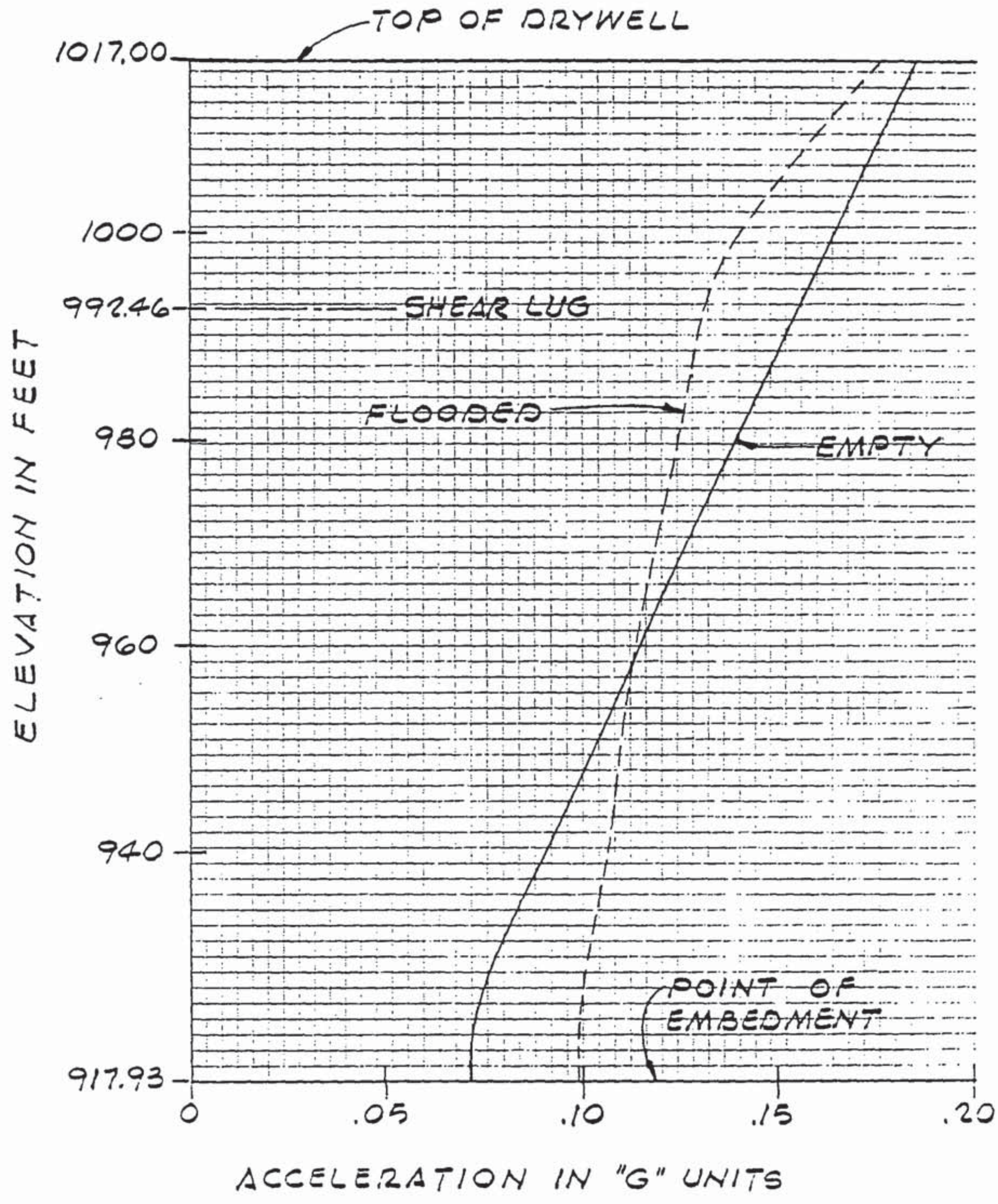
JOHN A. BLUME AND ASSOCIATES, ENGINEERS

MONTICELLO DRYWELL
SEISMIC ANALYSIS
ACCELERATION DIAGRAM
N-S DIRECTION



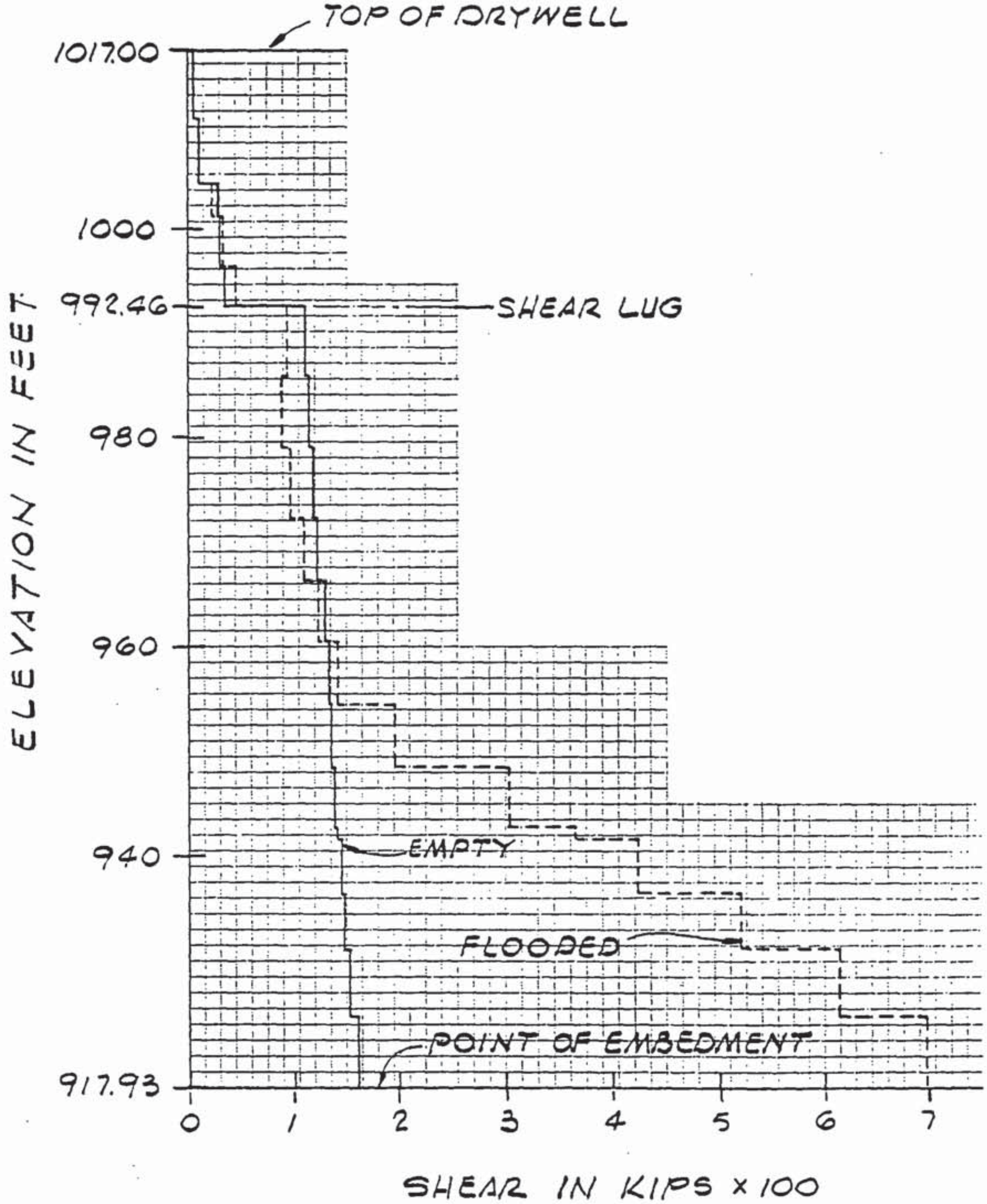
JOHN A. BLUME AND ASSOCIATES, ENGINEERS

MONTICELLO DRYWELL

SEISMIC ANALYSIS

SHEAR DIAGRAM

N-S DIRECTION



SHEET NO. 9

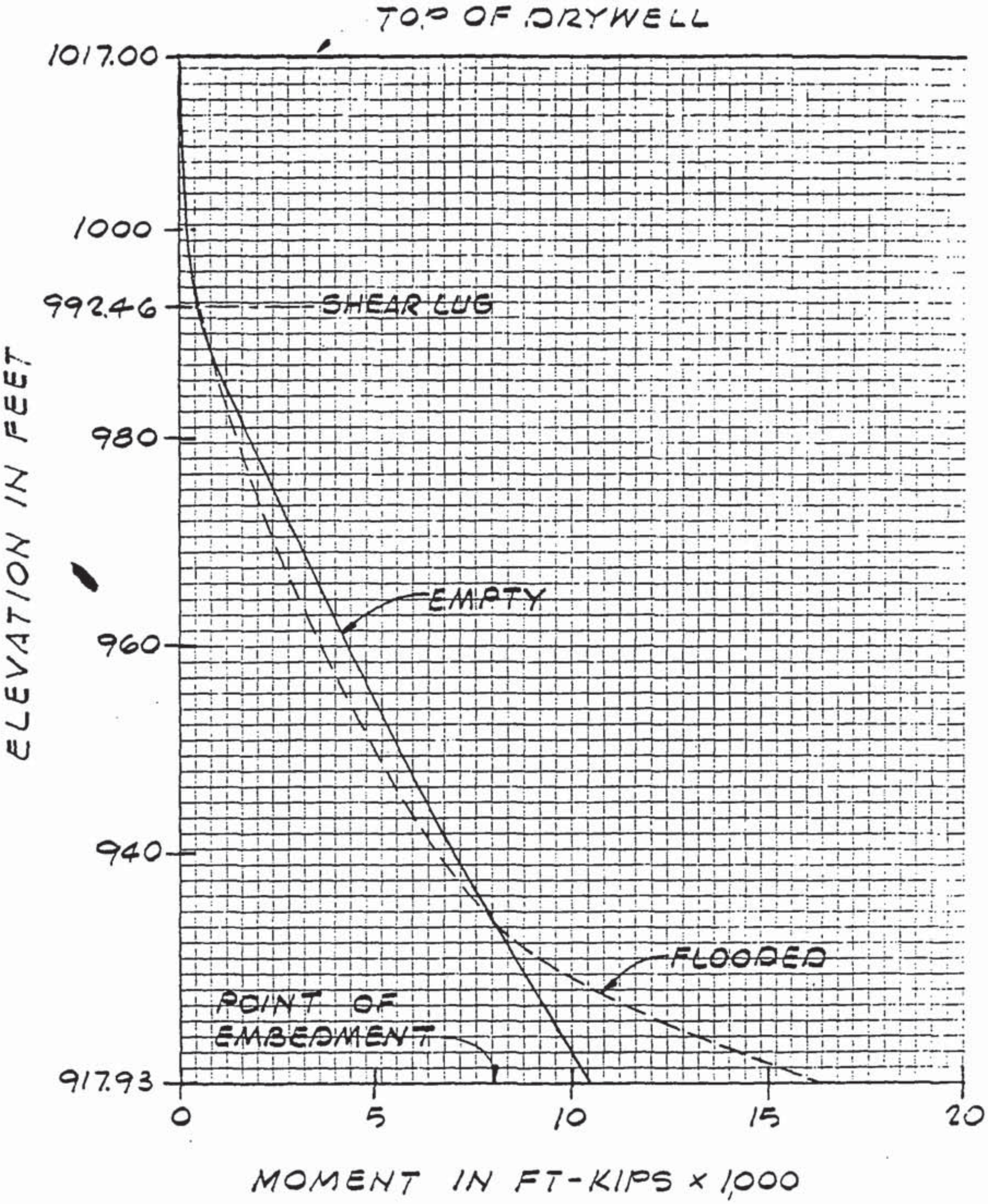
JOHN A. BLUME AND ASSOCIATES, ENGINEERS

MONTICELLO DRYWELL

SEISMIC ANALYSIS

MOMENT DIAGRAM

N-S DIRECTION



SHEET NO. 10

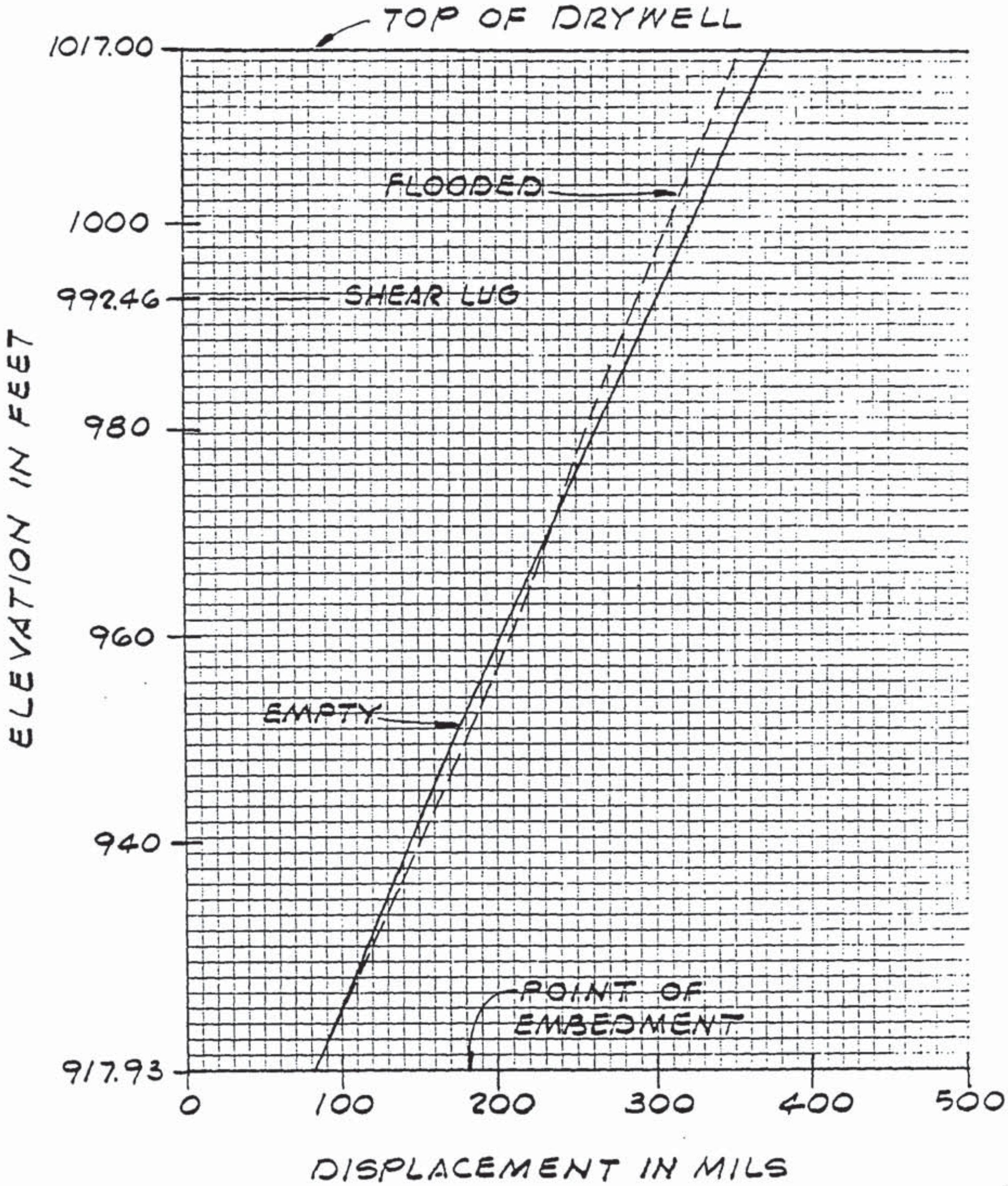
JOHN A. BLUME AND ASSOCIATES, ENGINEERS

MONTICELLO DRYWELL

SEISMIC ANALYSIS

DISPLACEMENT DIAGRAM

N-S DIRECTION



SHEET NO. 11

JOHN A. BLUME AND ASSOCIATES, ENGINEERS

MONTICELLO DRYWELL

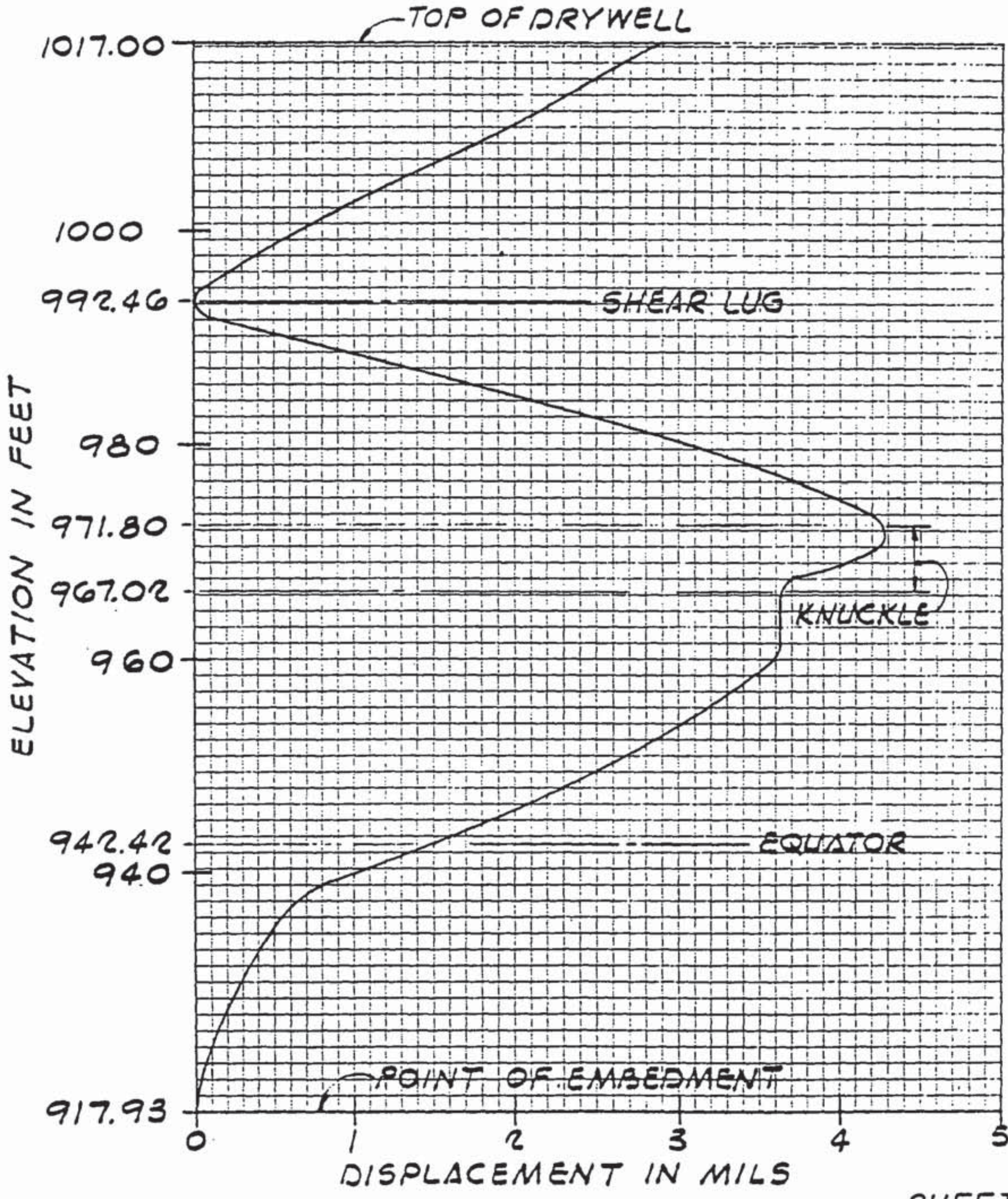
SEISMIC ANALYSIS

MAXIMUM DRYWELL DISPLACEMENTS

RELATIVE TO REACTOR BUILDING

DRYWELL EMPTY

N-S DIRECTION



SHEET NO. 12

GENERAL ELECTRIC COMPANY
ATOMIC POWER EQUIPMENT DEPARTMENT

MONTICELLO NUCLEAR GENERATION PLANT

EARTHQUAKE ANALYSIS: REACTOR PRESSURE VESSEL

JOHN A. BLUME AND ASSOCIATES, ENGINEERS
SAN FRANCISCO

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LLOYD A. LEE
RALPH T. YOKOYAMA

July 28, 1967

General Electric Company
Atomic Power Equipment Department
175 Curtner Avenue
San Jose, California 95125

ATTENTION: Mr. R. B. Gile
MC-750

SUBJECT: Monticello Nuclear Generation Plant
Report on Earthquake Analysis of
Reactor Pressure Vessel

Gentlemen:

Transmitted herein is the subject report based on information furnished by the General Electric Company.

The analysis assumes soil properties as described in the report on Earthquake Analysis of Reactor Building prepared by this office for the subject generation plant.

This report summarizes the analytical procedures and results for the seismic analysis of Monticello Reactor Pressure Vessel. The response of reactor pressure vessel to jet load reactions is also included.

The results presented herein should be used in review of the final designs' seismic adequacy and to determine whether any changes in soil or structural properties would warrant further earthquake analysis.

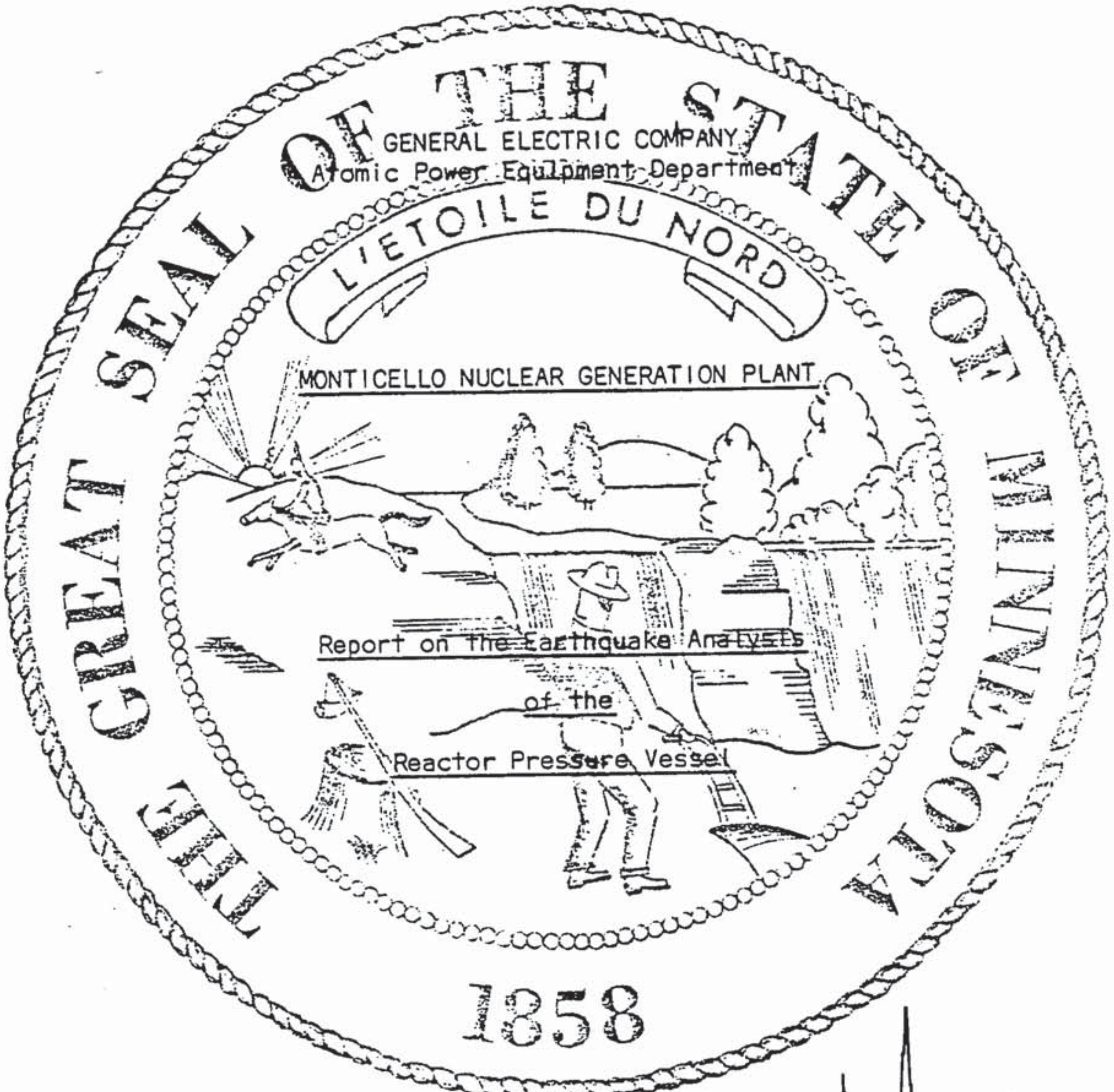
Very truly yours,

JOHN A. BLUME & ASSOCIATES, ENGINEERS

Ronald H. Hoy fa

E. J. Keith
Assistant Vice President

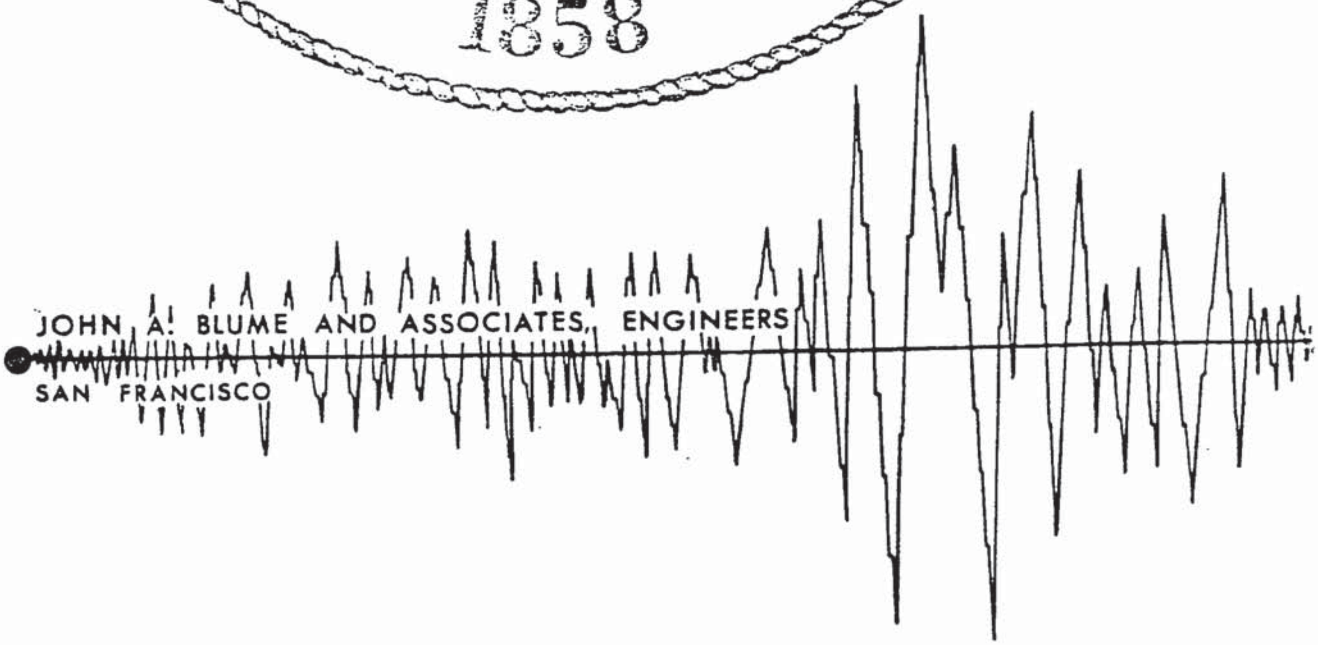
EJK/ss



GENERAL ELECTRIC COMPANY
Atomic Power Equipment Department

MONTICELLO NUCLEAR GENERATION PLANT

Report on the Earthquake Analysis of the Reactor Pressure Vessel



JOHN A. BLUME AND ASSOCIATES, ENGINEERS
