Design Analysis

Ginna Station

Containment Mat Design Water Level Elev. 265'-0"

ROCHESTER GAS AND ELECTRIC CORPORATION

89 EAST AVENUE

ROCHESTER, NEW YORK 14649

EWR #5327

Revision 0

August 27, 1990

Changed or New Equipment/System Information Requires Copy to Ginna. (Check Applicable Box)	Safety Class (1)	Review by NS&L (Y/N)
☐ Setpoints (Instrument, Relief Valve, Time Delay, Other)	_____	_____(2)
☐ Operating Parameters (Flow, Pressure, Temperature, Volume, Other)	_____	_____(2)
☐ Operational Restrictions		_____(3)

NS&L review by: N/A DWJ. (Nuclear Engineer) 8/27/90 (Date)

(1) If box is checked, mark "SR" is Safety Related. "SS" if Safety Significant, or "NSR" if Non-Safety Related.
(2) If Safety Class is "SR" or "SS", review by NS&L is required.
(3) If box is checked, review by NS&L is required.

Prepared By: Daniel W Hoffman (Structural Engineer) 8/27/90 (Date)

Reviewed By: L. A. Sucheski (Structural Engineer) 10/1/90 (Date)

Approved By: A. Gary Goetz (Manager, Structural Engineering) 10/4/90 (Date)

REVISION STATUS SHEET

Page	Latest Rev.
i	0
ii	0
Calculations:	
1	0
2	0
3	0
4	0
5	0
6	0
7	0
8	0
9	0
10	0
11	0
12	0
13	0
14	0
15	0
16	0
17	0
18	0
19	0
20	0
21	0
22	0

Design Analysis

1.0 Objective

To verify the adequacy of the containment mat for hydrostatic loading due to a water level of elev. 265'-0".

2.0 Design Inputs

2.1 Drawing #D-421-001, Revision 6, 02/10/69, Reactor Containment Vessel Mat Foundation Elev. 233'-8" and Ring Girder.

2.2 Drawing #D-421-002, Revision 2, 11/22/66, Reactor Containment Vessel Mat Foundation Elev. 233'-8", Reinforcement and Details.

3.0 Referenced Documents

3.1 R. E. Ginna Station Updated Final Safety Analysis Report, Revision 5, 12/89.

3.2 EWR #3645 - Groundwater Level.

4.0 Assumptions

See body of calculations.

5.0 Computer Codes

STARDYNE Finite Element Analysis Program.

6.0 Analysis

See body of calculations.

7.0 Results

The containment mat is structurally adequate for a groundwater level of Elev. 265'-0". For more details, see the calculation.

DWZ/099

OBJECTIVE

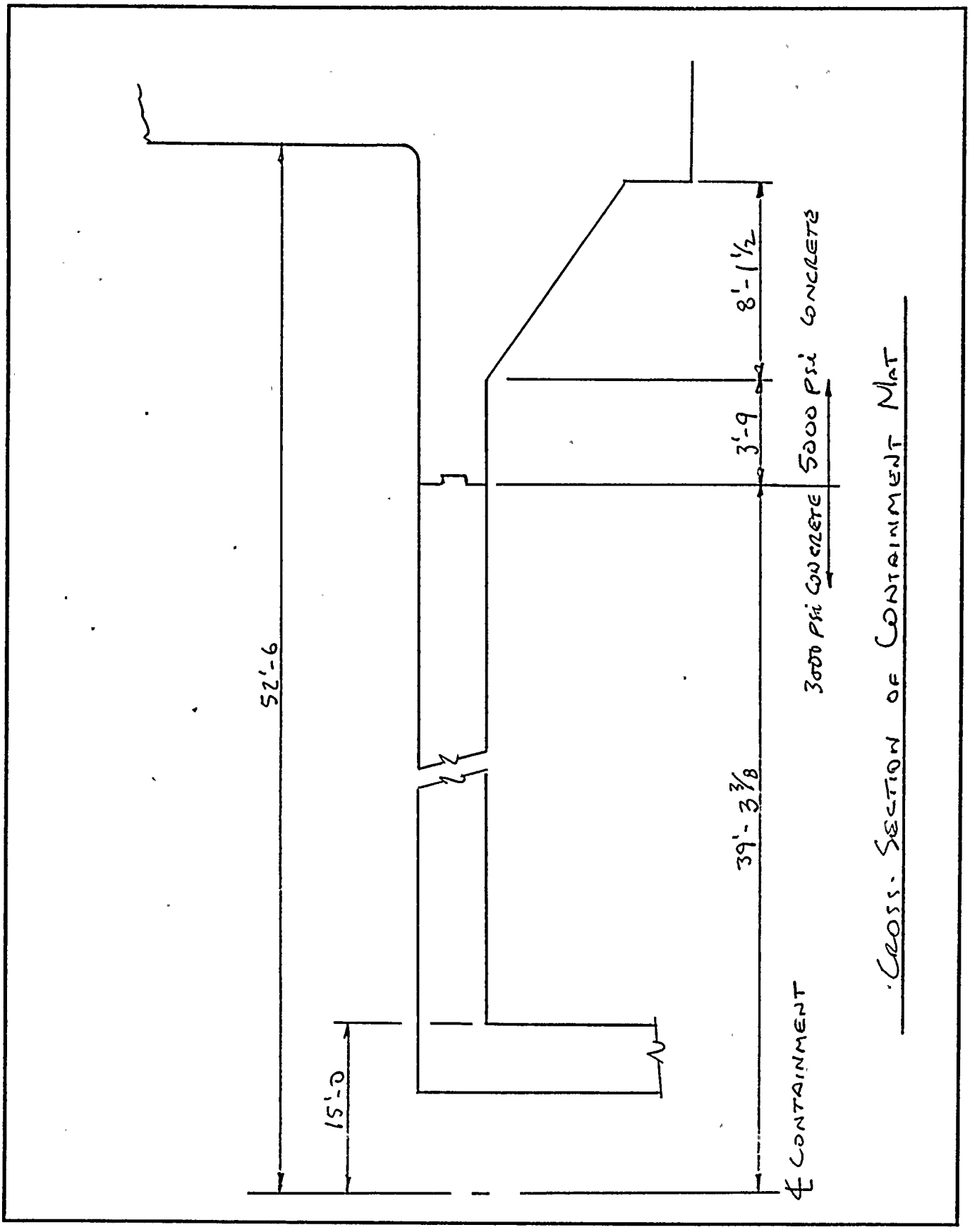
To verify the adequacy of the containment mat for increased hydrostatic loading. The UFSAR & original plant design considered the water level at 252'-0, the actual water level is at 265'-0.

