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LaRC DESIGN ANALYSIS REPORT

FOR

NATIONAL TRANSONIC FACILITY

FOR

304 STAINLESS STEEL TUNNEL SHELL

FINITE ELEMENT AND NUMERICAL INTEGRATION ANALYSES
OF THE BULKHEAD REGION

VOL. 5S

BY

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16. Abstract This report contains the results of extensive computer (finite element, finite difference and numerical integration), thermal, fatigue, and special analyses of critical portions of a large pressurized, cryogenic wind tunnel (National Transonic Facility). The computer models, loading and boundary conditions are described. Graphic capability was used to display model geometry, section properties, and stress results. A stress criteria is presented for evaluation of the results of the analyses. Thermal analyses were performed for major critical and typical areas. Fatigue analyses of the entire tunnel circuit is presented.

The major computer codes utilized are: SPAR - developed by Engineering Information Systems, Inc. under NASA Contracts NAS8-30536 and NAS1-13977; SALORS - developed by Langley Research Center and described in NASA TN D-7179; and SRA - developed by Structures Research Associates under NASA Contract NAS1-10091; "A General Transient Heat-Transfer Computer Program for Thermally Thick Walls" developed by Langley Research Center and described in NASA TM X-2058.

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NATIONAL TRANSONIC FACILITY

TUNNEL SHELL

NASA - LARC

FINITE ELEMENT

AND

NUMERICAL INTEGRATION ANALYSES

OF THE

BULKHEAD REGION

304 STAINLESS STEEL

SEPTEMBER 1976

VOLUME 5S

LaRC CALCULATIONS

FOR THE

NATIONAL TRANSONIC FACILITY

TUNNEL SHELL

DATE: SEPTEMBER, 1976

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This report is one volume of a Design Analysis Report prepared by LaRC on portions of the pressure shell for the National Transonic Facility. This report is to be used in conjunction with reports prepared under NASA Contract NAS1-13535(c) by the Ralph M. Parsons Company (Job Number 5409-3 dated September 1976) and Fluidyne Engineering Corporation (Job Number 1060 dated September 1976). The volumes prepared by LaRC are listed below:

1. Finite Difference Analysis of Cone/Cylinder Junction (304 S.S.) Vol. 1, NASA TM X-73957-1.
2. Finite Element Analysis of Corners #3 and #4 (304 S.S.), Vol. 2S, NASA TM X-73957-2.
3. Finite Element Analysis of Plenum Region Including Side Access Reinforcement, Side Access Door and Angle of Attack Penetration (304 S.S.), Vol. 3S, NASA TM X73957-3.
4. Thermal Analysis (304 S.S.) Vol. 4S, NASA TM X73957-4.
5. Finite Element and Numerical Integration Analyses of the Bulkhead Region (304 S.S.), Vol. 5S, NASA TM X73957-5.
6. Fatigue Analysis (304 S.S.), Vol. 6S, NASA TM X73957-6.
7. Special Studies (304 S.S.), Vol. 7S, NASA TM X73957-7.

NTF DESIGN CRITERIA
FOR 304 STAINLESS STEEL

GENERAL

THE DESIGN OF THE PRESSURE SHELL REFLECTED IN THIS REPORT SATISFIES THE DESIGN REQUIREMENTS OF THE ASME BOILER AND PRESSURE VESSEL CODE, SECTION VIII, DIVISION 1. SINCE DIVISION 1 DOES NOT CONTAIN RULES TO COVER ALL DETAILS OF DESIGN, ADDITIONAL ANALYSES WERE PERFORMED IN AREAS HAVING COMPLEX CONFIGURATIONS SUCH AS THE CONE CYLINDER JUNCTIONS, THE GATE VALVE BULKHEADS, THE BULKHEAD-SHELL ATTACHMENTS, THE PLENUM ACCESS DOORS AND REINFORCEMENT AREAS, THE ELLIPTICAL CORNER SECTIONS, AND THE FIXED REGION (RING S8) OF THE TUNNEL. THE DIVISION 1 DESIGN CALCULATIONS, THE ADDITIONAL ANALYSES AND THE CRITERIA FOR EVALUATION OF THE RESULTS OF THE ADDITIONAL ANALYSES TO ENSURE COMPLIANCE WITH THE INTENT OF DIVISION 1 REQUIREMENTS ARE CONTAINED IN THE TEXT OF THIS REPORT. THE DESIGN ANALYSES AND ASSOCIATED CRITERIA CONSIDERED BOTH THE OPERATING AND HYDROSTATIC TEST CONDITIONS.

IN CONJUNCTION WITH THE DESIGN, A DETAILED FATIGUE ANALYSIS OF THE PRESSURE SHELL WAS ALSO PERFORMED UTILIZING THE METHODS OF THE ASME CODE, SECTION VIII, DIVISION 2.

MATERIAL

THE PRESSURE SHELL MATERIAL SHALL BE ASME, SA-240, GRADE 304 FOR PLATE AND SA-182, GRADE F304 FOR FORGINGS. THE MATERIAL PROPERTIES AT TEMPERATURES EQUAL TO OR BELOW 150°F ARE AS FOLLOWS:

(A) PLATE

YIELD = 30.0 KSI
ULTIMATE = 75.0 KSI

(B) WELDS (AUTOMATIC, SEMIAUTOMATIC, OR "STICK")

YIELD = 30.0 KSI
ULTIMATE = 75.0 KSI

OPERATING, DESIGN AND TEST CONDITIONS

THE OPERATING, DESIGN AND TEST CONDITIONS FOR THE TUNNEL PRESSURE SHELL AND ASSOCIATED SYSTEMS AND ELEMENTS ARE SUMMARIZED BELOW:

1. OPERATING MEDIUM

ANY MIXTURE OF AIR AND NITROGEN

2. DESIGN TEMPERATURE RANGE

MINUS 320 DEGREES FAHRENHEIT TO PLUS 150 DEGREES FAHRENHEIT, EXCEPT IN THE REGION OF THE PLENUM BULKHEADS AND GATE VALVES INSIDE A 23-FOOT, 4-INCH DIAMETER, FOR WHICH THE TEMPERATURE RANGE IS MINUS 320 DEGREES FAHRENHEIT TO PLUS 200 DEGREES FAHRENHEIT.

3. PRESSURE RANGE

	TUNNEL CONFIGURATION	OPERATING PRESSURE RANGE, PSIA	DESIGN PRESSURES PSID
A.	CONDITION I - PLENUM ISOLATION GATES OPEN AND TUNNEL OPERATING:		
	TUNNEL CIRCUIT EXCEPT PLENUM	8.3 to 130	A. 8 EXTERNAL B. 119 INTERNAL
	PLENUM (PLENUM PRESSURE IS LIMITED TO .4 TO 1 TIMES THE REMAINDER OF THE TUNNEL CIRCUIT	3.3 to 130	A. 15 EXTERNAL B. 119 INTERNAL
	BULKHEAD		56 (EXTERNAL TO PLENUM)
B.	CONDITION II - PLENUM ISOLATION GATES OPEN AND TUNNEL SHUTDOWN:		
	ENTIRE TUNNEL CIRCUIT	8.3 to 130	A. 8 EXTERNAL B. 119 INTERNAL
	BULKHEAD		0
C.	CONDITION III - PLENUM ISOLATION GATES AND ACCESS DOORS CLOSED:		
	TUNNEL CIRCUIT EXCEPT PLENUM	8.3 to 130	A. 8 EXTERNAL B. 119 INTERNAL

PLENUM (PLENUM OPERATING PRESSURE CAN EXCEED THE PRESSURE IN THE REMAINDER OF THE TUNNEL CIRCUIT BY 24 PSI, BUT DOES NOT EXCEED THE 130 PSIA MAXIMUM OPERATING PRESSURE)	0 to 130	A. 15 EXTERNAL B. 119 INTERNAL
BULKHEAD		A. 25 (INTERNAL TO PLENUM) B. 119 (EXTERNAL TO PLENUM) FOR MINUS 320 DEGREES FAHRENHEIT TO PLUS 150 DEGREES FAHRENHEIT *C. 115.7 (EXTERNAL TO PLENUM) FOR PLUS 151 DEGREES FAHRENHEIT TO PLUS 200 DEGREES FAHRENHEIT

*OPERATING PROCEDURES LIMIT PRESSURES TO THAT SHOWN.

D. CONDITION IV - PLENUM ISOLATION GATES CLOSED AND ACCESS DOORS OPEN:

TUNNEL CIRCUIT EXCEPT PLENUM	8.3 to 130	A. 8 EXTERNAL B. 119 INTERNAL
PLENUM	14.7	0
BULKHEAD		A. 119 (EXTERNAL TO PLENUM) FOR MINUS 320 DEGREES FAHRENHEIT TO PLUS 150 DEGREES FAHRENHEIT *B. 115.7 (EXTERNAL TO PLENUM) FOR PLUS 151 DEGREES FAHRENHEIT TO PLUS 200 DEGREES FAHRENHEIT

*OPERATING PROCEDURES LIMIT PRESSURES TO THAT SHOWN.

4. HYDROSTATIC TEST DESIGN CONDITIONS

THE PRESSURE SHELL WAS DESIGNED FOR HYDROSTATIC TEST IN ACCORDANCE WITH THE REQUIREMENTS OF THE ASME CODE, SECTION VIII, DIVISION 1. THE TEST PRESSURES SHALL BE AS FOLLOWS. PRESSURE SHELL TEMPERATURE SHALL BE EQUAL TO OR BELOW 100°F DURING HYDROSTATIC TESTS.

CONDITION (1) - MAXIMUM INTERNAL PRESSURE CONDITION FOR THE ENTIRE TUNNEL CIRCUIT

$$PH_1 = 1.5\ (119)\ \left(\frac{18.7}{18.2}\right) + \text{HYDROSTATIC HEAD}$$

$$= 183.4\ \text{PSI} + \text{HYDROSTATIC HEAD}$$

CONDITION (2) - MAXIMUM DIFFERENTIAL PRESSURE CONDITION ACROSS THE PLENUM BULKHEADS

$$PH_2 = 1.5\ \left(\frac{18.7}{18.2}\right)\ (119) + \text{HYDROSTATIC HEAD}$$

$$= 183.4 + \text{HYDROSTATIC HEAD}$$

$$PH_2{}^{*} = 1.5\ (115.7)\ \left(\frac{18.7}{17.7}\right) + \text{HYDROSTATIC HEAD}$$

$$= 183.4 + \text{HYDROSTATIC HEAD}$$

*TUNNEL OPERATION LIMITATIONS PRECLUDE PRESSURE DIFFERENTIALS ACROSS BULKHEADS IN EXCESS OF 115.7 PSI FOR BULKHEAD AND GATE TEMPERATURES IN EXCESS OF 150°F.

CONDITION (3) - MAXIMUM REVERSE DIFFERENTIAL PRESSURE CONDITION ACROSS THE PLENUM BULKHEADS

$$PH_3 = 1.5\ \left(\frac{18.7}{18.2}\right)\ (25) = 38.5\ \text{PSI}$$

THE PRESSURE SHELL EXCEPT FOR THE PLENUM SHALL BE PRESSURIZED TO 144.9 PSIG. THE PLENUM SHALL BE PRESSURIZED TO 183.4 PSIG.

PRESSURE SHELL STRESS EVALUATION CRITERIA

THIS CRITERIA ESTABLISHES THE BASIS FOR ANALYSIS AND DESIGN OF THE PRESSURE SHELL SO IT WILL MEET OR EXCEED ALL OF THE REQUIREMENTS OF SECTION VIII, DIVISION 1 OF THE ASME BOILER AND PRESSURE VESSEL CODE AND CAN BE STAMPED WITH A DIVISION 1 "U" STAMP.

1. SECTION VIII, DIVISION 1, DIRECT APPLICATION

(A) THE MAXIMUM ALLOWABLE STRESS (S)

$S = 18.2$ KSI (-320°F TO +150°F)

$S = 17.7$ KSI (-320°F TO +200°F)

(B) PRIMARY BENDING PLUS PRIMARY MEMBRANE STRESSES

THE LOCAL MEMBRANE STRESSES ARE NOT GENERALLY CONSIDERED IN SECTION VIII, DIVISION 1 DESIGNS. HOWEVER, FOR THE PURPOSE OF DESIGNING LOCAL REINFORCEMENT AT BRACKETS, RINGS OR PENETRATIONS NOT COVERED BY DESIGN BASED ON STRESS ANALYSIS, THE LOCAL SHELL MEMBRANE STRESS SHALL BE:

$$P_b + P_m \leq 1.5\ SE$$

NOTE: E IS JOINT EFFICIENCY

2. IN REGIONS OF THE PRESSURE SHELL WHERE DIVISION 1 DOES NOT CONTAIN RULES TO COVER ALL DETAILS OF DESIGN (REF. U-2(g)), ADDITIONAL ANALYSES WERE PERFORMED UTILIZING THE GUIDELINES OF THE ASME CODE, SECTION VIII, DIVISION 2, APPENDIX 4, "DESIGN BASED ON STRESS ANALYSIS." THE BASIC STRESS CRITERIA FOR DIVISION 2 IS REPRESENTED IN FIGURE 4-130.1 AND RESTATED BELOW INDICATING ANY MODIFICATIONS OR EXCESS REQUIREMENTS APPLIED TO IT TO REMAIN WITHIN THE INTENT OF DIVISION 1 AND TO OBTAIN A DIVISION 1 STAMP.

A. GENERAL PRINCIPAL MEMBRANE STRESS

MAXIMUM ALLOWABLE STRESS

$S = 18.2$ KSI (-320°F TO +150°F)

$S = 17.7$ KSI (-320°F TO +200°F)

MAXIMUM ALLOWABLE STRESS INTENSITY

$S_m = 20.0$ KSI (-320°F TO +300°F)

B. PRIMARY GENERAL MEMBRANE STRESS INTENSITY

$$P_m \leq S_m$$

AND IN ORDER TO COMPLY WITH DIVISION 1, THE MAXIMUM PRINCIPAL MEMBRANE STRESS MUST BE:

$$P_m^* \leq S$$

NOTE: THE * IS USED TO DENOTE THAT MAXIMUM PRINCIPAL STRESSES ARE TO BE COMPUTED FOR THE GIVEN LOADING CONDITION. THE INTENT IS TO DETERMINE THE STRESSES WHICH REPRESENT THE HOOP STRESSES AND MERIDIONAL STRESSES WHICH ARE THE STRESSES USED IN DIVISION 1 COMPUTATIONS.

C. DESIGN LOADS, PRIMARY LOCAL MEMBRANE STRESS INTENSITY

$$P_L \leq 1.5\ S_m$$

NOTE: LOCAL MEMBRANE STRESS INTENSITY IS DEFINED IN ACCORDANCE WITH DIVISION 2, APPENDIX 4-112(i). THE TOTAL MERIDIONAL LENGTH IS CONSIDERED TO BE $1.0 \sqrt{RT}$.

D. DESIGN LOADS, PRIMARY LOCAL MEMBRANE PLUS PRIMARY BENDING STRESS INTENSITY

$$P_L + P_b \leq 1.5\ S_m$$

E. OPERATING LOADS, PRIMARY PLUS SECONDARY STRESS INTENSITY

$$P_L + P_b + Q \leq 3\ S_m$$

3. A FATIGUE ANALYSIS WAS CONDUCTED IN ACCORDANCE WITH SECTION VIII, DIVISION 2 WITHOUT MODIFICATION.

4. HYDROSTATIC TEST CONDITION DESIGN CONSIDERATIONS

A. PRESSURE SHELL

IN ACCORDANCE WITH DIVISION 1 OF THE ASME CODE, DESIGN ANALYSIS OF THE PRESSURE SHELL FOR THE HYDROSTATIC TEST CONDITION IS NOT REQUIRED. HOWEVER, IN ORDER TO PROVIDE A SATISFACTORY ENGINEERING DESIGN FOR THE PRESSURE SHELL SPECIAL EMPHASIS WAS GIVEN, AS PROMPTED BY NOTE (1) OF SECTION VIII, DIVISION 1 OF THE ASME CODE, TO FLANGES OF GASKETED JOINTS OR OTHER APPLICATIONS WHERE SLIGHT AMOUNTS OF DISTORTION CAN CAUSE LEAKAGE OR MALFUNCTION. EXAMPLES OF THESE AREAS ARE THE PLENUM, PLENUM ACCESS DOORS, PLENUM ACCESS DOOR REINFORCEMENT, THE BULKHEADS, AND BULKHEAD FLANGES.

B. SUPPORT RINGS

DESIGN OF THE PRESSURE SHELL SUPPORT RINGS, INCLUDING

THE CORNER RINGS, FOR THE HYDROSTATIC TEST CONDITION, COMPLIES WITH THE FOLLOWING:

(A) THE COMBINED VALUE OF THE SHELL CIRCUMFERENTIAL PRESSURE STRESS, S_1 AND SHELL

BENDING STRESS S_2, RESULTING FROM ACTION OF A

PORTION OF THE SHELL AS AN INNER FLANGE OF THE RING, SHALL NOT EXCEED 0.8 WELD YIELD STRESS:

$$S_1 + S_2 \leq 0.8 \text{ WELD YIELD STRESS,}$$

WHERE, FOR SUPPORT RINGS NOT ANALYZED BY FINITE ELEMENT TECHNIQUES,

$S_1 = P_H \left(\frac{R}{T}\right) + .6\, P_H$; P_H INCLUDES HYDROSTATIC

HEAD CORRECTION, AND

S_2 = RING BENDING STRESS AT INNER FLANGE, BASED

ON AN EFFECTIVE WIDTH OF THE PRESSURE SHELL ACTING AS AN INNER FLANGE OF THE RING OF 1.1 MULTIPLIED BY THE SQUARE ROOT OF D_O T.

(B) THE BENDING STRESS, S_{2F} ON THE OUTSIDE FLANGE

SHALL NOT EXCEED .9 WELD YIELD STRESS. (IN THE COMPUTER ANALYSIS ALL LOADING CONDITIONS ARE LIMITED TO .9 S_Y ON THE OUTER FLANGE.)

(C) BRACKETS AND SUPPORT PAD WELDMENTS

THE DESIGN FOR ALL LOADING CONDITIONS INCLUDING THE HYDROSTATIC TEST CONDITION OF THOSE PORTIONS OF BRACKETS AND SUPPORT PAD WELDMENTS WHICH ARE ATTACHED TO THE PRESSURE SHELL BUT NOT ON THE SURFACE OF THE SHELL SHALL COMPLY WITH THE REQUIREMENTS OF THE AISC CODE, I.E. MAXIMUM STRESS IN TENSION EQUALS .6 S_Y, ETC.

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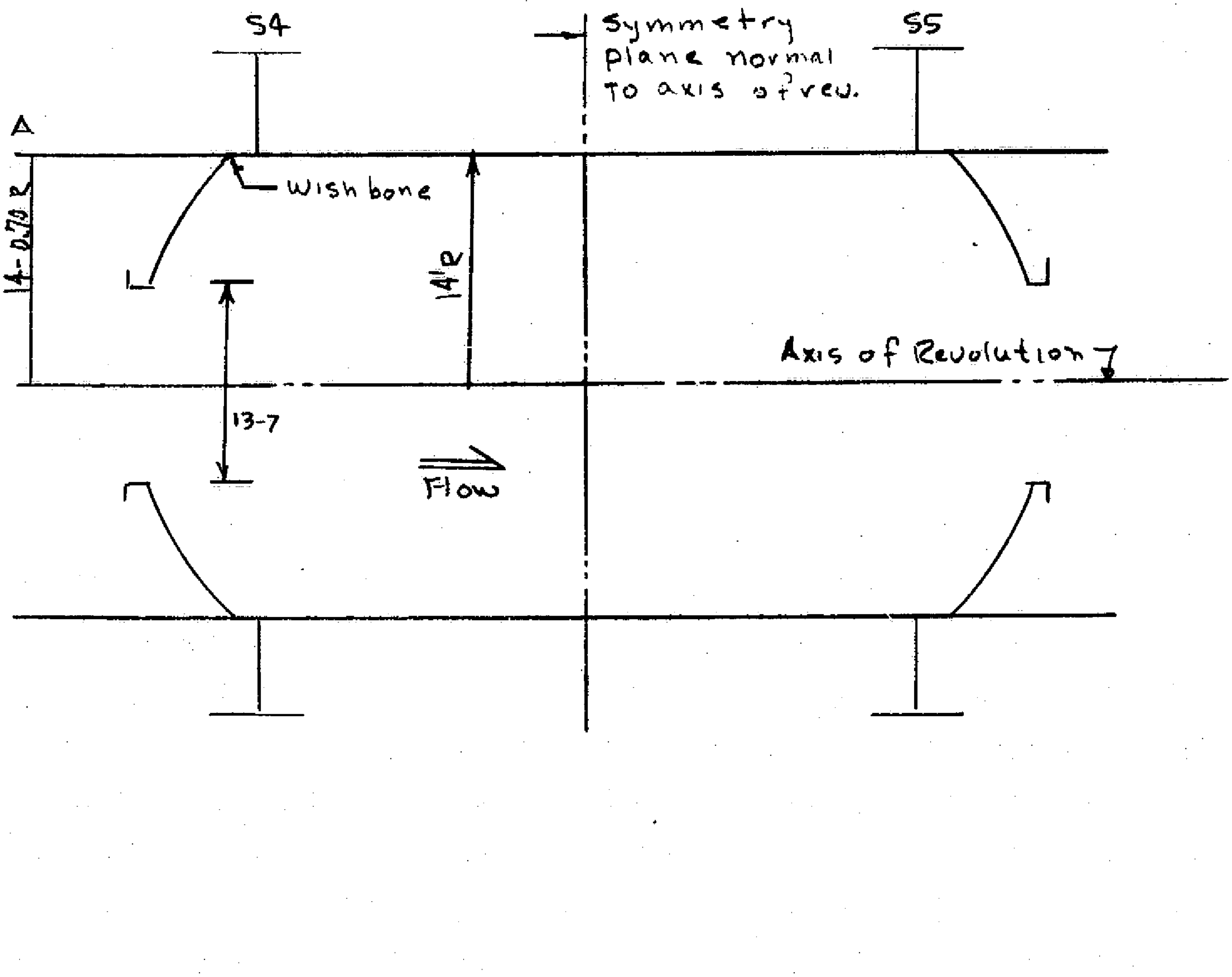
CHKD. BY ______ DATE ______ Analysis of Bulkhead JOB NO. ______

Reference drawing no. LE-944432S



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i Spar; a finite element computer code developed and maintained by Engineering Information System, Inc. Under NASA Contracts:

a. NAS8 - 30536
b. NAS1 - 13977.

ii SRA; a Shells of Revolution computer Code based on a technique of foward integration.
Prepared under Contract NAS1 - 10091,
by Structures Research Associates.

The above two codes were used to model This region of the tunnel, from point A To the Symmetric plane normal to the axis of revolution.

Spar model description.

Due to a high degree of interconnectivity in the bulkhead / cylindrical shell intersection, and axial symmetry a quarter model using forty elements around the circumference was generated.

See figure 1 for a computer plot of the basic geometric construction, of the model. also, shown on the model for orientation purposes is the right-handed orthogonal basis used in defining;

a. rigid body constraints
b. model geometry
c. direction of all discreet loads

rigid body constraints.

Constraints were imposed on the model for the following resons:

1. To maintain static equilibrium. The axial displacement on the model had to be removed, to generate a state of equilibrium. This was accomplished by modeling the effective spring rate, from the end of the model to the axis of symmetry normal to the shell, as rods. then fixing the end of the rods on the axis of symmetry. Thus, any axial forces that were required to set up the proper stress state in the shell elements would be self generating. (see figure 2) Changing the spring rates was found to have no effect on the general structure. This simply caused the model to seek a new relative equilibrium point before setting its stress state.

2. Symmetric boundary conditions.
The (1,3) and (2,3) planes were modeled as planes of symmetry. So that in effect a full 360° model was constructed. see figure 1.

3. Impose continious cylindrical shell boundary conditions.
On the up stream shell the rotations were removed and all translational degrees of freedom were left in the model. By removing the rotations, moments were generated to simulate a continious cylindrical shell.
The down stream shell had the same boundary conditions, with the exception of the rods being attached to these points.
Note: Rod elements are not capable of transmitting bending moments. So all bending moments had to be taken out by the shell elements. see figure. 2.

all other degrees of freedom were left in the model.

The model had 2009 nodes or, after imposing all the boundary conditions, a little less than 12,000 degrees of freedom.

Model geometry

As previously mentioned a greater model, with forty elements around the circumference and 2005 nodes, was generated. all elements were membrane and bending flat plates.

Approximately six feet, of cylindrical shell was modeled on either side of the bulkhead/shell intersection. a detailed sketch of this intersection is shown in figure 3. The extra metal around the 3" rad is from a modeling stand point is rather difficult to model. Therefore, this section was modeled as shown in figure 4. leaving out this extra stiffness, by not connecting say points A and B (see figure 4) with elements that would exhibit the same stiffness; no unusualy high stresses were found to exist.

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Modeling of the extra shell lengths served to main purposes:

First the bulkhead / shell intersection effect on the shell had to be determined. It was found that this discontinuity had no adverse effect on the shell, and tends to die out very quickly.

Second, a check point on the model had ~~to~~ be built-in so that one might conclude that the appropriate loads and boundary conditions had been imposed. Stresses on the shell boundarys showed that little or no bending was taking place and hand calculations could predict stresses in these regions.

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The gussets on the bulkhead flange were modeled as plate elements connecting the flange to the bulkhead. See figure [illegible]

The support ring [illegible] was modeled with plate elements and stem of the ring connected directly into the shell at point C. (See figure. 4.)

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The joint numbering sequence started at the top of the flange surface, at theta equal 0° increased in the theta direction first, then along the meridian. The joint numbering sequences are shown in figures 21 thru 25.

The shell section properties (plate thickness) were modeled as indicated in figure 1. Tapers were modeled as an average of the two adjacent thicknesses.

Section properties are shown in figures 26 thru 32.

Section property numbers and their corresponding thickness are listed below.

Sect. No.	Thickness	Sect. No.	Thickness
1	4.00	10	1.25
2	5.25	11	3.00
3	4.00	12	4.00
4	4.00	13	1.50
5	4.00	14	3.00
6	4.00	15	2.50
7	3.00	16	[illegible]
8	1.30	17	2.15
9	3.00		

Material Properties used in this analysis are listed below.

304 stainless Steel

ρ	.283 lb/IN^3	density
α	$.730 \times 10^{-5}$ IN/IN°F	Coef. of Ther. exp.
E	$28. \times 10^6$ psi	Mod. of elast.
ν	.3	Poisson's ratio.

Table 17. Selected Thermal Properties of Some Steels
(See also Tables 5A and 5B, Page 12)

3½% Nickel Steel	
Thermal Expansion Coefficient	
0 to +200°F	6.15×10^{-6} in./in./°F
Thermal Conductivity	
−150°F (mean)	214 Btu/in./hr./ft^2/°F
+68°F (mean)	253 Btu/in./hr./ft^2/°F
+200°F (mean)	270 Btu/in./hr./ft^2/°F
Specific Heat	
−150 to +80°F	0.798 Btu/lb./°F
+80 to +1000°F	0.147 Btu/lb./°F
9% Nickel Steel	
Thermal Expansion Coefficient	
At room temperature	5.8×10^{-6} in./in./°F
−300 to 0°F (avg.)	5.3×10^{-6} in./in./°F
−300 to +200°F (avg.)	5.6×10^{-6} in./in./°F
at −300°F	4.0×10^{-6} in./in./°F
Thermal Conductivity	
−320°F	91.3 Btu/in./hr./ft^2/°F
−150°F	169.0 Btu/in./hr./ft^2/°F
+68°F	189.0 Btu/in./hr./ft^2/°F
+200°F	209.0 Btu/in./hr./ft^2/°F
Specific Heat	
−320 to +80°F	0.0878 Btu/lb./°F (avg.)
+80 to +700°F	0.119 Btu/lb./°F (avg.)
304 Stainless Steel	
Thermal Expansion Coefficient	
+32 to +212°F	9.6×10^{-6} in./in./°F
−300 to +70°F (mean)	7.3×10^{-6} in./in./°F
+70 to +1000°F (mean)	10.0×10^{-6} in./in./°F
at −300°F	5.9×10^{-6} in./in./°F
Thermal Conductivity	
−320°F	56.4 Btu/in./hr./ft^2/°F
−155°F	90.0 Btu/in./hr./ft^2/°F
+70°F	113.0 Btu/in./hr./ft^2/°F
+600°F	120.0 Btu/in./hr./ft^2/°F
Specific Heat	
−320°F	0.037 Btu/lb./°F (avg.)
−150°F	0.088 Btu/lb./°F (avg.)
+ 80°F	0.120 Btu/lb./°F (avg.)

U.S. Steel "Low Temperature and Cryogenic Steels" Materials Manual Feb. 1967 Second Revised Printing

Loadings

The following loading cases were run.

Case 1. Gate Value Closed

Case 2. Gate Value open

Case 3. Full pressure

Case 4. Gate Value open w/ steady state temperature distribution

Case 5. Gate Value closed w/ transient Temperature distribution.

To aid in explaining the different loading configuration refer to figures 2 and 5.

P_1 is a nodal pressure applied to all nodes on the up stream shell and bulk head.

P_2 is a nodal pressure applied to all nodes on the down stream shell and bulk head.

P_3 is a nodal pressure applied to all nodes on the up stream and down stream shell.

LG is a nodal force applied to each node around the circumference, except for the nodes on the $\theta = 0°$ and $90°$ axis here the magnitude of LG is 1/2. This load is due to the sealing force generated by the gate valve, and/or dog pre loads

LD is a nodal force applied in pairs of nodes at dog locations.
These loads are spring preloads or reaction to aerodynamic loads.

LS is a nodal force:

1. applied in pairs of nodes at dog locations, for valve closed cond.
2. applied to each node around the circumference, except for nodes at $\theta = 0° \& 90°$, here the magnitude is 1/2.

for valve open conditions.

LTF is a nodal force applied in pairs of nodes at dog locations. These loads are spring preloads

M is a nodal moment applied to each node around the circumference, except for nodes located on the $\theta = 0°$ and $90°$ axis, here the magnitude is 1/2.
This moment is a result of an assumed misalignment of components

F is a nodal force applied to each node around the circumference, except for nodes located on the $\theta = 0°$ and $\theta = 90°$ axis, here the maxnitude is "1/2".
This is a boundary load due to capping off the end of the cylinder.

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Case 1. Gate Valve Closed

For this loading configuration
The following loads were applied.

P_1 = 119.0 Psia
P_2 = 0.0 Psia
P_3 = 0.0 Psia
LG = -17483.0 lbs
LS = 19500.0 lbs
LTF = -19500.0 lbs
F = 66242.0 lbs
LD = 0.0 lbs
M = 0.0 IN-lbs

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Case 2. Gate Valve open / running cond.

For this loading configuration
The following loads were applied:

P_1 = 133.7 PSIA
P_2 = 53.4 PSIA
P_3 = 14.7 PSIA

actual down stream shell
pressure 57.6 PSIG.

LD = 13000. lbs.
LG = -5568.8 lbs.
LS = 3018.8 lbs.
LTF = -19500. lbs.
M = 145275. IN-lbs
F = 66242.0 lbs

Case 3. Full pressure

For this loading configuration the following loads were applied.

P_1 = 119.0 psia
P_2 = 119.0 psia
P_3 = 0.0 psia
F = 66242.0 lbs
LG = 0. lbs
LD = 0. lbs
LTF = 0. lbs
LS = 0. lbs
M = 0. in-lbs

This loading case was run primarly for superposition of shell stresses on a S4 and S5 asymmetric ring load analysis.

Case 4 Gate Valve open w/ steady state temperature distribution

For this loading configuration the following loads were applied:

P_1 = 133.7 psia
P_2 = 53.4 psia
P_3 = 14.7 psia

actual downstream shell pressure 57.6 psig.

LD = 13000. lbs
LG = -5568.8 lbs
LS = 3018.8 lbs
LTF = -19500. lbs
M = 145275. in-lbs
F = 66242. lbs

And the temperature distribution shown in figure 7a was applied. This temperature distribution was uniform through the element thickness and around the circumference of the model.

Case 5 Gate Valve Closed w/ Transient temperature distribution

For this loading configuration the following loads were applied.

P_1 = 119. PSIA
P_2 = 0.0 PSIA
P_3 = 0.0 PSIA
LG = -17483.0 lbs
LTF = - 19500.0 lbs
LS = 19500.0 lbs
F = 66242.0 lbs
LD = 0.0 lbs
M = 0.0 lbs

and the temperature distribution shown in figure 7b. was applied. This temperature distribution was uniform through the element thickness and around the circumference of the model.

Stress and deflection results

Presented with the summary results for the following cases are computer stress plots. where the circumferential (sx) or merdian (sy) nodal stresses are given for,

mid-surface (surface 0),
inside surface (surface 1), and
outside surface (suface 2).

The stresses are plotted for joint one of the element (reference figure 6 and 18). For the element defined by the joints 1 2 43 42, Joint one for that element is node 1.
Nodal stresses for a joint are given from the four surrounding elements. If any descripancies exist in the stresses for a joint due to discontinuties in the structure (ie. rings, cone cyl. junct.) The larger value is used in the interpretation of the results.

Results Load Case 1

Valve Closed

The following table is a list of the max. and min. principle stresses at the joints indicated. also, in the table is the max. bending stress at these node and the surface they accure on.

Surface A = inside surface.

Surface B = Outside Surface.

BY______ DATE______ SUBJECT______ SHEET NO. 24 OF______
CHKD. BY______ DATE______ JOB NO.______
LAK

NODE See fig 6	Max Ps Membrane	MIN Ps Membrane	σbending / surface
1	-0.69	-3.77	-4.71 / B
83	-0.80	-3.72	-4.73/B
124	-0.68	-4.30	-4.75/A
206	-0.03	-6.85	-6.90/A
288	-1.55	-7.27	-7.49/A
329	-2.52	-6.32	-7.70/A
370	-3.40	-7.67	-11.73/A
411	-3.12	-7.46	-12.42/B
452	-3.42	-6.89	-8.23/B
493	-3.53	-5.60	-6.27/B
534	-3.59	-4.92	-5.57/B
575	-3.62	-4.47	-5.18/B
616	-3.43	-3.60	-5.39/B
657	-2.10	-3.51	-5.96/B
698	.00	-3.35	-5.72/B
739	1.70	-3.10	-3.91 /B
780	4.16	-2.90	-8.69/A
821	4.86	-2.81	-11.42/A
862	5.10	-2.71	-11.42/A
903	4.91	-2.61	-9.71/A
944	6.16	3.33	6.17/A
985	7.01	3.33	7.16/B
1190	15.71	7.69	15.79/A
1272	4.67	-.08	5.32/B
1559	4.12	-.08	4.41/B
1641	2.38	-.10	–
1805	-.29	-.13	–
1887	-.05	-.13	–
247	-.03	-7.52	-7.68 /B

Shown in figures 33 thru 59 are stress plots for this loading case.

The stresses shown are not principle stresses however, due to the symmetry in the geometry and loads there is very little transverse shear. Thus, these stress values could be treated as principle stresses

Membrane Stress (intensity)
Primary local membrane stress intensity
(node 370)

$\sigma_1 = -3.40$ KSI

$\sigma_2 = -7.67$ KSI

$\sigma_3 = -.06$ KSI

$S_{12} = -3.40 - (-7.67) = 4.27$ KSI

$S_{23} = -7.67 - (-.06) = -7.61$ KSI

$S_{31} = -.06 - (-3.40) = 3.34$ KSI

$S = |-7.61| = 7.61$

$P_m = 7.61 < 20.0$ KSI ok

Since the stress intensity is < Sm (20KSI) the stress intensity meets the criteria for general membrane stress intensity.

General membrane stress

$S = 15.71$ KSI (Shell node 1150)

$15.71 < 18.2$ KSI ok

This region meets the stress evaluation criteria for general membrane stress.

Primary plus secondary stress intensity
(node 446)

inside Surface

$\sigma_1 = -4.93$ KSI
$\sigma_2 = -11.73$ KSI
$\sigma_3 = -.119$ KSI

$S_{12} = -4.93 - (-11.73) = 6.8$ KSI
$S_{23} = -11.73 - (-.119) = -11.61$ KSI
$S_{31} = -.119 - (-4.93) = 4.81$ KSI

$S = |-11.61| = 11.61$ KSI
$P_L + P_B + Q < 3S_m$
$11.61 < 3S_m = 60$ KSI ok

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Outside side surface
(node 411)

$\sigma_1 = -12.83$ KSI
$\sigma_2 = -13.44$ KSI
$\sigma_3 = 0$ KSI

$S_{12} = -12.83 - (-13.44) = .61$ KSI
$S_{23} = -13.44 - 0 = -13.44$ KSI
$S_{31} = 0 - (-12.83) = 12.83$ KSI

$S = |-13.44| = 13.44$ KSI

$P_L + P_b + Q < 3 S_m$
$13.44 < 60$ KSI ok

The primary plus secondary stress intensity meets the stress evaluation criteria.

BY	DATE	SUBJECT	SHEET NO. 29 OF
CHKD. BY	DATE		JOB NO.

The following sketch and table shows the relative displacement and indicates the rotation of the sealing surface

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OF POOR QUALITY

BY ______ DATE ______ SUBJECT ______ SHEET NO. 36 OF ______
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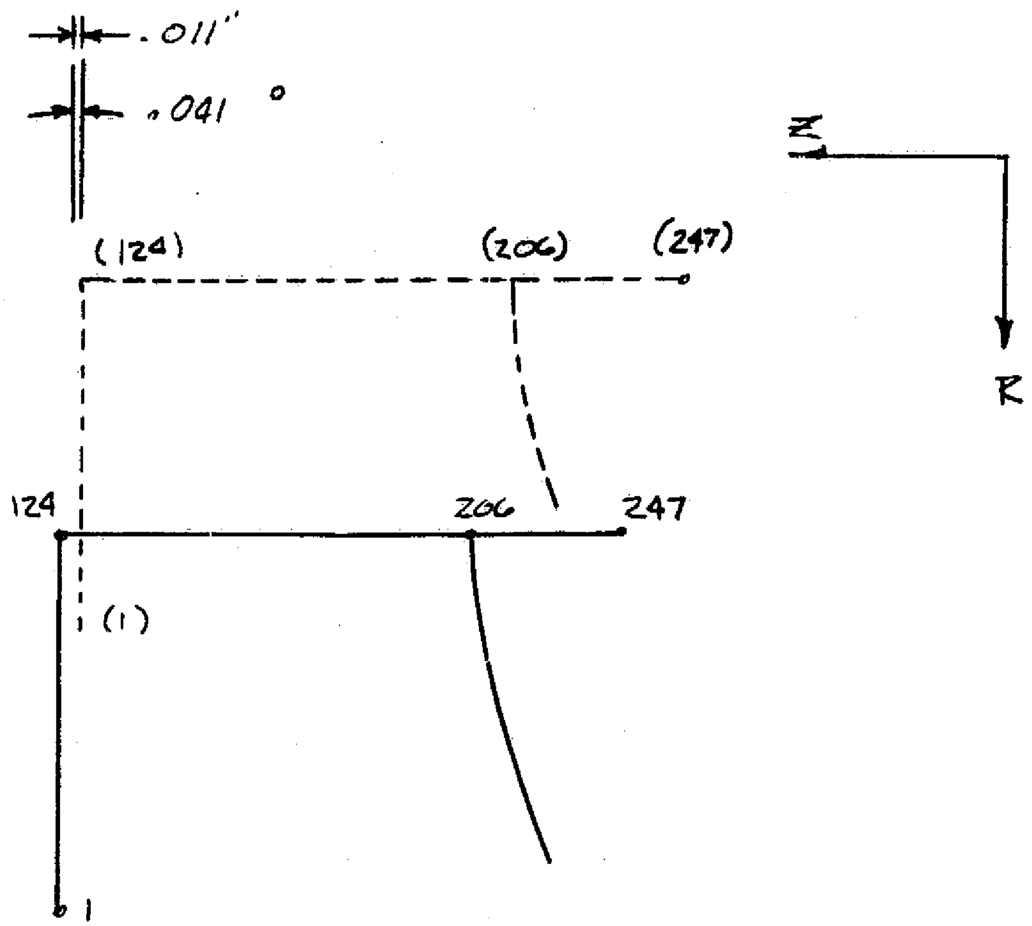


Displacements

Joint	Δ R IN.	Δ Z IN.
1	-.012	-.0907
124	-.012	-.0797
206	-.0198	-.0800
247	-.0228	-.0803

Results Load Case 2

Valve open / running condition

Due to the decreased pressure differential across the bulkhead (76.3 psig) and The downstream pressure being far less than design (57.6 psig vs. 119.0 psig design). Stresses were as expected Very low and futher analysis of this loading condition was not warrented.

Stresses for this loading Condition:

Upstream and down stream shell,

Here, the stresses are equal To those generated from Case 1 (see fig 60 thru 86 and compare to 33 fig 59 thru)

∴, this region meets the stress evalation criteria.

Bulkhead,

Here the stress are less than those generated from Case 1.

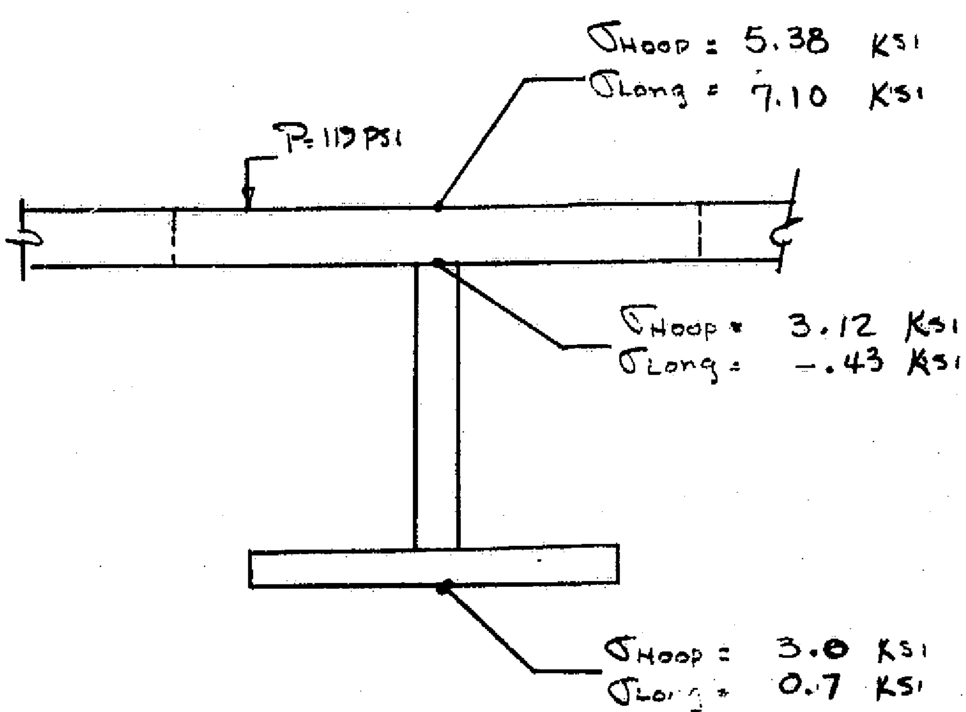
∴, this region meets the stress evaluation criteria for this loading condition

BY ____ DATE ____ SUBJECT ____ SHEET NO. 33 OF ____
CHKD. BY ____ DATE ____ JOB NO. ____

Results load case 3

Full Pressure

Below is a sketch of the stress picture used on a 54 and 55 asymmetric ring load analysis. Refer to section "54 and 55 ring analysis" for composite analysis of this support ring region.



54 or 55

figures 87 thru 113 show the general stress picture of the model during this loading condition.

Results Load Case 4

Gate Valve open / running condition
w/ temperature distribution

(Steady State)

The following table is a list of The max. and min. principle stresses at the joints indicated. also, in the table is the max. principle bending stress at the nodes and the surface they accure on.

Surface A = inside surface

surface B = outside surface

BY ________ DATE ________ SUBJECT ________ SHEET NO. 36 OF ____

CHKD. BY ______ DATE ________ JOB NO. ________

LAD

NODE See fig 6	Max Ps Membrane	MIN Ps Membrane	σbending /surface
1	-.14	-1.60	-2.78 /A
83	-.21	-.70	-2.39 /A
124	.47	.22	5.33/A
206	-.15	-3.27	-3.35/A
288	.30	-4.56	-5.59/A
329	1.45	-4.75	-5.60/A
370	-2.04	-5.32	-9.45/A
411	-1.18	-7.00	-13.05/B
452	-1.76	-6.18	-9.70 /B
493	-1.88	-4.90	-10.09 /B
534	-1.96	-3.46	-10.98/B
575	-1.95	-1.95	-11.56/B
616	-0.54	-1.89	-12.49/B
657	-0.18	-1.77	-12.54/B
698	2.41	-1.62	-10.55/B
739	-1.48	-1.59	-7.25/B
780	11.80	-1.21	13.05/A
821	4.13	-1.24	-9.98/A
862	9.98	-1.28	-15.54/A
903	14.91	-1.39	20.76/B
944	3.33	3.31	42.20/B
985	3.33	-4.27	27.93/B
1190	18.45	7.69	18.57/B
1272	1.36	1.11	10.67/B
1559	2.68	1.36	11.10/ B
1641	6.09	1.63	9.31/B
1805	6.04	2.04	6.20 /A
1887	4.66	2.04	4.67 /B
247	-.15	-4.60	-4.74/A

Shown in figures 114 thru 140 are stress plots for this loading case.

The stresses shown are not principle stresses however, due to the symmetry in the geometry and loads there is very little to no transverse shear.

thus, these stress values could be treated as principle stresses.

Membrane stress (intensity)
Primary local stress intensity
(Node 903)

$\sigma_1 = 14.91$ KSI

$\sigma_2 = -1.39$ KSI

$\sigma_3 = -.06$ KSI

$S_{12} = 14.91 - (-1.39) = 16.3$ KSI
$S_{23} = -1.39 - (-.06) = -1.33$ KSI
$S_{31} = (-.06) - (+14.91) = -14.97$ KSI

$\sigma = |16.3| = 16.3$ KSI
P_m: 16.3 KSI < 20.0 KSI ok

Since the stress intensity is < S_m (20 KSI)
The stress intensity meets the criteria
for general membrane stress intensity.

General Membrane Stress
S = 18.45 KSI (Shell node 1190)
18.45 < S_m KSI ok

This region meets the stress
evaluation criteria for general
membrane stress

Primary plus Secondary
stress intensity
(node 944)

Inside surface

$\sigma_1 = -8.36$ KSI

$\sigma_2 = -35.54$ KSI

$\sigma_3 = -.119$ KSI

$S_{12} = -8.36 - (-35.54) = 27.18$ KSI

$S_{23} = -35.54 - (-.119) = -35.421$ KSI

$S_{31} = -.119 - (-8.36) = 8.241$ KSI

$S = |-35.421|$ KSI $= 35.421$ KSI

$P_L + P_B + Q < 3 S_m$

$35.421 < 3 S_m = 60$ KSI, OK

Out side surface Stress
(node 944)

$\sigma_1 = 42.2$ ksi

$\sigma_2 = 14.97$ ksi

$\sigma_3 = 0.$ ksi

$S_{12} = 42.2 - 14.97 = 27.23$ ksi

$S_{23} = 14.97 - 0 = 14.97$ ksi

$S_{31} = 0 - 42.2 = -42.2$ ksi

$S = |-42.2| = 42.2$ ksi

$P_L + P_b + Q < 3S_m = 60$ ksi

$42.2 < 60$ ksi ok

The primary plus secondary stress intensity meets the stress evaluation criteria.

Results load case 5

Valve Closed w/ transient temp. dist.

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Shown in figures 141 thru 167 are stress plots for this loading case.
The stresses shown are not principle stresses however, due to the symmetry in geometry and loads there is very little transverse shear. Thus, these stress values could be treated as principle stresses.

The following table is a list of max. and MIN principle stresses at the joints indicated.

also, in the table is the max. principle bending stress at the node and the surface the accure on.

Surface A = inside Surface

Surface B = outside Surface

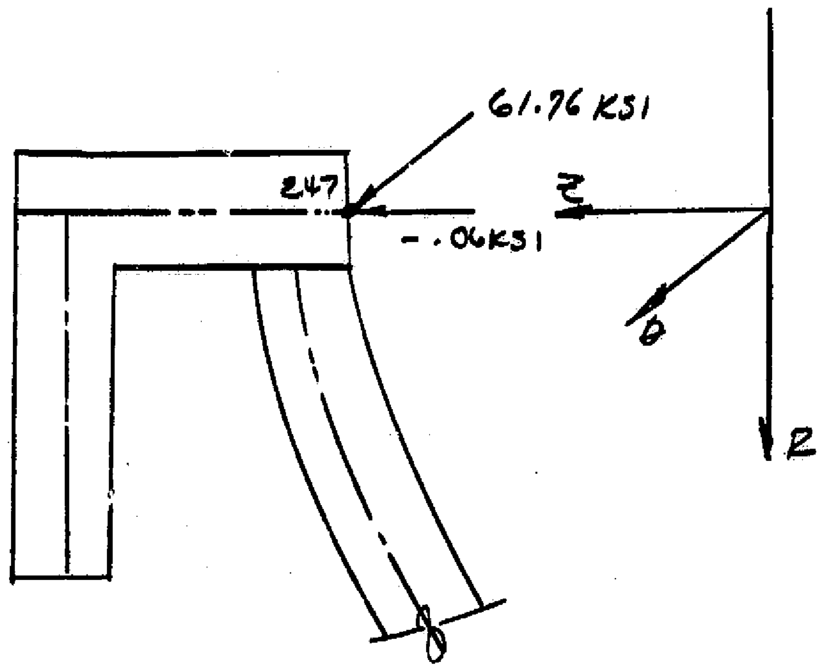
BY ______ DATE ______ SUBJECT ______ SHEET NO. 44 OF ______

CHKD. BY ______ DATE ______ JOB NO. ______

AAK

NODE See fig 6	Max Ps Membrane	Min Ps Membrane	σbending/surface
1	19.89	2.66	27.41/A
83	20.80	-1.91	22.52/A
124	11.84	-2.61	15.11/A
206	-0.06 -7.51	-57.89 -59.70	-59.47/A -61.76/A
288	3.58	-7.69	-9.49/B
329	3.13	-8.81	-10.80/B
370	.92	-5.52	-10.50/B
411	6.63	-3.84	13.38/B
452	1.71	-4.17	11.06/B
493	-.51	-3.82	-15.25/B
534	-1.22	-3.77	-16.43/B
575	-.87	-3.67	-16.88/B
616	-2.04	-3.59	-17.45/B
657	-3.43	-3.52	-17.62/B
698	-3.43	-3.52	-17.62/B
739	5.15	-2.89	-14.66/B
780	12.55	-2.45	15.12/A
821	19.54	-2.29	19.97/B
862	20.58	-2.30	24.02/B
903	12.56	-2.30	-25.02/A
944	3.33	2.86	45.00/B
985	3.33	-4.89	29.13/A
1190	16.00	8.00	16.00/A
1272	4.00	.0	
1559	4.0	.0	
1641	3.0	.0	
1805	1.0	.0	
1887	0	0	
247	-.06	-61.76	-61.81/A -61.71/B

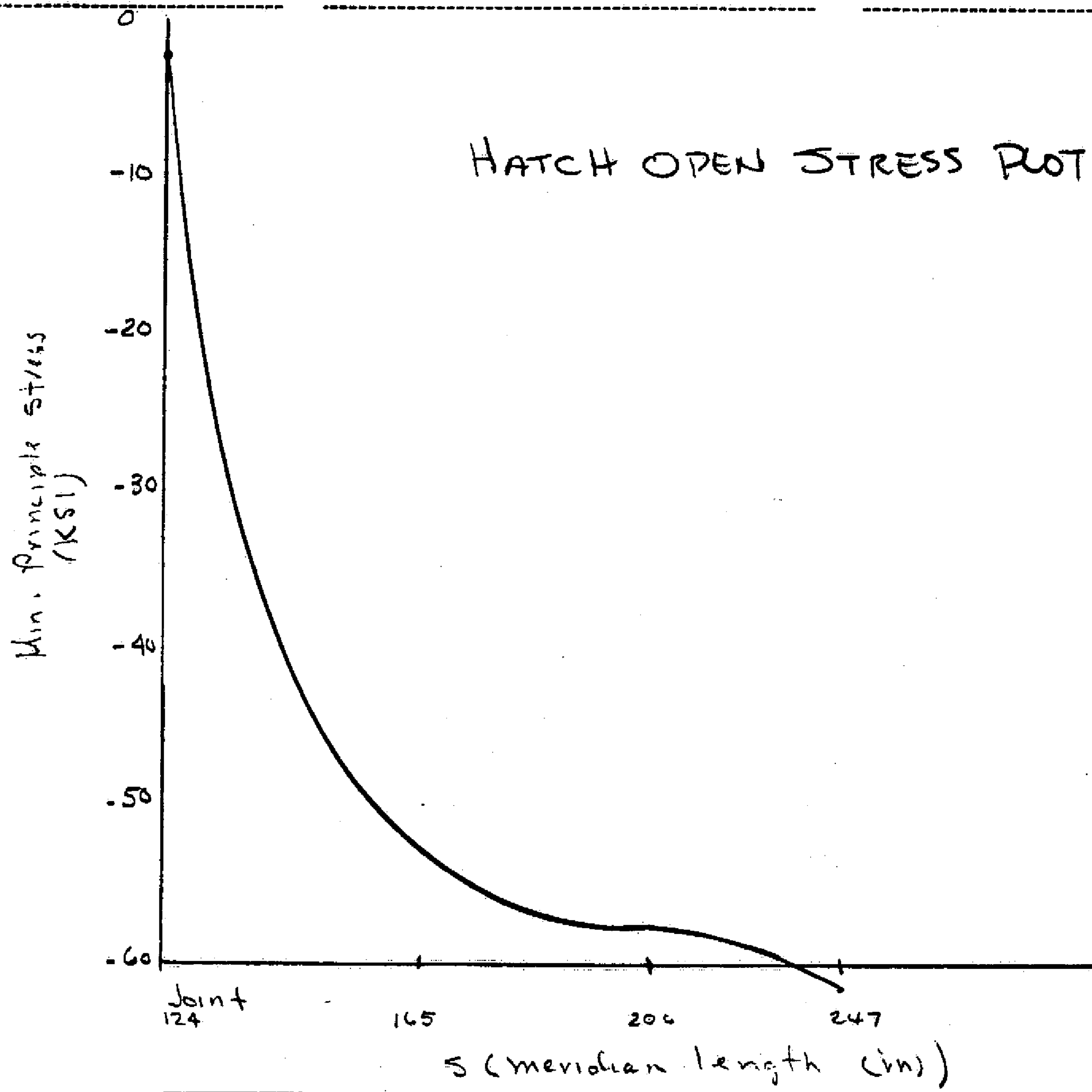
Membrane Stress (intensity)
primary local stress intensity

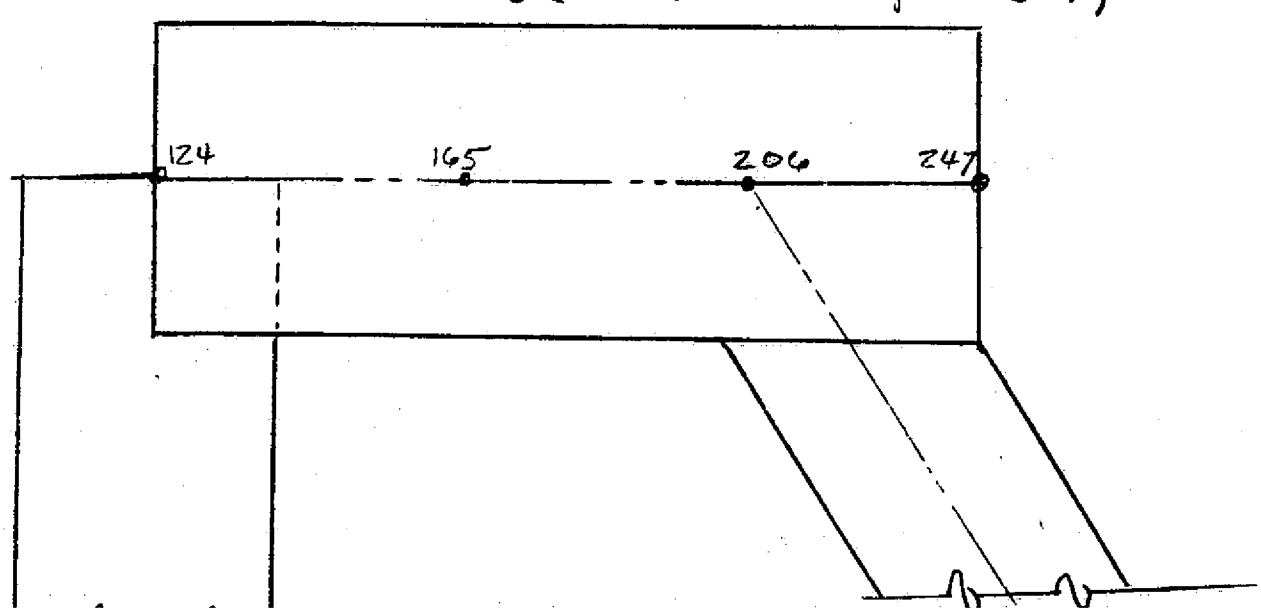


$\sigma_1 = -0.06 KSI$
$\sigma_2 = -61.76 KSI$
$\sigma_3 = 0 KSI$

$S_{12} = -.06 - (-61.76) = +61.70 KSI$
$S_{23} = -61.76 - 0 = -61.76 KSI$
$S_{31} = 0 - (-0.06) = .06 KSI$
$= |-61.76| = 61.76 KSI$

BY ______ DATE ______ SUBJECT ______ SHEET NO. 46 OF ______
CHKD. BY ______ DATE ______ JOB NO. ______





SHAKEDOWN ANALYSIS
FOR HATCH OPENING AREA.

$$P_b + P_m + Q - \text{Thermal} \leq 3S_m$$

from Case I

$$P_b + P_m + Q \leq -7.58 \text{ KSI} \leq 3S_m \quad \text{OK}$$

$S_m = 30$ KSI

$S_n = 62.0$ KSI

$$K_e = 1.0 + \frac{(1-n)}{n(m-1)}\left(\frac{S_n}{3S_m} - 1\right)$$

for $3S_m < S_n < 3mS_m$

$m = 1.7$, $n = .3$

$$60 < 62 < (3)(1.7)(62) = 316.2 \text{ KSI}$$

$$K_e = 1.0 + \frac{(.7)}{.3(.7)}\left(\frac{62}{60} - 1\right) = 1.111$$

THERMAL RATCHET IN SHELL

$$Y' = \frac{S_T}{S_Y} \qquad X = \frac{|-7.56|}{S_Y} = .252$$

$S_y = 30$ KSI

LINEAR VARIATION OF TEMPERATURE THROUGH THE SHELL WALL (CONSTANT)

$$Y' = \frac{1}{X} \text{ for } 0 < X < .5$$

$$Y' = \frac{1}{.252} = 3.964$$

$$S_T = Y' S_y = (3.964)(30) = 118.9 \text{ KSI}$$

$$\therefore \quad P_L + P_B + Q < S_T$$

$$P_L + P_B + Q = 61.76 \text{ KSI} < S_T = 118.9 \text{ KSI}$$ ok

WITH NEW K_c FACTOR $K_c = 1.111$

THE TEMPERATURE DOES NOT EXCEED:

$-320°F <$ TEMPERATURE < 200

AND,

$$\frac{S_y}{S_{ULT}} = \frac{30}{75} = .4 < .8$$

Membrane stress (intensity)
(away from hatch opening)

Primary local Membrane stress intensity
(Node 862)

$\sigma_1 = 20.58$ KSI

$\sigma_2 = -2.30$ KSI

$\sigma_3 = -.06$ KSI

$S_{12} = 20.58 - (-2.30) = 22.88$ KSI

$S_{23} = -2.30 - (-.06) = -2.24$ KSI

$S_{31} = -.06 - 20.58 = -20.64$ KSI

$S = |22.88| = 22.88$ KSI

$P_m = 22.88 < 30.0$ KSI ok

Since the stress intensity is < Sm (30.0KSI)
The stress intensity meets the criteria
for general membrane stress intensity.

GENERAL Membrane stress (Shell, Node 1190)
S = 16.00 KSI < S
16.00 < 18.2KSI ok

This region meets the stress evaluation
criteria for general membrane stress

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PRIMARY PLUS SECONDARY STRESS INTENSITY

(NODE 944)

INSIDE SURFACE

$\sigma_1 = 45.0$ KSI

$\sigma_2 = 15.0$ KSI

$\sigma_3 = -.119$ KSI

$S_{12} = 45 - 15 = 30$ KSI

$S_{23} = 15 - (-.119) = 15.119$ KSI

$S_{31} = -.119 - 45 = -45.119$

$S = |-45.119| = 45.119$ KSI

$P_L + P_b + Q < 3S_m$

45.119 KSI < 60 KSI ok

OUTSIDE SURFACE STRESS
(NODE 944)

$\sigma_1 = 38.0$ KSI

$\sigma_2 = -10.0$ KSI

$\sigma_3 = 0$ KSI

$S_{12} = 38 - (-10) = 48$ KSI

$S_{23} = -10 - 0 = -10$ KSI

$S_{31} = 0 - 38 = 38$ KSI

$S = |48| = 48.0$ KSI

$P_L + P_B + Q < 3S_m$

$48.0 < 60$ KSI OK

THE PRIMARY PLUS SECONDARY STRESS INTENSITY MEETS THE STRESS EVALUATION CRITERIA.

THE TRANSIENT TEMPERATURE DISTRIBUTION SHOWN IN FIGURE 7b WAS A RESULT OF THE UPSTREAM GAS REMAINING AT -300°F, AND THE PLENUM GAS MAINTAINING 100°F.

THE POSSIBILITY OF THIS CONDITION EXISTING IS VERY REMOTE.

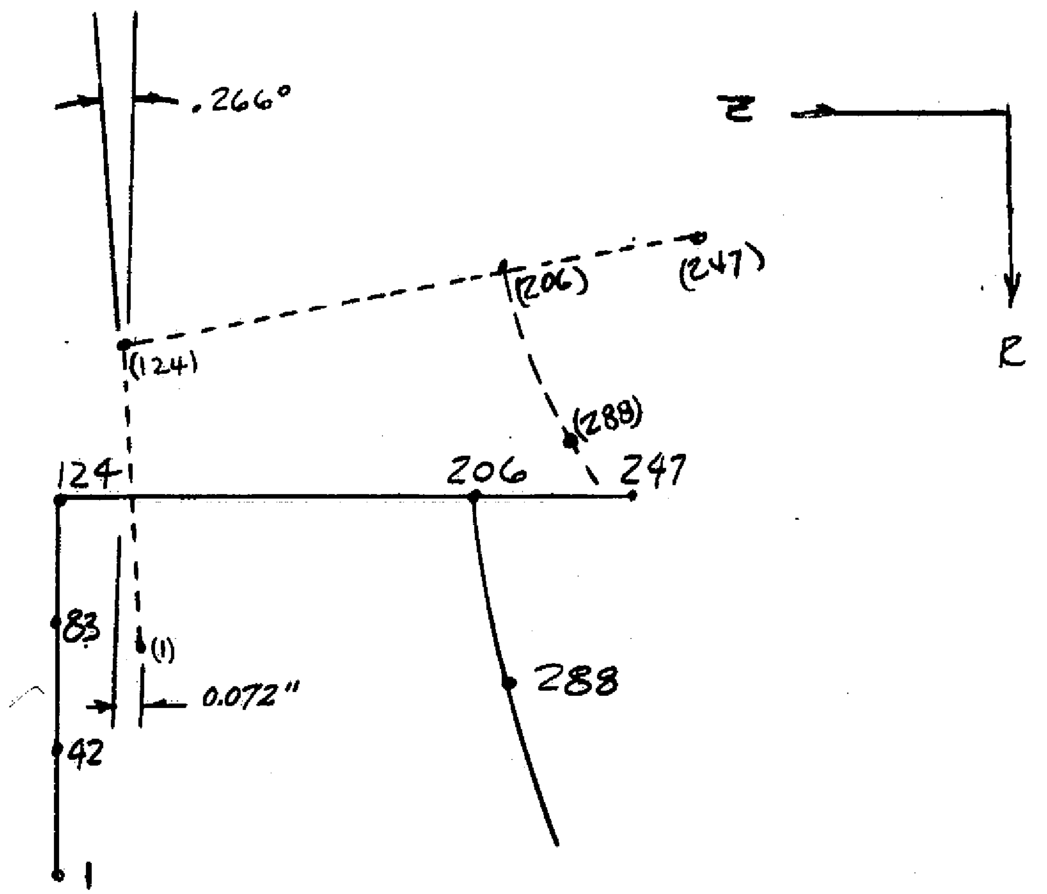
FIRST, HEATERS WOULD HAVE TO BE EMPLOYED TO MAINTAIN THE 100°F IN THE PLENUM AREA.

SECOND THE UPSTREAM GAS CAN NOT BE MAINTAINED AT -300°F WITH OUT SOME HEAT TRANSFER THROUGH THE INSULATION.

THE 62.KSI PEAK THERMAL STRESS ALL THOUGH, ALLOWED BY A SHAKE DOWN ANALYSIS, WILL PROBABLY NEVER OCCURE. HOWEVER, THE WARM UP CYCLE FOR THE PLENUM SHOULD PRECLUDE ANY WARM UP TIME LESS THAN 30 MIN.

THIS ANALYSIS WAS ALSO, RUN ON A BETTER COMPUTER CODE - SRA, TO VERIFY THESE RESULTS.

SEE CASE 2 UNDER SRA COMPUTER ANALYSIS, OF BULK HEAD REGION.



Displacements

Joint	Δ R IN.	Δ Z IN.
1	-0.120	-.367
124	-.0884	-.295
206	-.123	-.299
247	-.135	-.303
288	-.130	-.310
42	-.108	-.341
83	-.0991	-.321

SEA model description

SEA was used to compute a linear and a non-linear stress and displacement responce under symmetric loads.

The structure was assumed to be an axisymmetric structure.
See figure 8 for a computer plot of the meridional surface.
also, shown on the plot is the right-handed triad (S, θ, Z) used in defining:

a. rigid body constraints
b. Model geometry
c. direction of all discreet loads
d. location of all bifrication points

rigid body constraints

Boundary conditions were imposed as shown in figure 8.

On the upstream shell the axial displacement as well as rotations were taken out. This forced the model to generate it's own axial forces when pressure applied across the bulkhead.

On the downstream shell only the rotations were taken out.

Model geometry

as previously stated the structure was axisymmmetric with the exception of the bulkhead flange gussets.

these gussets were modeled as stringers- where their additional stiffness was smeared along both the backside of the fange and bulkhead in the areas of their actual location.

The model was constructed with 31 subsections (the "+" marks on figures 8 thru 11) with stress recovery points at the begining, middle and end of each subsection.

The subsection or fictitious boundaries were inserted to:

a. limit the subinterval length ($\Delta l < 3\sqrt{rt}$)

b. locate rings (indicated on figure 8 by an "O"

c. points of discreet loads.

d. locate a branch point in the shell.

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The bulkhead insulation rings were included in this model.
They were input as discreet ring properties at the ring's centroid located relative to the shells surface.

all taper thickness were modeled as tapers.

See figure 9 which is a computer profile plot with the various section thickness noted.

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Loadings

The following cases were run:

Case 1. Gate Valve Closed

Case 2. Gate Valve Closed
w/ Transient temperature distribution.
30 min. warm up. time

Case 3. Gate Valve Closed
w/ TRANSIENT TEMPERATURE
DISTRIBUTION.
4 HOUR WARMUP TIME

Case 1 Gate Valve Closed

For this loading configuration the following loads were applied to the model: (see fig 11)

P_1 = 119 psia
P_2 = 0 psia
P_3 = 0 psia
LG = $P_1 R/2$ = 119 x 84.0 /2 = 4998 lbs/in

BY ______ DATE ______ SUBJECT ______ SHEET NO. 61 OF ______
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Case 2 Gate Valve Closed w/
transient temp. dist.
(30 min. warm up)

For this loading case the following loads were applied to the model:
(See figure 11)

$P_1 = 119.0$ PSIG
$P_2 = 0.0$ PSIG
$P_3 = 0.0$ PSIG
$LG = P_1 R/2 = 119 \times 84.0/2 = 4998$ lb/IN

The transient temperature distributions vs. joint locations are shown on the next page. See figure 10 to find the relative joint location with respect to the model

also, see figure 7b

BY ______ DATE ______ SUBJECT ______ SHEET NO. 62 OF ______
CHKD. BY ______ DATE ______ JOB NO. ______

Transient temp. dist. Gate Valve Closed

$T_{ref} = 200°R$
$\alpha = .730 \times 10^{-5}$ IN/IN°F

or $T_{ref} = -260°F$

		$\alpha(T-T_{ref})$
1	0.	.000000
3	0	.000000
4	50.	.000365
6	350.	.002555
7	356.	.002599
10	350.	.002555
14	94.	.000686
17	0.	.000000
20	0.	.000000
32	73.	.000533
35	129.	.000942
38	197.	.001438
41	20.	.000146
45	282.	.002059
46	305.	.002227
66	300.	.002190
67	357.	.002606
78	334.	.002438
79	300.	.002190
93	324.	.002365

The merdian and circumferential thermal strains (θ_s, θ_ϕ) are defined to be

$$\theta_s = \int_{t_0}^{t} \alpha_s \, dt \; , \quad \theta_\phi = \int_{t_0}^{t} \alpha_\phi \, dt .$$

$$\alpha = \alpha_s = \alpha_\phi = \text{constant} \quad \therefore \; \theta_s = \theta_\phi = \alpha T$$

Case 3 Gate Valve Closed w/
transient temp. dist.
(4 hour warm up time)

For this loading case the following loads were applied to the model: (See figure 11)

$P_1 = 119.0$ psia
$P_2 = 0$ psia
$P_3 = 0$ psia
$LG = P_1 R/2 = 119 \times 84.0/2 = 4998$ lb/in.

The transient temperature distributions vs. joint locations are shown on the next page. See figure 10 to find the relative joint location with respect to the model.

Also, see figure 7C.

Transient - Gate Value Closed

$t = 4.0$ Hours

JOINT	T-TREF °R	α(T-TREF)
1	0.	.0
3	0.	.0
4	55.	.000293
6	347.	.00185
7	355.	.001892
10	347.	.00185
14	124.	.000661
17	8.	.000043
20	5.	.000027
32	47.	.000251
35	82.	.000437
38	140.	.000746
41	205.	.001093
45	280.	.001492
46	223.	.00189
66	300.	.001599
67	355.	.001892
78	300.	.001599
79	300.	.001599
93	323.	.001722

Tref = 200. °R
$\alpha = .533 \times 10^{-5}$ IN/IN°F
or Tref = -260°F

The merdian and circumferential thermal strains (Θ_s, Θ_ϕ) are defined to be

$\Theta_s = \int_{t_0}^{t} \alpha_s \, dt \quad \Theta_\phi = \int_{t_0}^{t} \alpha_\phi \, dt$.

$\alpha = \alpha_s = \alpha_\phi = \text{Constant} \quad \therefore, \ \Theta_s = \Theta_\phi = \alpha T$

BY ______ DATE ______	SUBJECT ______	SHEET NO. 65 OF ______
CHKD. BY ______ DATE ______		JOB NO. ______

Stress and buckling results

Note: a definition on how to read the following data.

Figure 8 is a reference surface plot of the model indicating the + s and z direction. The inside surface shall be defined as the reference surface and the outside surface as measured in the z direction away from the reference surface.

See figure 9, the inside surface shall shall be the continious line with "+" indicated on it. the outside surface will then be the continious line next to it.

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Figure 10 is a plot showing the node loctions the double numbers indicates the end then the begining of a subsegment, the triple numbers a branch points.

BY______ DATE______ SUBJECT______ SHEET NO. 64 OF______
CHKD. BY______ DATE______ JOB NO.______

The integer numbers shown on figure 11 Corespond to the integers shown on figure 12.

Here they indicate the different regions of the model relative to the Continious meridian al distance.

Results load Case 1

Valve Closed

From computer run AG7 and shown in figures 12, 13, 14 are stress plots of σ_{Hoop} and $\sigma_{meridian}$ vs. meridian distance.

Figure 12 is a numerical average of the inside and outside surface stresses, in the circumferential and meridian directions.

Figure 13 outside surface stresses in the circumferential and meridian directions.