SAN FRANCISCO

MONTICELLO NUCLEAR GENERATION PLANT
REACTOR PRESSURE VESSEL
SEISMIC ANALYSIS

TABLE OF CONTENTS | Page

MONTICELLO NUCLEAR GENERATION PLANT

REACTOR PRESSURE VESSEL

SEISMIC ANALYSIS

INTRODUCTION

The purpose of this report is to summarize the results of the seismic investigation of the Monticello Nuclear Generation Plant Reactor Pressure Vessel. Based on the recommended earthquake design criteria 1, design envelopes of maximum acceleration, displacement, moment and shear have been developed and are presented herein. In addition, the response of the reactor pressure vessel to the jet load reactions has also been determined and is presented.

Some minor differences exist between the known RPV component weights as compared to those used in this analysis. The differences result in a net decrease in weight that is a small percentage of overall system mass. Therefore, Monticello recognizes this analysis as providing conservative results for the RPV seismic response. 01245382

DESCRIPTION OF REACTOR PRESSURE VESSEL

The reactor pressure vessel consists of a 63' - 2" long cylindrical shell having an inside diameter of 17' - 1". It is supported by concrete pedestal through steel skirt. Lateral support is provided by stabilizers between reactor pressure vessel and shield wall at El. 994' - 2". A truss consisting of 16' - 10" XXS pipes between shield wall and reactor building laterally support the shield wall at El. 992' - 5½". Geometric relation between reactor pressure vessel, shield wall, pedestal wall and reactor building is shown in Appendix A, Sheet 1.

MATHEMATICAL MODEL OF REACTOR PRESSURE VESSEL

The entire Monticello reactor structure (i.e., building, drywell, pressure vessel and shield) was mathematically modeled as a 27 mass coupled system. The system couples model described in previous report[2] with the shield wall, reactor pressure vessel and pedestal wall. The mathematical model is shown in Appendix A, Sheet 2.

ANALYTICAL PROCEDURES PERIODS AND MODE SHAPES

Subsequent to the formation of mass and stiffness matrices for the coupled system, the periods and mode shapes are calculated by solving for the eigenvalues and eigenvectors of Equation (1).

$$\left[\underline{K} - \omega_n^2 \, \underline{M}\right] \underline{\Phi_n} = \underline{0} \text{ --(1)}$$

Where $\underline{K}$ = Stiffness matrix of coupled system.

$\underline{\Phi_n}$ = Mode shape of the n^{th} mode.

ω_n = Natural circular frequency of the n^{th} mode.

$\underline{M}$ = Mass matrix.

$\underline{0}$ = Null matrix.