METHOD

A 4 foot wide strip from the reactor cavity to mid-way through the thickened section near the ring girder was modeled. Conservatively, only the 2 foot section below the liner was considered for strength. The 2 feet of lightly reinforced concrete above the liner was considered for dead weight. The results of this analysis are extremely conservative when you look at the arrangement of the lower level of the containment. A four foot wide strip from the reactor cavity out does not exist that doesn't have a wall or column base on it, increasing the vertical stiffness and reducing the effect of uplift.

METHOD, cont.

In order to get an accurate representation of stresses, 3 models, with increasingly finer mesh at the reactor cavity end were employed. The initial model (sketch pg) had a max deflection of .159" and max stress of 860 psi. at the center of the reactor cavity end. The second model had a max deflection of .157" and max stress of 1303 psi. The final model (pg) has a max deflection of .1595" and a max stress of 1320 psi. Since the stresses are converging at this point a finer mesh was not necessary.



DESIGN ANALYSIS

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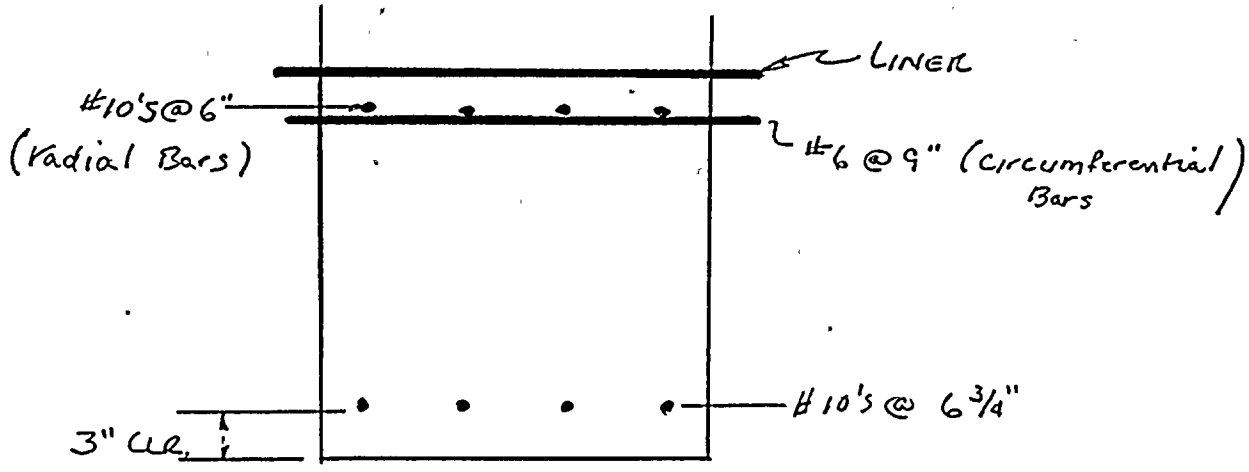
DATE 8/27/90

- CALCULATE ALLOWABLE STRESSES

AT THE INSIDE END - NEAR THE REACTOR CAVITY

- Conservatively considering only the 2' of concrete under the liner.



2 ft wide section looking towards ℄ Cont.

For tension on the bottom - X1 Direction

$$\phi M_n = \phi \left[A_s f_y d \left(1 - .59\rho \frac{f_y}{f'_c}\right)\right]$$

$$- \phi \left[A_s f_y d \left(1 - \frac{.59\, A_s f_y}{bd\, f'_c}\right)\right]$$

A_s = #10 @ 6 3/4 = $\frac{12"}{2(6.75)}(1.27\ in^2)-(2) = 2.26\ in^2/1ft\ section$

$b = 12"$ $\quad d = 24-(3+.375) = 20.625$

$$\phi M_n = \phi \left[2.26\,(40{,}000)(20.625)\left(1 - \frac{.59(2.26)(40)}{12(20.625)(3)}\right)\right]$$

$\phi M_n = \phi\,(1731\ K\text{-}in)$

for $\phi = .85$; $\phi M_n = 1471$ K-in

then $S = \frac{1}{6}(12)(24^2) = 1152 \text{ in}^3$

Stress allowable = $\frac{1471000}{1152} \approx 1277$ psi

NOTE: This is the allowable stress at the point of maximum moment (at the fixed ends) and the smallest section (at the reactor cavity).