Figure 14 inside surface stresses in the circumferential and merdian directions.

Primary plus Secondary stress intensity

inside surface.

$\sigma_1 = -15.$ ksi

$\sigma_2 = -12.4$ ksi

$\sigma_3 = -.119$ ksi

$S_{12} = -15. - (-12.4) = -2.6$ ksi

$S_{23} = -12.4$ ksi $- (-.119) = -12.281$ ksi

$S_{31} = -.119 - (-15.0) = -14.881$ ksi

$S = |-14.881| = 14.881$ ksi

$P_L + P_b + Q < 3S_m$

$14.881 < 3S_m = 60$ ksi OK

Out side Surface

$\sigma_1 = -10.0$ KSI

$\sigma_2 = 2.8$ KSI

$\sigma_3 = 0$ KSI

$S_{12} = -10 - 2.8 = -12.8$ KSI

$S_{23} = 2.8 - 0 = 2.8$ KSI

$S_{31} = 0 - (-10) = +10$ KSI

$S = |-12.8| = 12.8$ KSI

$P_L + P_b + Q < 3 S_m$

12.8 < 60 KSI OK

The primary plus secondary stress intensity meets the stress evaluation criteria.

Membrane Stress (intensity)

Primary local Membrane stress intensity

(See fig 12)

$\sigma_1 = 5.$ KSI

$\sigma_2 = -3.$ KSI

$\sigma_3 = -.06$ KSI

$S_{12} = 5 - (-3) = 8.0$ KSI

$S_{23} = -3. - (-.06) = -2.94$ KSI

$S_{31} = -.06 - 5. = -5.06$ KSI

$S = |8.0| = 8.0$ KSI

$P_m = 8.0 < 20.0$ KSI ok

Since the stress intensity is < Sm (20 KSI) The stress intensity meets the criteria for general membrane stress intensity

General Membrane stress

$S = 15.53$ KSI $< 18.2 = S$ OK

This region meets the stress evaluation criteria for general Membrane stress.

BY ______ DATE ______	SUBJECT ______	SHEET NO. 72 OF ______
CHKD. BY ______ DATE ______	______	JOB NO. ______

Bifurcation buckling of bulkhead.

There were several runs made to determine the critical load factor for the Bulkhead region. Here the "prestressed "Value Closed" condition was run. The loading condition generated the maximum pressure differential across the bulkhead (P = 119 psig). Early attempts to extract an eigenvalue generated negative eigen values bifurcating on the shell. A step wise proceedure of shifting The eigen value was adopted untill a positive eigenvalue was generated.

The following table sumarizes the eigen value solution, which indicates that the minimum critical load factor of 26.58 when applied To the 119 PSI external pressure would require a pressure of 3163. psi before buckling would accure.

BY	DATE	SUBJECT	SHEET NO. 73 OF
CHKD. BY	DATE		JOB NO.

Value Closed loading condition
Bifurcation Buckling load factor

Harmonic Number	λ	Location	Node
2	26.58	Bulkhead	14
3	28.89	"	14
4	35.17	"	1
5	41.78	"	15,16
6	48.85	"	17
7	56.30	"	17
8	-43.52	Shell	51,52
9	-32.03	"	51,52
10	-25.46	"	51,52

Also, along with the linear analysis a non-linear analysis was performed with a load factor of 26 on a prestressed structure, using a 119 PSI pressure, an estimated load factor of $\lambda_c = 25.30$ was found.

Which is in good agreement with the linear bifurcation buckling analysis.

Results load Case 2

Gate Valve Closed w/ Tran, Temp dist.

w/ 30 Min warm up time

BY ________ DATE ________ SUBJECT ________ SHEET NO. 16 OF ________

CHKD. BY ________ DATE ________ JOB NO. ________

From computer run NMW and shown in figures 15, 16 and 17 are stress plots of σ_{HOOP} and $\sigma_{meridian}$ vs. meridian length.

Figure 15 is a numerical average of the inside and outside surface stresses in the circumferential and meridian directions

Figure 16 outside surface stresses in the circumferential and meridian directions.

Figure 17 inside surface stresses in the circumferential and meridian directions.

MEMBRANE STRESS (INTENSITY)

PRIMARY LOCAL MEMBRANE STRESS INTENSITY

$\sigma_1 = 22.0$ KSI

$\sigma_2 = -3.0$ KSI

$\sigma_3 = -.06$ KSI

$S_{12} = 22 - 3 = 25$ KSI

$S_{23} = -3 - (-.06) = -2.94$ KSI

$S_{31} = -.06 - 22 = -22.06$ KSI

$S = |25.0| = 25$ KSI

$P_L = 25 < 30$ KSI $= 1.5 S_m$ OK

$\sqrt{RT} = 20.6''$ EXCURSION LENGTH = 4"

SINCE THE STRESS INTENSITY IS $< 1.5 S_m$ THE STRESS INTENSITY MEETS THE CRITERIA FOR LOCAL MEMBRANE STRESS INTENSITY.

GENERAL MEMBRANE STRESS

$S = 15.5$ KSI $< 18.2 = S$ ok

THIS REGION MEETS THE STRESS EVALUATION CRITERIA FOR GENERAL MEMBRANE STRESS.

THERMAL STRESSES

PRIMARY PLUS SECONDARY STRESS INTENSITY

INSIDE SURFACE

$\sigma_1 = 20.0$ KSI

$\sigma_2 = -45.5$ KSI

$\sigma_3 = -.119$ KSI

$S_{12} = 20 - (-45.5) = 65.5$ KSI

$S_{23} = -45.5 - (-.119) = 45.38$ KSI

$S_{31} = -.119 - 20 = -20.119$ KSI

$S = |65.5|$ KSI

SEE SHAKE DOWN ANALYIS
FOR THIS TRANSIENT
TEMPERATURE PROFILE
STRESS ANALYSIS, THAT
WAS RUN ON SPAR.

$S_T = 118$ KSI

$65.5 < 118$ KSI OK

THERMAL STRESSES

PRIMARY PLUS SECONDARY STRESS INTENSITY

OUTSIDE SURFACE

$\sigma_1 = 0$ KSI

$\sigma_2 = -54.5$ KSI

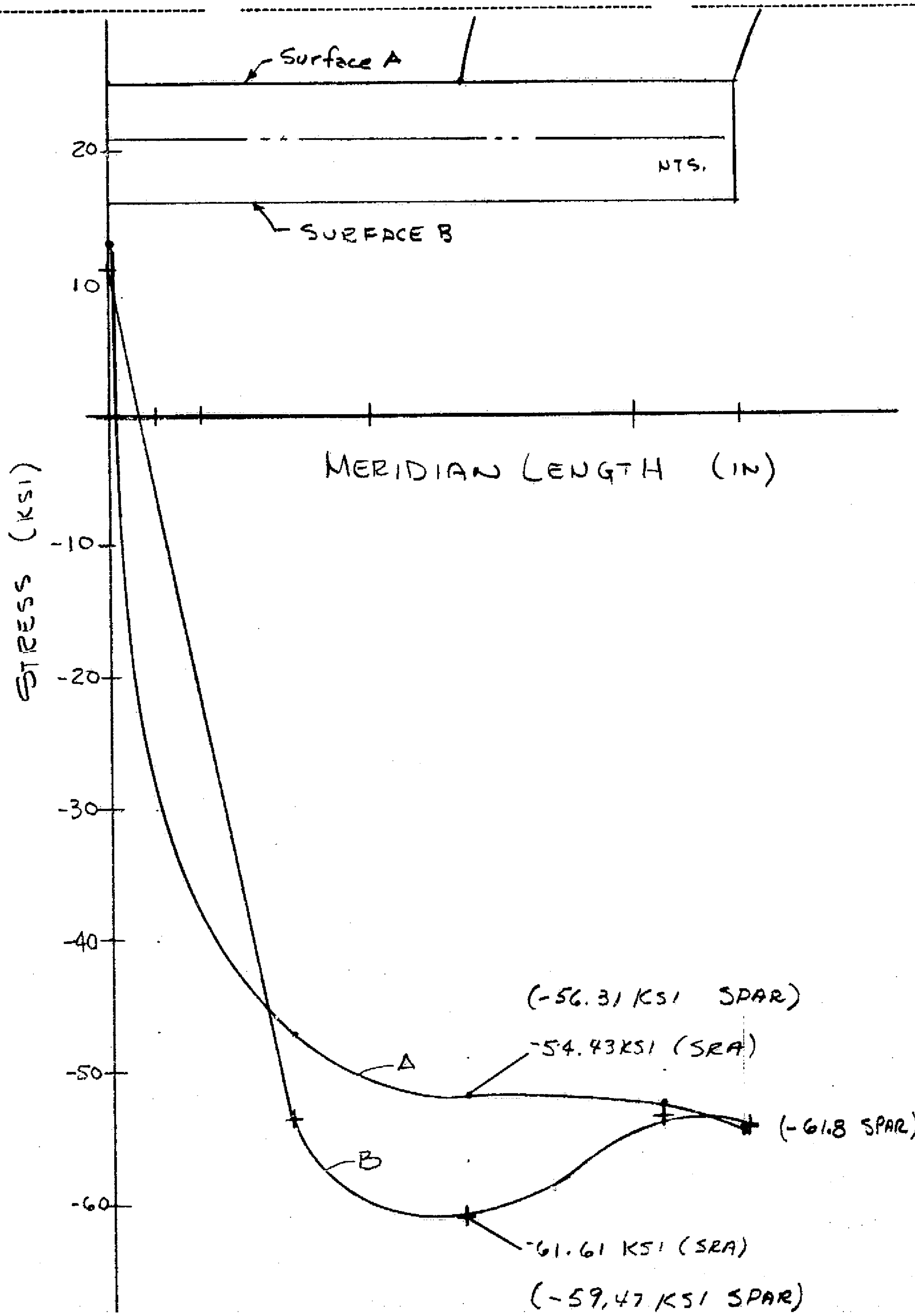
$\sigma_3 = 0$ KSI

$S = |-54.5| = 54.5$ KSI

$P_L + P_B + Q = 54.5 < 60$ KSI OK

THE PRIMARY PLUS SECONDARY STRESS MEET THE STRESS EVALUATION CRITERIA.

BY ________ DATE ________ SUBJECT ________ SHEET NO. 80 OF ______
CHKD. BY ______ DATE ________ JOB NO. ________



Valve Closed Transient temperature critical load factors:

Buckling analysis
(warm up time 30 min)

Harmonic Number	λ	Location	Node
2	22.80	Bulkhead	14
3	27.36	"	15,16
4			
5	-		
6			
7			
8			
9			
10			

BY______________ DATE__________ SUBJECT____ SHEET NO. 82 OF______

CHKD. BY_______ DATE__________ JOB NO.____________________

Results load Case 3

Gate Valve Closed w/ Tran. Temp dist.

w/ 4 Hour warm up time.

From computer run ESS and shown in figures 18, 19, and 20 are stress plots of σ_{hoop} and $\sigma_{meridian}$ vs. meridian length.

Fig. 18 is a numerical average of the inside and outside surface stresses in the circumferential and meridian directions.

Fig. 19 outside surface stresses in the circumferential and meridian directions.

Fig. 20 inside surface stresses in the circumferential and meridian direction.

MEMBRANE STRESS (INTENSITY)

PRIMARY LOCAL MEMBRANE STRESS INTENSITY
THERMAL

$\sigma_1 = -39.1$ KSI
$\sigma_2 = 0$ KSI
$\sigma_3 = -.06$ KSI

$S_{12} = -39.1 - 0 = -39.1$ KSI
$S_{23} = 0 - -.06 = .06$ KSI
$S_{31} = -.06 - 39.1 = -39.16$ KSI
$S = |-39.16| = -39.16$ KSI

$P_L + P_B + Q = 39.16$ KSI
$P_L + P_B + Q < 3S_m = 60$ KSI OK

GENERAL MEMBRANE STRESS

$S = 15.59$ KSI $< 18.2 = S$ OK

THIS REGION MEET THE STRESS EVALUATION CRITERIA FOR GENERAL MEMBRANE STRESS.

INSIDE SURFACE

$\sigma_1 = -39.1$ KSI

$\sigma_2 = 0$ KSI

$\sigma_3 = -.119$ KSI

$S_{12} = -39.1 - 0 = -39.1$ KSI

$S_{23} = 0 - (-.119) = .119$ KSI

$S_{31} = -.119 - (-39.1) = 38.981$ KSI

$S = |-39.1| = 39.1$ KSI

$P_L + P_b + Q < 3S_m$

$P_L + P_b + Q = 39.1 < 60$ KSI ok.

OUTSIDE SURFACE

$\sigma_1 = -39.1$ KSI

$\sigma_2 = 0.$ KSI

$\sigma_3 = 0.$ KSI

$S_{12} = -39.1 - 0 = -39.1$ KSI

$S_{23} = 0 - 0 = 0$

$S_{31} = 0 - (-39.1) = 39.1$ KSI

$S = |39.1| = 39.1$ KSI

$P_L + P_b + Q = 39.1 < 3S_m = 60$ KSI

THE PRIMARY PLUS SECONDARY STRESS INTENSITY MEETS THE STRESS EVALUATION CRITERIA.

Valve closed transient Temp.

Critical load factor:

Buckling analysis

(warm up time 4 Hours)

Harmonic Number	λ	Location	Node.
2	23.47	BULKHEAD	14
3	25.63	"	14
4	35.26	"	14

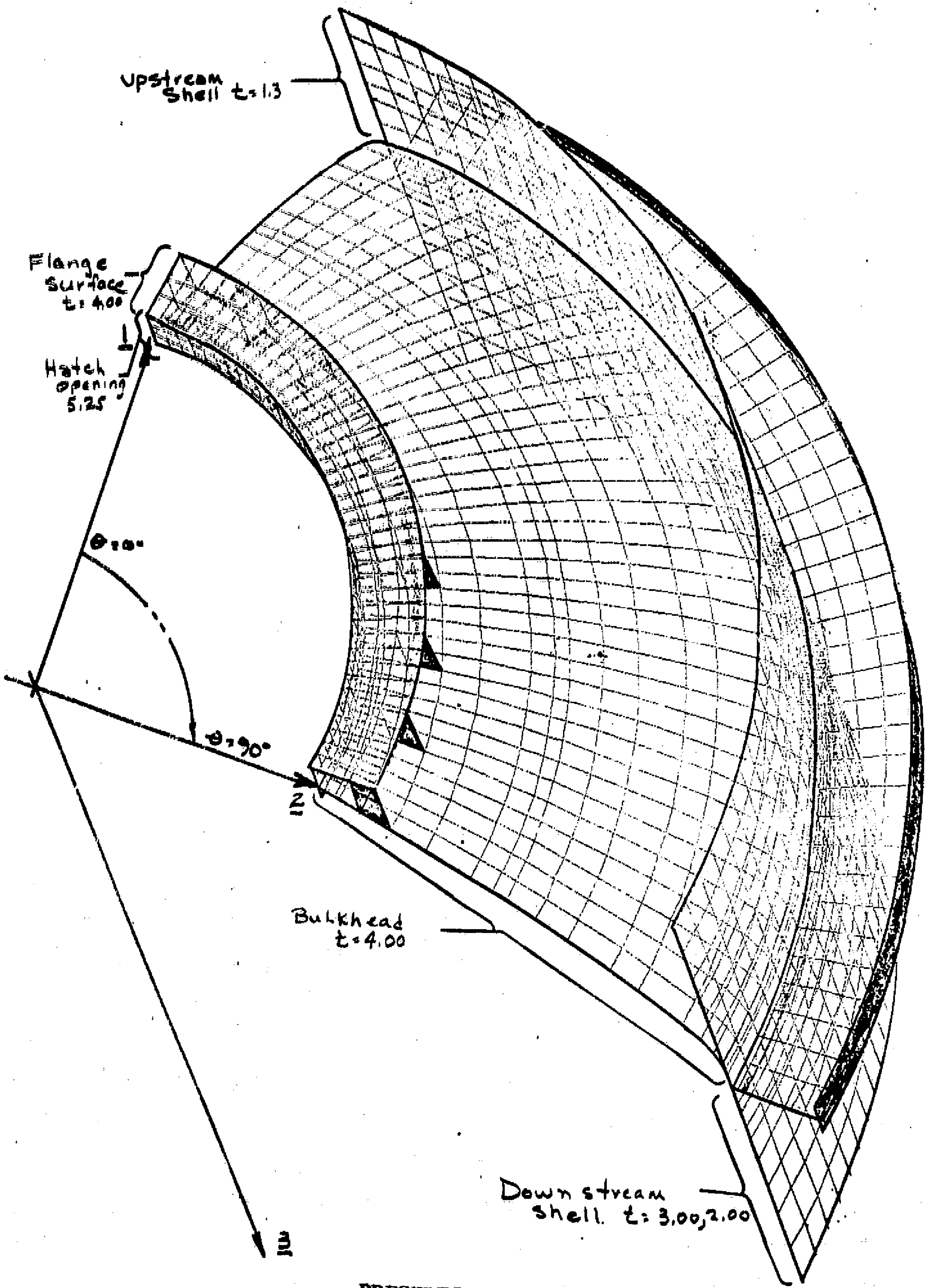


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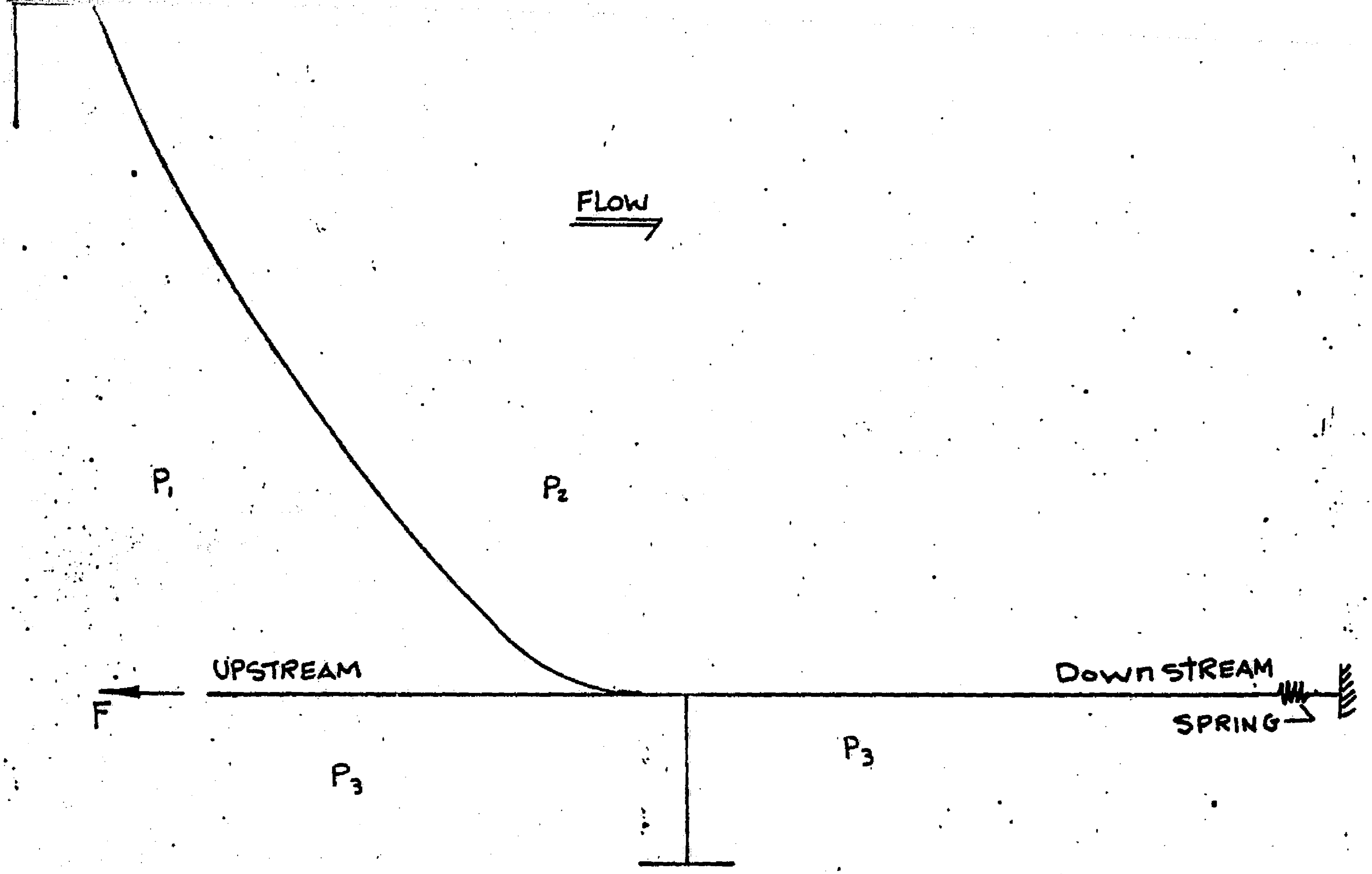
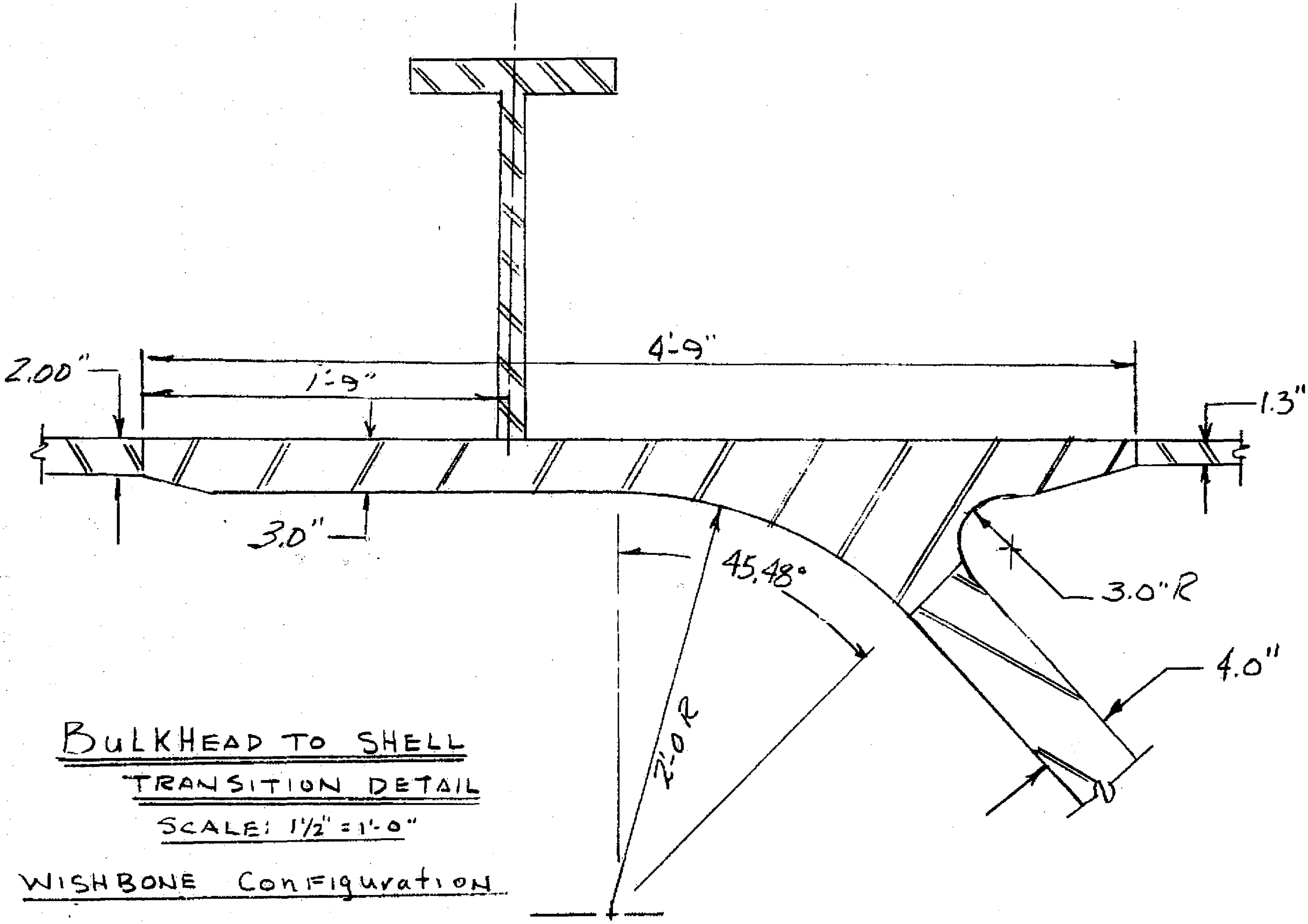
FIG. 1

NTF BULKHEAD



NTF BULKHEAD
CROSS SECTION. VIEW

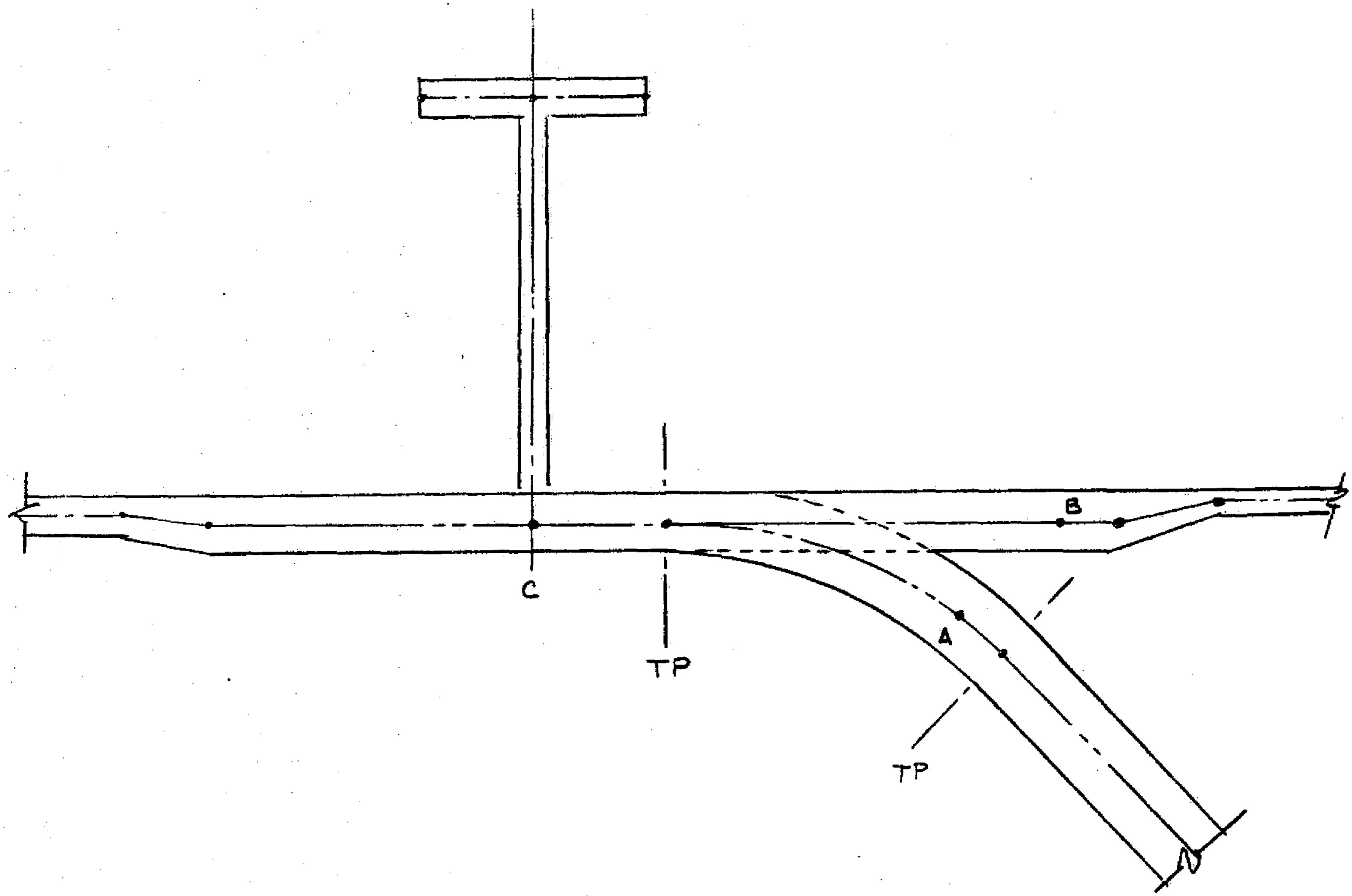


BULKHEAD TO SHELL
TRANSITION DETAIL
SCALE: 1½" = 1'-0"

WISHBONE CONFIGURATION

FIG. 3.

BY ______ DATE ______
CHKD. BY ______ DATE ______
SUBJECT ______
SHEET NO. ______ OF ______
JOB NO. ______



WISHBONE CONFIGURATION

The way it was modeled on SPAR & SRA

FIG. 4

BY ________ DATE ________
CHKD. BY ________ DATE ________
SUBJECT ________
SHEET NO. ________ OF ________
JOB NO. ________

BY ______________ DATE _________ SUBJECT ____ SHEET NO. _________ OF ______

CHKD. BY ________ DATE ________ JOB NO. ____________________

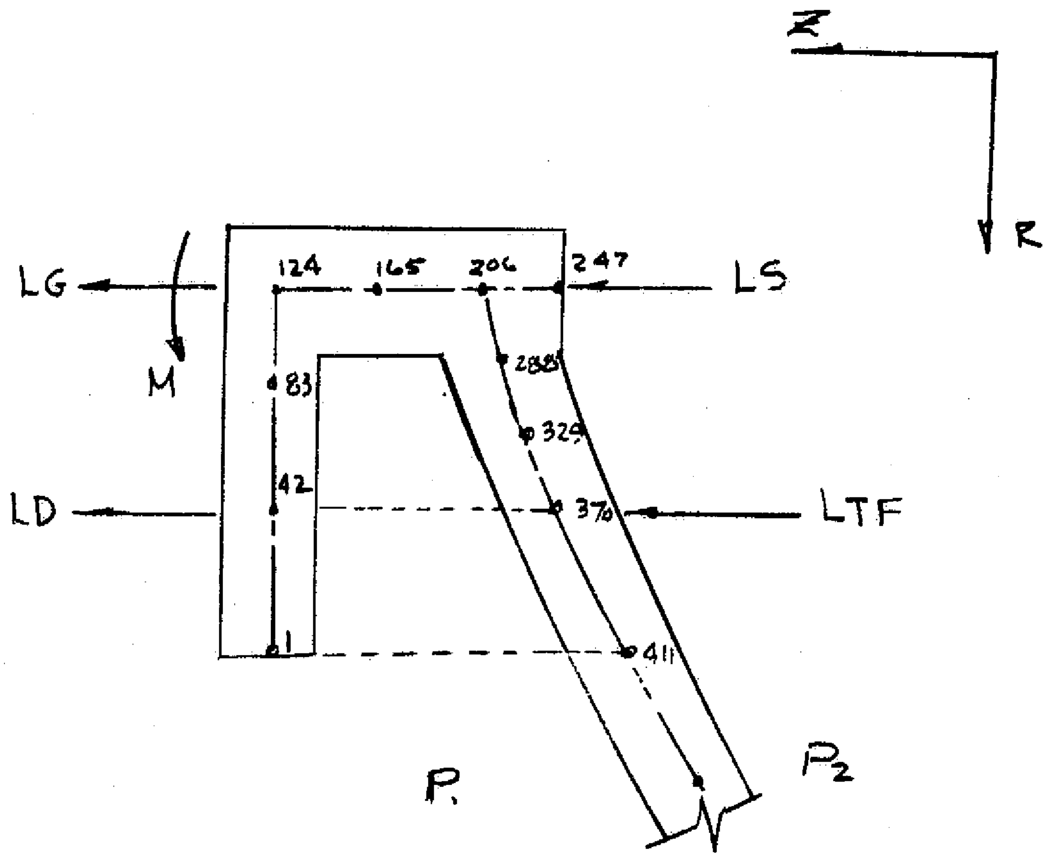
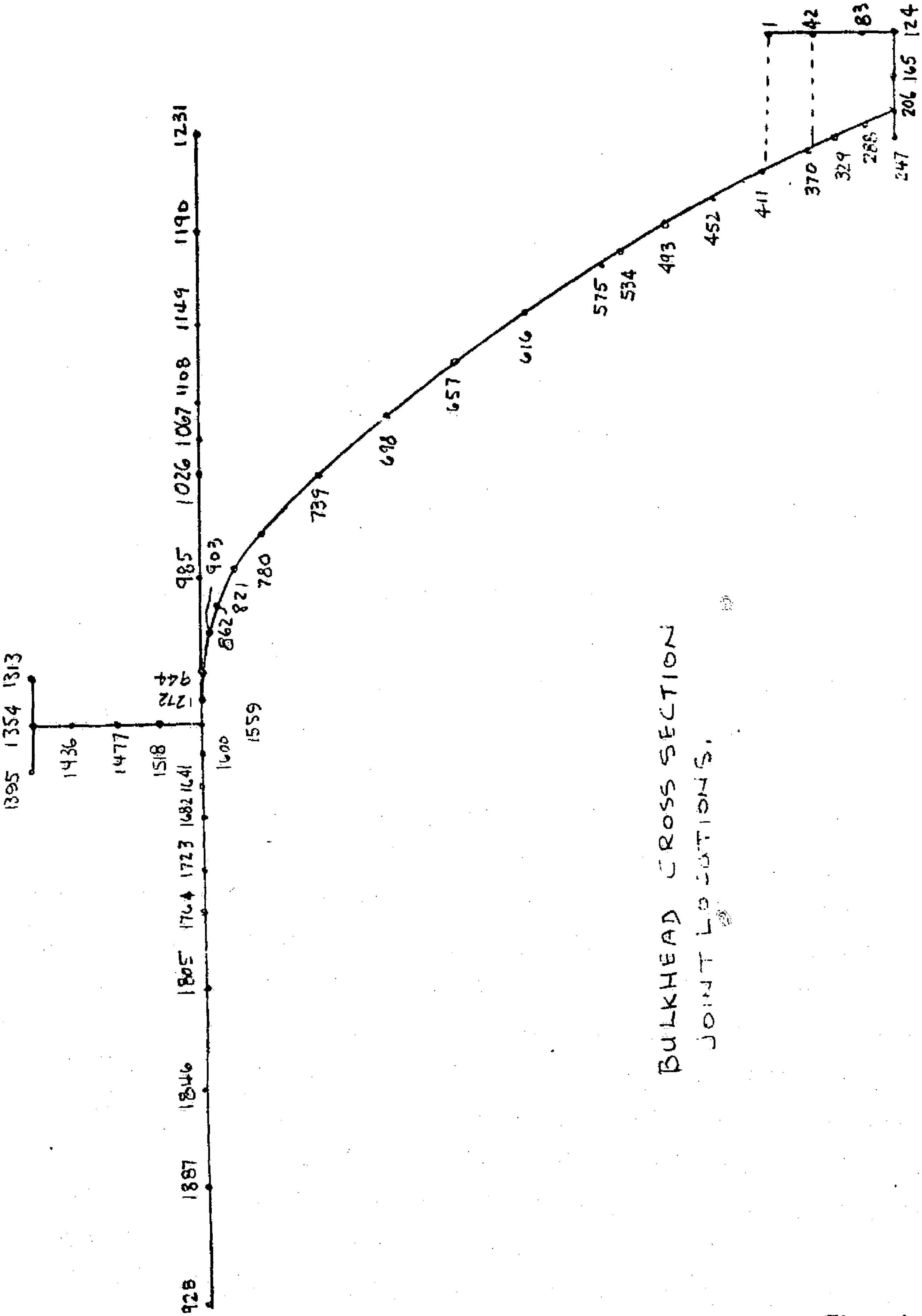


FIG 5

BY ______ DATE ______ SUBJECT ______ SHEET NO. ______ OF ______

CHKD. BY ______ DATE ______ JOB NO. ______



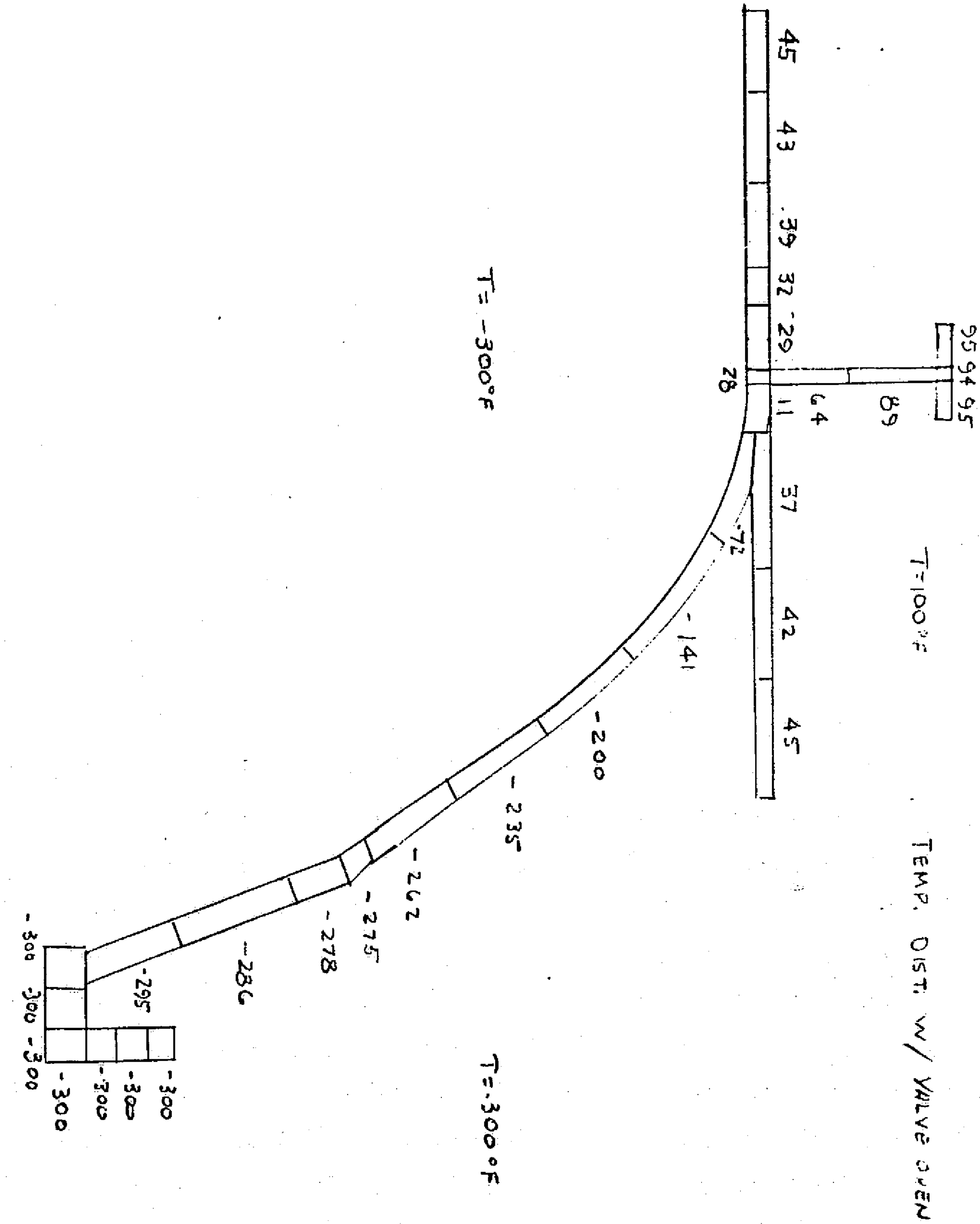
BULKHEAD CROSS SECTION
JOINT LOCATIONS.

FIG 6

BY ______ DATE ______ SUBJECT ______ SHEET NO. ______ OF ______

CHKD. BY ______ DATE ______ JOB NO. ______

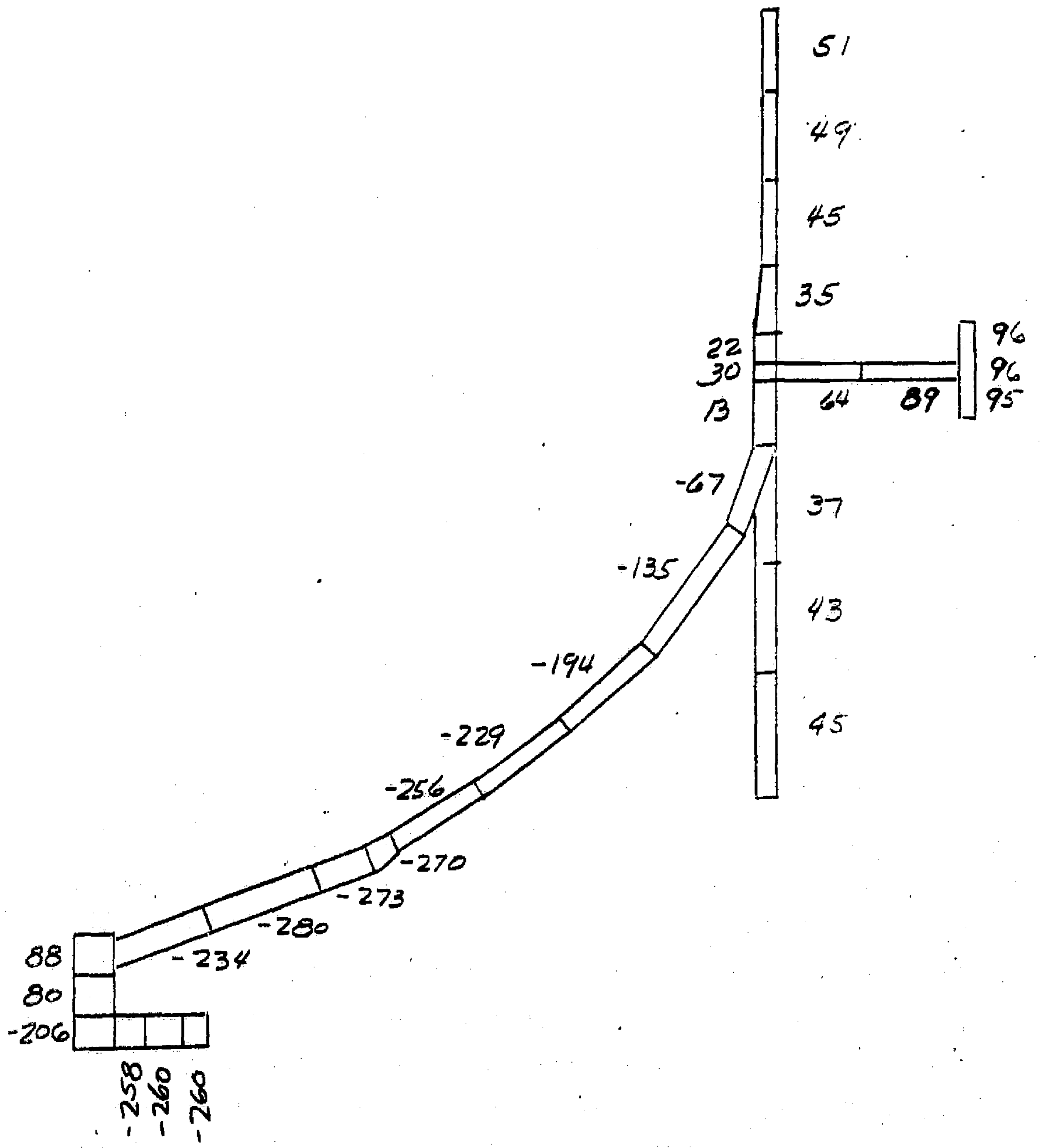
Steady State



TEMP. DIST. W/ VALVE OPEN

FIG. 7a

BY.............. DATE.......... SUBJECT Transient Temp. dist. Heat up time 30 MIN. SHEET NO.......... OF......
CHKD. BY........ DATE.......... JOB NO....................



(HEAT UP TIME OF 30 MIN) FIG. 7b

BY________ DATE________ SUBJECT____________________ SHEET NO.______ OF______
CHKD. BY______ DATE________ JOB NO.____________

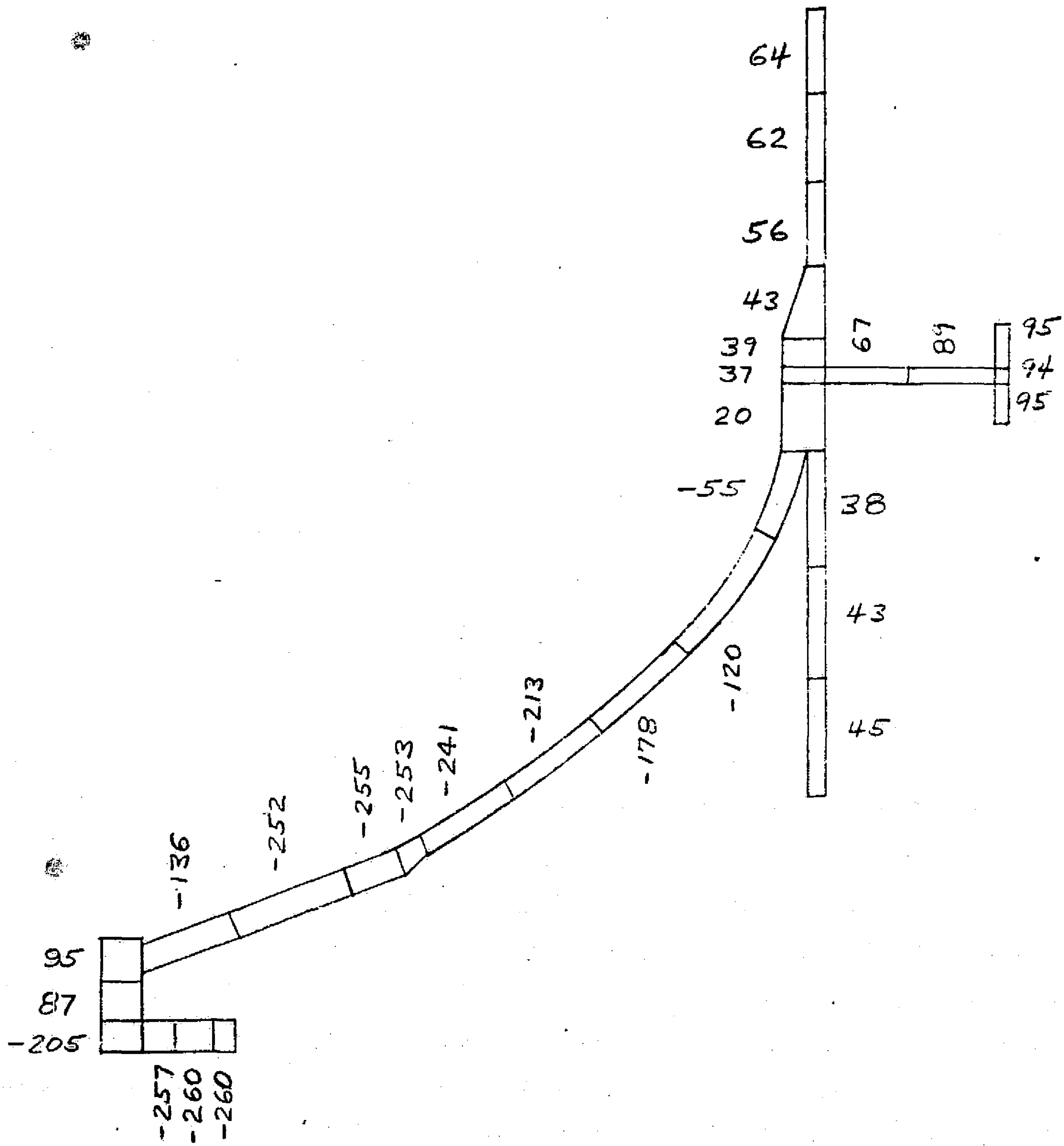
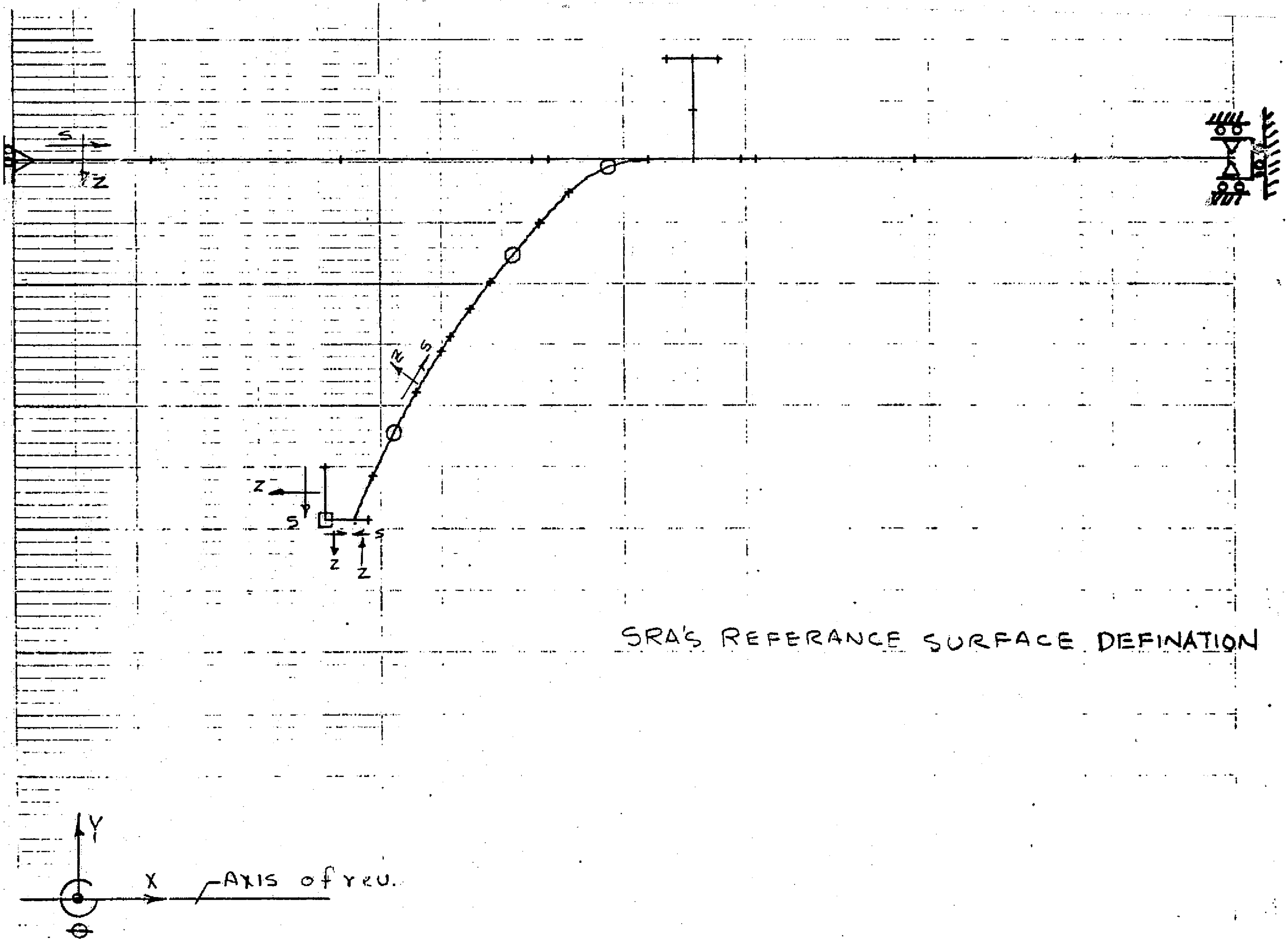


FIGURE - 7c

(HEAT UP TIME OF 4 HOURS)



SRA'S REFERANCE SURFACE DEFINATION

UTF BULKHEAD

PROFILE PLOT

304 S.S.

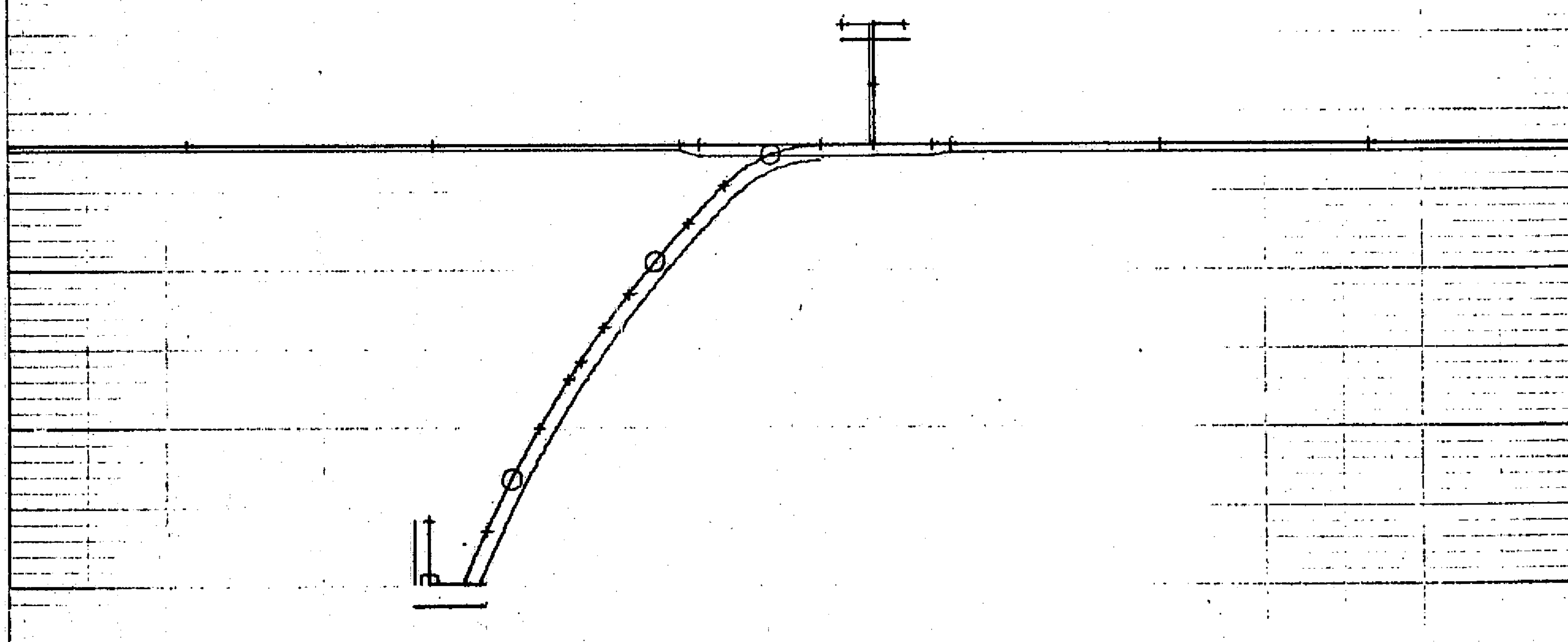
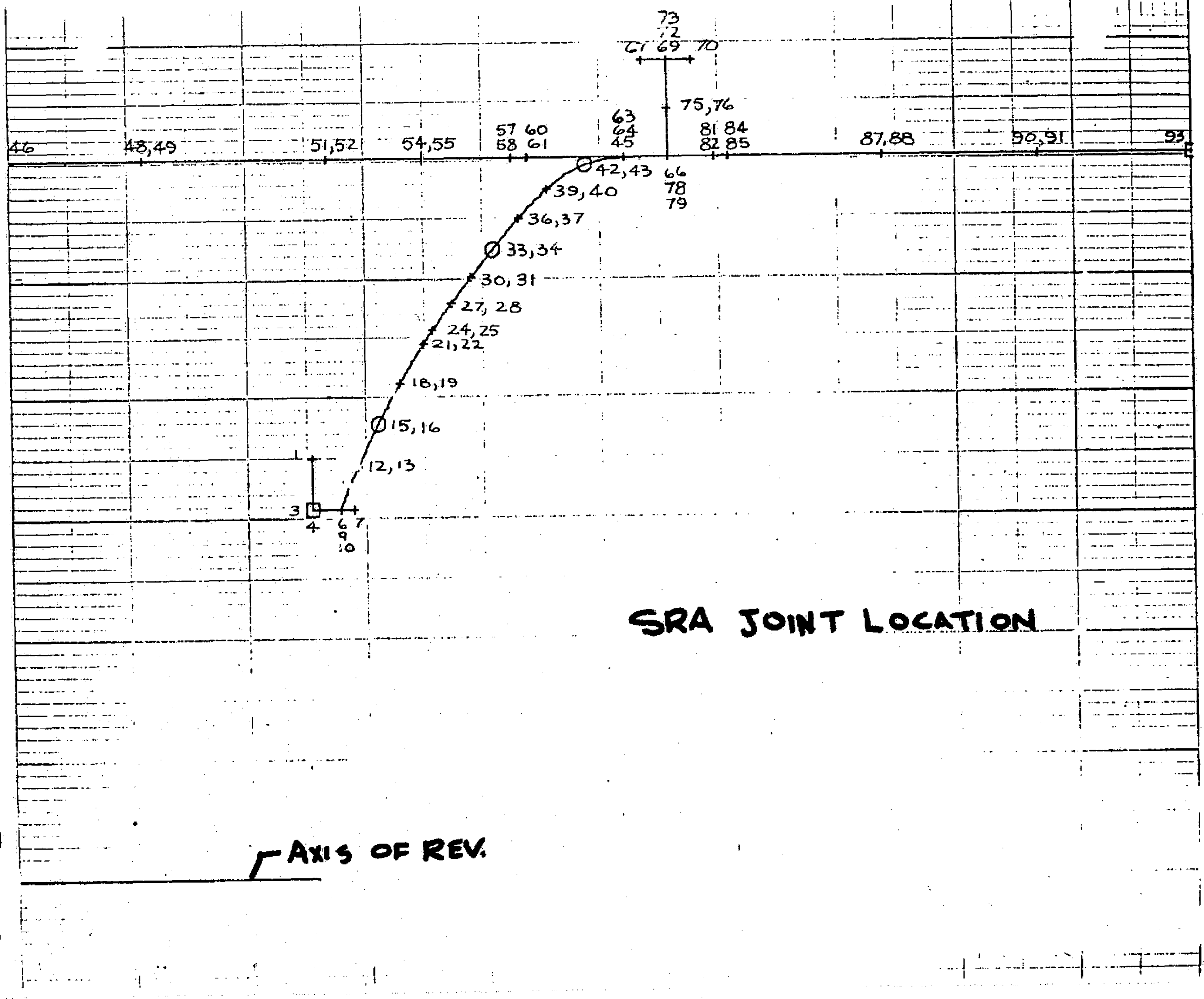


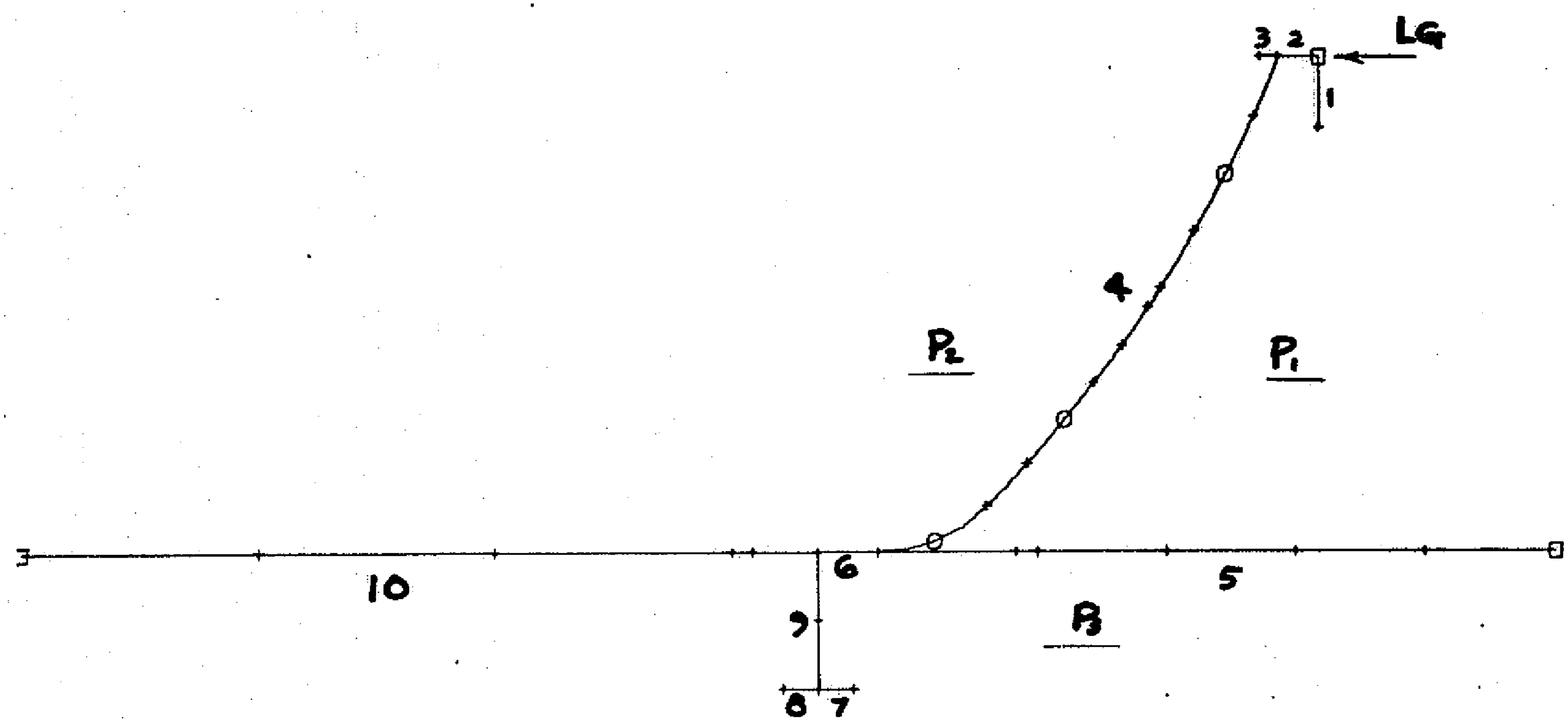
FIG. 9



46
48,49
51,52
54,55
57 58
60 61
63 64 45
73 72
67 69 70
75,76
81 82
84 85
87,88
90,91
93
42,43
66 78 79
39,40
36,37
33,34
30,31
27,28
24,25
21,22
18,19
15,16
12,13
1
3
4
6 9 10
7
SRA JOINT LOCATION
AXIS OF REV.