ANALYTICAL PROCEDURES - RESPONSE

With mode shapes and frequencies calculated, the generalized coordinate response can be calculated by solution of Equation (2).

$$\underline{\ddot{Y}_n(t)} + 2\omega_n\lambda_n \; \underline{\dot{Y}_n(t)} + \omega_n^2 \; \underline{Y_n(t)} = \frac{R_n}{M_n^*} \; \underline{\ddot{U}_g(t)} \text{ ------------(2)}$$

Where $\underline{Y_n(t)}$ = Generalized coordinate vector for the n^{th} mode.

$$= \frac{R_n}{M_n^* \omega_n} \int_0^t \ddot{U}_g(\tau) \, e^{-\lambda_n \omega_n (t-\tau)} \sin\omega_n(t-\tau) d\tau$$

λ_n = Damping value for the n^{th} mode, selected as 0.03 for all modes.

R_n = Participation factor of the n^{th} mode.

M_n^* = Generalized mass of the n^{th} mode.

$$= \underline{\Phi_n^T} \, \underline{M} \; \underline{\Phi_n}$$

$\underline{\ddot{U}_g(t)}$ = Design earthquake.

$d\tau$ = Integration interval, selected as 0.01 seconds; the Duhamel Integral is numerically integrated.

The general acceleration vector may be obtained from Equation (3).

$$\underline{\ddot{Y}_n(t)} = \underline{D_2} \; \underline{Y_n(t)} \text{ --(3)}$$

Where $\underline{\ddot{Y}_n}(t)$ = Generalized acceleration vector for the n^{th} mode.

$\underline{D_2}$ = Second order differentiating matrix.

The acceleration time history of the i^{th} point of the coupled system can be obtained with Equation (4).

$$\underline{\ddot{U}_i(t)} = \Phi_{in} \underline{\ddot{Y}_n(t)} \text{ -- (4)}$$

Where $\underline{\ddot{U}_i(t)}$ = Acceleration time history of the i^{th} point of the coupled system.

Φ_{in} = Modal displacement of the i^{th} point of the coupled system for the n^{th} mode.

$$\underline{V(t)} = \underline{\Phi_n}\, \underline{Y_n(t)} \text{ -- (5)}$$

Where $\underline{V(t)}$ = Displacement time history of the coupled system considering n modes.

The time history of inertia forces can then be determined with Equation (6).

$$\underline{Q(t)} = \underline{K}\, \underline{V(t)} \text{ -- (6)}$$

Where $\underline{Q(t)}$ = Inertia force time history of coupled system.

Once the displacement and inertia force time histories have been established, time histories for shears and moments are easily determined. These records are scanned for maximum values to be used by the designer.

ANALYTICAL PROCEDURES - COMPUTER PROGRAMMING

The computer program used in this analysis was specially designed to solve the dynamic response of structures subject to arbitrary ground motions.[6,7,8] Member input data for the program, except for foundation springs and lateral supports of the reactor pressure vessel and shield, are in the form of moments of inertia, areas and effective shear areas. The effects of axial and shear deformations are included in the formation of the stiffness matrices.

The response of each mass for each mode considered at each increment of time is retained in the computations and total response for each increment of time is obtained through the algebraic sum of each mass point's modal contribution at that particular instant of time. This results in a precise combination of mode participations.

The process logic of the computer aided solution is summarized in Diagram I.

MONTICELLO REACTOR PRESSURE VESSEL

SEISMIC ANALYSIS

COMPUTER PROCESS DIAGRAM

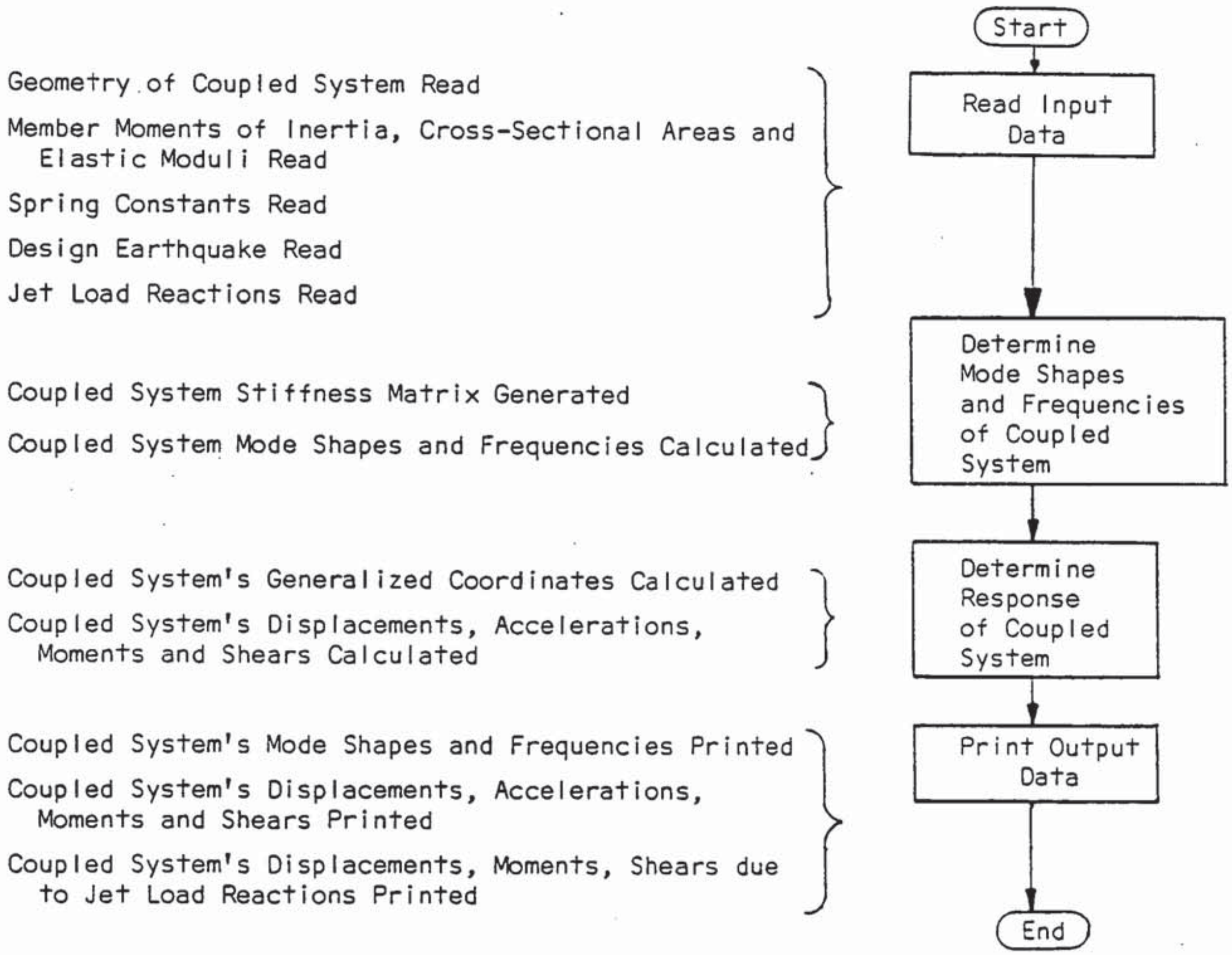


DIAGRAM I

CALCULATED DATA

Calculated data used as input to the computers is given in Appendix B. Values of the foundation springs were taken from a previous report.[2]

The following assumptions were made in calculating the spring constant between shield wall and reactor building.

(1) Compared to the truss members, the ring which consists of the concrete reactor shield is very rigid.

(2) All end reactions are tangential to the supporting ring.

(3) Young's modulus of elasticity is 4.32×10^6 K/Ft^2.

The remaining calculations result from information or drawings supplied by General Electric.[3,4]

RESULTS

The results of the seismic analysis in the form of design moment, design shear, maximum absolute acceleration and relative displacement envelopes are presented in Appendix A, Sheets 3 through 6.

Summary of spring forces is presented on Sheet 16.

Displacements, shears and moments induced in the structure due to jet reaction at steam outlet and recirculation outlet are presented in Appendix A, Sheets 7, 8, 9 and 10, 11, 12, respectively.

Forces in truss members are presented in Appendix A, Sheets 13, 14 and 15.

The previously described calculations were performed with the aid of an IBM 7094/II digital computer. The influence of 7th and higher modes of vibration were considered negligible and, therefore, ignored in the coupled system's response calculations. The first 6 natural periods of vibration for the coupled system are as below:

First Mode	0.535 Seconds	Fourth Mode	0.102 Seconds
Second Mode	0.215 Seconds	Fifth Mode	0.065 Seconds
Third Mode	0.140 Seconds	Sixth Mode	0.048 Seconds

A damping value of three percent was assigned to the coupled system.

RECOMMENDATIONS

It is recommended that the subject structural elements be designed to resist the seismic shears and moments presented herein without the usual increase in stress for short term loadings. In addition, these elements should be reviewed to assure that they can resist twice the seismic shears and moments presented here without hindering the ability of the reactor plant to safely shut down. A vertical acceleration of 0.04g acting simultaneously with the horizontal accelerations included herein, is recommended for design.

MONTICELLO NUCLEAR GENERATION PLANT

REACTOR PRESSURE VESSEL

SEISMIC ANALYSIS

REFERENCES

1. Monticello Nuclear Generation Plant Recommended Earthquake Criteria, John A. Blume & Associates, Engineers, July 15, 1966.

2. Monticello Nuclear Generation Plant Earthquake Analysis: Reactor Building, John A. Blume & Associates, Engineers, July 18, 1967.

3. Drawings:

   General Electric

   719E110, 719E401, 719E489

   718E944, Sheet 1 through 3

   886D482, Sheet 1 and 7

   C. B. & I. Company

   VPF-1811-36-1

   VPF-1811-78-1

   VPF-1811-75-3

4. Sketch of Estimated Weights 9-5624.

5. General Electric Specification Sheet 5 of 21A5642.

6. Use of Modern Computers in Structural Analysis, R. W. Clough, Journal of the Structural Division of the American Society of Civil Engineers, ST3, May 1958.

7. Structural Analysis of Multistory Buildings, R. W. Clough, I. P. King and E. L. Wilson, Journal of the Structural Division of the American Society of Civil Engineers, ST3, June 1964.

8. Dynamic Effects of Earthquakes, R. W. Clough, Transactions of the American Society of Civil Engineers, Paper No. 3252.

