INTENSIFICATION.

CHECK DESIGN ACCEL.

$$\frac{f'}{f} = \left(\frac{\ell}{\ell'}\right)^2$$ FOR A UNIFORMLY LOADED BEAM

$$f' = 20\left(\frac{15.2}{20}\right)^2$$

$$= 11.6\ HZ$$

f' = FREQ. OF ACTUAL SPAN
f = " " DESIGN " = 20HZ
ℓ' = LENGTH OF ACTUAL SPAN = 20'
ℓ = " " DESIGN " = 15.2FT

FROM AUX BLDG SPECTRA PAGE B-16, E-W DIRECTION (Z)
AT 11.6 HZ, ACCEL. = .172g < .5g - DESIGN ACCEL.

CHECK MAX. STRESS

$$\sigma_{MAX} = \sigma_{DES.\,SPAN} \times i_{ELBOW} \times \left(\frac{\ell_{SPAN}}{\ell_{DES.\,SPAN}}\right)^2 + \sigma_{PRESS}$$

$\sigma_{DES.\,SPAN}$ = 2046 PSI (SEE PG A-6)

$$= 2046 \times 3 \times \left(\frac{20}{15.3}\right)^2 + 3940$$

$i_{8" SCH 20\ ELBOW} = 3$

$$= 2046 \times 5.13 + 3940$$

σ_{PRESS} = 3940 (SEE PG A-6)

$$= 10500 + 3940$$

$$= 14{,}440 < 18{,}600 = S_{ALLOW.}$$

∴ SPAN IS (OK)

Form 184

SYS. SYA(3) Development OCONEE ·1 See Dwg. ______ File No. ______

RUN A Subject PIPING SEISMIC ANALYSIS Sheet No. AZ-3 of ______

AUX BUILDING Z DIRECTION OF EXCITATION By WHS Date 5-20-70

SYSTEM NAME RB SPRAY

LINE NO. 82-87 ELEV. 776'-6" SUPPORTED FROM 783'-9"

SPAN LENGTH = 18.5 > DESIGN SPAN

HOWEVER SINCE THIS SPAN IS SHORTER THAN LINE 70-82 (SEE SHEET AZ-1) AND ELEVATION IS SAME, IT IS (OK)

LINE 97-107 ELEV. 776'-6"

SPAN LENGTH = 17 > DESIGN SPAN

(OK) - SEE ABOVE - LINE 82-87

Form 184

SYS. ______ Development Project I ______ See Dwg. ______ File No. ______
RUN ______ Subject PIPING SEISMIC ANALYSIS ______ Sheet No. AZ-4 of ______
______ BUILDING ______ DIRECTION OF EXCITATION ______ By WHS ______ Date 5-20-70
SYSTEM NAME ______

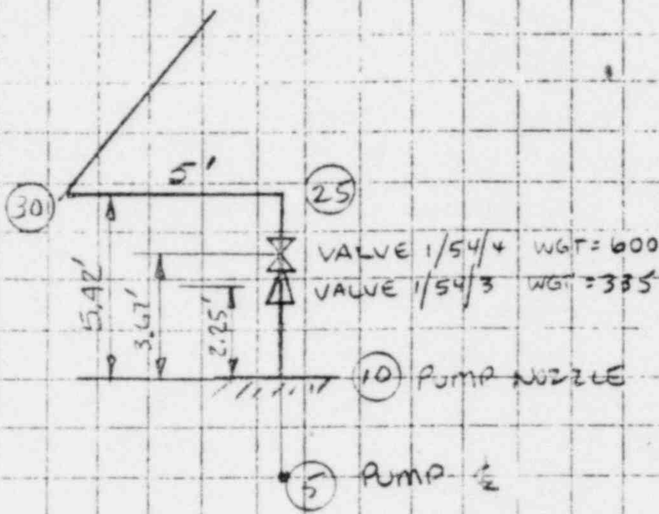
DATA PT. (5) PUMP NOZZLE –

VERTICAL NOZZLE 4" SCH 40

$Z = 3.27$

INSIDE AREA = 12.73

METAL AREA = 3.17



$M_{(10)} = N_g \left[335 \times 2.25 + 600 \times 3.67 + 2.5(44.84)(5.42) + 2.42(44.84)(3) \right]$