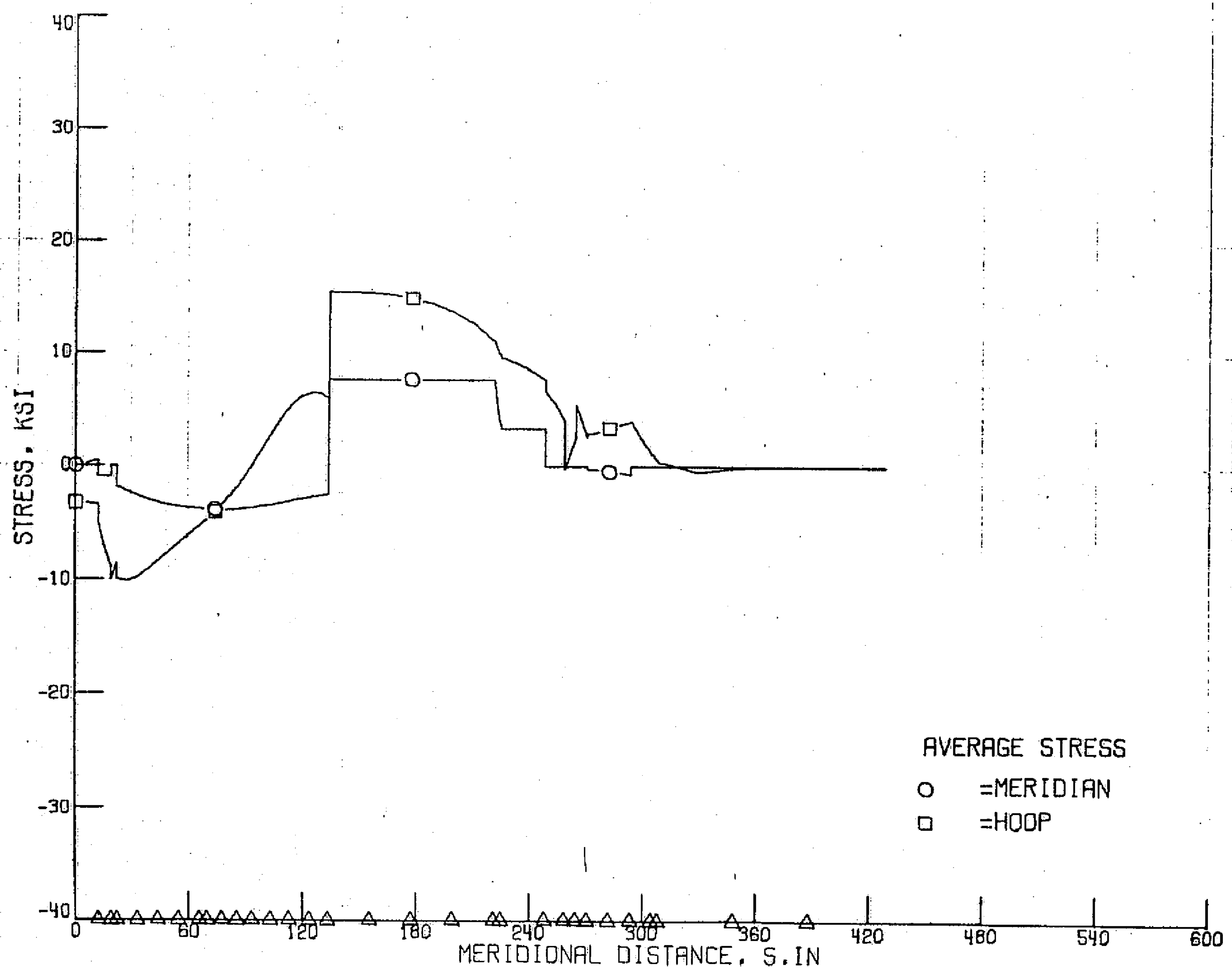
FIG. 10

NTF BULKHEAD LRC1 CONF. W/ INS. T RINGS



SRA REGION LOCATION

FIG. 11



STRESS, KSI
40
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480
540
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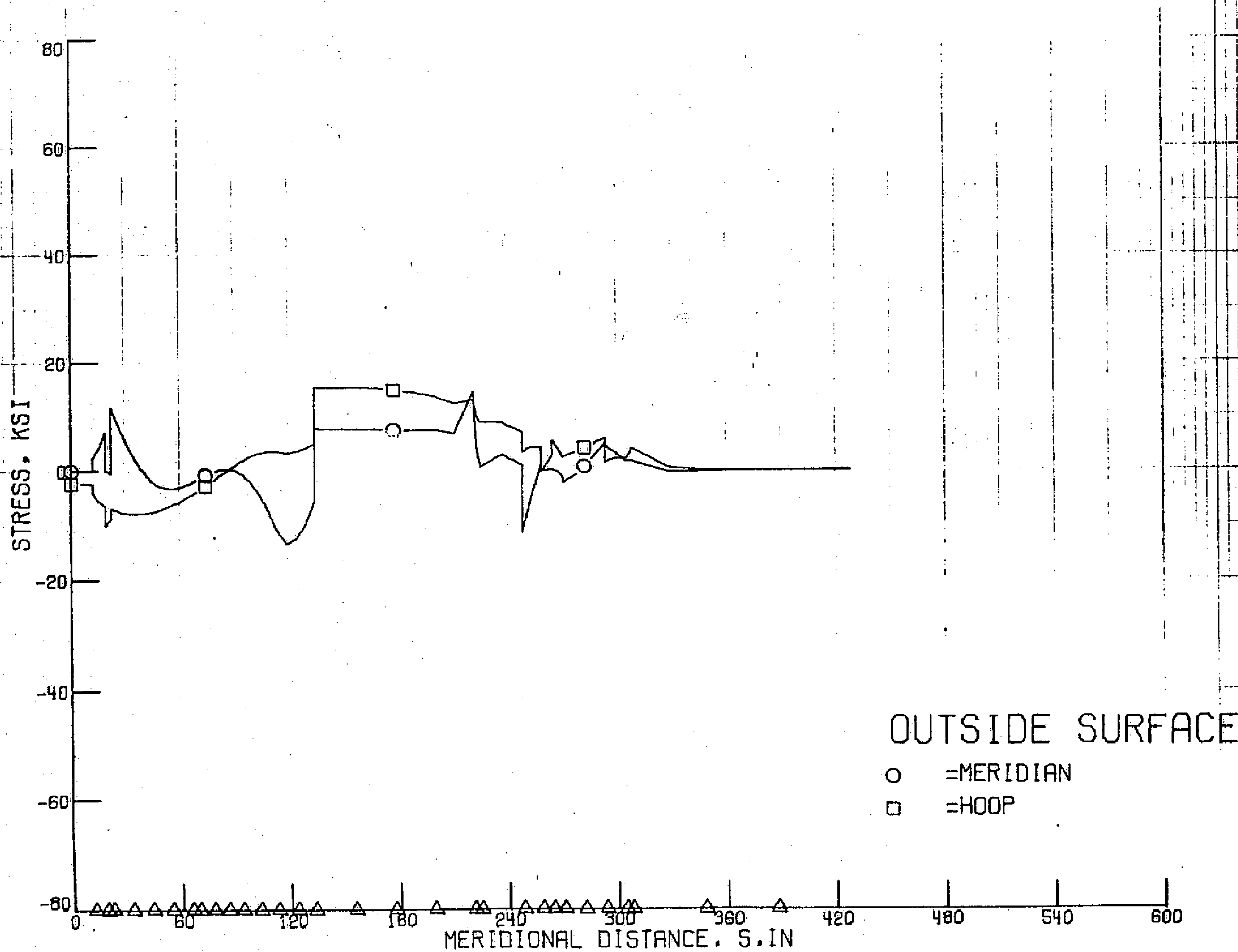
MERIDIONAL DISTANCE, S.IN
AVERAGE STRESS
○ =MERIDIAN
□ =HOOP

FIG 12



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-80
STRESS, KSI
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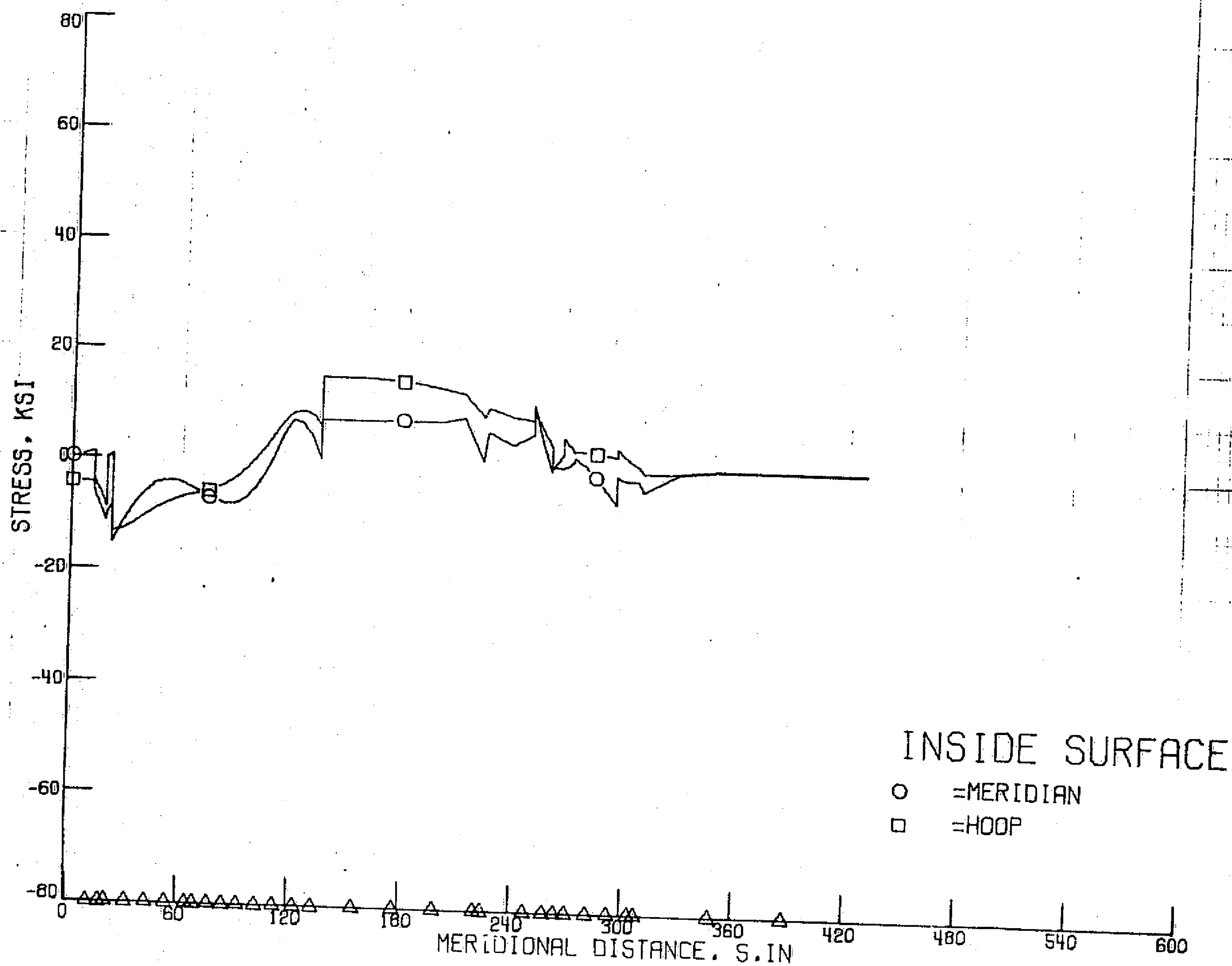
540
600
MERIDIONAL DISTANCE, S.IN
OUTSIDE SURFACE
○ =MERIDIAN
□ =HOOP

FIG. 3



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STRESS, KSI
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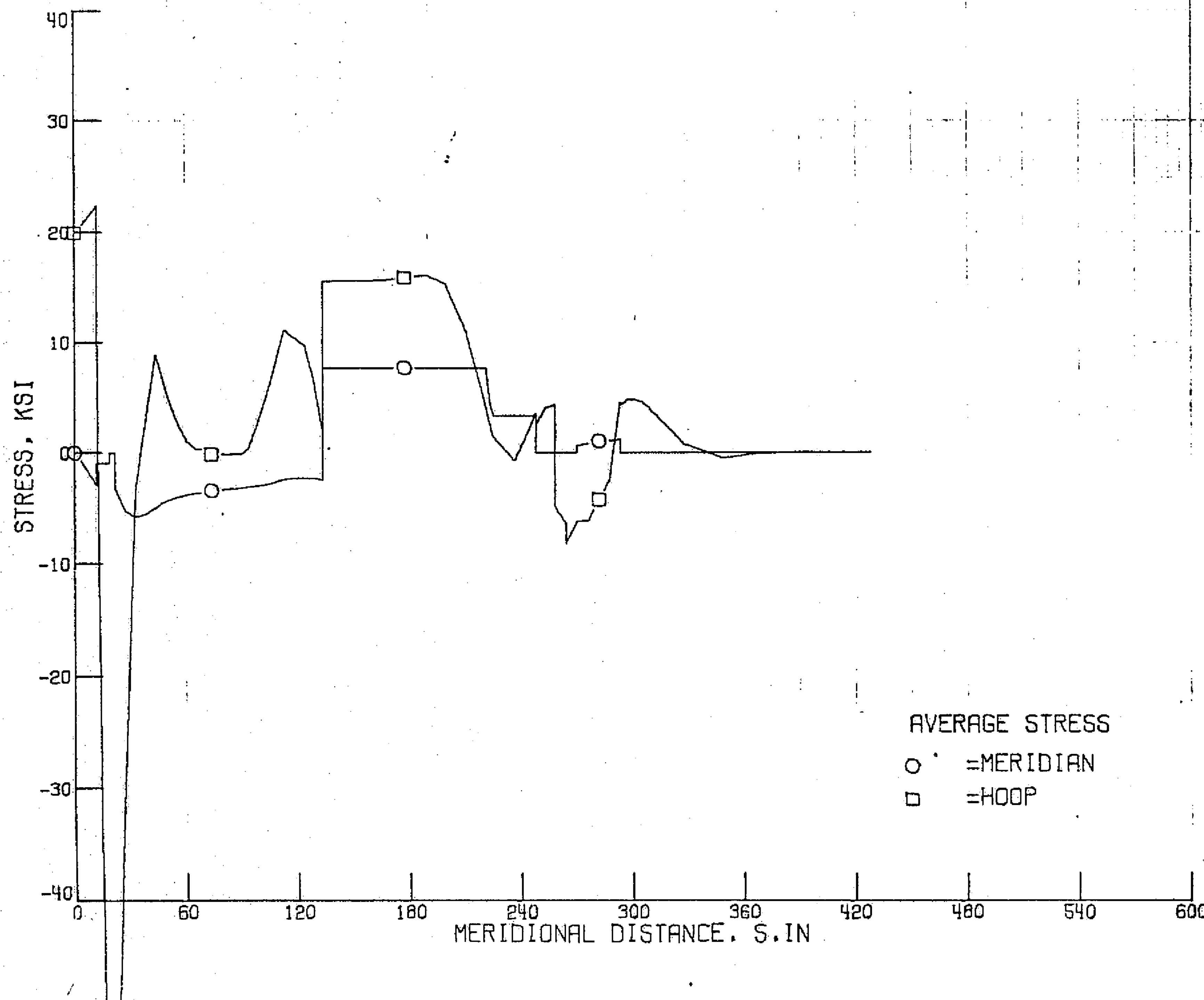
540
600
MERIDIONAL DISTANCE, S.IN
INSIDE SURFACE
○ =MERIDIAN
□ =HOOP

FIG. 4



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STRESS, KSI
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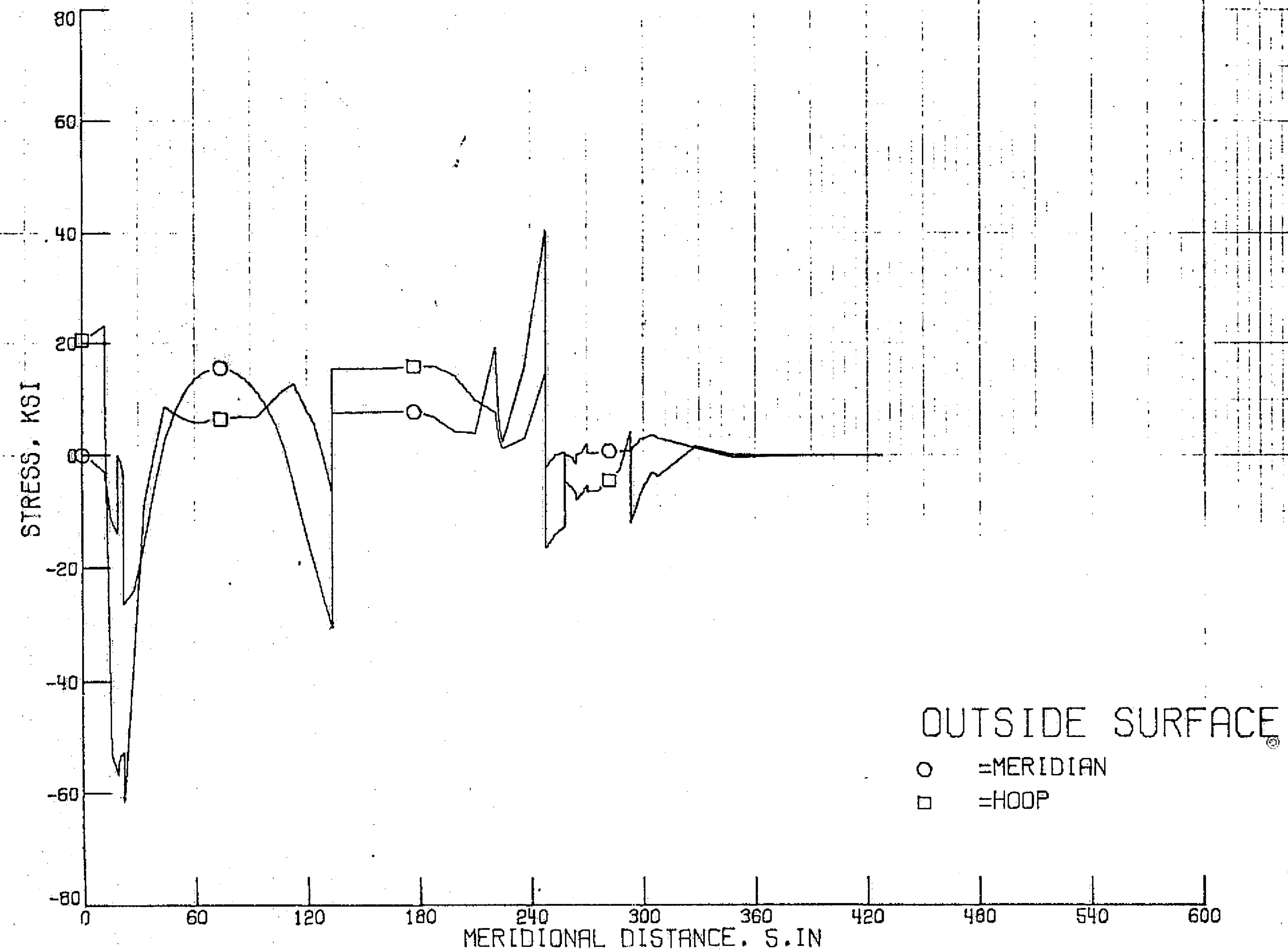
MERIDIONAL DISTANCE, S.IN
AVERAGE STRESS
○ =MERIDIAN
□ =HOOP

FIG. 15



80
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-20
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-80
STRESS, KSI
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60
120
180
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300
360
420
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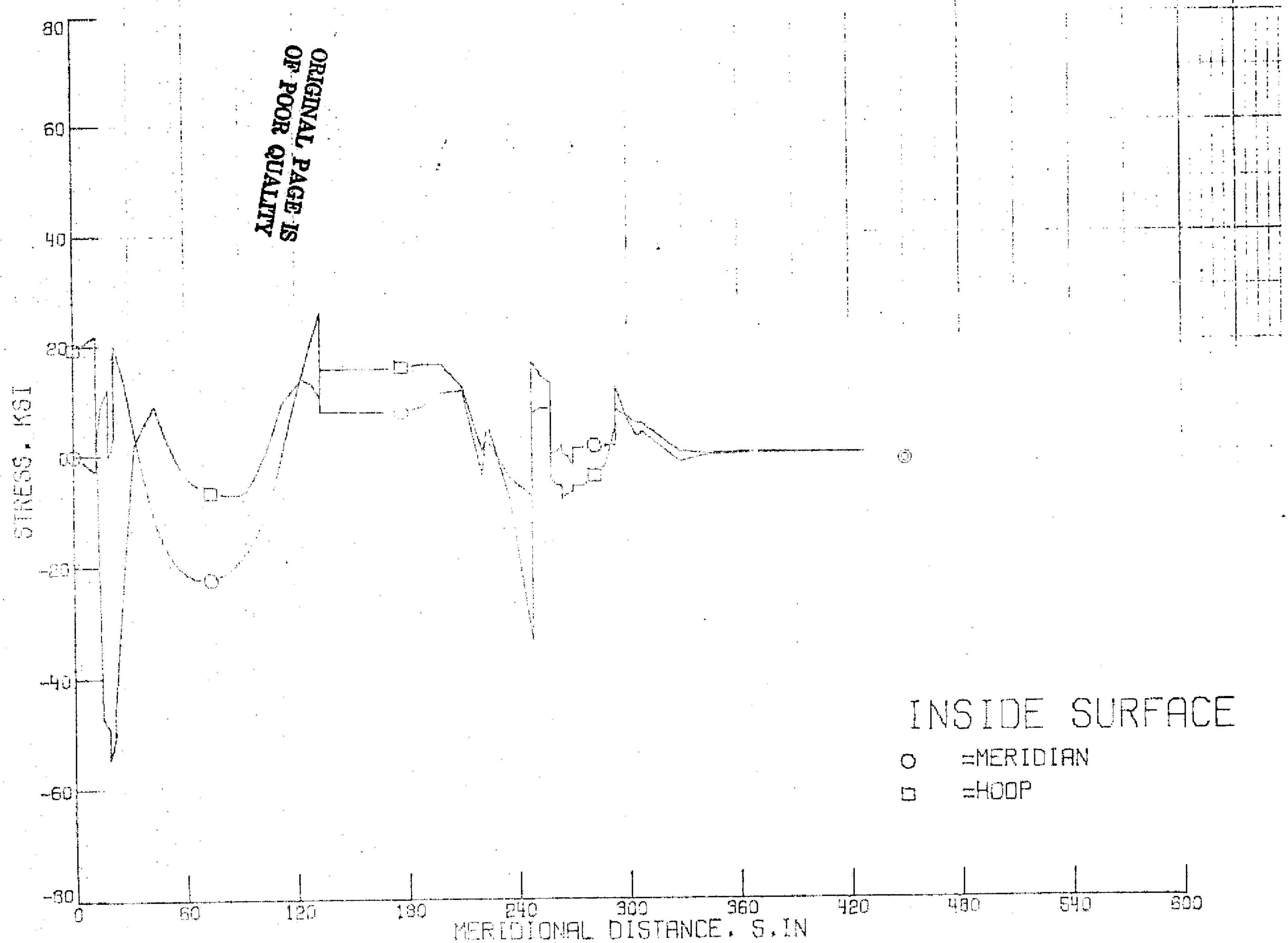
540
600
MERIDIONAL DISTANCE. S.IN
OUTSIDE SURFACE
○ =MERIDIAN
□ =HOOP



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80
60
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-80
STRESS, KSI
0
60
120
180
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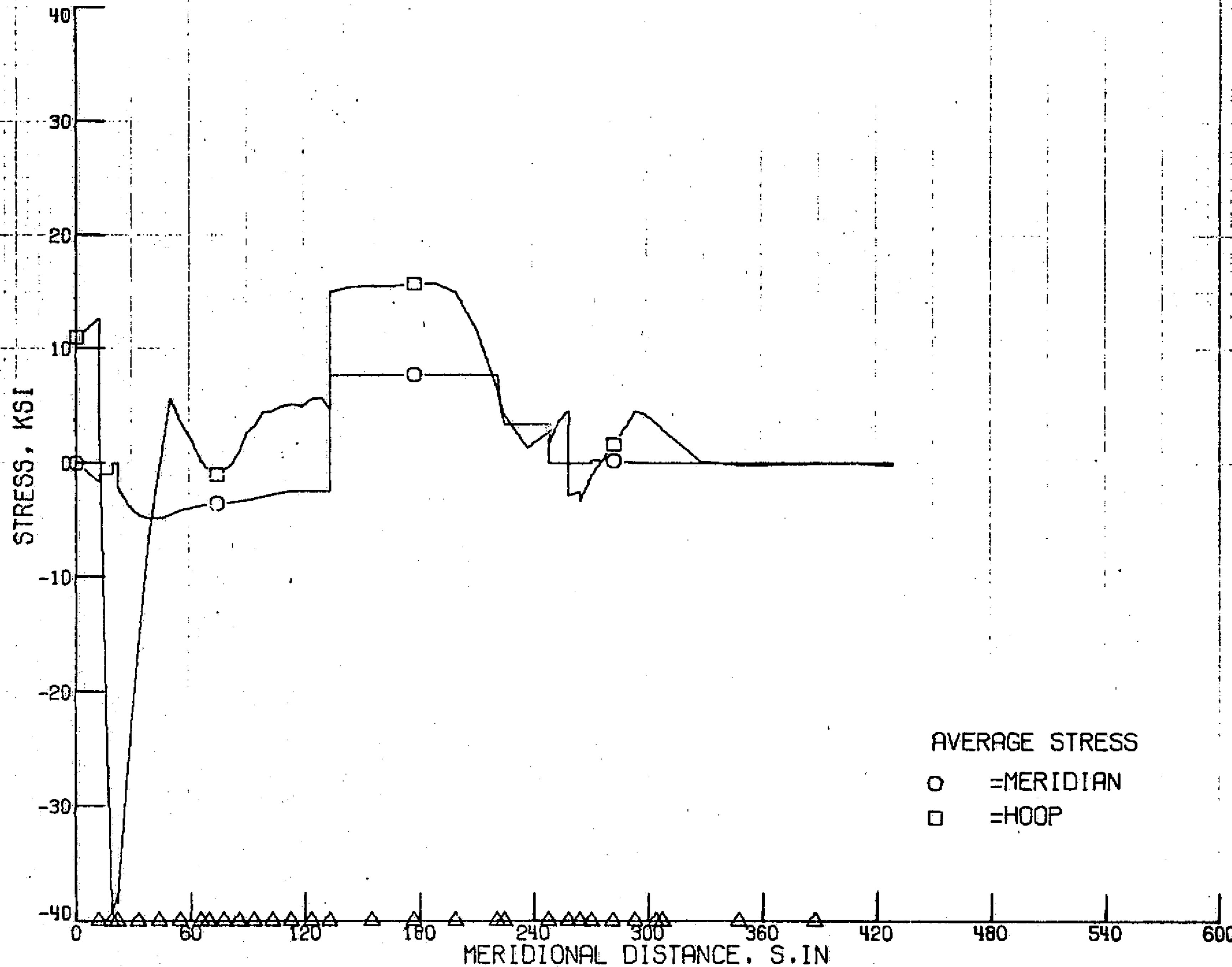
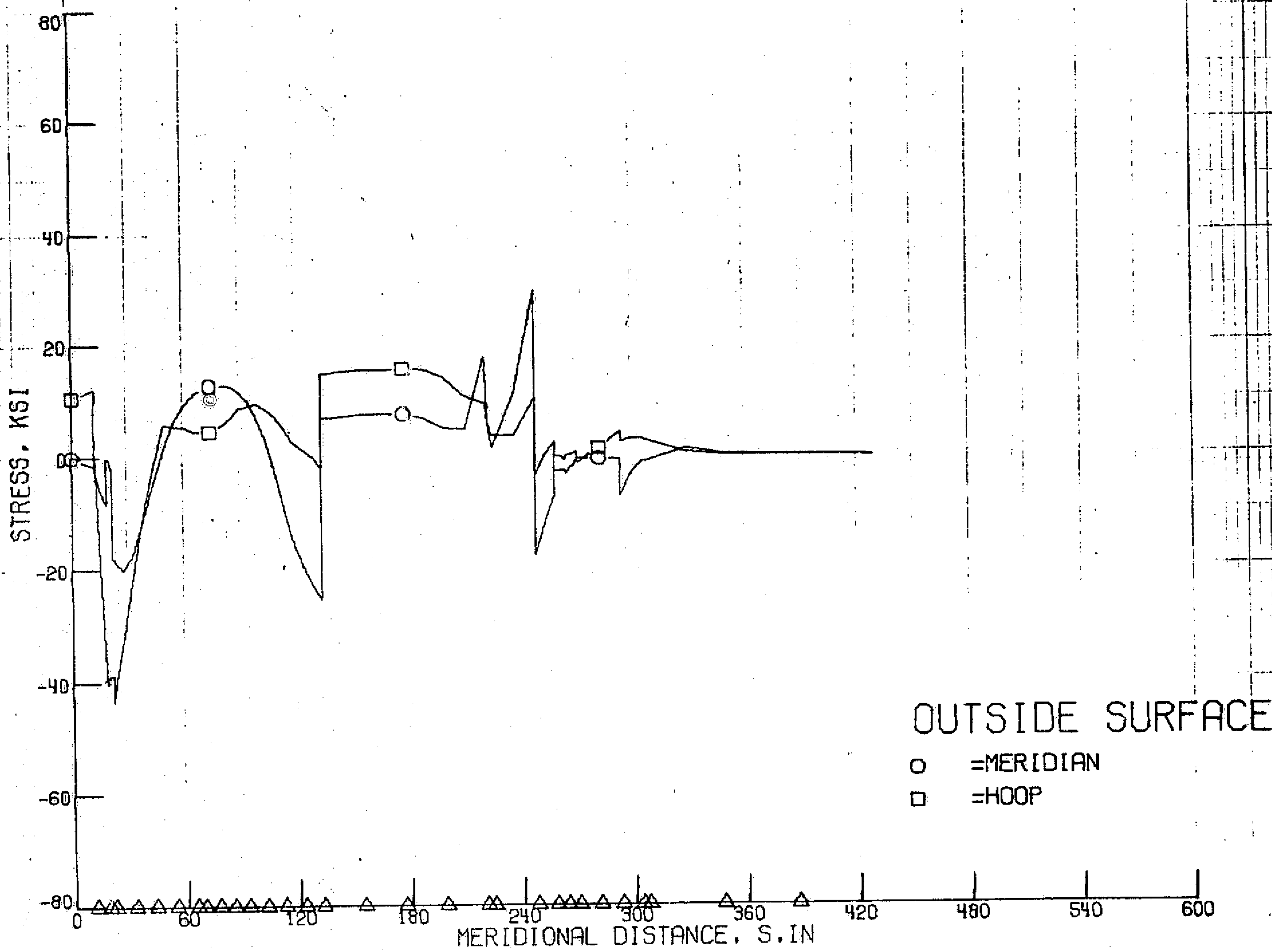
360
420
480
540
600
MERIDIONAL DISTANCE, S.IN
INSIDE SURFACE
○ =MERIDIAN
□ =HOOP

FIG. 17



40
30
20
10
0
-10
-20
-30
-40
STRESS, KSI
0
60
120
180
240
300
360
420
480
540
600
MERIDIONAL DISTANCE, S.IN
AVERAGE STRESS
○ =MERIDIAN
□ =HOOP

FIG. 18



STRESS, KSI
80
60
40
20
0
-20
-40
-60
-80
0
60
120
180
240
300
360
420
480
540
600
MERIDIONAL DISTANCE, S.IN
OUTSIDE SURFACE
O =MERIDIAN
□ =HOOP

FIG 19

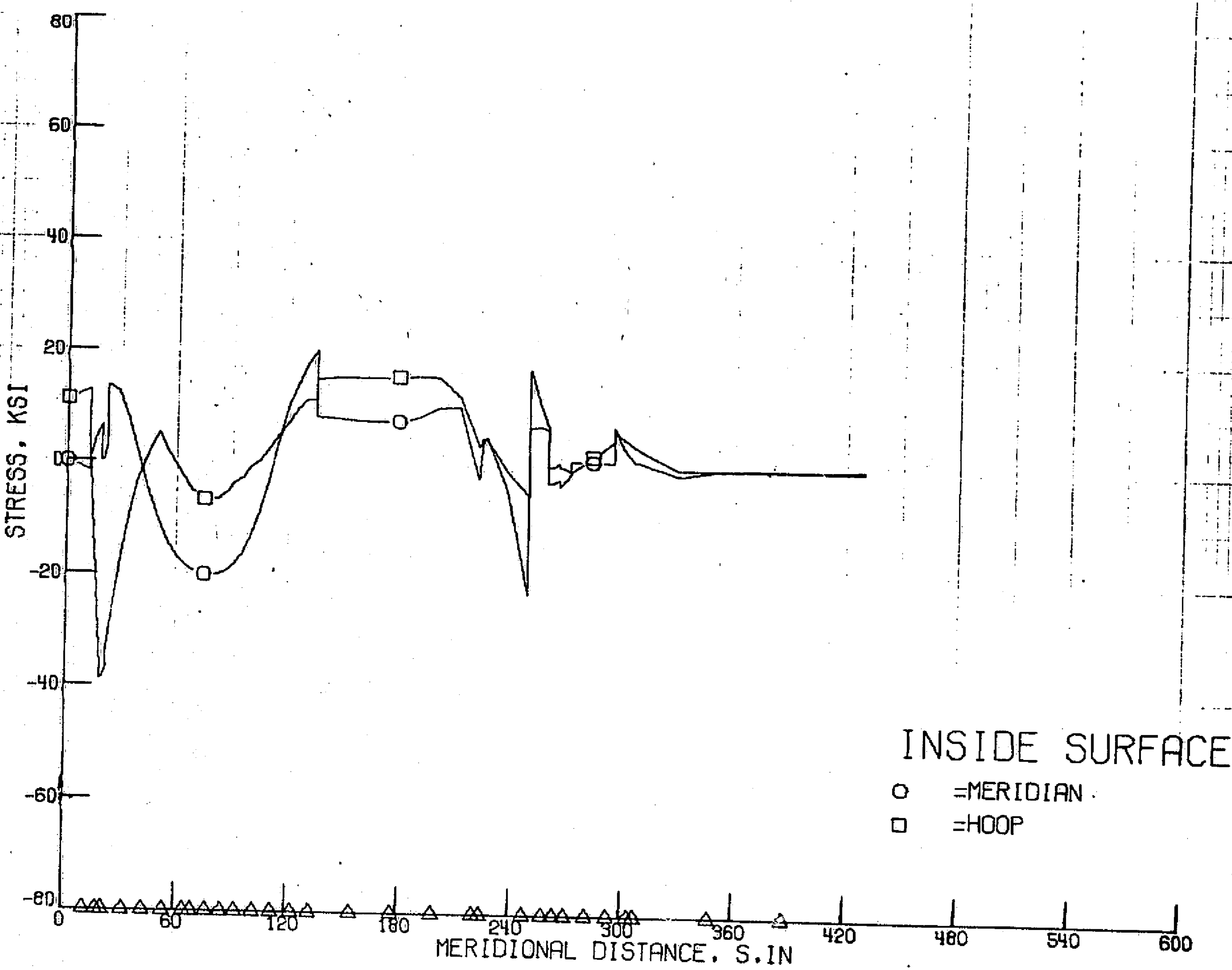
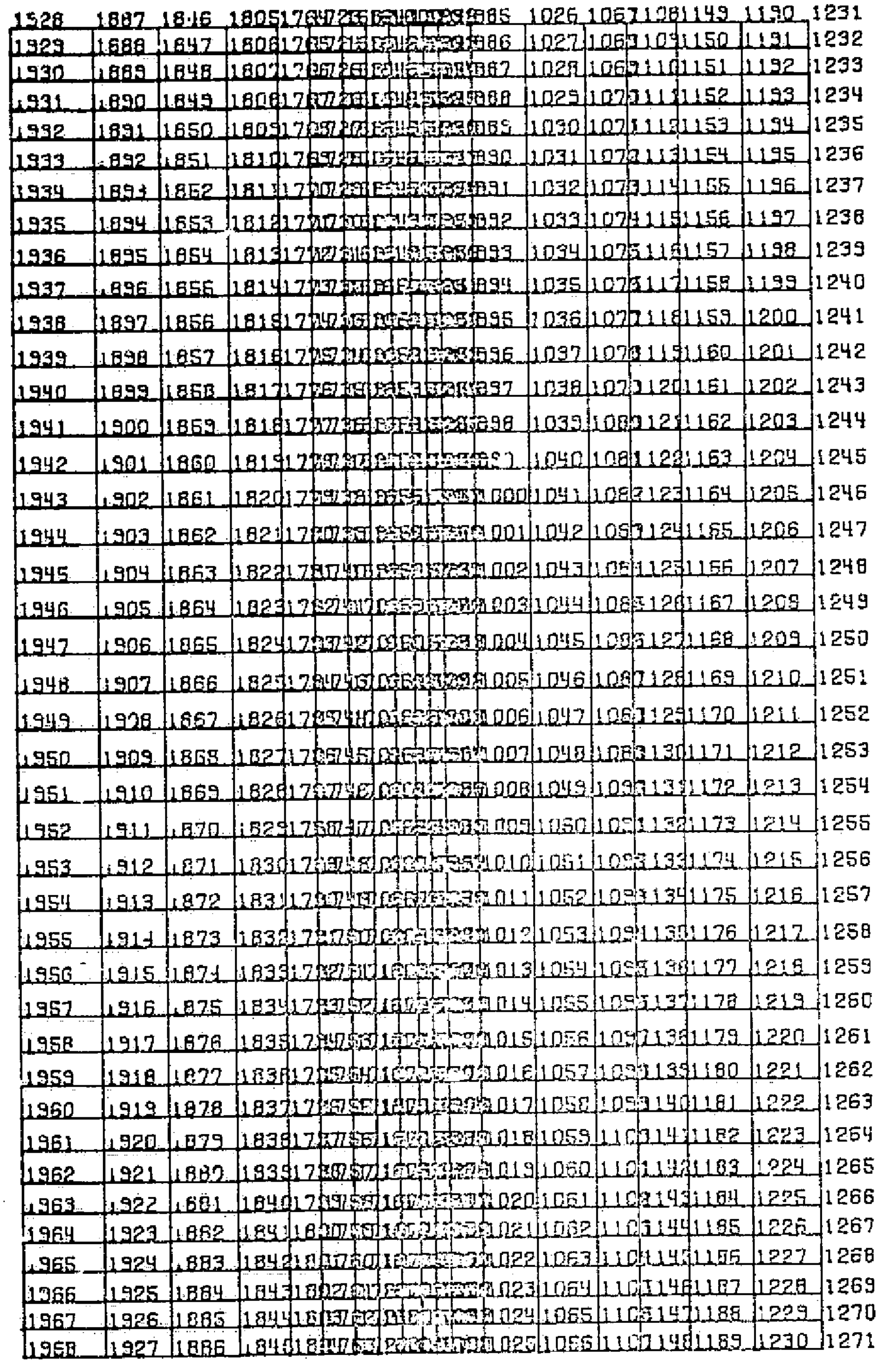

INSIDE SURFACE
○ =MERIDIAN
□ =HOOP
STRESS, KSI
80
60
40
20
0
-20
-40
-60
-80
0
60
120
180
240
300
360
420
480
540
600
MERIDIONAL DISTANCE, S.IN

FIG. 20



SPEC 5.1

NTF BULKHEAD SHELL

0 SCALE 36

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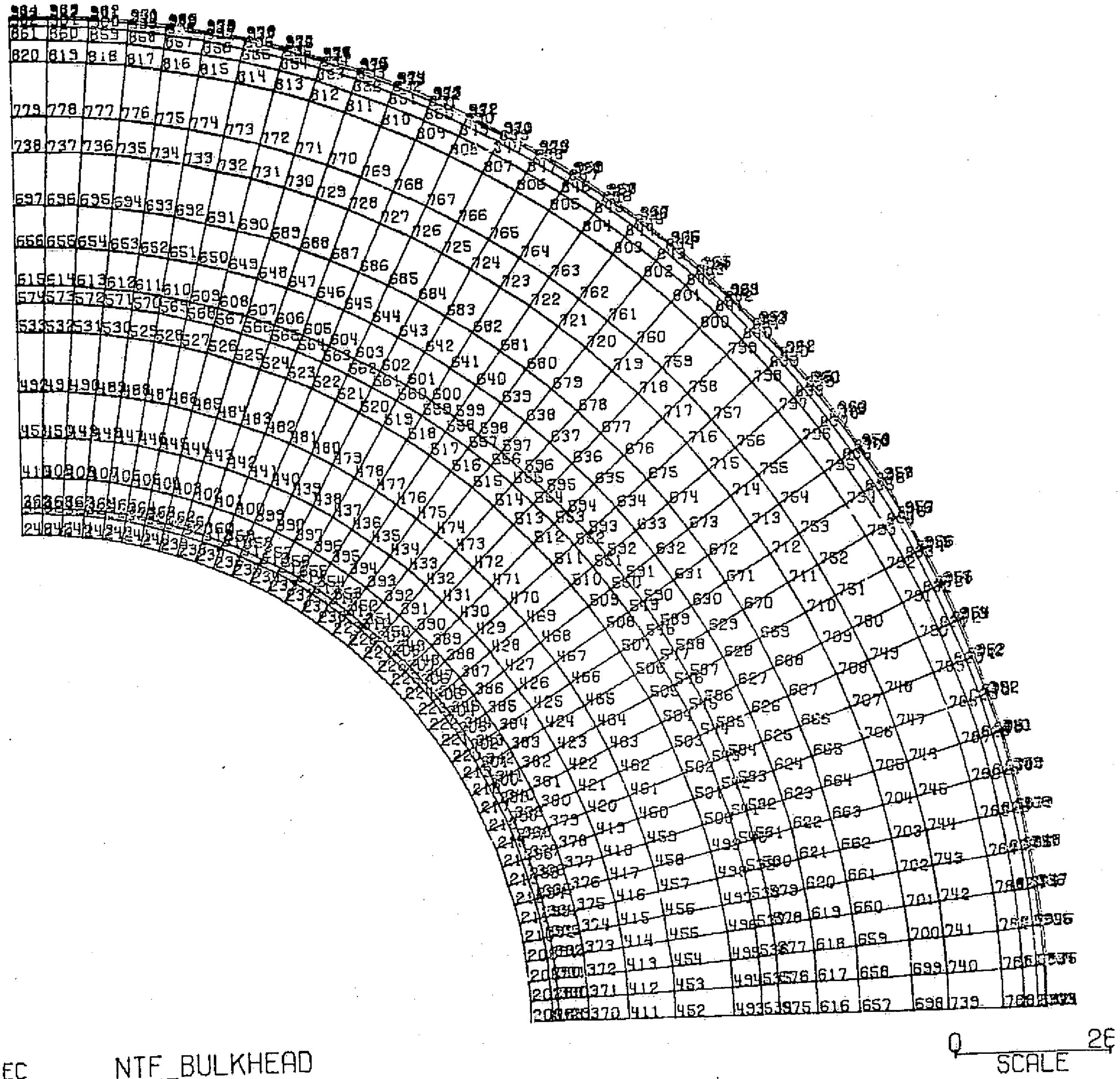
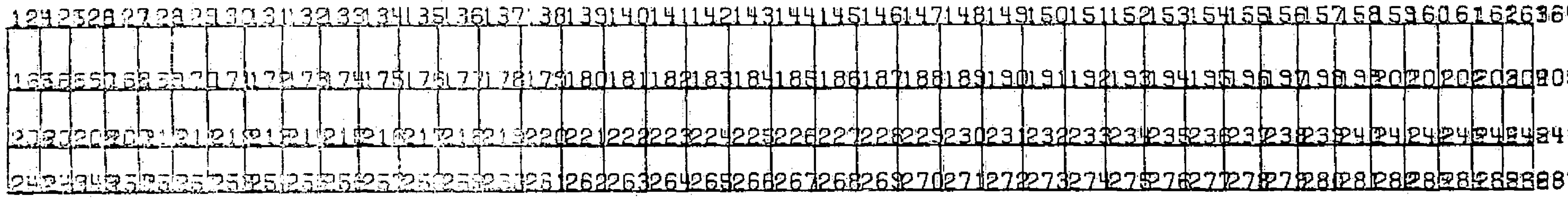
FIG. 21



SPEC
3.1

NTF BULKHEAD
DOME

FIG. 22

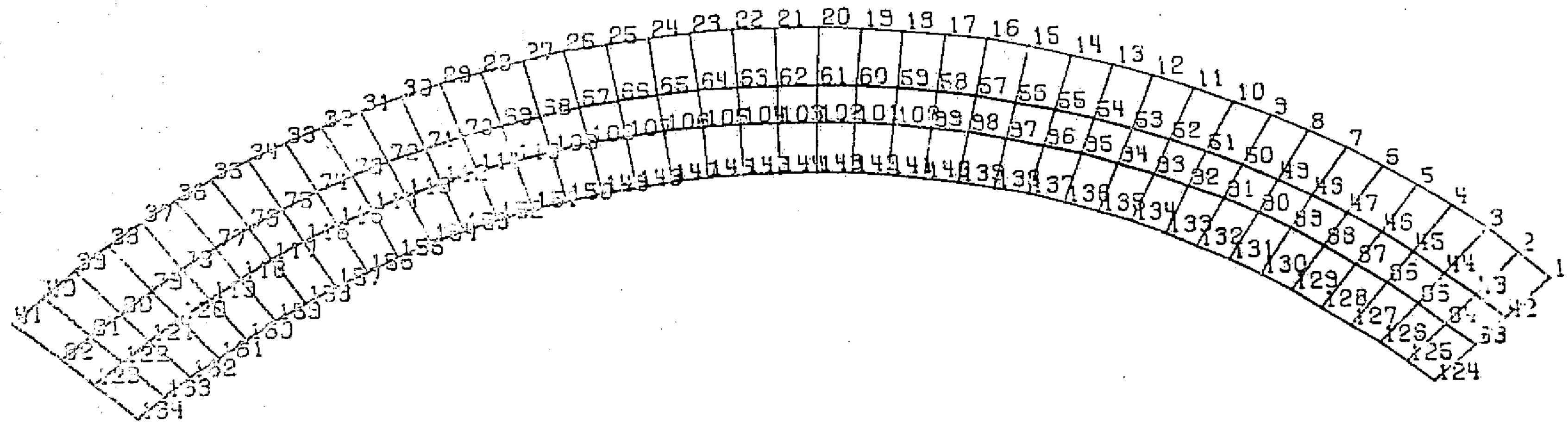


SPEC
10.1

NTF BULKHEAD
HATCH OPENING

0
SCALE

FIG. 23

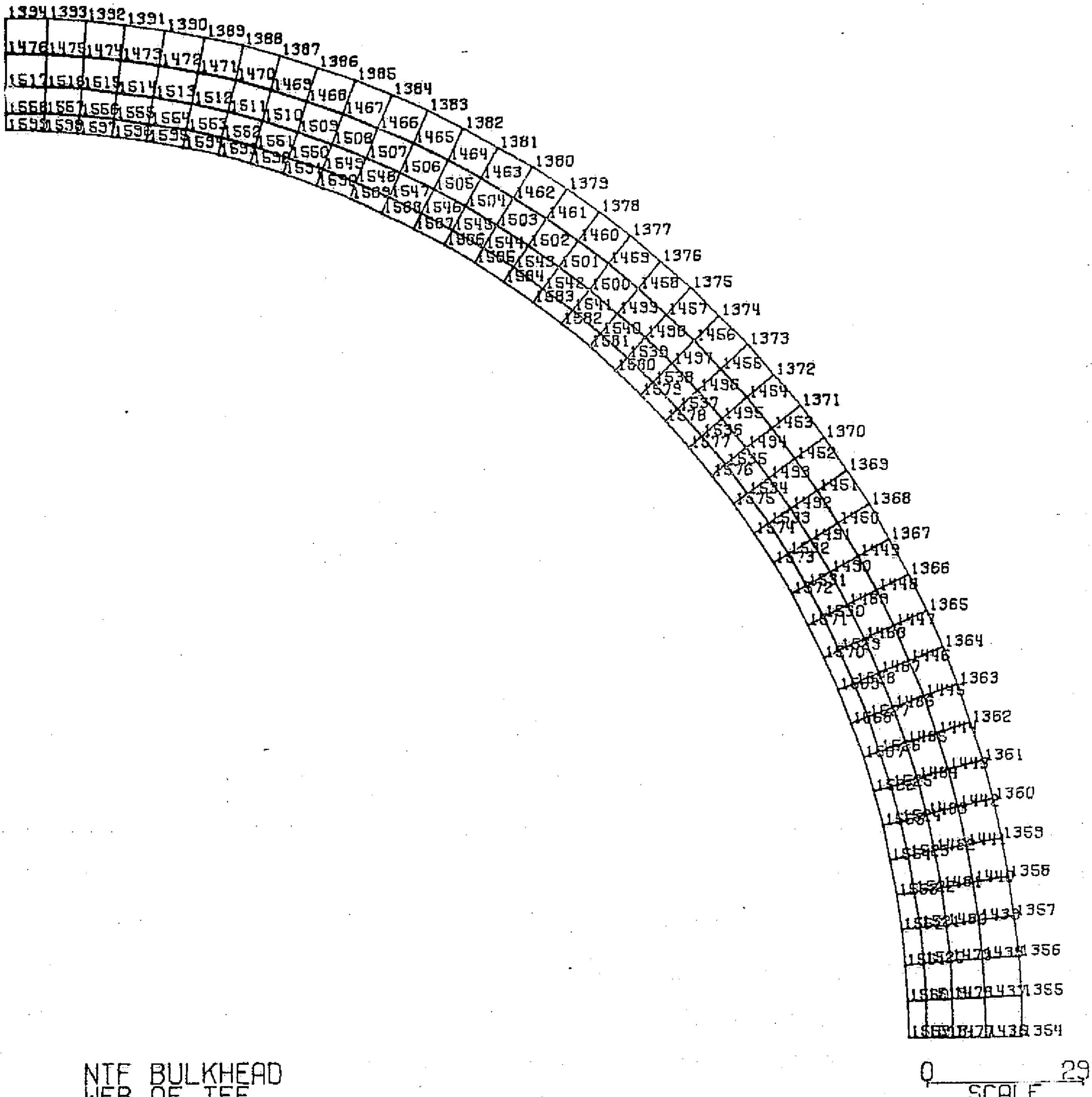


0 SCALE

SPEC
2.1

NTF BULKHEAD
FLANGE SURFACE

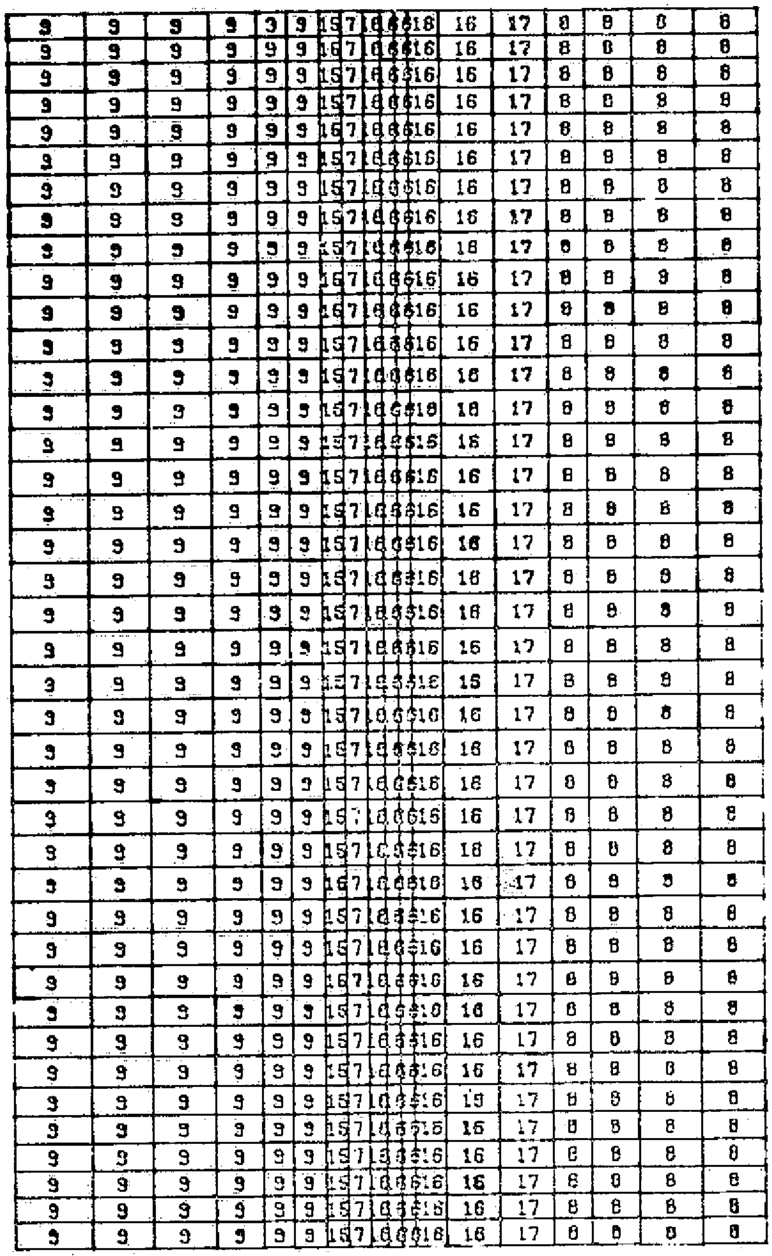
FIG 24



SPEC
9.1

NTF BULKHEAD
WEB OF TEE

FIG 25



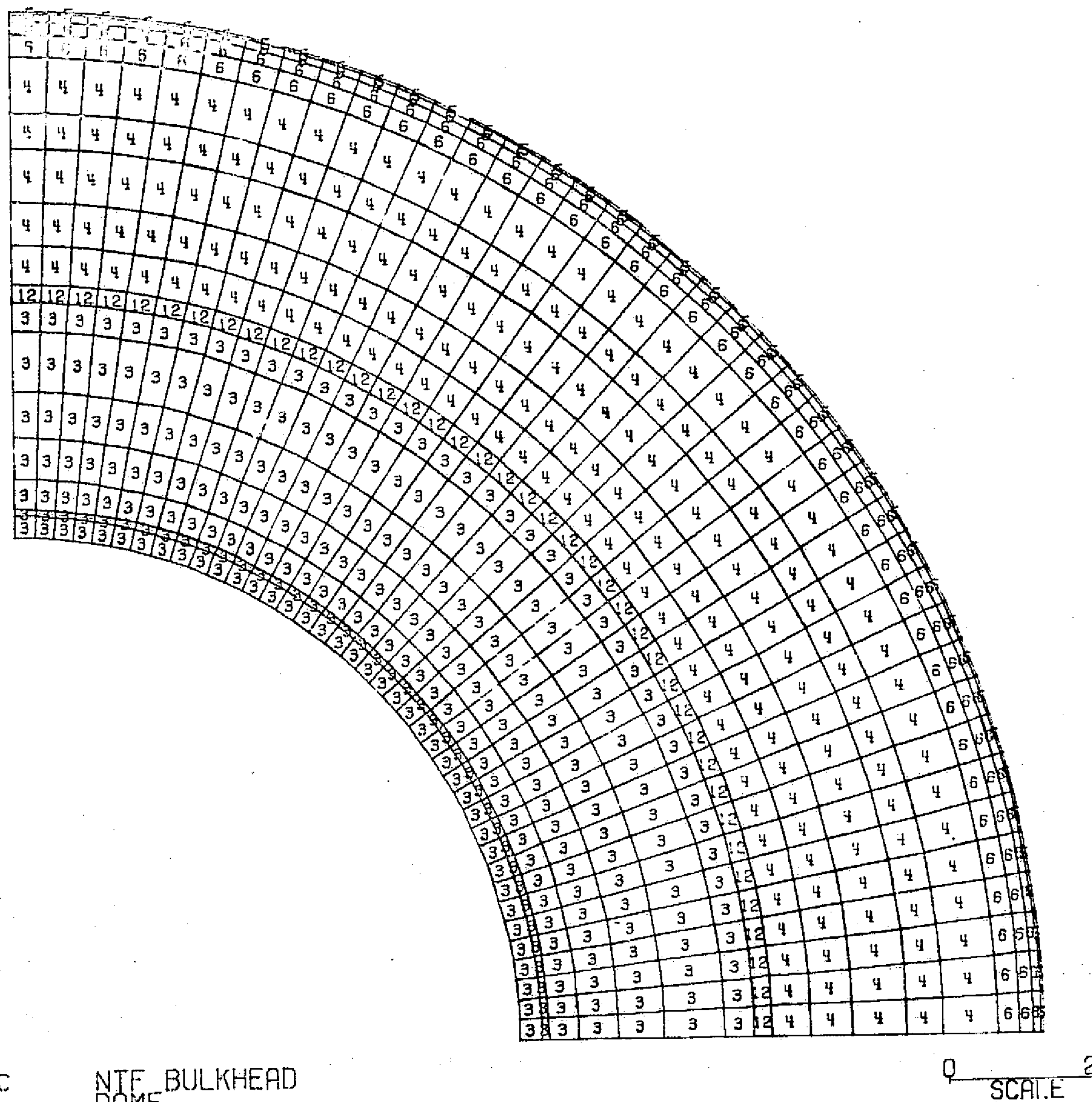
SPEC
5.1

NTF BULKHEAD
SHELL

0 SCALE 36

ELEMENT SECTION PROPERTY GROUPS

FIG 26

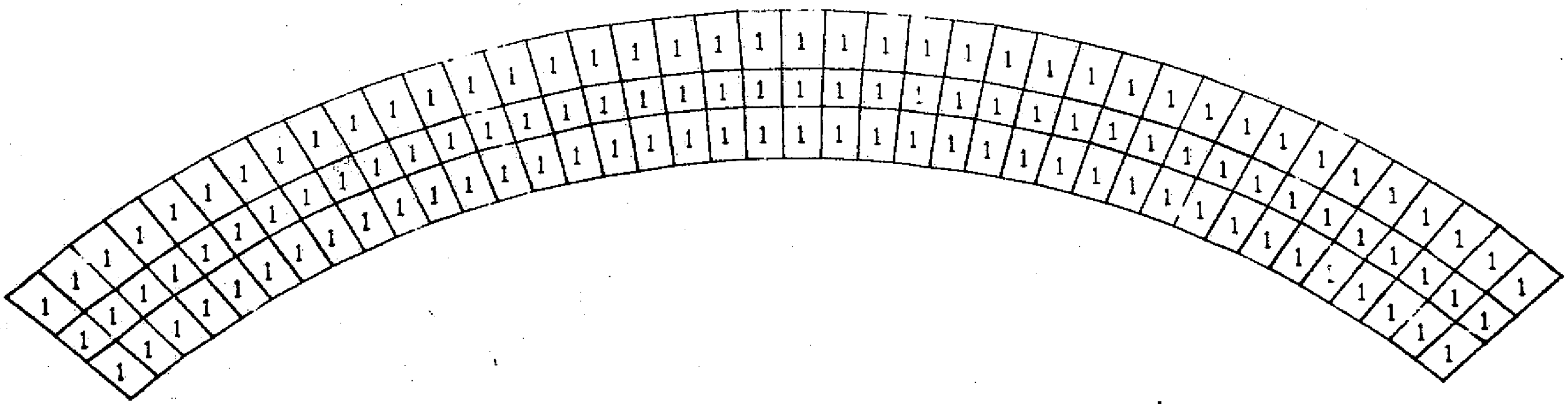


SPEC 3.1

NTF BULKHEAD DOME

ELEMENT SECTION PROPERTY GROUPS

FIG 27



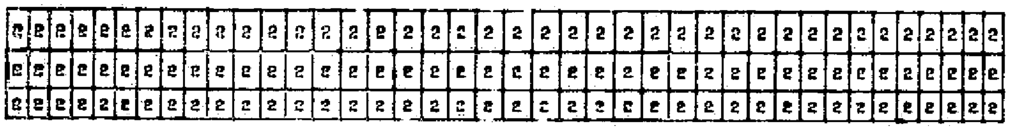
ELEMENT SECTION PROPERTY GROUPS

0 21
SCALE

SPEC
2.1

NTF BULKHEAD
FLANGE SURFACE

FIG 28

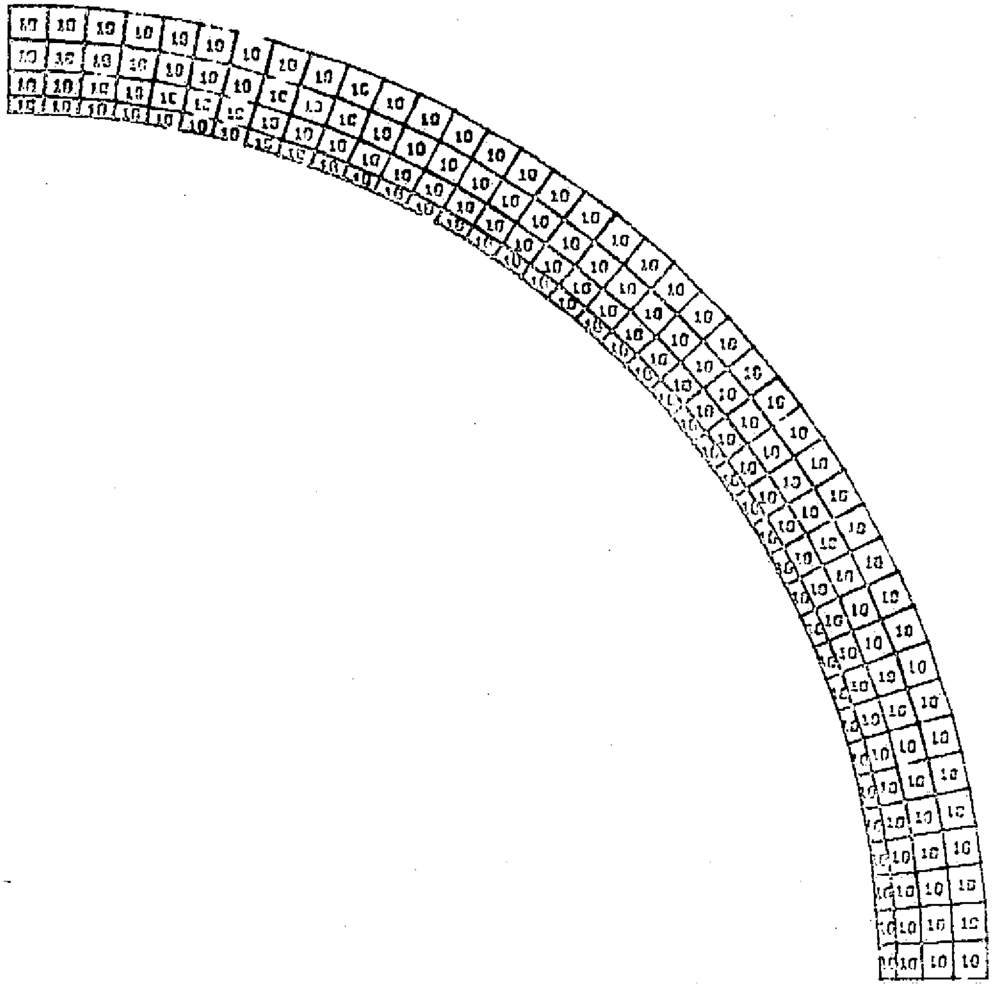


SPEC 10-1 NTF BULKHEAD HATCH OPENING

0 18 SCALE

...GENT SECTION PROPERTY GROUPS

FIG. 29



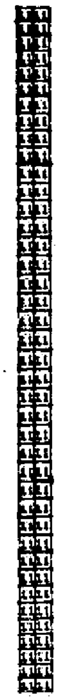
SPEC 9.1

NIE BULKHEAD
WEB OF TEE

0 29
SCALE

ELEMENT SECTION PROPERTY GROUPS

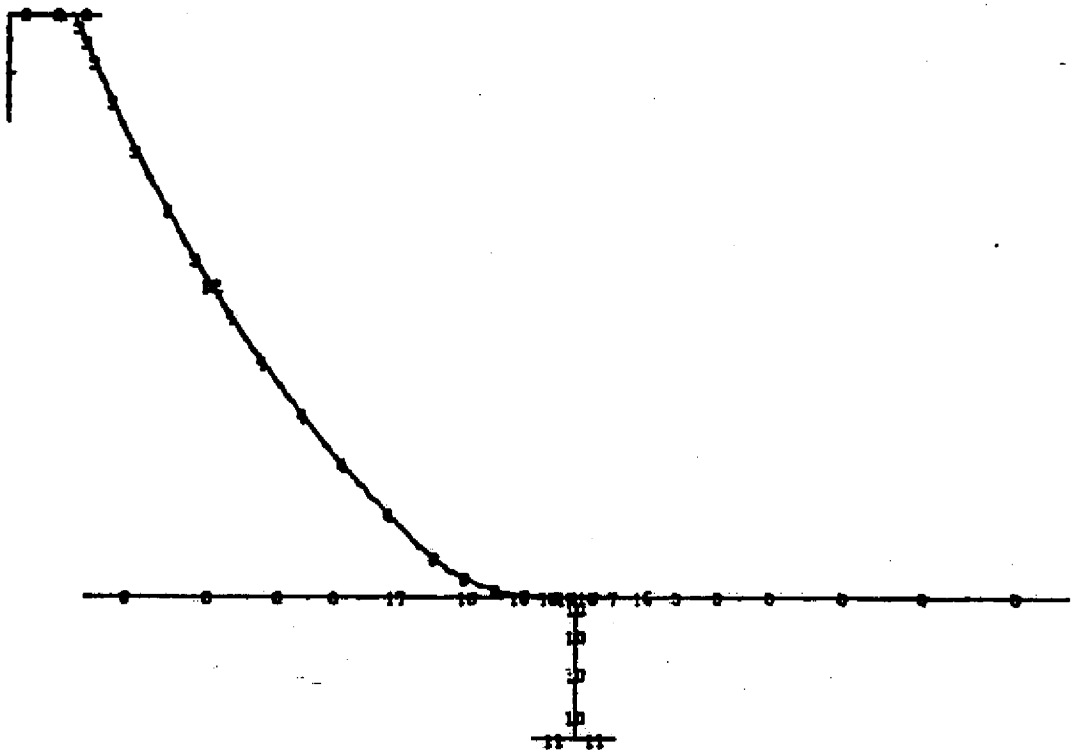
FIG 30



SPEC 11-1 NTE BULKHEAD TEE

0 SCALE 41

FIG 31



SPEC
12.1

NTF BULKHEAD
CROSS-SECTION VIEW

0 ______ 24
SCALE

FIG 32

CASE 1

GATE VALVE CLOSED

STRESS PLOTS

FIGURES 33 THRU 59

COMPUTER RUN NO. LAK

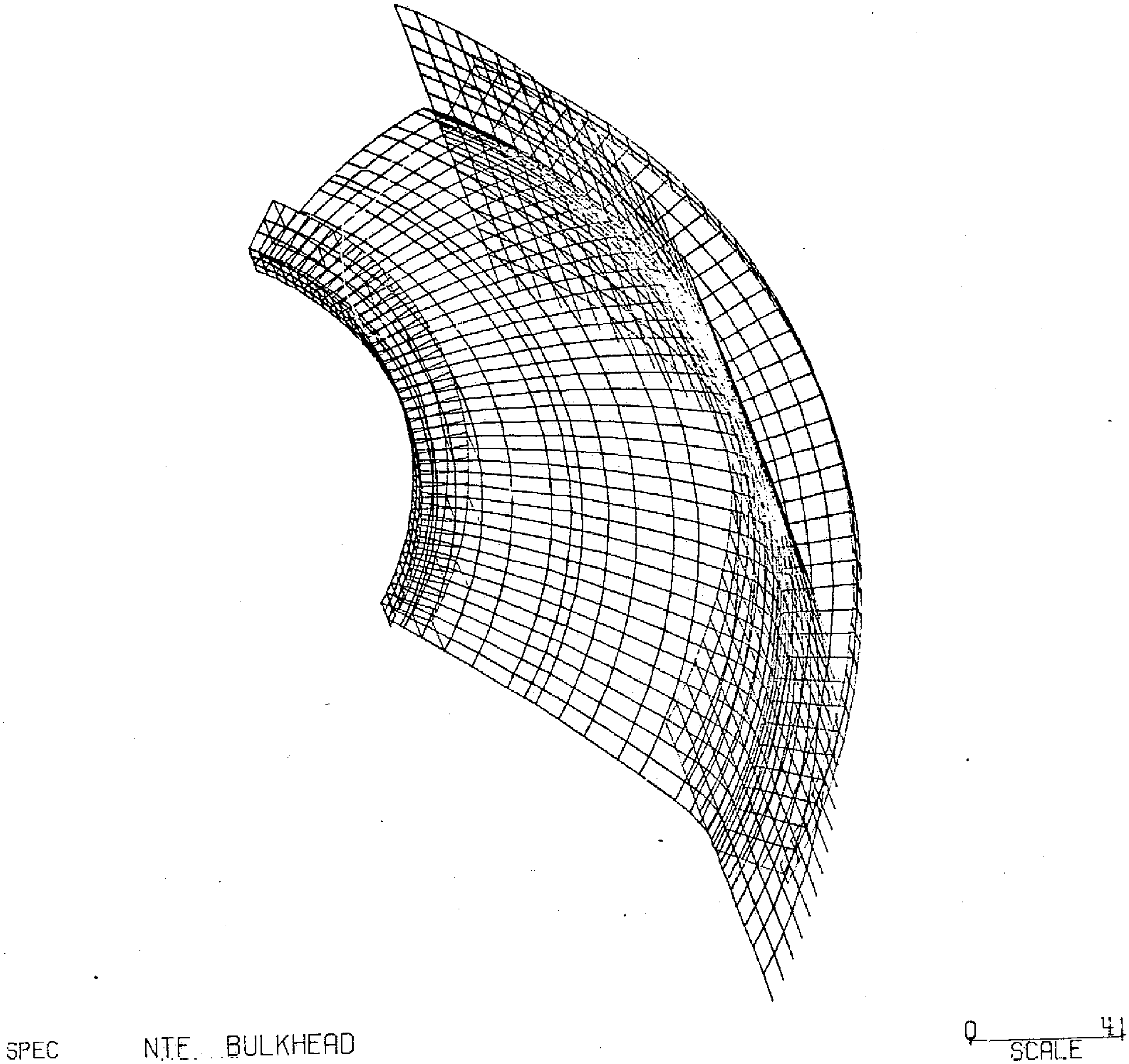


FIG. 33

DISPLAY= SX /1000 , NODE= 1, SURFACE= 0

0	0	0	0	1	1	2	3	4	5	5	6	7	9	12	14	15	16
0	0	0	0	1	1	2	3	4	5	5	6	7	9	12	14	15	16
0	0	0	0	1	1	2	3	4	5	5	6	7	9	12	14	15	16
0	0	0	0	1	1	2	3	4	5	5	6	7	9	12	14	15	16
0	0	0	0	1	1	2	3	4	5	5	6	7	9	12	14	15	16
0	0	0	0	1	1	2	3	4	5	5	6	7	9	12	14	15	16
0	0	0	0	1	1	2	3	4	5	5	6	7	9	12	14	15	16
0	0	0	0	1	1	2	3	4	5	5	6	7	9	12	14	15	16
0	0	0	0	1	1	2	3	4	5	5	6	7	9	12	14	15	16
0	0	0	0	1	1	2	3	4	5	5	6	7	9	12	14	15	16
0	0	0	0	1	1	2	3	4	5	5	6	7	9	12	14	15	16
0	0	0	0	1	1	2	3	4	5	5	6	7	9	12	14	15	16
0	0	0	0	1	1	2	3	4	5	5	6	7	9	12	14	15	16
0	0	0	0	1	1	2	3	4	5	5	6	7	9	12	14	15	16
0	0	0	0	1	1	2	3	4	5	5	6	7	9	12	14	15	16
0	0	0	0	1	1	2	3	4	5	5	6	7	9	12	14	15	16
0	0	0	0	1	1	2	3	4	5	5	6	7	9	12	14	15	16
0	0	0	0	1	1	2	3	4	5	5	6	7	9	12	14	15	16
0	0	0	0	1	1	2	3	4	5	5	6	7	9	12	14	15	16
0	0	0	0	1	1	2	3	4	5	5	6	7	9	12	14	15	16
0	0	0	0	1	1	2	3	4	5	5	6	7	9	12	14	15	16
0	0	0	0	1	1	2	3	4	5	5	6	7	9	12	14	15	16
0	0	0	0	1	1	2	3	4	5	5	6	7	9	12	14	15	16
0	0	0	0	1	1	2	3	4	5	5	6	7	9	12	14	15	16
0	0	0	0	1	1	2	3	4	5	5	6	7	9	12	14	15	16
0	0	0	0	1	1	2	3	4	5	5	6	7	9	12	14	15	16
0	0	0	0	1	1	2	3	4	5	5	6	7	9	12	14	15	16
0	0	0	0	1	1	2	3	4	5	5	6	7	9	12	14	15	16
0	0	0	0	1	1	2	3	4	5	5	6	7	9	12	14	15	16
0	0	0	0	1	1	2	3	4	5	5	6	7	9	12	14	15	16
0	0	0	0	1	1	2	3	4	5	5	6	7	9	12	14	15	16
0	0	0	0	1	1	2	3	4	5	5	6	7	9	12	14	15	16
0	0	0	0	1	1	2	3	4	5	5	6	7	9	12	14	15	16
0	0	0	0	1	1	2	3	4	5	5	6	7	9	12	14	15	16
0	0	0	0	1	1	2	3	4	5	5	6	7	9	12	14	15	16
0	0	0	0	1	1	2	3	4	5	5	6	7	9	12	14	15	16
0	0	0	0	1	1	2	3	4	5	5	6	7	9	12	14	15	16
0	0	0	0	1	1	2	3	4	5	5	6	7	9	12	14	15	16
0	0	0	0	1	1	2	3	4	5	5	6	7	9	12	14	15	16
0	0	0	0	1	1	2	3	4	5	5	6	7	9	12	14	15	16

SPEC .1 NTF BULKHEAD SHELL

0 36 SCALE

FIG 34

DISPLAY= SX /1000 , NODE= 1 , SURFACE= 1

0	0	0	0	1	2	3	3	4	4	3	6	7	9	12	14	16	16
0	0	0	0	1	2	3	3	4	4	3	6	7	9	12	14	16	16
0	0	0	0	1	2	3	3	4	4	3	6	7	9	12	14	16	16
0	0	0	0	1	2	3	3	4	4	3	6	7	9	12	14	16	16
0	0	0	0	1	2	3	3	4	4	3	6	7	9	12	14	16	16
0	0	0	0	1	2	3	3	4	4	3	6	7	9	12	14	16	16
0	0	0	0	1	2	3	3	4	4	3	6	7	9	12	14	16	16
0	0	0	0	1	2	3	3	4	4	3	6	7	9	12	14	16	16
0	0	0	0	1	2	3	3	4	4	3	6	7	9	12	14	16	16
0	0	0	0	1	2	3	3	4	4	3	6	7	9	12	14	16	16
0	0	0	0	1	2	3	3	4	4	3	6	7	9	12	14	16	16
0	0	0	0	1	2	3	3	4	4	3	6	7	3	12	14	16	16
0	0	0	0	1	2	3	3	4	4	3	6	7	9	12	14	16	16
0	0	0	0	1	2	3	3	4	4	3	6	7	9	12	14	16	16
0	0	0	0	1	2	3	3	4	4	3	6	7	9	12	14	16	16
0	0	0	0	1	2	3	3	4	4	3	6	7	9	12	14	16	16
0	0	0	0	1	2	3	3	4	4	3	6	7	9	12	14	16	16
0	0	0	0	1	2	3	3	4	4	3	6	7	9	12	14	16	16
0	0	0	0	1	2	3	3	4	4	3	6	7	9	12	14	16	16
0	0	0	0	1	2	3	3	4	4	3	6	7	9	12	14	16	16
0	0	0	0	1	2	3	3	4	4	3	6	7	9	12	14	16	16
0	0	0	0	1	2	3	3	4	4	3	6	7	9	12	14	16	16
0	0	0	0	1	2	3	3	4	4	3	6	7	9	12	14	16	16
0	0	0	0	1	2	3	3	4	4	3	6	7	9	12	14	16	16
0	0	0	0	1	2	3	3	4	4	3	6	7	9	12	14	16	16
0	0	0	0	1	2	3	3	4	4	3	6	7	9	12	14	16	16
0 -	0	0	0	1	2	3	3	4	4	3	6	7	9	12	14	16	16
0	0	0	0	1	2	3	3	4	4	3	6	7	9	12	14	16	16
0	0	0	0	1	2	3	3	4	4	3	6	7	9	12	14	16	16
0	0	0	0	1	2	3	3	4	4	3	6	7	9	12	14	16	16
0	0	0	0	1	2	3	3	4	4	3	6	7	9	12	14	16	16
0	0	0	0	1	2	3	3	4	4	3	6	7	9	12	14	16	16
0	0	0	0	1	2	3	3	4	4	3	6	7	9	12	14	16	16
0	0	0	0	1	2	3	3	4	4	3	6	7	9	12	14	16	16
0	0	0	0	1	2	3	3	4	4	3	6	7	9	12	14	16	16
0	0	0	0	1	2	3	3	4	4	3	6	·7	9	12	14	16	16
0	0	0	0	1	2	3	3	4	4	3	6	7	9	12	14	16	16
0	0	0	0	1	2	3	3	4	4	3	6	7	9	12	14	16	16
0	0	0	0	1	2	3	3	4	4	3	6	7	9	12	14	16	16
0	0	0	0	1	2	3	3	4	4	3	6	7	9	12	14	16	16

SPEC
.1

NTF BULKHEAD
SHELL

0 36
SCALE

FIG. 35

DISPLAY= SX /1000 , NODE= 1 , SURFACE= 2

0	0	0	0	0	1	2	3	4	6	7	6	7	10	12	13	15	16
0	0	0	0	0	1	2	3	4	6	7	6	7	10	12	13	15	16
0	0	0	0	0	1	2	3	4	6	7	6	7	10	12	13	15	16
0	0	0	0	0	1	2	3	4	6	7	6	7	10	12	13	15	16
0	0	0	0	0	1	2	3	4	6	7	6	7	10	12	13	15	16
0	0	0	0	0	1	2	3	4	6	7	6	7	10	12	13	15	16
0	0	0	0	0	1	2	3	4	6	7	6	7	10	12	13	15	16
0	0	0	0	0	1	2	3	4	6	7	6	7	10	12	13	15	16
0	0	0	0	0	1	2	3	4	6	7	6	7	10	12	13	15	16
0	0	0	0	0	1	2	3	4	6	7	6	7	10	12	13	15	16
0	0	0	0	0	1	2	3	4	6	7	6	7	10	12	13	15	16
0	0	0	0	0	1	2	3	4	6	7	6	7	10	12	13	15	16
0	0	0	0	0	1	2	3	4	6	7	6	7	10	12	13	15	16
0	0	0	0	0	1	2	3	4	6	7	6	7	10	12	13	15	16
0	0	0	0	0	1	2	3	4	6	7	6	7	10	12	13	15	16
0	0	0	0	0	1	2	3	4	6	7	6	7	10	12	13	15	16
0	0	0	0	0	1	2	3	4	6	7	6	7	10	12	13	15	16
0	0	0	0	0	1	2	3	4	6	7	6	7	10	12	13	15	16
0	0	0	0	0	1	2	3	4	6	7	6	7	10	12	13	15	16
0	0	0	0	0	1	2	3	4	6	7	6	7	10	12	13	15	16
0	0	0	0	0	1	2	3	4	6	7	6	7	10	12	13	15	16
0	0	0	0	0	1	2	3	4	6	7	6	7	10	12	13	15	16
0	0	0	0	0	1	2	3	4	6	7	6	7	10	12	13	15	16
0	0	0	0	0	1	2	3	4	6	7	6	7	10	12	13	15	16
0	0	0	0	0	1	2	3	4	6	7	6	7	10	12	13	15	16
0	0	0	0	0	1	2	3	4	6	7	6	7	10	12	13	15	16
0	0	0	0	0	1	2	3	4	6	7	6	7	10	12	13	15	16
0	0	0	0	0	1	2	3	4	6	7	6	7	10	12	13	15	16
0	0	0	0	0	1	2	3	4	6	7	6	7	10	12	13	15	16
0	0	0	0	0	1	2	3	4	6	7	6	7	10	12	13	15	16
0	0	0	0	0	1	2	3	4	6	7	6	7	10	12	13	15	16
0	0	0	0	0	1	2	3	4	6	7	6	7	10	12	13	15	16
0	0	0	0	0	1	2	3	4	6	7	6	7	10	12	13	15	16
0	0	0	0	0	1	2	3	4	6	7	6	7	10	12	13	15	16
0	0	0	0	0	1	2	3	4	6	7	6	7	10	12	13	15	16
0	0	0	0	0	1	2	3	4	6	7	6	7	10	12	13	15	16
0	0	0	0	0	1	2	3	4	6	7	6	7	10	12	13	15	16
0	0	0	0	0	1	2	3	4	6	7	6	7	10	12	13	15	16
0	0	0	0	0	1	2	3	4	6	7	6	7	10	12	13	15	16
0	0	0	0	0	1	2	3	4	6	7	6	7	10	12	13	15	16