This stress should be compared with the SX on the negative Z face (bottom) of the elements. (Tension face)

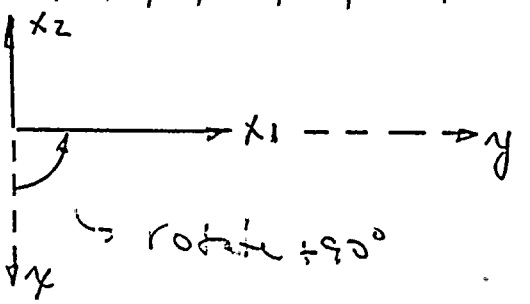
All elements are coded so that the X-direction is radial (from ℄ containment out) or parallel to global X1

Rotations for Triangular elements:

Elements 1, 2, 3, 4, 13, 14, 15 & 16 No rotation required

(local x parallel to global X1)

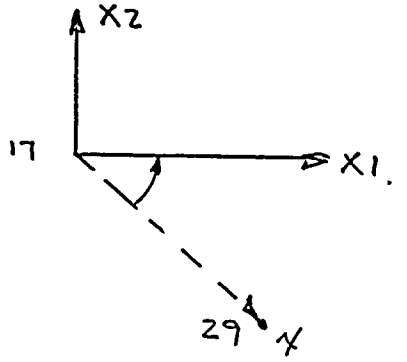
Elements 5, 6, 7, 8, 17, 18, 19 & 20



Elements 9, 10, 11 & 12

pt 17 192., -18., 0.

pt 29 204., -24., 0.



$$\text{rotation} = \tan^{-1}\frac{\Delta X2}{\Delta X1}$$

$$= \tan^{-1}\frac{24-18}{204-192}$$

$$= +26.565^\circ$$

Elements 21, 22, 27 & 24

pt 28 204, -36., 0.

pt 36 228, -48., 0.

$$\text{rotation} = \tan^{-1}\frac{48-36}{228-204}$$

$$= +26.565^\circ$$

LOADING

Pressure load applied (psi.) - water line @ -265'

$$p = 62.4\,(265 - 231.67)\,\frac{1}{144} = 14.44 \text{ psi}$$

for water level @ 270'

$$p = 62.4\,(270 - 231.67)\,\frac{1}{144} = 16.61 \text{ psi}$$

dead weight - 2 ft of concrete - 1 ft thick model

$$\text{density}\ (\#/in^3) = 2(150\ \#/ft^3)\,\frac{1}{12^3} = .1736\ \#/in^3$$

RESULTS

Results will only be presented for tensile stresses at the reactor cavity in the X1 direction (Sx Local). These are the highest stresses in that direction and the radial reinforcement is consistently #10's at 6" or 6 3/4" top & bottom except in the central portion on the bottom where there are only compressive stresses.

X2 direction (Sy Local) stresses are small as can be seen from the stress contour plots.

For Water level @ 265'-0

Max Stress Sx = 1320 psi Elements 6 & 7 (Quadrilats)

Allowable Stress = 1277 ; 3% overstress OK due to conservatism in model also the stresses drop off quickly ; 1002 psi in triplates 3 & 6 (1 foot from the model end).

For Water level @ 270'-0

Max Stress S_x = 1599 psi elements 6 & 7 (Quad plates)

This is a 25% overstress but this is a very conservative loading (water level is 265') and the stresses drop off quickly

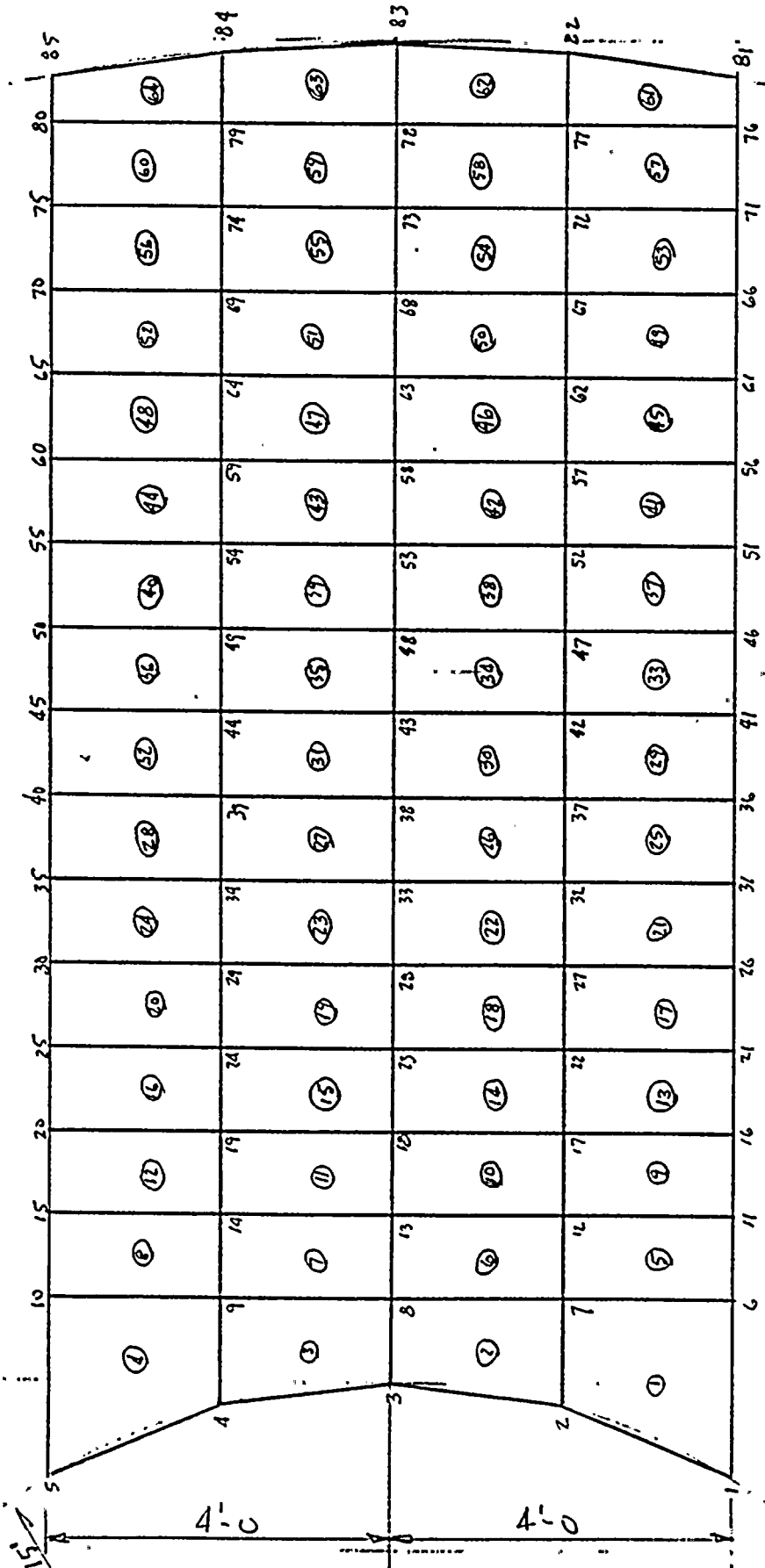
- just past 1 ft from edge S_x = 1214 psi
- just past 2 ft from edge S_x = 764 psi