$= .5 \left[752 + 2200 + 607 + 326 \right]$

$= .5 \left[3885 \right] = 1943$

$= 1943$ FT. #

$\sigma_B = \dfrac{M}{Z} = \dfrac{(1943)(12)}{3.27} = 7130$ PSI

$w = \#/FT = 44.84$

OVERALL VALVE LENGTH = 3'

REMAINING PIPE IN RISER = 5.42 − 3 = 2.42'

ASSUMED TO ACT @ 3'

σ_{WGT} = ZERO

$\sigma_{PRESSURE} = \dfrac{P A_{INSIDE}}{A_{METAL}} = \dfrac{500(12.73)}{3.17} = 2000$ PSI

$\sigma_{TOTAL} = 7130 + 2000 = 9130$ PSI < 18600 (OK)

HOWEVER, PUMP ALLOWABLE LOADS MUST BE CHECKED.

Form 184

SYS. 54A(3) Development OCONEE 1 See Dwg. File No.
RUN C Subject PIPING SEISMIC ANALYSIS Sheet No. 1 of 3
AUX BUILDING X DIRECTION OF EXCITATION By JHS Date 5-20-70
MATERIAL [illegible] SYSTEM NAME R.B. SPRAY

CX

DESIGN PERIOD ≦ .05 SEC.

LATERAL ACCELERATION .5

AXIAL ACCELERATION = (APPROPRIATE FLOOR ACCELERATION OR VERTICAL ACCELERATION - SEE TABLE X-1).

LINE NO.	PIPE SIZE	SPAN (FT)	DESIGN SPAN (FT)	MEETS SPAN CRITERIA	DESIGN ACCEL.	ONE "G" PIPE REACTION	LENGTH FACTOR	PIPING RESTRAINT REACTION	
Δ5-10	8 SCH 20	SEE SHEET CX-1			.5	342	—	171	SNUBBER TO BE ADDED
10-40					.5	342	1.08	185	
40-65		40.53	15.25	AXIAL	.1	684	2.69	183	
Δ70-85		21.0	SEE SHEET CX-2		.5				RESTRAINT TO BE ADDED
85-100		15	15.25	[illegible]	.5	342	—	171	
100-115		15	}	AXIAL	.	684	—	68	
115-125		15.88	}	AXIAL	.1	684	1.04	71	

Form 1[illegible]

Sys. 54A31 Development OCONEE I See Dwg. File No.

Run: C Subject PIPING SEISMIC ANALYSIS Sheet No. 2 of 3

AUX BUILDING X DIRECTION OF EXCITATION By WHS Date 5-20-70

SYSTEM NAME RI [illegible]

LINE NO.	VALVE NO.	VALVE WGT	DESIGN ACCEL.	VALVE REACTION
7[illegible]-85	1/54/15	700	.5	350
75-100	1/54/12	[illegible]	.[illegible]	[illegible]

Form 18?

SYS. 54A(3) Development OCONEE 1 See Dwg. ______ File No. ______

RUN C Subject PIPING SEISMIC ANALYSIS Sheet No. 3 of 3

AUX BUILDING X DIRECTION OF EXCITATION By WHS Date 5-20-70

SYSTEM NAME RE SPRAY

RESTRAINT NO.	PIPING REACTION	VALVE REACTION	TOTAL SEISMIC REACTION	
40	*	500		VALVE REAC. = [illegible]
115	*	300		
Δ 5	*			
Δ 70	*			

* DEPENDENT ON OUTCOME OF DYNAMIC ANALYSIS

SYS. 5 & 3 Development OCONEE 1 See Dwg. File No.

RUN 1 Subject PIPING SEISMIC ANALYSIS Sheet No. of

AUX BUILDING X DIRECTION OF EXCITATION By WHS Date 5-20-70

SYSTEM NAME RB SPRAY

ANCHOR NO.	PIPING REACTION	VALVE REACTION	TOTAL SEISMIC REACTION
A-190, C-5	*	—	
C-70	*		

* DEPENDENT ON RESULTS OF DYNAMIC ANALYSIS

Form 164

SYS. 54A(3) Development OCONEE 1 See Dwg. File No.

