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**NASA TECHNICAL
MEMORANDUM**

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NASA TM X- 73956-3

(NASA-TM-X-73956-3) LaRC DESIGN ANALYSIS
REPORT FOR NATIONAL TRANSONIC FACILITY FOR
9% NICKEL TUNNEL SHELL. VOLUME 3: FINITE
ELEMENT ANALYSIS OF PLENUM REGION INCLUDING
SIDE ACCESS REINFORCEMENT, SIDE ACCESS DOOR

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LaRC DESIGN ANALYSIS REPORT
FOR
NATIONAL TRANSONIC FACILITY
FOR
9% NICKEL TUNNEL SHELL

FINITE ELEMENT ANALYSIS OF PLENUM REGION INCLUDING SIDE ACCESS
REINFORCEMENT, SIDE ACCESS DOOR AND ANGLE OF ATTACK PENETRATION

VOL. 3

BY

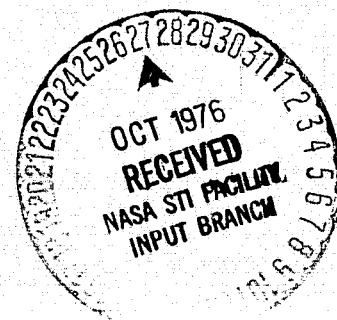
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16. Abstract This report contains the results of extensive computer (finite element, finite difference and numerical integration), thermal, fatigue, and special analyses of critical portions of a large pressurized, cryogenic wind tunnel (National Transonic 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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NTF TUNNEL SHELL

NASA LARC

FINITE ELEMENT ANALYSIS
OF
PLENUM REGION INCLUDING
SIDE ACCESS REINFORCEMENT,
SIDE ACCESS DOOR AND ANGLE OF
ATTACK PENETRATION

9% Ni

SEPTEMBER 1976

VOLUME 3

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 (9% Ni), Vol. 1, NASA TM X73956-1.
 2. Finite Element Analysis of Corners #3 and #4 (9% Ni), Vol. 2, NASA TM X73956-2.
 3. Finite Element Analysis of Plenum Region Including Side Access Reinforcement, Side Access Door and Angle of Attack Penetration (9% Ni), Vol. 3, NASA TM X73956-3.
 4. Thermal Analysis (9% Ni), Vol. 4, NASA TM X73956-4.
 5. Finite Element and Numerical Integration Analyses of the Bulkhead Region (9% Ni), Vol. 5, NASA TM X73956-5.
 6. Fatigue Analysis (9% Ni), Vol. 6, NASA TM X73956-6.
 7. Special Studies (9% Ni), Vol. 7, NASA TM X73956-7.
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NTF DESIGN CRITERIA
FOR 9% NICKEL

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-553-1 FOR PLATE AND SA-522 FOR FORGINGS. THE MATERIAL PROPERTIES AT TEMPERATURES EQUAL TO OR BELOW 150°F ARE AS FOLLOWS:

- (A) PLATE, 2.0 INCHES OR THINNER

YIELD = 85.0 KSI
ULTIMATE = 100 KSI

- (B) WELDS (AUTOMATIC AND SEMIAUTOMATIC)

YIELD = 52.5 KSI
ULTIMATE = 95.0 KSI

- (C) WELDS (HAND)

YIELD = 58.5 KSI
ULTIMATE = 95.0 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. 110.5 (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. 110.5 (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

$$\begin{aligned} PH_1 &= 1.5 (119) + \text{HYDROSTATIC HEAD} \\ &= 178.5 \text{ PSI} + \text{HYDROSTATIC HEAD} \end{aligned}$$

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

$$\begin{aligned} PH_2 &= 1.5 (119) + \text{HYDROSTATIC HEAD} \\ &= 178.5 + \text{HYDROSTATIC HEAD} \end{aligned}$$

$$\begin{aligned} PH_2^* &= 1.5 (111.5) \left(\frac{23.7}{22.2} \right) + \text{HYDROSTATIC HEAD} \\ &= 178.5 + \text{HYDROSTATIC HEAD} \end{aligned}$$

*TUNNEL OPERATION LIMITATIONS PRECLUDE PRESSURE DIFFERENTIALS ACROSS BULKHEADS IN EXCESS OF 110.5 PSI FOR BULKHEAD AND GATE TEMPERATURES IN EXCESS OF 150°F.

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

$$PH_3 = 1.5 (25) = 37.5 \text{ PSI}$$

THE PRESSURE SHELL EXCEPT FOR THE PLENUM SHALL BE PRESSURIZED TO 141 PSIG. THE PLENUM SHALL BE PRESSURIZED TO 178.5 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)

$$S = 23.7 \text{ KSI } (-320^{\circ}\text{F TO } +150^{\circ}\text{F})$$

$$S = 22.2 \text{ KSI } (-320^{\circ}\text{F TO } +200^{\circ}\text{F})$$

(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

$$S = 23.7 \text{ KSI } (-320^{\circ}\text{F TO } +150^{\circ}\text{F})$$

$$S = 22.2 \text{ KSI } (-320^{\circ}\text{F TO } +200^{\circ}\text{F})$$

MAXIMUM ALLOWABLE STRESS INTENSITY

$$S_m = 31.7 \text{ KSI } (-320^{\circ}\text{F TO } +200^{\circ}\text{F})$$

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

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

F. COMMENT

BECAUSE OF THE LOW YIELD STRENGTH EXPECTED AT THE WELDS AS COMPARED TO THE YIELD STRENGTH OF THE PLATE, STRESS INTENSITIES COMPUTED IN (A), (B), (C), (D), OR (E) SHALL NOT EXCEED THE YIELD STRENGTH OF THE MATERIAL AT EITHER WELD OR PLATE LOCATIONS.

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 THE FOLLOWING CRITERIA WAS USED:

(a) THE MAXIMUM GENERAL MEMBRANE STRESS PERPENDICULAR TO A WELD LINE WAS LIMITED TO THE LESSER OF:

$$P_m * \leq 0.8 \text{ WELD YIELD STRESS}$$

OR

$$P_m * \leq 0.5 \text{ WELD ULTIMATE STRESS}$$

(b) THE GENERAL PRINCIPAL MEMBRANE STRESS IN THE PLATE (NOT AT A WELD) WAS LIMITED TO THE LESSER OF:

$$P_m * \leq 0.8 \text{ PLATE YIELD STRESS}$$

$$P_m * \leq 0.5 \text{ PLATE ULTIMATE STRESS}$$

(*) THE STRESSES SATISFYING THIS CRITERIA ARE BASED ON MAXIMUM MEMBRANE STRESSES RATHER THAN INTENSITY CRITERIA.

Vol. 3

Finite Element Analyses of Plenum
 Region Including the Side Access
 Reinforcement, Side Access Door
 and Angle of Attack Penetration

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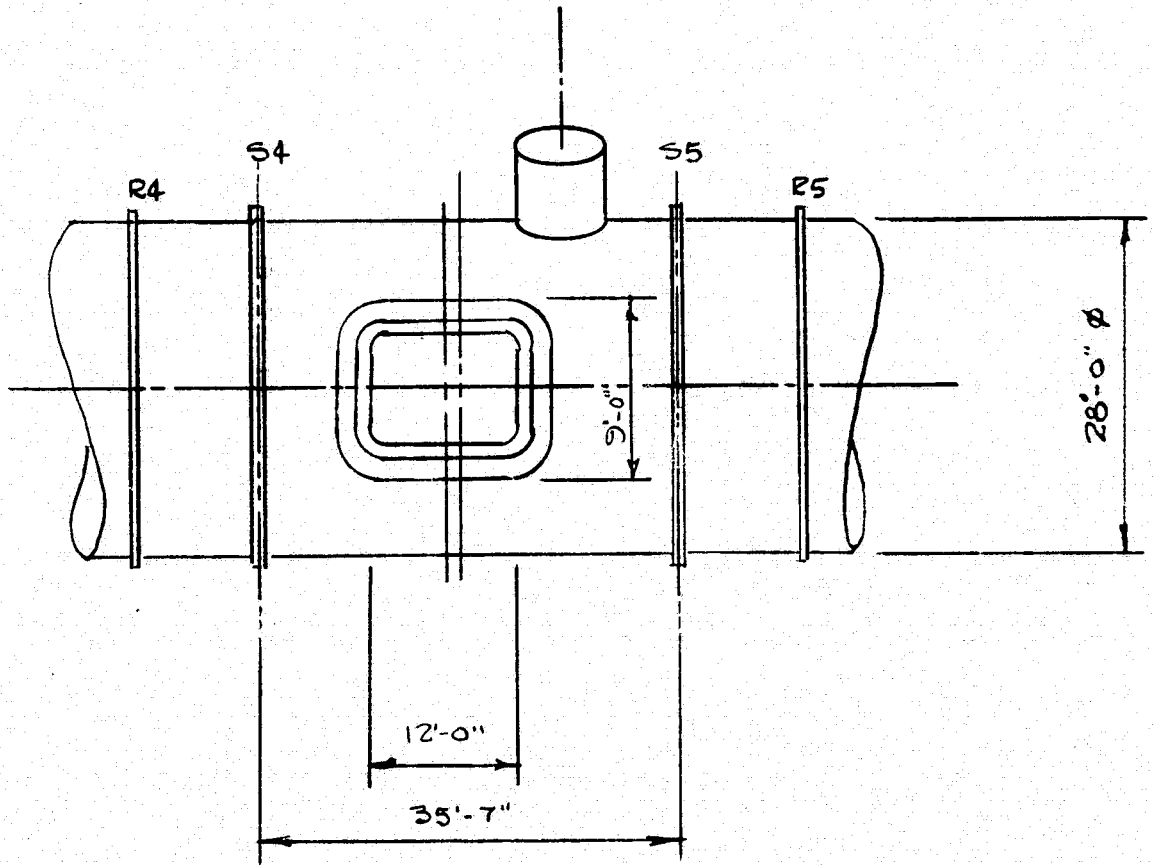
BY _____ DATE _____
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SUBJECT UTF SHEET NO. 1 OF _____
FINITE ELEMENT ANALYSES JOB NO. _____
OF ACCESS DOOR REINFORCEMENT

(Plenum)

99. N₆

REFERENCE DRAWING NO. LE-944431

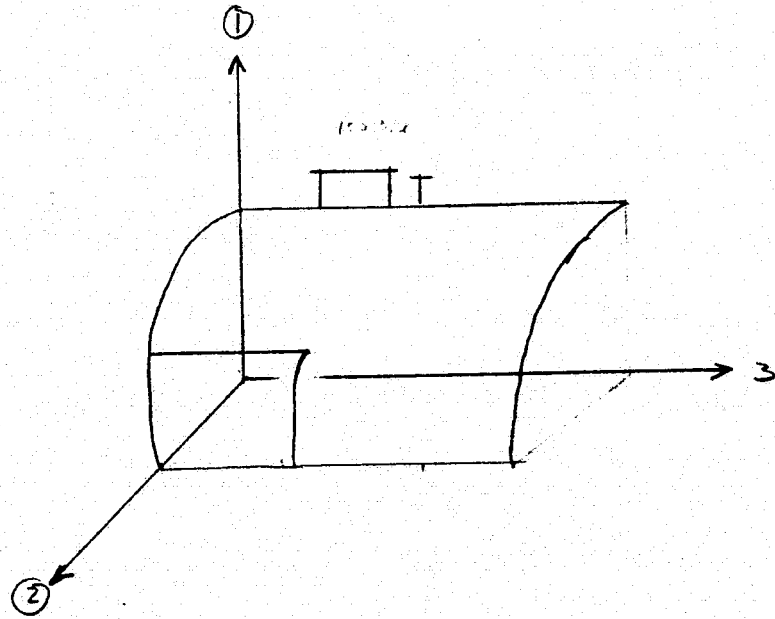


SPAR (a finite element computer code developed & maintained by Engineering Information System, Inc. under NASA contract NAS8-30536 and NAS1-13977) was used to analyze this region of the pressure shell.