Conclusion

The higher water level does not affect the structural integrity of the containment mat.

MATL, IN

INITIAL MODEL



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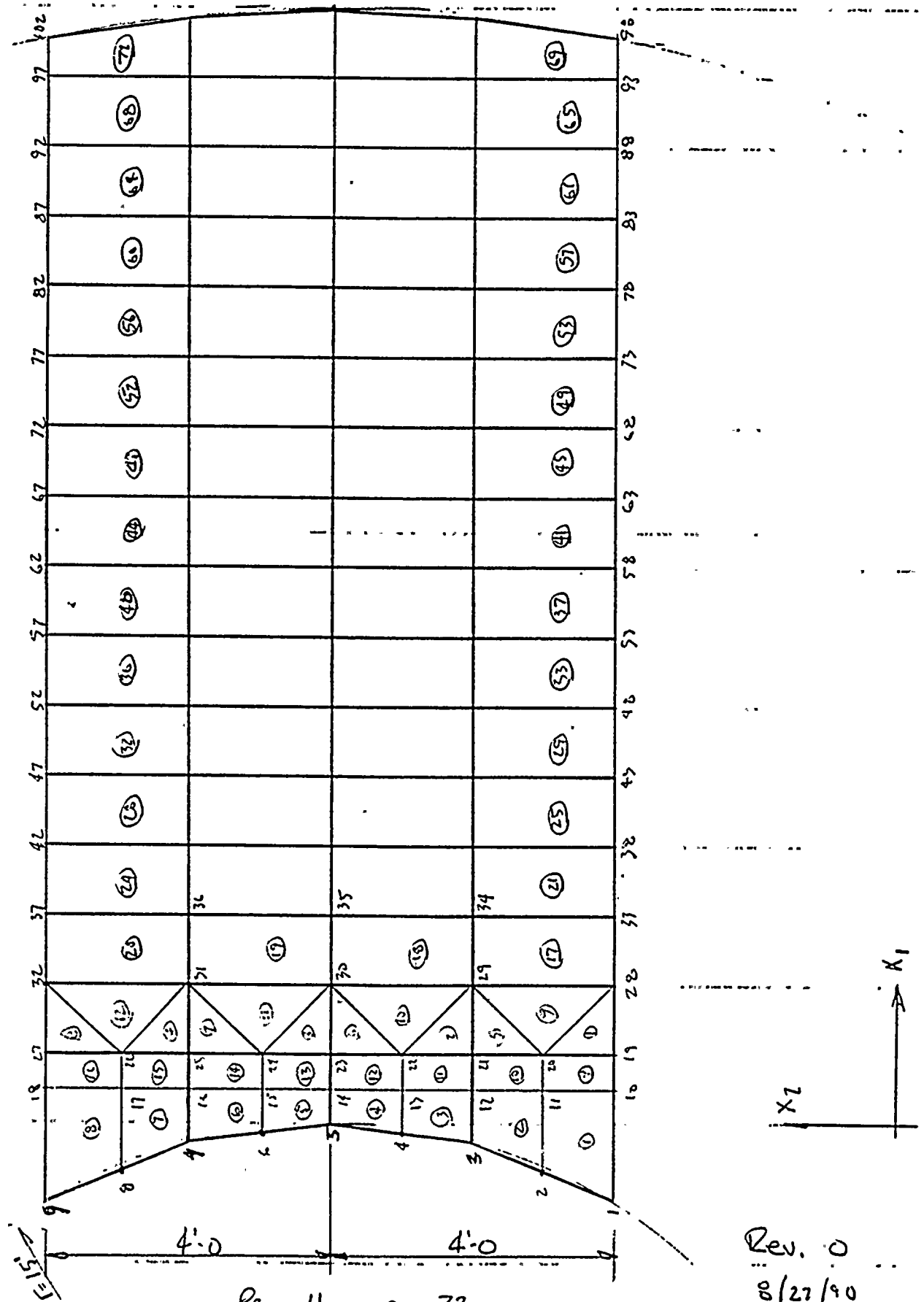
MAT2.IN