APPENDIX A

DATA AND DESIGN FIGURES

MONTICELLO NUCLEAR GENERATION PLANT
REACTOR PRESSURE VESSEL
SEISMIC ANALYSIS

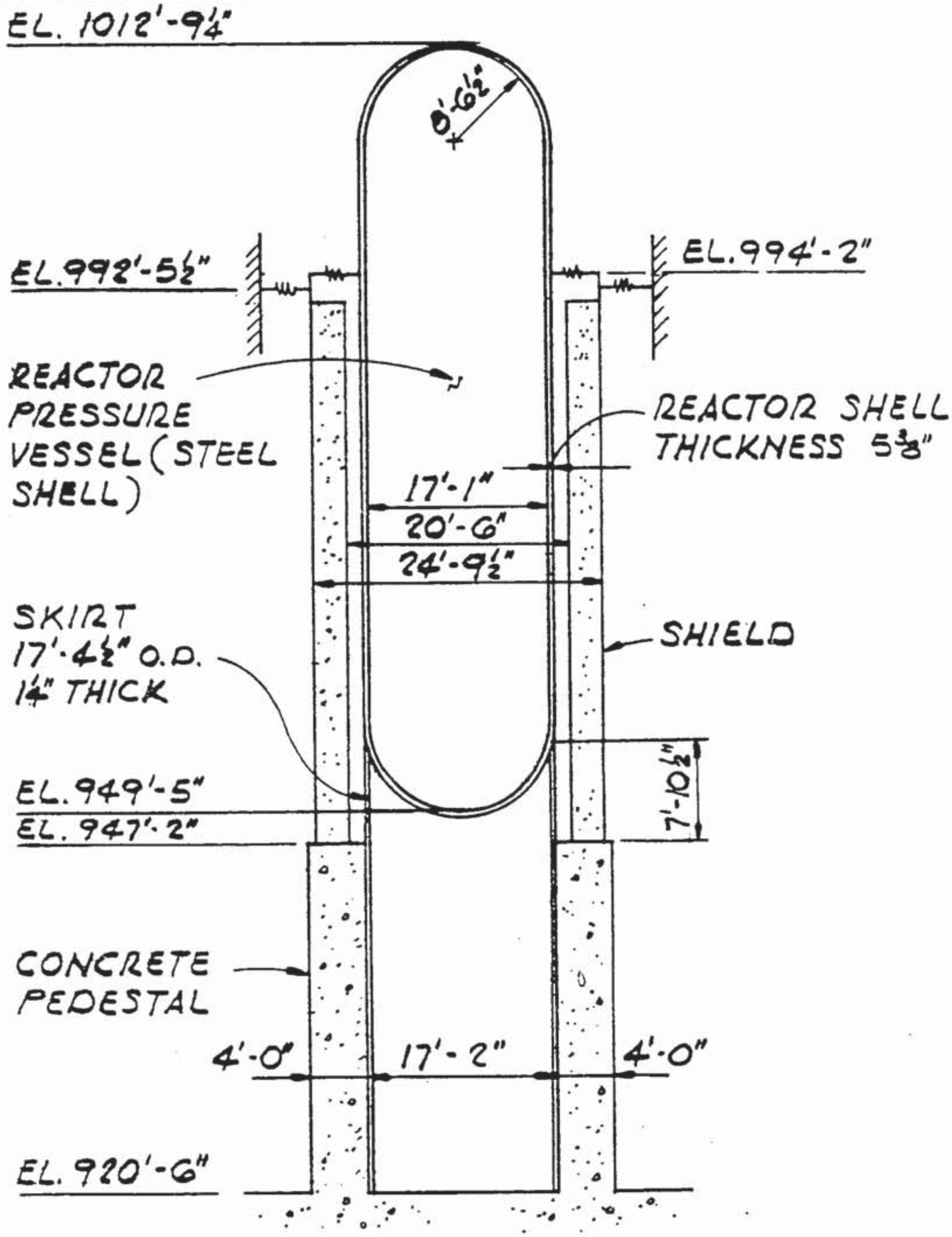
LIST OF FIGURES — Sheet

JOHN A. BLUME AND ASSOCIATES, ENGINEERS

MONTICELLO REACTOR PRESSURE VESSEL

SEISMIC ANALYSIS

GEOMETRIC FIGURE

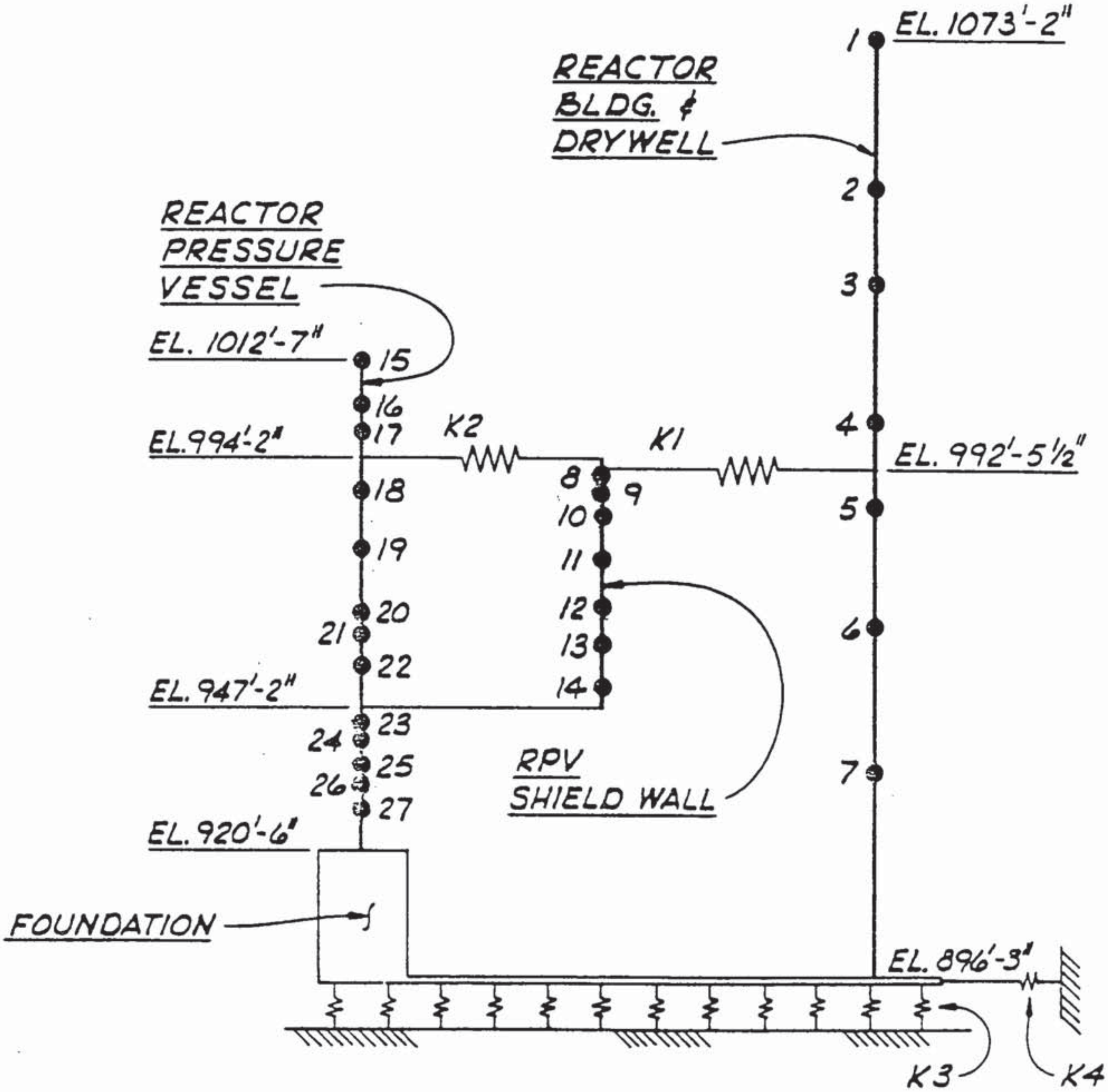


JOHN A. BLUME AND ASSOCIATES, ENGINEERS

MONTICELLO REACTOR PRESSURE VESSEL

SEISMIC ANALYSIS

MATHEMATICAL MODEL
COUPLED REACTOR BLDG. &
REACTOR PRESSURE VESSEL

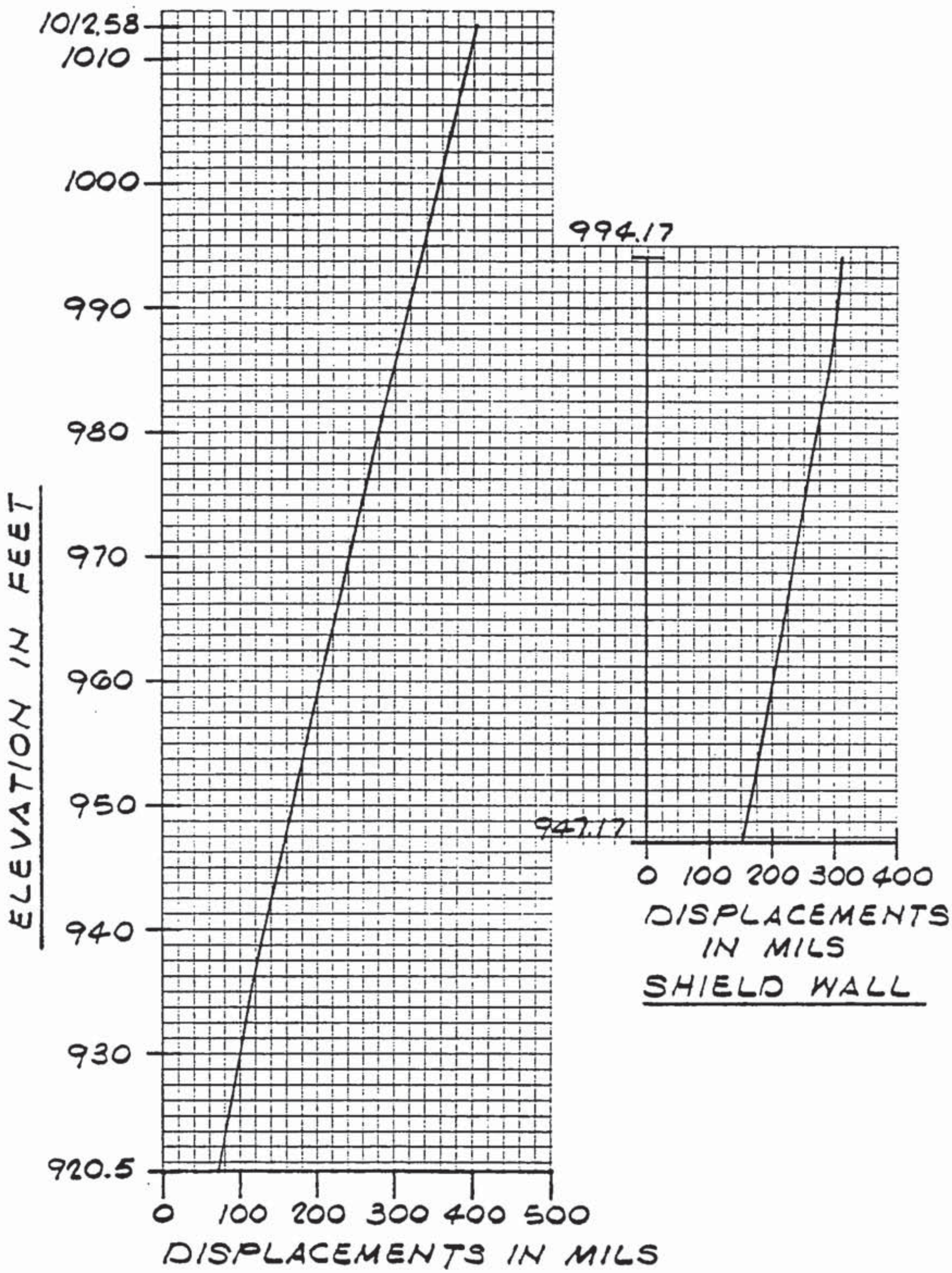


SHEET NO. 2

JOHN A. BLUME AND ASSOCIATES, ENGINEERS

MONTICELLO REACTOR PRESSURE VESSEL SEISMIC ANALYSIS

DISPLACEMENT DIAGRAM



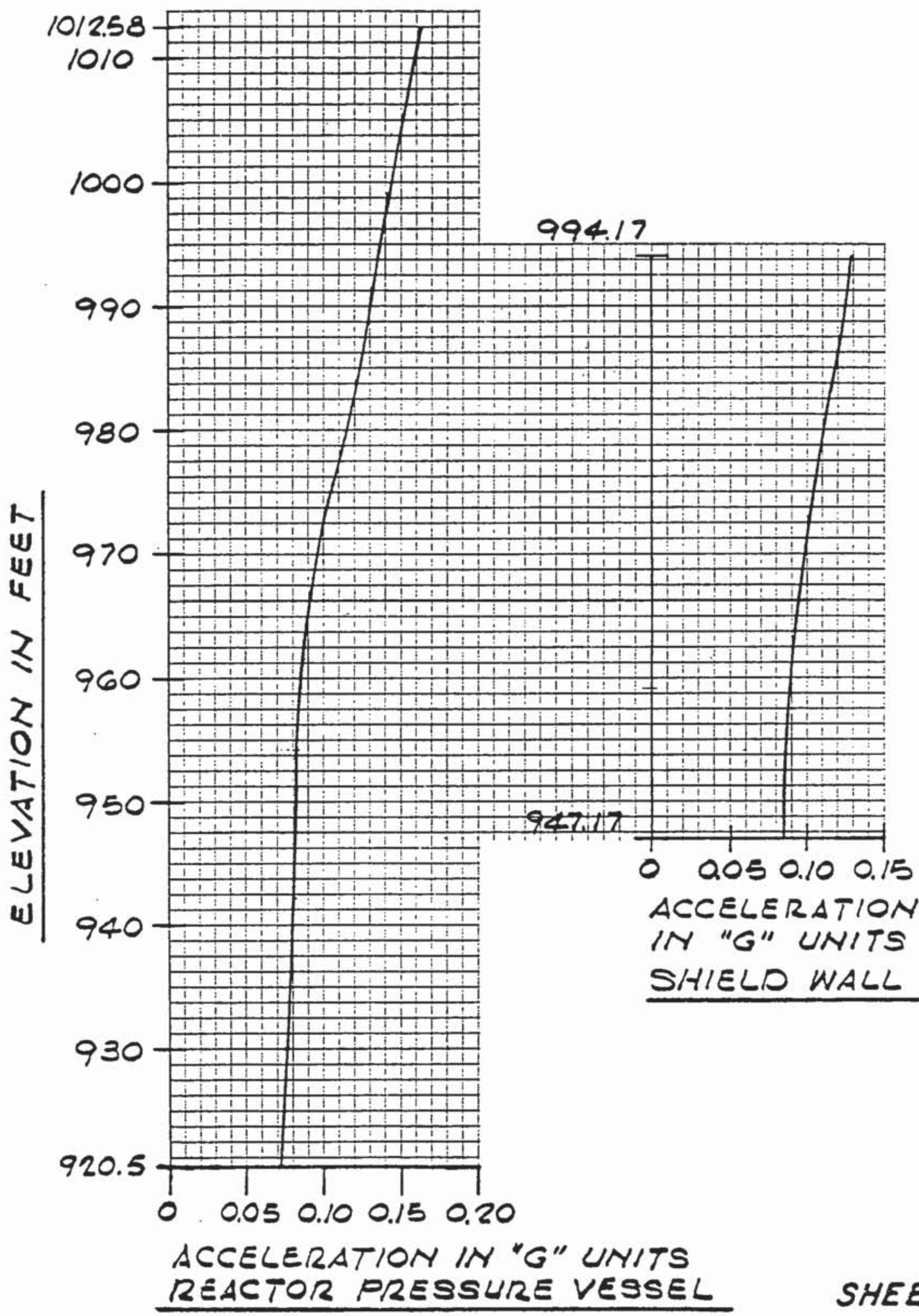
SHEET NO. 3

JOHN A. BLUME AND ASSOCIATES, ENGINEERS

MONTICELLO REACTOR PRESSURE VESSEL

SEISMIC ANALYSIS

ACCELERATION DIAGRAM



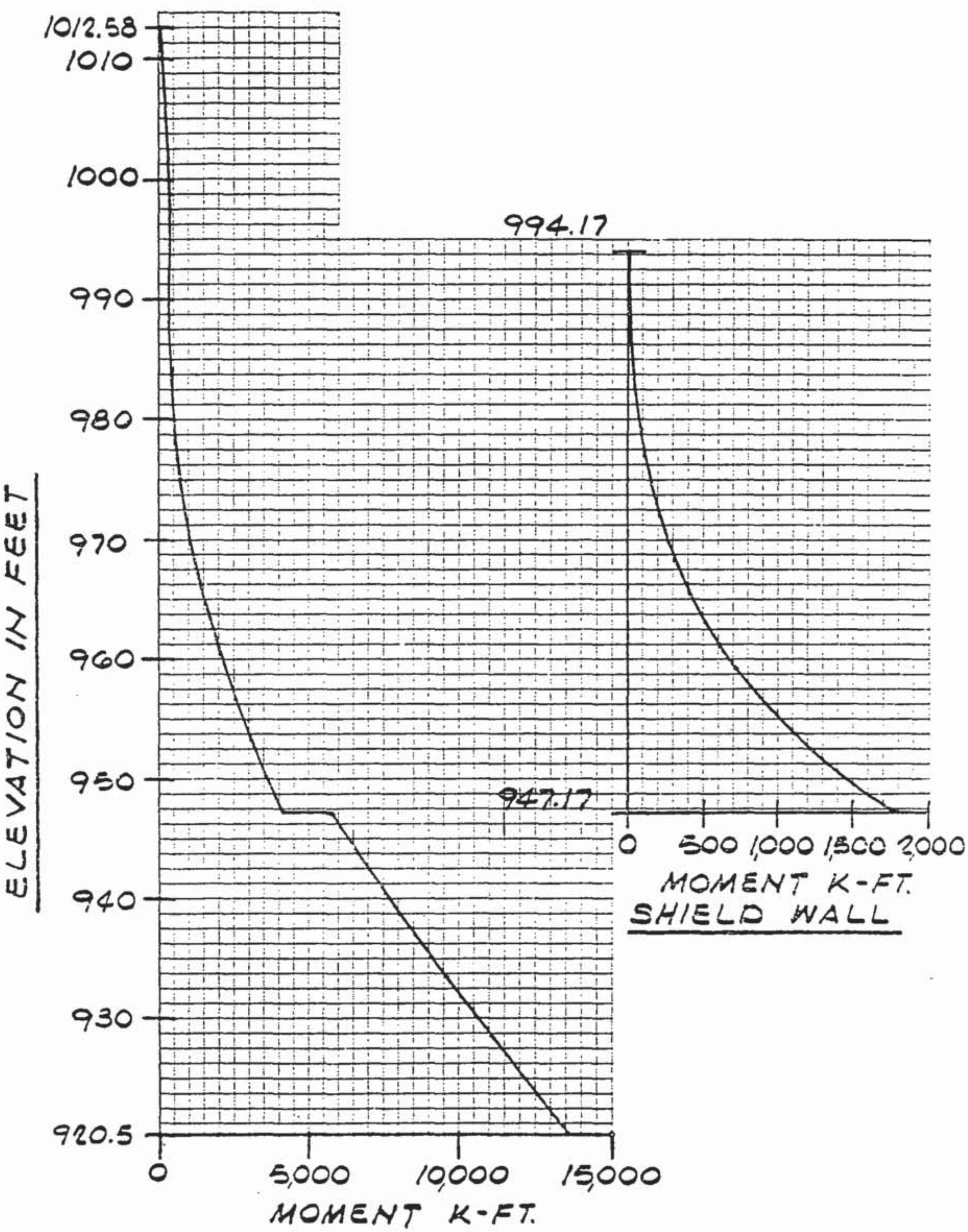
SHEET NO. 4

JOHN A. BLUME AND ASSOCIATES, ENGINEERS

MONTICELLO REACTOR PRESSURE VESSEL

SEISMIC ANALYSIS

MOMENT DIAGRAM

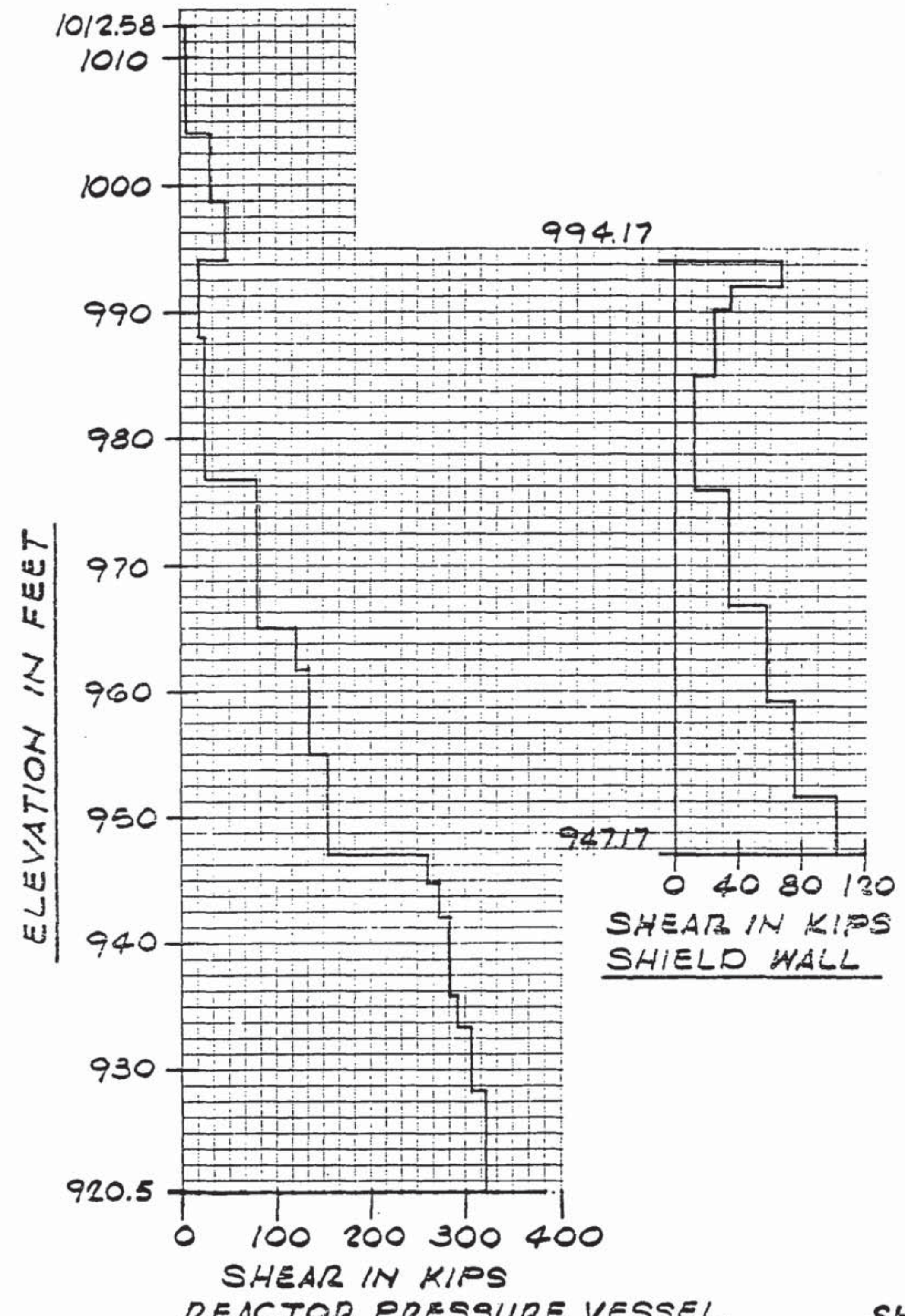


JOHN A. BLUME AND ASSOCIATES, ENGINEERS

MONTICELLO REACTOR PRESSURE VESSEL

SEISMIC ANALYSIS

SHEAR DIAGRAM



SHEET NO. 6

JOHN A. BLUME AND ASSOCIATES, ENGINEERS

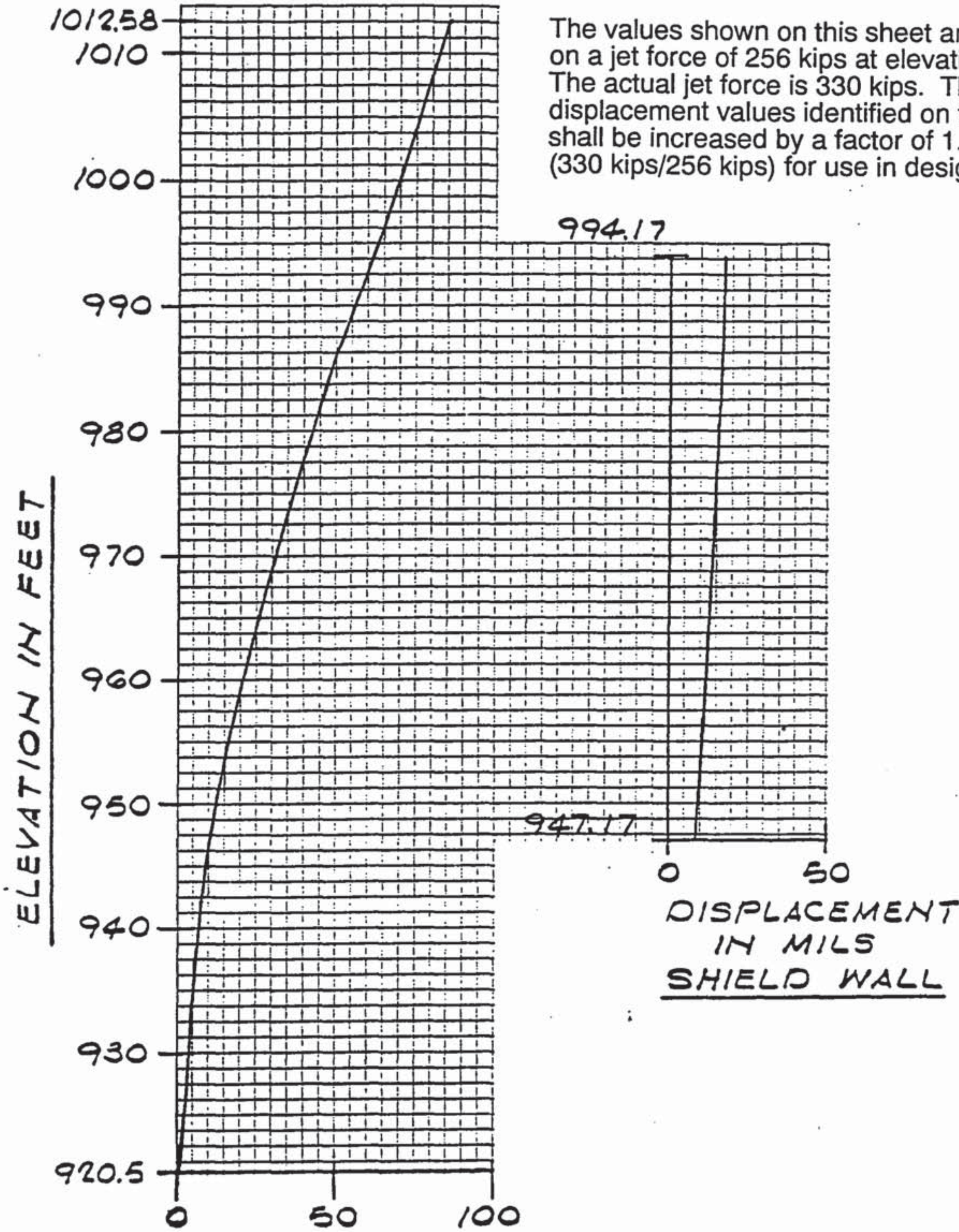