SPEC 5.1 NTF BULKHEAD SHELL

0 SCALE 36

FIG. 36

DISPLAY= SY /1000 , NODE= 1 , SURFACE= 0

0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8

SPEC 5.1 NTF BULKHEAD SHELL

0 36 SCALE

FIG. 37

1/1/1

DISPLAY= SY /1000 , NODE= 1 , SURFACE= 1

0	0	1	1	2	2	1	0	1	4	7	3	3	3	7	9	9	8
0	0	1	1	2	2	1	0	1	4	7	3	3	3	7	9	9	8
0	0	1	1	2	2	1	0	1	4	7	3	3	3	7	9	9	8
0	0	1	1	2	2	1	0	1	4	7	3	3	3	7	9	9	8
0	0	1	1	2	2	1	0	1	4	7	3	3	3	7	9	9	8
0	0	1	1	2	2	1	0	1	4	7	3	3	3	7	9	9	8
0	0	1	1	2	2	1	0	1	4	7	3	3	3	7	9	9	8
0	0	1	1	2	2	1	0	1	4	7	3	3	3	7	9	9	8
0	0	1	1	2	2	1	0	1	4	7	3	3	3	7	9	9	8
0	0	1	1	2	2	1	0	1	4	7	3	3	3	7	9	9	8
0	0	1	1	2	2	1	0	1	4	7	3	3	3	7	9	9	8
0	0	1	1	2	2	1	0	1	4	7	3	3	3	7	9	9	8
0	0	1	1	2	2	1	0	1	4	7	3	3	3	7	9	9	8
0	0	1	1	2	2	1	0	1	4	7	3	3	3	7	9	9	8
0	0	1	1	2	2	1	0	1	4	7	3	3	3	7	9	9	8
0	0	1	1	2	2	1	0	1	4	7	3	3	3	7	9	9	8
0	0	1	1	2	2	1	0	1	4	7	3	3	3	7	9	9	8
0	0	1	1	2	2	1	0	1	4	7	3	3	3	7	9	9	8
0	0	1	1	2	2	1	0	1	4	7	3	3	3	7	9	9	8
0	0	1	1	2	2	1	0	1	4	7	3	3	3	7	9	9	8
0	0	1	1	2	2	1	0	1	4	7	3	3	3	7	9	9	8
0	0	1	1	2	2	1	0	1	4	7	3	3	3	7	9	9	8
0	0	1	1	2	2	1	0	1	4	7	3	3	3	7	9	9	8
0	0	1	1	2	2	1	0	1	4	7	3	3	3	7	9	9	8
0	0	1	1	2	2	1	0	1	4	7	3	3	3	7	9	9	8
0	0	1	1	2	2	1	0	1	4	7	3	3	3	7	9	9	8
0	0	1	1	2	2	1	0	1	4	7	3	3	3	7	9	9	8
0	0	1	1	2	2	1	0	1	4	7	3	3	3	7	9	9	8
0	0	1	1	2	2	1	0	1	4	7	3	3	3	7	9	9	8
0	0	1	1	2	2	1	0	1	4	7	3	3	3	7	9	9	8
0	0	1	1	2	2	1	0	1	4	7	3	3	3	7	9	9	8
0	0	1	1	2	2	1	0	1	4	7	3	3	3	7	9	9	8
0	0	1	1	2	2	1	0	1	4	7	3	3	3	7	9	9	8
0	0	1	1	2	2	1	0	1	4	7	3	3	3	7	9	9	8
0	0	1	1	2	2	1	0	1	4	7	3	3	3	7	9	9	8
0	0	1	1	2	2	1	0	1	4	7	3	3	3	7	9	9	8
0	0	1	1	2	2	1	0	1	4	7	3	3	3	7	9	9	8
0	0	1	1	2	2	1	0	1	4	7	3	3	3	7	9	9	8
0	0	1	1	2	2	1	0	1	4	7	3	3	3	7	9	9	8
0	0	1	1	2	2	1	0	1	4	7	3	3	3	7	9	9	8

SPEC 5.1 NTF BULKHEAD SHELL

0 36 SCALE

FIG. 38

DISPLAY= SY /1000 , NODE= 1, SURFACE= 2

0	0	-1	-2	-2	-2	-1	0	1	4	7	3	4	6	9	6	6	7
0	0	-1	-2	-2	-2	-1	0	1	4	7	3	4	6	9	6	6	7
0	0	-1	-2	-2	-2	-1	0	1	4	7	3	4	6	9	6	6	7
0	0	-1	-2	-2	-2	-1	0	1	4	7	3	4	6	9	6	6	7
0	0	-1	-2	-2	-2	-1	0	1	4	7	3	4	6	9	6	6	7
0	0	-1	-2	-2	-2	-1	0	1	4	7	3	4	6	9	6	6	7
0	0	-1	-2	-2	-2	-1	0	1	4	7	3	4	6	9	6	6	7
0	0	-1	-2	-2	-2	-1	0	1	4	7	3	4	6	9	6	6	7
0	0	-1	-2	-2	-2	-1	0	1	4	7	3	4	6	9	6	6	7
0	0	-1	-2	-2	-2	-1	0	1	4	7	3	4	6	9	6	6	7
0	0	-1	-2	-2	-2	-1	0	1	4	7	3	4	6	9	6	6	7
0	0	-1	-2	-2	-2	-1	0	1	4	7	3	4	6	9	6	6	7
0	0	-1	-2	-2	-2	-1	0	1	4	7	3	4	6	9	6	6	7
0	0	-1	-2	-2	-2	-1	0	1	4	7	3	4	6	9	6	6	7
0	0	-1	-2	-2	-2	-1	0	1	4	7	3	4	6	9	6	6	7
0	0	-1	-2	-2	-2	-1	0	1	4	7	3	4	6	9	6	6	7
0	0	-1	-2	-2	-2	-1	0	1	4	7	3	4	6	9	6	6	7
0	0	-1	-2	-2	-2	-1	0	1	4	7	3	4	6	9	6	6	7
0	0	-1	-2	-2	-2	-1	0	1	4	7	3	4	6	9	6	6	7
0	0	-1	-2	-2	-2	-1	0	1	4	7	3	4	6	9	6	6	7
0	0	-1	-2	-2	-2	-1	0	1	4	7	3	4	6	9	6	6	7
0	0	-1	-2	-2	-2	-1	0	1	4	7	3	4	6	9	6	6	7
0	0	-1	-2	-2	-2	-1	0	1	4	7	3	4	6	9	6	6	7
0	0	-1	-2	-2	-2	-1	0	1	4	7	3	4	6	9	6	6	7
0	0	-1	-2	-2	-2	-1	0	1	4	7	3	4	6	9	6	6	7
0	0	-1	-2	-2	-2	-1	0	1	4	7	3	4	6	9	6	6	7
0	0	-1	-2	-2	-2	-1	0	1	4	7	3	4	6	9	6	6	7
0	0	-1	-2	-2	-2	-1	0	1	4	7	3	4	6	9	6	6	7
0	0	-1	-2	-2	-2	-1	0	1	4	7	3	4	6	9	6	6	7
0	0	-1	-2	-2	-2	-1	0	1	4	7	3	4	6	9	6	6	7
0	0	-1	-2	-2	-2	-1	0	1	4	7	3	4	6	9	6	6	7
0	0	-1	-2	-2	-2	-1	0	1	4	7	3	4	6	9	6	6	7
0	0	-1	-2	-2	-2	-1	0	1	4	7	3	4	6	9	6	6	7
0	0	-1	-2	-2	-2	-1	0	1	4	7	3	4	6	9	6	6	7
0	0	-1	-2	-2	-2	-1	0	1	4	7	3	4	6	9	6	6	7
0	0	-1	-2	-2	-2	-1	0	1	4	7	3	4	6	9	6	6	7
0	0	-1	-2	-2	-2	-1	0	1	4	7	3	4	6	9	6	6	7
0	0	-1	-2	-2	-2	-1	0	1	4	7	3	4	6	9	6	6	7
0	0	-1	-2	-2	-2	-1	0	1	4	7	3	4	6	9	6	6	7
0	0	-1	-2	-2	-2	-1	0	1	4	7	3	4	6	9	6	6	7

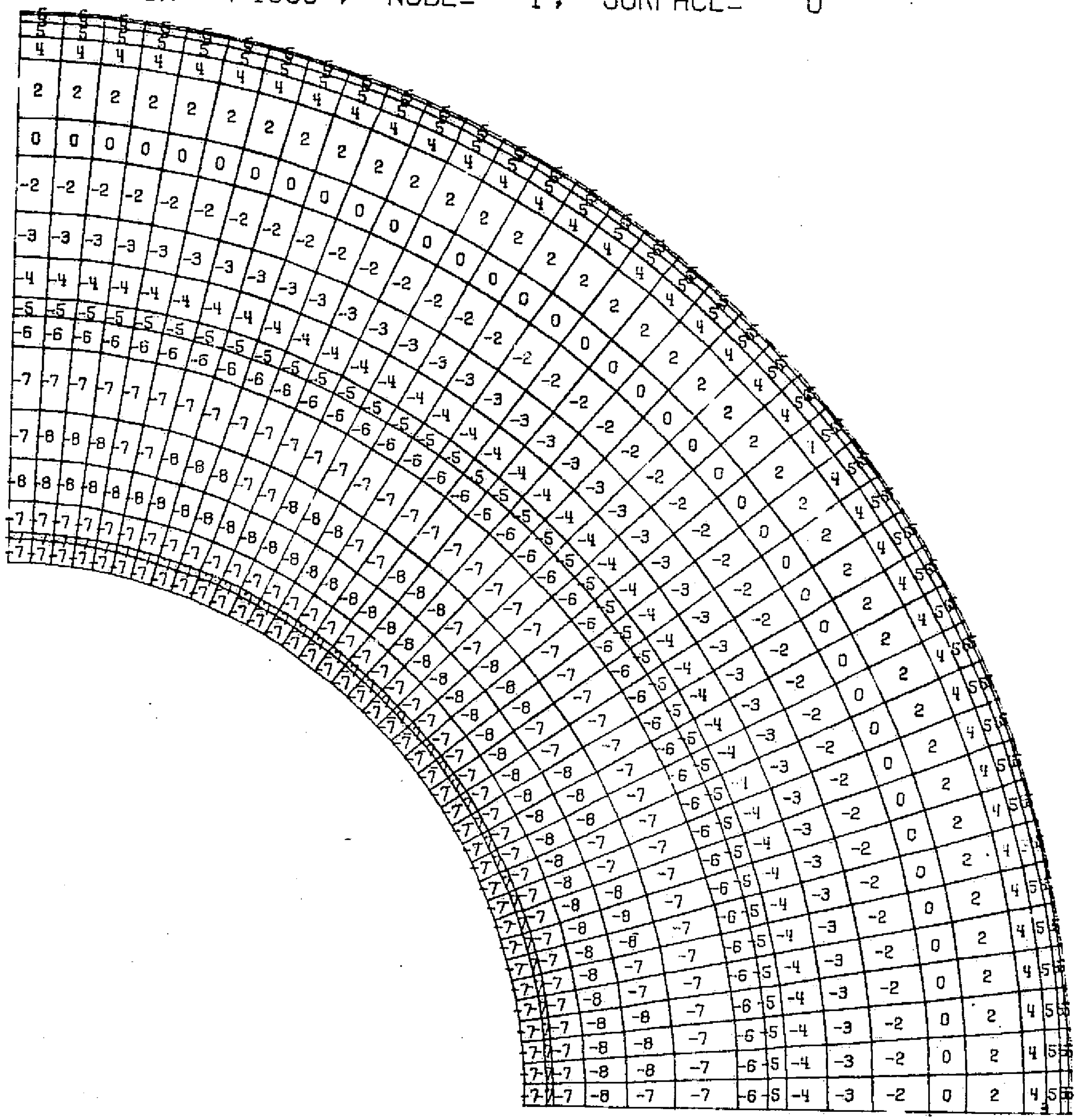
SPEC 5.1

NTF BULKHEAD SHELL

0 ______ 36
SCALE

FIG 39

DISPLAY= SX /1000 , NODE= 1 , SURFACE= 0 1/1/1



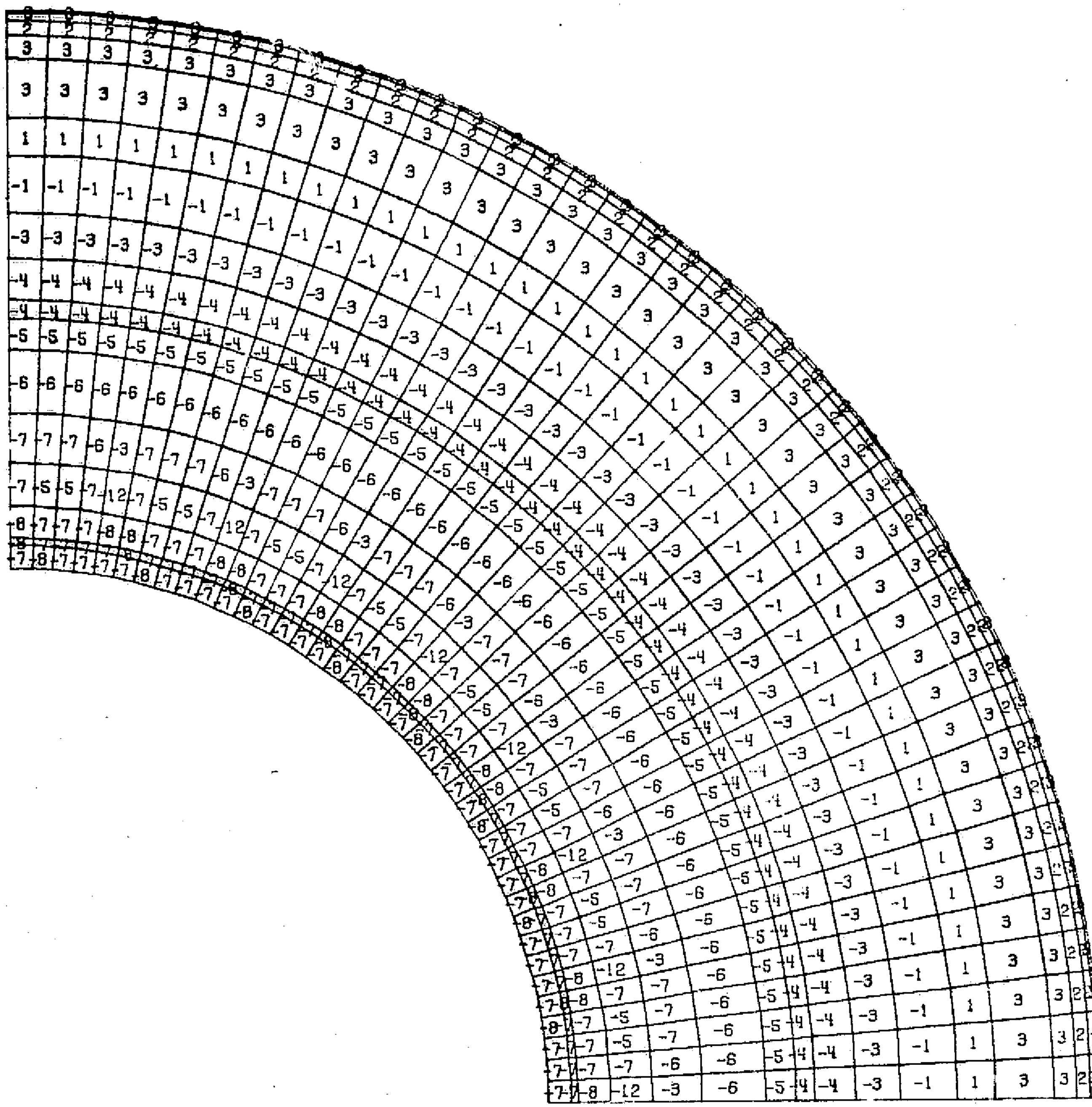
SPEC 3.1

NTF BULKHEAD DOME

0 SCALE 26

FIG 40

DISPLAY= SX /1000 , NODE= 1, SURFACE= 1



SPEC 3.1

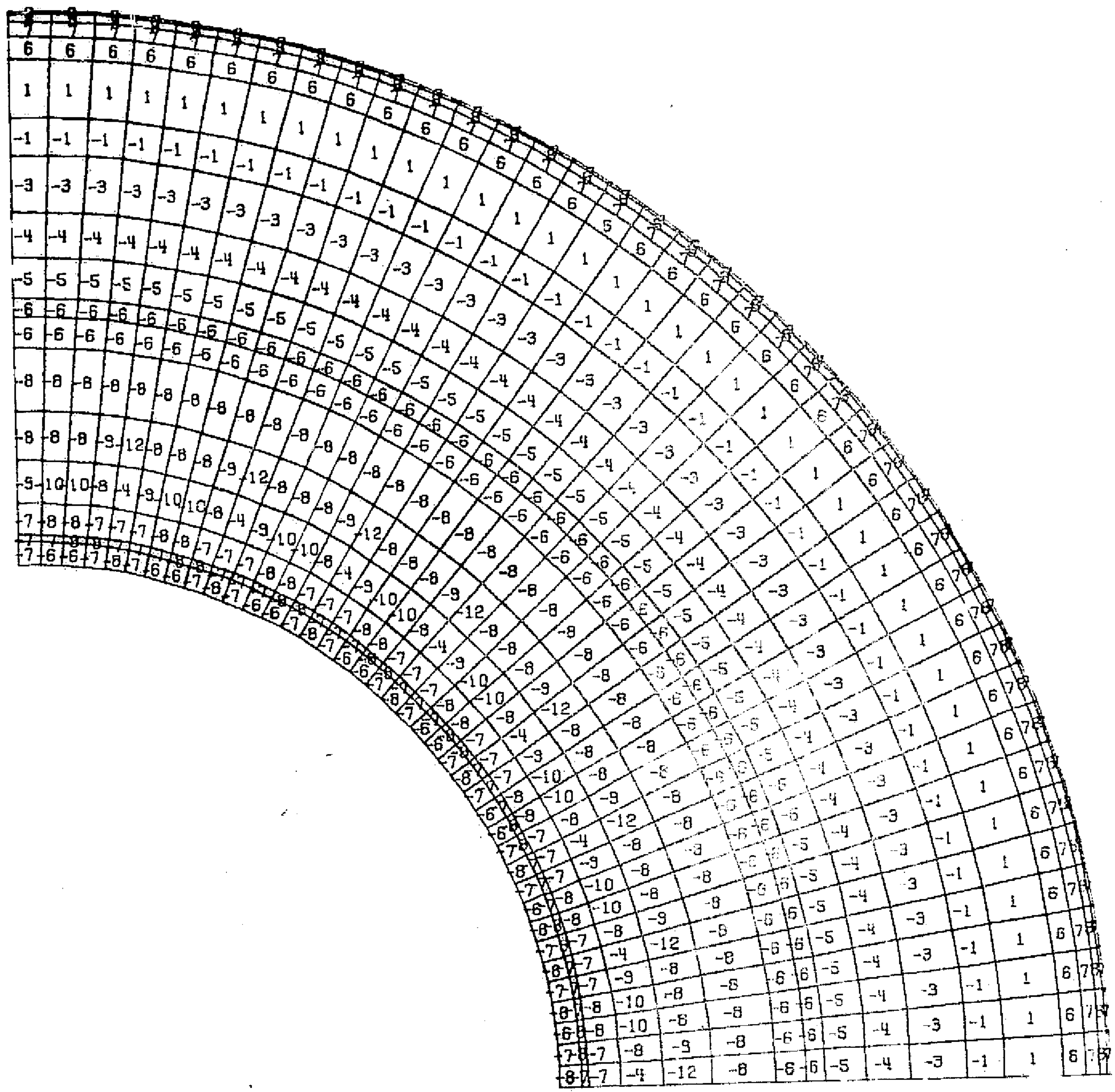
NTF BULKHEAD DOME

0 26 SCALE

FIG 41

1/1/1

DISPLAY= SX /1000 , NODE= 1 , SURFACE= 2



0 SCALE 26

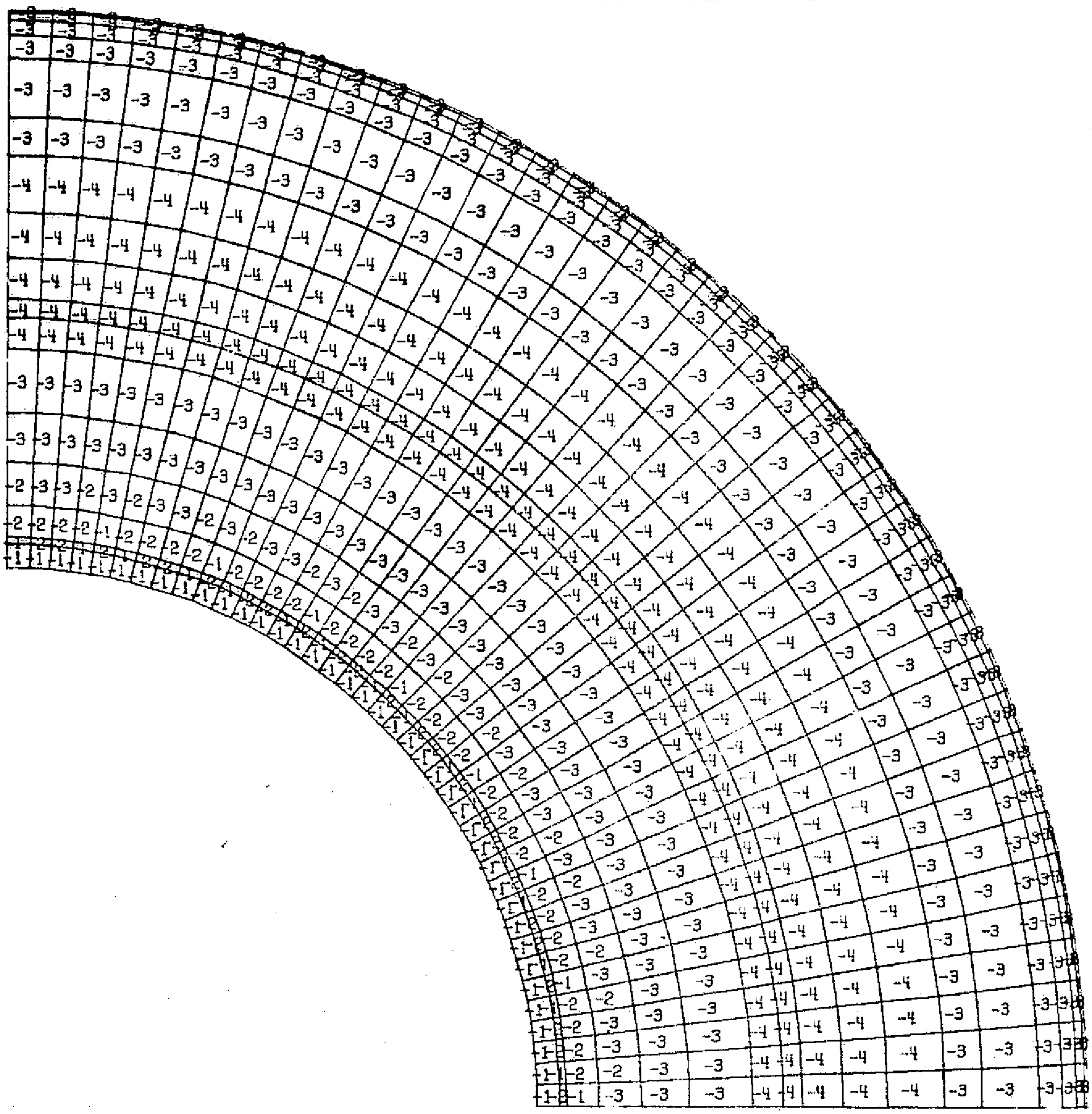
SPEC 3.1

NTF BULKHEAD DOME

FIG 42

1/1/1

DISPLAY= SY /1000 , NODE= 1, SURFACE= 0



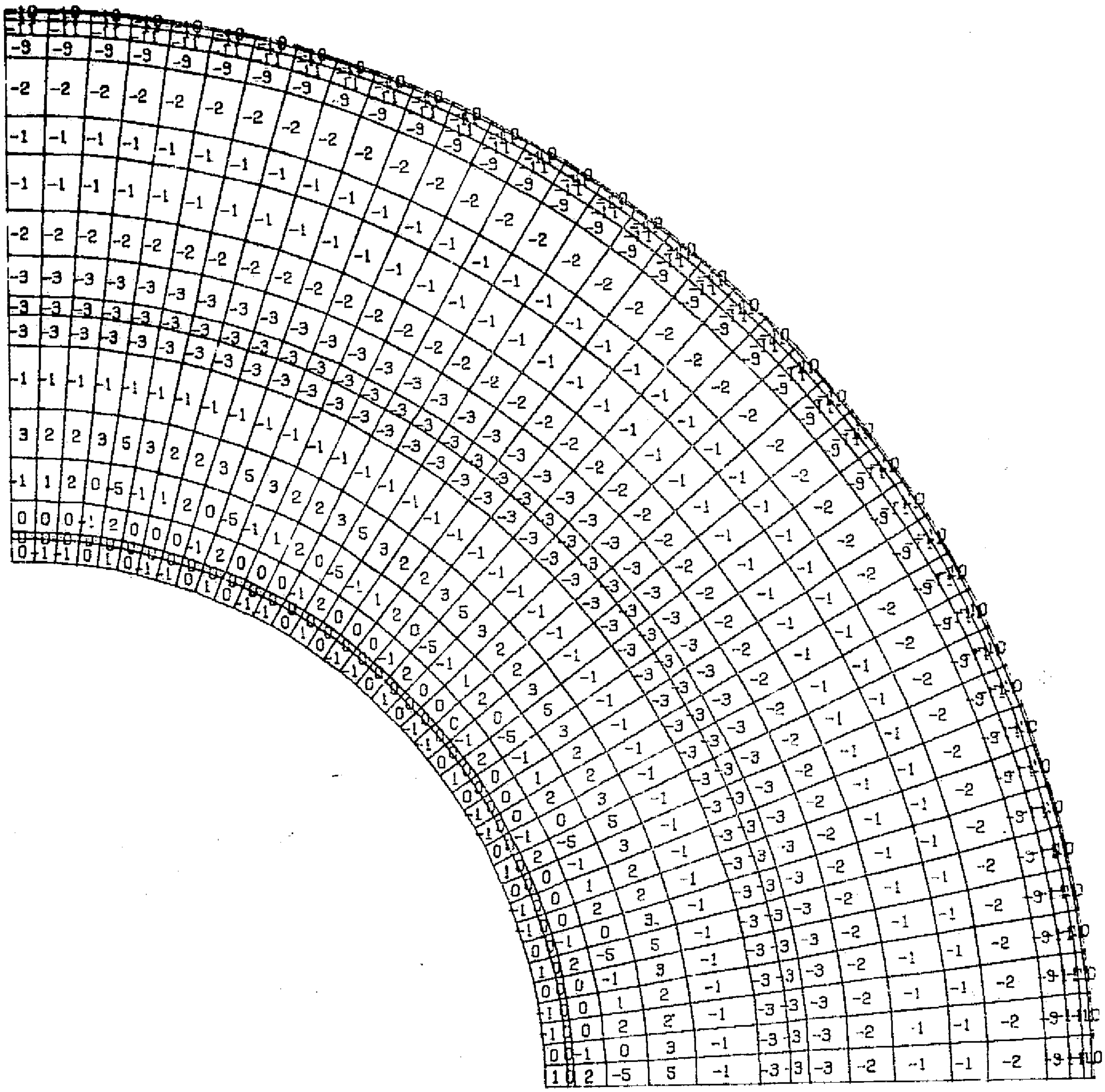
SPEC 3.1

NTF BULKHEAD DOME

0 26 SCALE

FIG 43

DISPLAY= SY /1000 , NODE= 1, SURFACE= 1



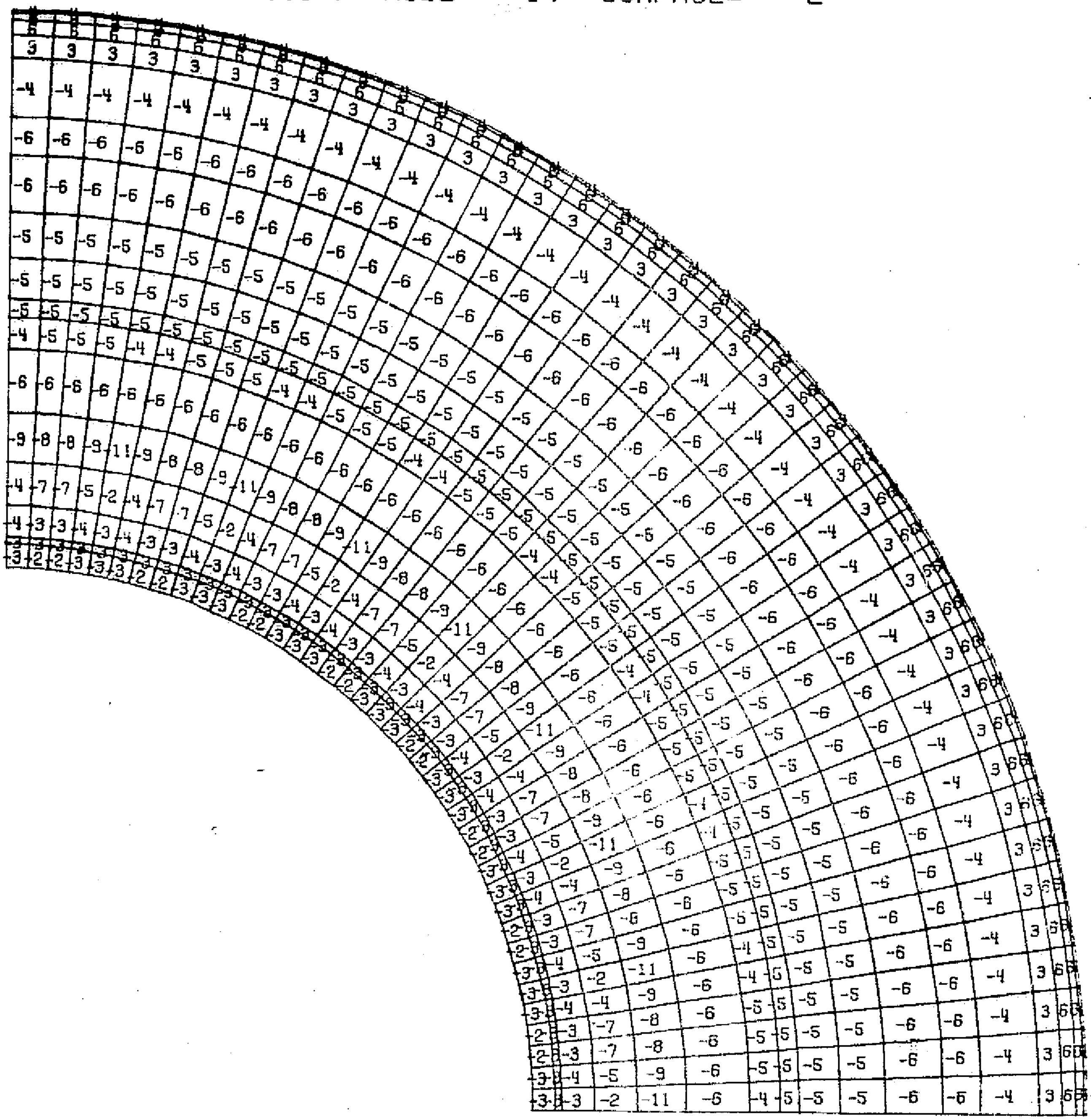
SPEC 3.1

NTF BULKHEAD DOME

0 SCALE 26

FIG 44

DISPLAY= SY /1000 , NODE= 1, SURFACE= 2



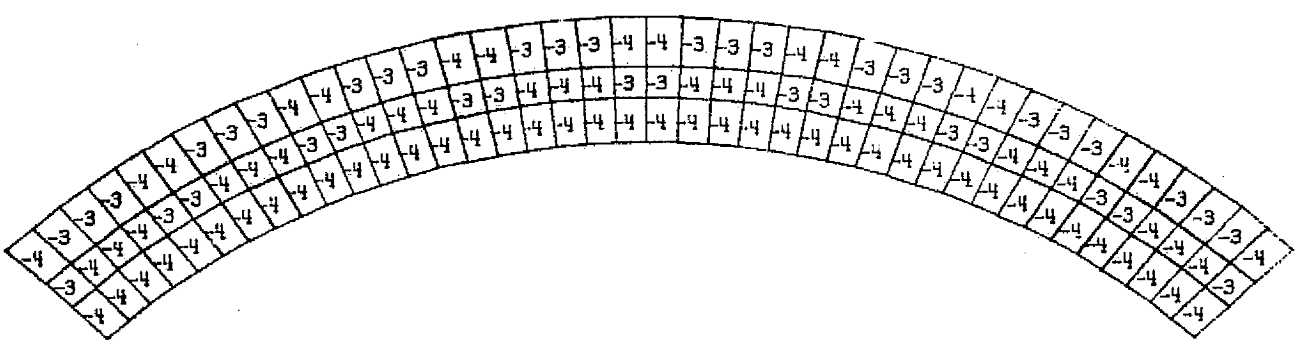
SPEC 3.1 NTF BULKHEAD DOME

0 SCALE 26

FIG 45

1/1/1

DISPLAY= SX /1000 , NODE= 1, SURFACE= 0



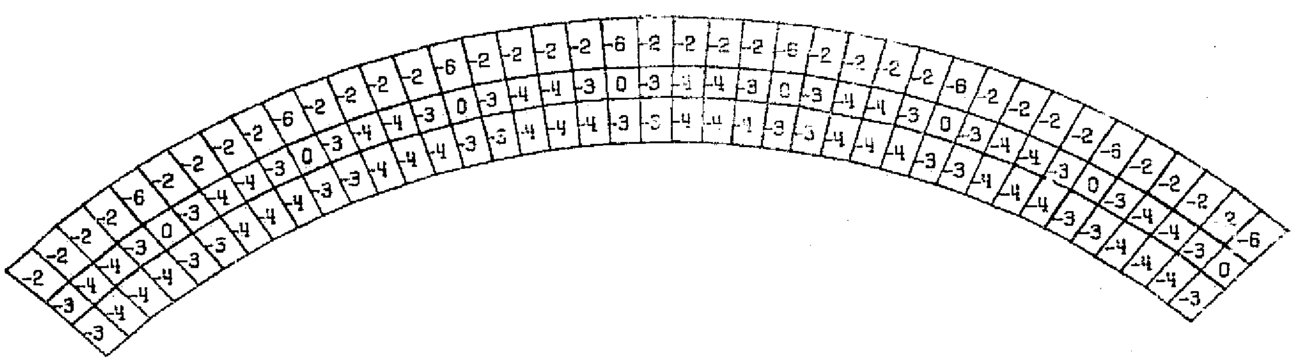
SPEC
2.1

NTF BULKHEAD
FLANGE SURFACE

0 SCALE 21

FIG 46

DISPLAY= SX /1000 , NODE= 1 , SURFACE= 1



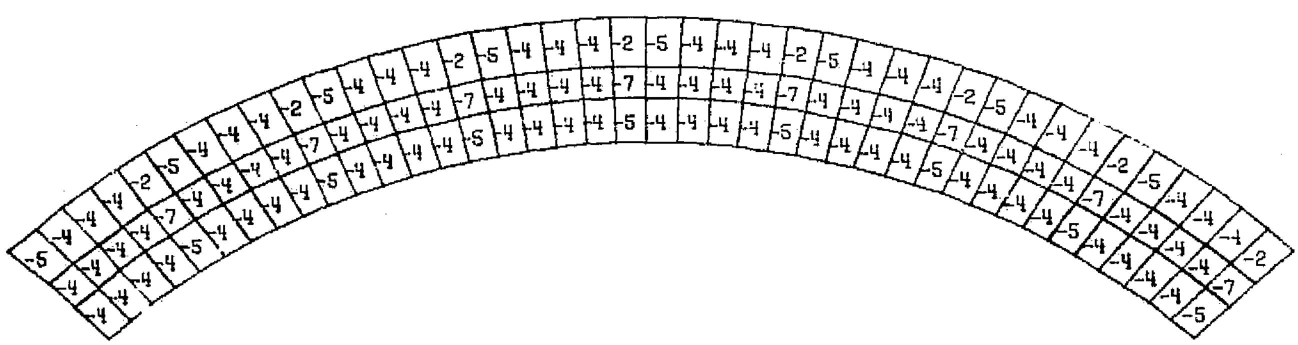
0 21
SCALE

SPEC 2.1 NTF BULKHEAD
FLANGE SURFACE

FIG 47

1/1/1

DISPLAY= SX /1000 , NODE= 1 , SURFACE= 2



SPEC
?.1

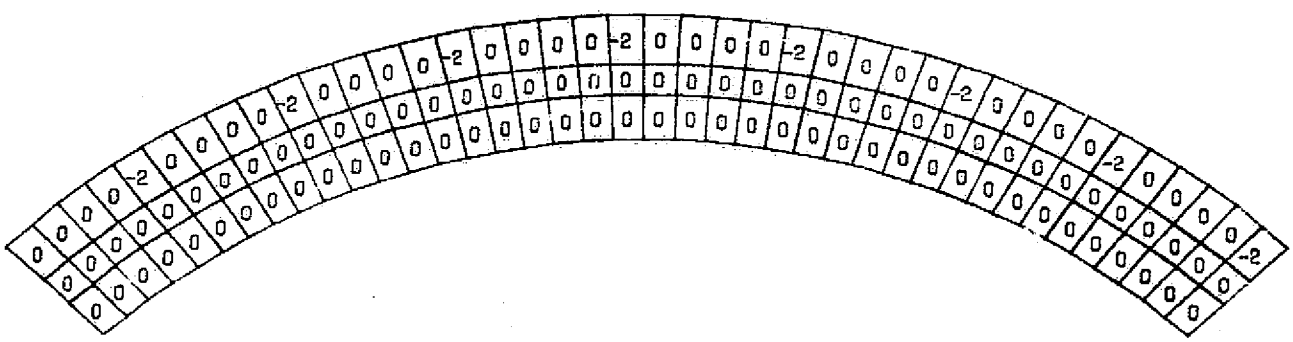
NTF BULKHEAD
FLANGE SURFACE

0 21
SCALE

FIG 48

DISPLAY= SY /1000 , NODE= 1 , SURFACE= 0

1/1/1



SPEC
^ 1

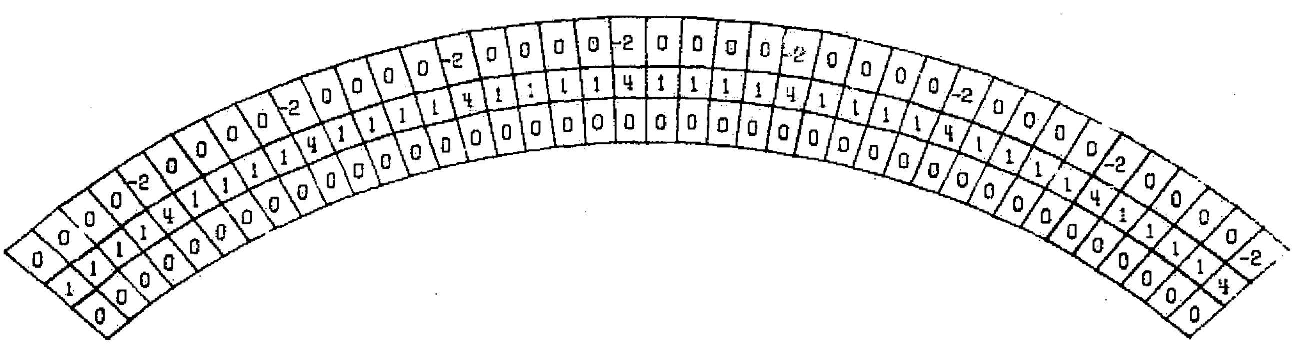
NTF BULKHEAD
FLANGE SURFACE

0 21
SCALE

FIG 49

1/1/1

DISPLAY= SY /1000 , NODE= 1 , SURFACE= 1

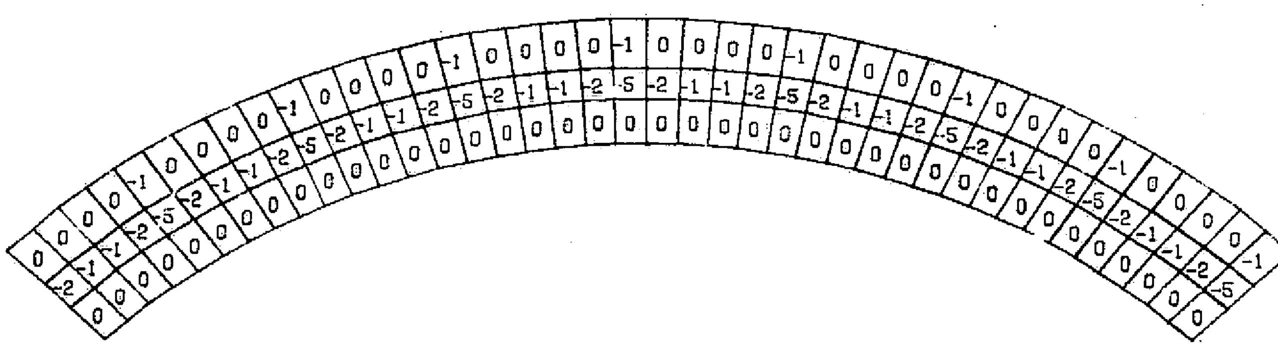


SPEC 2.1 NTF BULKHEAD FLANGE SURFACE

0 21
SCALE

FIG 50

DISPLAY= SY /1000 , NODE= 1 , SURFACE= 2



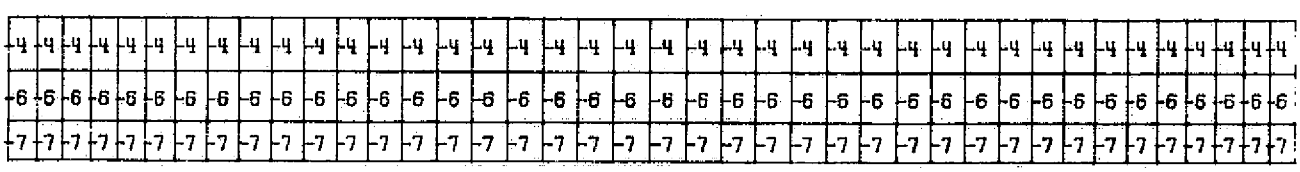
SPEC 2.1

NTF BULKHEAD
FLANGE SURFACE

0 SCALE 21

FIG 51

DISPLAY= SX /1000 , NODE= 1, SURFACE= 0



SPEC
10.1

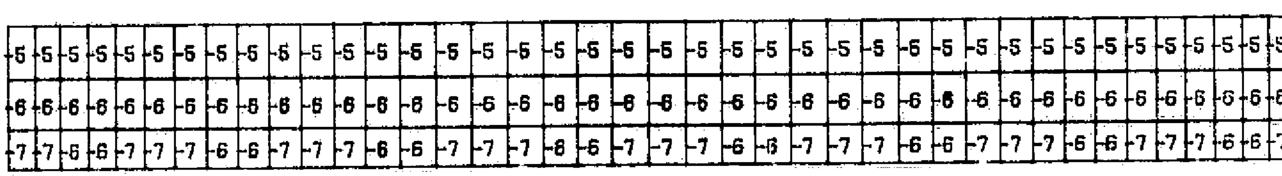
NTF BULKHEAD
HATCH OPENING

0 SCALE 18

FIG 52

1/1/1

DISPLAY= SX /1000 , NODE= 1 , SURFACE= 1



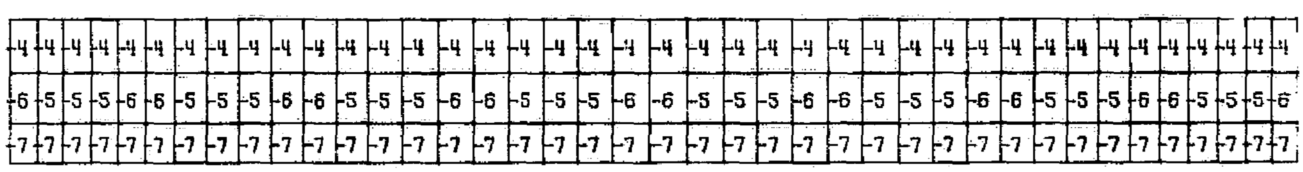
SPEC 10.1

NTF BULKHEAD HATCH OPENING

0 SCALE 18

FIG 53

DISPLAY= SX /1000 , NODE= 1 , SURFACE= 2



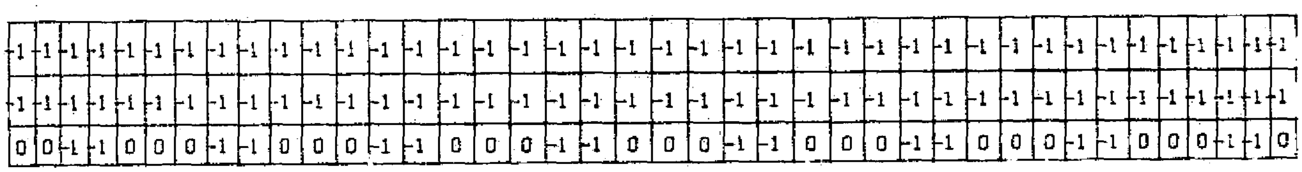
SPEC 10.1

NTF BULKHEAD
HATCH OPENING

0 SCALE 18

FIG 54

DISPLAY= SY /1000 , NODE= 1 , SURFACE= 0



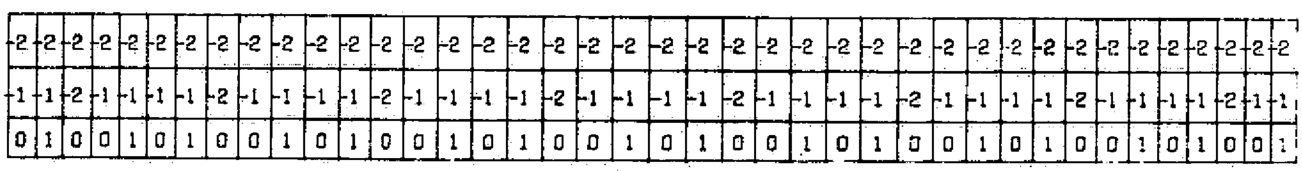
SPEC 10.1 NTF BULKHEAD HATCH OPENING

0 ___ 18
SCALE

FIG 55

DISPLAY= SY /1000 , NODE= 1 , SURFACE= 1

1/1/1

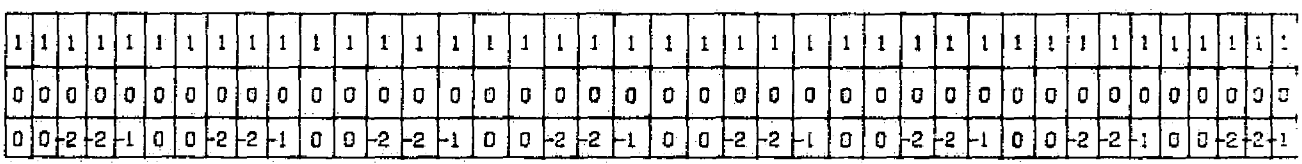


SPEC 10-1 NTF BULKHEAD HATCH OPENING

0 ―― 18 SCALE

FIG 56

DISPLAY= SY /1000 , NODE= 1, SURFACE= 2



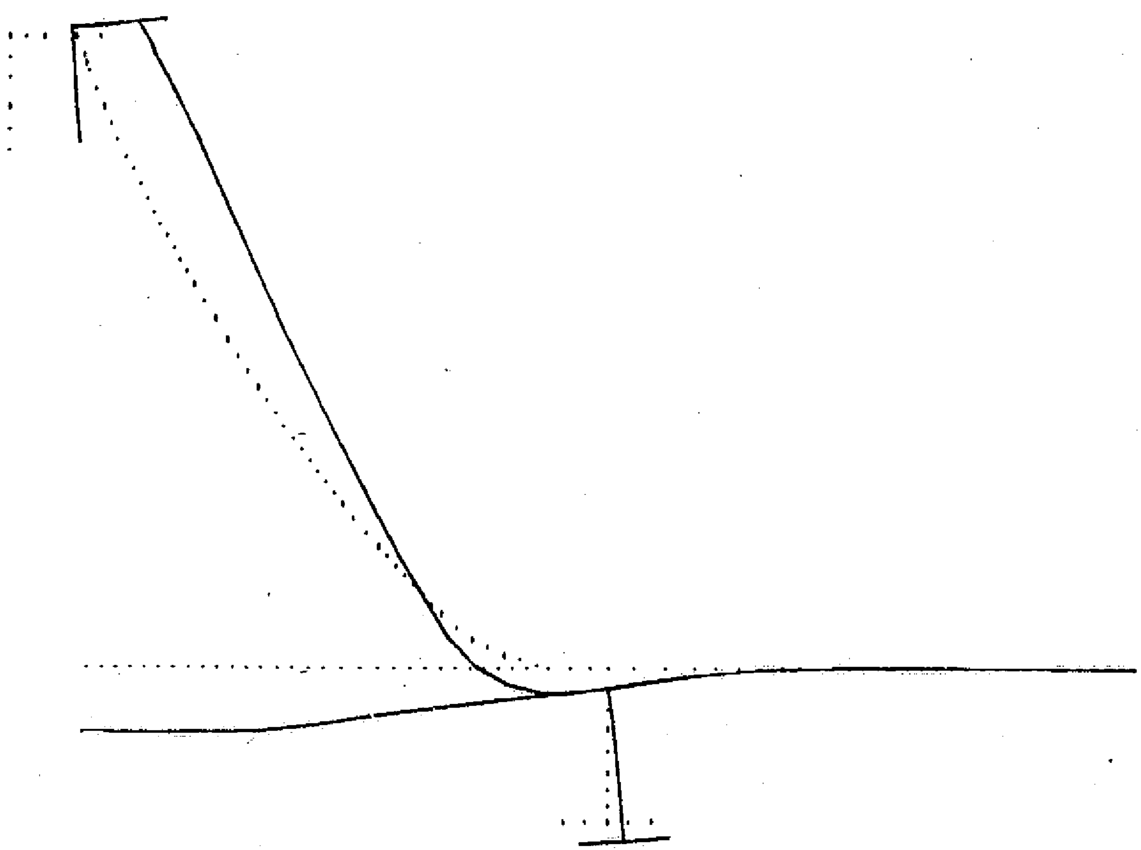
SPEC
10.1

NTF BULKHEAD
HATCH OPENING

0 SCALE 18

FIG 57

1/1/1

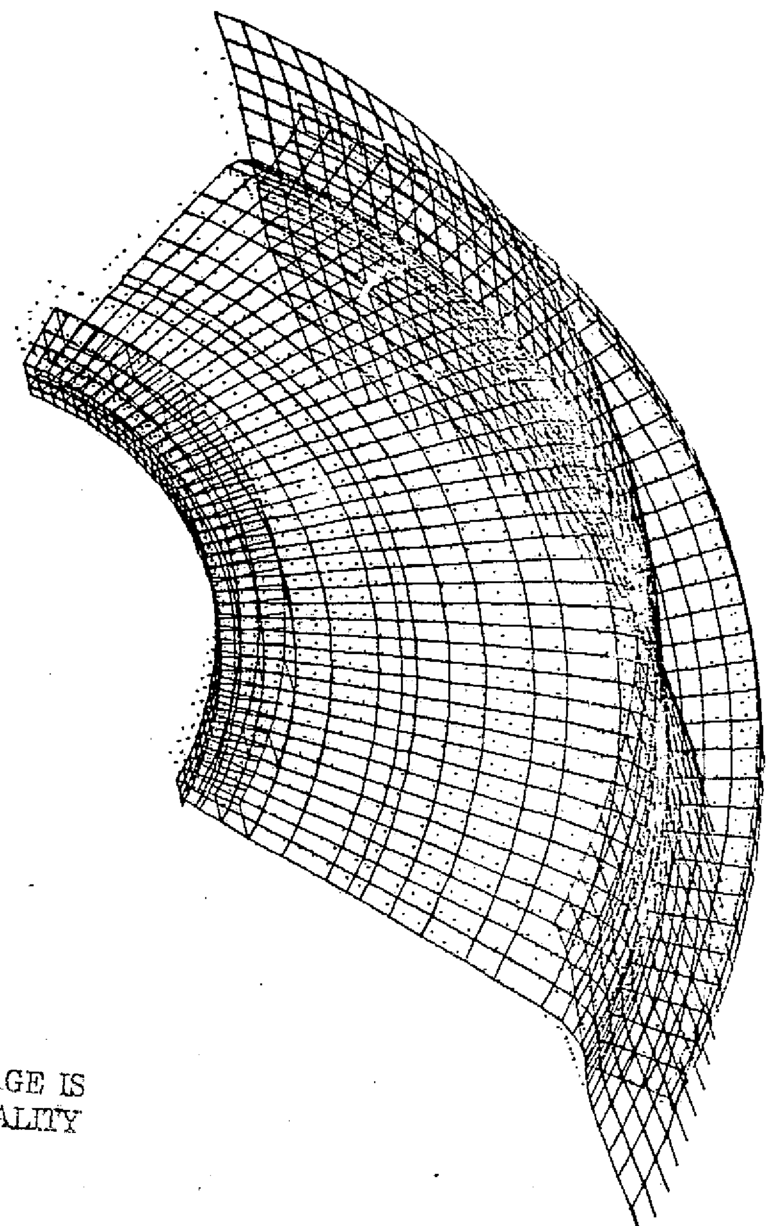


SPEC 12.1

NTF BULKHEAD
CROSS-SECTION VIEW

0 SCALE 27

FIG 58



SPEC 1.1 NTF BULKHEAD
..VALVE OPEN AND TEMP DIST

0 SCALE 44

FIG 59

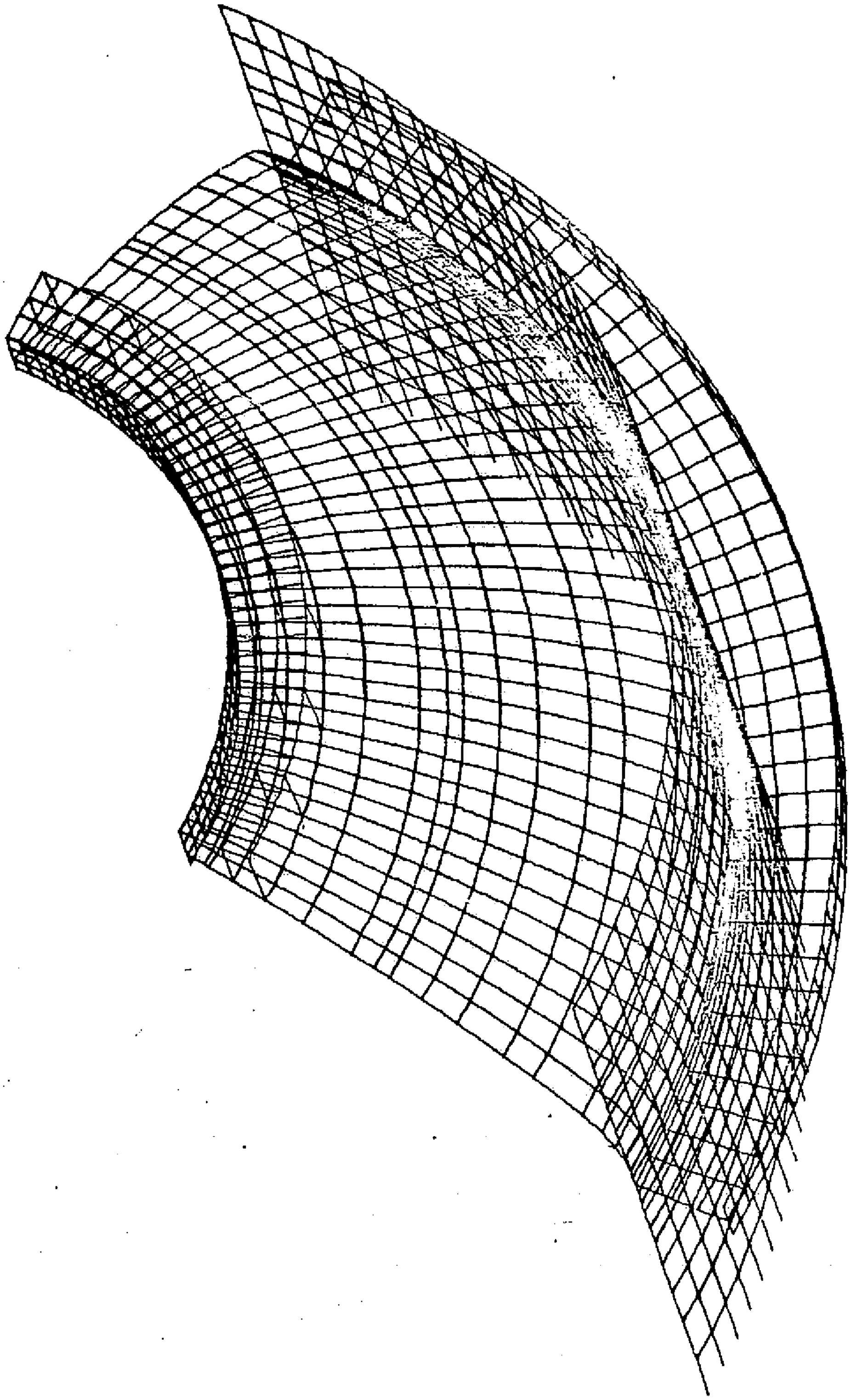
CASE 2

GATE VALVE OPEN

STRESS PLOTS

FIGURES 60 THRU 86

COMPUTER RUN NO. LEH



NTE BULKHEAD

0 41
SCALE

FIG. 60

DISPLAY= SX /1000 . NODE= 1. SURFACE= 0

5	5	5	4	4	4	4	4	4	4	4	5	5	8	11	14	15	16
5	5	5	4	4	4	4	4	4	4	4	5	5	8	11	14	15	16
5	5	5	4	4	4	4	4	4	4	4	5	5	8	11	14	15	16
5	5	5	4	4	4	4	4	4	4	4	5	5	8	11	14	15	16
5	5	5	4	4	4	4	4	4	4	4	5	5	8	11	14	15	16
5	5	5	4	4	4	4	4	4	4	4	5	5	8	11	14	15	16
5	5	5	4	4	4	4	4	4	4	4	5	5	8	11	14	15	16
5	5	5	4	4	4	4	4	4	4	4	5	5	8	11	14	15	16
5	5	5	4	4	4	4	4	4	4	4	5	5	8	11	14	15	16
5	5	5	4	4	4	4	4	4	4	4	5	5	8	11	14	15	16
5	5	5	4	4	4	4	4	4	4	4	5	5	8	11	14	15	16
5	5	5	4	4	4	4	4	4	4	4	5	5	8	11	14	15	16
5	5	5	4	4	4	4	4	4	4	4	5	5	8	11	14	15	16
5	5	5	4	4	4	4	4	4	4	4	5	5	8	11	14	15	16
5	5	5	4	4	4	4	4	4	4	4	5	5	8	11	14	15	16
5	5	5	4	4	4	4	4	4	4	4	5	5	8	11	14	15	16
5	5	5	4	4	4	4	4	4	4	4	5	5	8	11	14	15	16
5	5	5	4	4	4	4	4	4	4	4	5	5	8	11	14	15	16
5	5	5	4	4	4	4	4	4	4	4	5	5	8	11	14	15	16
5	5	5	4	4	4	4	4	4	4	4	5	5	8	11	14	15	16
5	5	5	4	4	4	4	4	4	4	4	5	5	8	11	14	15	16
5	5	5	4	4	4	4	4	4	4	4	5	5	8	11	14	15	16
5	5	5	4	4	4	4	4	4	4	4	5	5	8	11	14	15	16
5	5	5	4	4	4	4	4	4	4	4	5	5	8	11	14	15	16
5	5	5	4	4	4	4	4	4	4	4	5	5	8	11	14	15	16
5	5	5	4	4	4	4	4	4	4	4	5	5	8	11	14	15	16
5	5	5	4	4	4	4	4	4	4	4	5	5	8	11	14	15	16
5	5	5	4	4	4	4	4	4	4	4	5	5	8	11	14	15	16
5	5	5	4	4	4	4	4	4	4	4	5	5	8	11	14	15	16
5	5	5	4	4	4	4	4	4	4	4	5	5	8	11	14	15	16
5	5	5	4	4	4	4	4	4	4	4	5	5	8	11	14	15	16
5	5	5	4	4	4	4	4	4	4	4	5	5	8	11	14	15	16
5	5	5	4	4	4	4	4	4	4	4	5	5	8	11	14	15	16
5	5	5	4	4	4	4	4	4	4	4	5	5	8	11	14	15	16
5	5	5	4	4	4	4	4	4	4	4	5	5	8	11	14	15	16
5	5	5	4	4	4	4	4	4	4	4	5	5	8	11	14	15	16
5	5	5	4	4	4	4	4	4	4	4	5	5	8	11	14	15	16
5	5	5	4	4	4	4	4	4	4	4	5	5	8	11	14	15	16
5	5	5	4	4	4	4	4	4	4	4	5	5	8	11	14	15	16
5	5	5	4	4	4	4	4	4	4	4	5	5	8	11	14	15	16

SPEC 5.1 NTF BULKHEAD SHELL

0 36 SCALE

FIG 61

DISPLAY= SX /1000 . NODE= 1 . SURFACE= 1

5	5	5	4	4	4	4	4	5	4	4	4	4	7	11	14	16	16
5	5	5	4	4	4	4	4	5	4	4	4	4	7	11	14	16	16
5	5	5	4	4	4	4	4	5	4	4	4	4	7	11	14	16	16
5	5	5	4	4	4	4	4	5	4	4	4	4	7	11	14	16	16
5	5	5	4	4	4	4	4	5	4	4	4	4	7	11	14	16	16
5	5	5	4	4	4	4	4	5	4	4	4	4	7	11	14	16	16
5	5	5	4	4	4	4	4	5	4	4	4	4	7	11	14	16	16
5	5	5	4	4	4	4	4	5	4	4	4	4	7	11	14	16	16
5	5	5	4	4	4	4	4	5	4	4	4	4	7	11	14	16	16
5	5	5	4	4	4	4	4	5	4	4	4	4	7	11	14	16	16
5	5	5	4	4	4	4	4	5	4	4	4	4	7	11	14	16	16
5	5	5	4	4	4	4	4	5	4	4	4	4	7	11	14	16	16
5	5	5	4	4	4	4	4	5	4	4	4	4	7	11	14	16	16
5	5	5	4	4	4	4	4	5	4	4	4	4	7	11	14	16	16
5	5	5	4	4	4	4	4	5	4	4	4	4	7	11	14	16	16
5	5	5	4	4	4	4	4	5	4	4	4	4	7	11	14	16	16
5	5	5	4	4	4	4	4	5	4	4	4	4	7	11	14	16	16
5	5	5	4	4	4	4	4	5	4	4	4	4	7	11	14	16	16
5	5	5	4	4	4	4	4	5	4	4	4	4	7	11	14	16	16
5	5	5	4	4	4	4	4	5	4	4	4	4	7	11	14	16	16
5	5	5	4	4	4	4	4	5	4	4	4	4	7	11	14	16	16
5	5	5	4	4	4	4	4	5	4	4	4	4	7	11	14	16	16
5	5	5	4	4	4	4	4	5	4	4	4	4	7	11	14	16	16
5	5	5	4	4	4	4	4	5	4	4	4	4	7	11	14	16	16
5	5	5	4	4	4	4	4	5	4	4	4	4	7	11	14	16	16
5	5	5	4	4	4	4	4	5	4	4	4	4	7	11	14	16	16
5	5	5	4	4	4	4	4	5	4	4	4	4	7	11	14	16	16
5	5	5	4	4	4	4	4	5	4	4	4	4	7	11	14	16	16
5	5	5	4	4	4	4	4	5	4	4	4	4	7	11	14	16	16
5	5	5	4	4	4	4	4	5	4	4	4	4	7	11	14	16	16
5	5	5	4	4	4	4	4	5	4	4	4	4	7	11	14	16	16
5	5	5	4	4	4	4	4	5	4	4	4	4	7	11	14	16	16
5	5	5	4	4	4	4	4	5	4	4	4	4	7	11	14	16	16
5	5	5	4	4	4	4	4	5	4	4	4	4	7	11	14	16	16
5	5	5	4	4	4	4	4	5	4	4	4	4	7	11	14	16	16
5	5	5	4	4	4	4	4	5	4	4	4	4	7	11	14	16	16
5	5	5	4	4	4	4	4	5	4	4	4	4	7	11	14	16	16
5	5	5	4	4	4	4	4	5	4	4	4	4	7	11	14	16	16
5	5	5	4	4	4	4	4	5	4	4	4	4	7	11	14	16	16
5	5	5	4	4	4	4	4	5	4	4	4	4	7	11	14	16	16

SPEC 5.1 NTF BULKHEAD SHELL

0 36
SCALE

DISPLAY= SX /1000 , NODE= 1 , SURFACE= 2

5	5	5	4	4	4	4	4	4	4	5	6	7	9	12	13	15	16
5	5	5	4	4	4	4	4	4	4	5	6	7	9	12	13	15	16
5	5	5	4	4	4	4	4	4	4	5	6	7	9	12	13	15	16
5	5	5	4	4	4	4	4	4	4	5	6	7	9	12	13	15	16
5	5	5	4	4	4	4	4	4	4	5	6	7	9	12	13	15	16
5	5	5	4	4	4	4	4	4	4	5	6	7	9	12	13	15	16
5	5	5	4	4	4	4	4	4	4	5	6	7	9	12	13	15	16
5	5	5	4	4	4	4	4	4	4	5	6	7	9	12	13	15	16
5	5	5	4	4	4	4	4	4	4	5	6	7	9	12	13	15	16
5	5	5	4	4	4	4	4	4	4	5	6	7	9	12	13	15	16
5	5	5	4	4	4	4	4	4	4	5	6	7	9	12	13	15	16
5	5	5	4	4	4	4	4	4	4	5	6	7	9	12	13	15	16
5	5	5	4	4	4	4	4	4	4	5	6	7	9	12	13	15	16
5	5	5	4	4	4	4	4	4	4	5	6	7	9	12	13	15	16
5	5	5	4	4	4	4	4	4	4	5	6	7	9	12	13	15	16
5	5	5	4	4	4	4	4	4	4	5	6	7	9	12	13	15	16
5	5	5	4	4	4	4	4	4	4	5	6	7	9	12	13	15	16
5	5	5	4	4	4	4	4	4	4	5	6	7	9	12	13	15	16
5	5	5	4	4	4	4	4	4	4	5	6	7	9	12	13	15	16
5	5	5	4	4	4	4	4	4	4	5	6	7	9	12	13	15	16
5	5	5	4	4	4	4	4	4	4	5	6	7	9	12	13	15	16
5	5	5	4	4	4	4	4	4	4	5	6	7	9	12	13	15	16
5	5	5	4	4	4	4	4	4	4	5	6	7	9	12	13	15	16
5	5	5	4	4	4	4	4	4	4	5	6	7	9	12	13	15	16
5	5	5	4	4	4	4	4	4	4	5	6	7	9	12	13	15	16
5	5	5	4	4	4	4	4	4	4	5	6	7	9	12	13	15	16
5	5	5	4	4	4	4	4	4	4	5	6	7	9	12	13	15	16
5	5	5	4	4	4	4	4	4	4	5	6	7	9	12	13	15	16
5	5	5	4	4	4	4	4	4	4	5	6	7	9	12	13	15	16
5	5	5	4	4	4	4	4	4	4	5	6	7	9	12	13	15	16
5	5	5	4	4	4	4	4	4	4	5	6	7	9	12	13	15	16
5	5	5	4	4	4	4	4	4	4	5	6	7	9	12	13	15	16
5	5	5	4	4	4	4	4	4	4	5	6	7	9	12	13	15	16
5	5	5	4	4	4	4	4	4	4	5	6	7	9	12	13	15	16
5	5	5	4	4	4	4	4	4	4	5	6	7	9	12	13	15	16
5	5	5	4	4	4	4	4	4	4	5	6	7	9	12	13	15	16
5	5	5	4	4	4	4	4	4	4	5	6	7	9	12	13	15	16
5	5	5	4	4	4	4	4	4	4	5	6	7	9	12	13	15	16
5	5	5	4	4	4	4	4	4	4	5	6	7	9	12	13	15	16
5	5	5	4	4	4	4	4	4	4	5	6	7	9	12	13	15	16

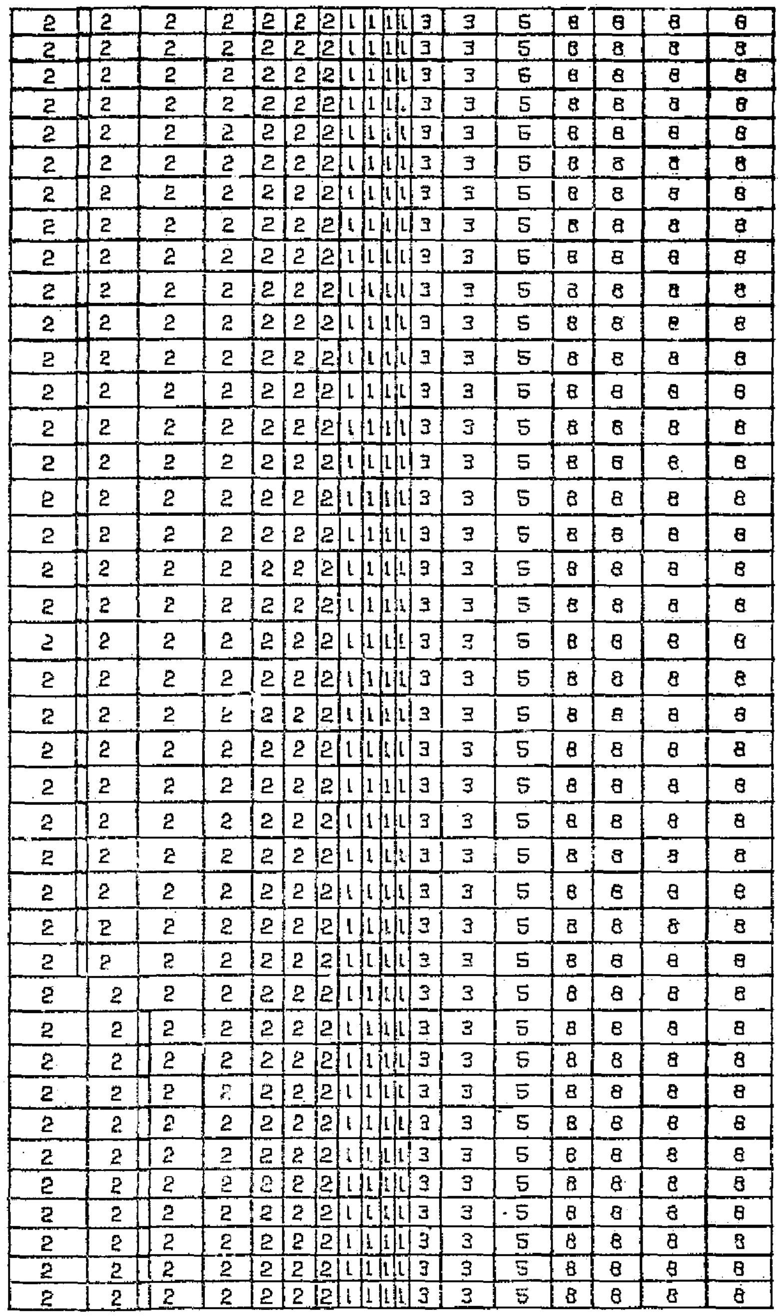
SPEC 5.1

NTF BULKHEAD
SHELL

0 36
SCALE

FIG 63

DISPLAY= SY /1000 , NODE= 1 , SURFACE= 0



SPEC 5.1 NTF BULKHEAD SHELL

0 36 SCALE

FIG 64

DISPLAY= SY /1000 . NODE= 1. SURFACE= 1

2	2	2	2	2	3	3	2	3	4	1	-1	0	2	7	10	10	8
2	2	2	2	2	3	3	2	3	4	1	-1	0	2	7	10	10	8
2	2	2	2	2	3	3	2	3	4	1	-1	0	2	7	10	10	8
2	2	2	2	2	3	3	2	3	4	1	-1	0	2	7	10	10	8
2	2	2	2	2	3	3	2	3	4	1	-1	0	2	7	10	10	8
2	2	2	2	2	3	3	2	3	4	1	-1	0	2	7	10	10	8
2	2	2	2	2	3	3	2	3	4	1	-1	0	2	7	10	10	8
2	2	2	2	2	3	3	2	3	4	1	-1	0	2	7	10	10	8
2	2	2	2	2	3	3	2	3	4	1	-1	0	2	7	10	10	8
2	2	2	2	2	3	3	2	3	4	1	-1	0	2	7	10	10	8
2	2	2	2	2	3	3	2	3	4	1	-1	0	2	7	10	10	8
2	2	2	2	2	3	3	2	3	4	1	-1	0	2	7	10	10	8
2	2	2	2	2	3	3	2	3	4	1	-1	0	2	7	10	10	8
2	2	2	2	2	3	3	2	3	4	1	-1	0	2	7	10	10	8
2	2	2	2	2	3	3	2	3	4	1	-1	0	2	7	10	10	8
2	2	2	2	2	3	3	2	3	4	1	-1	0	2	7	10	10	8
2	2	2	2	2	3	3	2	3	4	1	-1	0	2	7	10	10	8
2	2	2	2	2	3	3	2	3	4	1	-1	0	2	7	10	10	8
2	2	2	2	2	3	3	2	3	4	1	-1	0	2	7	10	10	8
2	2	2	2	2	3	3	2	3	4	1	-1	0	2	7	10	10	8
2	2	2	2	2	3	3	2	3	4	1	-1	0	2	7	10	10	8
2	2	2	2	2	3	3	2	3	4	1	-1	0	2	7	10	10	8
2	2	2	2	2	3	3	2	3	4	1	-1	0	2	7	10	10	8
2	2	2	2	2	3	3	2	3	4	1	-1	0	2	7	10	10	8
2	2	2	2	2	3	3	2	3	4	1	-1	0	2	7	10	10	8
2	2	2	2	2	3	3	2	3	4	1	-1	0	2	7	10	10	8
2	2	2	2	2	3	3	2	3	4	1	-1	0	2	7	10	10	8
2	2	2	2	2	3	3	2	3	4	1	-1	0	2	7	10	10	8
2	2	2	2	2	3	3	2	3	4	1	-1	0	2	7	10	10	8
2	2	2	2	2	3	3	2	3	4	1	-1	0	[illegible]	7	10	10	8
2	2	2	2	2	3	3	2	3	4	1	-1	0	2	7	10	10	8
2	2	2	2	2	3	3	2	3	4	1	-1	0	2	7	10	10	8
2	2	2	2	2	3	3	2	3	4	1	-1	0	2	7	10	10	8
2	2	2	2	2	3	3	2	3	4	1	-1	0	2	7	10	10	8
2	2	2	2	2	3	3	2	3	4	1	-1	0	2	7	10	10	8
2	2	2	2	2	3	3	2	3	4	1	-1	0	2	7	10	10	8
2	2	2	2	2	3	3	2	3	4	1	-1	0	2	7	10	10	8
2	2	2	2	2	3	3	2	3	4	1	-1	0	2	7	10	10	8
2	2	2	2	2	3	3	2	3	4	1	-1	0	2	7	10	10	8
2	2	2	2	2	3	3	2	3	4	1	-1	0	2	7	10	10	8