The region was modeled using, triangular and quadrilateral, membrane plus bending flat anisotropic elements. The "T" ring and flange was modeled with general beam elements.

A 90° segment of the pressure shell ^(Plenum) was modeled from the Φ of the access opening to beyond the support ring S5. A plane thru the access opening perpendicular to the axis of the shell is a plane of symmetry.

Horizontal & vertical planes thru the axis of the shell are also planes of symmetry.



Plane of symmetry

- 1-2 plane
- 1-3 plane
- 2-3 plane

A computer plot of the model is shown in fig 1. The model consists of 1092 joints with 6 DOF per joint except where boundary conditions were applied and rotation about an axis \perp to a plate element was restricted.

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SHEET NO. 4 OF _____

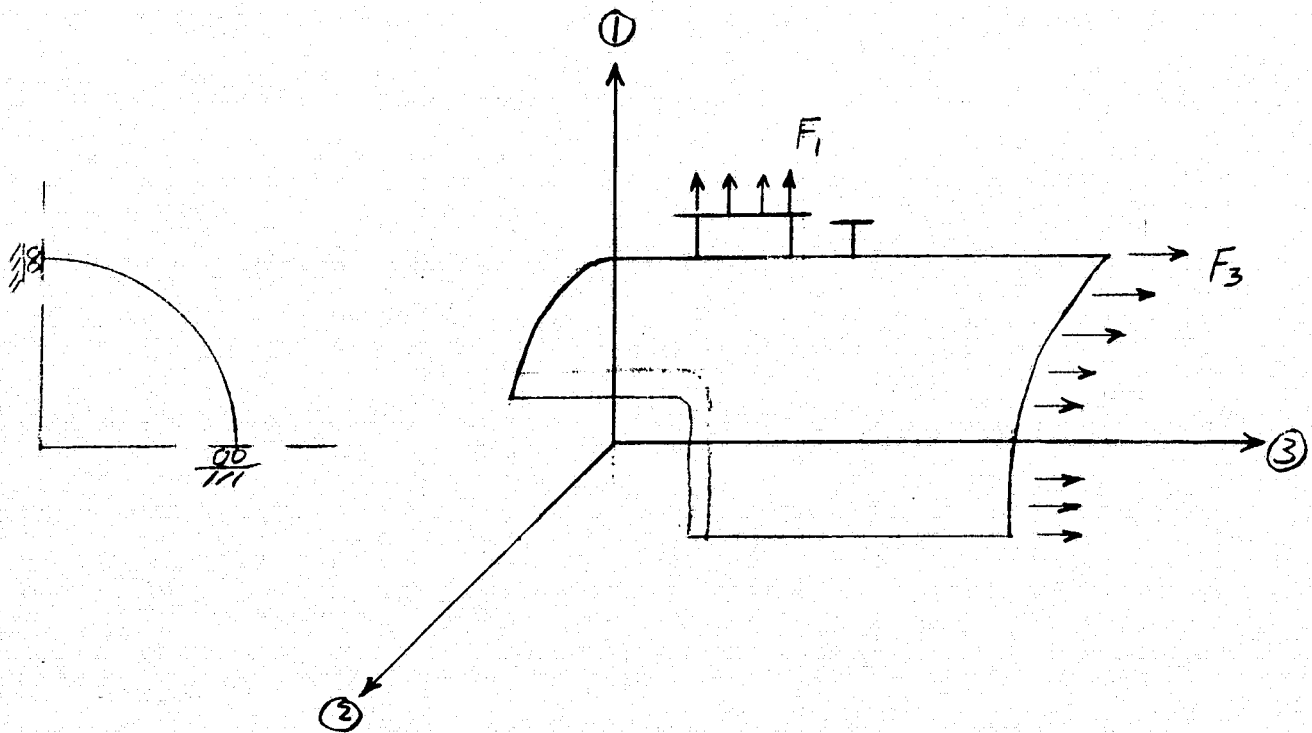
JOB NO. _____

The joint numbers for the model are shown in Fig 2 thru Fig. 10

The shell section properties (plate thickness) are shown in Fig 11 thru Fig. 19

Shell Section Property	Thickness
1	1.75
2	2.00
3	1.00
4	4.50
5	2.00
6	3.00
7	1.75
8	3.25
9	1.00
10	2.75
11	2.375

Boundary Conditions



1 2 plane is a plane of symmetry

1 3 plane is a plane of symmetry

2 3 plane is a plane of symmetry

on boundary of cylinder and pipe - restrict rotation about θ & z axes (cy. coord.)

Boundary Forces

Cylinder

$$F = (\pi R^2)(P) = \pi (169) (119) = 10,677,516 \text{ lbs.}$$

For $\frac{1}{4}$ model

$$F_3 = \frac{F}{4} = 10,677,516 \text{ lbs.}$$

$$F_3 = 2,669,379 \text{ lbs.}$$

This force was applied uniformly
around $\frac{1}{4}$ cylinder model

or Joint 1 + 16 - 88,979.2 lbs.

2 thru 15 - 177,958.3 lbs.

Pipe

$$F = (\pi R^2)(P) = \pi (50^2) 119 = 934,623.8 \text{ lbs.}$$

For a $\frac{1}{2}$ model of pipe

$$F_1 = \frac{F}{2} = \frac{934673.8 \text{ lbs}}{2}$$

$$F_1 = 467,336.9 \text{ lbs.}$$

This force was applied uniformly around a $\frac{1}{2}$ pipe model

Joint 1056 + 1092 - 6490 lb
1057 thru 1091 - 12980 lbs

9' X 12' opening

Forced displacements obtained from combining the Door and Plenum models were applied to the 9' X 12' opening. See discussion on combined analyses. (p. 9)

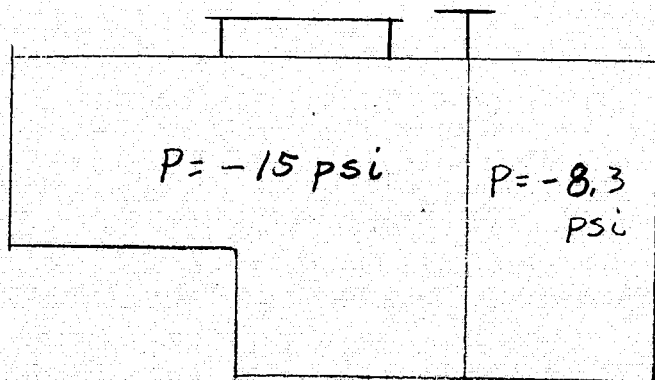
Loading

Internal Pressure

$P = 119 \text{ psi}$ (design pressure) was applied as nodal pressure to the joints of the pressure surface.

External Pressure

Nodal pressure was applied to the joints of the pressure surface according to the following sketch.



BY _____ DATE _____
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SHEET NO. 9 OF _____
JOB NO. _____

Combined Door & Plenum Analyses

see Finite Element Analyses of Side Access Door

To determine the interaction of the door and plenum, a combined reduced stiffness matrix from the 2 models (Plenum and Door) was generated. From this the relative displacement between the door and plenum ^(sealing surfaces) was determined for internal pressure.

Modal displacements from the combined run were used as boundary conditions at the sealing surfaces of the Door and Plenum to compute the final stress in each model.

For vacuum condition, the dog loads and relative displacement between the door & plenum (sealing surfaces) was determined.

Results

Nodal stresses are presented in Fig 20 thru Fig 67

The max principal stress (PS1) or min principal stress (PS2) are given for the mid-surface (surface 0), the inside surface (surface 1), and outside surface (surface 2).

The stresses plotted are for joint 1 of the element. As an example (reference Fig 2), for the element defined by joints 17, 18, 34, 33 joint 1 for that element is 17.

Nodal stresses for one joint are given from 4 elements (for quadrilateral elements). If any discrepancies exist in the stresses for a joint, the largest value is used in the interpretation of the results.

BY _____ DATE _____
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SHEET NO. 11 OF _____
JOB NO. _____

The displacement of the sealing surfaces for the Door and plenum for an internal $P = 119$ psi is given in table 1.

The sealing surfaces of the Door and Plenum remained in contact. (the relative displacements of the sealing surfaces was minus)

TABLE 1
 P = 119 PSI

* CONNECT POINT NO	DISPLACEMENTS AT SEALING SURFACE		RELATIVE DISPLACEMENT
	PLENUM	DOOR	
1	.0936	.0947	-.00110
2	.0845	.0854	-.00090
3	.0650	.0658	-.00083
4	.0398	.0400	-.00013
5	.0209	.0210	-.00009
6	.0110	.0114	-.00042
7	.0109	.0113	-.00032
8	.0109	.0115	-.00053
9	.0099	.0103	-.00034
10	.0098	.0099	-.00013

* SEE FIGURE 68

ALL RELATIVE DISPLACEMENTS ARE NEGATIVE
 ∴ ALL POINTS ALONG SEALING SURFACES
 OF DOOR AND PLENUM REMAIN IN
 CONTACT.