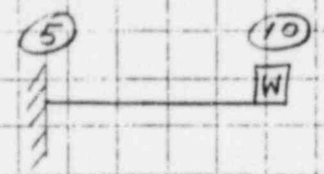
RUN C Subject PIPING SEISMIC ANALYSIS Sheet No. CX-1 of

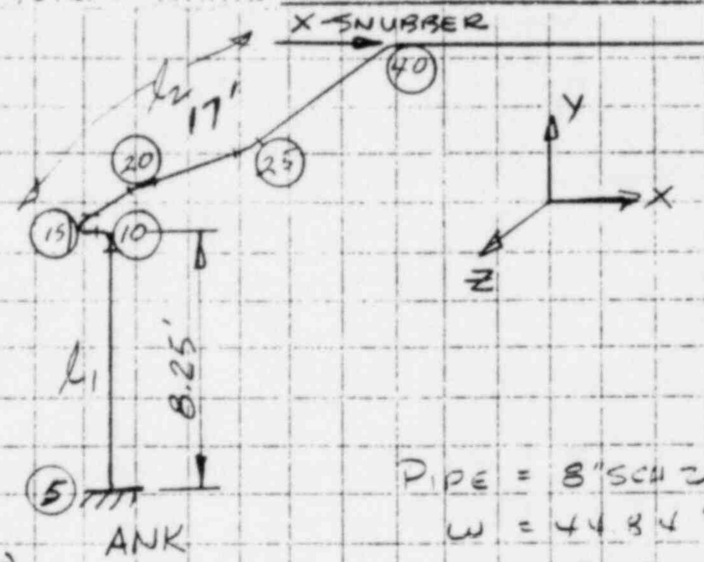
AUX BUILDING X DIRECTION OF EXCITATION By WHS Date 5-20-70

SYSTEM NAME

LINE 5-40

ASSUME MODEL





$W = \frac{1}{2} w l_2 + .24 w l_1$

$= \frac{1}{2}(44.84)(17) + .24(44.84)(8.25)$

$= 382 + 89 = 471^{\#}$

Pipe = 8" SCH 20

w = 44.84 #/ft

I = 57.7

$f = \frac{3.14}{\sqrt{\delta_{ST}}}$

$\delta_{ST} = \frac{W l_1^3}{3EI} = \frac{(471)(1728)(8.25)^3}{3(30)(10)^6(57.7)} = .088$

$f = \frac{3.14}{\sqrt{.088}} = \frac{3.14}{.297} = 10.6 \text{ HZ}$

THIS IS IN THE RESONANT RANGE. A SNUBBER SHOULD BE PLACED BETWEEN (15) AND (20) UNLESS THE SPAN CAN BE SHOWN ADEQUATE BY A DYNAMIC ANALYSIS.