SECOND MODEL



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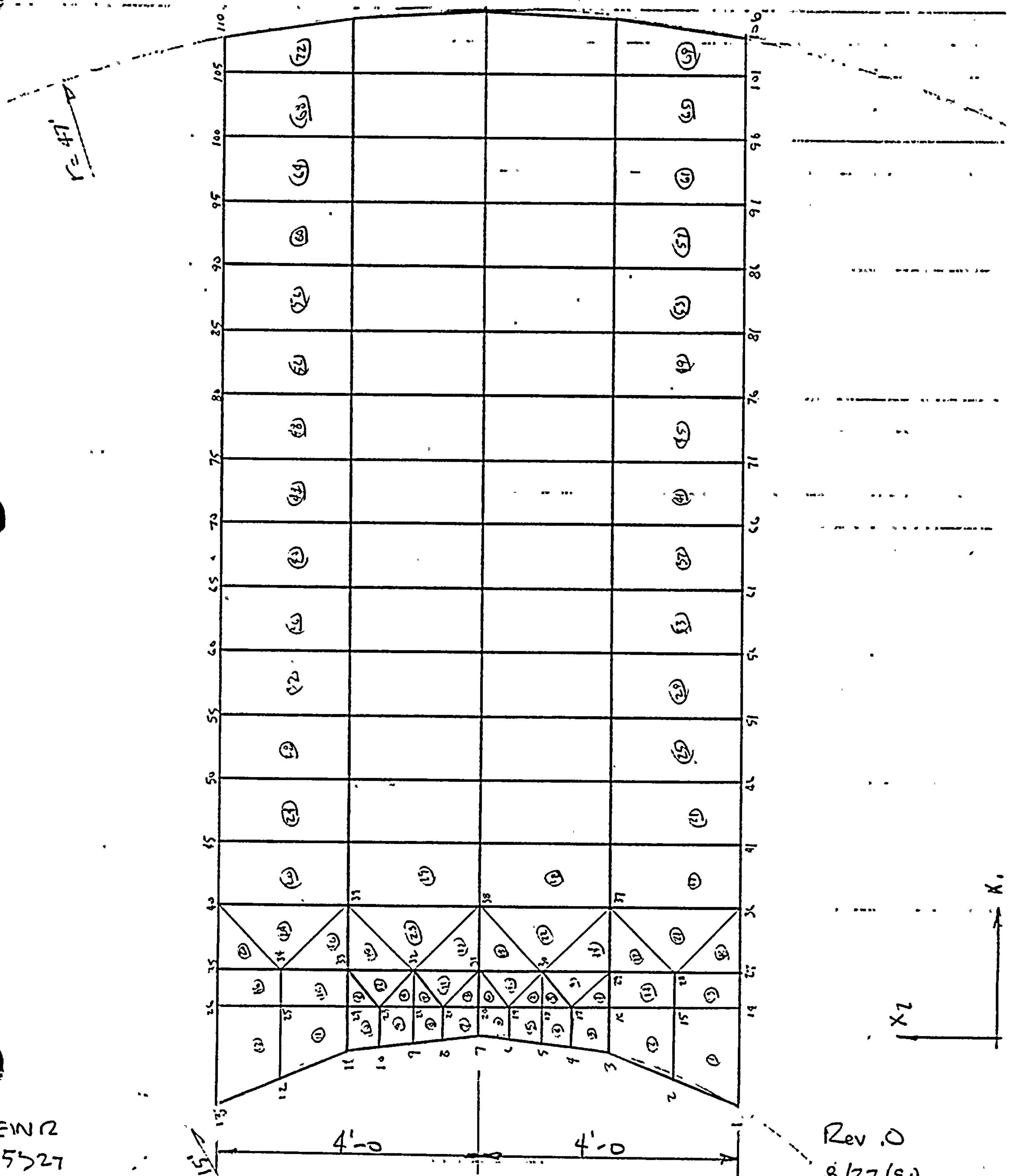
FINAL MODEL



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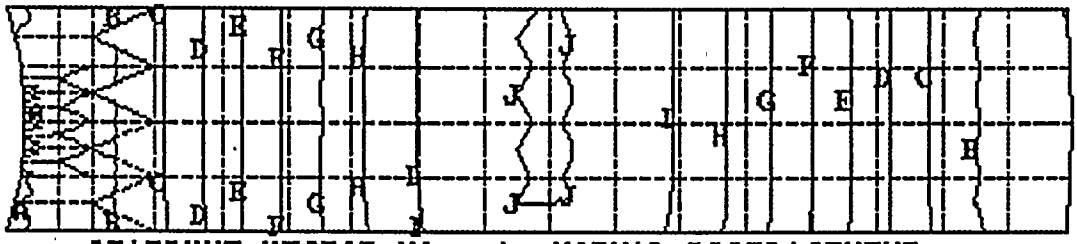
CONTAINMENT MAT - HYDROSTATIC LOADS

CONTOUR LEVELS
MIN0.1317E-02
A 0.1317E-02
B 0.1865E-01
C 0.3598E-01
D 0.5330E-01
E 0.7063E-01
F 0.8796E-01
G 0.1053
H 0.1226
I 0.1400
J 0.1573
MAX0.1573