RELATIVE DISPLACEMENTS X STIFFNESS (1.0×10^8)
 RESULTS IN A TOTAL DOOR FORCE OF 180,544 lb.

The displacement and relative displacement of the sealing surfaces of the Door and Plenum for vacuum conditions (external pressure = 15 psi) are given in table 2.

The dog loads for vacuum conditions are also given in Table 2.

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

TABLE 2
VACUUM PRESSURE

* CONNECT POINT NO.	DISPLACEMENTS AT SEALING SURFACE		RELATIVE DISPLACEMENT
	PLENUM	DOOR	
1	-.00661	-.02421	.01760
2	-.00555	-.02168	.01614
3	-.00318	-.01687	.01370
4	-.00035	-.00991	.00956
5	.00303	-.01389	.01691
6	.00501	-.01980	.02481
7	.00502	-.02351	.02853
8	.00503	-.02638	.03141
9	.00543	-.02806	.03349
10	.00547	-.02862	.03409

* SEE FIGURE 68
 CONNECT POINTS 1-4 ARE DOG LOCATIONS AND ARE THE ONLY POINTS CONSIDERED TO BE TIED TOGETHER DURING VACUUM PULL.

FORCES AT DOGS -

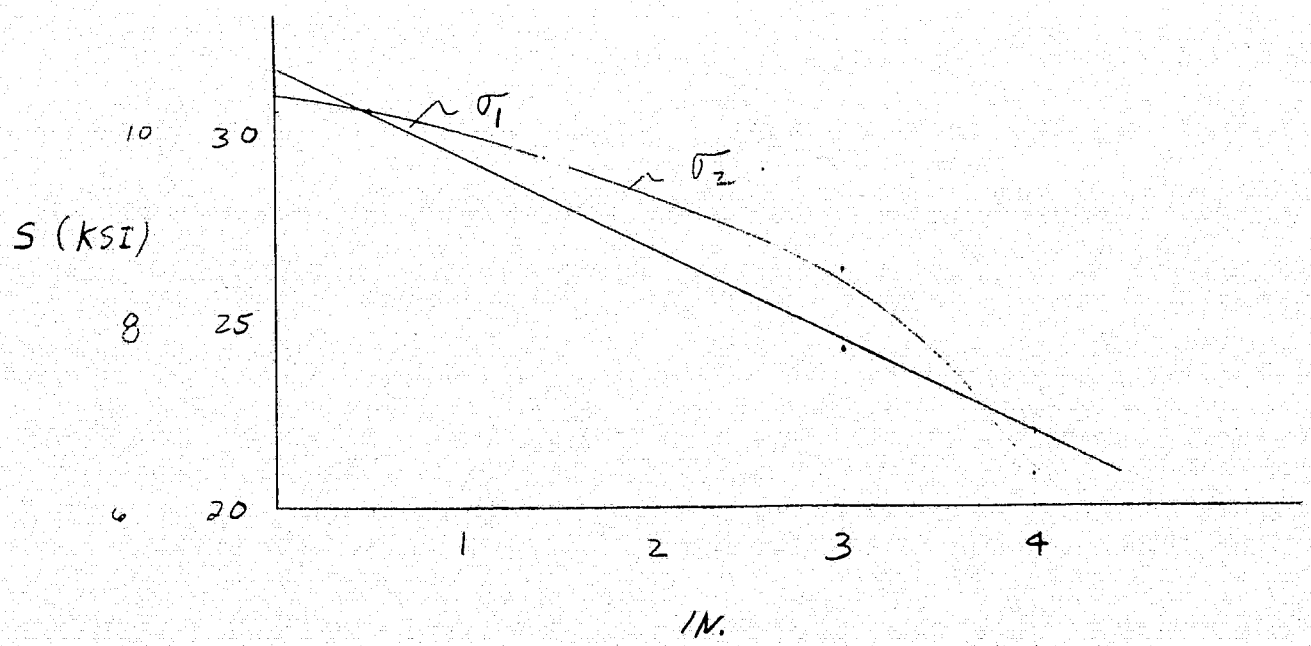
	REL. DISP.	X DOG STIFFNESS	= FORCE
* 1	.01760	.63 E+6	11088. #
2	.01614	.63 E+6	10167.
3	.01370	.63 E+6	8628.
4	.00956	3.21 E+6	30689.
			<u>Total 60572. #</u>

Region around the 9'x12' Opening

Max Membrane stress occurs in the corners.
See Fig 44

The max stress is at group 4 ind. 16

Since stress at surface 0 is at centroid of element, the stress is projected to edge of plate



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JOB NO. _____

$$\sigma_1 = 31.6 \text{ KSI}$$

$$\sigma_2 = 10.40 \text{ KSI}$$

$$\sigma_3 = -\frac{.119}{2} = -.06 \text{ KSI}$$

$$S_{12} = 31.16 - 10.40 = 20.76 \text{ KSI}$$

$$S_{23} = 10.40 - (-.06) = 10.46 \text{ KSI}$$

$$S_{31} = -0.06 - 31.6 = -31.66 \text{ KSI}$$

$$P_L = |-31.66| = 31.66 \text{ KSI}$$

$$P_L \leq 1.5 S_m$$

$$31.66 < 1.5 (31.7) = 47.55 \text{ KSI}$$

O.K.

The meridional distance at a stress intensity of $1.1 S_m$ (34.87 KSI) is 0

$$0 < \sqrt{VRT}$$

∴ The region meets the criteria for Primary local membrane stress intensity.

General Membrane Stress Intensity

212/137 (away from opening)

See Fig 20

$$\sigma_1 = 11.89 \text{ KSI}$$

$$\sigma_2 = 5.58 \text{ KSI}$$

$$\sigma_3 = -\frac{.119}{2} = -.06 \text{ KSI}$$

$$S_{12} = 11.89 - 5.58 = 6.31 \text{ KSI}$$

$$S_{23} = 5.58 - (-.06) = 5.64 \text{ KSI}$$

$$S_{31} = -.06 - 11.89 = -11.95 \text{ KSI}$$

$$P_m = |-11.95| = 11.95 \text{ KSI}$$

$$P_m \leq S_m$$

$$11.95 \leq 31.7 \text{ KSI} \quad \text{O.K.}$$

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General Principal Membrane Stress

$$\sigma_1 = 11.89 \text{ KSI}$$

$$\sigma_1 \leq S$$

$$11.89 < 23.7 \text{ KSI} \quad \text{O.K.}$$

\therefore The general principal membrane stress and general membrane stress intensity for the Plenum region meets the stress evaluation criteria.

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Primary Plus Secondary Stress Intensity

Inside Surface (see Fig 46)

Max stress intensity at

4 / 17 / 518

To correct for stress at edge

$$\text{add } 31.6 - 30.48 = 1.12 \quad \text{to } \sigma_1$$

$$\text{add } 10.4 - 10.25 = .15 \quad \text{to } \sigma_2$$

$$\sigma_1 = 46.27 + 1.12 = 47.39 \text{ KSI}$$

$$\sigma_2 = 23.25 + .15 = 23.40 \text{ KSI}$$

$$\sigma_3 = -.119 \text{ KSI}$$

$$S_{12} = 47.39 - 23.40 = 23.99 \text{ KSI}$$

$$S_{23} = 23.40 - (-.12) = 23.52 \text{ KSI}$$

$$S_{31} = -.12 - 47.39 = -47.51 \text{ KSI}$$

$$P_L + P_b + Q = |-47.51| = 47.51 \text{ KSI}$$

$$P_L + P_b + Q < \sigma_{yp}$$

$$47.51 < 52.5 \text{ KSI (auto weld)}$$

O.K.

Outside Surface (see Fig 45)

Max at 4/16/518

apply same correction as above

$$\sigma_1 = 25.77 + 1.12 = 26.89 \text{ KSI}$$

$$\sigma_2 = -2.07 + .15 = -1.92 \text{ KSI}$$

$$\sigma_3 = 0$$

$$S_{12} = 26.89 - (-1.92) = 28.81 \text{ KSI}$$

$$S_{23} = -1.92 - 0 = -1.92 \text{ KSI}$$

$$S_{31} = 0 - 26.89 = 26.89 \text{ KSI}$$

$$P_L + P_b + Q = |28.81| = 28.81 \text{ KSI}$$

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$$P_L + P_b + Q < \sigma_{yp}$$

$$28.81 < 52.5 \text{ KSI (auto weld)}$$

O.K.

The primary plus secondary stress intensity for the region around the 9' x 12' opening meets the stress evaluation criteria.

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Inside Stiffener Ring

See Fig 38

At 6/36/591

Membrane Stress

$$\sigma_1 = 27.03 \text{ KSI}$$

$$\sigma_2 = -5.98 \text{ KSI}$$

$$\sigma_3 = 0$$

$$S_{12} = 27.03 - (-5.98) = 33.01 \text{ KSI}$$

$$S_{23} = -5.98 - 0 = -5.98 \text{ KSI}$$

$$S_{31} = 0 - 27.03 = -27.03 \text{ KSI}$$

$$P_L = |33.01| = 33.01 \text{ KSI}$$

$$P_L \leq 1.5 S_m$$

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$$33.01 < 1.5(31.7) = 47.55 \text{ KSI}$$

This stress is a local stress
at a nozzle.

∴ This region meets the criteria
for local membrane stress intensity.