CHANGE REQ'D

Form 104

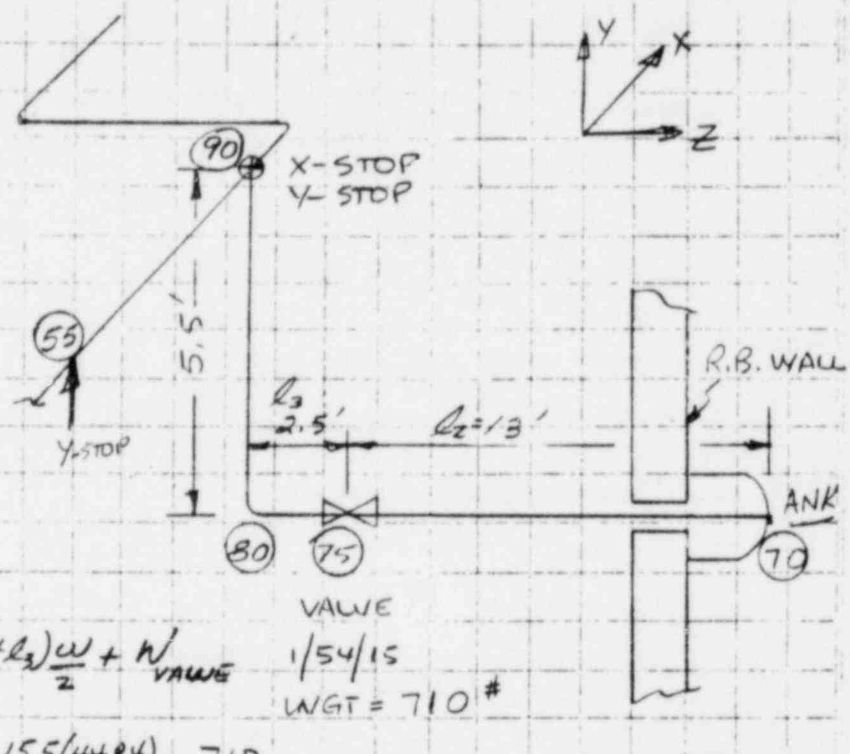
SYS. 54A(3) Development OCONEE 1 See Dwg File No.

RUN C Subject PIPING SEISMIC ANALYSIS Sheet No. CX-2 of

AUX BUILDING X DIRECTION OF EXCITATION By WHS Date 5-20-70

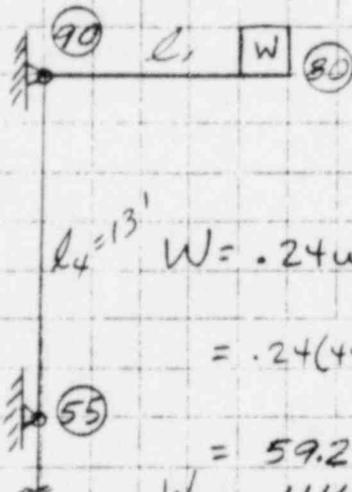
SYSTEM NAME R.B. SPRAY

LINE 70-85



CHECK SPAN 80-90

ASSUME MODEL



$$W = .24 w l_1 + (l_2 + l_3)\frac{w}{2} + W_{VALVE}$$

$$= .24(44.84)(5.5) + \frac{15.5(44.84)}{2} + 710$$

$$= 59.2 + 347 + 710$$

$$\underline{W = 1116^{\#}}$$

PIPE = 8" SCH 20

$w = 44.84$ #/FT

$I = 57.7$

$$f = \frac{3.14}{\sqrt{\delta_{ST}}}$$

$$\delta_{ST} = \frac{W l_1^3}{3EI} + \theta l_1$$

$$\theta = \frac{m l_4}{3EI}$$

$$m = W l_1$$

$$\theta = \frac{W l_1 l_4}{3EI}$$

$$\delta_{ST} = \frac{W l_1^3}{3EI} + \frac{W l_1^2 l_4}{3EI} = \frac{W l_1^2}{3EI}(l_1 + l_4)$$

SYS. SYA(3) Development OCONEE 1 See Dwg File No.
RUN C Subject PIPING SEISMIC ANALYSIS Sheet No. CX-3 of
AUX BUILDING X DIRECTION OF EXCITATION By WHS Date 5-20-70
SYSTEM NAME R.B. SPRAY

11

$$\delta_{ST} = \frac{1116(1728)(5.5)^2}{3(30)(10)^6(57.7)}(5.5+13) = .208$$

(18.5)

$$f = \frac{3.14}{\sqrt{\delta_{ST}}} = \frac{3.14}{\sqrt{.208}} = \frac{3.14}{.456} = \boxed{6.9\ HZ}$$

THIS IS IN THE RESONANT RANGE. A SEISMIC RESTRAINT IS RECOMMENDED BECAUSE A VALVE IS INVOLVED. THE RESTRAINT SHOULD BE PLACED CLOSE TO THE VALVE.

PUT X-STOP ON LINE (70)-(80) NEAR VALVE PREFERRABLY BETWEEN (70) AND (75) WHICH IS THE LONGER SPAN.