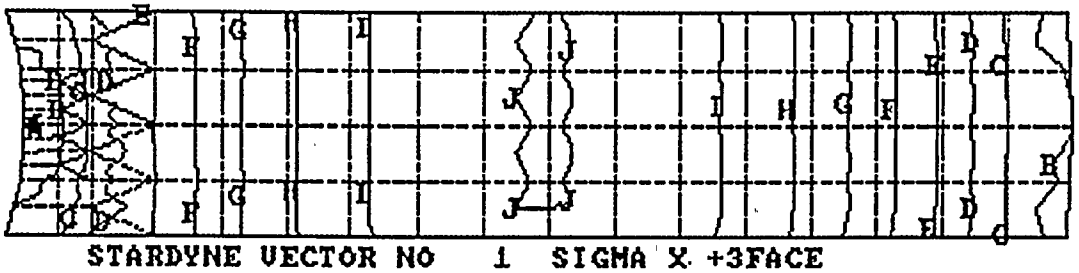


STARDYNE VECTOR NO 1 NORMAL DISPLACEMENT

WATER LEVEL EL. 265'

CONTAINMENT MAT - HYDROSTATIC LOADS

CONTOUR LEVELS
MIN-1320.
A -1320.
B -1101.
C -881.8
D -662.7
E -443.6
F -224.5
G -5.464
H 213.6
I 432.7
J 651.8
MAX 651.8

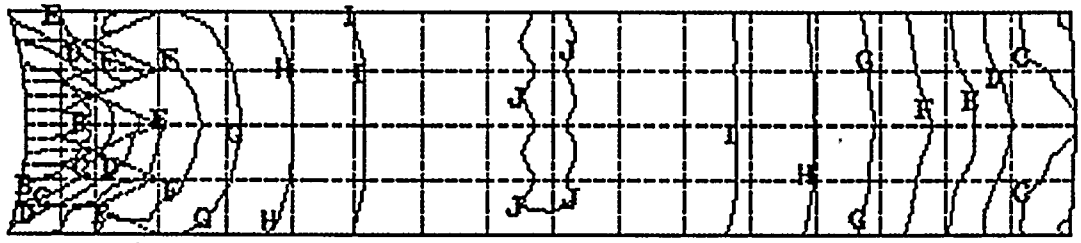


STARDYNE VECTOR NO 1 SIGMA X +3FACE

WATER LEVEL EL. 265'

CONTAINMENT MAT - HYDROSTATIC LOADS

CONTOUR LEVELS
MIN-230.4
A -230.4
B -193.9
C -157.5
D -121.0
E -84.53
F -48.07
G -11.61
H 24.85
I 61.32
J 97.78
MAX 97.78

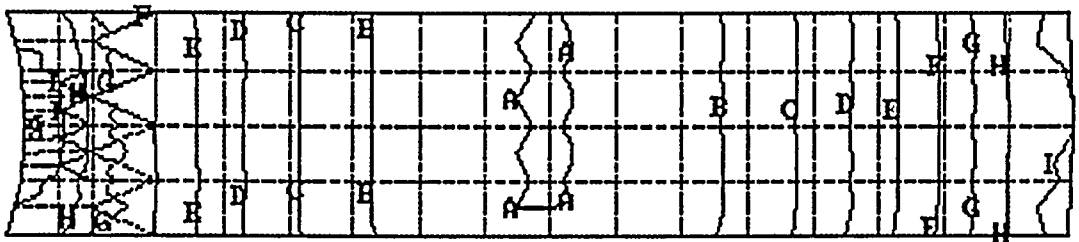


STARDYNE VECTOR NO 1 SIGMA Y. +3FACE

WATER LEVEL EL. 265'

CONTAINMENT MAT - HYDROSTATIC LOADS

CONTOUR LEVELS
MIN-651.8
A -651.8
B -432.7
C -213.6
D 5.464
E 224.5
F 443.6
G 662.7
H 881.8
I 1101.
J 1320.
MAX 1320.

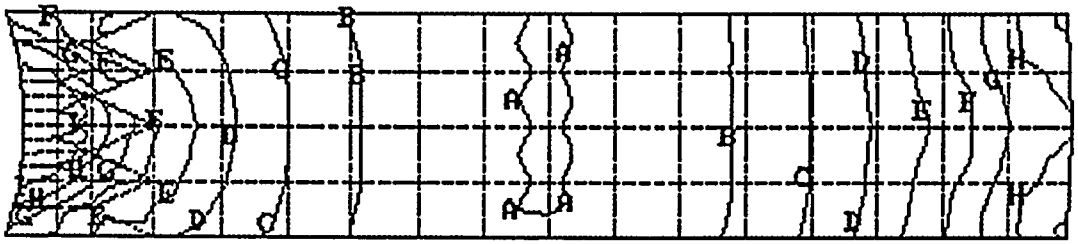


STARDYNE VECTOR NO 1 SIGMA X -3FACE

WATER LEVEL EL. 265'

CONTAINMENT MAT - HYDROSTATIC LOADS

CONTOUR LEVELS
MIN-97.78
A -97.78
B -61.32
C -24.85
D 11.61
E 48.07
F 84.53
G 121.0
H 157.5
I 193.9
J 230.4
MAX 230.4

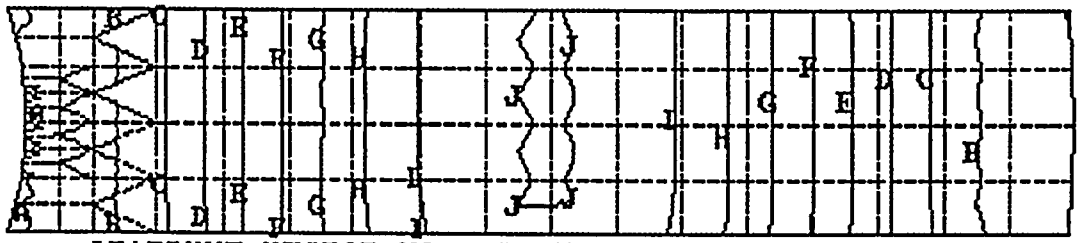


STARDYNE VECTOR NO 1 SIGMA Y -3FACE

WATER LEVEL EL. 265'