Primary plus secondary Stress Intensity

The max stress intensity is
on the pressure side of
the stiffener. (G/43/682) (Fig 39)

$$\sigma_1 = 29.64 \text{ KSI}$$

$$\sigma_2 = -21.19 \text{ KSI}$$

$$\sigma_3 = -.119 \text{ KSI}$$

$$S_{12} = 29.64 - (-21.19) = 50.83 \text{ KSI}$$

$$S_{23} = -21.19 - (-.119) = -21.31 \text{ KSI}$$

$$S_{31} = -.119 - 29.64 = 29.52 \text{ KSI}$$

$$P_L + P_b + Q = |50.83| = 50.83 \text{ KSI}$$

$$P_L + P_b + Q < \sigma_{yp}$$

$$50.83 < 52.5 \text{ KSI (auto weld)}$$

O.K

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CHKD. BY _____ DATE _____

JOB NO. _____

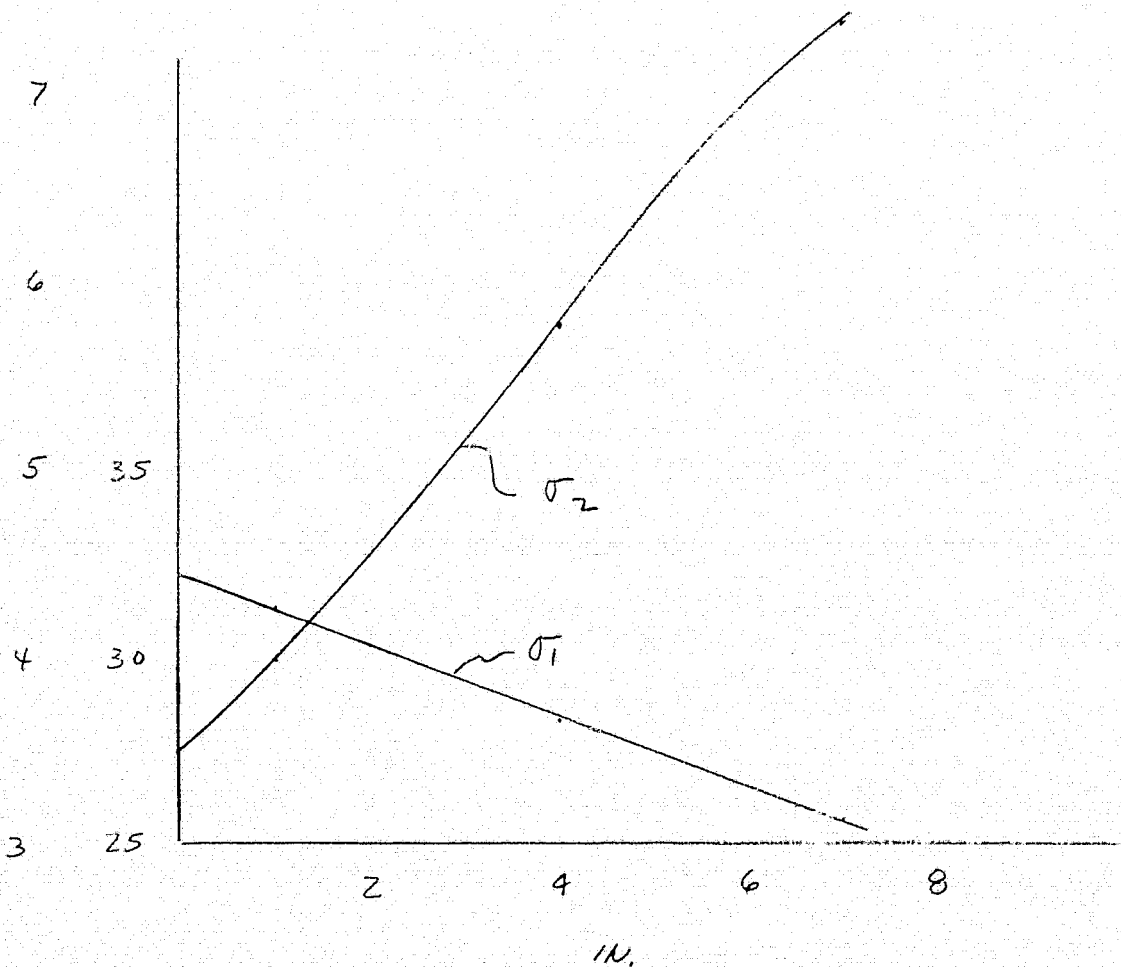
)
∴ This region meets the criteria
for primary + secondary stress
intensity

Region Around 8.33' dia circular hole

Ref. fig. 50

Max membrane stress at 6/71

Since stress at surface 0 is
for centroid of element, the stress
is projected to edge of plate.



$$\sigma_1 = 32.2 \text{ KSI}$$

$$\sigma_2 = 3.5 \text{ KSI}$$

$$\sigma_3 = -\frac{119}{2} = -0.06 \text{ KSI}$$

$$S_{12} = 32.2 - 3.5 = 28.7 \text{ KSI}$$

$$S_{23} = 3.5 - (-0.06) = 3.56 \text{ KSI}$$

$$S_{31} = -0.06 - (32.2) = -32.26 \text{ KSI}$$

$$P_L = |-32.26| = 32.26 \text{ KSI}$$

$$P_L \leq 1.5 S_m$$

$$32.26 < 1.5(31.7) = 47.55 \text{ KSI}$$

This stress is a local stress
at nozzle

∴ This region meets the criteria
for local membrane stress intensity

Primary Plus Secondary Stress intensity

Outside Surface (Fig 50)

Max stress at 6/1/760

To correct for stresses at edge
of plate

$$\text{add } 32.2 - 31.2 = 1.0 \text{ KSI } \sigma_1$$

$$\text{add } 3.5 - 3.97 = -.47 \text{ KSI } \sigma_2$$

$$\sigma_1 = 34.39 + 1.0 = 35.39 \text{ KSI}$$

$$\sigma_2 = 22.44 + (-.47) = 21.97 \text{ KSI}$$

$$\sigma_3 = 0$$

$$S_{12} = 35.39 - 21.97 = 13.42 \text{ KSI}$$

$$S_{23} = 21.97 - 0 = 21.97 \text{ KSI}$$

$$S_{31} = 0 - 35.39 = -35.39 \text{ KSI}$$

$$P_L + P_b + Q = |-35.39| = 35.39 \text{ KSI}$$

$$P_L + P_b + Q < \sigma_{yp}$$

$$35.39 < 52.5 \text{ KSI (auto welds)}$$

O.K.

Inside Surface
(see Fig 54)

6/71 / 796

$$\sigma_1 = 27.41 + 1.0 = 28.41 \text{ KSI}$$

$$\sigma_2 = -18.25 + (-.47) = -18.72 \text{ KSI}$$

$$\sigma_3 = -\frac{.119}{2} = -.06 \text{ KSI}$$

$$S_{12} = 28.41 - (-18.72) = 47.13 \text{ KSI}$$

$$S_{23} = -18.72 - (-.06) = -18.66 \text{ KSI}$$

$$S_{31} = -.06 - 28.41 = 28.47 \text{ KSI}$$

$$P_L + P_b + Q = |47.13| = 47.13 \text{ KSI}$$

$$P_L + P_b + Q < \sigma_{yp}$$

$$47.13 < 52.5 \text{ KSI} \quad (\text{auto welds})$$

O.K.

The primary plus secondary stress intensity for this region meets the stress evaluation criteria.

The holes used in this analyses is 8.33' dia. The thickness of reinforcement is 2.75 in. The hole shown on drawing LE 944429 is 6.0' dia. The thickness of reinforcement is 4 1/2".

Since the larger dia & smaller reinforcing thickness meets the stress evaluation criteria, the 6.0 dia hole was not analysed. It was assumed to also meet the criteria.

Hydro Test Conditions

Local membrane stress exists around the 9' x 12' opening and the 8.33' dia circular opening. The max general membrane stress outside these region and between S4 and S5 is

$$\sigma_x = 11.89 \text{ KSI} \quad (P = 119 \text{ psi})$$

For the plenum region, the pressure at hydro is

$$P_H = 1.5(119) + 62.4 \frac{\text{lb}}{\text{ft}^3} \frac{1 \text{ ft}^2}{144 \text{ in}^2} \left[\frac{41}{2} + \frac{28}{2} \right] \text{ ft}$$

$$P_H = 178.5 + 14.95$$

$$P_H = 193.45 \text{ psi}$$

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∴ The general membrane stress at hydro is

$$\sigma_{TH} = \frac{193.45}{119} (11.89)$$

$$\sigma_{TH} = 19.33 \text{ KSI}$$

The stress at hydro limited to

$$.8(52.5) = 42 \text{ KSI for auto welds}$$

$$19.33 < 42.0 \text{ KSI O.K.}$$

∴ The plenum meets the criteria for hydro test conditions

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Buckling of Plenum

The critical load factor for the plenum region at a pressure of -15 psi is 12.0. Buckling occurred at the center plenum.

A modal plot is shown in fig. 69

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Model check points

axial & hoop stress in 1" section of shell

$$S_H = \frac{P r}{t} = \frac{(119)(169)}{1.0} = 20.1 \text{ KSI}$$

$$S_a = \frac{P r}{2t} = \frac{(119)(169)}{2(1)} = 10.0 \text{ KSI}$$

Stress at surface 0

$$S_1 = 19.95 \text{ KSI}$$

$$S_2 = 10.05 \text{ KSI}$$

∴ stresses on 1" section of cylinder check with hand calculation

Model check - Buckling

Ref. Theory of Elastic Stability
Timoshenko & Gere
Second Edition
p. 495 to 497

Buckling under Combined Axial and
Uniform Lateral Pressure

Assume shell to be simply supported.
and a uniform cylinder with
 $t = 1.75$ $R = 168.875"$ $L = 427"$
 $E = 29 \times 10^6$ psi $\mu = 0.3$