THIS WILL REDUCE SPANS (75)-(90) AND (70)-(75) TO BELOW DESIGN SPAN LENGTHS WHICH MAKES THEM (OK).

DETERMINE REACTIONS AFTER LOCATING RESTRAINT.

A-31

CHANGE REQ'D

Form 184

Sys. [illegible] Development OCONEE I See Dwg. File No.
RUN 2 Subject PIPING SEISMIC ANALYSIS Sheet No. 1 of 3
[illegible] BUILDING Y DIRECTION OF EXCITATION By WHS Date 5-20-70
MATERIAL A376-[illegible] SYSTEM NAME RC SPRAY

CY

DESIGN PERIOD ≤ .05 SEC.
LATERAL ACCELERATION .2
AXIAL ACCELERATION = (APPROPRIATE FLOOR ACCELERATION OR VERTICAL ACCELERATION - SEE TABLE Y-1)

LINE NO.	PIPE SIZE	SPAN (FT)	DESIGN SPAN (FT)	MEETS SPAN CRITERIA	DESIGN ACCEL.	ONE "G" PIPE REACTION	LENGTH FACTOR	PIPING RESTRAINT REACTION
Δ 5-10	8" SCH 20	[illegible]	15.25	AXIAL	.05	684	—	34
[illegible]-38		15.5		[illegible]	.2	342	1.02	70
[illegible]		15.75		A	.2		1.03	70
[illegible]		11.63		A	.2		—	68
[illegible]		12.75		A	.2		—	68
Δ [illegible]		15.5		[illegible]	.2	342	1.02	70
[illegible]		5.5		AXIAL	.05	684	—	34
[illegible]		[illegible]		[illegible]	[illegible]	342	—	68
[illegible]		[illegible]		[illegible]	[illegible]	342	—	68
[illegible]		[illegible]		A	[illegible]	342	—	68

Δ -INDICATES ANCHOR

Form 18

Sys. 54A(3) Development OCONEE I See Dwg File No.

RUN C Subject PIPING SEISMIC ANALYSIS Sheet No 2 of 3

AUX BUILDING Y DIRECTION OF EXCITATION By WHS Date 5-20-70

SYSTEM NAME R.B. SPRAY

LINE NO.	VALVE NO.	VALVE WGT	DESIGN ACCEL.	V VE. REACTION
* 70-(80)	1/54/15	700	.2	140
85-(100)	1/54/12	600	.2	120

* (80) INDICATES VALVE IS LOCATED NEARER (80) THAN (70)
USE TOTAL WGT FOR BASIS AT (80), USE ONE-HALF
WGT FOR BASIS AT (70)

Form 1PA

SYS (4A3) Development OCONEE I See Dwg. File No.

RUN C Subject PIPING SEISMIC ANALYSIS Sheet No. 3 of 3

AUX BUILDING Y DIRECTION OF EXCITATION By WHS Date 5-20-70

SYSTEM NAME RE SPRAY

RESTRAINT NO.	PIPING REACTION	VALVE REACTION	TOTAL SEISMIC REACTION
38	140	—	140
45	138	—	138
55	136	—	136
65	136	200	336
100	136	120	256
110	136	—	136
Δ 5	104	—	105
Δ r	70	70	140

Δ - ANCHOR

SYS. "A" Development OCONEE I See Dwg. File No.
RUN Subject PIPING SEISMIC ANALYSIS Sheet No. of
AUX BUILDING / DIRECTION OF EXCITATION By WHS Date 5-20-70
SYSTEM NAME RB SPRAY

ANCHOR NO.	PIPING REACTION	VALVE REACTION	TOTAL SEISMIC REACTION
* A-140, C-5	141 + 104	—	245
C-70	70	70	140

* THIS IS POINT 140 ON RUN "A" AND POINT 5 ON RUN "C" TOTAL REACTION FROM BOTH RUNS IS INCLUDED ON THIS SHEET

Form 184

SYS. [illegible] Development: OCONEE 1 See Dwg. ______ File No. ______

RUN ______ Subject: PIPING SEISMIC ANALYSIS Sheet No. 1 of 3

______ BUILDING ______ DIRECTION OF EXCITATION ______ By WHS Date 5-20-70

MATERIAL [illegible] SYSTEM NAME [illegible]

CZ

DESIGN PERIOD ≤ .05 SEC.