MONTICELLO REACTOR PRESSURE VESSEL SEISMIC ANALYSIS

DISPLACEMENT DIAGRAM

(JET LOAD 256ᴷ @ ELEV. 999'-0" - CASE 1)

The values shown on this sheet are based on a jet force of 256 kips at elevation 999'-0". The actual jet force is 330 kips. The displacement values identified on this sheet shall be increased by a factor of 1.29 (330 kips/256 kips) for use in design.

00-206



SHEET NO. 7

JOHN A. BLUME AND ASSOCIATES, ENGINEERS

MONTICELLO REACTOR PRESSURE VESSEL

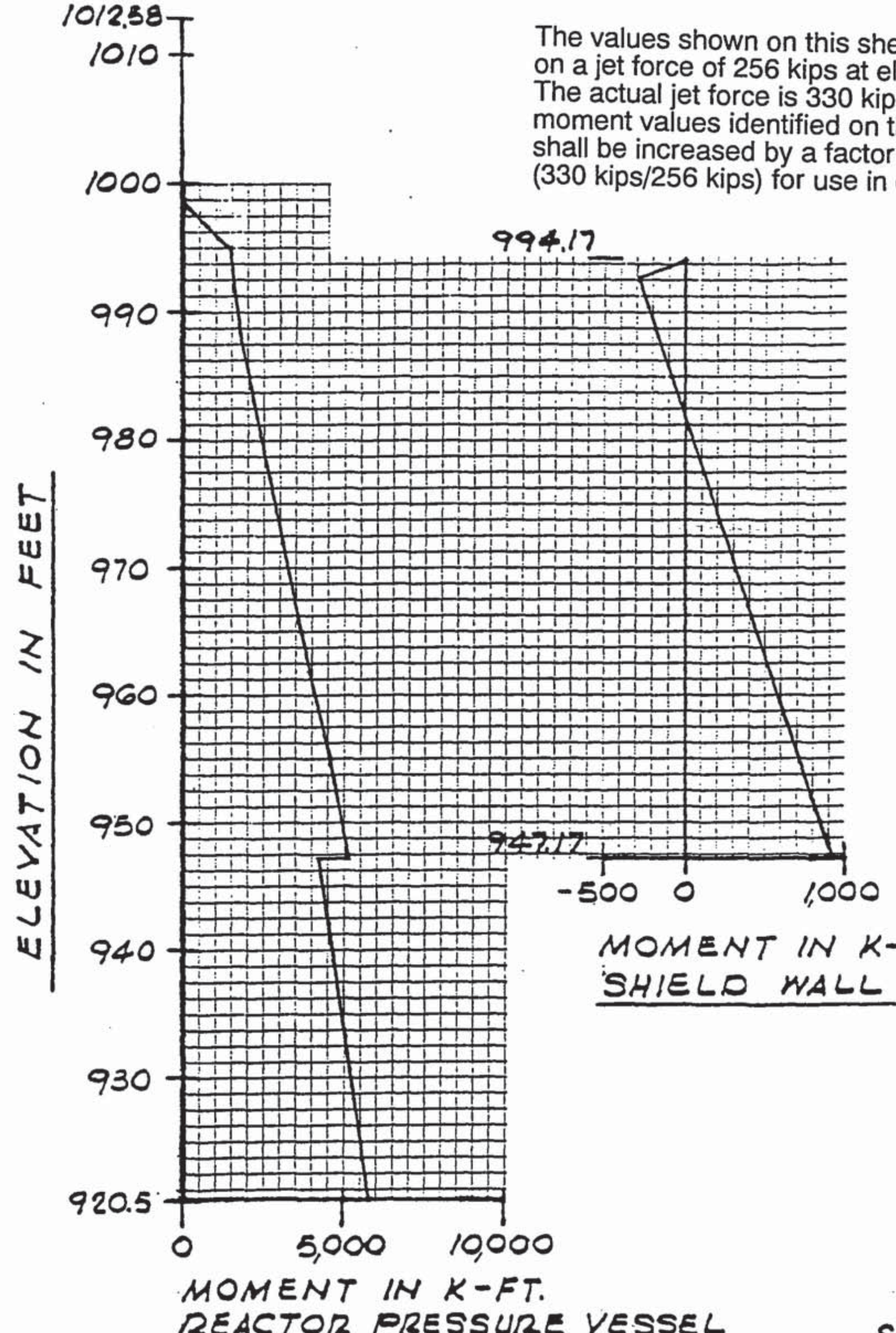
SEISMIC ANALYSIS

MOMENT DIAGRAM

(JET LOAD 256^{K} @ ELEV. 999'-0"-CASE 1)

The values shown on this sheet are based on a jet force of 256 kips at elevation 999'-0". The actual jet force is 330 kips. The moment values identified on this sheet shall be increased by a factor of 1.29 (330 kips/256 kips) for use in design.

00-206



JOHN A. BLUME AND ASSOCIATES, ENGINEERS

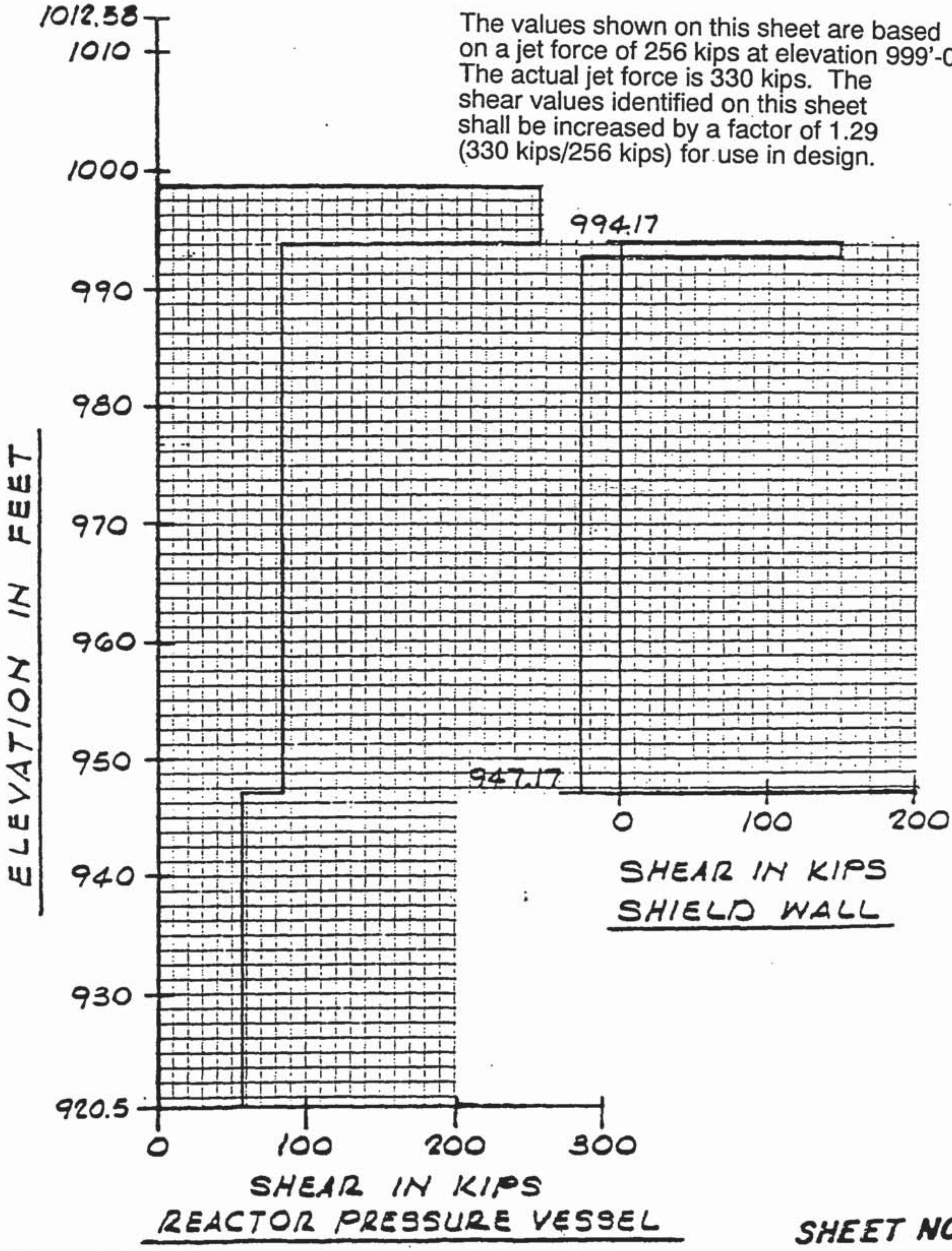
MONTICELLO REACTOR PRESSURE VESSEL SEISMIC ANALYSIS

SHEAR DIAGRAM

(JET LOAD 256^K @ ELEV. 999'-0" - CASE 1)

The values shown on this sheet are based on a jet force of 256 kips at elevation 999'-0". The actual jet force is 330 kips. The shear values identified on this sheet shall be increased by a factor of 1.29 (330 kips/256 kips) for use in design.