The critical pressure is 122.5 psi

The critical load factor for
15 psi is 8.2

Ref: Stress in Shell
W. Flügge
Second Printing
p. 432 to 434

For External Pressure only

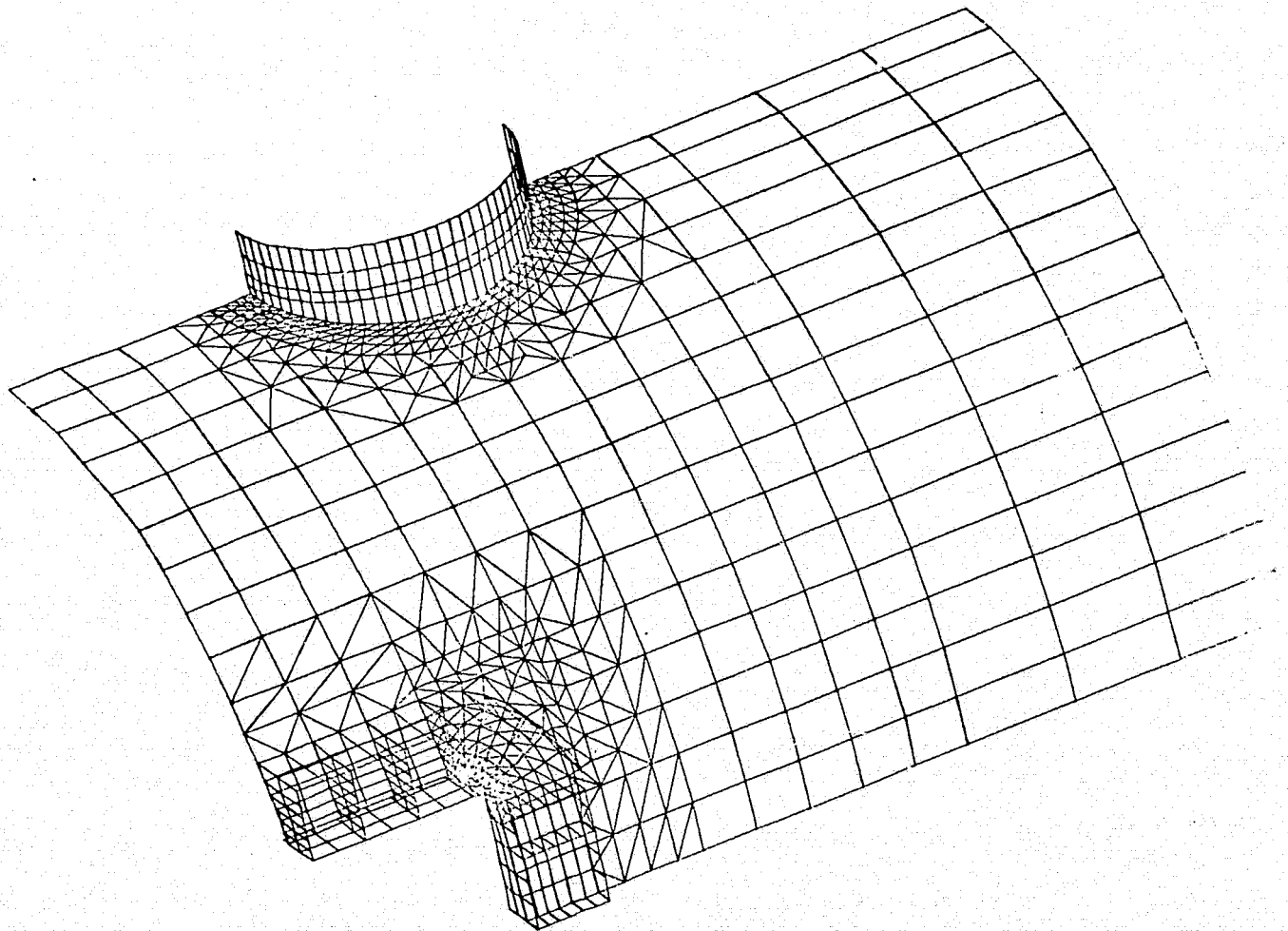
Assume edges clamped and
a uniform cylinder with $t = 1.75$
 $R = 168.75$ $L = 427''$ $E = 29 \times 10^6 \text{ psi}$
 $\mu = 0.3$

The critical pressure is 123.9 psi
The critical load factor for
15 psi is 8.3

Timoshenk & Flügge yield critical
load factor lower than the
finite element solution (8.3 vs 12.6)

This can be explain by the
fact part of the shell in the
finite element solution is 2" thick
and the heavy reinforcing provided
around the openings.

∴ Model is O.K.

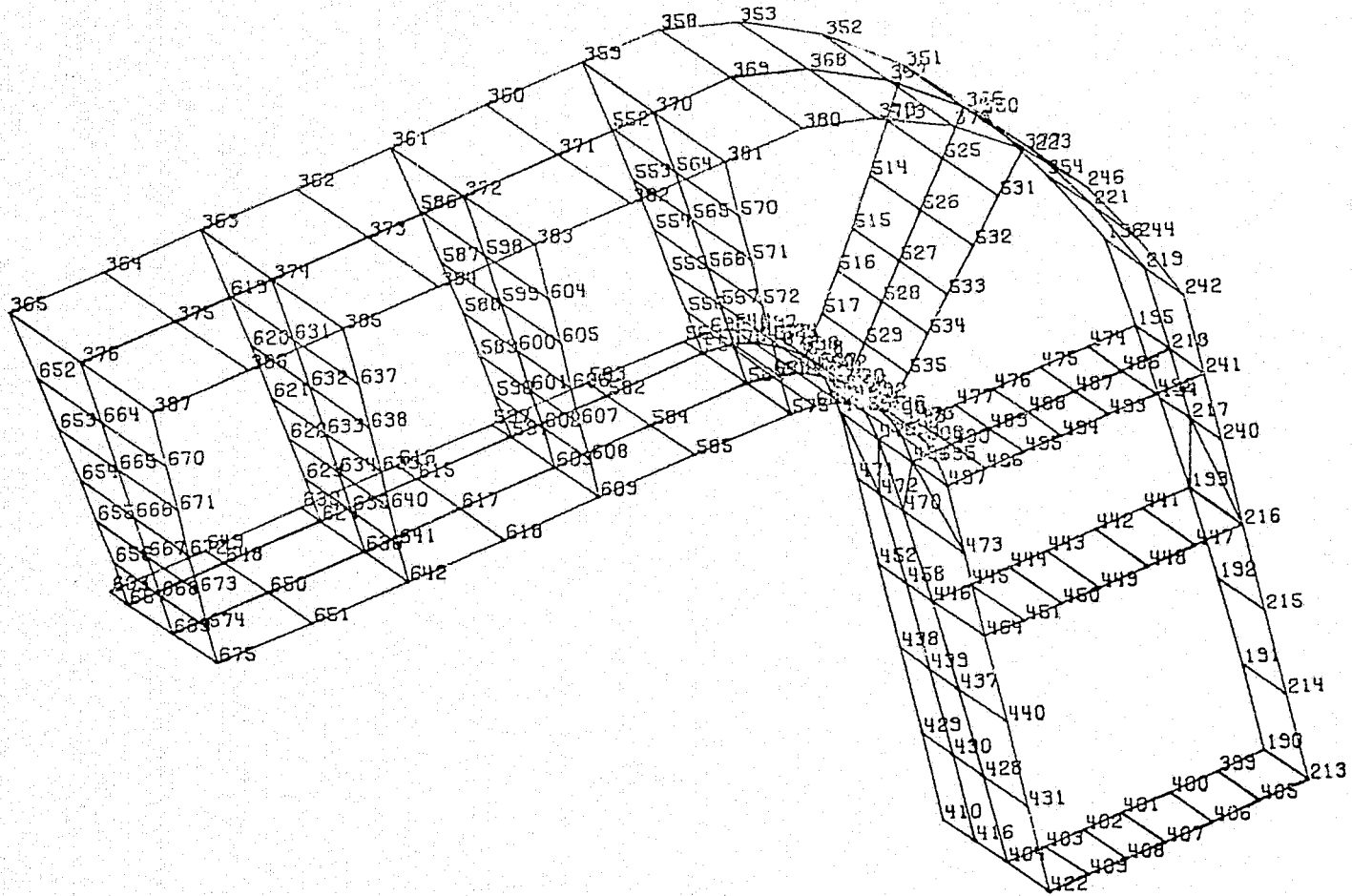


SPEC
1.1

NTF 9 X 12 ACCESS OPENING

0 SCALE 54

FIGURE 1



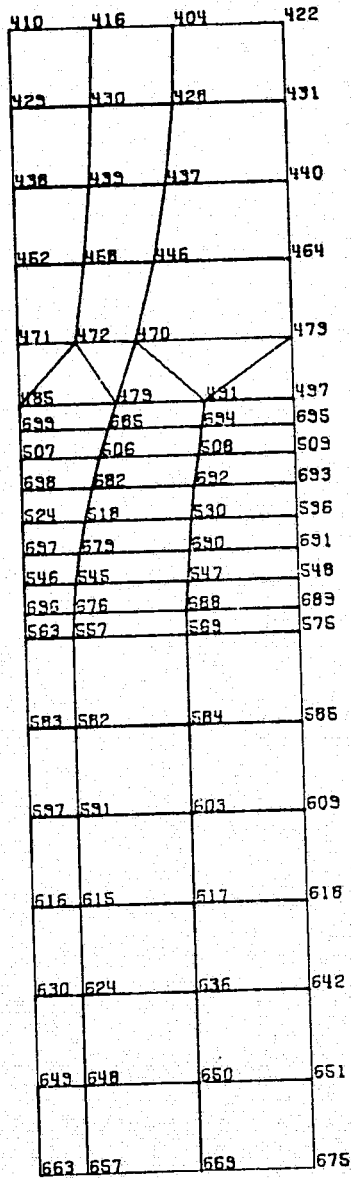
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SPEC
5.1