LATERAL ACCELERATION .5

AXIAL ACCELERATION = (APPROPRIATE FLOOR ACCELERATION OR VERTICAL ACCELERATION - SEE TABLE Z-1)

LINE NO.	PIPE SIZE	SPAN (FT)	DESIGN SPAN (FT)	MEETS SPAN CRITERIA	DESIGN ACCEL.	ONE "G" PIPE REACTION	LENGTH FACTOR	PIPING RESTRAINT REACTION
Δ –10	8" SCH 20	8.25	15.25	YES	.5	342	—	171
10-35		11.5		AXIAL	.1	684	—	68
35-40		5		AXIAL	.1	684	—	68
40-50		15.75		YES	.5	342	1.03	176
50-60		11.63		YES	.5	342	—	171
60-65		SEE SHEET CZ-1						
Δ 70-80					*			
80-85					*			
85-100								
100-115								
115-125								

* REACTOR BUILDING SPECTRA SHOULD BE USED FOR THIS LINE IF IT IS GREATER THAN AUX. BLDG. SPECTRA

Form 184

SYS. [illegible] Development OCONEE 1 See Dwg ______ File No ______

RUN C Subject PIPING SEISMIC ANALYSIS Sheet No 2 of 3

AUX BUILDING Z DIRECTION OF EXCITATION By WHS Date 5-20-7.

SYSTEM NAME RB SPRAY

LINE NO.	VALVE NO.	VALVE WGT	DESIGN ACCEL.	VALVE EXCITATION
70-80	1/54/15	500	.1	70
85-100	1/54/12	600		*

* DEPENDENT ON RESULTS OF DYNAMIC ANALYSIS

Form 184

SYS. S.K.S. Development OCONEE I See Dwg. File No.

RUN Subject PIPING SEISMIC ANALYSIS Sheet No. 3 of 3

A.X BUILDING → DIRECTION OF EXCITATION By WHS Date 5-20-70

SYSTEM NAME KC [illegible]

RESTRAINT NO.	PIPING REACTION	VALVE REACTION	TOTAL SEISMIC REACTION
35	483	—	483
50	347	—	347
60	*	—	
△ 5	171		
△ 70	*		

* DEPENDENT ON RESULTS OF DYNAMIC ANALYSIS

SYS [illegible] Development OCONEE I See Dwg. File No.
RUN [illegible] Subject PIPING SEISMIC ANALYSIS Sheet No. of
[illegible] BUILDING = DIRECTION OF EXCITATION By WNS Date 5-20-7[illegible]
SYSTEM NAME [illegible]

ANCHOR NO.	PIPING REACTION	VALVE REACTION	TOTAL SEISMIC REACTION
A-140-C-5	171+183	—	354
C-70	*		

* DEPENDENT ON RESULTS OF DYNAMIC ANALYSIS

SYS. 54A(3) Development OCONEE 1 See Dwg File No.
RUN C Subject PIPING SEISMIC ANALYSIS Sheet No. CZ-1 of
AUX. BUILDING Z DIRECTION OF EXCITATION By WHS Date 5-20-70
SYSTEM NAME

LINE - 65-125

THIS LINE CANNOT BE JUSTIFIED BY STATIC ANALYSIS BECAUSE OF THE CONFLICTING REQUIREMENTS FOR FLEXIBILITY AND STIFFNESS IN THIS AREA. BECAUSE OF THE RELATIVE BUILDING MOVEMENTS BETWEEN THE REACTOR BUILDING AND THE AUXILIARY BUILDING THE PIPE FROM 60 TO 105 SHOULD BE FLEXIBLE TO ABSORB THE MOVEMENTS. HOWEVER TO MEET DESIGN SPAN REQUIREMENTS AN ADDITIONAL RESTRAINT IS NEEDED.

THE NEXT STEP IS TO PERFORM A DYNAMIC ANALYSIS ON THIS PIPING. IF THE RESULTS OF THIS ANALYSIS ARE NOT ACCEPTABE THE PIPING MAY HAVE TO BE RE-ROUTED.