00-206

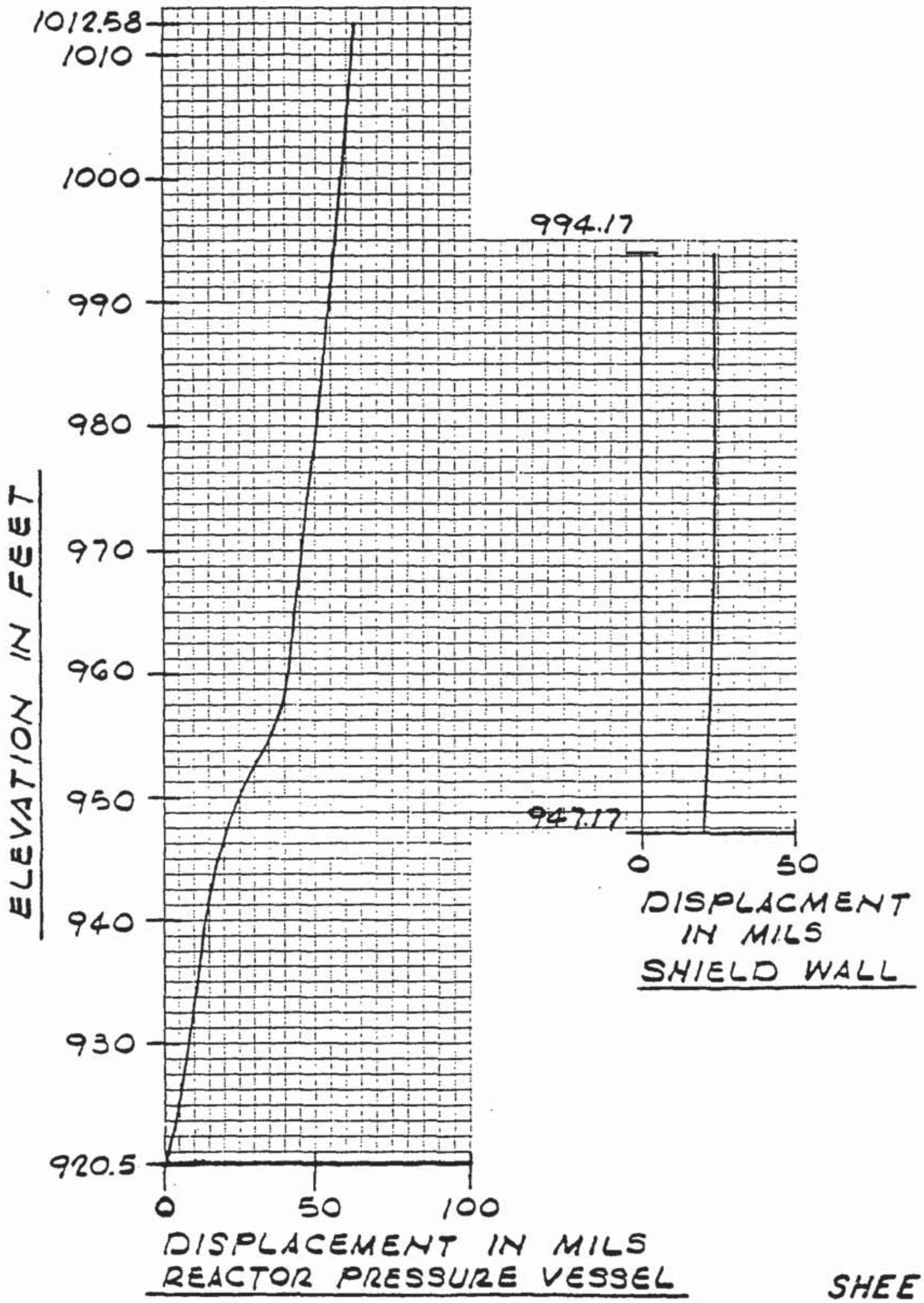


JOHN A. BLUME AND ASSCCIATES, ENGINEERS

MONTICELLO REACTOR PRESSURE VESSEL SEISMIC ANALYSIS

DISPLACEMENT DIAGRAM

(JET LOAD 664^K @ ELEV. 961'-11" - CASE 2)

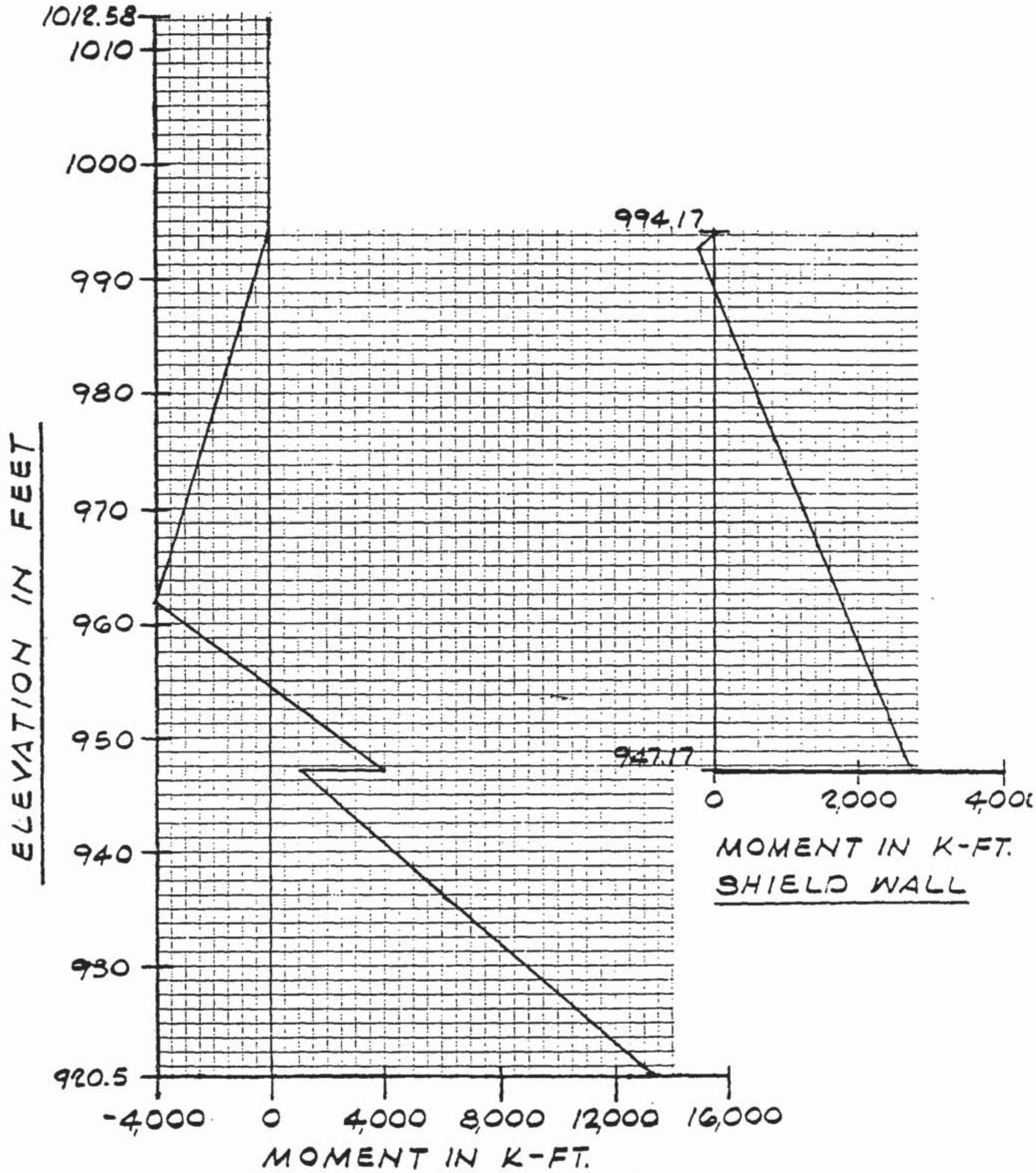


SHEET NO. 10

JOHN A. BLUME AND ASSOCIATES, ENGINEERS

MONTICELLO REACTOR PRESSURE VESSEL
SEISMIC ANALYSIS

MOMENT DIAGRAM
(JET LOAD 664^K @ ELEV. 961'-11" - CASE 2)



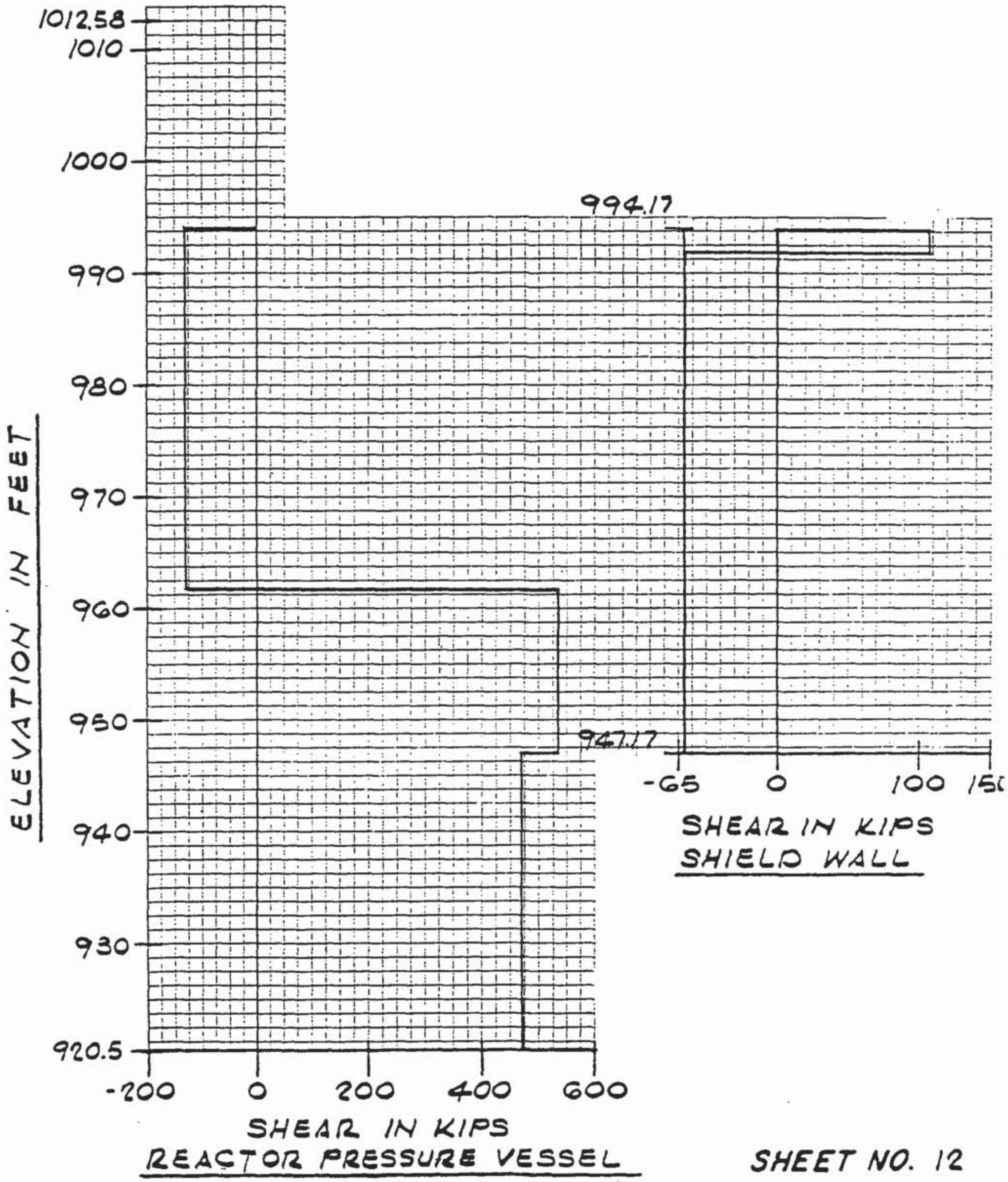
JOHN A. BLUME AND ASSOCIATES, ENGINEERS

MONTICELLO REACTOR PRESSURE VESSEL

SEISMIC ANALYSIS

SHEAR DIAGRAM

(JET LOAD 664^{K} @ ELEV. 961'-11" - CASE 2)



SHEET NO. 12

JOHN A. BLUME AND ASSOCIATES, ENGINEERS

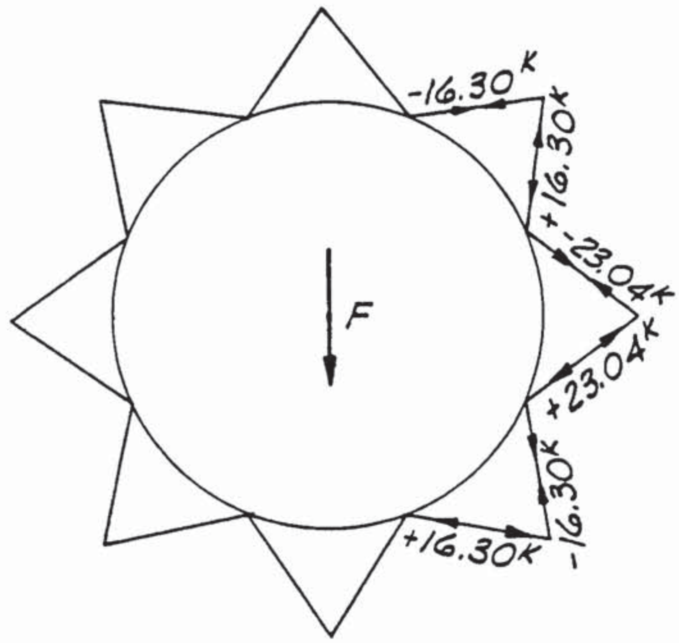
MONTICELLO REACTOR PRESSURE VESSEL

SEISMIC ANALYSIS

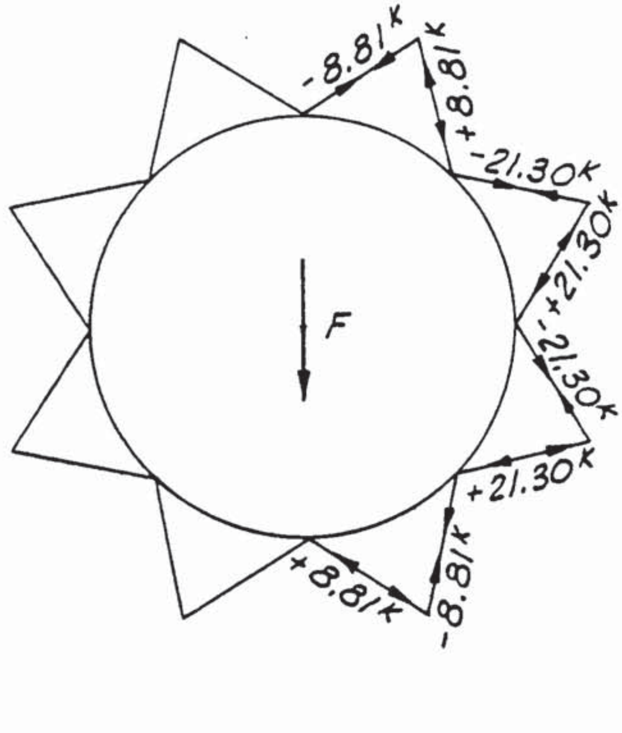
SHIELD SUPPORT ANALYSIS

TRUSS FORCES UNDER SEISMIC LOAD

SPRING FORCE $F = 106.1^K$



CASE I



CASE II

JOHN A. BLUME AND ASSOCIATES, ENGINEERS

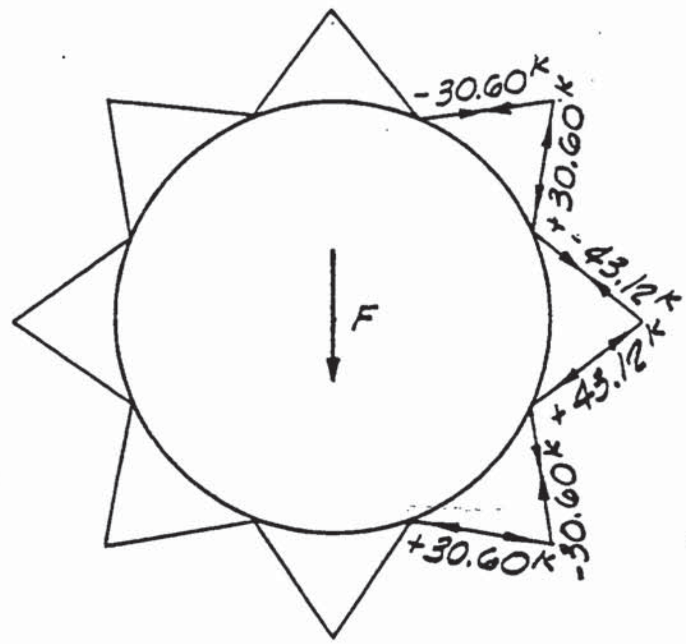
MONTICELLO REACTOR PRESSURE VESSEL

SEISMIC ANALYSIS

SHIELD SUPPORT ANALYSIS (CONT'D)