NTF 9X12 ACCESS OPENING
GUSSET

0 SCALE 18

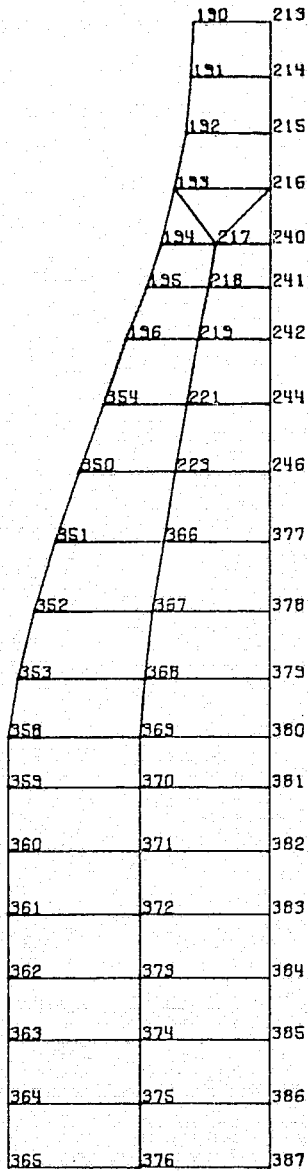
Figure 4



SPEC 6.1 NTF 9X12 REINF.
INNER RING

0 SCALE 14

Figure 5

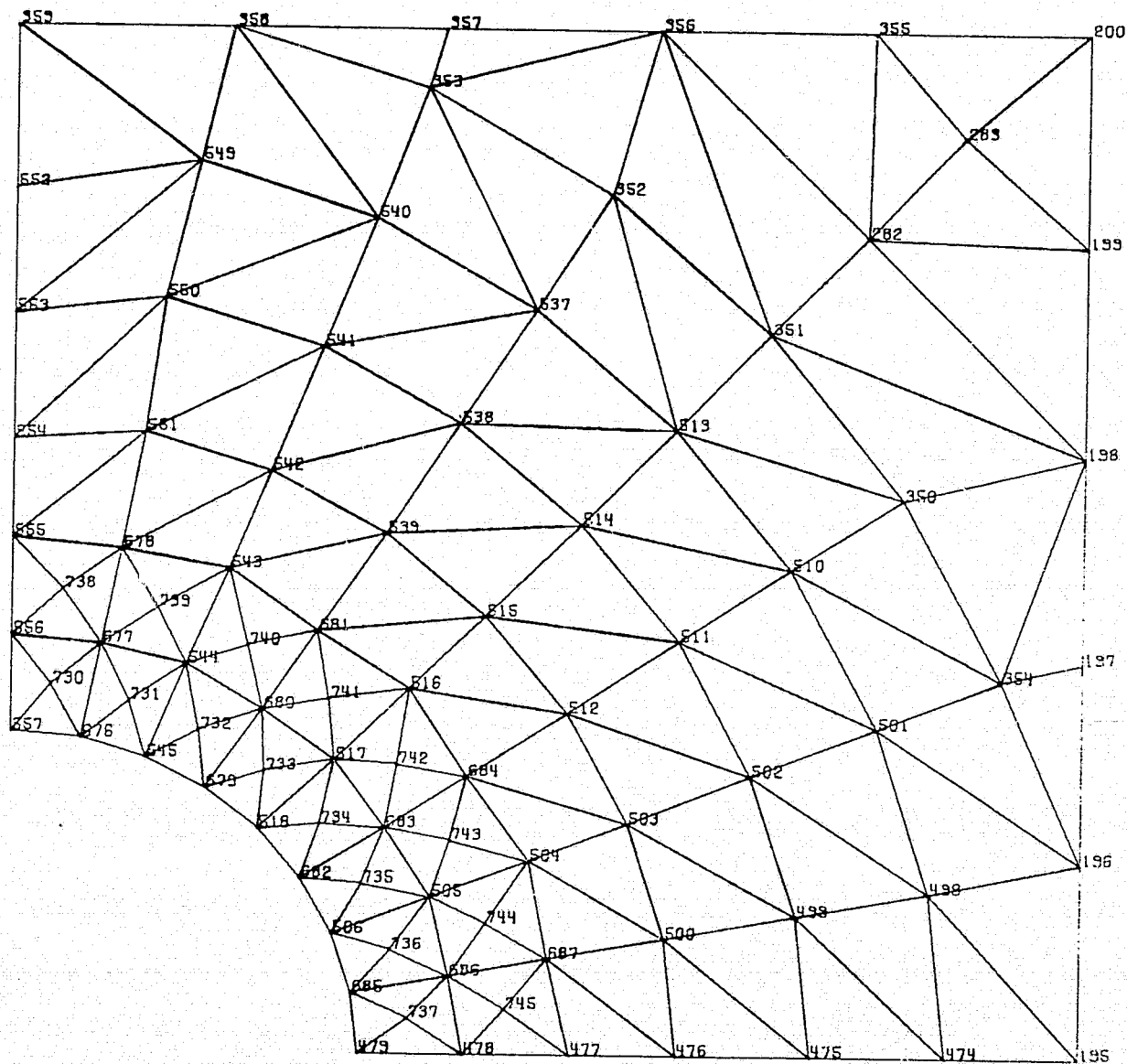


SPEC
7.1

NTF 9X12 DOOR REINF.
OUTER RING

0 SCALE 19

Figure 6



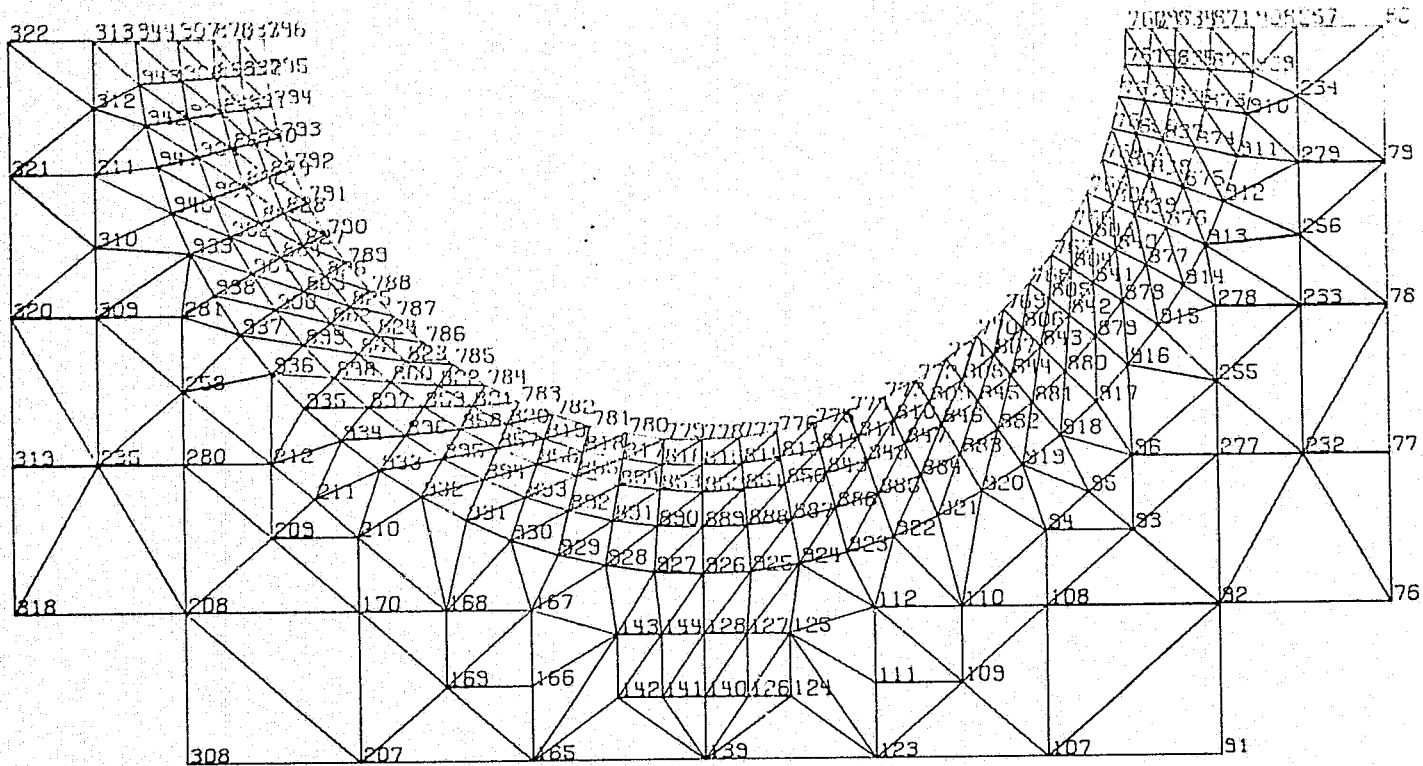
SPEC
8.1

NTF 9 X 12 REINF
CENTER TRIANGLES

0 SCALE 6

Figure 7

Figure 8



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SPEC 9.1

9 X 12 REINF WITH 9 FT HOLE TRIANGLES AROUND 9 FT HOLE

0 24 SCALE

1074	1073	1072	1071	1070	1069	1068	1067	1066	1065	1064	1063	1062	1061	1060	1059	1058	1057	1056	
1037	1036	1035	1034	1033	1032	1031	1030	1029	1028	1027	1026	1025	1024	1023	1022	1021	1020	1019	
1000	999	998	997	996	995	994	993	992	991	990	989	988	987	986	985	984	983	982	
963	962	961	960	959	958	957	956	955	954	953	952	951	950	949	948	947	946	945	
778	777	776	775	774	773	772	771	770	769	768	767	766	765	764	763	762	761	760	

Figure 9

SPEC
10.1

9 X 12 REINF WITH 9 FT HOLE
9 FT PIPE SECTION 1

0  11
SCALE

1092	1091	1090	1089	1088	1087	1086	1085	1084	1083	1082	1081	1080	1079	1078	1077	1076	1075	1074
1055	1054	1053	1052	1051	1050	1049	1048	1047	1046	1045	1044	1043	1042	1041	1040	1039	1038	1037
1018	1017	1016	1015	1014	1013	1012	1011	1010	1009	1008	1007	1006	1005	1004	1003	1002	1001	1000
981	980	979	978	977	976	975	974	973	972	971	970	969	968	967	966	965	964	963
796	795	794	793	792	791	790	789	788	787	786	785	784	783	782	781	780	779	778