SPEC 5.1

NTF BULKHEAD SHELL

0 36 SCALE

FIG 65

DISPLAY= SY /1000 . NODE= 1 . SURFACE= 2

2	2	2	2	2	1	0	0	0	2	4	8	7	8	9	6	6	7
2	2	2	2	2	1	0	0	0	2	4	8	7	8	9	6	6	7
2	2	2	2	2	1	0	0	0	2	4	8	7	8	9	6	6	7
2	2	2	2	2	1	0	0	0	2	4	8	7	8	9	6	6	7
2	2	2	2	2	1	0	0	0	2	4	8	7	8	9	6	6	7
2	2	2	2	2	1	0	0	0	2	4	8	7	8	9	6	6	7
2	2	2	2	2	1	0	0	0	2	4	8	7	8	9	6	6	7
2	2	2	2	2	1	0	0	0	2	4	8	7	8	9	6	6	7
2	2	2	2	2	1	0	0	0	2	4	8	7	8	9	6	6	7
2	2	2	2	2	1	0	0	0	2	4	8	7	8	9	6	6	7
2	2	2	2	2	1	0	0	0	2	4	8	7	8	9	6	6	7
2	2	2	2	2	1	0	0	0	2	4	8	7	8	9	6	6	7
2	2	2	2	2	1	0	0	0	2	4	8	7	8	9	6	6	7
2	2	2	2	2	1	0	0	0	2	4	8	7	8	9	6	6	7
2	2	2	2	2	1	0	0	0	2	4	8	7	8	9	6	6	7
2	2	2	2	2	1	0	0	0	2	4	8	7	8	9	6	6	7
2	2	2	2	2	1	0	0	0	2	4	8	7	8	9	6	6	7
2	2	2	2	2	1	0	0	0	2	4	8	7	8	9	6	6	7
2	2	2	2	2	1	0	0	0	2	4	8	7	8	9	6	6	7
2	2	2	2	2	1	0	0	0	2	4	8	7	8	9	6	6	7
2	2	2	2	2	1	0	0	0	2	4	8	7	8	9	6	6	7
2	2	2	2	2	1	0	0	0	2	4	8	7	8	9	6	6	7
2	2	2	2	2	1	0	0	0	2	4	8	7	8	9	6	6	7
2	2	2	2	2	1	0	0	0	2	4	8	7	8	9	6	6	7
2	2	2	2	2	1	0	0	0	2	4	8	7	8	9	6	6	7
2	2	2	2	2	1	0	0	0	2	4	8	7	8	9	6	6	7
2	2	2	2	2	1	0	0	0	2	4	8	7	8	9	6	6	7
2	2	2	2	2	1	0	0	0	2	4	8	7	8	9	6	6	7
2	2	2	2	2	1	0	0	0	2	4	8	7	8	9	6	6	7
2	2	2	2	2	1	0	0	0	2	4	8	7	8	9	6	6	7
2	2	2	2	2	1	0	0	0	2	4	8	7	8	9	6	6	7
2	2	2	2	2	1	0	0	0	2	4	8	7	8	9	6	6	7
2	2	2	2	2	1	0	0	0	2	4	8	7	8	9	6	6	7
2	2	2	2	2	1	0	0	0	2	4	8	7	8	9	6	6	7
2	2	2	2	2	1	0	0	0	2	4	8	7	8	9	6	6	7
2	2	2	2	2	1	0	0	0	2	4	8	7	8	9	6	6	7
2	2	2	2	2	1	0	0	0	2	4	8	7	8	9	6	6	7
2	2	2	2	2	1	0	0	0	2	4	8	7	8	9	6	6	7
2	2	2	2	2	1	0	0	0	2	4	8	7	8	9	6	6	7
2	2	2	2	2	1	0	0	0	2	4	8	7	8	9	6	6	7

SPEC
5.1

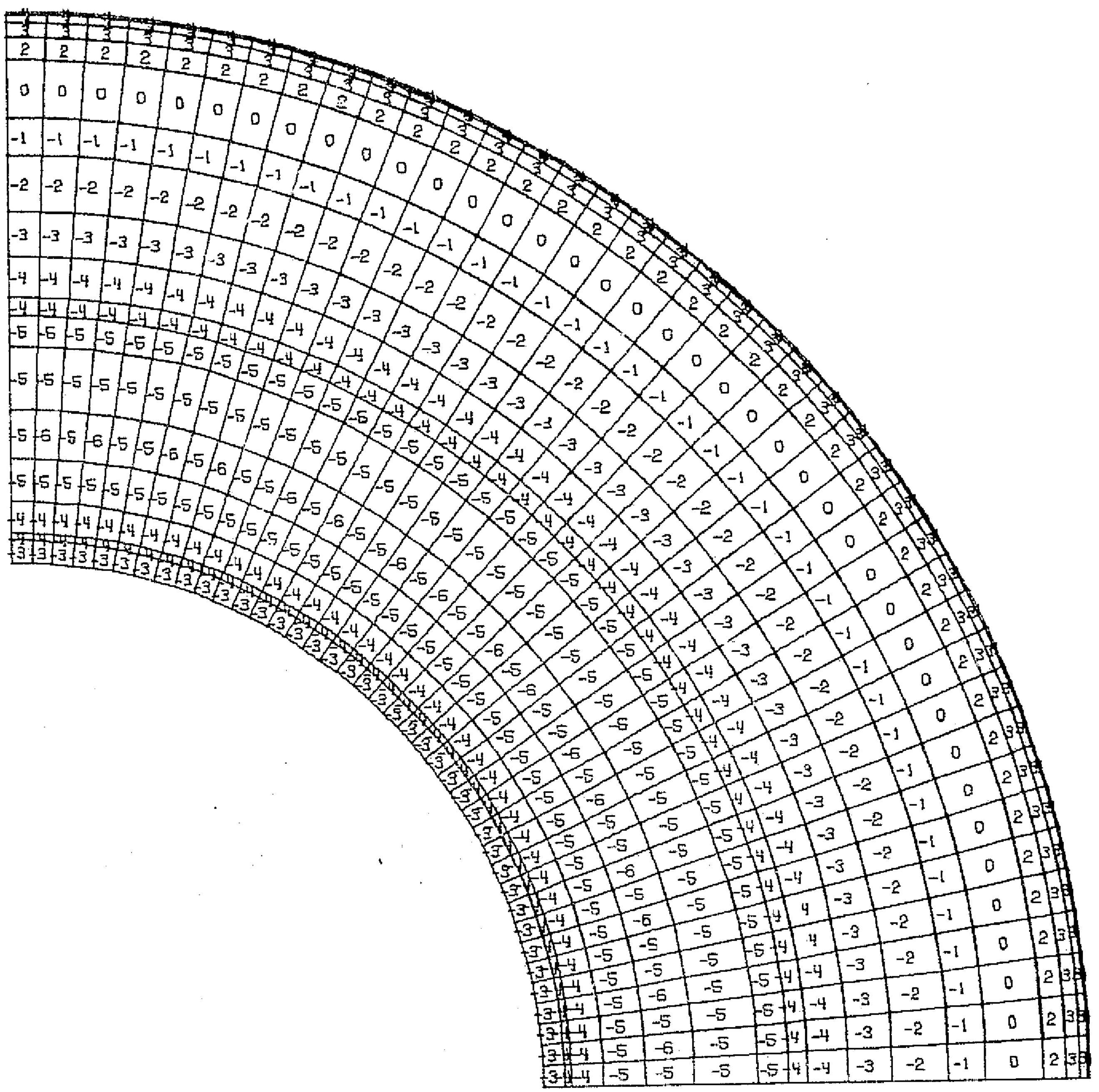
NTF BULKHEAD
SHELL

0 SCALE 36

FIG 66

1/1/1

DISPLAY= SX /1000 , NODE= 1 , SURFACE= 0



SPEC 3.1

NTF BULKHEAD DOME

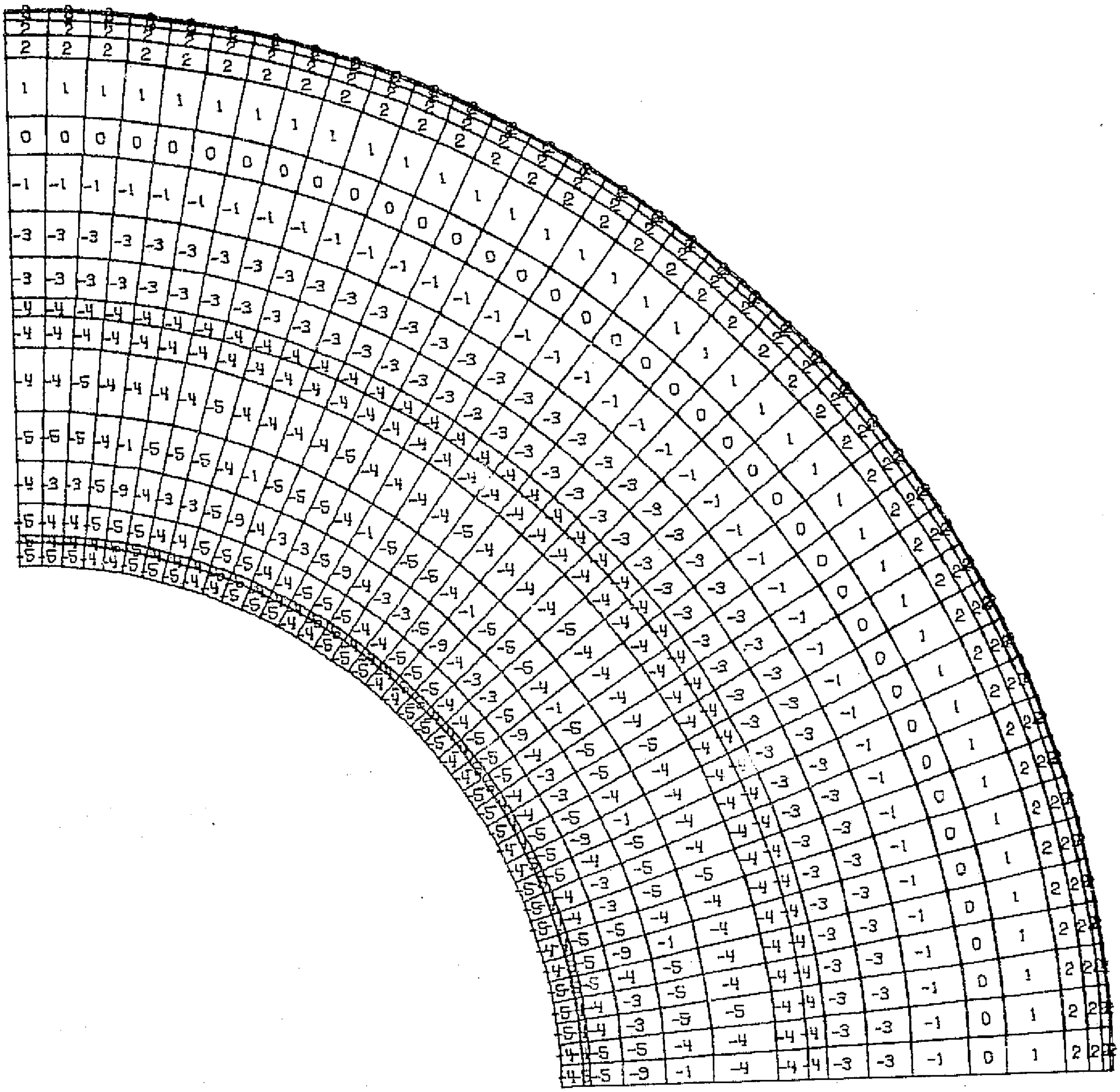
0 26 SCALE

ORIGINAL PAGE IS OF POOR QUALITY

FIG 67

1/1/1

DISPLAY= SX /1000 , NODE= 1 , SURFACE= 1



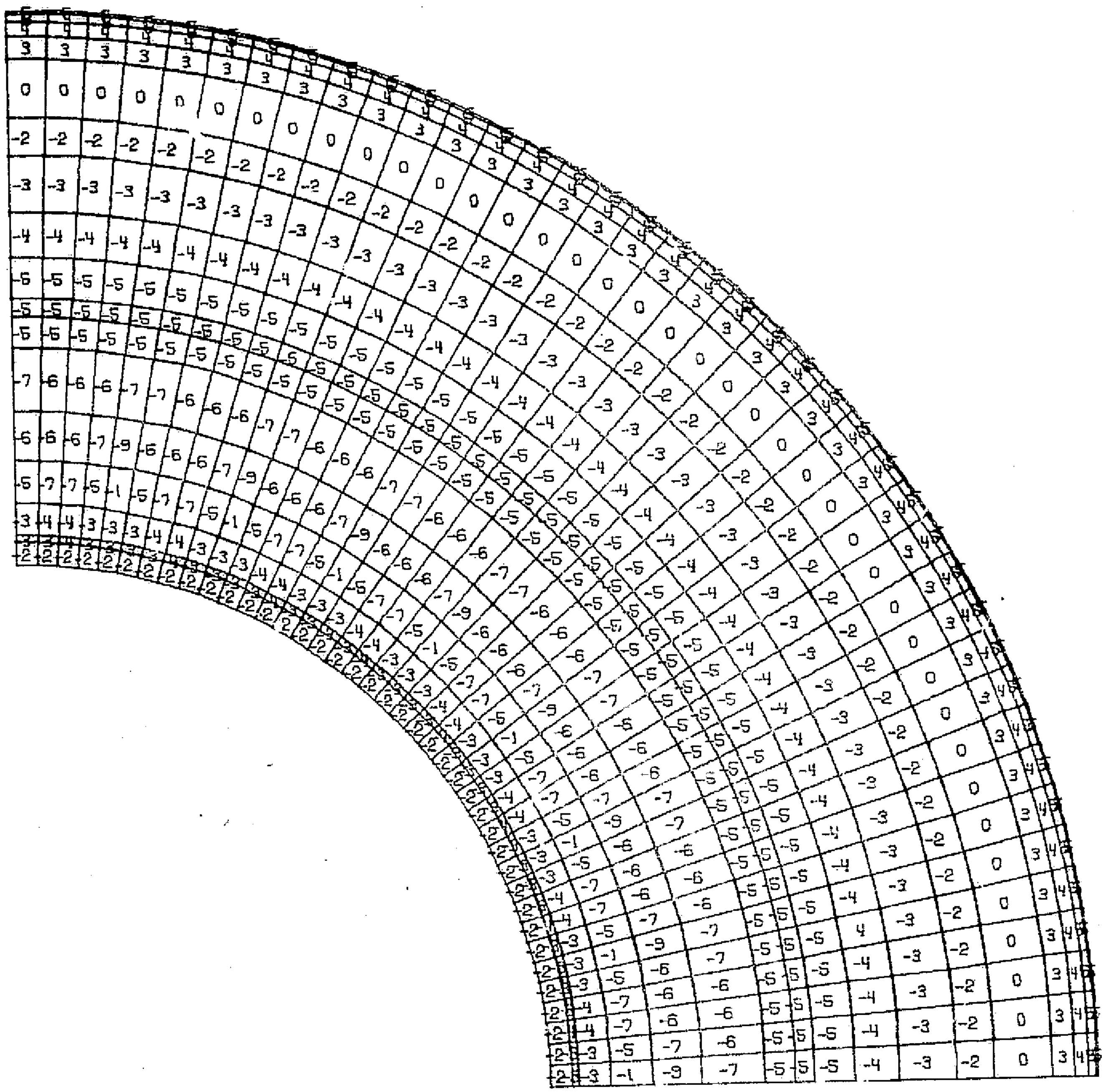
0 26
SCALE

SPEC
3.1

NTF BULKHEAD
DOME

FIG 68

DISPLAY= SX /1000 , NODE= 1, SURFACE= 2



0 26
SCALE

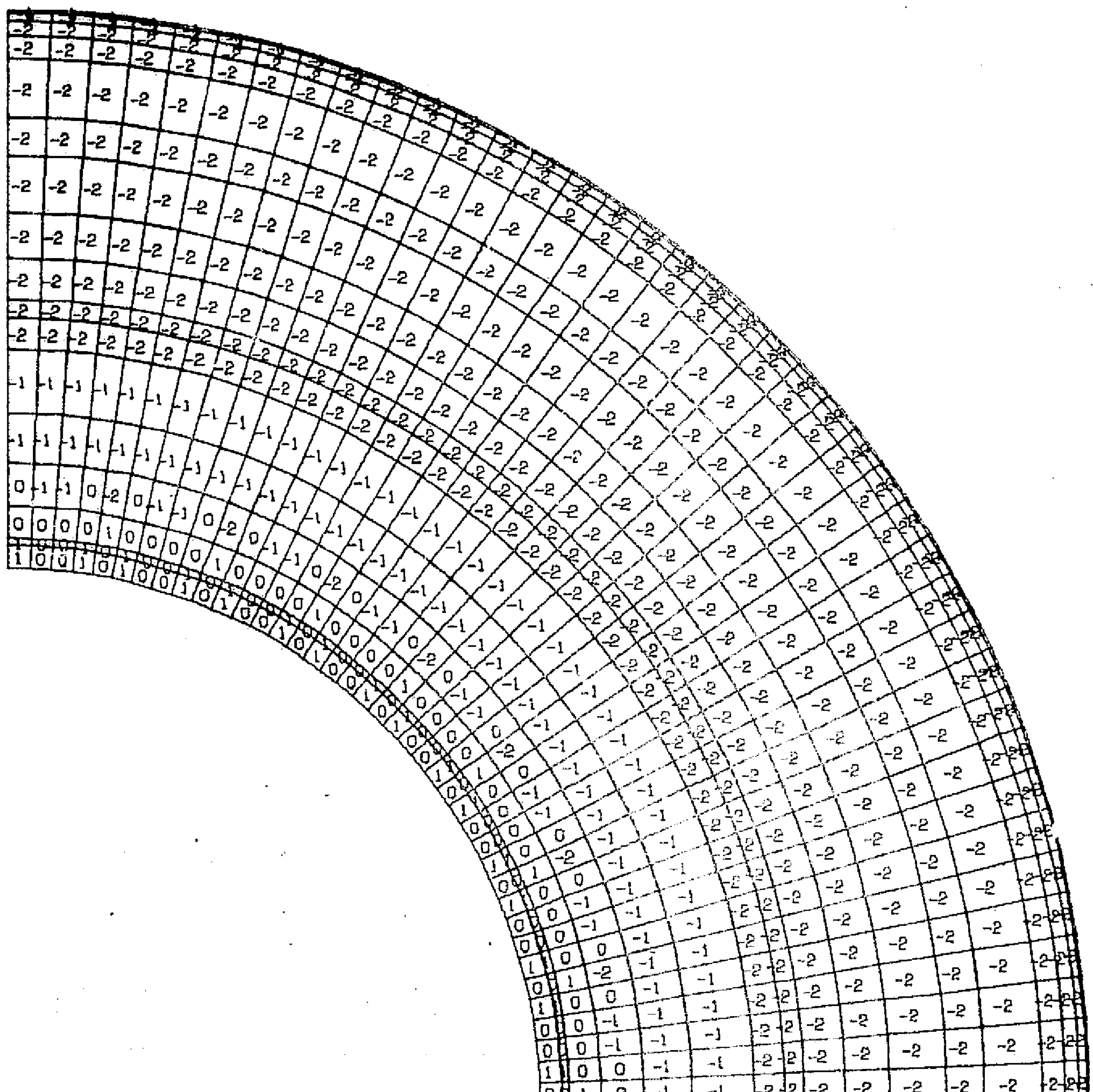
SPEC
3-1

NTF BULKHEAD
DOME

FIG 69

1/1/1

DISPLAY= SY /1000 , NODE= 1 , SURFACE= 0



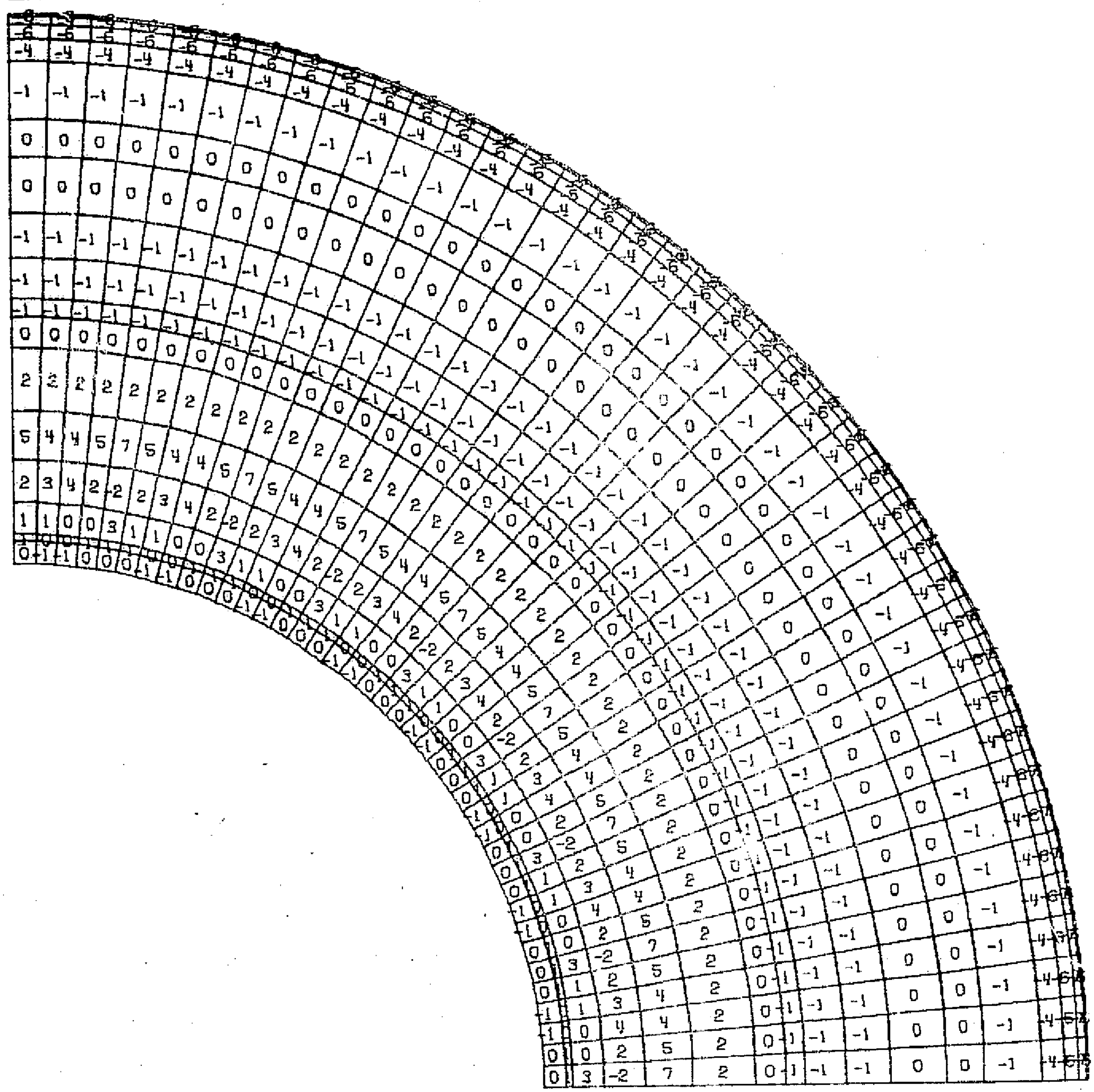
SPEC 3.1

NTF BULKHEAD
DOME

0 26
SCALE

FIG. 70

DISPLAY= SY /1000 , NODE= 1 , SURFACE= 1



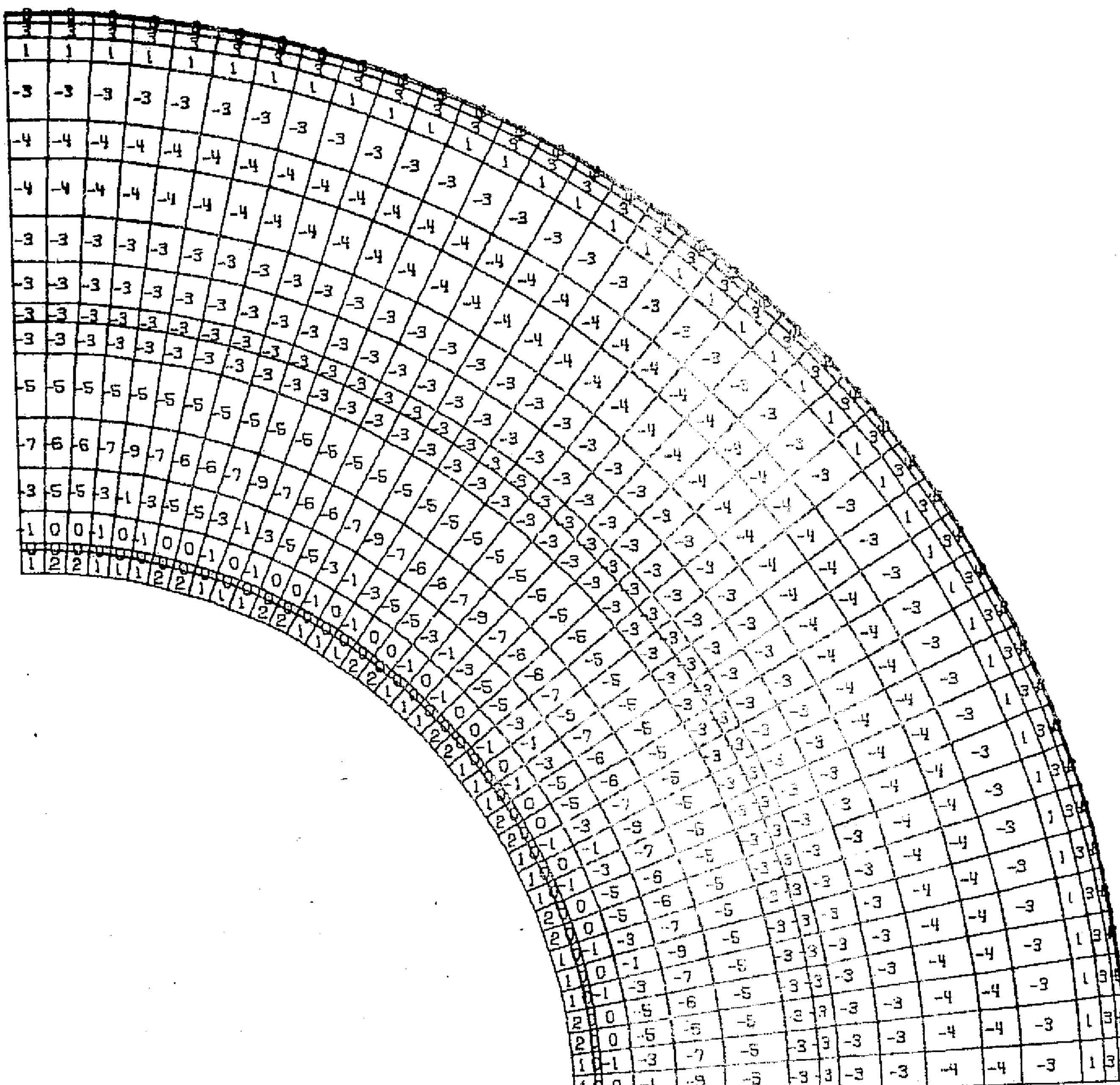
SPEC 3.1 NTF BULKHEAD DOME

0 26 SCALE

FIG 71

1/1/1

DISPLAY= SY /1000 , NODE= 1 , SURFACE= 2



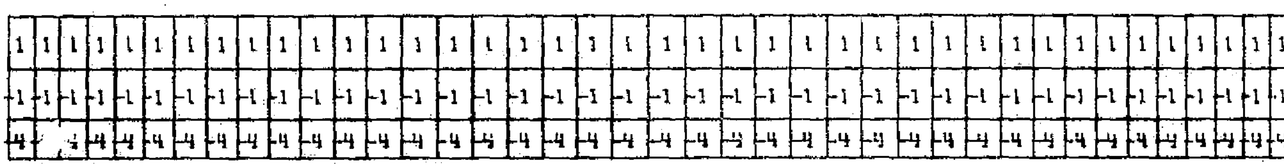
0 26
SCALE

SPEC
3.1

NTF BULKHEAD
DOME

FIG. 72

DISPLAY= SX /1000 . NODE= 1 . SURFACE= 0



SPEC 10.1

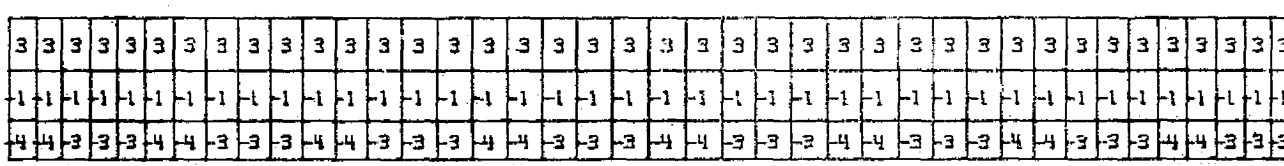
NTF BULKHEAD
HATCH OPENING

0 18
SCALE

FIG. 73

DISPLAY= SX /1000 . NODE= 1 . SURFACE= 1

1/1/1



SPEC 10.1

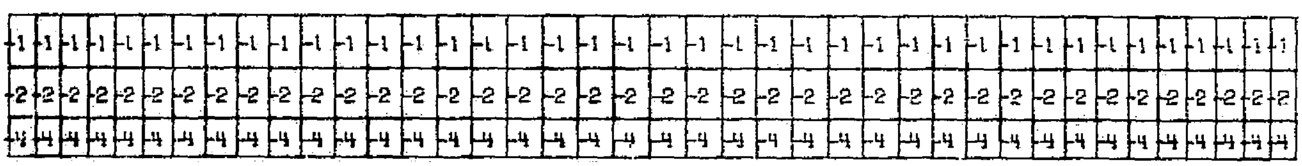
NTF BULKHEAD HATCH OPENING

0 SCALE 18

FIG. 74

DISPLAY= SX /1000 , NODE= 1 , SURFACE= 2

1/1/1



SPEC 10-1

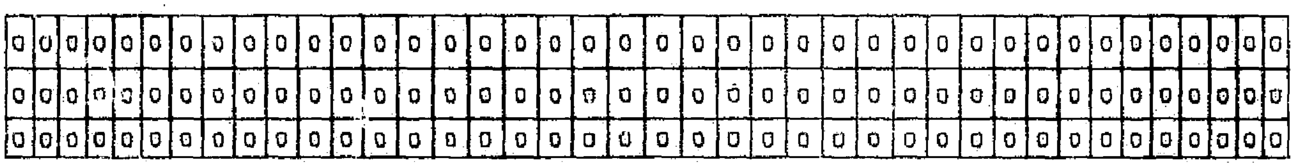
NTF BULKHEAD HATCH OPENING

0 18 SCALE

FIG 75

1/1/1

DISPLAY= SY /1000 . NODE= 1 . SURFACE= 0



SPEC 10.1

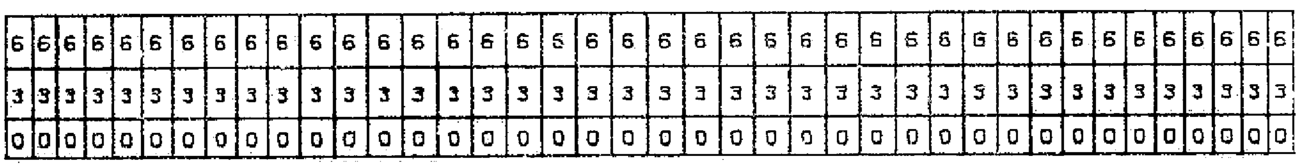
NTF BULKHEAD
HATCH OPENING

0 18
SCALE

FIG 78

1/1/1

DISPLAY= SY /1000 , NODE= 1, SURFACE= 1



SPEC 10-1

NTF BULKHEAD HATCH OPENING

0 ——— 18
SCALE

FIG. 77

DISPLAY= SY /1000 , NODE= 1 . SURFACE= 2

1/1/1

-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5
-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
0	0	-1	-1	-1	0	0	-1	-1	-1	0	0	-1	-1	-1	0	0	-1	-1	-1	0	0	-1	-1	-1	0	0	-1	-1	-1	0	0	-1	-1	-1	0	0	-1	-1	-1

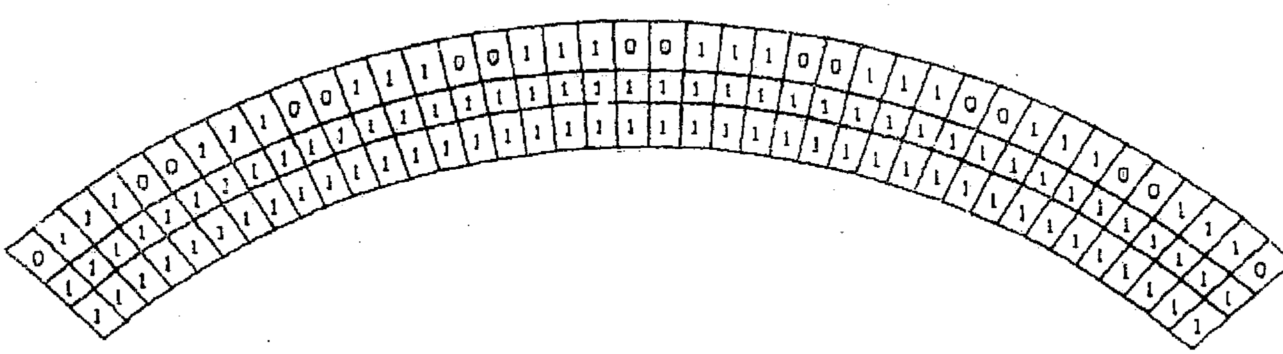
SPEC
10-1

NTF BULKHEAD
HATCH OPENING

0 18
SCALE

FIG. 78

DISPLAY= SX /1000 . NODE= 1 . SURFACE= 0 1/1/1



SPEC
2.1

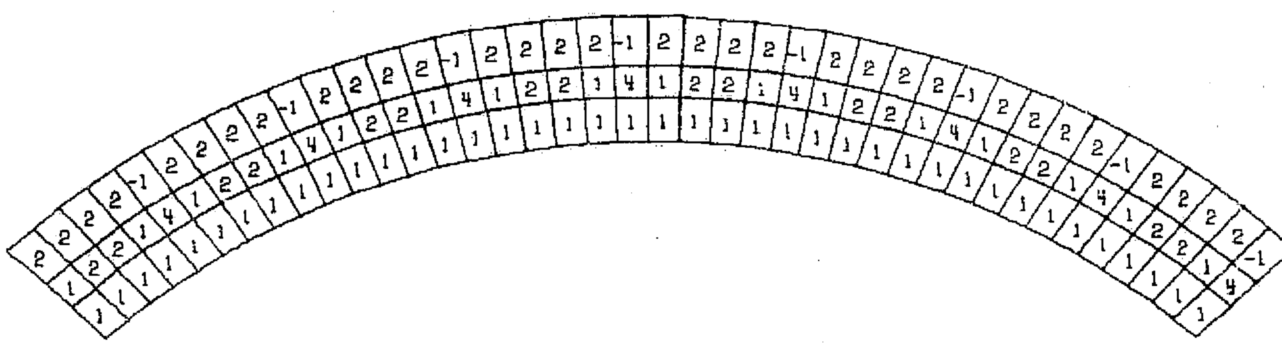
NTF BULKHEAD
FLANGE SURFACE

ORIGINAL PAGE IS
OF POOR QUALITY

0 21
SCALE

FIG 79

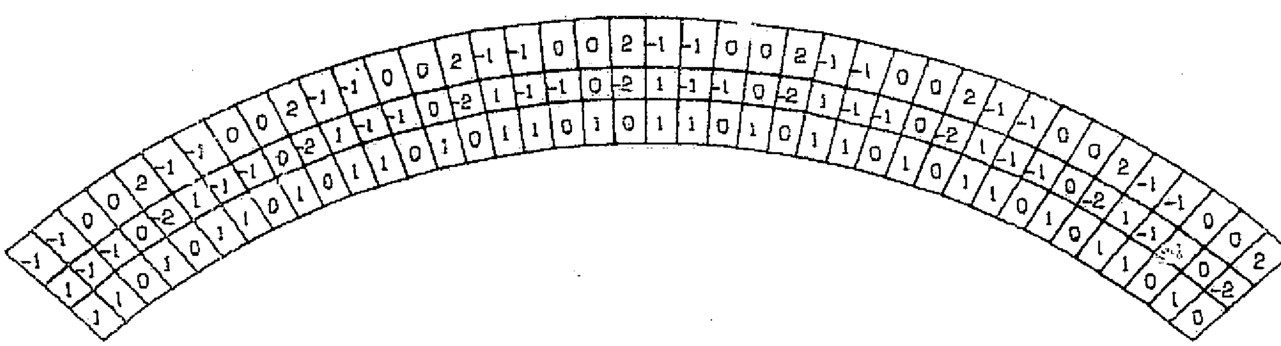
DISPLAY= SX /1000 , NODE= 1, SURFACE= 1



SPEC 2-1 NTF BULKHEAD FLANGE SURFACE

0 SCALE 21

DISPLAY= SX /1000 , NODE= 1 , SURFACE= 2



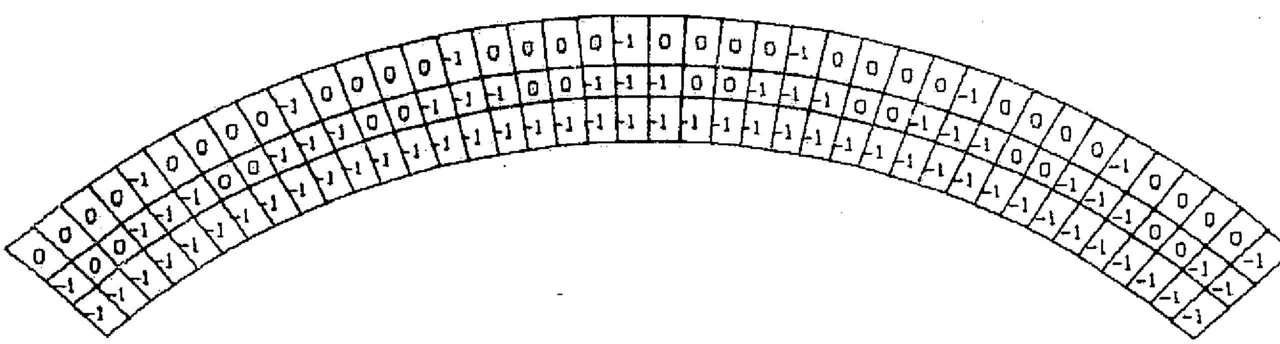
SPEC 2.1

NTF BULKHEAD
FLANGE SURFACE

0 ______ 21
SCALE

FIG 81

DISPLAY= SY /1000 . NODE= 1 . SURFACE= 0



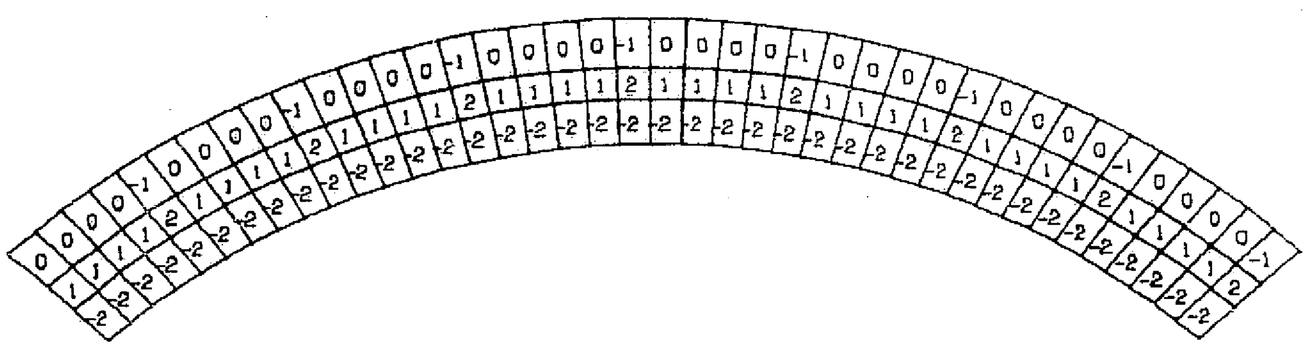
SPEC
2.1

NTF BULKHEAD
FLANGE SURFACE

0 SCALE 21

1/1/1

DISPLAY= SY /1000 . NODE= 1 . SURFACE= 1



ORIGINAL PAGE IS OF POOR QUALITY

SPEC 2.1

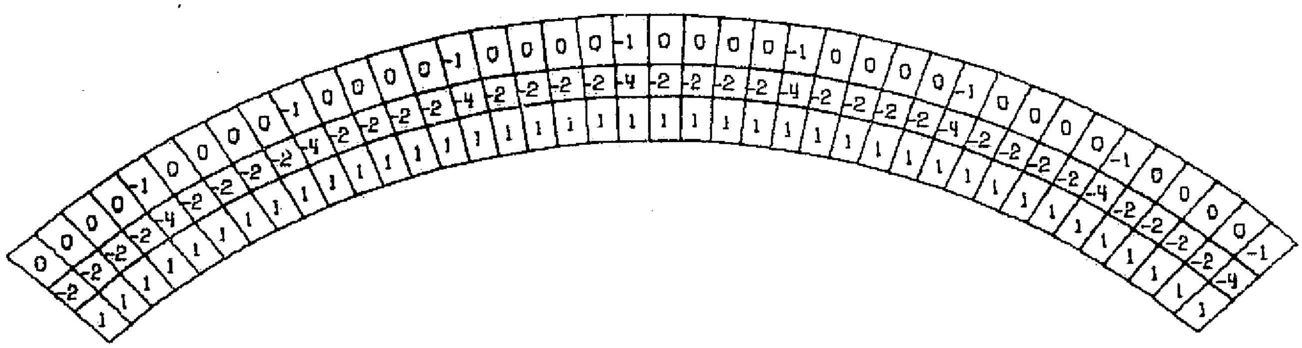
NTF BULKHEAD FLANGE SURFACE

0 21 SCALE

FIG 83

1/1/1

DISPLAY= SY /1000 . NODE= 1 . SURFACE= 2

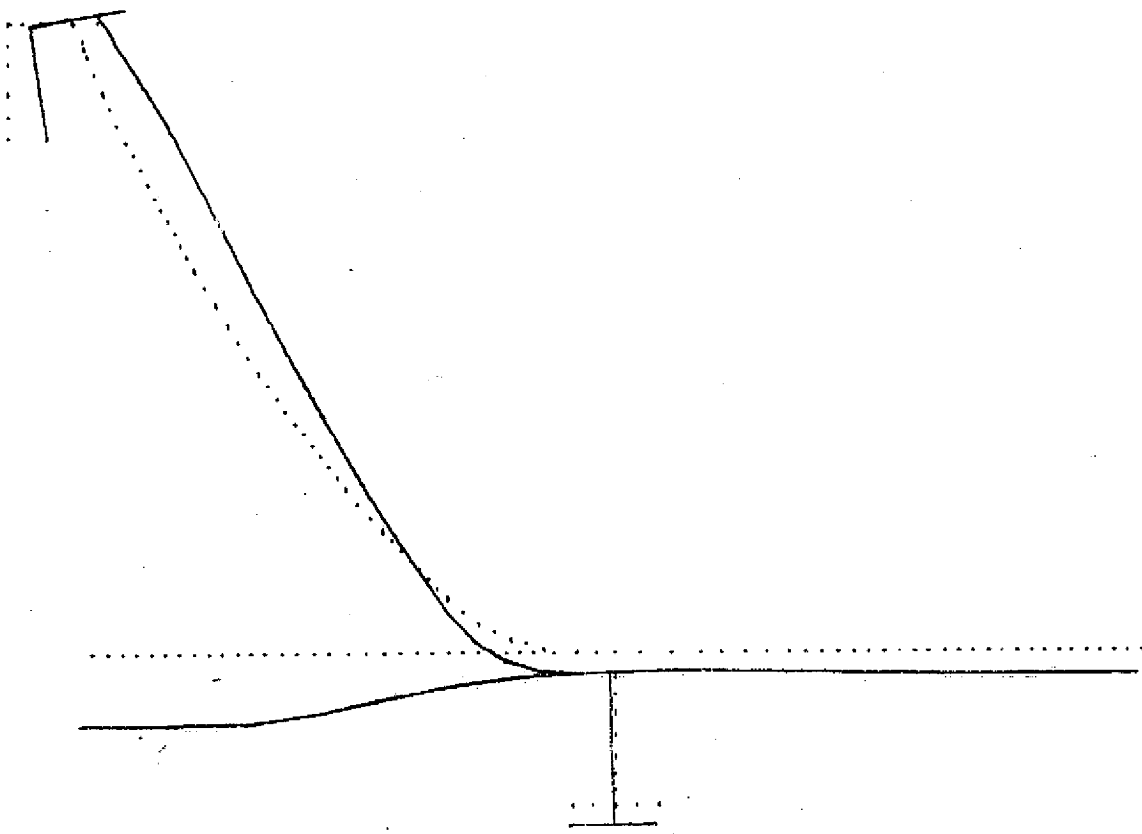


SPEC
2.1

NTF BULKHEAD
FLANGE SURFACE

0 21
SCALE

FIG. 84

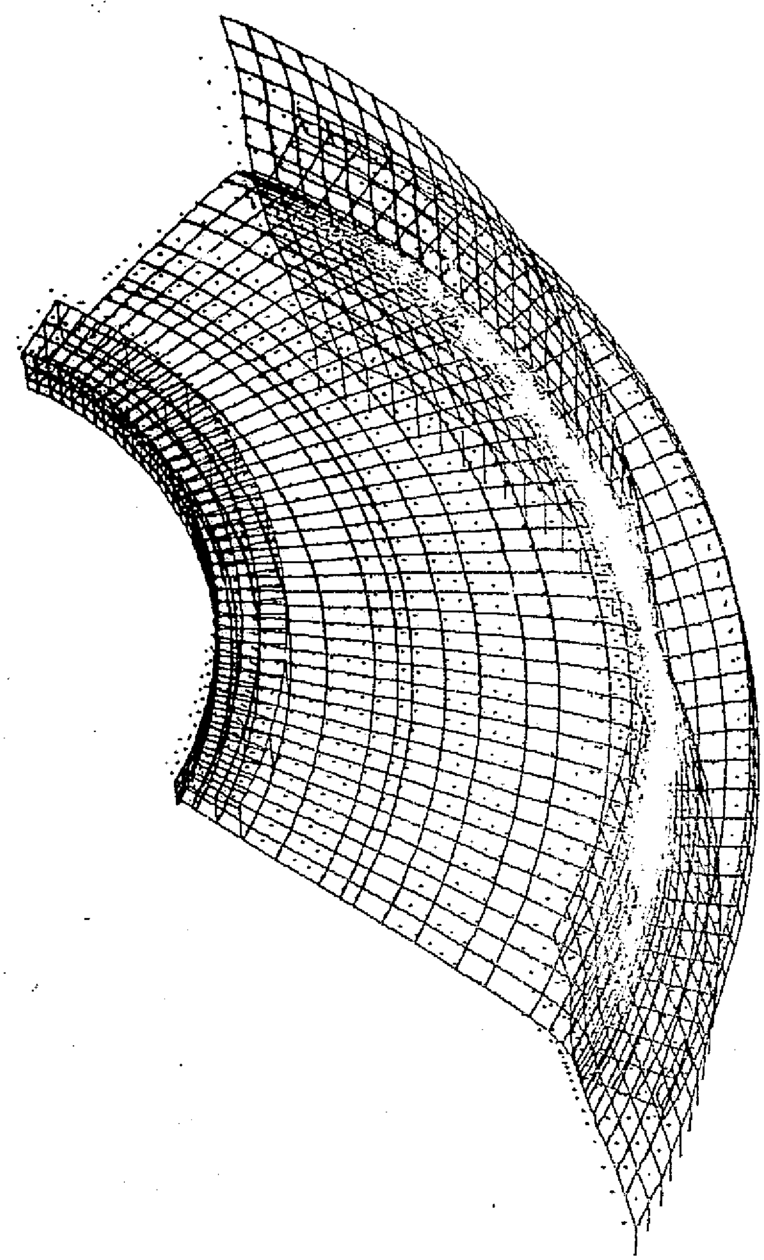


SPEC 12.1

NTF BULKHEAD
CROSS-SECTION VIEW

0 SCALE 27

FIG 85



SPEC
1.1

NTF BULKHEAD

0 44
SCALE

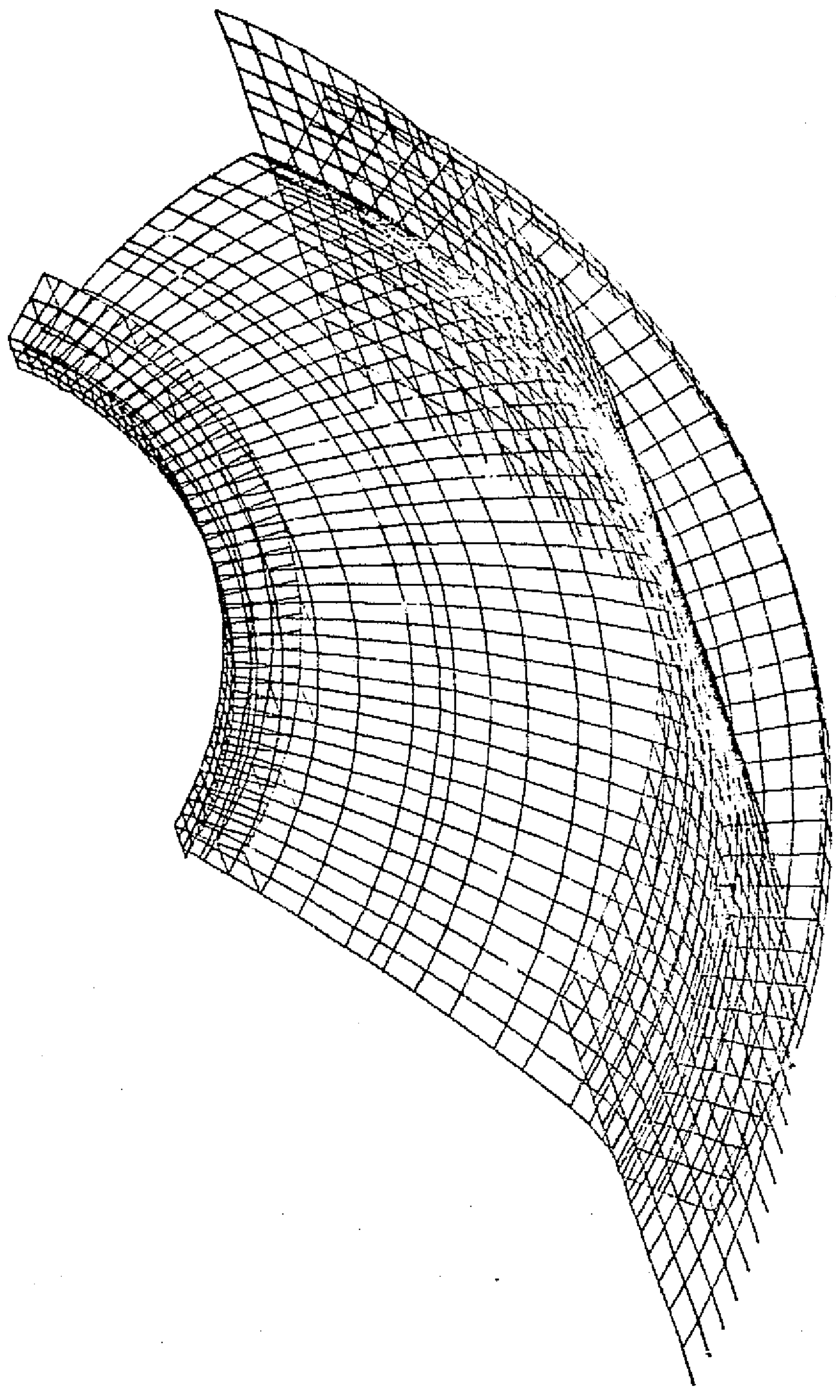
FIG 86

CASE 3

FULL PRESSURE
STRESS PLOTS

FIGURES 87 THRU 113

COMPUTER RUN NO. AAU



SPEC
1.1

NTF BULKHEAD

0 41
SCALE

FIG. 87

DISPLAY= SX /1000 , NODE= 1, SURFACE= 0

10	10	10	9	8	7	6	5	4	4	4	4	4	6	11	13	15	16
10	10	10	9	8	7	6	5	4	4	4	[illegible]	4	6	11	13	15	16
10	10	10	9	8	7	6	5	4	4	4	4	4	6	11	13	15	16
10	10	10	9	8	7	6	5	4	4	4	4	4	6	11	13	15	16
10	10	10	9	8	7	6	5	4	4	4	4	4	6	11	13	15	16
10	10	10	9	6	7	6	5	4	4	4	4	4	6	11	13	15	15
10	10	10	9	8	7	6	5	4	4	4	4	4	6	11	13	15	16
10	10	10	9	8	7	6	5	4	4	4	4	4	6	11	13	15	16
10	10	10	9	8	7	6	5	4	4	4	4	4	6	11	13	15	16
10	10	10	9	6	7	6	5	4	4	4	4	4	6	11	13	15	16
10	10	10	9	8	7	6	5	4	4	4	4	4	6	11	13	15	16
10	10	10	9	8	7	6	5	4	4	4	4	4	6	11	13	15	16
10	10	10	9	8	7	6	5	4	4	4	4	4	6	11	13	15	16
10	10	10	9	8	7	6	5	4	4	4	4	4	6	11	13	15	16
10	10	10	9	8	7	6	5	4	4	4	4	4	6	11	13	15	16
10	10	10	9	8	7	6	5	4	4	4	4	4	6	11	13	15	16
10	10	10	9	8	7	6	5	4	4	4	4	4	6	11	13	15	16
10	10	10	9	8	7	6	5	4	4	4	4	4	6	11	13	15	16
10	10	10	9	8	7	6	5	4	4	4	4	4	6	11	13	15	16
10	10	10	9	8	7	6	5	4	4	4	4	4	6	11	13	15	16
10	10	10	9	8	7	6	5	4	4	4	4	4	6	11	13	15	16
10	10	10	9	8	7	6	5	4	4	4	4	4	6	11	13	15	16
10	10	10	9	8	7	6	5	4	4	4	4	4	6	11	13	15	16
10	10	10	9	8	7	6	5	4	4	4	4	4	6	11	13	15	16
10	10	10	9	8	7	6	5	4	4	4	4	4	6	11	13	15	16
10	10	10	9	8	7	6	5	4	4	4	4	4	6	11	13	15	16
10	10	10	9	6	7	6	5	4	4	4	4	4	6	11	13	15	16
10	10	10	9	8	7	6	5	4	4	4	4	4	6	11	13	15	16
10	10	10	9	8	7	6	5	4	4	4	4	4	6	11	13	15	16
10	10	10	9	8	7	6	5	4	4	4	4	4	6	11	13	15	16
10	10	10	9	8	7	6	5	4	4	4	4	4	6	11	13	15	16
10	10	10	9	8	7	6	5	4	4	4	4	4	6	11	13	15	16
10	10	10	9	8	7	6	5	4	4	4	4	4	6	11	13	15	16
10	10	10	9	8	7	6	5	4	4	4	4	4	6	11	13	15	16
10	10	10	9	8	7	6	5	4	4	4	4	4	6	11	13	15	16
10	10	10	9	8	7	6	5	4	4	4	4	4	6	11	13	15	16
10	10	10	9	8	7	6	5	4	4	4	4	4	6	11	13	15	16
10	10	10	9	8	7	6	5	4	4	4	4	4	6	11	13	15	16
10	10	10	9	8	7	6	5	4	4	4	4	4	6	11	13	15	16
10	10	10	9	8	7	6	5	4	4	4	4	4	6	11	13	15	16

SPEC
5.1

NTF BULKHEAD
SHELL

0 SCALE 36

FIG. 88

DISPLAY= SX /1000 , NODE= 1, SURFACE= 1

10	10	10	9	8	7	6	5	5	5	5	1	2	5	10	14	16	16
10	10	10	9	8	7	6	5	5	5	5	1	2	5	10	14	16	16
10	10	10	9	8	7	6	5	5	5	5	1	2	5	10	14	16	16
10	10	10	9	8	7	6	5	5	5	5	1	2	5	10	14	16	16
10	10	10	9	9	7	6	5	5	5	5	1	2	5	10	14	16	16
10	10	10	9	8	7	6	5	5	5	5	1	2	5	10	14	16	16
10	10	10	9	8	7	6	5	5	5	5	1	2	5	10	14	16	16
10	10	10	9	8	7	6	5	5	5	5	1	2	5	10	14	16	16
10	10	10	9	8	7	6	5	5	5	5	1	2	5	10	14	16	16
10	10	10	9	8	7	6	5	5	5	5	1	2	5	10	14	16	16
10	10	10	9	8	7	6	5	5	5	5	1	2	5	10	14	16	16
10	10	10	9	8	7	6	5	5	5	5	1	2	5	10	14	16	16
10	10	10	9	8	7	6	5	5	5	5	1	2	5	10	14	16	16
10	10	10	9	8	7	6	5	5	5	5	1	2	5	10	14	16	16
10	10	10	9	8	7	6	5	5	5	5	1	2	5	10	14	16	16
10	10	10	9	8	7	6	5	5	5	5	1	2	5	10	14	16	16
10	10	10	9	8	7	6	5	5	5	5	1	2	5	10	14	16	16
10	10	10	9	8	7	6	5	5	5	5	1	2	5	10	14	16	16
10	10	10	9	8	7	6	5	5	5	5	1	2	5	10	14	16	16
10	10	10	9	8	7	6	5	5	5	5	1	2	5	10	14	16	16
10	10	10	9	8	7	6	5	5	5	5	1	2	5	10	14	16	16
10	10	10	9	8	7	[illegible]	5	5	5	5	1	2	5	10	14	16	16
10	10	10	9	8	7	6	5	5	5	5	1	2	5	10	14	16	16
10	10	10	9	8	7	6	5	5	5	5	1	2	5	10	14	16	16
10	10	10	9	8	7	6	5	5	5	5	1	2	5	10	14	16	16
10	10	10	9	8	7	6	5	5	5	5	1	2	5	10	14	16	16
10	10	10	9	8	7	6	5	5	5	5	1	2	5	10	14	16	16
10	10	10	9	8	7	6	5	5	5	5	1	2	5	10	14	16	16
10	10	10	9	8	7	6	5	5	5	5	1	2	5	10	14	16	16
10	10	10	9	8	7	6	5	5	5	5	1	2	5	10	14	16	16
10	10	10	9	8	7	6	5	5	5	5	1	2	5	10	14	16	16
10	10	10	9	8	7	6	5	5	5	5	1	2	5	10	14	16	16
10	10	10	9	8	7	6	5	5	5	5	1	2	5	10	14	16	16
10	10	10	9	8	7	6	5	5	5	5	1	2	5	10	14	16	16
10	10	10	9	8	7	6	5	5	5	5	1	2	5	10	14	16	16
10	10	10	9	8	7	6	5	5	5	5	1	2	5	10	14	16	16
10	10	10	9	8	7	6	5	5	5	5	1	2	5	10	14	16	16
10	10	10	9	8	7	6	5	5	5	5	1	2	5	10	14	16	16
10	10	10	9	8	7	6	5	5	5	5	1	2	5	10	14	16	16
10	10	10	9	8	7	6	5	5	5	5	1	2	5	10	14	16	16

SPEC
5.1

NTF BULKHEAD
SHELL

0 36
SCALE

C-3

FIG. 89

DISPLAY= SX /1000 , NODE= 1, SURFACE= 2

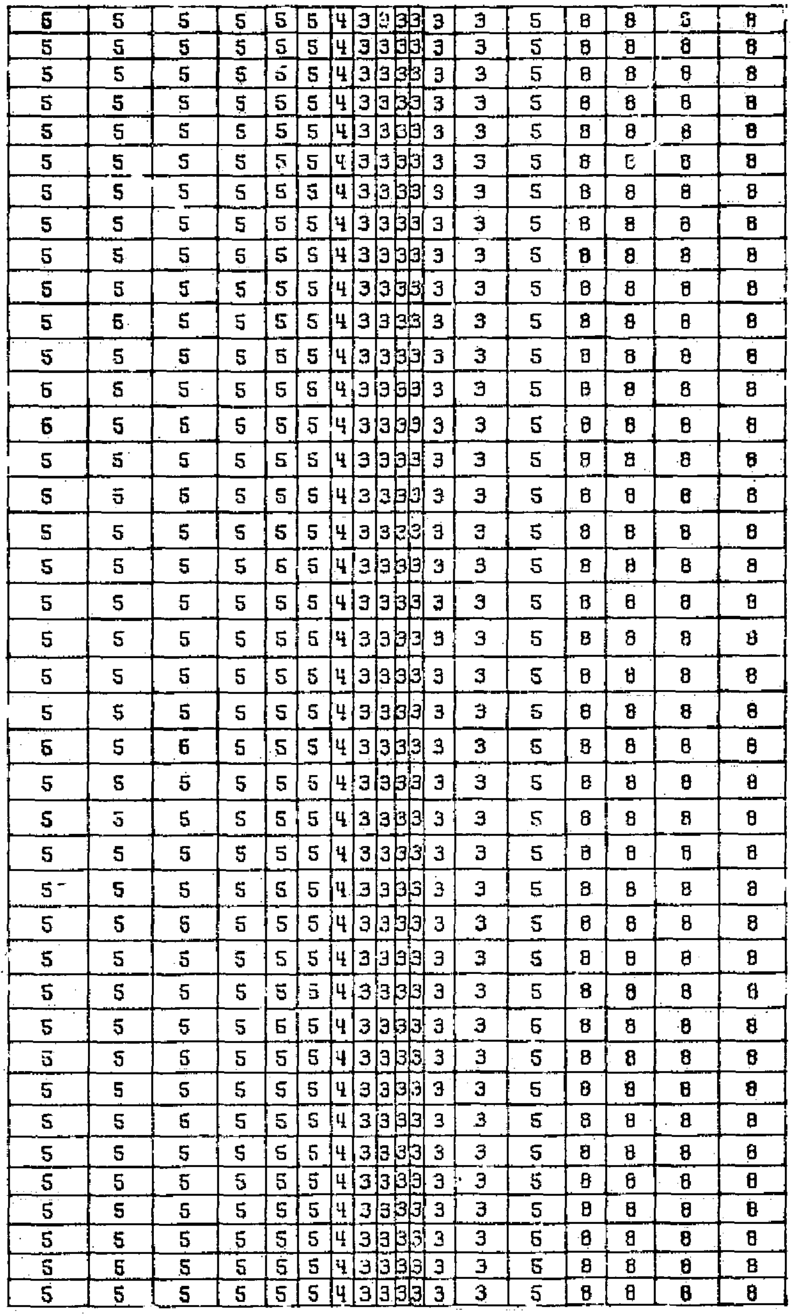
10	10	10	10	9	7	5	4	3	3	3	7	6	8	11	12	15	16
10	10	10	10	9	7	5	4	3	3	3	7	6	8	11	12	15	16
10	10	10	10	9	7	5	4	3	3	3	7	6	8	11	12	15	16
10	10	10	10	9	7	5	4	3	3	3	7	6	8	11	12	15	16
10	10	10	10	9	7	5	4	3	3	3	7	6	8	11	12	15	16
10	10	10	10	9	7	5	4	3	3	3	7	6	8	11	12	15	16
10	10	10	10	9	7	5	4	3	3	3	7	6	8	11	12	15	16
10	10	10	10	9	7	5	4	3	3	3	7	6	8	11	12	15	16
10	10	10	10	9	7	5	4	3	3	3	7	6	8	11	12	15	16
10	10	10	10	9	7	5	4	3	3	3	7	6	8	11	12	15	16
10	10	10	10	9	7	5	4	3	3	3	7	6	8	11	12	15	16
10	10	10	10	9	7	5	4	3	3	3	7	6	8	11	12	15	16
10	10	10	10	9	7	5	4	3	3	3	7	6	8	11	12	15	16
10	10	10	10	9	7	5	4	3	3	3	7	6	8	11	12	15	16
10	10	10	10	9	7	5	4	3	3	3	7	6	8	11	12	15	16
10	10	10	10	9	7	5	4	3	3	3	7	6	8	11	12	15	16
10	10	10	10	9	7	5	4	3	3	3	7	6	8	11	12	15	16
10	10	10	10	9	7	5	4	3	3	3	7	6	8	11	12	15	16
10	10	10	10	9	7	5	4	3	3	3	7	6	8	11	12	15	16
10	10	10	10	9	7	5	4	3	3	3	7	6	8	11	12	15	16
10	10	10	10	9	7	5	4	3	3	3	7	6	8	11	12	15	16
10	10	10	10	9	7	5	4	3	3	3	7	6	8	11	12	15	16
10	10	10	10	9	7	5	4	3	3	3	7	6	8	11	12	15	16
10	10	10	10	9	7	5	4	3	3	3	7	6	8	11	12	15	16
10	10	10	10	9	7	5	4	3	3	3	7	6	8	11	12	15	16
10	10	10	10	9	7	5	4	3	3	3	7	6	8	11	12	15	16
10	10	10	10	9	7	5	4	3	3	3	7	6	8	11	12	15	16
10	10	10	10	9	7	5	4	3	3	3	7	6	8	11	12	15	16
10	10	10	10	9	7	5	4	3	3	3	7	6	8	11	12	15	16
10	10	10	10	9	7	5	4	3	3	3	7	6	8	11	12	15	16
10	10	10	10	9	7	5	4	3	3	3	7	6	8	11	12	15	16
10	10	10	10	9	7	5	4	3	3	3	7	6	8	11	12	15	16
10	10	10	10	9	7	5	4	3	3	3	7	6	8	11	12	15	16
10	10	10	10	9	7	5	4	3	3	3	7	6	8	11	12	15	16
10	10	10	10	9	7	5	4	3	3	3	7	6	8	11	12	15	16
10	10	10	10	9	7	5	4	3	3	3	7	6	8	11	12	15	16
10	10	10	10	9	7	5	4	3	3	3	7	6	8	11	12	15	16
10	10	10	10	9	7	5	4	3	3	3	7	6	8	11	12	15	16
10	10	10	10	9	7	5	4	3	3	3	7	6	8	11	12	15	16
10	10	10	10	9	7	5	4	3	3	3	7	6	8	11	12	15	16

SPEC 5.1 NTF BULKHEAD SHELL

0 36 SCALE

FIG. 90

DISPLAY= SY /1000 , NODE= 1 , SURFACE= 0



SPEC
5.1

NTF BULKHEAD
SHELL

0 36
SCALE

FIG 91

DISPLAY= SY /1000 , NODE= 1 , SURFACE= 1

5	5	4	3	4	5	6	6	7	7	7	-6	-3	0	7	10	10	8
5	5	4	3	4	5	6	6	7	7	7	-6	-3	0	7	10	10	8
5	5	4	3	4	5	6	6	7	7	7	-6	-3	0	7	10	10	8
5	5	4	3	4	5	6	6	7	7	7	-6	-3	0	7	10	10	8
5	5	4	3	4	5	6	6	7	7	7	-6	-3	0	7	10	10	8
5	5	4	3	4	5	6	6	7	7	7	-6	-3	0	7	10	10	8
5	5	4	3	4	5	6	6	7	7	7	-6	-3	0	7	10	10	8
5	5	4	3	4	5	6	6	7	7	7	-6	-3	0	7	10	10	8
5	5	4	3	4	5	6	6	7	7	7	-6	-3	0	7	10	10	8
5	5	4	3	4	5	6	6	7	7	7	-6	-3	0	7	10	10	8
5	5	4	3	4	5	6	6	7	7	7	-6	-3	0	7	10	10	8
5	5	4	3	4	5	6	6	7	7	7	-6	-3	0	7	10	10	8
5	5	4	3	4	5	6	6	7	7	7	-6	-3	0	7	10	10	8
5	5	4	3	4	5	6	6	7	7	7	-6	-3	0	7	10	10	8
5	5	4	3	4	5	6	6	7	7	7	-6	-3	0	7	10	10	8
5	5	4	3	4	5	6	6	7	7	7	-6	-3	0	7	10	10	8
5	5	4	3	4	5	6	6	7	7	7	-6	-3	0	7	10	10	8
5	5	4	3	4	5	6	6	7	7	7	-6	-3	0	7	10	10	8
5	5	4	3	4	5	6	6	7	7	7	-6	-3	0	7	10	10	8
5	5	4	3	4	5	6	6	7	7	7	-6	-3	0	7	10	10	8
5	5	4	3	4	5	6	6	7	7	7	-6	-3	0	7	10	10	8
5	5	4	3	4	5	6	6	7	7	7	-6	-3	0	7	10	10	8
5	5	4	3	4	5	6	6	7	7	7	-6	-3	0	7	10	10	8
5	5	4	3	4	5	6	6	7	7	7	-6	-3	0	7	10	10	8
5	5	4	3	4	5	6	6	7	7	7	-6	-3	0	7	10	10	8
5	5	4	3	4	5	6	6	7	7	7	-6	-3	0	7	10	10	8
5	5	4	3	4	5	6	6	7	7	7	-6	-3	0	7	10	10	8
5	5	4	3	4	5	6	6	7	7	7	-6	-3	0	7	10	10	8
5	5	4	3	4	5	6	6	7	7	7	-6	-3	0	7	10	10	8
5	5	4	3	4	5	6	6	7	7	7	-6	-3	0	7	10	10	8
5	5	4	3	4	5	6	6	7	7	7	-6	-3	0	7	10	10	8
5	5	4	3	4	5	6	6	7	7	7	-6	-3	0	7	10	10	8
5	5	4	3	4	5	6	6	7	7	7	-6	-3	0	7	10	10	8
5	5	4	3	4	5	6	6	7	7	7	-6	-3	0	7	10	10	8
5	5	4	3	4	5	6	6	7	7	7	-6	-3	0	7	10	10	8
5	5	4	3	4	5	6	6	7	7	7	-6	-3	0	7	10	10	8
5	5	4	3	4	5	6	6	7	7	7	-6	-3	0	7	10	10	8
5	5	4	3	4	5	6	6	7	7	7	-6	-3	0	7	10	10	8
5	5	4	3	4	5	6	6	7	7	7	-6	-3	0	7	10	10	8
5	5	4	3	4	5	6	6	7	7	7	-6	-3	0	7	10	10	8