Form 134

SYS. ALL Development OCONEE ·1 See Dwg. ______ File No. ______

RUN ______ Subject PIPING SEISMIC ANALYSIS Sheet No. ______ of ______

AUX BUILDING X DIRECTION OF EXCITATION By WHS Date 5/20/70

SYSTEM NAME ALL SYSTEMS

FLOOR ACCELERATIONS

REFERENCE: SEISMIC ANALYSIS
REPORT PREPARED BY BECHTEL CORP.
GAITHERSBURG, MD. JOB 6210
DATED JANUARY 1970

ELEVATION	ACCELERATION G's
858'	.151
848'	.113
838'	.100
822'	.080
809'-3"	.087
796'-6"	.065
783'-9"	.056
776'	.043
771'	.032
760'	.050

TABLE X-1

VERTICAL ACCELERATIONS

REFERENCES: GROUND RESPONSE SPECTRA RECOMMENDED FOR THE SITE

GROUND MOTION SPECTRA RECOMMENDED FOR THE SITE

ELEVATION	ACCELERATION	
	LATERAL	AXIAL
ALL	0.2G	0.05G

TABLE Y-1

Form 184

SYS. ALL Development OCONEE ·1 See Dwg. ______ File No. ______

RUN ______ Subject PIPING SEISMIC ANALYSIS Sheet No. ______ of ______

AUX BUILDING Z DIRECTION OF EXCITATION By WHS Date 5/20/70

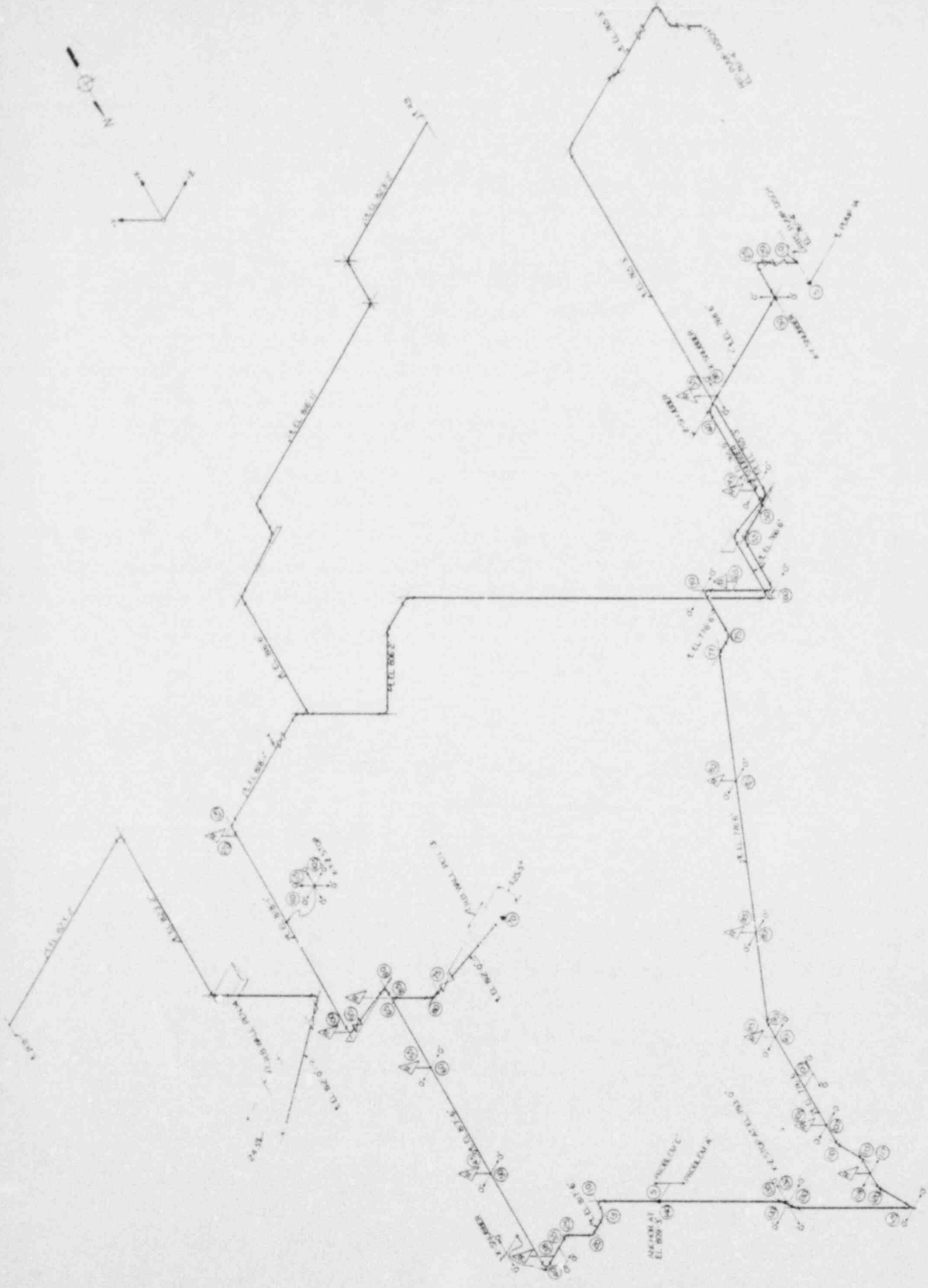
SYSTEM NAME ALL SYSTEMS

FLOOR ACCELERATIONS

REFERENCE : SEISMIC ANALYSIS
REPORT PREPARED BY BECHTEL CORP.
GAITHERSBURG, MD. JOB 6210
DATED JANUARY 1970

ELEVATION	ACCELERATION G's
858'	.159
848'	.114
838'	.105
822'	.083
809'-3"	.091
796'-6"	.067
783'-9"	.057
776'	.045
771'	.035
760'	.050

TABLE Z-1