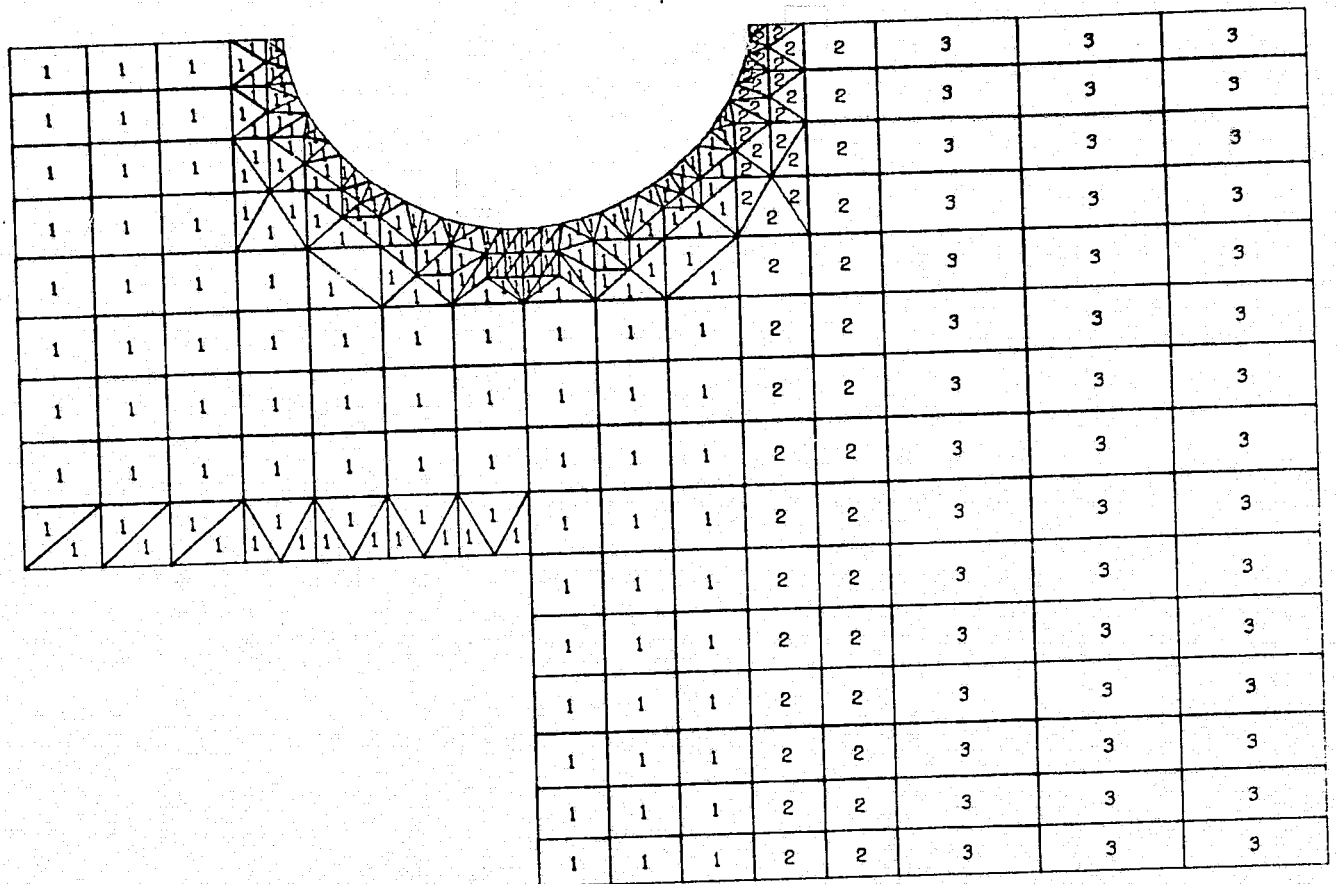
Figure 10

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SPEC 11.1

9 X 12 REINF WITH 9 FT HOLE
9 FT PIPE SECTION 2





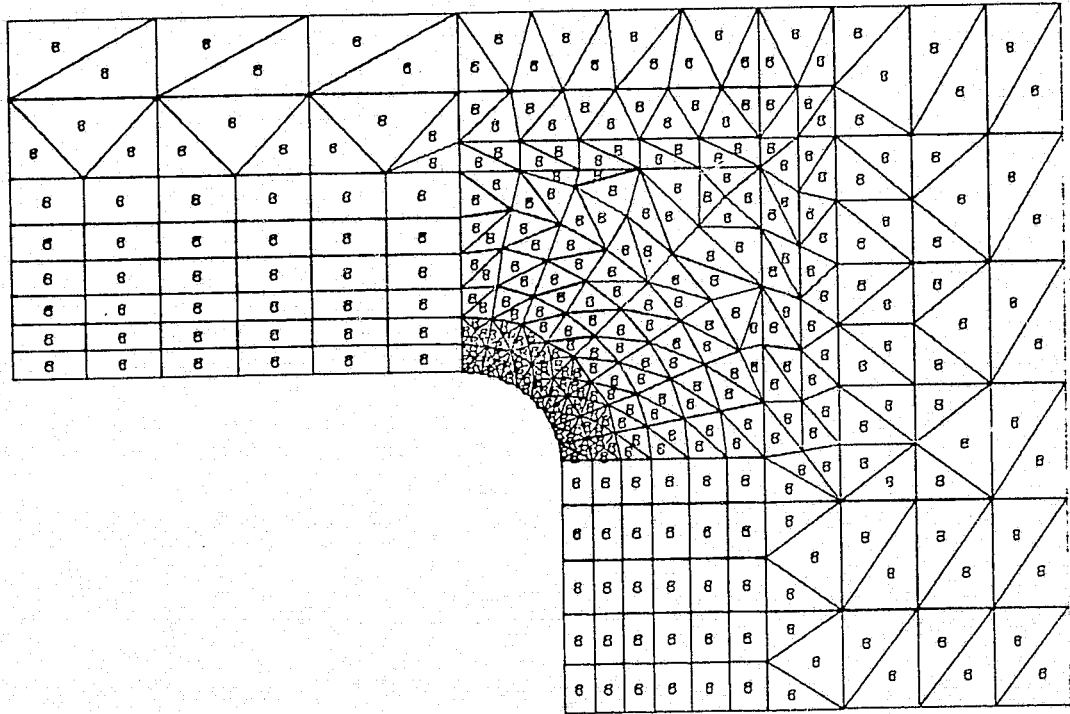
SPEC
3.1

NTF 9 X 12 ACCESS OPENING
SHELL

0 SCALE 5

ELEMENT DEFINITION PROPERTY GROUPS

Figure 11



SPEC
4.1

NTF 9 X 12 ACCESS OPENING
SHELL

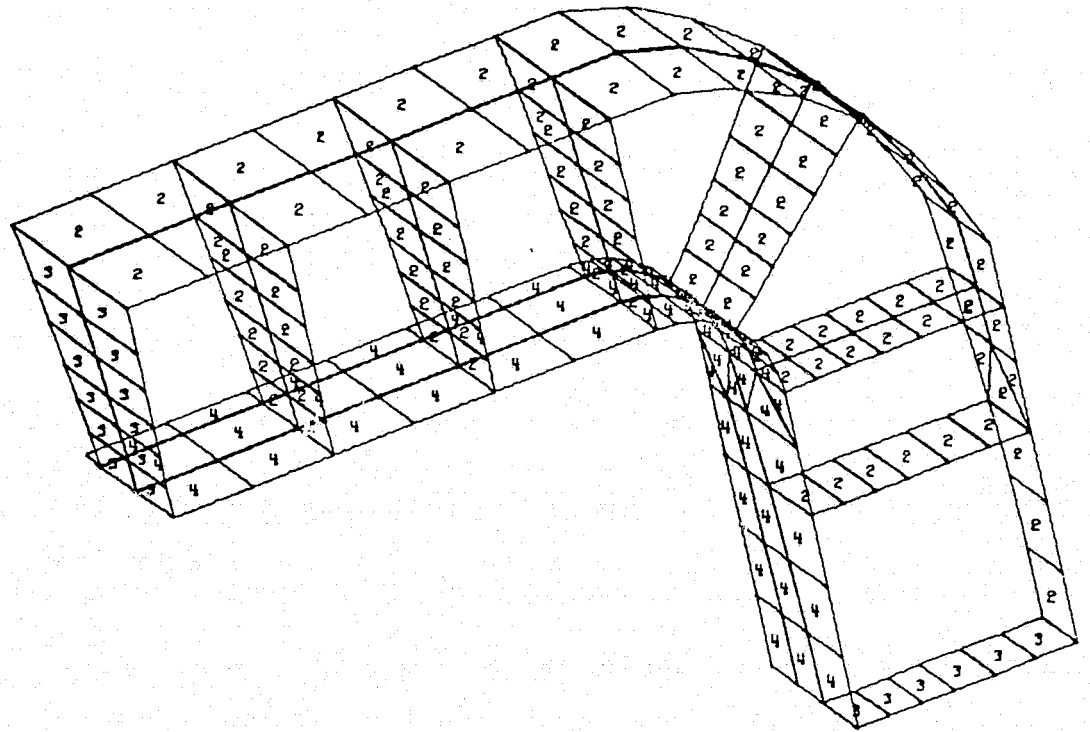
0 SCALE 21

Figure 12

00000000

00 00N

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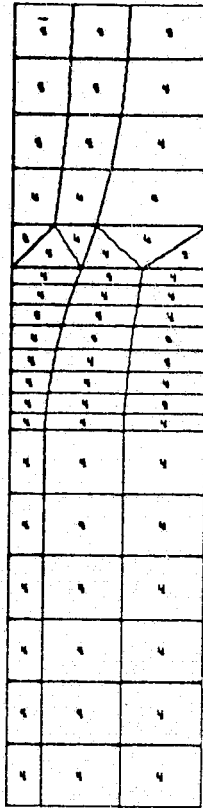