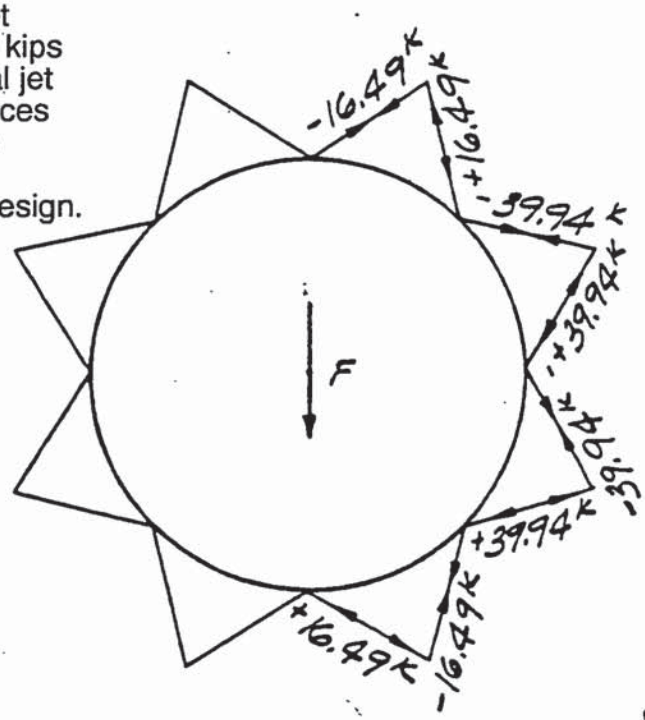
TRUSS FORCES UNDER JET LOAD (CASE I, 256.0^K @ EL. 999'-0")

SPRING FORCE $F = 198.7^K$



CASE I

The values shown on this sheet are based on a jet force of 256 kips at elevation 999'-0". The actual jet force is 330 kips. The truss forces identified on this sheet shall be increased by a factor of 1.29 (330 kips/256 kips) for use in design.



00-206

CASE II

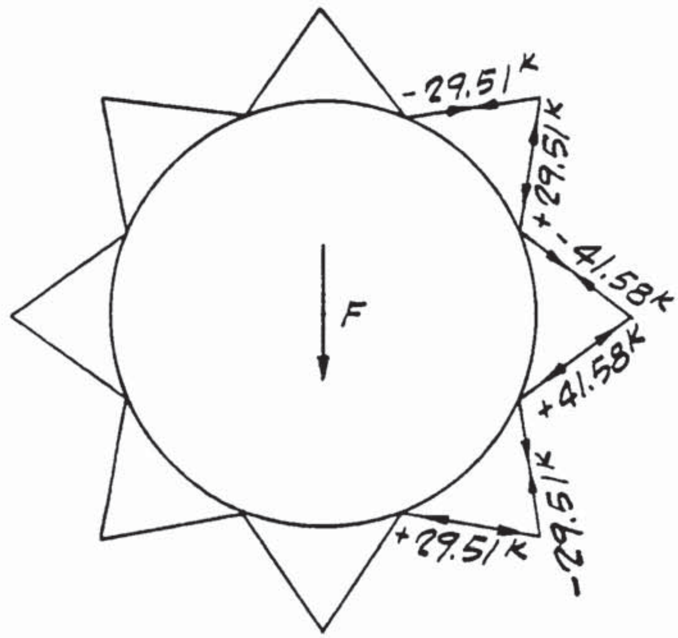
JOHN A. BLUME AND ASSOCIATES, ENGINEERS

MONTICELLO REACTOR PRESSURE VESSEL
SEISMIC ANALYSIS

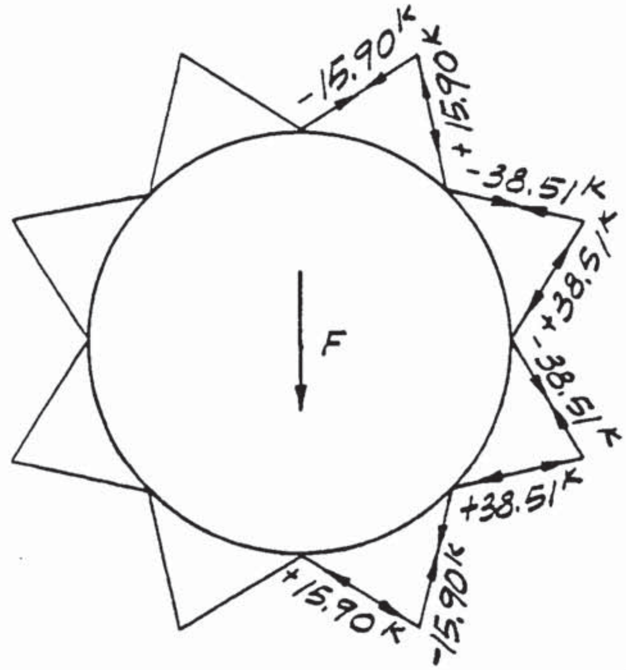
SHIELD SUPPORT ANALYSIS (CONT'D)

TRUSS FORCES UNDER JET LOAD (CASE 2 664^K @ EL. 961'-11")

SPRING FORCE $F = 191.6^K$



CASE I



CASE II

JOHN A. BLUME AND ASSOCIATES, ENGINEERS

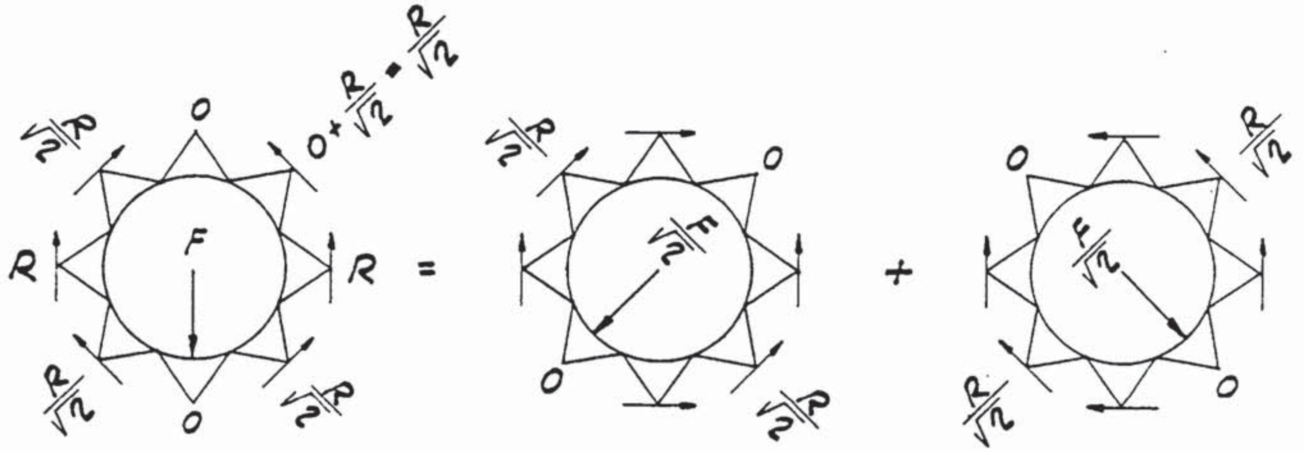
MONTICELLO REACTOR PRESSURE VESSEL

SEISMIC ANALYSIS

SPRING CONSTANT

CASE I (ARBITRARY FORCE F)

A. TANGENTIAL REACTIONS



NATURE OF SYMMETRY AND ANTISYMMETRY REDUCE THE STRUCTURE TO STATICALLY DETERMINATE.

$F = 4R$

$R = F/4$

APPENDIX B

CALCULATED DATA SHEETS

MONTICELLO NUCLEAR GENERATION PLANT
REACTOR PRESSURE VESSEL
SEISMIC ANALYSIS

LIST OF SHEETS

JOHN A. BLUME AND ASSOCIATES, ENGINEERS

MONTICELLO REACTOR PRESSURE VESSEL

SEISMIC ANALYSIS

LUMPED WEIGHTS

LOCATION & STATION NO.		ELEVATION	WEIGHT	LOCATION & STATION NO.		ELEVATION	WEIGHT
REACTOR BUILDING	1	1073'-2"	736 K	REACTOR PRESSURE VESSEL	15	1012'-7"	29.46 K
REACTOR BUILDING	2	1045'-8"	140	REACTOR PRESSURE VESSEL	16	1004'-0"	172.78
REACTOR BUILDING	3	1027'-8"	12,786	REACTOR PRESSURE VESSEL	17	999'-0"	124.89
REACTOR BUILDING	4	1001'-2"	13,149	REACTOR PRESSURE VESSEL	18	988'-3"	316.23
REACTOR BUILDING	5	985'-6"	17,386	REACTOR PRESSURE VESSEL	19	977'-0"	538.43
REACTOR BUILDING	6	962'-6"	19,232	REACTOR PRESSURE VESSEL	20	964'-11"	324.11
REACTOR BUILDING	7	935'-0"	22,840	REACTOR PRESSURE VESSEL	21	961'-11"	237.94
SHEILD WALL	8	992'-5½"	42.92	REACTOR PRESSURE VESSEL	22	955'-0½"	278.15
SHEILD WALL	9	990'-3½"	113.10	PEDESTAL WALL	23	944'-11"	142.9
SHEILD WALL	10	984'-11½"	187.43	PEDESTAL WALL	24	942'-2"	178.5
SHEILD WALL	11	975'-11½"	281.59	PEDESTAL WALL	25	936'-0"	182.9
SHEILD WALL	12	966'-11½"	270.40	PEDESTAL WALL	26	933'-6"	314.3
SHEILD WALL	13	959'-3"	202.35	PEDESTAL WALL	27	928'-6"	269.5
SHEILD WALL	14	951'-6"	454.66				

JOHN A. BLUME AND ASSOCIATES, ENGINEERS

MONTICELLO REACTOR PRESSURE VESSEL

SEISMIC ANALYSIS

LUMPED WEIGHTS

I. REACTOR BUILDING & DRYWELL

WEIGHT 1 @ EL. 1073'-2"	*736^K
WEIGHT 2 @ EL. 1045'-8"	*140^K
WEIGHT 3 @ EL. 1027'-8"	*12,786^K
WEIGHT 4 @ EL. 1001'-2"	13,749^K
LESS 1/5 R.P.V, WATER & FUEL	- 600
	13,149^K
WEIGHT 5 @ EL. 985'-6"	18,586^K
LESS 2/5 R.P.V, WATER & FUEL	1,200
	17,386^K
WEIGHT 6 @ EL. 962'-6"	20,432^K
LESS 2/5 R.P.V, WATER & FUEL	1,200
	19,232^K
WEIGHT 7 @ EL. 935'-0"	29,782^K
LESS CONTROL ROD DRIVE EQUIPMENT	121
LESS CENTRAL POLYGON 1/2 2347×38.75×.15	6821
	22,840^K

* = WEIGHT AS PER REFERENCE No. 2

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MONTICELLO REACTOR PRESSURE VESSEL

SEISMIC ANALYSIS

LUMPED WEIGHTS (CONT'D.)

II SHIELD WALL

WEIGHT 8 @ EL. 993'-7"	
CONCRETE	37.54^K
STEEL (12-27WF177)	3.48
STEEL (¼" PL)	1.90
	42.92^K
WEIGHT 9 @ EL. 990'-3½"	
CONCRETE	98.90^K
STEEL (12-27WF177)	9.18
STEEL (¼" PL)	5.02
	113.10^K
WEIGHT 10 @ EL. 984'-11½"	
CONCRETE	163.91^K
STEEL (12-27WF177)	15.21
STEEL (¼" PL)	8.31
	187.43^K
WEIGHT 11 @ EL. 975'-11½"	
CONCRETE	206.04^K
STEEL (12-27WF177)	19.12
STEEL (¼" PL)	10.45
STEEL (1½" PL)	45.98
	281.59^K
WEIGHT 12 @ EL. 966'-11½"	
CONCRETE	191.38^K
STEEL (12-27WF177)	17.76
STEEL (¼" PL)	9.71
STEEL (1½" PL)	51.55
	270.40^K
WEIGHT 13 @ EL. 959'-3"	
CONCRETE	176.96^K
STEEL (12-27WF177)	16.42
STEEL (¼" PL)	8.97
	202.35^K
WEIGHT 14 @ EL. 951'-6"	
CONCRETE	187.72^K
STEEL (12-27WF177)	17.42
STEEL (¼" PL)	9.52
BEAM REACTION	240.00
	454.66^K

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MONTICELLO REACTOR PRESSURE VESSEL

SEISMIC ANALYSIS

LUMPED WEIGHTS

III REACTOR PRESSURE VESSEL

WEIGHT 15 @ EL. 1012'-7"

TOP HEAD PLATES	= 28.36^K
NOZZLE N-6	= 0.87
NOZZLE N-7	= 0.23
	29.46^K

WEIGHT 16 @ EL. 1004'-0"

TOP HEAD PLATES	= 12.94^K
TOP HEAD FLANGE	= 57.31
SHELL PLATES	= 4.06
SHELL FLANGE	= 47.59
STUDS	= 17.80
NUTS	= 12.16
WASHERS	= 1.09
GUIDE RODS	= 0.10
½ STEAM DRYER PANELS	= 7.81
½ HOUSING	= 11.92
	172.78^K

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MONTICELLO REACTOR PRESSURE VESSEL

SEISMIC ANALYSIS

LUMPED WEIGHTS (CONT'D.)