SPEC 5.1 NTF BULKHEAD SHELL

0 36 SCALE

FIG 92

DISPLAY= SY /1000 , NODE= 1 , SURFACE= 2

5	5	6	7	6	5	2	1	0	0	13	9	9	8	5	5	7
5	5	6	7	6	5	2	1	0	0	13	9	9	8	5	5	7
5	5	6	7	6	5	2	1	0	0	13	9	9	8	5	5	7
5	5	6	7	6	5	2	1	0	0	13	9	9	8	5	5	7
5	5	6	7	6	5	2	1	0	0	13	9	9	8	5	5	7
5	5	6	7	6	5	2	1	0	0	13	9	9	8	5	5	7
5	5	6	7	6	5	2	1	0	0	13	9	9	8	5	5	7
5	5	6	7	6	5	2	1	0	0	13	9	9	8	5	5	7
5	5	6	7	6	5	2	1	0	0	13	9	9	8	5	5	7
5	5	6	7	6	5	2	1	0	0	13	9	9	8	5	5	7
5	5	6	7	6	5	2	1	0	0	13	9	9	8	5	5	7
5	5	6	7	6	5	2	1	0	0	13	9	9	8	5	5	7
5	5	6	7	6	5	2	1	0	0	13	9	9	8	5	5	7
5	5	6	7	6	5	2	1	0	0	13	9	9	8	5	5	7
5	5	6	7	6	5	2	1	0	0	13	9	9	8	5	5	7
5	5	6	7	6	5	2	1	0	0	13	9	9	8	5	5	7
5	5	6	7	6	5	2	1	0	0	13	9	9	8	5	5	7
5	5	6	7	6	5	2	1	0	0	13	9	9	8	5	5	7
5	5	6	7	6	5	2	1	0	0	13	9	9	8	5	5	7
5	5	6	7	6	5	2	1	0	0	13	9	9	8	5	5	7
5	5	6	7	6	5	2	1	0	0	13	9	9	8	5	5	7
5	5	6	7	6	5	2	1	0	0	13	9	9	8	5	5	7
5	5	6	7	6	5	2	1	0	0	13	9	9	8	5	5	7
5	5	6	7	6	5	2	1	0	0	13	9	9	8	5	5	7
5	5	6	7	6	5	2	1	0	0	13	9	9	8	5	5	7
5	5	6	7	6	5	2	1	0	0	13	9	9	8	5	5	7
5	5	6	7	6	5	2	1	0	0	13	9	9	8	5	5	7
5	5	6	7	6	5	2	1	0	0	13	9	9	8	5	5	7
5	5	6	7	6	5	2	1	0	0	13	9	9	8	5	5	7
5	5	6	7	6	5	2	1	0	0	13	9	9	8	5	5	7
5	5	6	7	6	5	2	1	0	0	13	9	9	8	5	5	7
5	5	6	7	6	5	2	1	0	0	13	9	9	8	5	5	7
5	5	6	7	6	5	2	1	0	0	13	9	9	8	5	5	7
5	5	6	7	6	5	2	1	0	0	13	9	9	8	5	5	7
5	5	6	7	6	5	2	1	0	0	13	9	9	8	5	5	7
5	5	6	7	6	5	2	1	0	0	13	9	9	8	5	5	7
5	5	6	7	6	5	2	1	0	0	13	9	9	8	5	5	7
5	5	6	7	6	5	2	1	0	0	13	9	9	8	5	5	7
5	5	6	7	6	5	2	1	0	0	13	9	9	8	5	5	7
5	5	6	7	6	5	2	1	0	0	13	9	9	8	5	5	7

SPEC
5.1

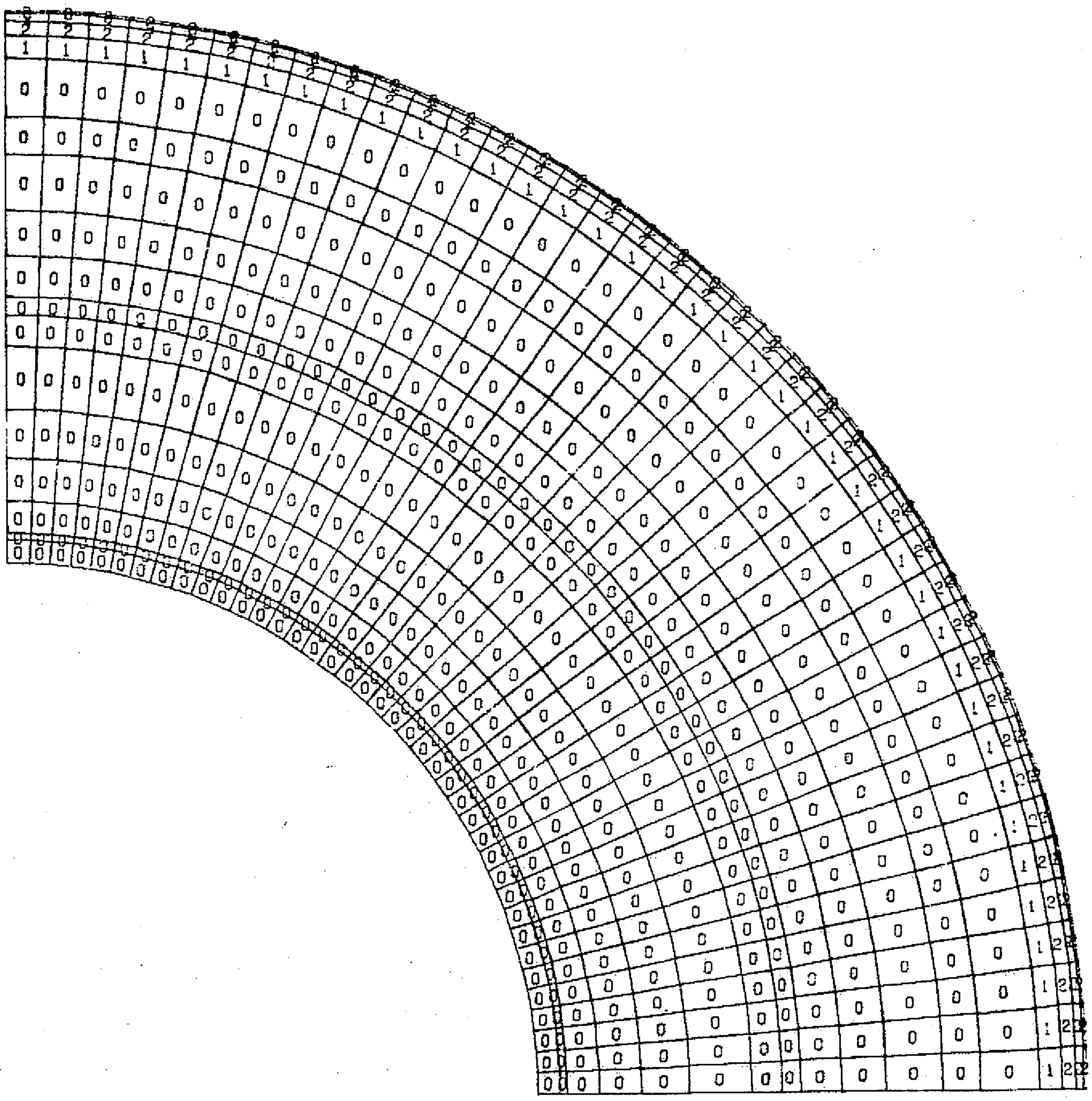
NTF BULKHEAD
SHELL

0 36
SCALE

FIG 93

1/1/1

DISPLAY= SX /1000 , NODE= 1, SURFACE= 0



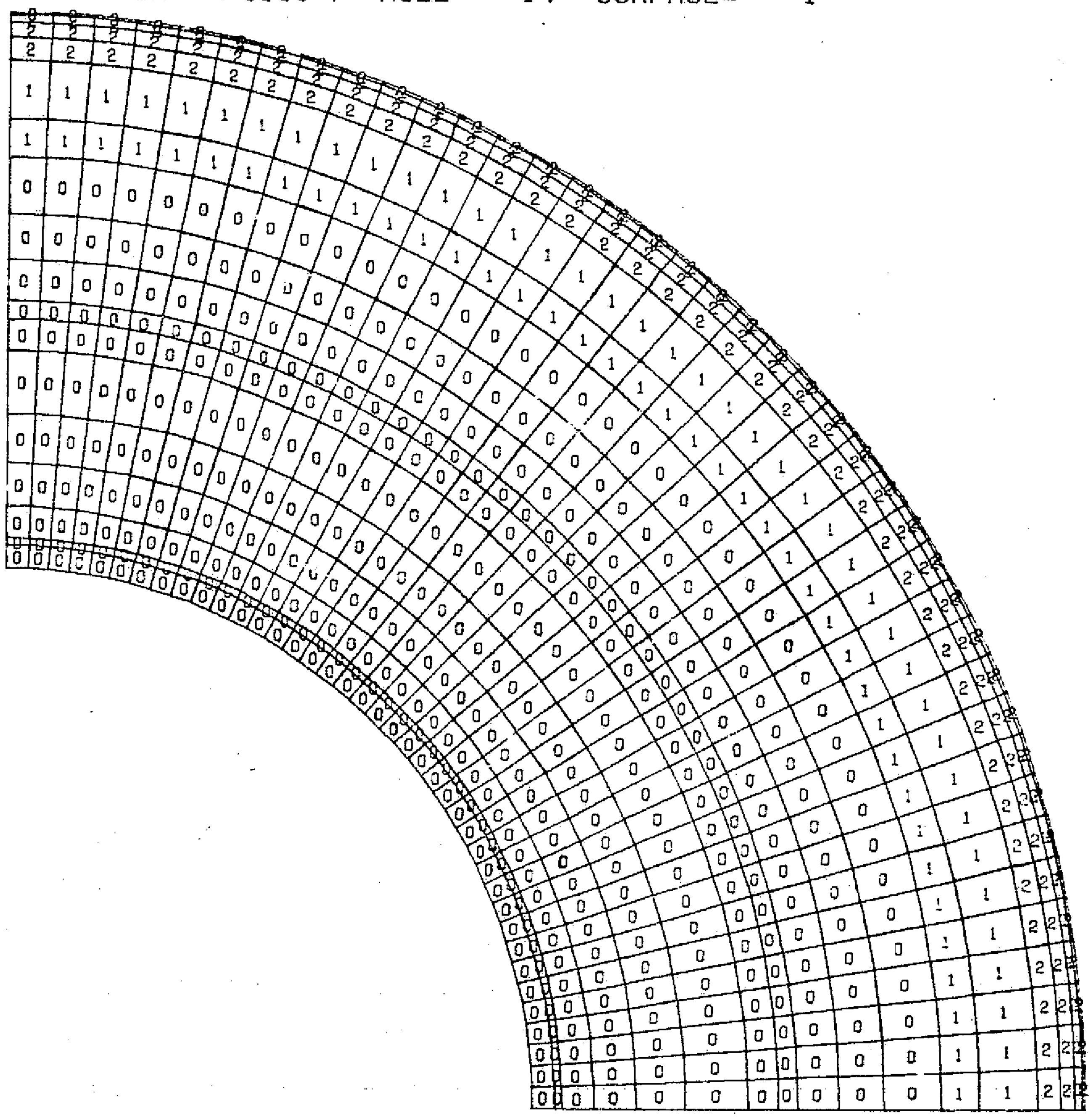
SPEC 3.1 NTF BULKHEAD DOME

0 26 SCALE

FIG 94

DISPLAY= SX /1000 , NODE= 1 , SURFACE= 1

1/1/1



SPEC 3.1

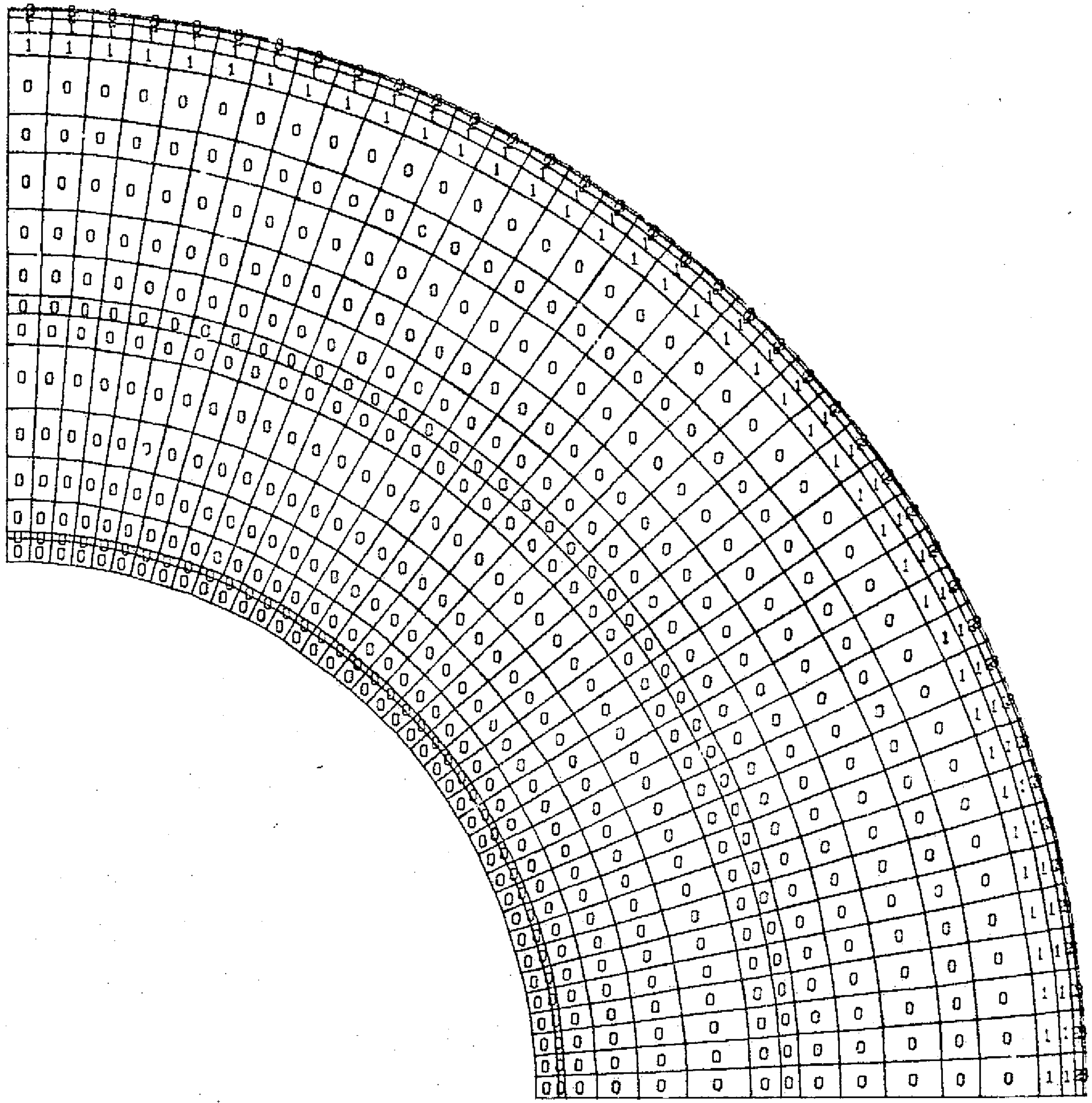
NTF BULKHEAD DOME

0 26 SCALE

FIG 95

1/1/1

DISPLAY= SX /1000 , NODE= 1, SURFACE= 2



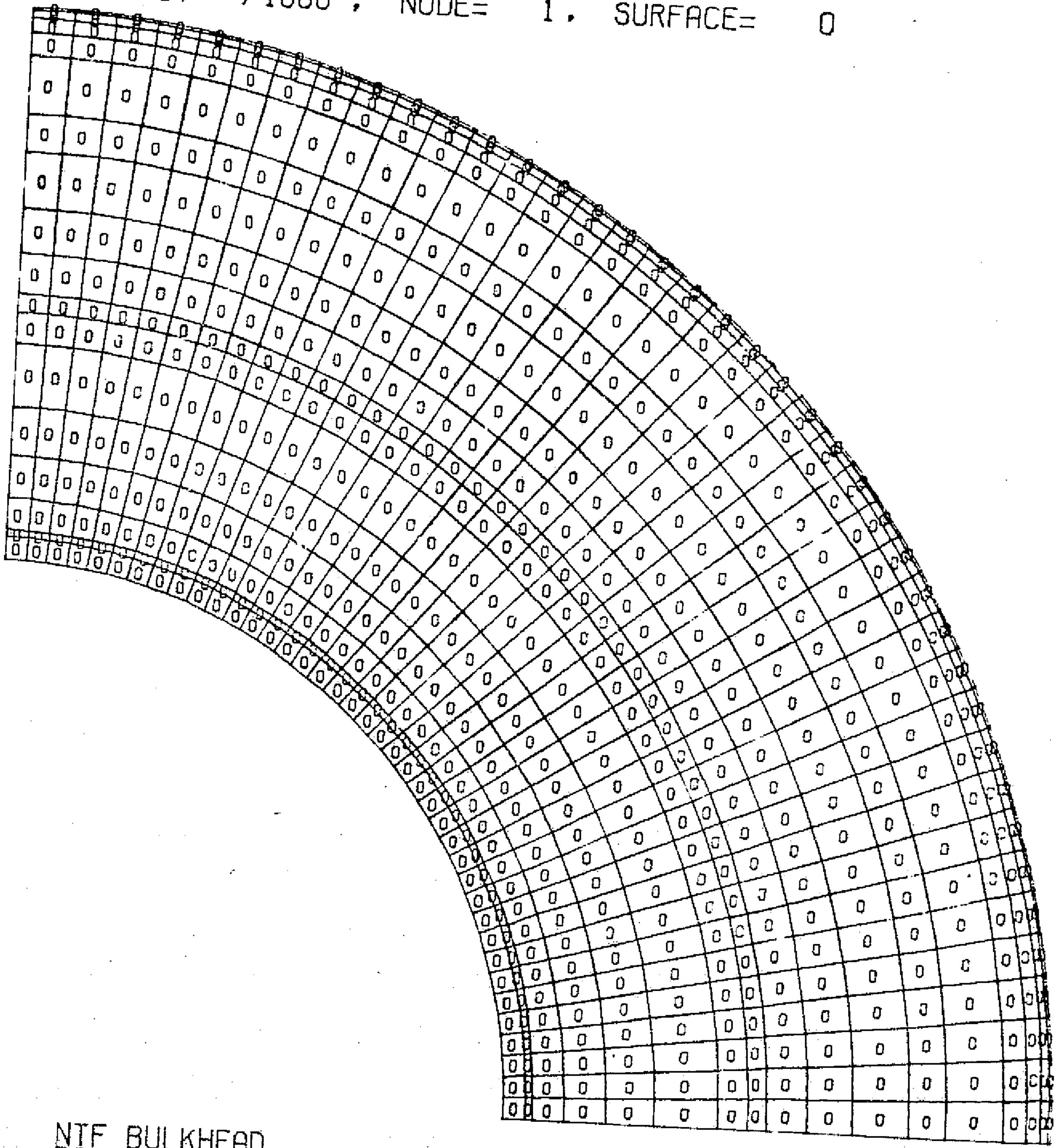
SPEC 3.1

NTF BULKHEAD DOME

0 26 SCALE

FIG. 96

DISPLAY= SY /1000 , NODE= 1. SURFACE= 0 1/1/1



SPEC 3.1

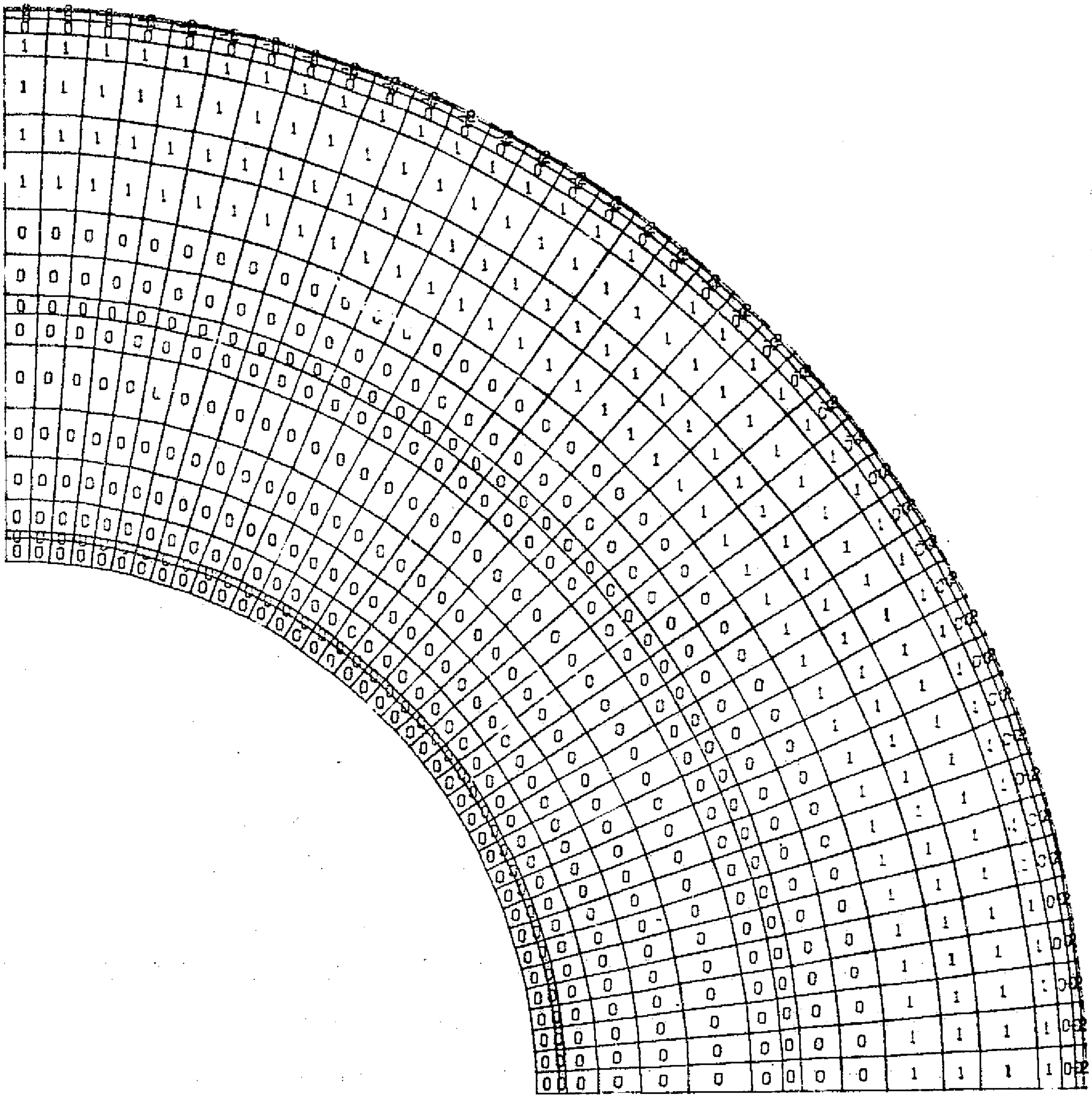
NTF BULKHEAD DOME

0 26 SCALE

FIG 97

1/1/1

DISPLAY= SY /1000 , NODE= 1 , SURFACE= 1



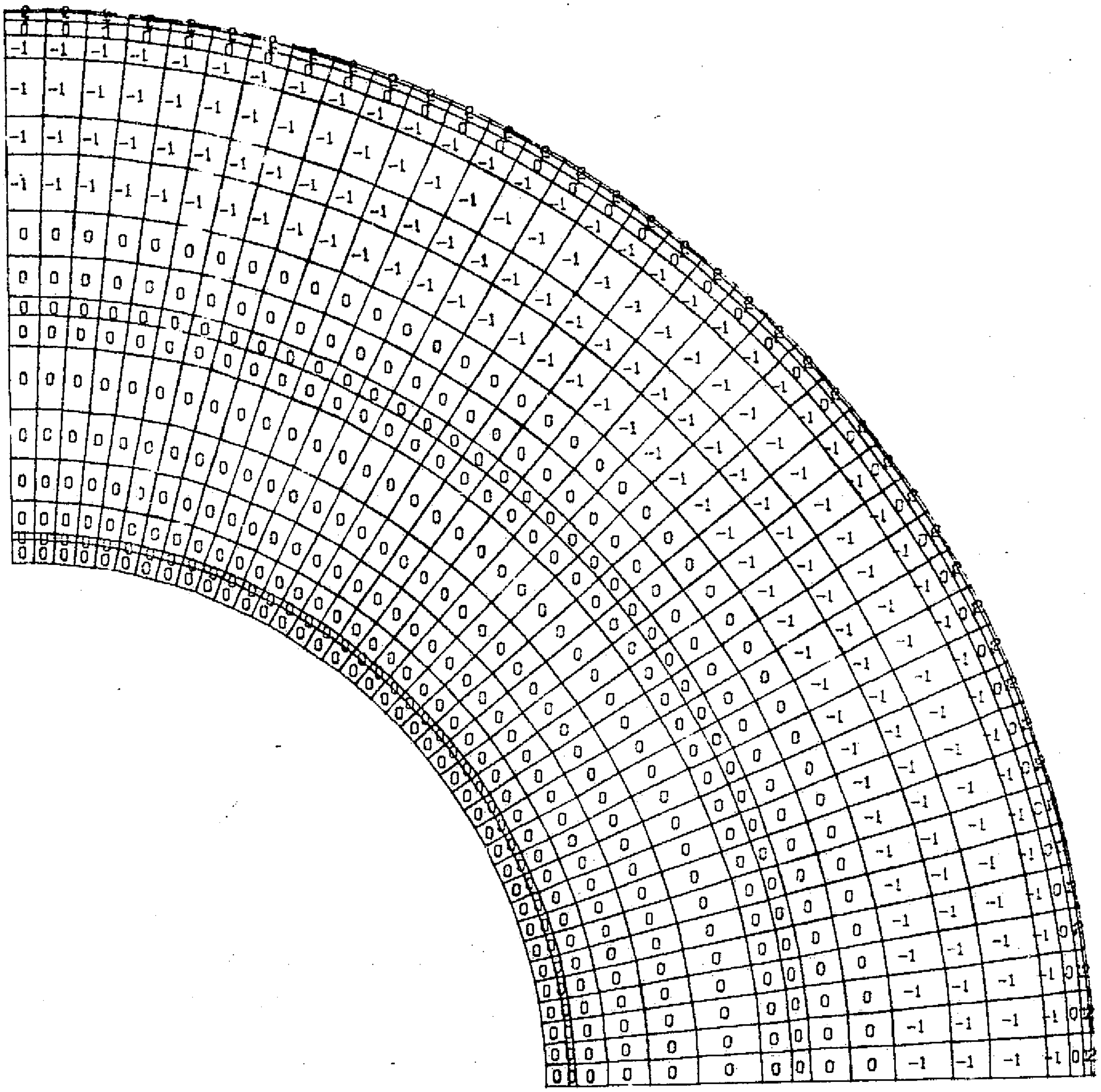
SPEC 3.1

NTF BULKHEAD DOME

0 26 SCALE

FIG 98

DISPLAY= SY /1000 , NODE= 1 , SURFACE= 2



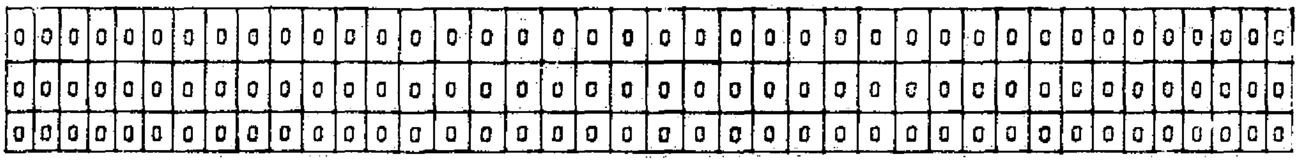
SPEC NTF BULKHEAD
3.1 DOME

0 ___ 26
SCALE

ORIGINAL PAGE IS
OF POOR QUALITY

FIG 99

DISPLAY= SX /1000 , NODE= 1, SURFACE= 0



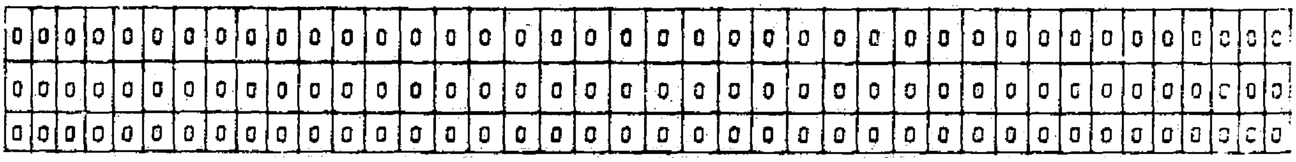
SPEC 10.1

NTF BULKHEAD
HATCH OPENING

0 SCALE 18

FIG 100

DISPLAY= SX /1000 , NODE= 1, SURFACE= 1 1/1/1



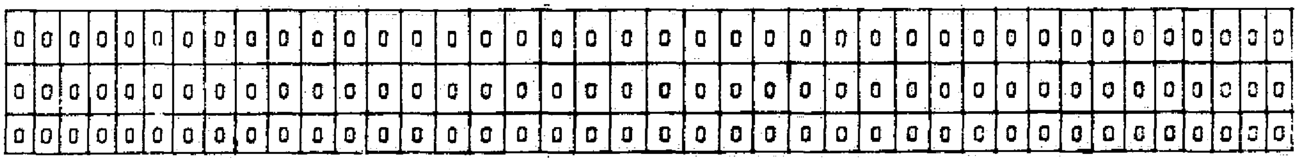
SPEC 10.1 NTF BULKHEAD HATCH OPENING

0 18
SCALE

FIG. 101

1/1/1

DISPLAY= SX /1000 , NODE= 1 , SURFACE= 2



SPEC
0.1

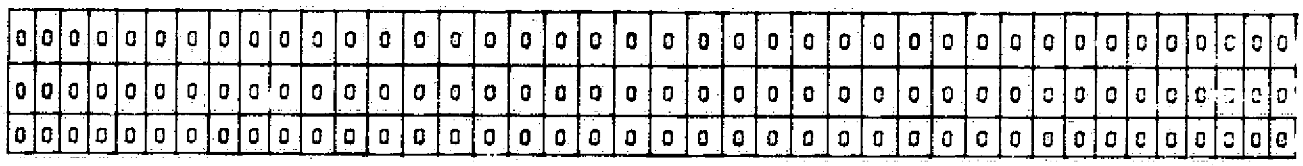
NTF BULKHEAD
HATCH OPENING

0 18
SCALE

FIG 102

DISPLAY= SY /1000 , NODE= 1, SURFACE= 0

1/1/1



SPEC 10.1

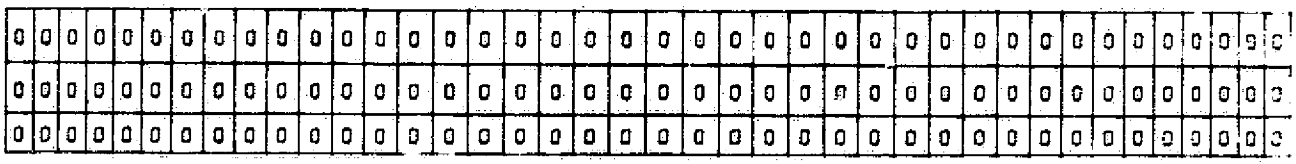
NTF BULKHEAD
HATCH OPENING

0 18
SCALE

FIG 103

1/1/1

DISPLAY= SY /1000 , NODE= 1 , SURFACE= 1



SPEC 10.1

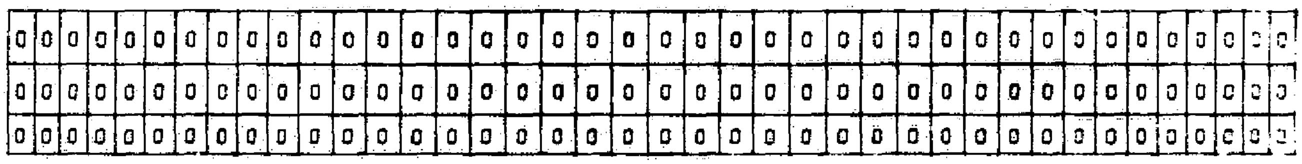
NTF BULKHEAD
HATCH OPENING

0 18
SCALE

FIG 104

1/1/1

DISPLAY= SY /1000 , NODE= 1, SURFACE= 2



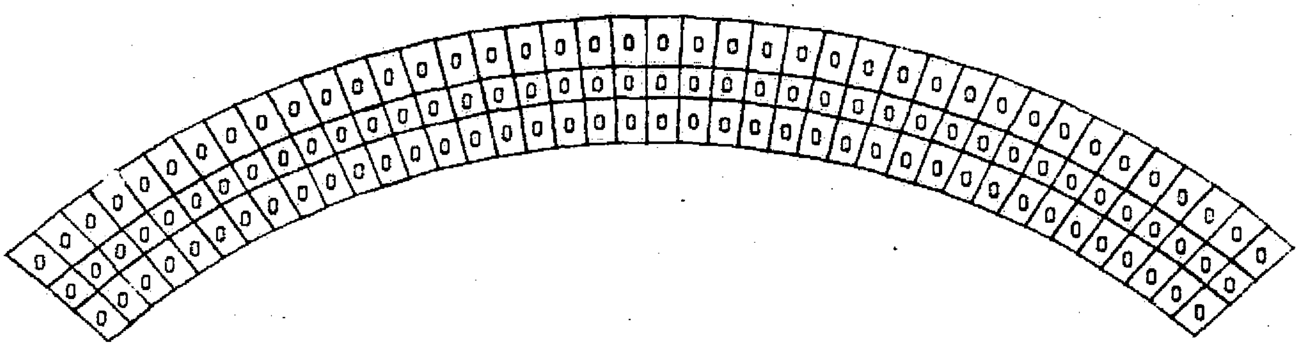
SPEC 10.1 NTF BULKHEAD HATCH OPENING

0 18
SCALE

FIG 105

DISPLAY= SX /1000 , NODE= 1, SURFACE= 0

1/1/1



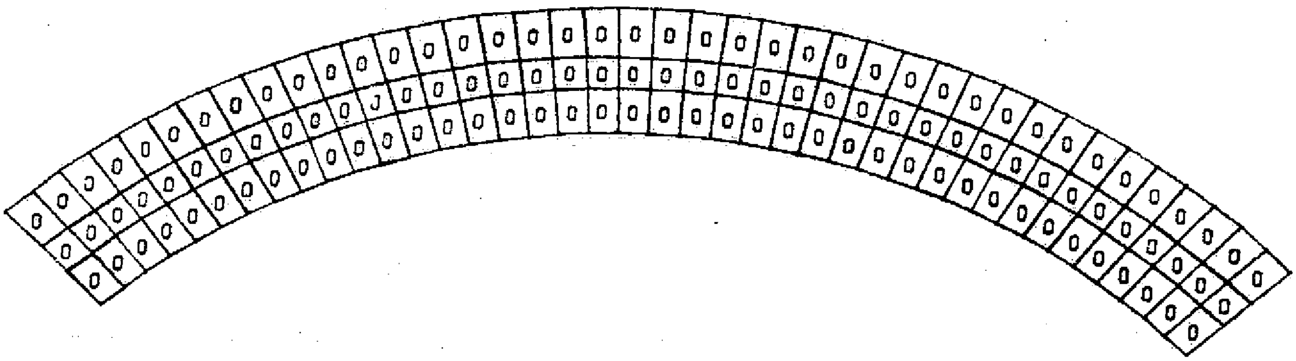
SPEC
?-1

NTF BULKHEAD
FLANGE SURFACE

0 21
SCALE

FIG 106

DISPLAY= SX /1000 , NODE= 1 , SURFACE= 1 1/1/1



SPEC 2.1

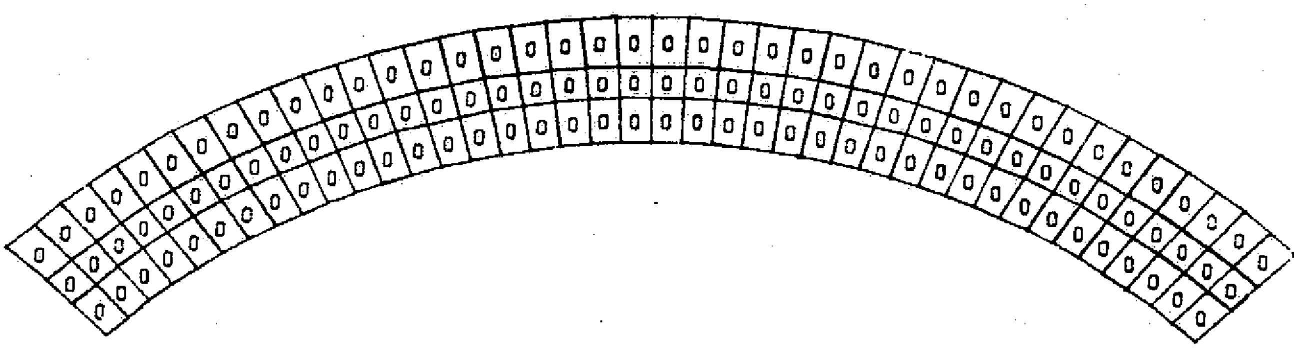
NTF BULKHEAD
FLANGE SURFACE

0 SCALE 21

FIG 107

DISPLAY= SX /1000 , NODE= 1 , SURFACE= 2

1/1/1



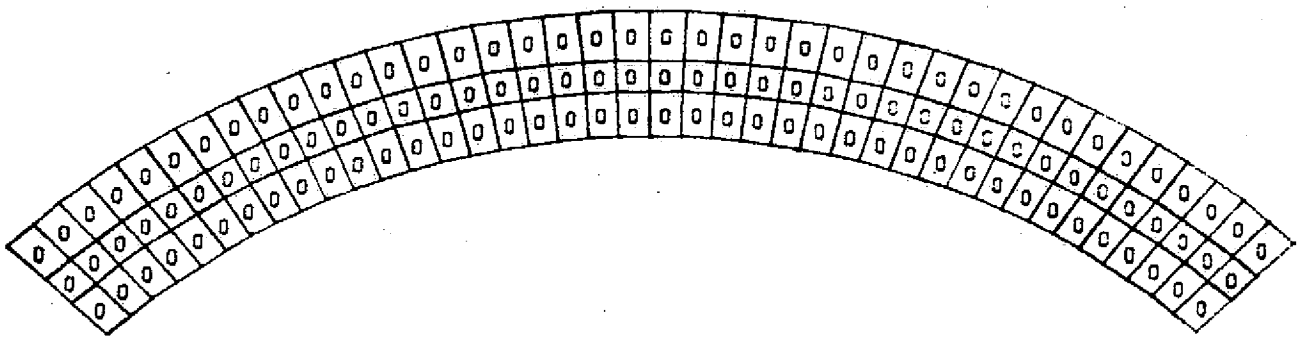
SPEC
2.1

NTF BULKHEAD
FLANGE SURFACE

0 SCALE 21

FIG 108

DISPLAY= SY /1000 , NODE= 1 , SURFACE= 0



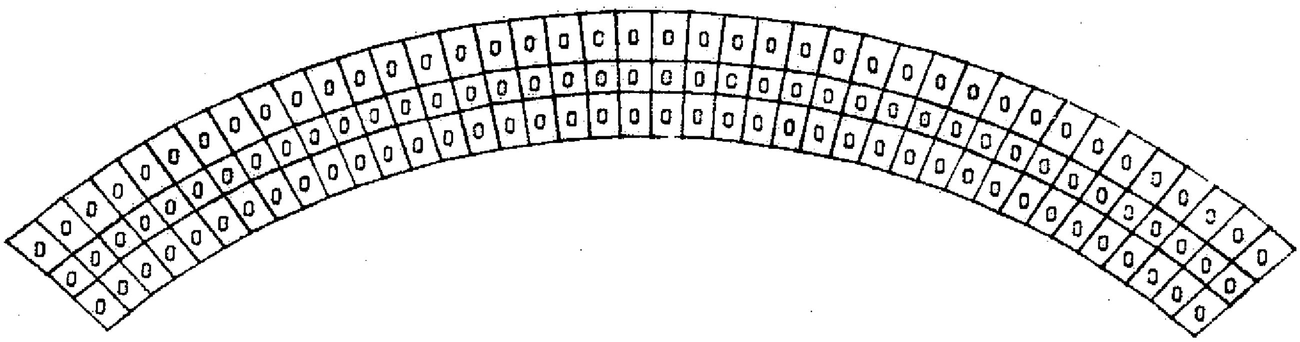
SPEC 2.1 NTF BULKHEAD FLANGE SURFACE

0 SCALE 21

FIG 109

DISPLAY= SY /1000 , NODE= 1 , SURFACE= 1

1/1/1



SPEC 2.1

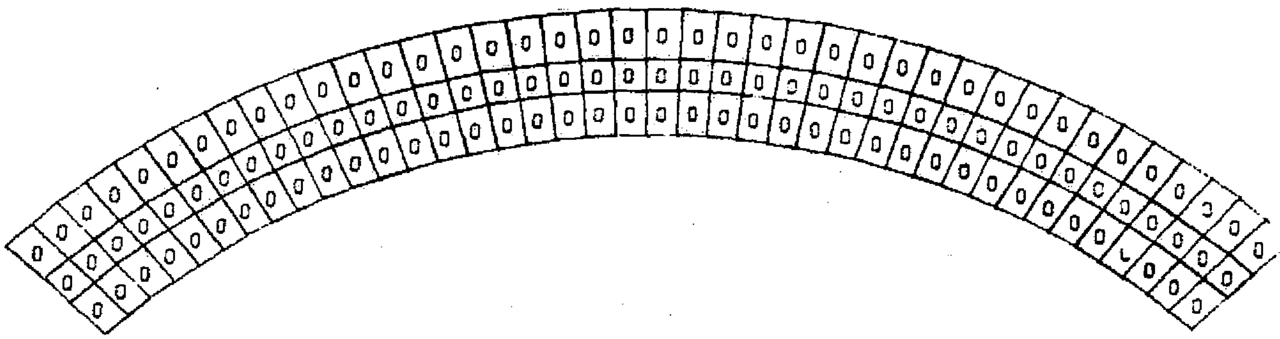
NTF BULKHEAD
FLANGE SURFACE

0 21
SCALE

FIG 110

1/1/1

DISPLAY= SY /1000 , NODE= 1 , SURFACE= 2



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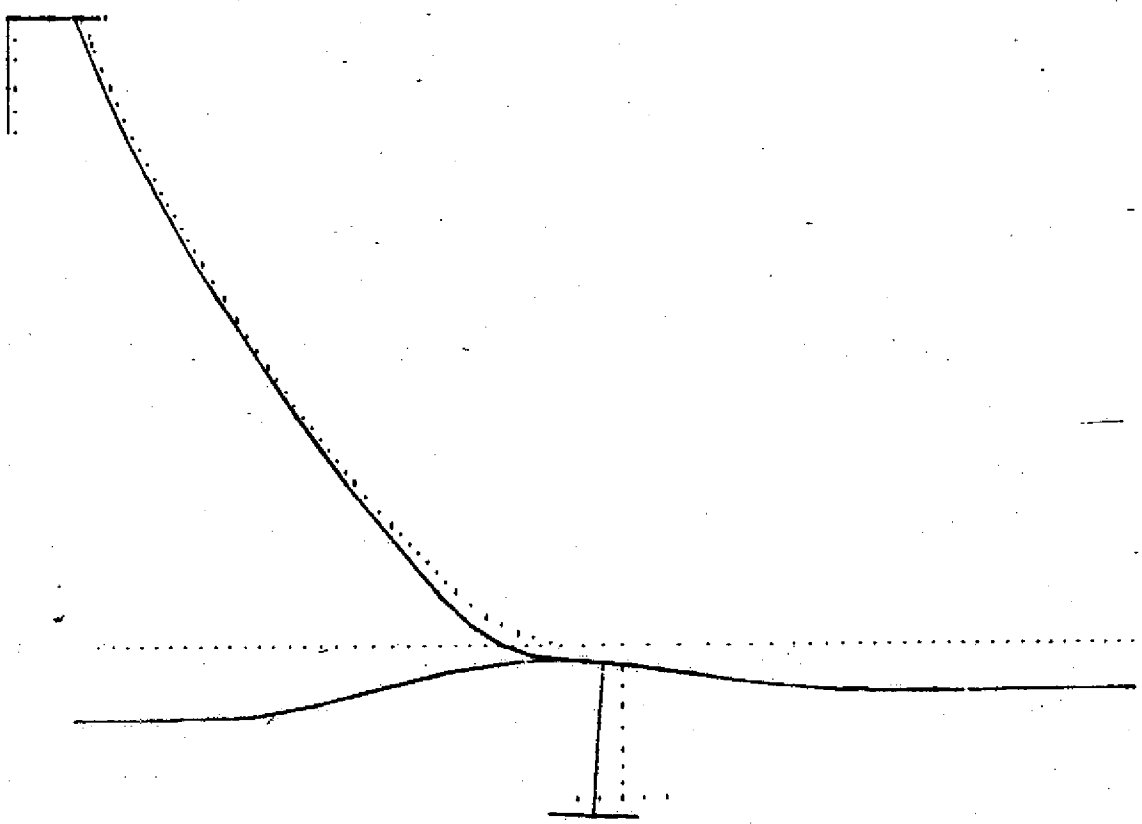
SPEC 2.1

NTF BULKHEAD
FLANGE SURFACE

0 ______ 21
SCALE

FIG 111

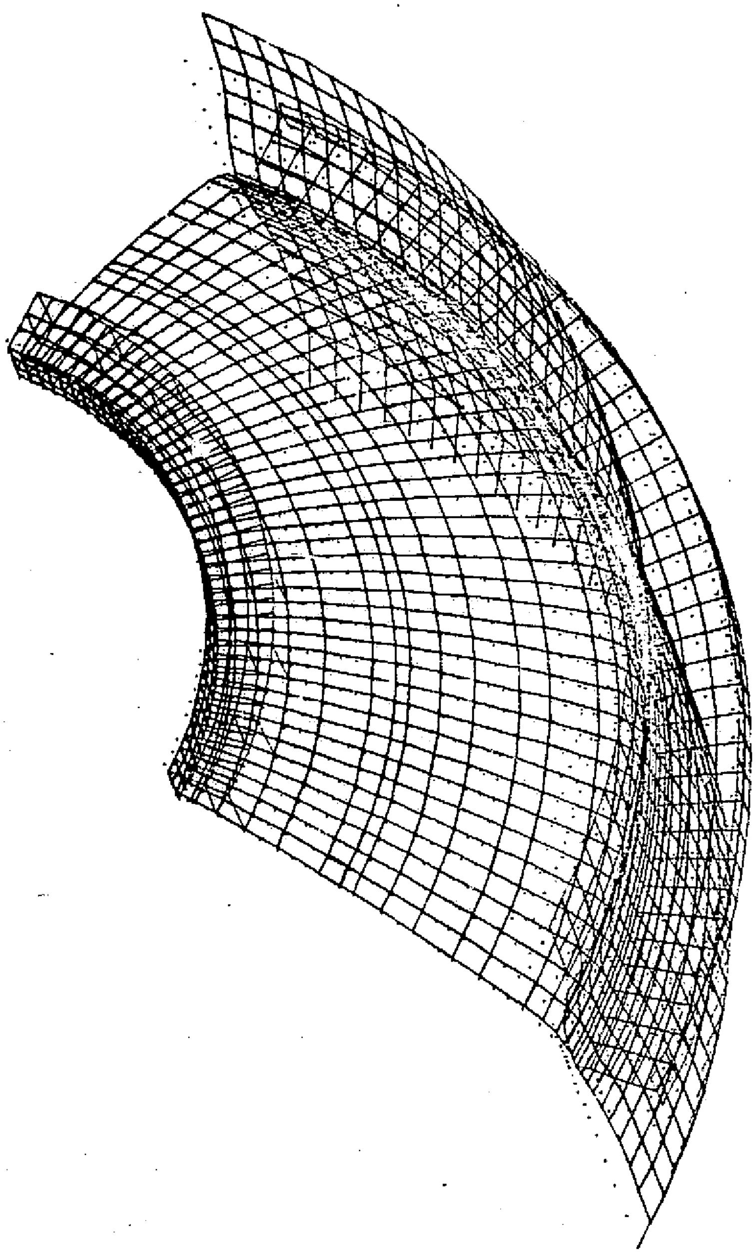


SPEC
12.1

NTF BULKHEAD
CROSS-SECTION VIEW

0 SCALE 27

FIG 112



SPEC
1.1

NTF BULKHEAD

0 44
SCALE

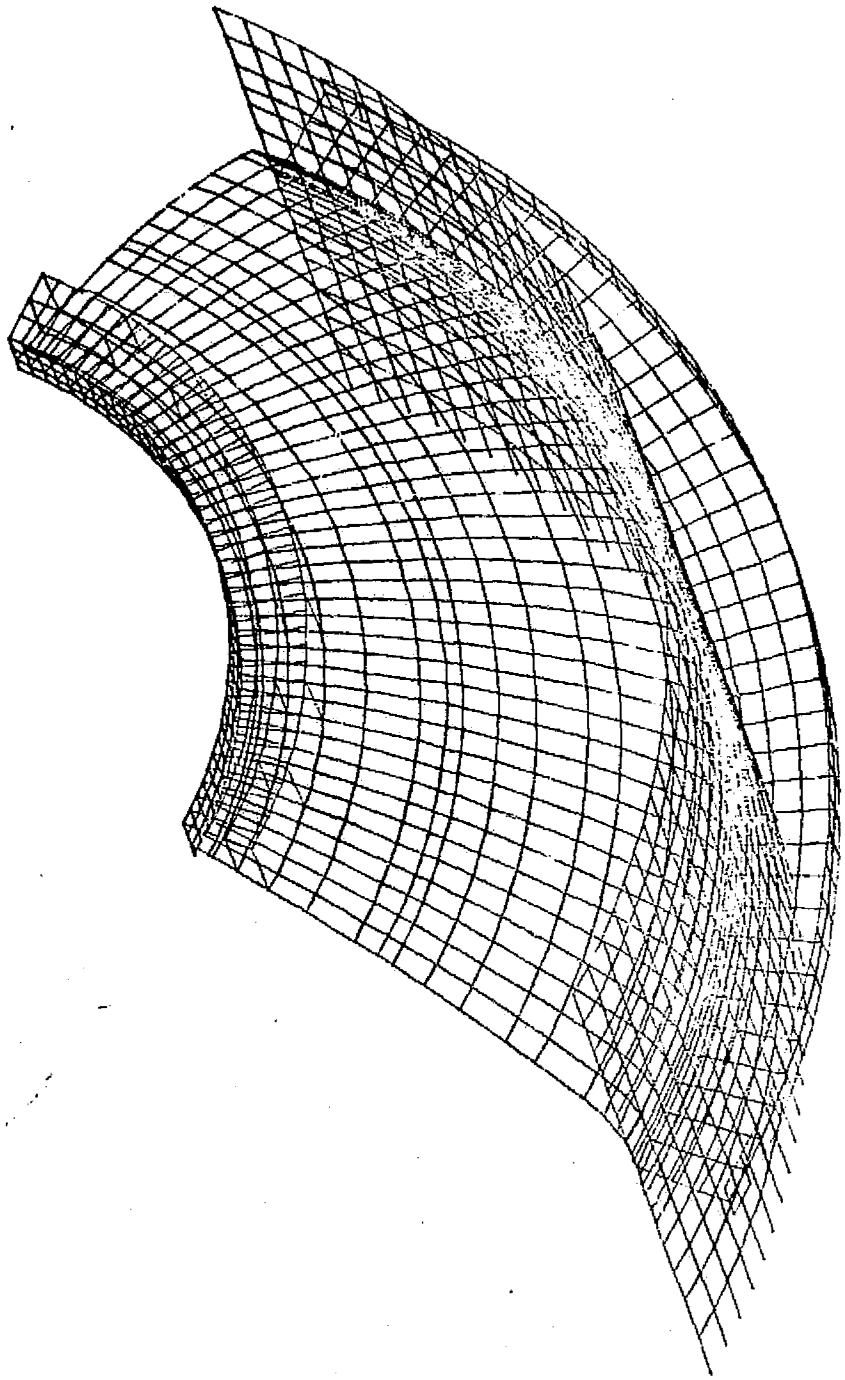
FIG 113

CASE 4

GATE VALVE OPEN
W/ STEADY STATE TEMP. PROFILE.
STRESS PLOTS

FIGURES 114 THRU 140

COMPUTER RUN NO. LAD



SPEC
1.1

NTE BULKHEAD

0 ___ 41
SCALE

FIG. 114

DISPLAY= SX /1000 , NODE= 1 , SURFACE= 0

5	5	6	6	8	7	6	4	3	1	3	3	-4	-1	8	7	12	18
5	5	6	6	8	7	6	4	3	1	3	3	-4	-1	8	7	12	18
5	5	6	6	8	7	6	4	3	1	3	3	-4	-1	8	7	12	18
5	5	6	6	8	7	6	4	3	1	3	3	-4	-1	8	7	12	18
5	5	6	6	8	7	6	4	3	1	3	3	-4	-1	8	7	12	18
5	5	6	6	8	7	6	4	3	1	3	3	-4	-1	8	7	12	18
5	5	6	6	8	7	6	4	3	1	3	3	-4	-1	8	7	12	18
5	5	6	6	8	7	6	4	3	1	3	3	[illegible]	-1	8	7	12	18
5	5	6	6	8	7	6	4	3	1	3	3	-4	-1	8	7	12	18
5	5	6	6	8	7	6	4	3	1	3	3	-4	-1	8	7	12	18
5	5	6	6	8	7	6	4	3	1	3	3	-4	-1	8	7	12	18
5	5	6	6	8	7	6	4	3	1	3	3	-4	-1	8	7	12	18
5	5	6	6	8	7	6	4	3	1	3	3	-4	-1	8	7	12	18
5	5	6	6	8	7	6	4	3	1	3	3	-4	-1	8	7	12	18
5	5	6	6	8	7	6	4	3	1	3	3	-4	-1	8	7	12	18
5	5	6	6	8	7	6	4	3	1	3	3	-4	-1	8	7	12	18
5	5	6	6	8	7	6	4	3	1	3	3	-4	-1	8	7	12	18
5	5	6	6	8	7	6	4	3	1	3	3	-4	-1	8	7	12	18
5	5	6	6	8	7	6	4	3	1	3	3	-4	-1	8	7	12	18
5	5	6	6	8	7	6	4	3	1	3	3	-4	-1	8	7	12	18
5	5	6	6	8	7	6	4	3	1	3	3	-4	-1	8	7	12	18
5	5	6	6	8	7	6	4	3	1	3	3	-4	-1	8	7	12	18
5	5	6	6	8	7	6	4	3	1	3	3	-4	-1	8	7	12	18
5	5	6	6	8	7	6	4	3	1	3	3	-4	-1	8	7	12	18
5	5	6	6	8	7	6	4	3	1	3	3	-4	-1	8	7	12	18
5	5	6	6	8	7	6	4	3	1	3	3	-4	-1	8	7	12	18
5	5	6	6	8	7	6	4	3	1	3	3	-4	-1	8	7	12	18
5	5	6	6	8	7	6	4	3	1	3	3	-4	-1	8	7	12	18
5	5	6	6	8	7	6	4	3	1	3	3	-4	-1	8	7	12	18
5	5	6	6	8	7	6	4	3	1	3	3	-4	-1	8	7	12	18
5	5	6	6	8	7	6	4	3	1	3	3	-4	-1	8	7	12	18
5	5	6	6	8	7	6	4	3	1	3	3	-4	-1	8	7	12	18
5	5	6	6	8	7	6	4	3	1	3	3	-4	-1	8	7	12	18
5	5	6	6	8	7	6	4	3	1	3	3	-4	-1	8	7	12	18
5	5	6	6	8	7	6	4	3	1	3	3	-4	-1	8	7	12	18
5	5	6	6	8	7	6	4	3	1	3	3	-4	-1	8	7	12	18
5	5	6	6	8	7	6	4	3	1	3	3	-4	-1	8	7	12	18
5	5	6	6	8	7	6	4	3	1	3	3	-4	-1	8	7	12	18
5	5	6	6	8	7	6	4	3	1	3	3	-4	-1	8	7	12	18
5	5	6	6	8	7	6	4	3	1	3	3	-4	-1	8	7	12	18

SPEC 5.1

NTF BULKHEAD
SHELL

0 36
SCALE

FIG 115

DISPLAY= SX /1000 , NODE= 1 , SURFACE= 1

5	5	6	6	7	5	4	2	0	-2	0	-8	-12	-6	7	9	14	18
5	5	6	6	7	5	4	2	0	-2	0	-8	-12	-6	7	9	14	18
5	5	6	6	7	5	4	2	0	-2	0	-8	-12	-6	7	9	14	18
5	5	6	6	7	5	4	2	0	-2	0	-8	-12	-6	7	9	14	18
5	5	6	6	7	5	4	2	0	-2	0	-8	-12	-6	7	9	14	18
5	5	6	6	7	5	4	2	0	-2	0	-8	-12	-6	7	9	14	18
5	5	6	6	7	5	4	2	0	-2	0	-8	-12	-6	7	9	14	18
5	5	6	6	7	5	4	2	0	-2	0	-8	-12	-6	7	9	14	18
5	5	6	6	7	5	4	2	0	-2	0	-8	-12	-6	7	9	14	18
5	5	6	6	7	5	4	2	0	-2	0	-8	-12	-6	7	9	14	18
5	5	6	6	7	5	4	2	0	-2	0	-8	-12	-6	7	9	14	18
5	5	6	6	7	5	4	2	0	-2	0	-8	-12	-6	7	9	14	18
5	5	6	6	7	5	4	2	0	-2	0	-8	-12	-6	7	9	14	18
5	5	6	6	7	5	4	2	0	-2	0	-8	-12	-6	7	9	14	18
5	5	6	6	7	5	4	2	0	-2	0	-8	-12	-6	7	9	14	18
5	5	6	6	7	5	4	2	0	-2	0	-8	-12	-6	7	9	14	18
5	5	6	6	7	5	4	2	0	-2	0	-8	-12	-6	7	9	14	18
5	5	6	6	7	5	4	2	0	-2	0	-8	-12	-6	7	9	14	18
5	5	6	6	7	5	4	2	0	-2	0	-8	-12	-6	7	9	14	18
5	5	6	6	7	5	4	2	0	-2	0	-8	-12	-6	7	9	14	18
5	5	6	6	7	5	4	2	0	-2	0	-8	-12	-6	7	9	14	18
5	5	6	6	7	5	4	2	0	-2	0	-8	-12	-6	7	9	14	18
5	5	6	6	7	5	4	2	0	-2	0	-8	-12	-6	7	9	14	18
5	5	6	6	7	5	4	2	0	-2	0	-8	-12	-6	7	9	14	18
5	5	6	6	7	5	4	2	0	-2	0	-8	-12	-6	7	9	14	18
5	5	6	6	7	5	4	2	0	-2	0	-8	-12	-6	7	9	14	18
5	5	6	6	7	5	4	2	0	-2	0	-8	-12	-6	7	9	14	18
5	5	6	6	7	5	4	2	0	-2	0	-8	-12	-6	7	9	14	18
5	5	6	6	7	5	4	2	0	-2	0	-8	-12	-6	7	9	14	18
5	5	6	6	7	5	4	2	0	-2	0	-8	-12	-6	7	9	14	18
5	5	6	6	7	5	4	2	0	-2	0	-8	-12	-6	7	9	14	18
5	5	6	6	7	5	4	2	0	-2	0	-8	-12	-6	7	9	14	18
5	5	6	6	7	5	4	2	0	-2	0	-8	-12	-6	7	9	14	18
5	5	6	6	7	5	4	2	0	-2	0	-8	-12	-6	7	9	14	18
5	5	6	6	7	5	4	2	0	-2	0	-8	-12	-6	7	9	14	18
5	5	6	6	7	5	4	2	0	-2	0	-8	-12	-6	7	9	14	18
5	5	6	6	7	5	4	2	0	-2	0	-8	-12	-6	7	9	14	18
5	5	6	6	7	5	4	2	0	-2	0	-8	-12	-6	7	9	14	18
5	5	6	6	7	5	4	2	0	-2	0	-8	-12	-6	7	9	14	18
5	5	6	6	7	5	4	2	0	-2	0	-8	-12	-6	7	9	14	18

SPEC 5.1 NTF BULKHEAD SHELL

0 36 SCALE

FIG

DISPLAY= SX /100C , NODE= 1, SURFACE= 2

5	5	6	7	9	10	8	7	6	4	5	15	3	4	10	4	9	19
5	5	6	7	9	10	8	7	6	4	5	15	3	4	10	4	9	19
5	5	6	7	9	10	8	7	6	4	5	15	3	4	10	4	9	19
5	5	6	7	9	10	8	7	6	4	5	15	3	4	10	4	9	19
5	5	6	7	9	10	8	7	6	4	5	15	3	4	10	4	9	19
5	5	6	7	9	10	8	7	6	4	5	15	3	4	10	4	9	19
5	5	6	7	9	10	8	7	6	4	5	15	3	4	10	4	9	19
5	5	6	7	9	10	8	7	6	4	5	15	3	4	10	4	9	19
5	5	6	7	9	10	8	7	6	4	5	15	3	4	10	4	9	19
5	5	6	7	9	10	8	7	6	4	5	15	3	4	10	4	9	19
5	5	6	7	9	10	8	7	6	4	5	15	3	4	10	4	9	19
5	5	6	7	9	10	8	7	6	4	5	15	3	4	10	4	9	19
5	5	6	7	9	10	8	7	6	4	5	15	3	4	10	4	9	19
5	5	6	7	9	10	8	7	6	4	5	15	3	4	10	4	9	19
5	5	6	7	9	10	8	7	6	4	5	15	3	4	10	4	9	19
5	5	6	7	9	10	8	7	6	4	5	15	3	4	10	4	9	19
5	5	6	7	9	10	8	7	6	4	5	15	3	4	10	4	9	19
5	5	6	7	9	10	8	7	6	4	5	15	3	4	10	4	9	19
5	5	6	7	9	10	8	7	6	4	5	15	3	4	10	4	9	19
5	5	6	7	9	10	8	7	6	4	5	15	3	4	10	4	9	19
5	5	6	7	9	10	8	7	6	4	5	15	3	4	10	4	9	19
5	5	6	7	9	10	8	7	6	4	5	15	3	4	10	4	9	19
5	5	6	7	9	10	8	7	6	4	5	15	3	4	10	4	9	19
5	5	6	7	9	10	8	7	6	4	5	15	3	4	10	4	9	19
5	5	6	7	9	10	8	7	6	4	5	15	3	4	10	4	9	19
5	5	6	7	9	10	8	7	6	4	5	15	3	4	10	4	9	19
5	5	6	7	9	10	8	7	6	4	5	15	3	4	10	4	9	19
5	5	6	7	9	10	8	7	6	4	5	15	3	4	10	4	9	19
5	5	6	7	9	10	8	7	6	4	5	15	3	4	10	4	9	19
5	5	6	7	9	10	8	7	6	4	5	15	3	4	10	4	9	19
5	5	6	7	9	10	8	7	6	4	5	15	3	4	10	4	9	19
5	5	6	7	9	10	8	7	6	4	5	15	3	4	10	4	9	19
5	5	6	7	9	10	8	7	6	4	5	15	3	4	10	4	9	19
5	5	6	7	9	10	8	7	6	4	5	15	3	4	10	4	9	19
5	5	6	7	9	10	8	7	6	4	5	15	3	4	10	4	9	19
5	5	6	7	9	10	8	7	6	4	5	15	3	4	10	4	9	19
5	5	6	7	9	10	8	7	6	4	5	15	3	4	10	4	9	19
5	5	6	7	9	10	8	7	6	4	5	15	3	4	10	4	9	19
5	5	6	7	9	10	8	7	6	4	5	15	3	4	10	4	9	19
5	5	6	7	9	10	8	7	6	4	5	15	3	4	10	4	9	19

SPEC 5.1 NTF BULKHEAD SHELL

0 36 SCALE

FIG 117

DISPLAY= SY /1000 , NODE= 1 , SURFACE= 0

2	2	2	2	2	2	2	1	1	1	1	3	3	5	8	8	8	8
2	2	2	2	2	2	2	1	1	1	1	3	3	5	8	8	8	8
2	2	2	2	2	2	2	1	1	1	1	3	3	5	8	8	8	8
2	2	2	2	2	2	2	1	1	1	1	3	3	5	8	8	8	8
2	2	2	2	2	2	2	1	1	1	1	3	3	5	8	8	8	8
2	2	2	2	2	2	2	1	1	1	1	3	3	5	8	8	8	8
2	2	2	2	2	2	2	1	1	1	1	3	3	5	8	8	8	8
2	2	2	2	2	2	2	1	1	1	1	3	3	5	8	8	8	8
2	2	2	2	2	2	2	1	1	1	1	3	3	5	8	8	8	8
2	2	2	2	2	2	2	1	1	1	1	3	3	5	8	8	8	8
2	2	2	2	2	2	2	1	1	1	1	3	3	5	8	8	8	8
2	2	2	2	2	2	2	1	1	1	1	3	3	5	8	8	8	8
2	2	2	2	2	2	2	1	1	1	1	3	3	5	8	8	8	8
2	2	2	2	2	2	2	1	1	1	1	3	3	5	8	8	8	8
2	2	2	2	2	2	2	1	1	1	1	3	3	5	8	8	8	8
2	2	2	2	2	2	2	1	1	1	1	3	3	5	8	8	8	8
2	2	2	2	2	2	2	1	1	1	1	3	3	5	8	8	8	8
2	2	[illegible]	2	2	2	2	1	1	1	1	3	3	5	8	8	8	8
2	2	2	2	2	2	2	1	1	1	1	3	3	5	8	8	8	8
2	2	2	2	2	2	2	1	1	1	1	3	3	5	8	8	8	8
2	2	2	2	2	2	2	1	1	1	1	3	3	5	8	8	8	8
2	2	2	2	2	2	2	1	1	1	1	3	3	5	8	8	8	8
2	2	2	2	2	2	2	1	1	1	1	3	3	5	8	8	8	8
2	2	2	2	2	2	2	1	1	1	1	3	3	5	8	8	8	8
2	2	2	2	2	2	2	1	1	1	1	3	3	5	8	8	8	8
2	2	2	2	2	2	2	1	1	1	1	3	3	5	8	8	8	8
2	2	2	2	2	2	2	1	1	1	1	3	3	5	8	8	8	8
2	2	2	2	2	2	2	1	1	1	1	3	3	5	8	8	8	8
2	2	2	2	2	2	2	1	1	1	1	3	3	5	8	8	8	8
2	2	2	2	2	2	2	1	1	1	1	3	3	5	8	8	8	8
2	2	2	2	2	2	2	1	1	1	1	3	3	5	8	8	8	8
2	2	2	2	2	2	2	1	1	1	1	3	3	5	8	8	8	8
2	2	2	2	2	2	2	1	1	1	1	3	3	5	8	8	8	8
2	2	2	2	2	2	2	1	1	1	1	3	3	5	8	8	8	8
2	2	2	2	2	2	2	1	1	1	1	3	3	5	8	8	8	8
2	2	2	2	2	2	2	1	1	1	1	3	3	5	8	8	8	8
2	2	2	2	2	2	2	1	1	1	1	3	3	5	8	8	8	8
2	2	2	2	2	2	2	1	1	1	1	3	3	5	8	8	8	8
2	2	2	2	2	2	2	1	1	1	1	3	3	5	8	8	8	8
2	2	2	2	2	2	2	1	1	1	1	3	3	5	8	8	8	8

SPEC
5.1

NTF BULKHEAD
SHELL

0 36
SCALE

FIG 118

DISPLAY= SY /1000 , NODE= 1, SURFACE= 1

2	3	3	1	-2	-6	-6	-6	-8	[illegible]	[illegible]	36	-21	-12	2	16	17	7
2	3	3	1	-2	-6	-6	-6	-8	[illegible]	[illegible]	36	-21	-12	2	16	17	7
2	3	3	1	-2	-6	-6	-6	-8	[illegible]	[illegible]	36	-21	-12	2	16	17	7
2	3	3	1	-2	-6	-6	-6	-8	[illegible]	[illegible]	36	-21	-12	2	16	17	7
2	3	3	1	-2	-6	-6	-6	-8	[illegible]	[illegible]	36	-21	-12	2	16	17	7
2	3	3	1	-2	-6	-6	-6	-8	[illegible]	[illegible]	36	-21	-12	2	16	17	7
2	3	3	1	-2	-6	-6	-6	-8	[illegible]	[illegible]	36	-21	-12	2	16	17	7
2	3	3	1	-2	-6	-6	-6	-8	[illegible]	[illegible]	36	-21	-12	2	16	17	7
2	3	3	1	-2	-6	-6	-6	-8	[illegible]	[illegible]	36	-21	-12	2	16	17	7
2	3	3	1	-2	-6	-6	-6	-8	[illegible]	[illegible]	36	-21	-12	2	16	17	7
2	3	3	1	-2	-6	-6	-6	-8	[illegible]	[illegible]	36	-21	-12	2	16	17	7
2	3	3	1	-2	-6	-6	-6	-8	[illegible]	[illegible]	36	-21	-12	2	16	17	7
2	3	3	1	-2	-6	-6	[illegible]	[illegible]	[illegible]	[illegible]	36	-21	-12	2	16	17	7
2	3	3	1	-2	-6	-6	-6	-8	[illegible]	[illegible]	36	-21	-12	2	16	17	7
2	3	3	1	-2	-6	-6	-6	-8	[illegible]	[illegible]	36	-21	-12	2	16	17	7
2	3	3	1	-2	-6	-6	-6	-8	[illegible]	[illegible]	36	-21	-12	2	16	17	7
2	3	3	1	-2	-6	-6	-6	-8	[illegible]	[illegible]	36	-21	-12	2	16	17	7
2	3	3	1	-2	-6	-6	-6	-8	[illegible]	[illegible]	36	-21	-12	2	16	17	7
2	3	3	1	-2	-6	-6	-6	-8	[illegible]	[illegible]	36	-21	-12	2	16	17	7
2	3	3	1	-2	-6	-6	-6	-8	[illegible]	[illegible]	36	-21	-12	2	16	17	7
2	3	3	1	-2	-6	-6	-6	-8	[illegible]	[illegible]	36	-21	-12	2	16	17	7
2	3	3	1	-2	-6	-6	-6	-8	[illegible]	[illegible]	36	-21	-12	2	16	17	7
2	3	3	1	-2	-6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	36	-21	-12	2	16	17	7
2	3	3	1	-2	-6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	36	-21	-12	2	16	17	7
2	3	3	[illegible]	-2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	36	-21	-12	2	16	17	7
2	3	3	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-21	-12	2	16	17	7
2	3	3	1	-2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-21	-12	2	16	17	7
2	3	3	1	-2	-6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-21	-12	2	16	17	7
2	3	3	1	[illegible]	-6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	36	-21	-12	2	16	17	7
2	3	3	1	[illegible]	-6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-21	-12	2	16	17	7
2	3	3	1	-2	-6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	36	-21	-12	2	16	17	7
2	3	3	1	-2	-6	-6	-6	[illegible]	[illegible]	[illegible]	36	-21	-12	2	16	17	7
2	3	3	1	-2	-6	-6	-6	-8	[illegible]	[illegible]	36	-21	-12	2	16	17	7
2	3	3	1	-2	-6	-6	-6	-8	[illegible]	[illegible]	36	-21	-12	2	16	17	7
2	3	3	1	-2	-6	-6	-6	-8	[illegible]	[illegible]	36	-21	-12	2	16	17	7
2	3	3	1	-2	-6	-6	-6	-8	[illegible]	[illegible]	36	-21	-12	2	16	17	7
2	3	3	1	-2	-6	-6	-6	-8	[illegible]	[illegible]	36	-21	-12	2	16	17	7
2	3	3	1	-2	-6	-6	-6	-8	[illegible]	[illegible]	36	-21	-12	2	16	17	7
2	3	3	1	-2	-6	-6	-6	-8	[illegible]	[illegible]	36	-21	-12	2	16	17	7
2	3	3	1	-2	-6	-6	-6	-8	[illegible]	[illegible]	36	-21	-12	2	16	17	7