CONTAINMENT MAT - HYDROSTATIC LOADS

CONTOUR LEVELS
MIN0.1595E-02
A 0.1595E-02
B 0.2258E-01
C 0.4357E-01
D 0.6456E-01
E 0.8555E-01
F 0.1065
G 0.1275
H 0.1485
I 0.1695
J 0.1905
MAX0.1905

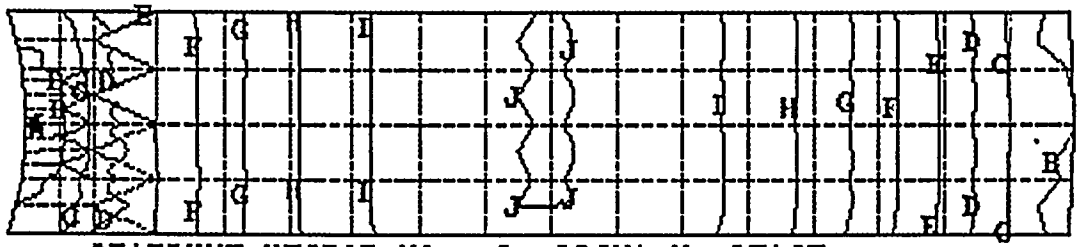


STARDYNE VECTOR NO 2 NORMAL DISPLACEMENT

WATER LEVEL EL. 270'

CONTAINMENT MAT - HYDROSTATIC LOADS

CONTOUR LEVELS
MIN-1599.
A -1599.
B -1333.
C -1068.
D -802.6
E -537.3
F -272.0
G -6.617
H 258.7
I 524.1
J 789.4
MAX 789.4



STARDYNE VECTOR NO 2 SIGMA X +3FACE

WATER LEVEL EL. 270'

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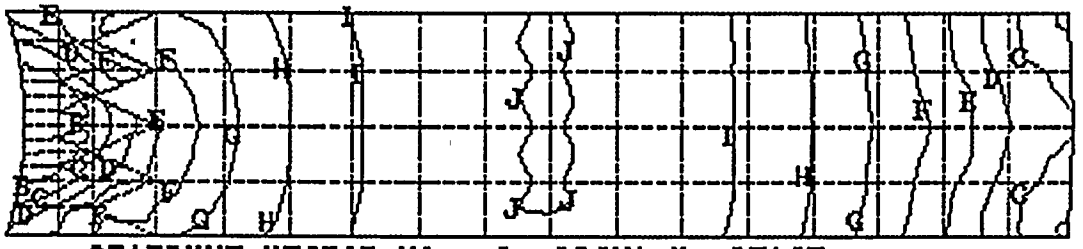
CONTAINMENT MAT - HYDROSTATIC LOADS

CONTOUR LEVELS
MIN-279.0
A -279.0
B -234.9
C -190.7
D -146.5
E -102.4
F -58.22
G -14.06
H 30.10
I 74.26
J 118.4
MAX 118.4

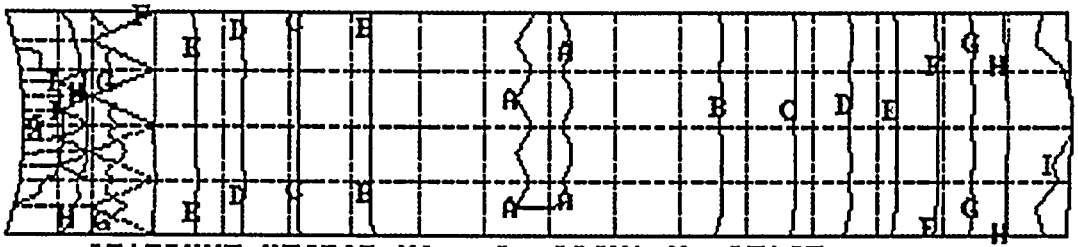


STARDYNE VECTOR NO 2 SIGMA Y +3FACE

WATER LEVEL EL. 270'

CONTAINMENT MAT - HYDROSTATIC LOADS

CONTOUR LEVELS
MIN-789.4
A -789.4
B -524.1
C -258.7
D 6.617
E 272.0
F 537.3
G 802.6
H 1068.
I 1333.
J 1599.
MAX 1599.



STARDYNE VECTOR NO 2 SIGMA X -3FACE

WATER LEVEL EL. 270'

EWR 5327

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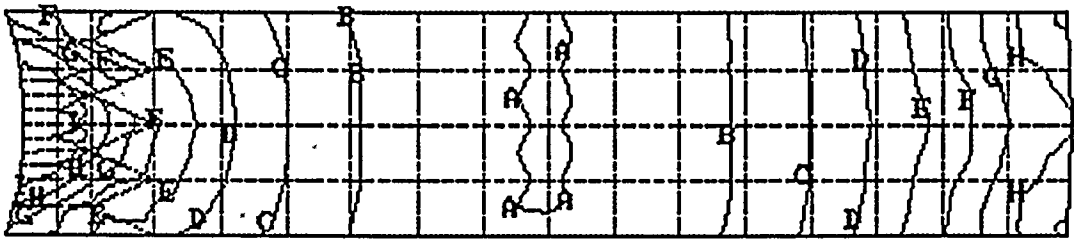
CONTAINMENT MAT - HYDROSTATIC LOADS

CONTOUR LEVELS
MIN-118.4
A -118.4
B -74.26
C -30.10
D 14.06
E 58.22
F 102.4
G 146.5
H 190.7
I 234.9
J 279.8
MAX 279.8



STARDYNE VECTOR NO 2 SIGMA Y. -3FACE

WATER LEVEL EL. 270'

ATTACHMENT E

Sheet # M91014

RGE AND

MATERIALS ENGINEERING

EXAMINATION SUMMARY RECORD

6/87 77-54

Examination for: ISI: ____ Maint: ____ Other: X EWR

Site: GINNA STATION System: CONTAINMENT VESSEL

ID: CONTAINMENT LINER Description: THICKNESS MEASUREMENTS.