REACTOR PRESSURE VESSEL

WEIGHT 17 @ EL. 999'-0"

SHELL PLATES	= 90.28^K
NOZZLES N-3	= 10.69
NOZZLES N-11	= 0.46
½ STEAM DRYER PANELS	= 7.81
SUPPORT RING	= 3.23
GUIDE RODS	= 0.50
½ HOUSING	= 11.92
	124.89^K

WEIGHT 18 @ EL. 988'-3"

SHELL PLATES	= 126.11^K
NOZZLES N-4	= 6.82
NOZZLES N-5	= 3.71
NOZZLES N-9	= 0.52
NOZZLES N-12	= 0.46
WATER SEAL SKIRT	= 4.72
GUIDE RODS	= 0.50
HOLD DOWN BOLTS	= 15.12
LIFT RODS	= 1.40
STEAM SEPARATORS	= 38.05
BOLT RINGS	= 4.01
STAND PIPES	= 14.10
½ SHROUD HD. DOME	= 4.22
½ SHROUD HD. FLANGE	= 2.42
FLUID WEIGHT	= 87.21
FLUID AROUND PERIPHERY	= 6.86
	316.23^K

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MONTICELLO REACTOR PRESSURE VESSEL

SEISMIC ANALYSIS

LUMPED WEIGHTS (CONT'D.)

REACTOR PRESSURE VESSEL

WEIGHT 19 @ EL. 977'-0"

SHELL PLATES	= 133.75 K
½ SHROUD HD. DOME	= 4.22
½ SHROUD HD. FLANGE	= 2.42
SHROUD	= 32.81
UPPER CORE GRID	= 10.19
CORE SPRAY SPARGERS & NOZZLES	= 1.34
½ FUEL SUPPORT CASTINGS	= 1.82
½ FUEL ASSEMBLIES	= 224.38
CONTROL RODS FULL IN	= 21.23
TEMPORARY CONTROL CURTAINS	= 4.37
IN-CORE ASSEMBLIES	= 3.37
SLEEVES	= 5.67
FLUID WEIGHT	= 54.76
FLUID AROUND PERIPHERY	= 38.10
	538.43 K

WEIGHT 20 @ EL. 964'-11"

SHELL PLATES	= 86.46 K
NOZZLES N-2	= 25.41
SHROUD	= 21.39
FUEL SUPPORT CASTING	= 1.82
FUEL ASSEMBLIES	= 108.13
CONTROL RODS (FULL IN)	= 10.23
TEMPORARY CONTROL CURTAINS	= 2.11
IN-CORE ASSEMBLIES	= 1.63
SLEEVES	= 2.73
FLUID WEIGHT	= 39.57
FLUID AROUND PERIPHERY	= 24.63
	324.11 K

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MONTICELLO REACTOR PRESSURE VESSEL

SEISMIC ANALYSIS

LUMPED WEIGHTS (CONT'D.)

REACTOR PRESSURE VESSEL

WEIGHT 21 @ EL. 961'-11"

SHELL PLATES	= 62.09 K
NOZZLE N-1	= 18.43
NOZZLE N-8	= 0.91
SHROUD	= 14.18
CORE PLATE ASSEMBLIES	= 15.29
JET PUMP ASSEMBLIES	= 20.00
½ GUIDE TUBES	= 16.94
½ CONTROL ROD DRIVES & THERMAL SLEEVES	= 33.76
FLUID WEIGHT	= 40.01
FLUID AROUND PERIPHERY	= 16.33
	237.94 K

WEIGHT 22 @ EL. 955'-0½"

BOTTOM HEAD	= 104.75 K
SKIRT KNUCKLE	= 15.10
SHROUD	= 12.84
½ CONTROL ROD DRIVES & THERMAL SLEEVES	= 33.76
½ GUIDE TUBES	= 16.94
NOZZLE N-10	= 0.23
INTERNAL SHROUD SUPPORT	= 8.95
SKIRT EXTENSION WEIGHT	= 24.60
FLUID WEIGHT	= 59.35
FLUID AROUND PERIPHERY	= 1.63
	278.15 K

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MONTICELLO REACTOR PRESSURE VESSEL

SEISMIC ANALYSIS

LUMPED WEIGHTS (CONT'D.)

IV PEDESTAL WALL

WEIGHT 23 @ EL. 944'-11"

CONCRETE $0.785(25.167^2-17.167^2)(2.25+\frac{2.75}{2})\times 0.15$
$-\frac{2.75}{2}\times 2(3.75+3.25)4\times 0.15$ $= 132.9^K$

STEEL $0.785(17.375^2-17.167^2)(2.25+\frac{2.75}{2})\times 0.49 = 10.0$

142.9^K

WEIGHT 24 @ EL. 942'-2"

CONCRETE $0.785(25.167^2-17.167^2)(\frac{2.75}{2}+\frac{6.167}{2})\times 0.15$
$-\frac{2.75}{2}\times 2(3.75+3.25)4\times 0.15$ $= 166.2^K$

STEEL $0.785(17.375^2-17.167^2)(\frac{2.75}{2}+\frac{6.167}{2})\times 0.49 = 12.3$

178.5^K

WEIGHT 25 @ EL. 936'-0"

CONCRETE $0.785(25.167^2-17.167^2)(\frac{6.167}{2}+\frac{2.5}{2})\times 0.15$
$-\frac{2.5}{2}\times 2.5\times 4.0\times 0.15$ $= 170.9^K$

STEEL $0.785(17.375^2-17.167^2)(\frac{6.167}{2}+\frac{2.5}{2})\times 0.49 = 12.0$

182.9^K

WEIGHT 26 @ EL. 933'-6"

CONCRETE $0.785(25.167^2-17.167^2)(\frac{2.5}{2}+\frac{5.0}{2})\times 0.15$
$-2.5\times(\frac{2.5}{2}+\frac{5.0}{2})4.0\times 0.15$ $= 143.9^K$

DEAD LOAD ON BEAMS $= 160.0$

STEEL $0.785(17.375^2-17.167^2)(\frac{2.5}{2}+\frac{5.0}{2})\times 0.49 = 10.4$

314.3^K

WEIGHT 27 @ EL. 928'-6"

CONCRETE $0.785(25.167^2-17.167^2)(\frac{5.0}{2}+\frac{8}{2})\times 0.15$
$-2.5\times 1.5\times 4.0\times 0.15$
$-3.0\times 3.0\times 4.0\times 0.15$ $= 251.5^K$

STEEL $0.785(17.375^2-17.167^2)(\frac{5.0}{2}+\frac{8}{2})\times 0.49 = 18.0$

269.5^K

JOHN A. BLUME AND ASSOCIATES, ENGINEERS

MONTICELLO REACTOR PRESSURE VESSEL SEISMIC ANALYSIS

MEMBER PROPERTIES

	STATION NO.	A (Ft^2)	I (Ft^4)		STATION NO.	A (Ft^2)	I (Ft^4)
REACTOR BUILDING	1			REACTOR PRESSURE VESSEL	15		
	2	BRACED AREA				10.62	299.2
	3				16		
		2,256	1,805,790			24.66	946.8
	4				17		
		3,365	5,140,204			24.66	946.8
	5				18		
		2,835	4,460,485			24.66	946.8
	6				19		
		2,784	5,006,316			24.66	946.8
	7				20		
		5,941	9,693,452			24.66	946.8
SHIELD WALL	8				21		
		6.70	434.40			23.52	821.3
	9				22		
		4.89	304.46			5.64	210.0
	10			PEDESTAL WALL			
		6.70	434.40			317.26	17321.
	11				23		
		6.70	434.40			261.26	10991.
	12				24		
		5.62	358.85			317.26	17321.
	13				25		
		6.31	380.87			307.26	16196.
	14				26		
		6.70	434.40			307.26	16196.
					27		
						307.26	16196.

$K_1 =$ 325,723 K/Ft.

$K_2 =$ 48,000 K/Ft.

$K_3 = I_b K_s =$ 3,299,934,382 K/Ft. RAD

$K_4 =$ 1,581,549 K/Ft.

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MONTICELLO REACTOR PRESSURE VESSEL SEISMIC ANALYSIS

CROSS SECTIONAL AREA & MOMENT OF INERTIA

I REACTOR BUILDING*

STATION NO.	A_c (Ft.^{2})	I_c (Ft.^{4})
1	BRACED AREA	
2		
3		
	2,256	1,805,790
4		
	3,365	5,140,204
5		
	2,835	4,460,485
6		
	2,784	5,006,316
7		
	5,941	9,693,452

$K_3 = I_6 K_5 = 3{,}299{,}934{,}382$ K-Ft/RAD

$K_4 = 1{,}581{,}549$ K/Ft.

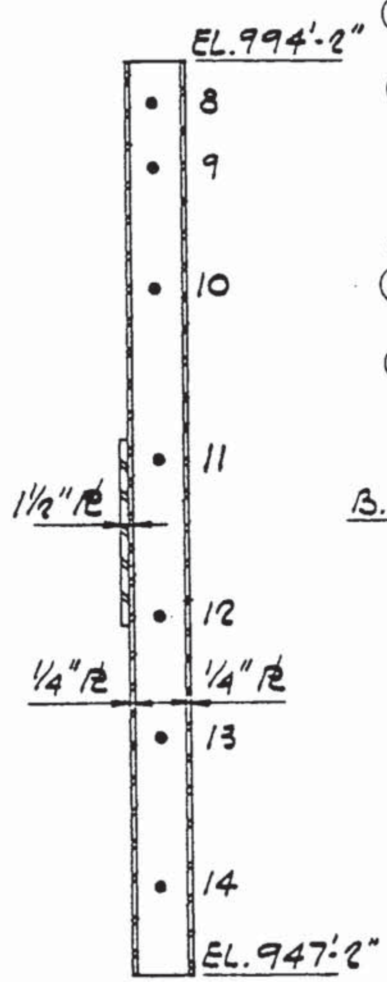
* AS PER REFERENCE NO. 2

JOHN A. BLUME AND ASSOCIATES, ENGINEERS

MONTICELLO REACTOR PRESSURE VESSEL SEISMIC ANALYSIS

CROSS SECTIONAL AREA & MOMENT OF INERTIA (CONT.)

II SHIELD WALL (ASSUME CONCRETE HAS NO STRENGTH)



A. SECTIONS (NO OPENINGS)

AREA

① 27WF177 $\quad 12 \times \frac{52.1}{144} = 4.33\ ft.^2$

② ¼" ℞ $\quad \frac{288}{360} \times 3.14(24.8+20.5) \times \frac{1}{4} \times \frac{1}{12} = \underline{2.37}$

$\underline{6.70\ ft.^2}$

MOMENT OF INERTIA

① 27WF177 $\quad \frac{52.1}{144} \times 4 \times (11.32)^2 \{Sin^2 15° + Sin^2 45° + Sin^2 75°\} = 278.18\ ft.^4$

② ¼" ℞ $\quad \frac{288}{360} \times 3.14 \times \frac{1}{48}(12.4^3 + 10.25^3) = \underline{156.22}$

$\underline{434.40\ ft.^4}$

B. SECTION (7 OPENINGS)

AREA

① 27WF177 $\quad 8 \times \frac{52.1}{144} = 2.89\ ft.^2$

② ¼" ℞ $\quad \left[\frac{312}{360} \times 3.14(24.8+20.5) - (14 \times 4.1) + (14 \times 2.15)\right]\frac{1}{48} = \underline{2.00}$

$\underline{4.89\ ft.^2}$

MOMENT OF INERTIA

① 27WF177 $\quad \frac{52.1}{144} \times 4 \times (11.32)^2 \{Sin^2 15° + Sin^2 75°\} = 185.45\ ft.^4$

② ¼" ℞ $\quad \frac{312}{360} \times 3.14 \times \frac{1}{48}(12.4^3 + 10.25^3)$

$-2 \times 4.1 \times \frac{1}{48}\left[4 Sin^2 45° + 2 Sin^2 90° + Sin^2 65°\right](11.32)^2$

$+2 \times 2.15 \times \frac{1}{48}\left[4 Sin^2 45° + 2 Sin^2 90° + Sin^2 65°\right](11.32)^2 = \underline{119.01}$

$\underline{304.46\ ft.^4}$

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MONTICELLO REACTOR PRESSURE VESSEL SEISMIC ANALYSIS

CROSS SECTIONAL AREA & MOMENT OF INERTIA (CONT.)

C. SECTION (10 x 4'-1" x 4'-1" + 2 x 5'-4" x 5'-4" OPENINGS)

AREA

① 27WF177 $12 \times \frac{52.1}{144} = 4.33\ ft^2$

② 1/4" PL $\left[\frac{288}{360} \times 3.14(24.8 + 20.5) - (20 \times 4.1) - (4 \times 5.33) + (24 \times 2.15)\right] \frac{1}{4} \times \frac{1}{12} = 1.29\ ft^2$

$5.62\ ft^2$

MOMENT OF INERTIA

① 27WF177 $\frac{52.1}{144} \times 4 \times (11.32)^2 \{\sin^2 15° + \sin^2 45° + \sin^2 75°\} = 278.18\ ft^4$

② 1/4" PL $\left[\frac{288}{360} \times 3.14 \times (12.4^3 + 10.25^3) - 2 \times 4.1 \times (11.32)^2 (4 \sin^2 30° + 4 \sin^2 60°) - 2 \times 5.33 \times (11.32)^2 (2 \sin^2 90°) + 2 \times 2.15 \times (11.32)^2 (4 \sin^2 30° + 4 \sin^2 60° + 2 \sin^2 90°)\right] \frac{1}{48} = 80.67$

$358.85\ ft^4$

D. SECTION (1 x 4'-1" x 4'-1" OPENING)

AREA

① 27WF177 $11 \times \frac{52.1}{144} = 3.97\ ft^2$

② 1/4" PL $\left[\frac{294}{360} \times 3.14(24.8 + 20.5) - (2 \times 4.1) + (2 \times 2.15)\right] \frac{1}{48} = 2.34$

$6.31\ ft^2$

MOMENT OF INERTIA

① 27WF177 $\frac{52.1}{144} \times (11.32)^2 [4 \sin^2 30° + 4 \sin^2 60° + \sin^2 90°] = 231.81\ ft^4$

② 1/4" PL $\left[\frac{294}{360} \times 3.14(12.4^3 + 10.25^3) - (2 \times 4.1)(11.32^2) + (2 \times 2.15)(11.32^2)\right] \frac{1}{48} = 149.06$

$380.87\ ft^4$

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MONTICELLO REACTOR PRESSURE VESSEL SEISMIC ANALYSIS

CROSS SECTIONAL AREAS & MOMENT OF INERTIA (CONT.)

III REACTOR PRESSURE VESSEL

A. TOP HEAD SECTION

$$A = 0.785\,(15.25^2 - 14.80^2) = \underline{10.62\ ft.^2}$$
$$I = 0.049\,(15.25^4 - 14.80^4) = \underline{299.2\ ft.^4}$$

B. CYLINDRICAL SECTION

$$A = 0.785\,(17.979^2 - 17.083^2) = \underline{24.66\ ft.^2}$$
$$I = 0.049\,(17.979^4 - 17.083^4) = \underline{946.8\ ft.^4}$$

C. SKIRT SECTION

$$A = 0.785\,(17.375^2 - 17.167^2) = \underline{5.64\ ft.^2}$$
$$I = 0.049\,(17.375^4 - 17.167^4) = \underline{210.0\ ft.^4}$$

D. BOTTOM HEAD

$$A = 0.785\,(17.167^2 - 16.271^2) = \underline{23.52\ ft.^2}$$
$$I = 0.049\,(17.167^4 - 16.271^4) = \underline{821.3\ ft.^4}$$