SPEC
5.1

NTF BULKHEAD
SHELL

0 36
SCALE

ORIGINAL PAGE IS
OF POOR QUALITY

FIG 119

DISPLAY= SY /1000 , NODE= 1 , SURFACE= 2

2	1	2	3	6	10	9	9	1	1	1042	28	21	13	-1	-2	8
2	1	2	3	6	10	9	9	1	1	1042	28	21	13	-1	-2	8
2	1	2	3	6	10	9	9	1	1	1042	28	21	13	-1	-2	8
2	1	2	3	6	10	9	9	1	1	1042	28	21	13	-1	-2	8
2	1	2	3	6	10	9	9	1	1	1042	28	21	13	-1	-2	8
2	1	2	3	6	10	9	9	1	1	1042	28	21	13	-1	-2	8
2	1	2	3	6	10	9	9	1	1	1042	28	21	13	-1	-2	8
2	1	2	3	6	10	9	9	1	1	1042	28	21	13	-1	-2	8
2	1	2	3	6	10	9	9	1	1	1042	28	21	13	-1	-2	8
2	1	2	3	6	10	9	9	1	1	1042	28	21	13	-1	-2	8
2	1	2	3	6	10	9	9	1	1	1042	28	21	13	-1	-2	8
2	1	2	3	6	10	9	9	1	1	1042	28	21	13	-1	-2	8
2	1	2	3	6	10	9	9	1	1	1042	28	21	13	-1	-2	8
2	1	2	3	6	10	9	9	1	1	1042	28	21	13	-1	-2	8
2	1	2	3	6	10	9	9	1	1	1042	28	21	13	-1	-2	8
2	1	2	3	6	10	9	9	1	1	1042	28	21	13	-1	-2	8
2	1	2	3	6	10	9	9	1	1	1042	28	21	13	-1	-2	8
2	1	2	3	6	10	9	9	1	1	1042	28	21	13	-1	-2	8
2	1	2	3	6	10	9	9	1	1	1042	28	21	13	-1	-2	8
2	1	2	3	6	10	9	9	1	1	1042	28	21	13	-1	-2	8
2	1	2	3	6	10	9	9	1	1	1042	28	21	13	-1	-2	8
2	1	2	3	6	10	9	9	1	1	1042	28	21	13	-1	-2	8
2	1	2	3	6	10	9	9	1	1	1042	28	21	13	-1	-2	8
2	1	2	3	6	10	9	9	1	1	1042	28	21	13	-1	-2	8
2	1	2	3	6	10	9	9	1	1	1042	28	21	13	-1	-2	8
2	1	2	3	6	10	9	9	1	1	1042	28	21	13	-1	-2	8
2	1	2	3	6	10	9	9	1	1	1042	28	21	13	-1	-2	8
2	1	2	3	6	10	9	9	1	1	1042	28	21	13	-1	-2	8
2	1	2	3	6	10	9	9	1	1	1042	28	21	13	-1	-2	8
2	1	2	3	6	10	9	9	1	1	1042	28	21	13	-1	-2	8
2	1	2	3	6	10	9	9	1	1	1042	28	21	13	-1	-2	8
2	1	2	3	6	10	9	9	1	1	1042	28	21	13	-1	-2	8
2	1	2	3	6	10	9	9	1	1	1042	28	21	13	-1	-2	8
2	1	2	3	6	10	9	9	1	1	1042	28	21	13	-1	-2	8
2	1	2	3	6	10	9	9	1	1	1042	28	21	13	-1	-2	8
2	1	2	3	6	10	9	9	1	1	1042	28	21	13	-1	-2	8
2	1	2	3	6	10	9	9	1	1	1042	28	21	13	-1	-2	8
2	1	2	3	6	10	9	9	1	1	1042	28	21	13	-1	-2	8
2	1	2	3	6	10	9	9	1	1	1042	28	21	13	-1	-2	8
2	1	2	3	6	10	9	9	1	1	1042	28	21	13	-1	-2	8

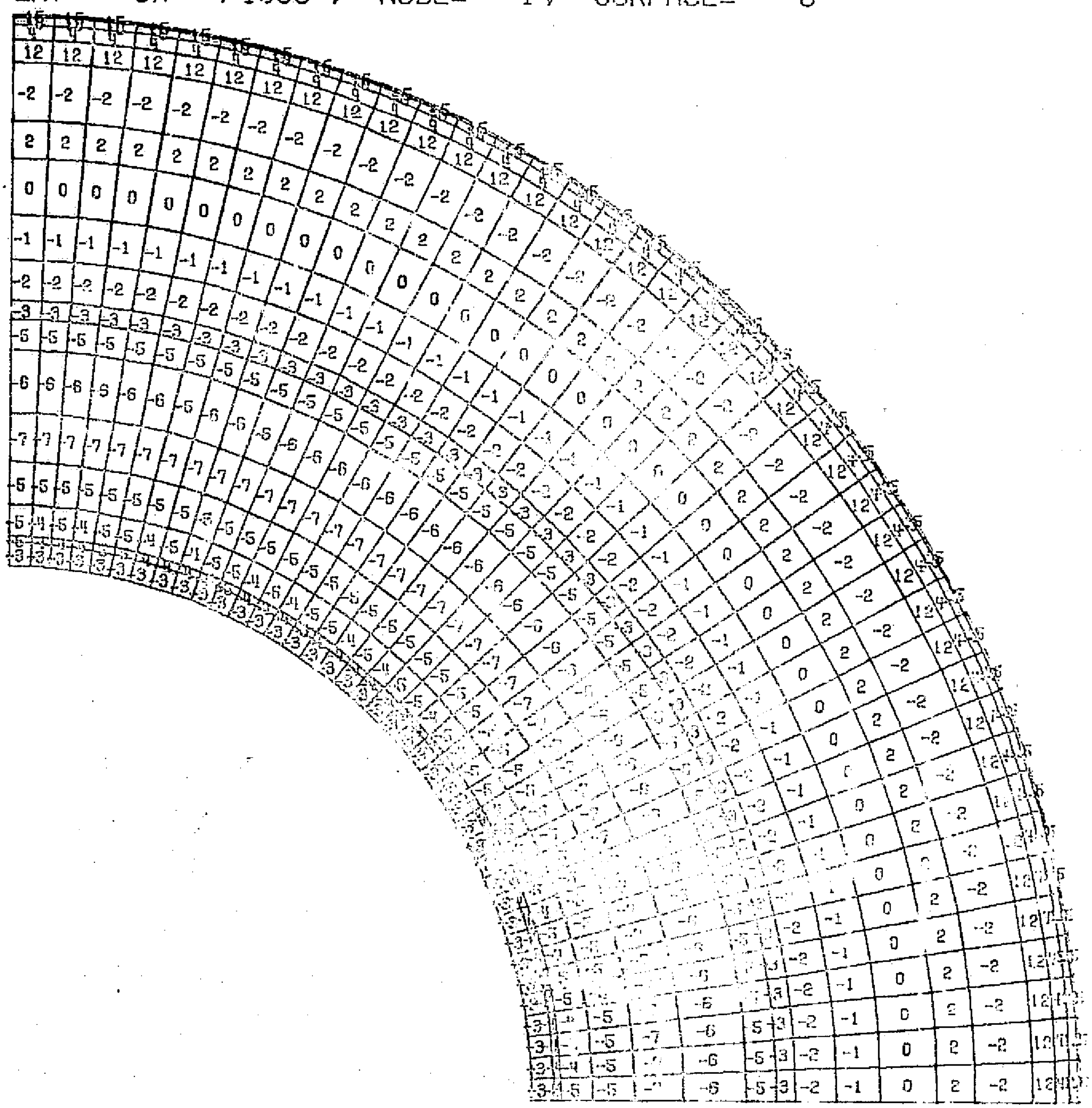
SPEC 5.1

NTF BULKHEAD SHELL

0 36 SCALE

FIG 120

DISPLAY= SX /1000 , NODE= 1, SURFACE= 0 1/1/1



SPEC 3-1 NTF_BULKHEAD DOME

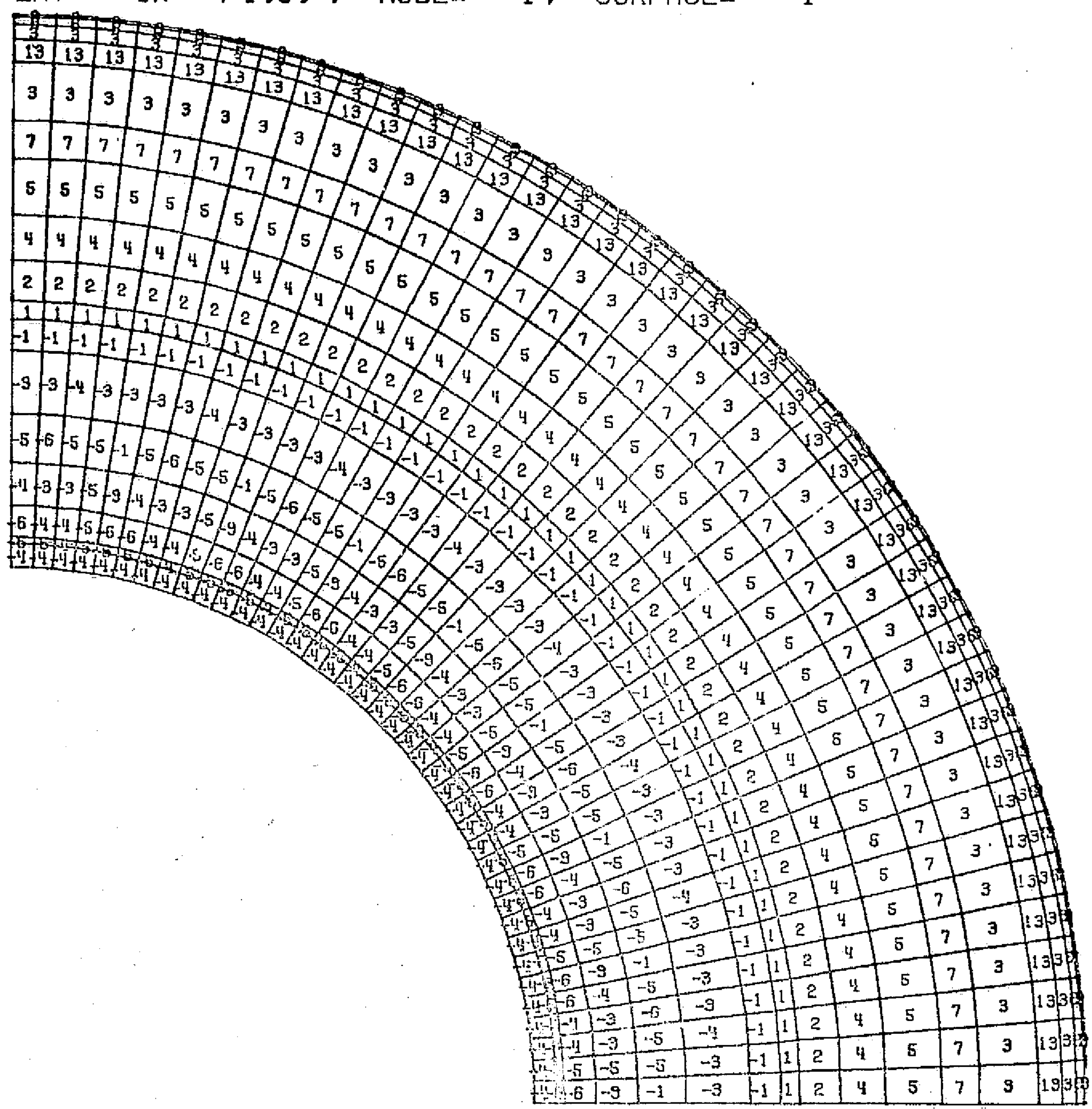
0 26 SCALE

ORIGINAL PAGE IS OF POOR QUALITY

FIG 121

DISPLAY= SX /1000 , NODE= 1, SURFACE= 1

1/1/1



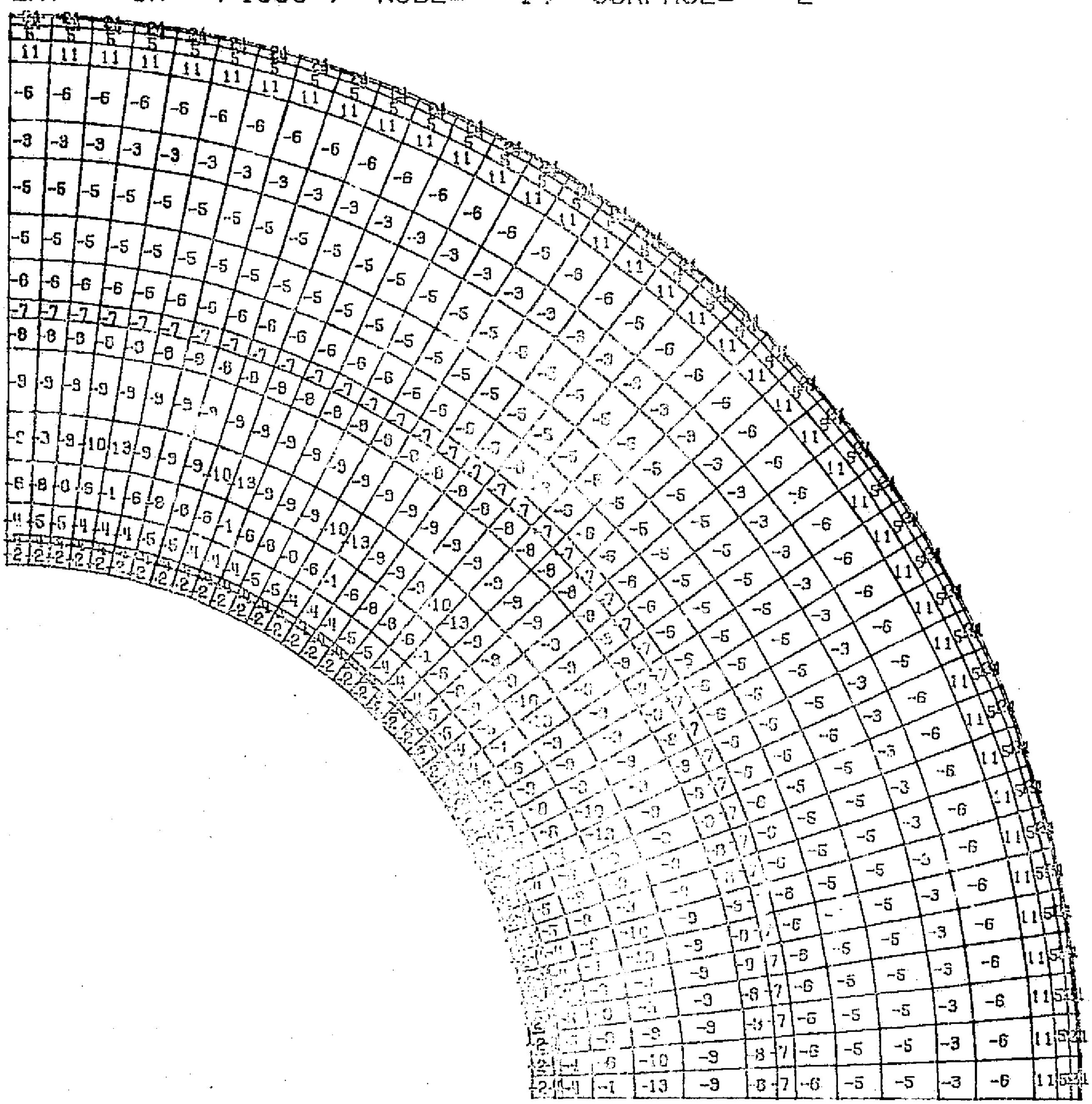
SPEC 3.1

NTF_BULKHEAD DOME

0 25 SCALE

FIG 122

DISPLAY= SX /1000 , NODE= 1 , SURFACE= 2



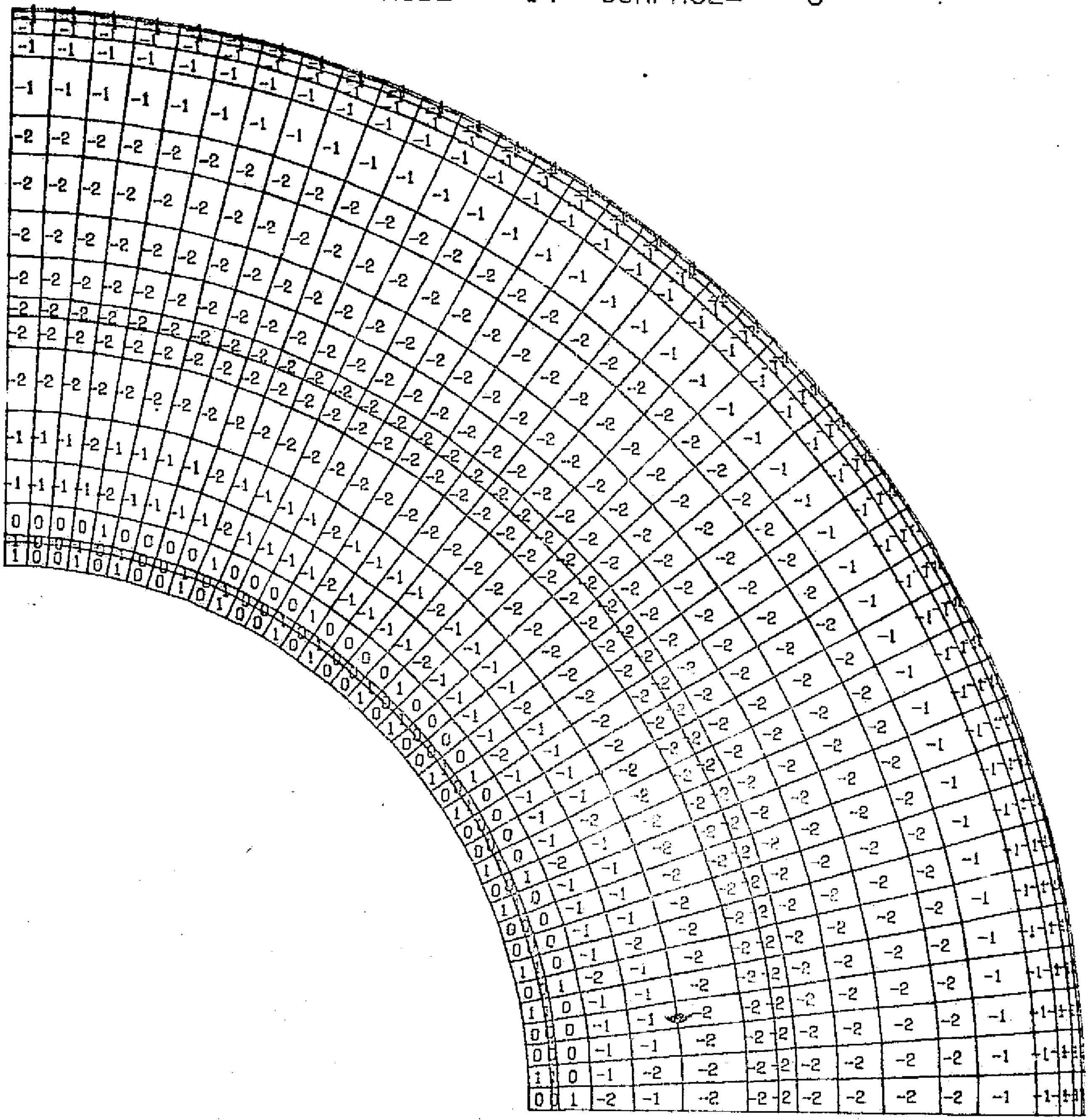
SPEC 3.1

NTF BULKHEAD
DOME

0 26
SCALE

FIG 123

DISPLAY= SY /1000 , NODE= 1 , SURFACE= 0



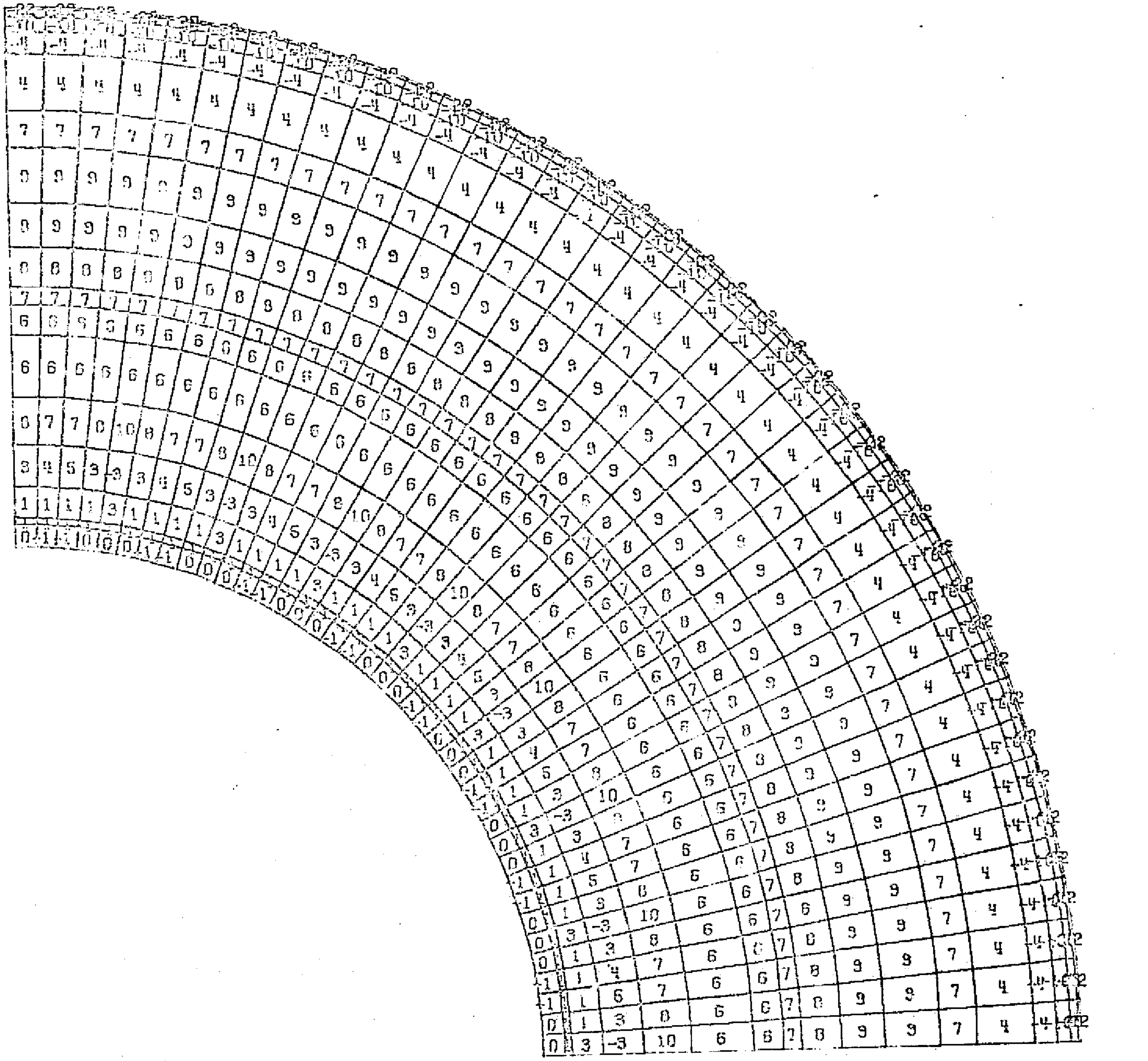
SPEC 3.1

NTF BULKHEAD DOME

0 26 SCALE

FIG 124

DISPLAY= SY /1000 , NODE= 1 , SURFACE= 1



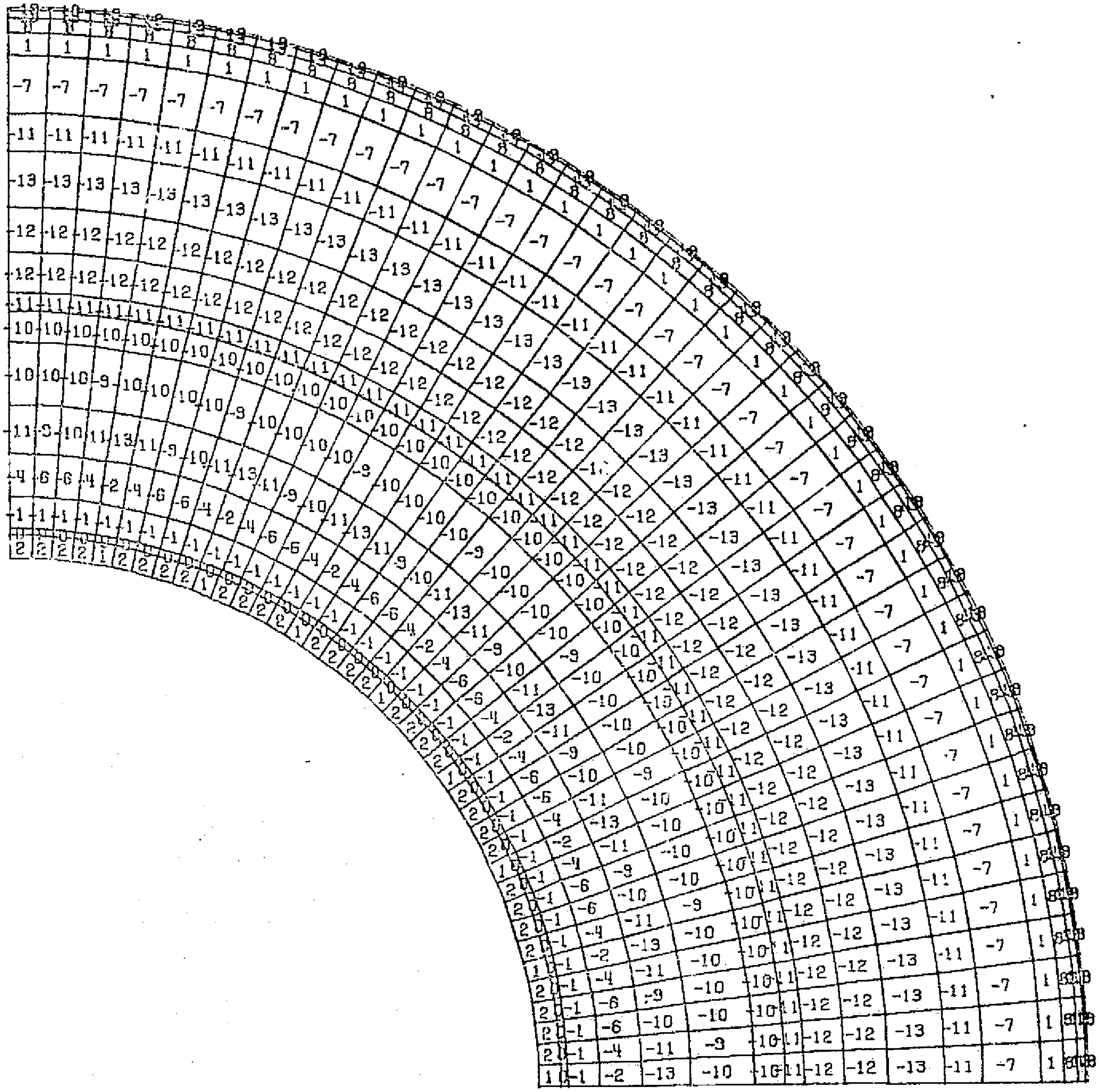
SPEC 3.1

NTF BULKHEAD DOME

FIG 125

1/1/1

DISPLAY= SY /1000 , NODE= 1, SURFACE= 2



SPEC 3.1

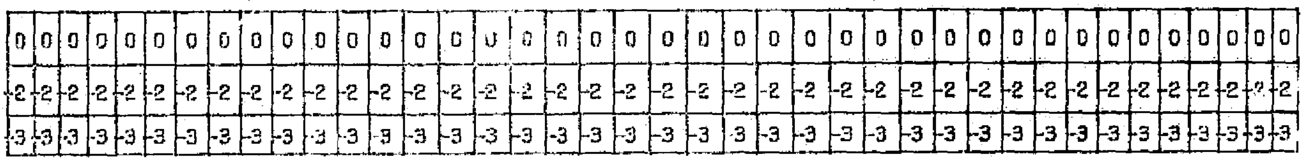
NTF BULKHEAD DOME

0 26
SCALE

FIG 126

DISPLAY= SX /1000 , MODE= 1 SURFACE= 0

1/1/1



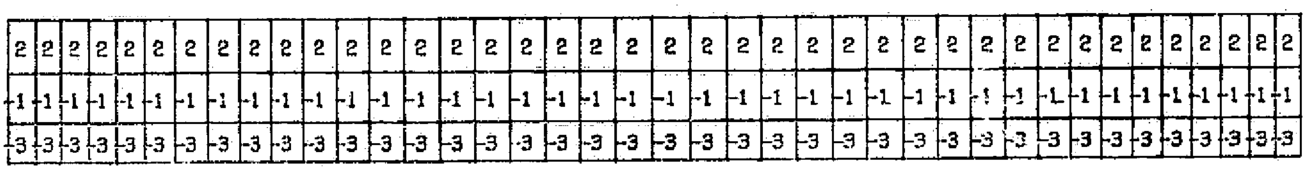
SPEC
10.1

NTF BULKHEAD
HATCH OPENING

0 18
SCALE

FIG 127

DISPLAY= SX /1000 , NODE= 1 , SURFACE= 1



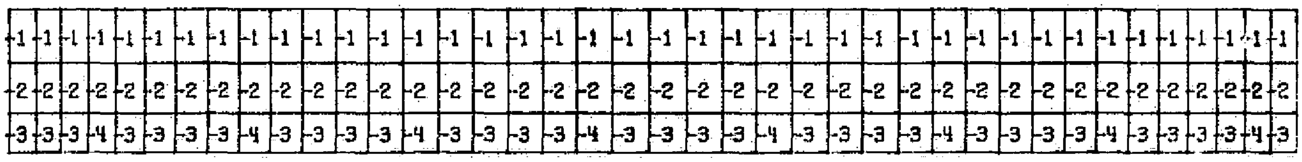
SPEC
10.1

NTF BULKHEAD
HATCH OPENING

0 18
SCALE

FIG 128

DISPLAY= SX /1000 , NODE= 1 , SURFACE= 2



SPEC 10.1

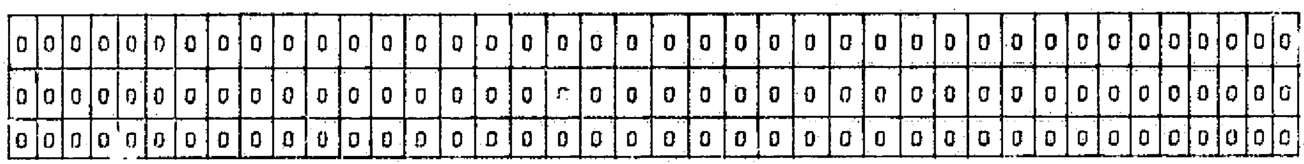
NTF BULKHEAD
HATCH OPENING

0 SCALE 18

FIG 129

1/1/1

DISPLAY= SY /1000 , NODE= 1, SURFACE= 0



SPEC 10.1

NTF BULKHEAD
HATCH OPENING

0 ____ 18
SCALE

FIG 130

DISPLAY= SY /10CO , NODE= 1, SURFACE= 1

5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
2	2	3	3	2	2	2	3	3	2	2	2	3	3	2	2	2	3	3	2	2	2	3	3	2	2	2	3	3	2	2	2	3	3	2	2	2	3	3	2
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

SPEC
10.1

NTF BULKHEAD
HATCH OPENING

0 18
SCALE

FIG 131

DISPLAY= SY /1000 , NODE= 1, SURFACE= 2

-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5
-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
0	0	-1	-1	-1	0	0	-1	-1	-1	0	0	-1	-1	-1	0	0	-1	-1	-1	0	0	-1	-1	-1	0	0	-1	-1	-1	0	0	-1	-1	-1	0	0	-1	-1	-1

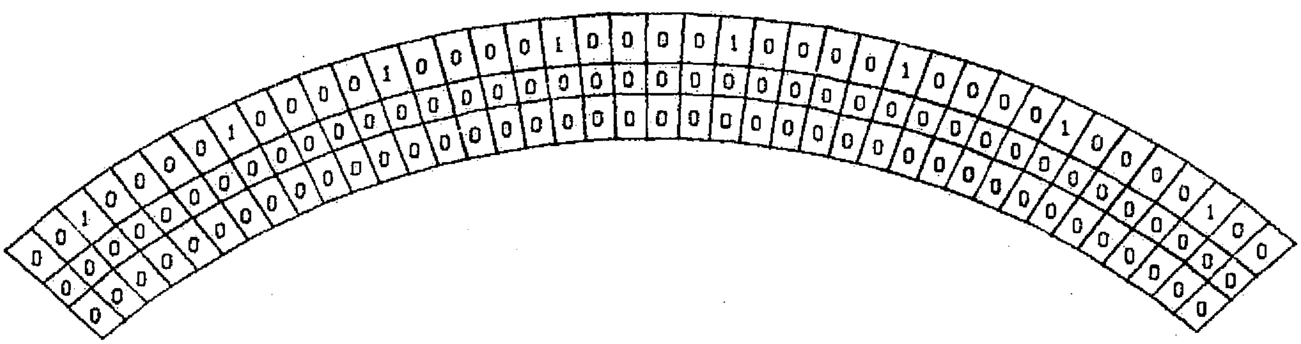
SPEC
10-1

NTF BULKHEAD
HATCH OPENING

0 ——— 18
SCALE

FIG 132

DISPLAY= SX /1000 , NODE= 1 , SURFACE= 0



SPEC 2.1

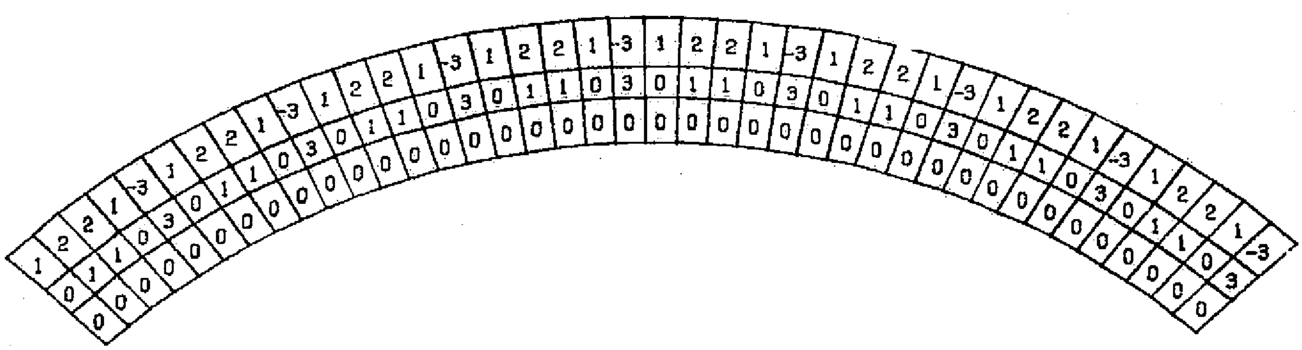
NTF BULKHEAD
FLANGE SURFACE

0 21
SCALE

FIG 133

1/1/1

DISPLAY= SX /1000 , NODE= 1 , SURFACE= 1

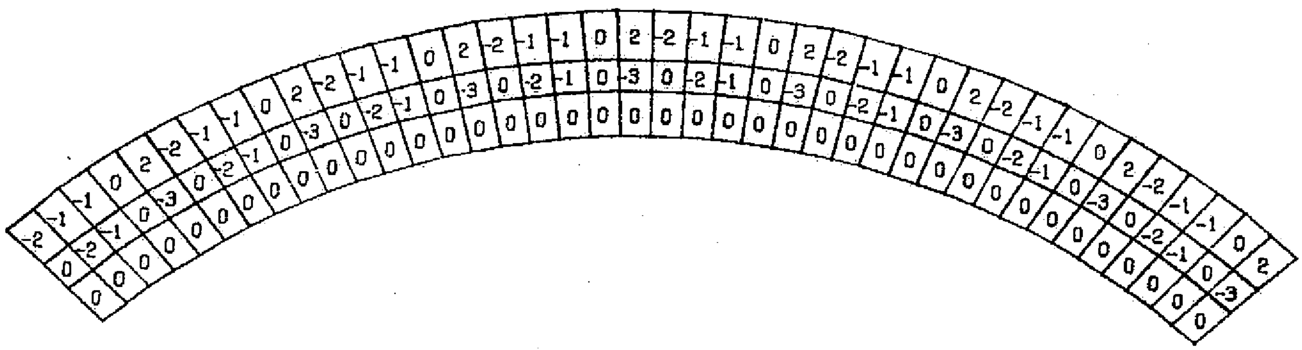


SPEC 2.1 NTF BULKHEAD FLANGE SURFACE

0 SCALE 21

FIG 134

DISPLAY= SX /1000 , NODE= 1, SURFACE= 2 1/1/1



SPEC 2.1

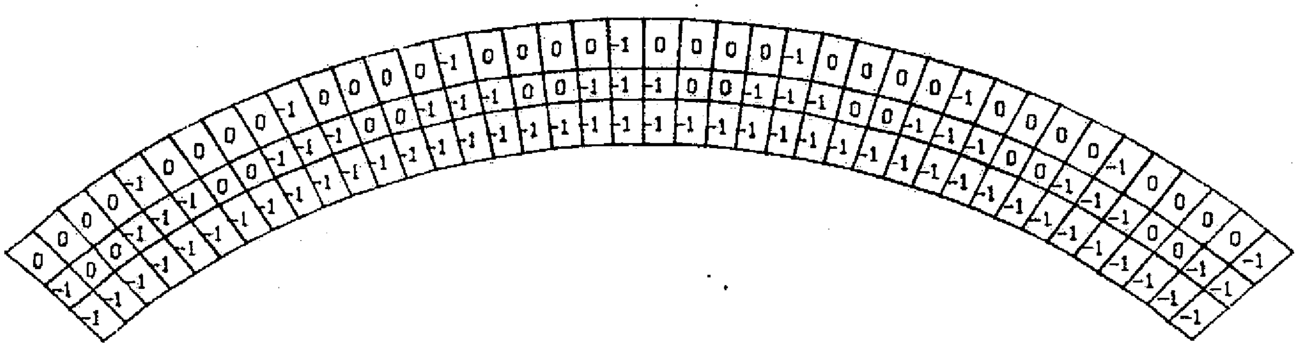
NTF BULKHEAD
FLANGE SURFACE

0 SCALE 21

FIG 125

DISPLAY= SY /1000 , NODE= 1 , SURFACE= 0

1/1/1



SPEC 2.1

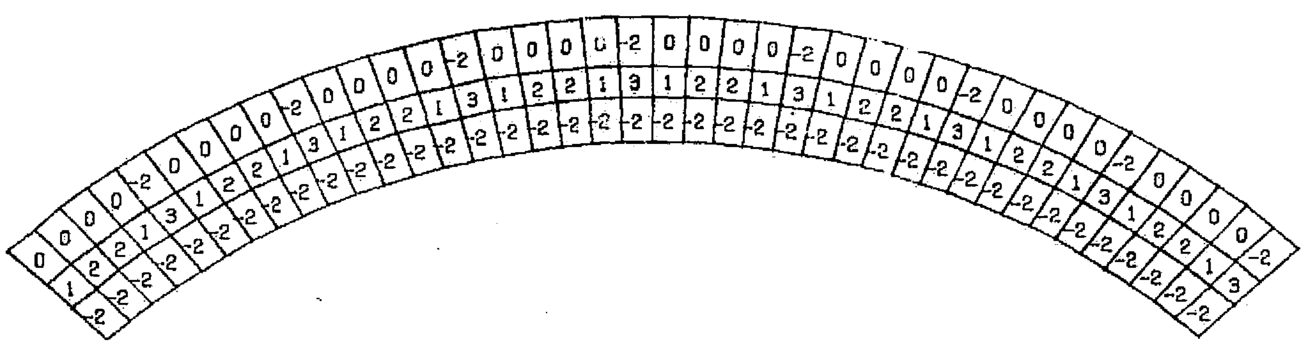
NTF BULKHEAD
FLANGE SURFACE

0 ____ 21
SCALE

FIG 136

1/1/1

DISPLAY= SY /1000 , NODE= 1, SURFACE= 1



SPEC
2.1

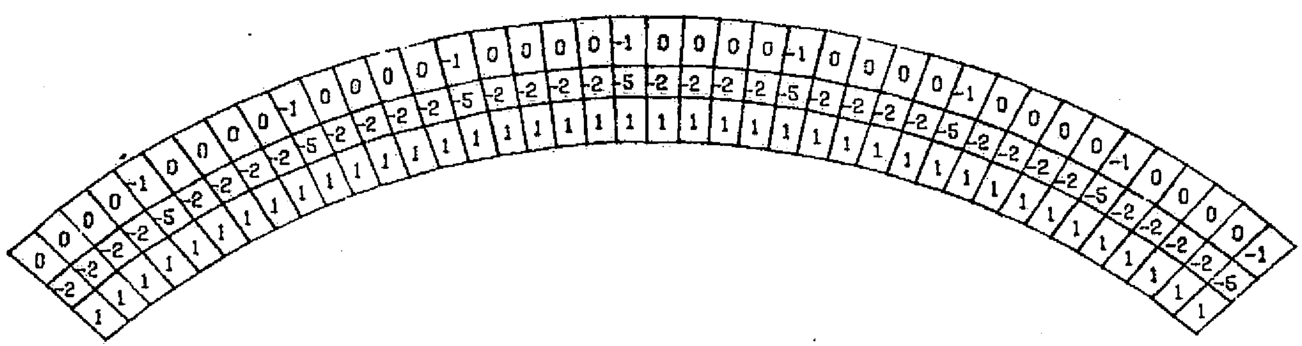
NTF BULKHEAD
FLANGE SURFACE

0 21
SCALE

FIG 137

1/1/1

DISPLAY= SY /1000 , NODE= 1, SURFACE= 2

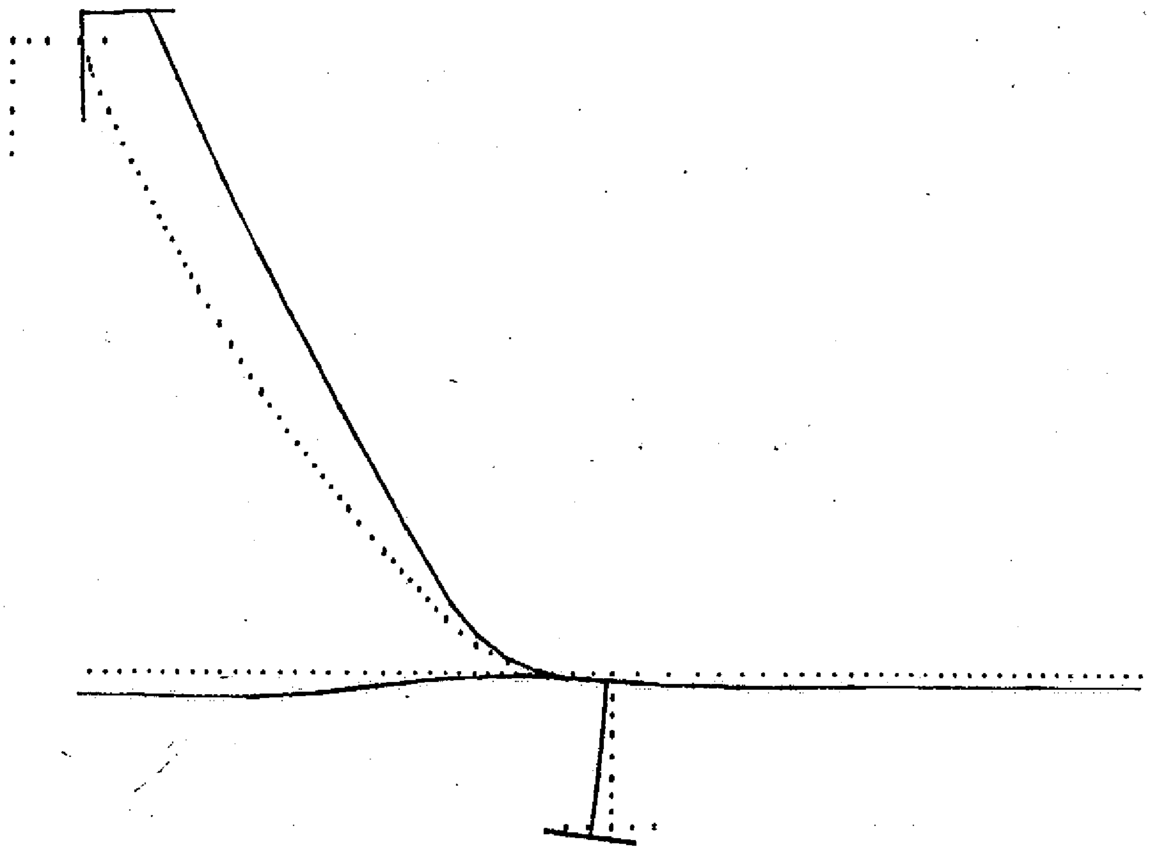


SPEC 2.1

NTF BULKHEAD
FLANGE SURFACE

0 21
SCALE

FIG 138

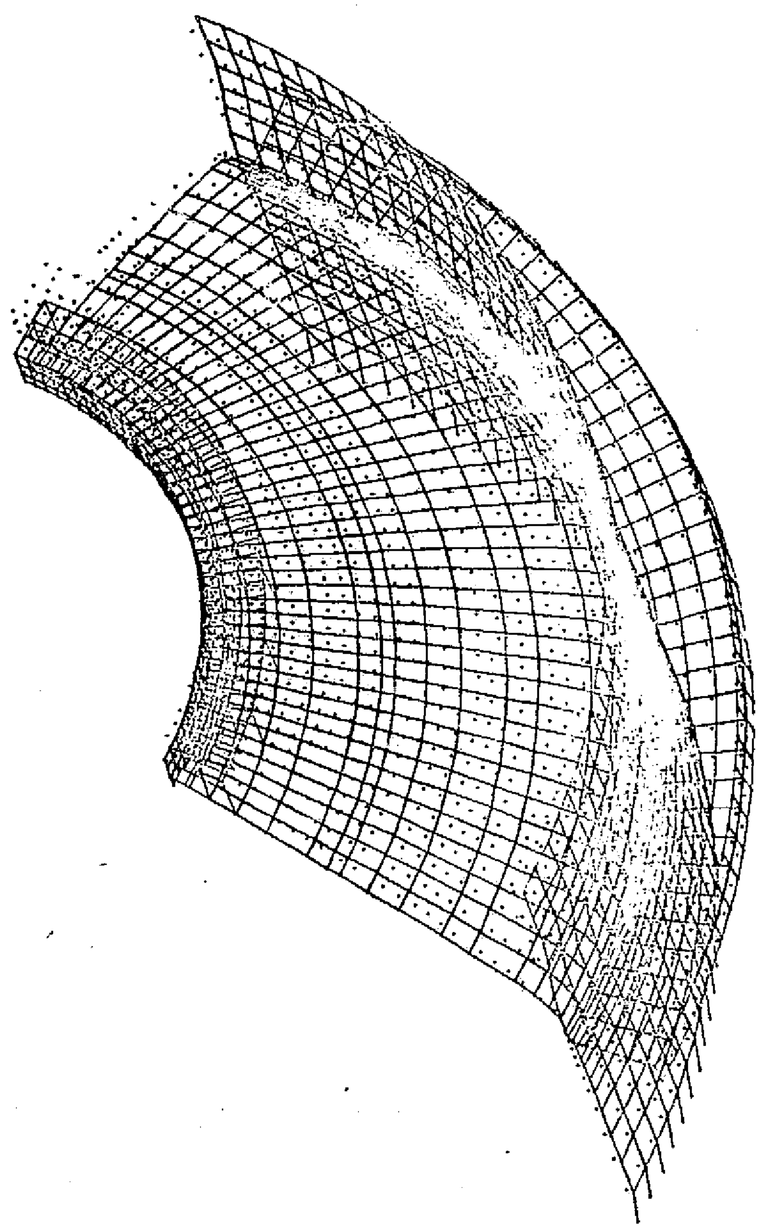


SPEC 12.1

NTF BULKHEAD
CROSS-SECTION VIEW

0 SCALE 27

FIG 139



SPEC
1.1

NTF BULKHEAD

0 SCALE 44

FIG 140

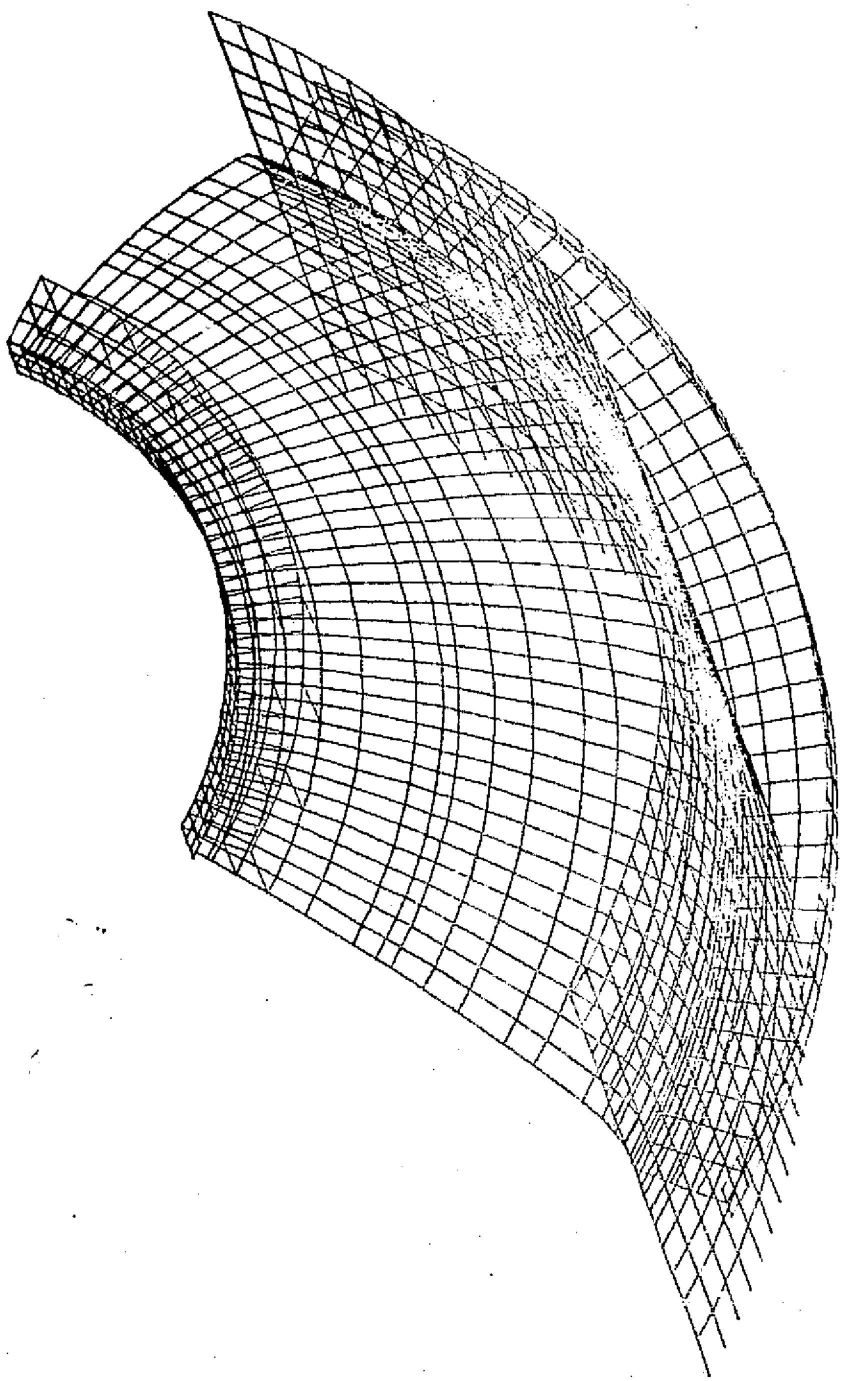
CASE 5

GATE VALVE CLOSED
W/ TRANSIENT TEMPERATURE
PROFILE, FOR HEAT UP TIME
OF 30 MIN.

STRESS PLOTS

FIGURES 141 THRU 167

COMPUTER RUN NO. AAK



SPEC NTF BULKHEAD
1.1 ..VALVE OPEN AND TEMP DIST

0 ——— 41
SCALE

FIG. 141

DISPLAY= SX /1000 , NODE= 1, SURFACE= 0

0	0	1	3	4	5	5	4	2	4	3	3	-5	-3	5	10	15	16
0	0	1	3	4	5	5	4	2	4	2	3	-5	-3	5	10	15	16
0	0	1	3	4	5	5	4	2	4	2	3	-5	-3	5	10	15	16
0	0	1	3	4	5	5	4	2	4	2	3	-5	-3	5	10	15	16
0	0	1	3	4	5	5	4	2	4	2	3	-5	-3	5	10	15	16
0	0	1	3	4	5	5	4	2	4	2	3	-5	-3	5	10	15	16
0	0	1	3	4	5	5	4	2	4	2	3	-5	-3	5	10	15	16
0	0	1	3	4	5	5	4	2	4	2	3	-5	-3	5	10	15	16
0	0	1	3	4	5	5	4	2	4	2	3	-5	-3	5	10	15	16
0	0	1	3	4	5	5	4	2	4	2	3	-5	-3	5	10	15	16
0	0	1	3	4	5	5	4	2	4	2	3	-5	-3	5	10	15	16
0	0	1	3	4	5	5	4	2	4	2	3	-5	-3	5	10	15	16
0	0	1	3	4	5	5	4	2	4	2	3	-5	-3	5	10	15	16
0	0	1	3	4	5	5	4	2	4	2	3	-5	-3	5	10	15	16
0	0	1	3	4	5	5	4	2	4	2	3	-5	-3	5	10	15	16
0	0	1	3	4	5	5	4	2	4	2	3	-5	-3	5	10	15	16
0	0	1	3	4	5	5	4	2	4	2	3	-5	-3	5	10	15	16
0	0	1	3	4	5	5	4	2	4	2	3	-5	-3	5	10	15	16
0	0	1	3	4	5	5	4	2	4	2	3	-5	-3	5	10	15	16
0	0	1	3	4	5	5	4	2	4	2	3	-5	-3	5	10	15	16
0	0	1	3	4	5	5	4	2	4	2	3	-5	-3	5	10	15	16
0	0	1	3	4	5	5	4	2	4	2	3	-5	-3	5	10	15	16
0	0	1	3	4	5	5	4	2	4	2	3	-5	-3	5	10	15	16
0	0	1	3	4	5	5	4	2	4	2	3	-5	-3	5	10	15	16
0	0	1	3	4	5	5	4	2	4	2	3	-5	-3	5	10	15	16
0	0	1	3	4	5	5	4	2	4	2	3	-5	-3	5	10	15	16
0	0	1	3	4	5	5	4	2	4	2	3	-5	-3	5	10	15	16
0	0	1	3	4	5	5	4	2	4	2	3	-5	-3	5	10	15	16
0	0	1	3	4	5	5	4	2	4	2	3	-5	-3	5	10	15	16
0	0	1	3	4	5	5	4	2	4	2	3	-5	-3	5	10	15	16
0	0	1	3	4	5	5	4	2	4	2	3	-5	-3	5	10	15	16
0	0	1	3	4	5	5	4	2	4	2	3	-5	-3	5	10	15	16
0	0	1	3	4	5	5	4	2	4	2	3	-5	-3	5	10	15	16
0	0	1	3	4	5	5	4	2	4	2	3	-5	-3	5	10	15	16
0	0	1	3	4	5	5	4	2	4	2	3	-5	-3	5	10	15	16
0	0	1	3	4	5	5	4	2	4	2	3	-5	-3	5	10	15	16
0	0	1	3	4	5	5	4	2	4	2	3	-5	-3	5	10	15	16
0	0	1	3	4	5	5	4	2	4	2	3	-5	-3	5	10	15	16
0	0	1	3	4	5	5	4	2	4	2	3	-5	-3	5	10	15	16
0	0	1	3	4	5	5	4	2	4	2	3	-5	-3	5	10	15	16

SPEC
5.1

NTF BULKHEAD
SHELL

0 ______ 36
SCALE

FIG 142

DISPLAY= SX /1000 , NODE= 1 , SURFPCE= 1

0	1	2	2	3	2	2	1	-2	9	2	10	-13	-8	4	12	16	17
0	1	2	2	3	2	2	1	-2	9	2	10	-13	-8	4	12	16	17
0	1	2	2	3	2	2	1	-2	9	2	10	-13	-8	4	12	16	17
0	1	2	2	3	2	2	1	-2	9	2	10	-13	-8	4	12	16	17
0	1	2	2	3	2	2	1	-2	9	2	10	-13	-8	4	12	16	17
0	1	2	2	3	2	2	1	-2	9	2	10	-13	-8	4	12	16	17
0	1	2	2	3	2	2	1	-2	9	2	10	-13	-8	4	12	16	17
0	1	2	2	3	2	2	1	-2	9	2	10	-13	-8	4	12	16	17
0	1	2	2	3	2	2	1	-2	9	2	10	-13	-8	4	12	16	17
0	1	2	2	3	2	2	1	-2	9	2	10	-13	-8	4	12	16	17
0	1	2	2	3	2	2	1	-2	9	2	10	-13	-8	4	12	16	17
0	1	2	2	3	2	2	1	-2	9	2	10	-13	-8	4	12	16	17
0	1	2	2	3	2	2	1	-2	9	2	10	-13	-8	4	12	16	17
0	1	2	2	3	2	2	1	-2	9	2	10	-13	-8	4	12	16	17
0	1	2	2	3	2	2	1	-2	9	2	10	-13	-8	4	12	16	17
0	1	2	2	3	2	2	1	-2	9	2	10	-13	-8	4	12	16	17
0	1	2	2	3	2	2	1	-2	9	2	10	-13	-8	4	12	16	17
0	1	2	2	3	2	2	1	-2	9	2	10	-13	-8	4	12	16	17
0	1	2	2	3	2	2	1	-2	9	2	10	-13	-8	4	12	16	17
0	1	2	2	3	2	2	1	-2	9	2	10	-13	-8	4	12	16	17
0	1	2	2	3	2	2	1	-2	9	2	10	-13	-8	4	12	16	17
0	1	2	2	3	2	2	1	-2	9	2	10	-13	-8	4	12	16	17
0	1	2	2	3	2	2	1	-2	9	2	10	-13	-8	4	12	16	17
0	1	2	2	3	2	2	1	-2	9	2	10	-13	-8	4	12	16	17
0	1	2	2	3	2	2	1	-2	9	2	10	-13	-8	4	12	16	17
0	1	2	2	3	2	2	1	-2	9	2	10	-13	-8	4	12	16	17
0	1	2	2	3	2	2	1	-2	9	2	10	-13	-8	4	12	16	17
0	1	2	2	3	2	2	1	-2	9	2	10	-13	-8	4	12	16	17
0	1	2	2	3	2	2	1	-2	9	2	10	-13	-8	4	12	16	17
0	1	2	2	3	2	2	1	-2	9	2	10	-13	-8	4	12	16	17
0	1	2	2	3	2	2	1	-2	9	2	10	-13	-8	4	12	16	17
0	1	2	2	3	2	2	1	-2	9	2	10	-13	-8	4	12	16	17
0	1	2	2	3	2	2	1	-2	9	2	10	-13	-8	4	12	16	17
0	1	2	2	3	2	2	1	-2	9	2	10	-13	-8	4	12	16	17
0	1	2	2	3	2	2	1	-2	9	2	10	-13	-8	4	12	16	17
0	1	2	2	3	2	2	1	-2	9	2	10	-13	-8	4	12	16	17
0	1	2	2	3	2	2	1	-2	9	2	10	-13	-8	4	12	16	17
0	1	2	2	3	2	2	1	-2	9	2	10	-13	-8	4	12	16	17
0	1	2	2	3	2	2	1	-2	9	2	10	-13	-8	4	12	16	17
0	1	2	2	3	2	2	1	-2	9	2	10	-13	-8	4	12	16	17

SPEC
5.1

NTF BULKHEAD
SHELL

0 36
SCALE

FIG 143

DISPLAY= SX /1000 , NODE= 1 , SURFACE= 2

1/1/1

0	0	1	3	5	8	8	7	7	8	6	15	3	2	6	8	13	16
0	0	1	3	5	8	8	7	7	8	6	15	3	2	6	8	13	16
0	0	1	3	5	8	8	7	7	8	6	15	3	2	6	8	13	16
0	0	1	3	5	8	8	7	7	8	6	15	3	2	6	8	13	16
0	0	1	3	5	8	8	7	7	8	6	15	3	2	6	8	13	16
0	0	1	3	5	8	8	7	7	8	6	15	3	2	6	8	13	16
0	0	1	3	5	8	8	7	7	8	6	15	3	2	6	6	13	16
0	0	1	3	5	8	8	7	7	8	6	15	3	2	6	8	13	16
0	0	1	3	5	8	8	7	7	8	6	15	3	2	6	8	13	16
0	0	1	3	5	8	8	7	7	8	6	15	3	2	6	8	13	16
0	0	1	3	5	8	8	7	7	8	6	15	3	2	6	8	13	16
0	0	1	3	5	8	8	7	7	8	6	15	3	2	6	8	13	16
0	0	1	3	5	8	8	7	7	8	6	15	3	2	6	8	13	16
0	0	1	3	5	8	8	7	7	8	6	15	3	2	6	8	13	16
0	0	1	3	5	8	8	7	7	8	6	15	3	2	6	8	13	16
0	0	1	3	5	8	8	7	7	8	6	15	3	2	6	8	13	16
0	0	1	3	5	8	8	7	7	8	6	15	3	2	6	8	13	16
0	0	1	3	5	8	8	7	7	8	6	15	3	2	6	8	13	16
0	0	1	3	5	8	8	7	7	8	6	15	3	2	6	6	13	16
0	0	1	3	5	8	8	7	7	8	6	15	3	2	6	8	13	16
0	0	1	3	5	8	8	7	7	8	6	15	3	2	6	8	13	16
0	0	1	3	5	8	8	7	7	6	6	15	3	2	6	8	13	16
0	0	1	3	5	8	8	7	7	8	6	15	3	2	6	8	13	16
0	0	1	3	5	8	8	7	7	8	5	15	3	2	6	8	13	16
0	0	1	3	5	8	8	7	7	8	6	15	3	2	6	8	13	16
0	0	1	3	5	8	8	7	7	8	6	15	3	2	6	8	13	16
0	0	1	3	5	8	8	7	7	8	6	15	3	2	6	8	13	16
0	0	1	3	5	8	8	7	7	8	5	15	3	2	6	8	13	16
0	0	1	3	5	8	8	7	7	8	6	15	3	2	6	8	13	16
0	0	1	3	5	8	8	7	7	8	6	15	3	2	6	6	13	16
0	0	1	3	5	8	8	7	7	6	6	15	3	2	6	8	13	16
0	0	1	3	5	8	8	7	7	8	6	15	3	2	6	8	13	16
0	0	1	3	5	8	8	7	7	8	5	15	3	2	3	8	13	16
0	0	1	3	5	8	8	7	7	8	6	15	3	2	6	6	13	16
0	0	1	3	5	8	8	7	7	8	5	15	3	2	6	8	13	16
0	0	1	3	5	8	8	7	7	8	6	15	3	2	6	8	13	16
0	0	1	3	5	8	8	7	7	8	6	15	3	2	6	8	13	16
0	0	1	3	5	8	8	7	7	8	6	15	3	2	6	8	13	16
0	0	1	3	5	8	8	7	7	8	6	15	3	2	6	8	13	16
0	0	1	3	5	8	8	7	7	8	6	15	3	2	6	6	13	16

SPEC 5.1

NTF BULKHEAD SHELL

0 — 36 SCALE

FIG 144

DISPLAY= SY /1000 , NODE= 1 , SURFACE= 0

0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8
0	0	0	0	0	0	0	0	0	0	0	3	3	5	8	8	8	8

SPEC 5.1

NTF BULKHEAD SHELL

0 ______ 36
SCALE

FIG 145

DISPLAY= SY /1000 , NODE= 1 , SURFACE= 1

0	1	1	-1	-4	-10	14	14	-6	-4	438	-22	-11	5	13	13	9
0	1	1	-1	-4	-10	14	14	-6	-4	438	-22	-11	5	13	13	9
0	1	1	-1	-4	-10	14	14	-6	-4	438	-22	-11	5	13	13	9
0	1	1	-1	-4	-10	14	14	-6	-4	438	-22	-11	5	13	13	9
0	1	1	-1	-4	-10	14	14	-6	-4	438	-22	-11	5	13	13	9
0	1	1	-1	-4	-10	14	14	-6	-4	438	-22	-11	5	13	13	9
0	1	1	-1	-4	-10	14	14	-6	-4	438	-22	-11	5	13	13	9
0	1	1	-1	-4	-10	14	14	-6	-4	438	-22	-11	5	13	13	9
0	1	1	-1	-4	-10	14	14	-6	-4	438	-22	-11	5	13	13	9
0	1	1	-1	-4	-10	14	14	-6	-4	438	-22	-11	5	13	13	9
0	1	1	-1	-4	-10	14	14	-6	-4	438	-22	-11	5	13	13	9
0	1	1	-1	-4	-10	14	14	-6	-4	438	-22	-11	5	13	13	9
0	1	1	-1	-4	-10	14	14	-6	-4	438	-22	-11	5	13	13	9
0	1	1	-1	-4	-10	14	14	-6	-4	438	-22	-11	5	13	13	9
0	1	1	-1	-4	-10	14	14	-6	-4	438	-22	-11	5	13	13	9
0	1	1	-1	-4	-10	14	14	-6	-4	438	-22	-11	5	13	13	9
0	1	1	-1	-4	-10	14	14	-6	-4	438	-22	-11	5	13	13	9
0	1	1	-1	-4	-10	14	14	-6	-4	438	-22	-11	5	13	13	9
0	1	1	-1	-4	-10	14	14	-6	-4	438	-22	-11	5	13	13	9
0	1	1	-1	-4	-10	14	14	-6	-4	438	-22	-11	5	13	13	9
0	1	1	-1	-4	-10	14	14	-6	-4	438	-22	-11	5	13	13	9
0	1	1	-1	-4	-10	14	14	-6	-4	438	-22	-11	5	13	13	9
0	1	1	-1	-4	-10	14	14	-6	-4	438	-22	-11	5	13	13	9
0	1	1	-1	-4	-10	14	14	-6	-4	438	-22	-11	5	13	13	9
0	1	1	-1	-4	-10	14	14	-6	-4	438	-22	-11	5	13	13	9
0	1	1	-1	-4	-10	14	14	-6	-4	438	-22	-11	5	13	13	9
0	1	1	-1	-4	-10	14	14	-6	-4	438	-22	-11	5	13	13	9
0	1	1	-1	-4	-10	14	14	-4	-4	438	-22	-11	5	13	13	9
0	1	1	-1	-4	-10	14	14	-6	-4	438	-22	-11	5	13	13	9
0	1	1	-1	-4	-10	14	14	-6	-4	438	-22	-11	5	13	13	9
0	1	1	-1	-4	-10	14	14	-6	-4	438	-22	-11	5	13	13	9
0	1	1	-1	-4	-10	14	14	-6	-4	438	-22	-11	5	13	13	9
0	1	1	-1	-4	-10	14	14	-6	-4	438	-22	-11	5	13	13	9
0	1	1	-1	-4	-10	14	14	-6	-4	438	-22	-11	5	13	13	9
0	1	1	-1	-4	-10	14	14	-6	-4	438	-22	-11	5	13	13	9
0	1	1	-1	-4	-10	14	14	-6	-4	438	-22	-11	5	13	13	9
0	1	1	-1	-4	-10	14	14	-6	-4	438	-22	-11	5	13	13	9
0	1	1	-1	-4	-10	14	14	-6	-4	438	-22	-11	5	13	13	9
0	1	1	-1	-4	-10	14	14	-6	-4	438	-22	-11	5	13	13	9
0	1	1	-1	-4	-10	14	14	-6	-4	438	-22	-11	5	13	13	9

SPEC 5.1

NTF BULKHEAD SHELL

0 36
SCALE

FIG 146

DISPLAY= SY /1000 , NODE= 1 , SURFACE= 2

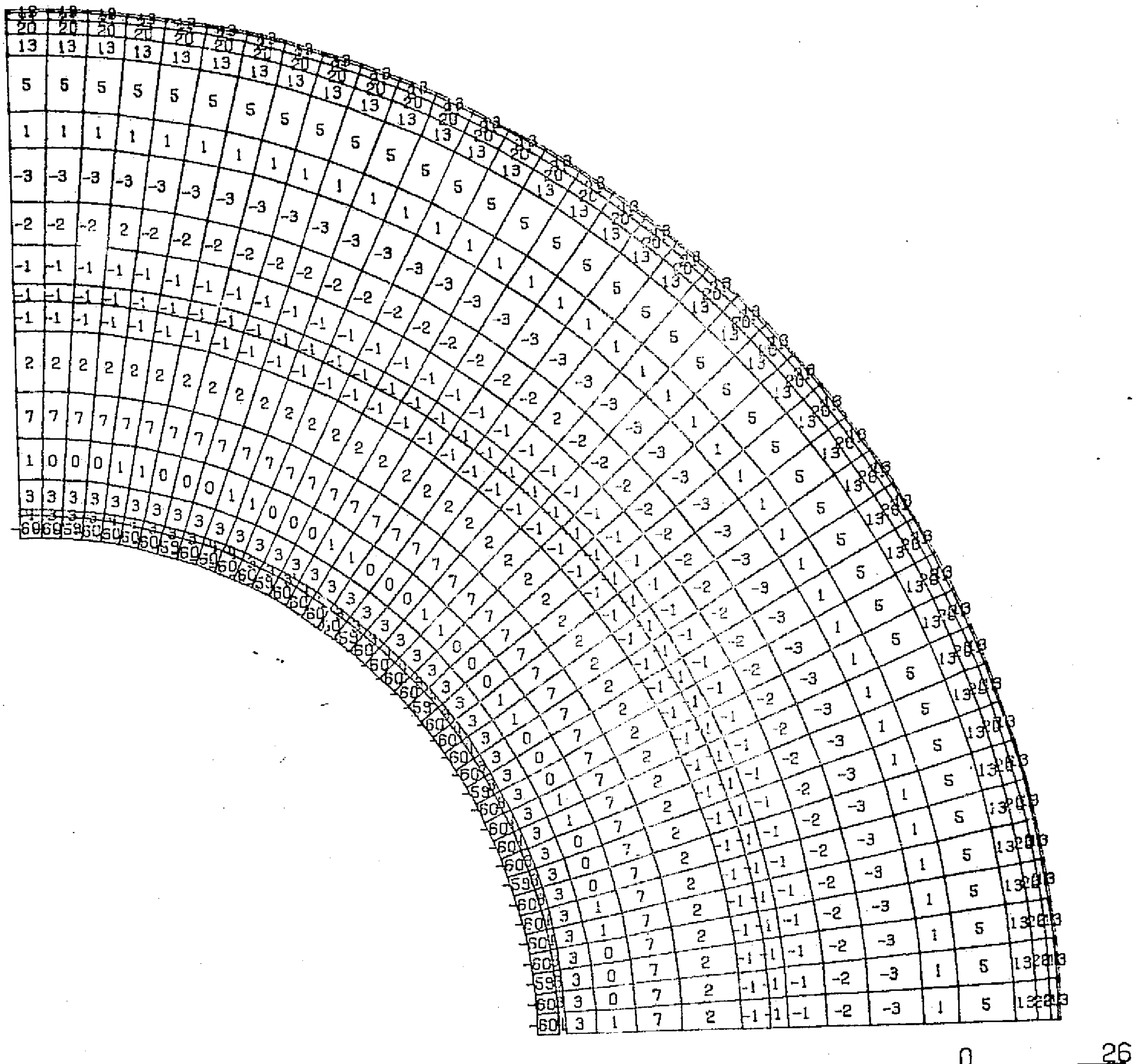
0	-1	-1	1	4	10	10	11	5	4	445	29	20	10	2	2	7
0	-1	-1	1	4	10	10	11	5	4	445	29	20	10	2	2	7
0	-1	-1	1	4	10	10	11	5	4	445	29	20	10	2	2	7
0	-1	-1	1	4	10	10	11	5	4	445	23	20	10	2	2	7
0	-1	-1	1	4	10	10	11	5	4	445	29	20	10	2	2	7
0	-1	-1	1	4	10	10	11	5	4	445	29	20	10	2	2	7
0	-1	-1	1	4	10	10	11	5	4	445	29	20	10	2	2	7
0	-1	-1	1	4	10	10	11	5	4	445	29	20	10	2	2	7
0	-1	-1	1	4	10	10	11	5	4	445	29	20	10	2	2	7
0	-1	-1	1	4	10	10	11	5	4	445	29	20	10	2	2	7
0	-1	-1	1	4	10	10	11	5	4	445	29	20	10	2	2	7
0	-1	-1	1	4	10	10	11	5	4	445	29	20	10	2	2	7
0	-1	-1	1	4	10	10	11	5	4	445	29	20	10	2	2	7
0	-1	-1	1	4	10	10	11	5	4	445	29	20	10	2	2	7
0	-1	-1	1	4	10	10	11	5	4	445	29	20	10	2	2	7
0	-1	-1	1	4	10	10	11	5	4	445	29	20	10	2	2	7
0	-1	-1	1	4	10	10	11	5	4	445	29	20	10	2	2	7
0	-1	-1	1	4	10	10	11	5	4	445	29	20	10	2	2	7
0	-1	-1	1	4	10	10	11	5	4	445	29	20	10	2	2	7
0	-1	-1	1	4	10	10	1	5	4	445	29	20	10	2	2	7
0	-1	-1	1	4	10	10	11	5	4	445	29	20	10	2	2	7
0	-1	-1	1	4	10	10	11	5	4	445	29	20	10	2	2	7
0	-1	-1	1	4	10	10	11	5	4	445	29	20	10	2	2	7
0	-1	-1	1	4	10	10	11	5	4	445	29	20	10	2	2	7
0	-1	-1	1	4	10	10	11	5	4	445	29	20	10	2	2	7
0	-1	-1	1	4	10	10	11	5	4	445	25	23	10	2	2	7
0	-1	-1	1	4	10	10	11	5	4	445	25	20	10	2	2	7
0	-1	-1	1	4	10	10	11	5	4	445	25	20	10	2	2	7
0	-1	-1	1	4	10	10	11	5	4	445	29	20	10	2	2	7
0	-1	-1	1	4	10	10	11	5	4	445	29	20	10	2	2	7
0	-1	-1	1	4	10	10	11	5	4	445	29	20	10	2	2	7
0	-1	-1	1	4	10	10	11	5	4	445	29	20	10	2	2	7
0	-1	-1	1	4	10	10	11	5	4	445	29	20	10	2	2	7
0	-1	-1	1	4	10	10	11	5	4	445	29	20	10	2	2	7
0	-1	-1	1	4	10	10	11	5	4	445	29	20	10	2	2	7
0	-1	-1	1	4	10	10	11	5	4	445	29	20	10	2	2	7
0	-1	-1	1	4	10	10	11	5	4	445	29	20	10	2	2	7
0	-1	-1	1	4	10	10	11	5	4	445	29	20	10	2	2	7
0	-1	-1	1	4	10	10	11	5	4	445	29	20	10	2	2	7
0	-1	-1	1	4	10	10	11	5	4	445	29	20	10	2	2	7