Exam Type	Exam Rec. #	Examiner	Date	Results					Remarks
				No Rec	Insig	Geom	Other	Rej	
UTTK	916025	GB	3/25/91				X		UT THICKNESS
									MEASUREMENTS
									16" FROM FLOOR (TOP)
									12" FROM FLOOR (BOTTOM)
									AT 1', 2', 3', 4', 5', 6'
									and 7'

Summarized By: W. S. Galloway SNT Level N/A Date 3/26/91

Reviewed By: [illegible] SNT Level III Date 3/26/91

Sheet # 916025

RGE

MATERIALS ENGINEERING AND INSPECTION SERVICES
ULTRASONIC THICKNESS RECORD

Summary Sheet # M91014

Site Ginna Station Procedure NDE 600-12 Rev 2
Time: 1400 Date: 25Mar91 PDR #: 695
System Id Containment Liner Id 12" From floor (Bot) 16" From Floor (TOP)
Desc: EWR 5196
Cal. Sheet 918060 Exam for: ISI ___ Maint ___ R/R Mod X Other ___
Remarks: ~~N/A~~ Low Measurements were Recorded at each Foot
Examiner: George B Lais SNT Level: II
Examiner: Carl Ferraris SNT Level: I

		1'		2'		3'		4'		5'		6'		7'				
Top		0.364		0.376		0.358		0.353		0.355		0.350		0.379				
Bot		0.355		0.366		0.378		0.362		0.367		0.360		0.366				

DISPOSITION: Temp 69°

EXAMINER'S SIGNATURE George B Lais DATE 25Mar91
EXAMINER'S SIGNATURE Carl J Ferraris DATE 3/25/91

REVIEWED BY: Linda Lewis SNT LEVEL III DATE 3/26/91

MATERIALS ENGINEERING AND INSPECTION SERVICES

INSTRUMENT CALIBRATION RECORD FOR ULTRASONIC THICKNESS EXAMINATIONS (DIGITAL)

Summary Sheet # M91014

Site Ginna Station Sys Id Containment Liner Date: 25 Mar 91 Time: 1313

Examiner: George BLais SNT Level: II

Examiner: Carl Ferraris SNT Level: I

Instrument Type: KB - DME

Serial Number: 500505

UT Procedure: NDE 600-12 Rev 2

PDR #: 695 Couplant: Ultragel Batch #: 8868

Calibration Verification

Time	1313	1510	/			
Initials	GB	GB	/	Final		

Ver. Blk S/N: RG&E THK 0.1-1.0 CS

S.U. Cable

Length	6'
Type	Lemo/xdr

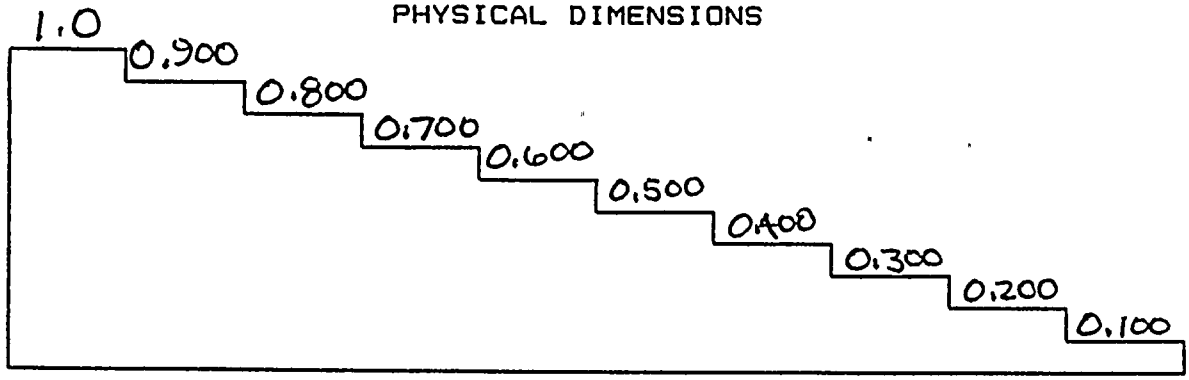
Search Units

Manufacturer	Aerotech
Serial No.	K01055
Size	0.375
Non Freq MHz	5.0

UT MEASUREMENT

1.009	0.903	0.803	0.703	0.601	0.501	0.401	0.301	0.199	0.096

PHYSICAL DIMENSIONS



Velocity: 2347 in./sec.

REMARKS: 70° Technoterm #L-153

Exam. Sheet Nos. 916025

EXAMINER'S SIGNATURE George Blais DATE 25 Mar 91

EXAMINER'S SIGNATURE Carl Ferraris DATE 3/25/91

REVIEWED BY: Paul A Lewis SNT LEVEL III DATE 3/26/91