OCONEE NUCLEAR STATION - 1
REACTOR BUILDING SPRAY SYSTEM
PUMPS TO REACTOR BUILDING

SYS 541(3) Development OCONEE 1 See Dwg File No.
Run AEC Subject PIPING SEISMIC ANALYSIS Sheet No. of
AUX BUILDING — DIRECTION OF EXCITATION By J.N.U. Date 5-22-70

SYSTEM NAME R.B. SPRAY

PIPING FLEXIBILITY ANALYSIS SUMMARY

1) TITLE RB SPRAY: ANK AT 809'-3", PEN 13, 791', 820'

2) DATE OF RUN 5-20-70

3) PIPE SIZE 8.625 SCH 20 (t=.25) 4) MATERIAL A376-304 H

5) OPERATING PRESSURE 500 PSIG 6) OPERATING TEMP. 225°F

7) THERMAL CONDITION

A. DATA POINT (125) ELEMENT TYPE BEND
B. ACTUAL EXPANSION STRESS = 25,000
C. ALLOW. EXPANSION STRESS = $f(1.25 S_c + 0.25 S_H)$ = 27,400 PSI

8) OPERATING BASIS EARTHQUAKE CONDITION

A. RESPONSE SPECTRA IDENTIFICATION
B. DATA POINT (10) ELEMENT TYPE PUMP NOZZLE REDUCER
C. SEISMIC STRESS 7130 PSI
D. LONG. WEIGHT STRESS 0
E. LONG. PRESS. STRESS 2000
F. TOTAL STRESS 8C+8D+8E = 9130
G. ALLOW SEISMIC STRESS = $1.2 S_H$ = 1.2 (15500) = 18,600

9) DESIGN BASIS EARTHQUAKE CONDITION

A. DATA POINT (10) ELEMENT TYPE PUMP NOZZLE REDUCER
B. SEISMIC STRESS = 2 × 8C = 14260
C. LONG. WEIGHT STRESS = 8D = 0
D. LONG. PRESS. STRESS = 8E = 2000
E. TOTAL STRESS = 9B + 9C + 9D = 16,260
F. ALLOW MAX. SEISMIC STRESS = S_y @ OP. TEMP. = 24,700