SPEC 5.1 NTF BULKHEAD SHELL

0 36 SCALE

FIG 147

DISPLAY= SX /1000 , NODE= 1 , SURFACE= 0

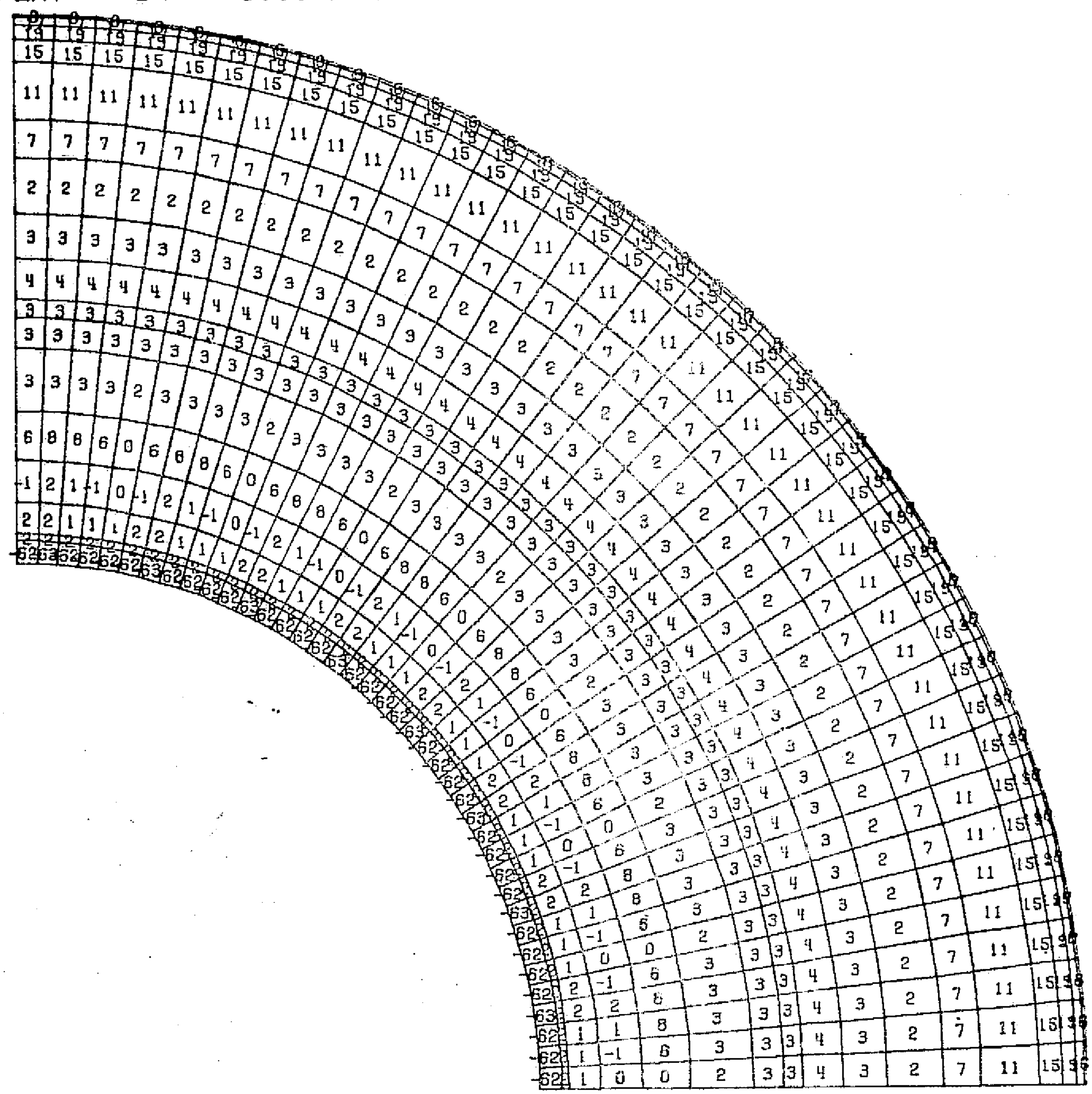


SPEC 3.1

NTF BULKHEAD DOME

FIG 148

DISPLAY= SX /1000 , NODE= 1, SURFACE= 1



SPEC 3.1

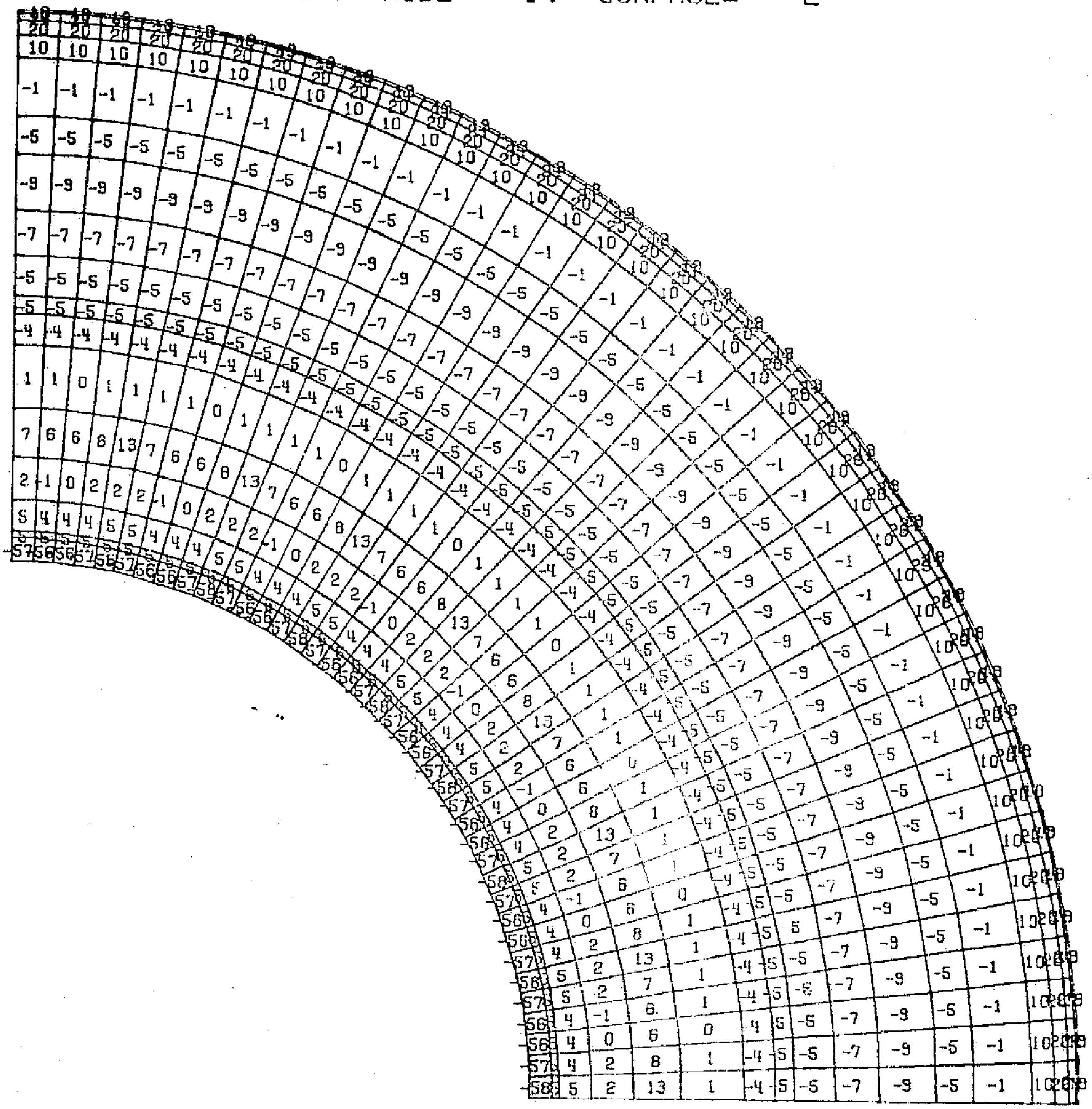
NTF BULKHEAD DOME

0 26 SCALE

FIG 149

DISPLAY= SX /1000 , NODE= 1, SURFACE= 2

1/1/1



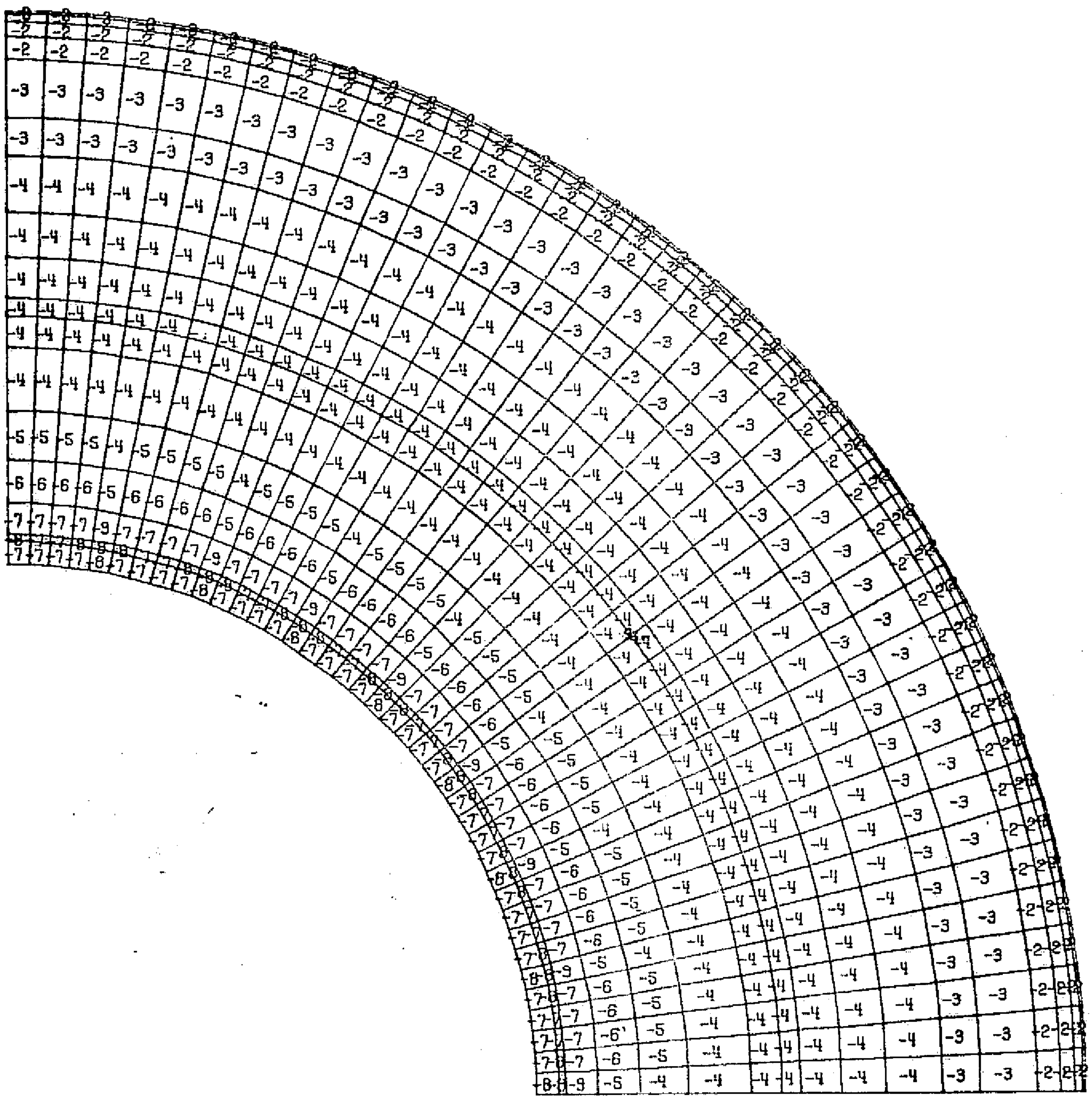
SPEC 3.1

NTF BULKHEAD DOME

0 26 SCALE

FIG 150

DISPLAY= SY /1000 , NODE= 1 , SURFACE= 0



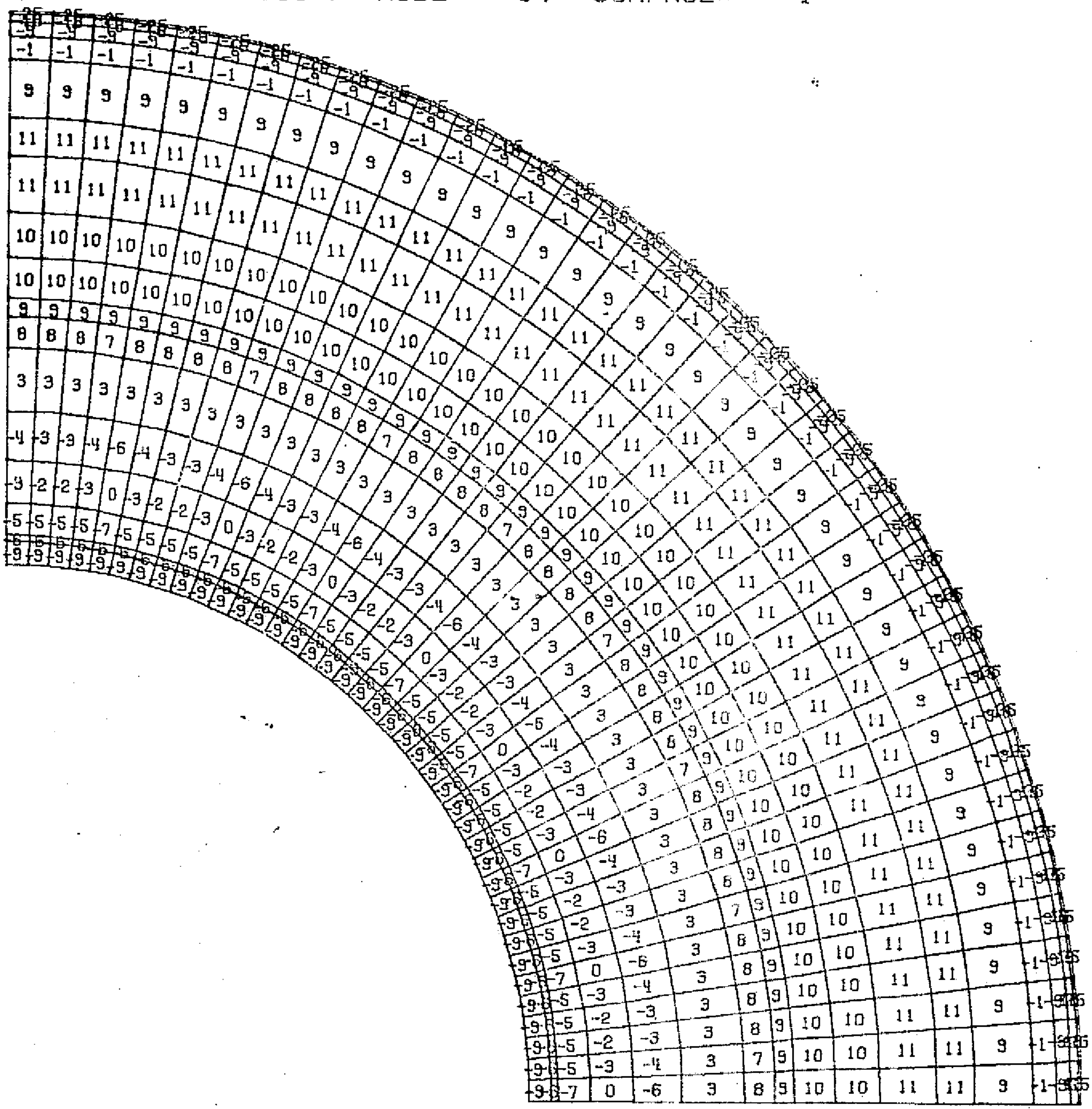
SPEC 3.1

NTF BULKHEAD DOME

0 26 SCALE

FIG 151

DISPLAY= SY /1000 , NODE= 1, SURFACE= 1

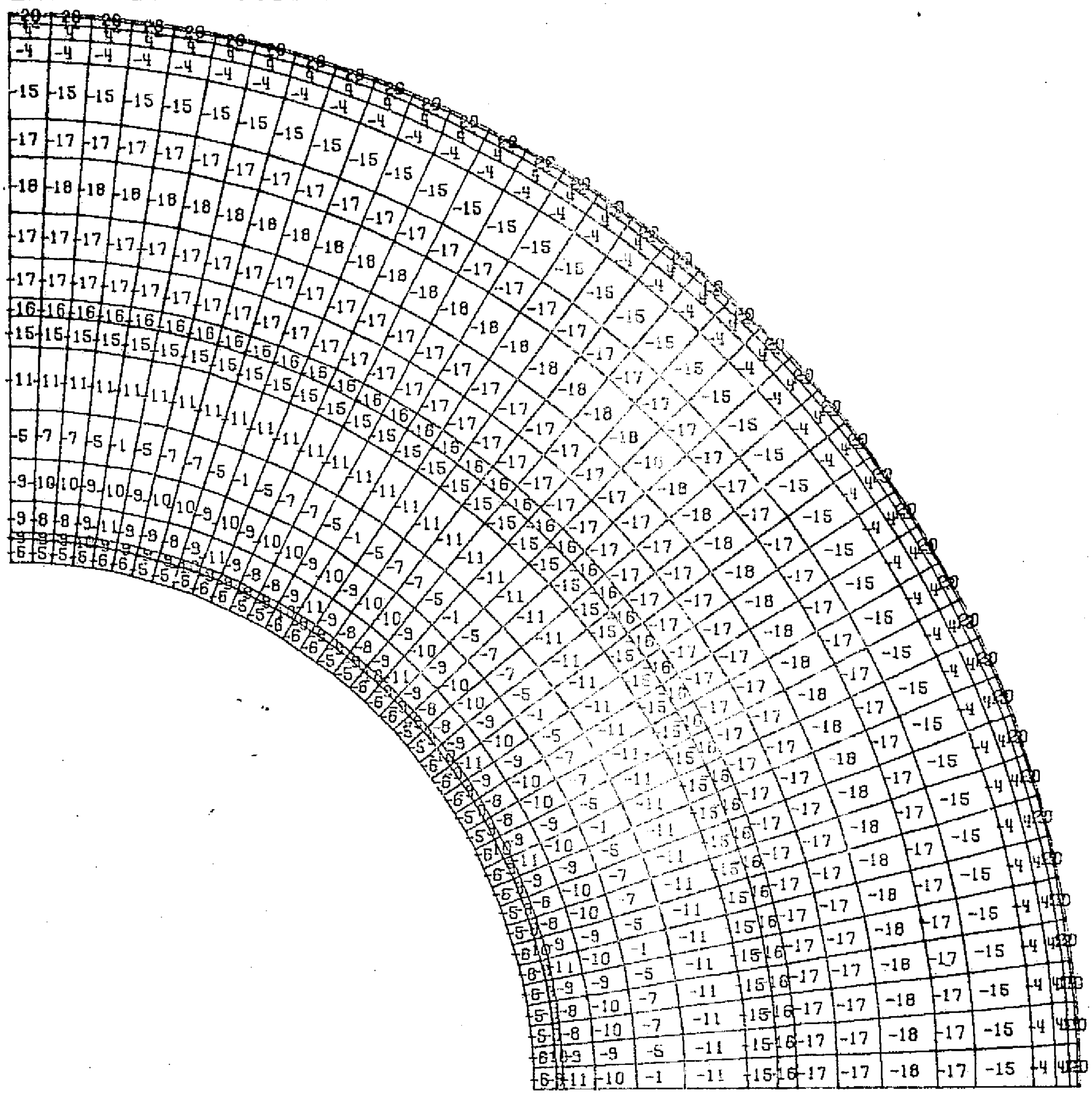


SPEC 3.1 NTF BULKHEAD DOME

0 26 SCALE

FIG 152

DISPLAY= SY /1000 , NODE= 1, SURFACE= 2



SPEC 3.1

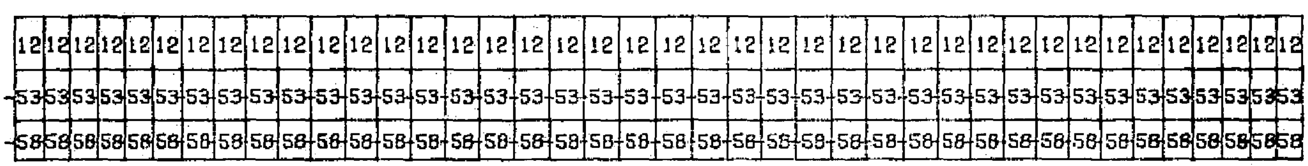
NTF BULKHEAD DOME

0 26
SCALE

FIG 153

1/1/1

DISPLAY= SX /1000 , NODE= 1 , SURFACE= 0



SPEC
10.1

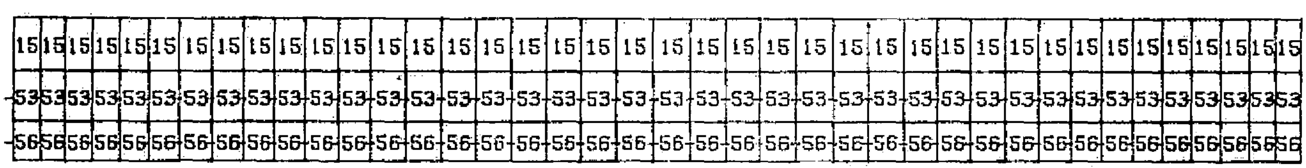
NTF BULKHEAD
HATCH OPENING

0 18
SCALE

FIG 154

1/1/1

DISPLAY= SX /1000 , NODE= 1 , SURFACE= 1

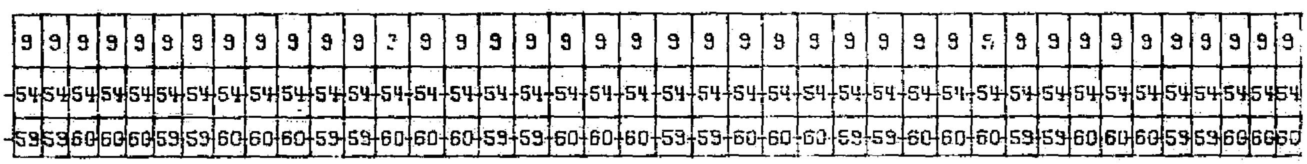


SPEC 10.1 NTF BULKHEAD
HATCH OPENING

0 18
SCALE

FIG 155

DISPLAY= SX /1000 , NODE= 1, SURFACE= 2



SPEC 10.1

NTF BULKHEAD
HATCH OPENING

0 18
SCALE

FIG 156

DISPLAY= SY /1000 , NODE= 1 , SURFACE= 0

-3	-2	-2	-2	-2	-3	-2	-2	-2	-2	-3	-2	-2	-2	-2	-3	-2	-2	-2	-2	-3	-2	-2	-2	-2	-3	-2	-2	-2	-2	-3	-2	-2	-2	-2	-3	-2	-2	-2	-2
-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
0	0	-1	-1	0	0	0	-1	-1	0	0	0	-1	-1	0	0	0	-1	-1	0	0	0	-1	-1	0	0	0	-1	-1	0	0	0	-1	-1	0	0	0	-1	-1	0

SPEC 10.1

NTF BULKHEAD
HATCH OPENING

0 — 18
SCALE

FIG 157

DISPLAY= SY /1000 , NODE= 1 , SURFACE= 1

9	9	8	8	8	9	9	8	8	8	9	9	8	8	8	9	9	8	8	8
-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
5	5	4	5	6	5	5	4	5	6	5	5	4	5	6	[illegible]	5	4	5	6

9	9	8	8	8	9	9	8	8	8	9	9	8	8	8	9	9	8	8	8
-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
5	5	4	5	6	5	5	4	5	6	5	5	4	5	6	5	5	4	5	6

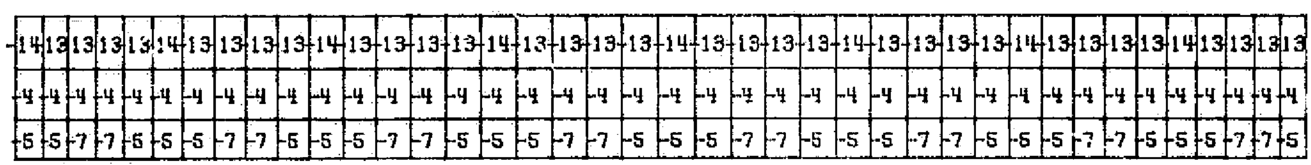
SPEC
10.1

NTF BULKHEAD
HATCH OPENING

0 18
SCALE

FIG 158

DISPLAY= SY /1000 , NODE= 1 , SURFACE= 2



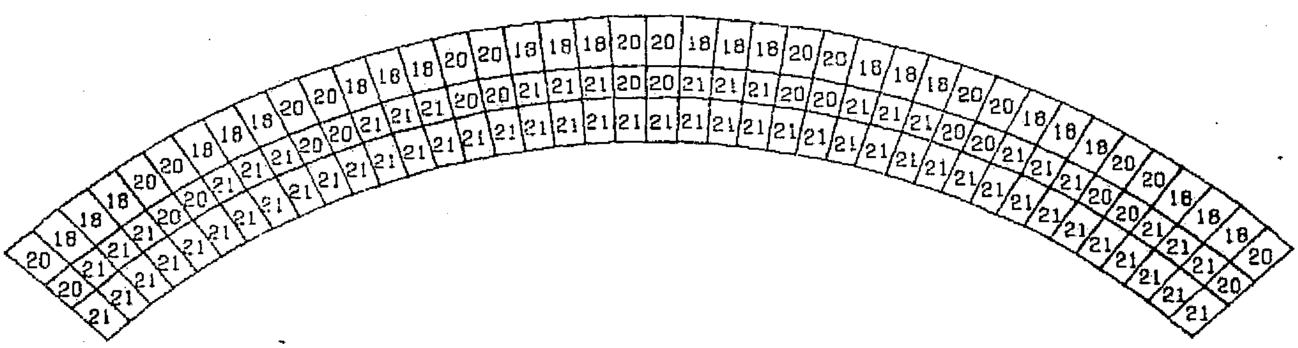
SPEC 10.1

NTF BULKHEAD
HATCH OPENING

0 18
SCALE

FIG 159

DISPLAY= SX /1000 , NODE= 1 , SURFACE= 0



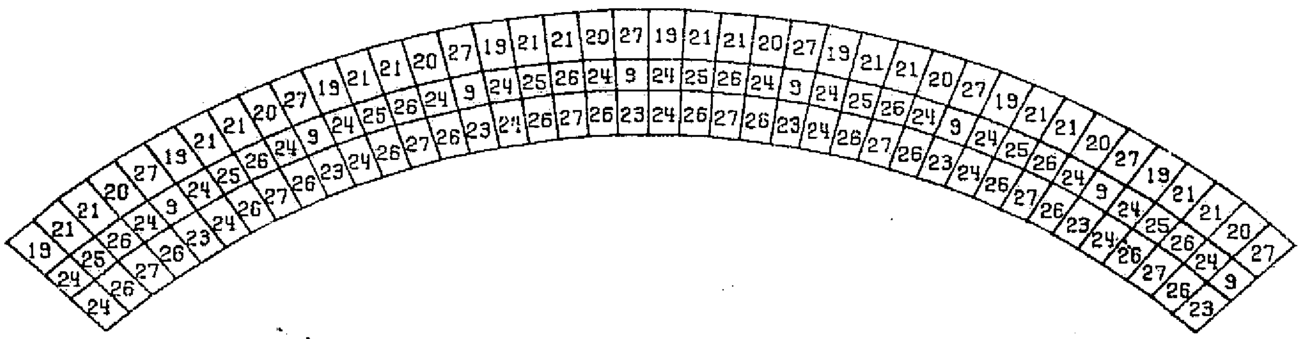
SPEC 2.1

NTF BULKHEAD
FLANGE SURFACE

0 21
SCALE

FIG 160

DISPLAY= SX /1000 , NODE= 1 , SURFACE= 1



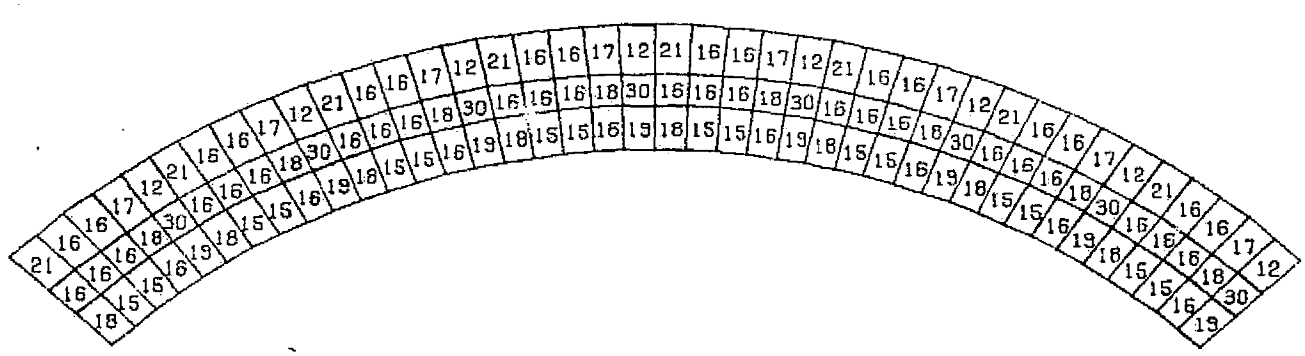
SPEC
2.1

NTF BULKHEAD
FLANGE SURFACE

0 ______ 21
SCALE

FIG 261

DISPLAY= SX /1000 , NODE= 1 , SURFACE= 2



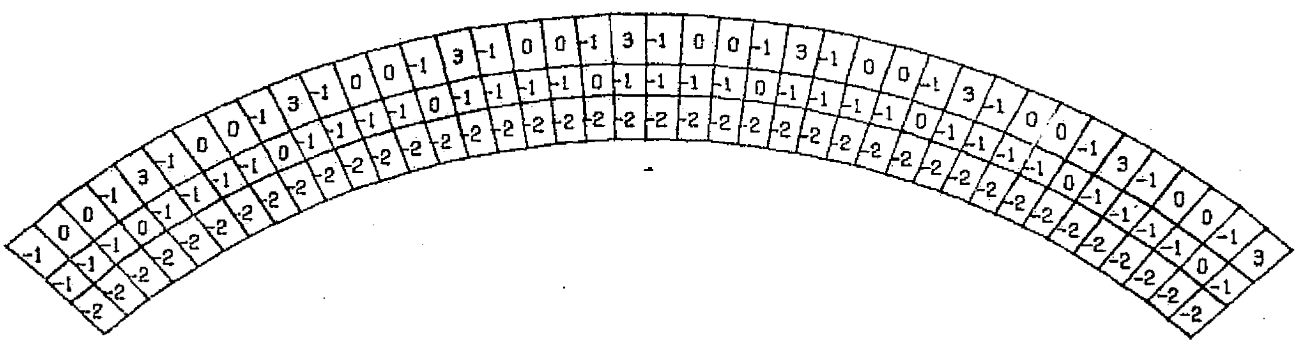
SPEC 2.1

NTF BULKHEAD
FLANGE SURFACE

0 21
SCALE

FIG 162

DISPLAY= SY /1000 , NODE= 1, SURFACE= 0



ORIGINAL PAGE IS
OF POOR QUALITY

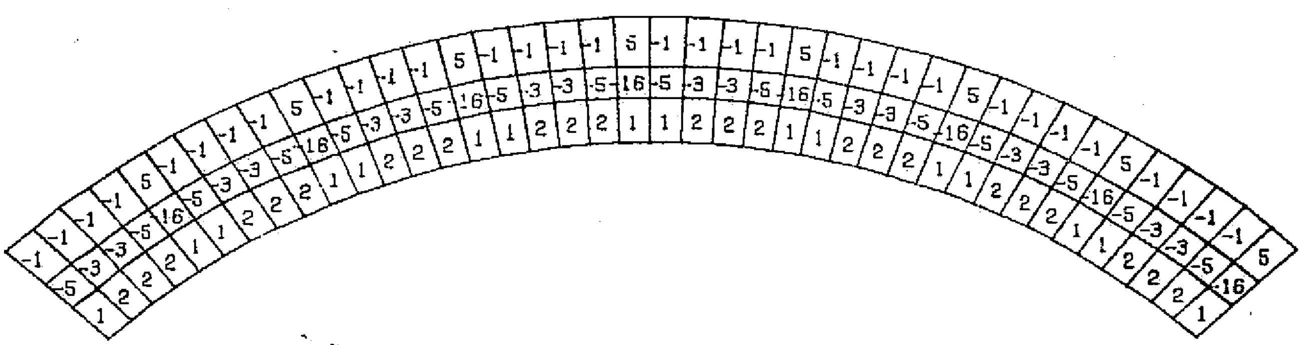
SPEC 2.1 NTF BULKHEAD FLANGE SURFACE

0 ______ 21
SCALE

FIG. 163

1/1/1

DISPLAY= SY /1000 , NODE= 1 , SURFACE= 1



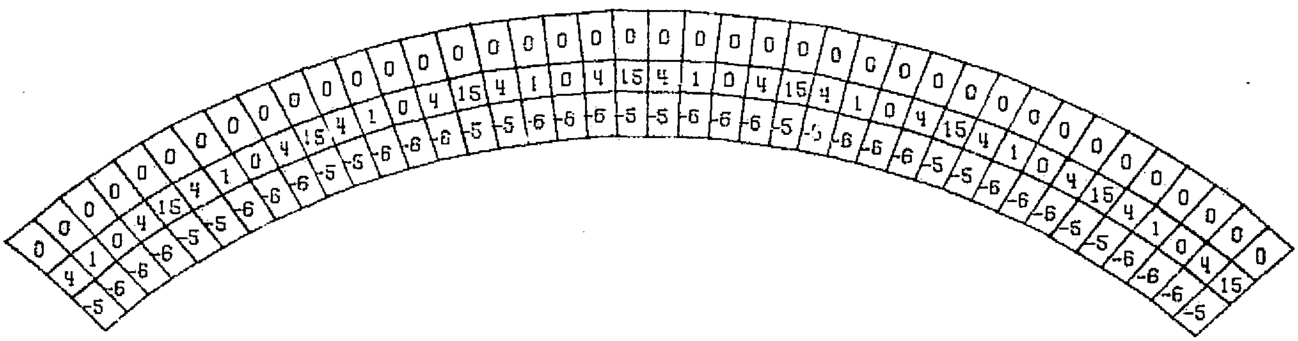
SPEC
2.1

NTF BULKHEAD
FLANGE SURFACE

0 21
SCALE

FIG 1.64

DISPLAY= SY /1000 , NODE= 1 , SURFACE= 2

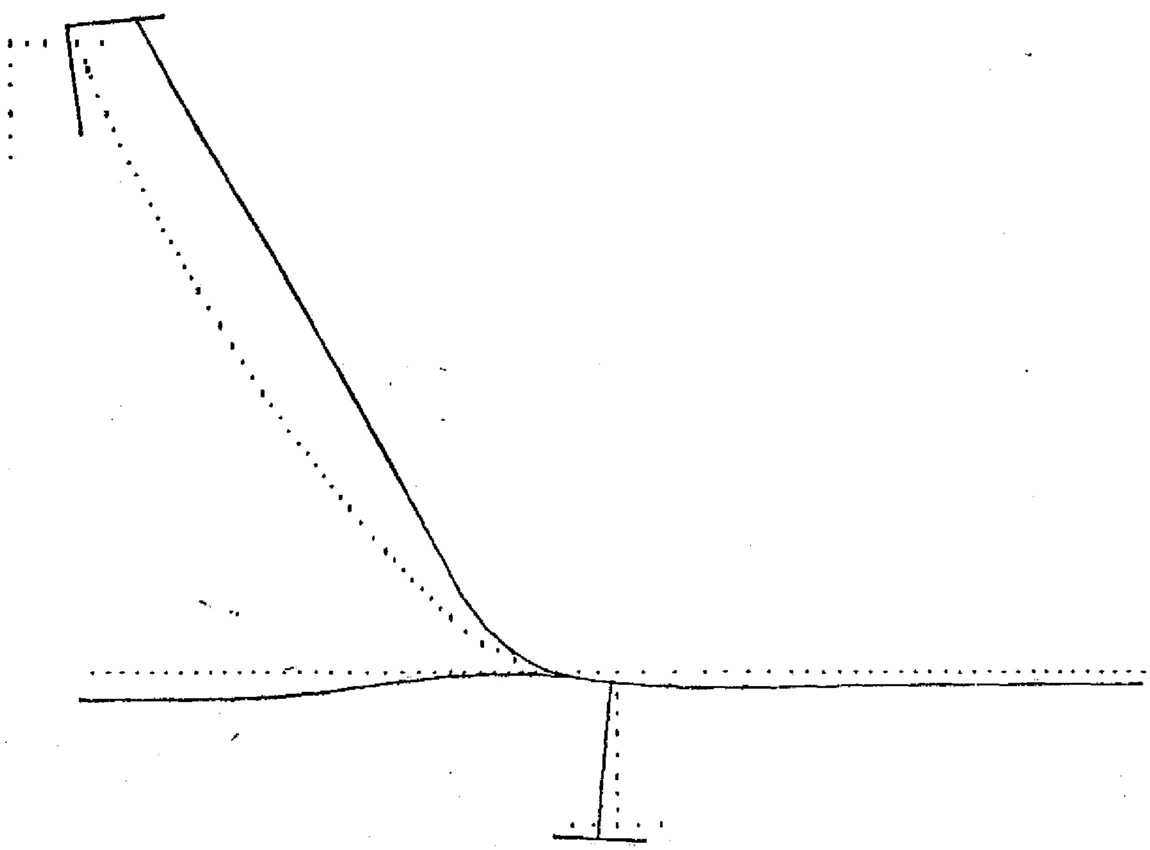


SPEC 2-1

NTF BULKHEAD
FLANGE SURFACE

0 21
SCALE

FIG 165

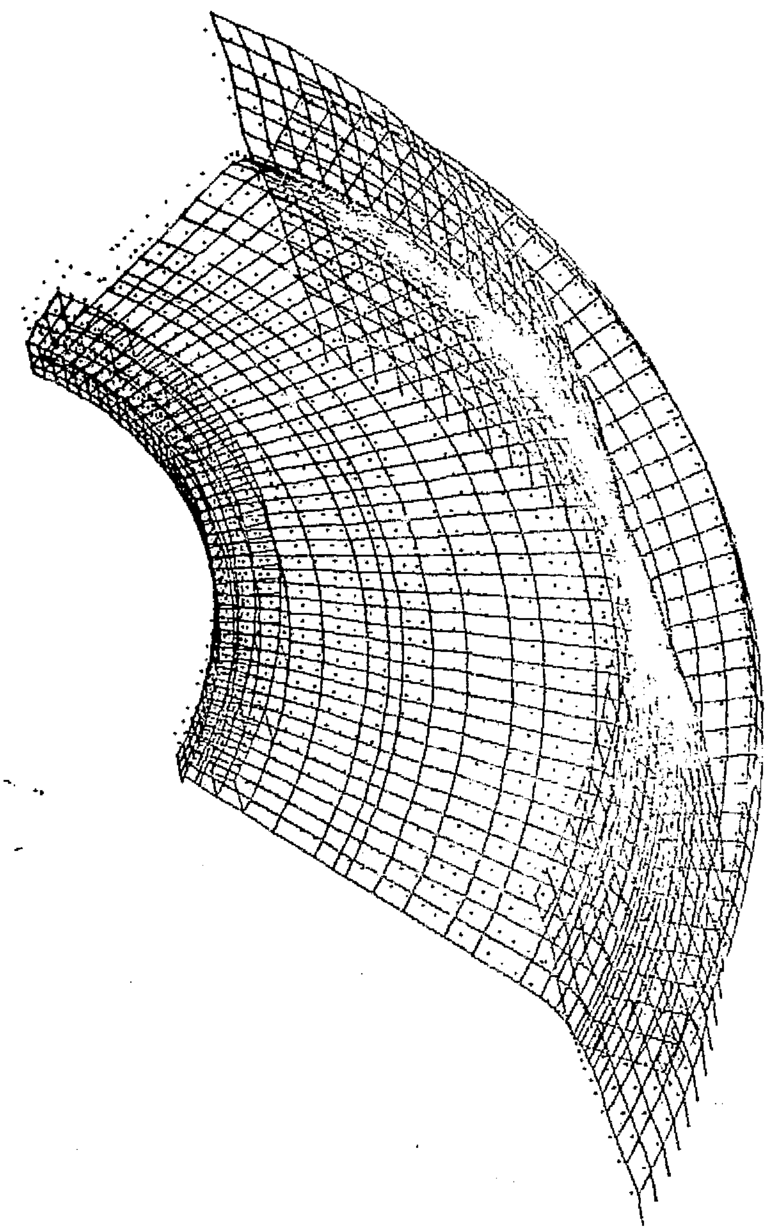


SPEC
12.1

NTF BULKHEAD
CROSS-SECTION VIEW

0 27
SCALE

FIG 166



SPEC 1.1 NTF BULKHEAD ..VALVE OPEN AND TEMP DIST

0 SCALE 44

FIG 167

S4 & S5 Ring Analysis

Asymmetric Ring Loads

MAT'L 304 SS

NTF 54 & 55 RING ANALYSIS

(304 S.S)

BY	DATE	SUBJECT	SHEET NO. 90 OF
CHKD. BY	DATE		JOB NO.

DESCRIPTION

Stresses in subject Ring have been calculated based on external loads supplied by A/E. These stresses have been superimposed on pressure stresses from a finite element model. The resulting combined stresses for both hydro and normal opperations are considered, and the stress evaluation follows. The ring as presently designed meets both the stress criteria and AISC Code.

INRING

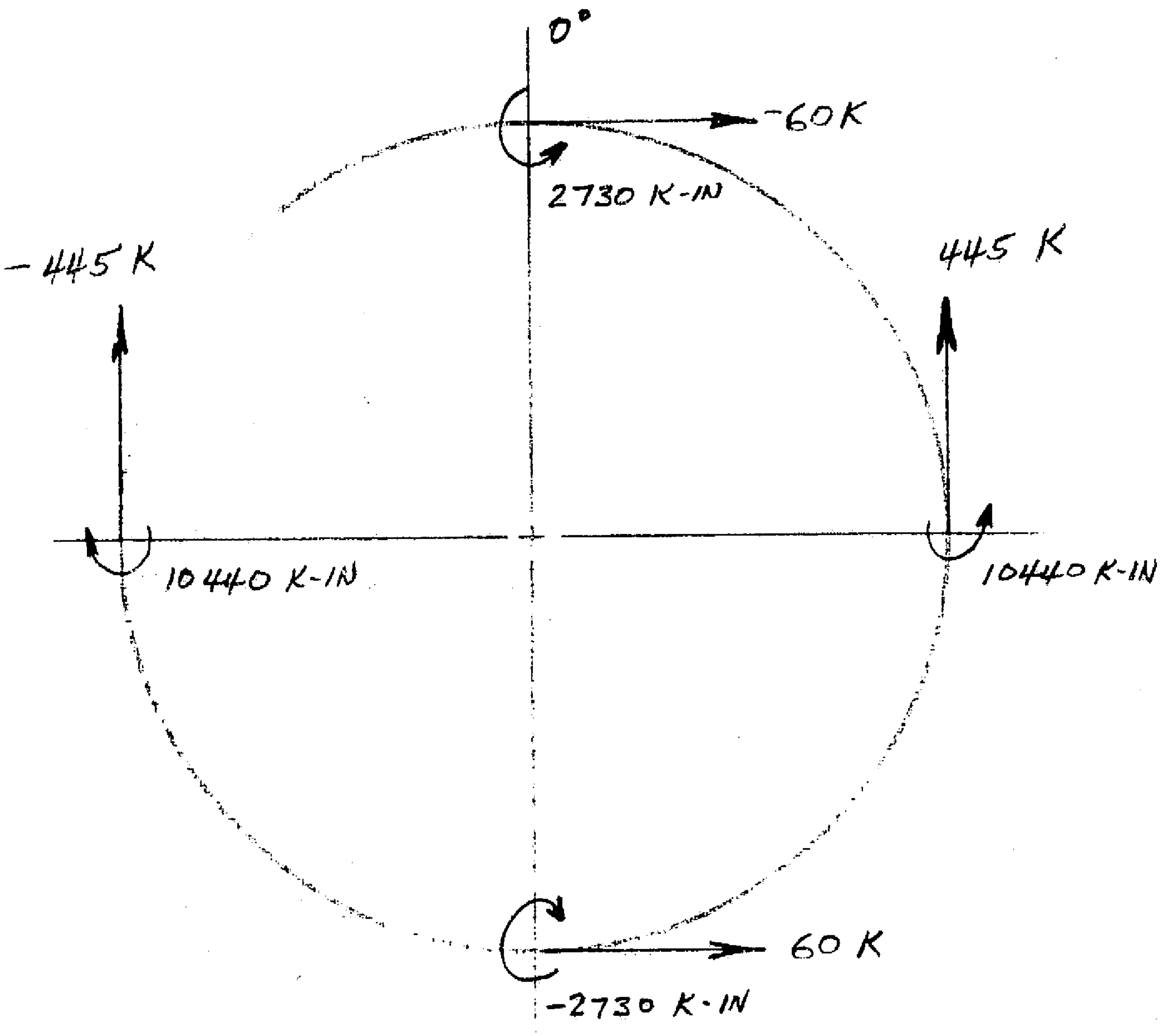
is a time-shared computer program which performs a structural analysis of circular rings subject to loading in the plane of the ring.

SPAR

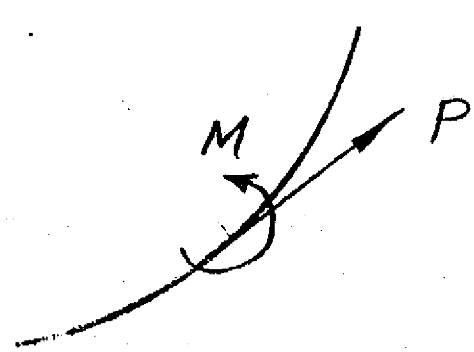
is a finite element computer code used to calculate pressure stresses from a full pressure cycle on a bulkhead computer model.

BY ______ DATE ______	SUBJECT ______	SHEET NO. 92 OF ______
CHKD. BY ______ DATE ______		JOB NO. ______

COMPUTER MODEL FOR OPERATING CASE

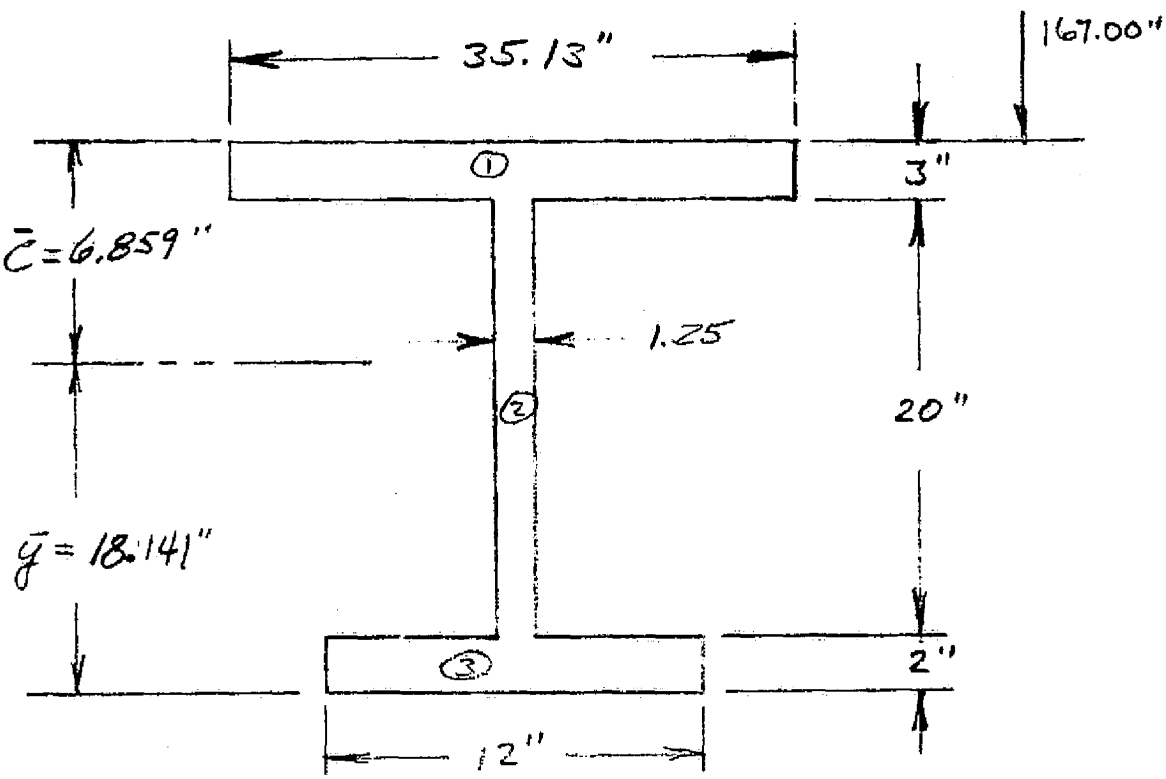


SIGN CONVENTION



RING DESIGN FOR 304 S. STEEL

RING DETAILS



$D_o = 28'-4"$

$t = 3"$

$1.1\sqrt{D_o t} = 1.1\left[(340)(3")\right]^{\frac{1}{2}} = (31.94)(1.1) = 35.13"$

WEIGHT OF STEEL AT RING SUPPORT

735 K

WEIGHT OF WATER & STEEL = **1846 K**

OTHER LOADS, SIMILAR TO ROOKER'S

CROSS SECTIONAL AREA

$$A = A_1 + A_2 + A_3$$

$$A = (35.13)(3) + (1.25)(20) + (12)(2)$$

$$A = 105.4 + 25 + 24$$

$$\boxed{A = 154.4 \text{ IN}^2}$$

CENT. LOCATION

$$\bar{y} = \frac{\Sigma A y}{\Sigma A}$$

$$\bar{y} = \frac{[A_1 d_1 + A_2 d_2 + A_3 d_3]}{A_1 + A_2 + A_3}$$

$$\bar{y} = \frac{(105.4)(23.5) + (25)(12) + (24)(1)}{154.4}$$

$$\boxed{\bar{y} = 18.141''}$$

$$\bar{C} = 25.00 - 18.141''$$

$$\boxed{\bar{C} = 6.859 \text{ IN.}}$$

MOMENT OF INERTIA

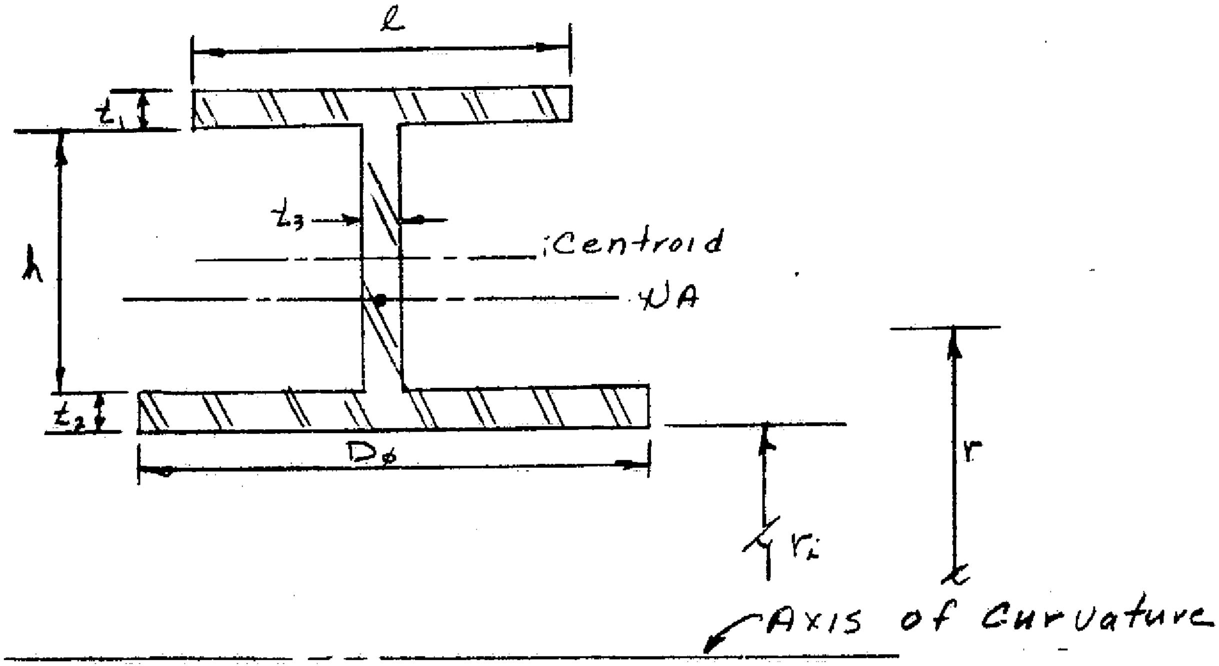
$$\bar{I} = \Sigma (I_i + A_i d_i^2)$$

$$\bar{I} = \left(\tfrac{1}{12}\right)(35.13)(3)^3 + \left(\tfrac{1}{12}\right)(1.25)(20)^3 + \tfrac{1}{12}(12)(2)^3 + (105.4)(5.359)^2 + (25)(6.141)^2 + (24)(17.141)^2$$

$$\bar{I} = 79.04 + 833.33 + 8 + 3026.97 + 942.80 + 7051.53$$

$$\boxed{\bar{I} = 11941.7 \text{ IN}^4}$$

BENDING OF CURVED BEAMS



Bending Stresses for a curved beam is given by:

$$\sigma_\theta = \frac{M\,(R - r)}{r A (\bar{r} - R)}$$

M = moment

r = stress point

$\bar{r}$ = centroid

$R = \dfrac{A}{\int_A \frac{dA}{r}}$

A = AREA

R, for a "Tee"

$$R = \frac{t_1 l + h t_3 + D_o t_2}{\int_{r_i}^{r_i+t_2} \frac{D_o\,dr}{r} + \int_{r_i+t_2}^{r_i+t_2+h} \frac{t_3\,dr}{r} + \int_{r_i+t_2+h}^{r_i+t_2+h+t_1} \frac{l\,dr}{r}} =$$

$$R = \frac{t_1 l + h t_3 + D_o t_2}{D_o \ln\left(\frac{r_i+t_2}{r_i}\right) + t_3 \ln\left(\frac{r_i+t_2+h}{r_i+t_2}\right) + l \ln\left(\frac{r_i+t_2+h+t_1}{r_i+t_2+h}\right)}$$

GEOMETRICAL & MATERIAL PROPERTIES

$D_o = 35.13''$

$t_1 = 2.00''$

$t_2 = 3.00''$

$t_3 = 1.25''$

$\ell = 12.00''$

$r_i = 167.00''$

$\bar{r} = 173.86''$

$h = 20.00''$

$I = 119467 \text{ IN}^4$

$E = 20 \times 10^6 \text{ psi}$

$\rho = .283 \text{ \#/IN}^3$

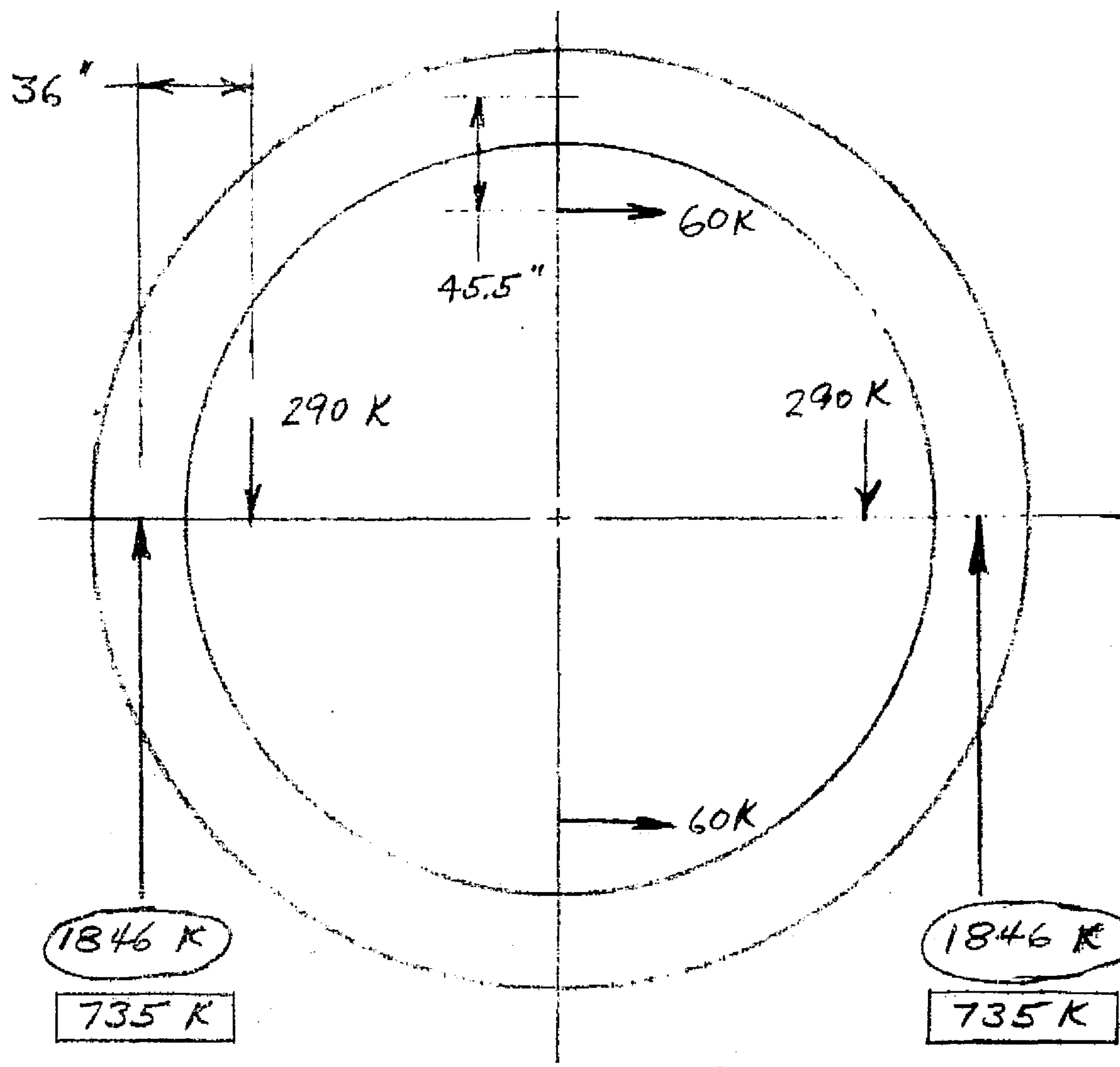
$A = 154.4 \text{ IN}^2$

NEUTRAL AXIS LOCATION

$$R = \frac{2 \times 12 + 20 \times 1.25 + 35.13 \times 3.00}{35.13 \ln\left(\frac{167 + 3.00}{167}\right) + 1.25 \ln\left(\frac{167 + 3 + 20}{167 + 3}\right) + 12 \ln\left(\frac{167 + 3 + 20 + 2}{167 + 3 + 20}\right)}$$

$R = 173.451''$ Neutral Axis

LOAD CONDITIONS



WEIGHT OF 304 S. STEEL

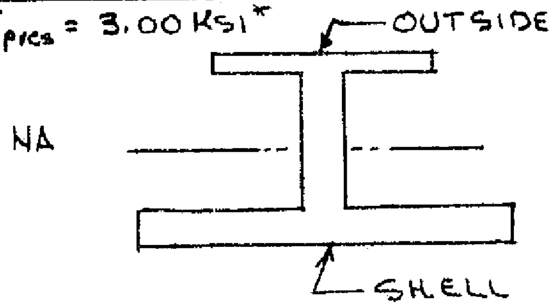
$$W_s = 735 - 290 = \boxed{445\ K}$$

WEIGHT OF WATER DURING HYDRO.

$$W_w = 1846 - 735 = \boxed{1111\ K}$$

STRESS SUMMARY (OPPERATING)

σ_{pres} = 3.00 KSI*



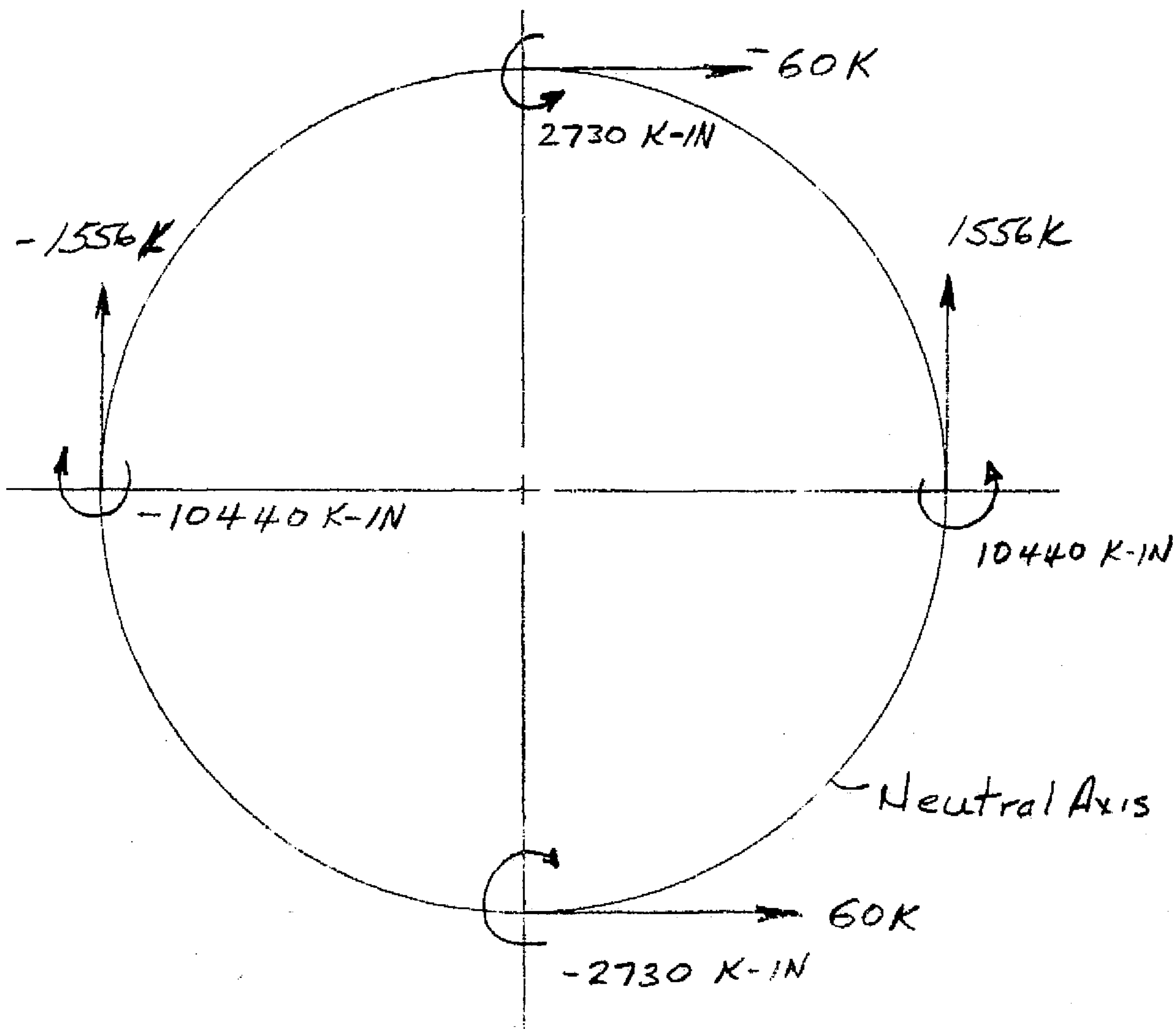
σ_{pres} = 5.38 KSI *

* from spar computer analysis

Location	OUTSIDE (KSI) Axial	Bending	Comb	Comb w/press.	Shell (KSI) Bending	Combined	Combined w/Press	Peak
0	4.05	-2.57	-2.16	0.84	1.02	1.43	6.81	
0	.02	1.61	1.63	4.63	-.64	-.63	4.75	
30	-.10	1.64	1.53	4.53	-.65	-.76	4.62	
60	.65	.07	-.58	2.42	-.03	-.68	4.7	
90	-1.3	-8.91	-10.23	-7.23	3.56	2.25	7.63	
90	1.57	7.06	8.62	11.62	-2.82	-1.25	4.13	
120	.80	.60	1.40	4.40	-.24	.56	5.94	
150	.0	.75	.75	3.76	-.3	-.3	5.09	
180	-.40	2.57	2.16	5.16	-1.03	-1.43	3.95	
180	-.02	-1.61	-1.63	1.37	.64	.627	6.01	
210	.11	-1.64	-1.53	1.47	.66	.76	6.14	
240	.65	-.07	.58	3.58	.03	.68	6.57	
270	1.31	8.9	10.23	13.23	-3.57	-2.25	3.13	13.23
270	-1.57	-7.06	-8.62	-5.62	2.82	1.25	6.63	
300	-.804	.60	-.21	2.79	-.24	-1.04	4.33	
330	-.009	-75.0	-84.03	2.916	.030	.021	5.40	
360	.404	-2.57	-2.16	.84	1.05	1.43	6.81	

BY ____ DATE ____ SUBJECT ____ SHEET NO. 100 OF ____
CHKD. BY ____ DATE ____ JOB NO. ____
304

COMPUTER MODEL FOR HYDROSTATIC CASE



GEOMETRICAL + MATERIAL PROPERTIES

$R = 173.85$ IN to NA

$A = 154.4$ IN^2

$c = 18.55$ IN

$I = 11941.7$ IN^4

$E = 28 \times 10^6$ psi

$\rho = .283$ #/IN^3

BY__________ DATE________ SUBJECT______________________ SHEET NO. 101 OF______
CHKD. BY______ DATE________ JOB NO.______________

HYDROSTATIC PRESSURE STRESS

OPERATING PRESSURE STRESSES:

5.38 KSI on shell
3.00 KSI outside fiber

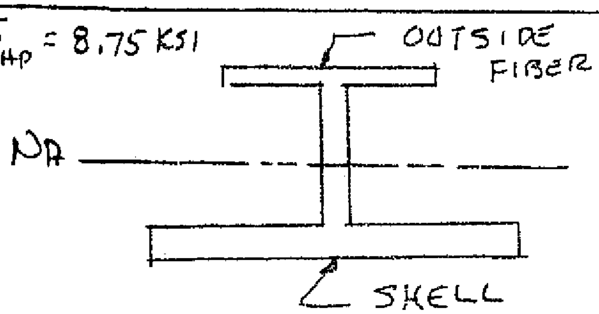
$$P_H = 1.5 \times 119 + \frac{62.4}{144}\left(\frac{41}{2} + \frac{28}{2}\right) = 193.45 \text{ PSI}$$

Stress scale factor $\frac{193.45}{119} = 1.626$

$1.626 \times 5.38 = 8.75$ KSI, on shell
$1.626 \times 3.00 = 4.88$ KSI, out side fiber

Stress Summary (Hydro)

$\sigma_{HP} = 8.75$ KSI



$\sigma_{HP} = 4.880$ KSI

	OUTSIDE FIBER (KSI)				SHELL (KSI)		
Location	Axial	Bending	Combined	Combined w/pressure	Bending	Combined	Combined w/pressure
0	1.670	-18.000	-16.352	-11.472	7.206	8.876	17.626
0	1.281	-13.845	-12.564	-7.684	5.536	6.536	15.567
30	1.290	-13.995	-12.706	-7.826	5.596	6.885	15.635
60	0.451	5.985	6.436	11.316	-2.393	-1.942	6.808
90	-1.986	13.363	11.377	16.257	-5.343	-7.336	1.426
90	-4.788	-1.928	-6.716	-1.836	0.771	-4.017	4.733
120	5.290	-1.929	3.360	8.240	0.771	6.061	14.811
150	2.356	-14.531	-12.174	-7.294	5.810	8.166	16.916
180	-.425	-.511	-.936	3.944	.204	-.220	8.530
180	-1.670	10.213	8.544	13.424	-4.084	-5.753	2.997
210	-1.281	6.037	4.756	9.636	-2.414	-3.695	5.055
240	-0.451	2.179	1.727	6.607	-.871	-1.322	7.428
270	4.788	-10.091	14.879	19.759	-4.035	0.753	9.503
270	-5.290	-5.879	-11.169	-6.289	2.351	-2.939	5.811
300	-2.688	6.722	4.366	9.246	-2.688	-5.044	3.706
330	0.425	-7.297	-6.873	-1.993	2.918	3.343	12.093
360	1.670	-18.000	-16.352	-11.472	7.206	8.876	17.626

Stress Evaluation

Hydrostatic Test condition design consideration.

at $\theta = 0°$

$S_1 = 5.38$ KSI (INSIDE FIBER)

$S_2 = 8.876$

$S_1 + S_2 = 14.256$ KSI $\leq .8\,\sigma_{yd}$ (weld) = 24 ok

$S_{2f} = 19.759$ KSI (OUTSIDE FIBER)

$S_{2f} \leq .9\,\sigma_{yf}$ (weld) = 27 KSI

$19.759 < 27.0$ KSI ok.

This support Ring (54 AND/OR 55) meet the stress evaluation Hydrostatic Test criteria.

ASME code

$F_B \leq 2/3\,F_y = 2/3\,(30) = 20$ KSI

at $\theta = 270°$ $F_B = 19.759$ (OUTSIDE FIBER)

$19.759 < 20$ KSI ok

SHD