SPEC
S.1

NTF 9X12 ACCESS OPENING
GUSSET

0 SCALE 18

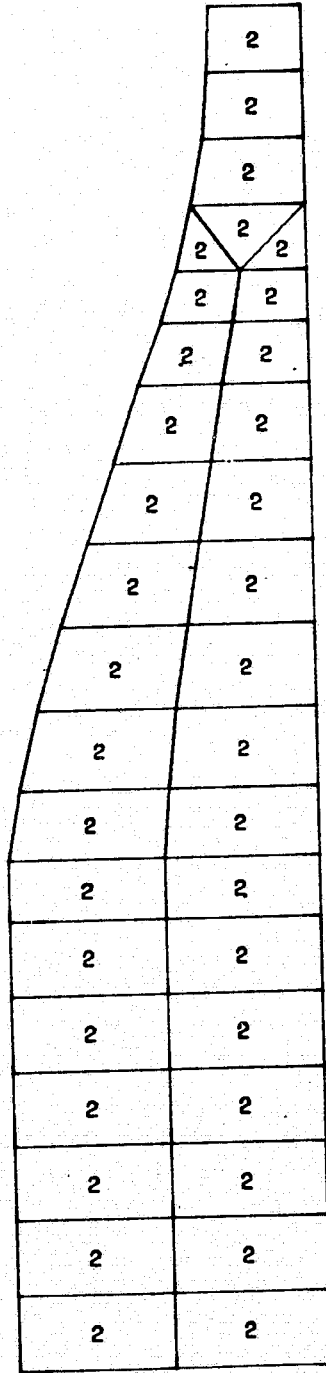
Figure 13



SPEC 6.1 NTF 9X12 REINF. INNER RING

Q SCALE 14

Figure 14



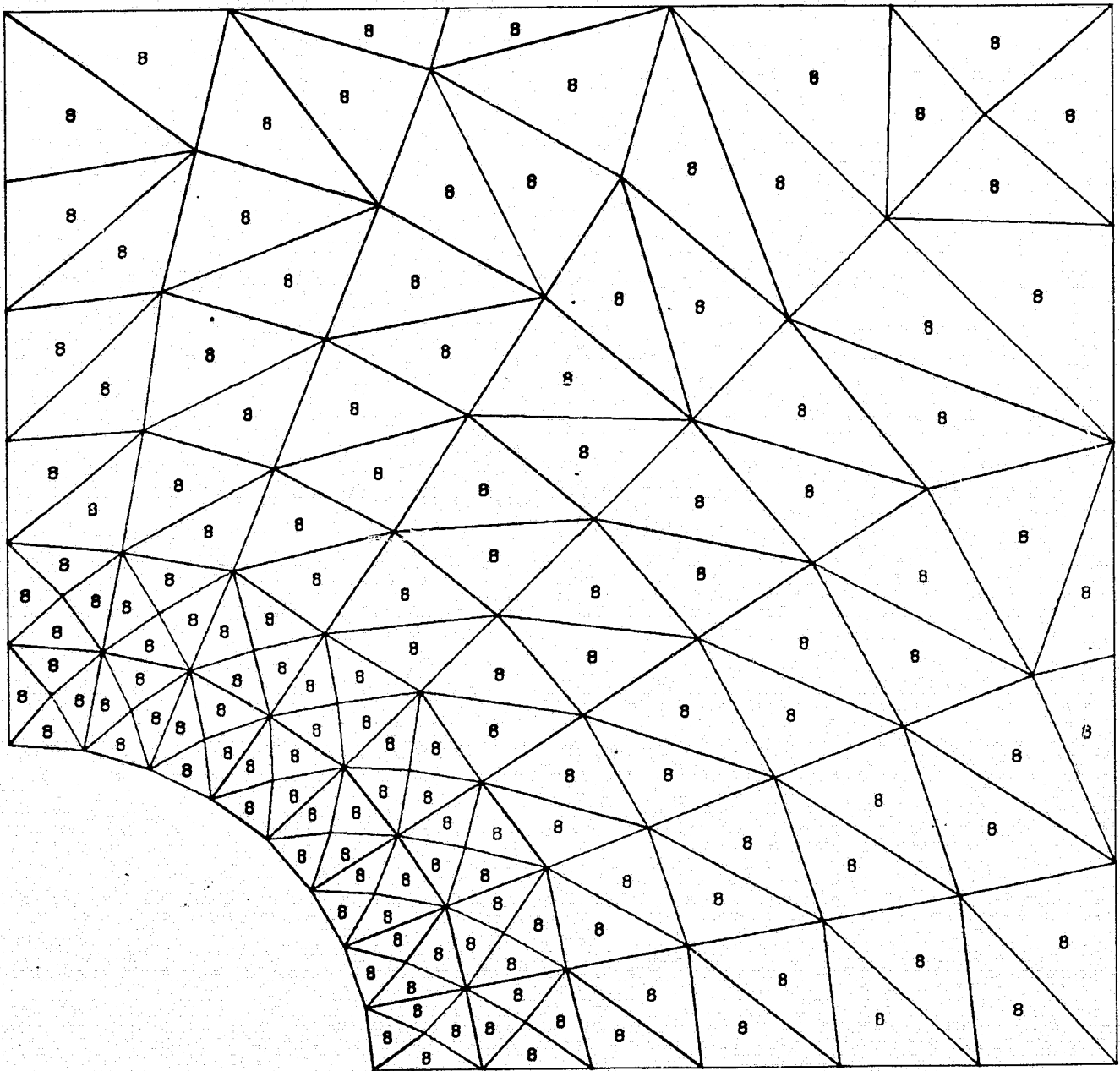
ELEMENT SECTION PROPERTY GROUPS

SPEC 7.1

NTF 9X12 DOOR REINF.
 OUTER RING

0 SCALE 19

Figure 15



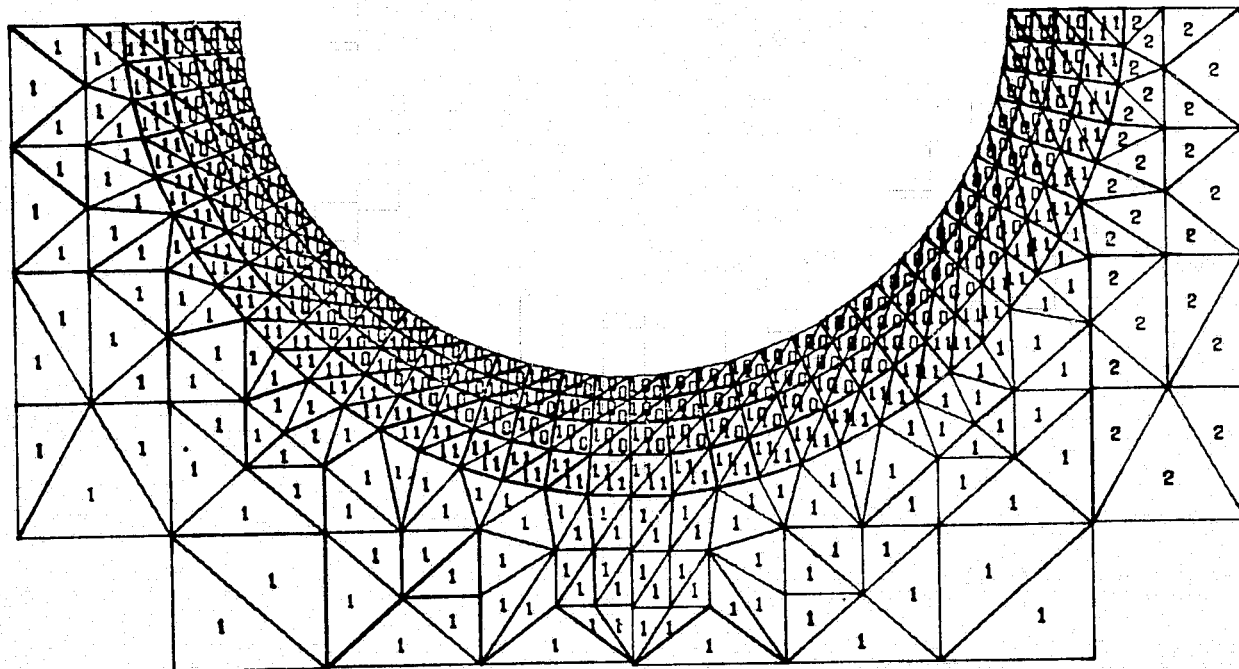
SPEC
8.1

NTF 9 X 12 REINF
CENTER TRIANGLES

Q SCALE

ELEMENT SECTION PROPERTY GROUPS

Figure 16



SPEC
9.1

9 X 12 REINF WITH 9 FT HOLE
TRIANGLES AROUND 9 FT HOLE

0 SCALE 24

Figure 17

9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10

SPEC
10.1

9 X 12 REINFC WITH 9 FT HOLE
9 FT PIPE SECTION I

0 SCALE 11

Figure 18

9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	
10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	

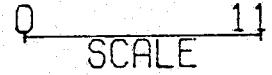
ELEMENT SECTION PROPERTY GROUPS

Figure 19

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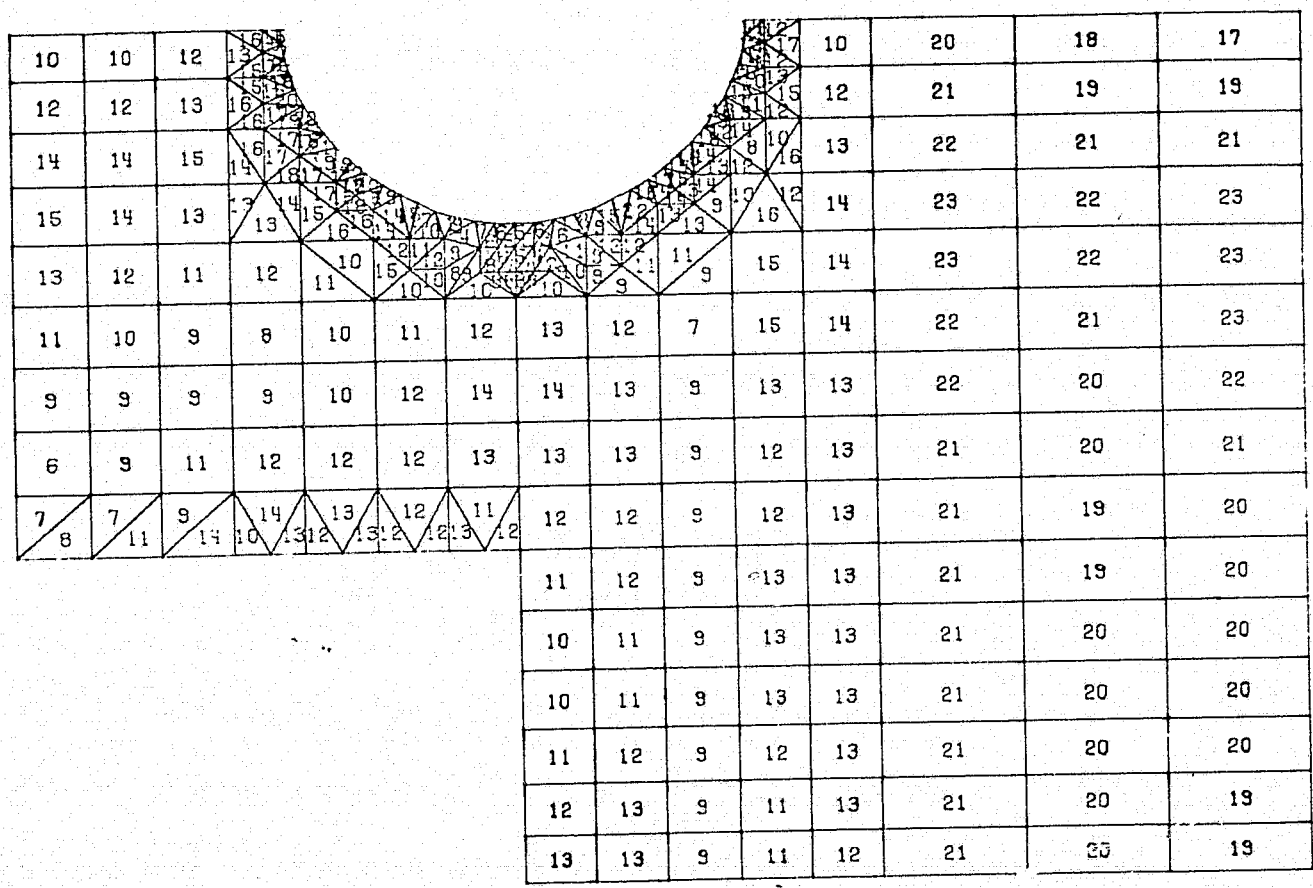
SPEC 11.1

9 X 12 REINF WITH 9 FT HOLE
9 FT PIPE SECTION 2



10/1/1

DISPLAY= PS1 /1000 , NODE= 1, SURFACE= 2



SPEC 3.1

NTF 9 X 12 ACCESS OPENING SHELL

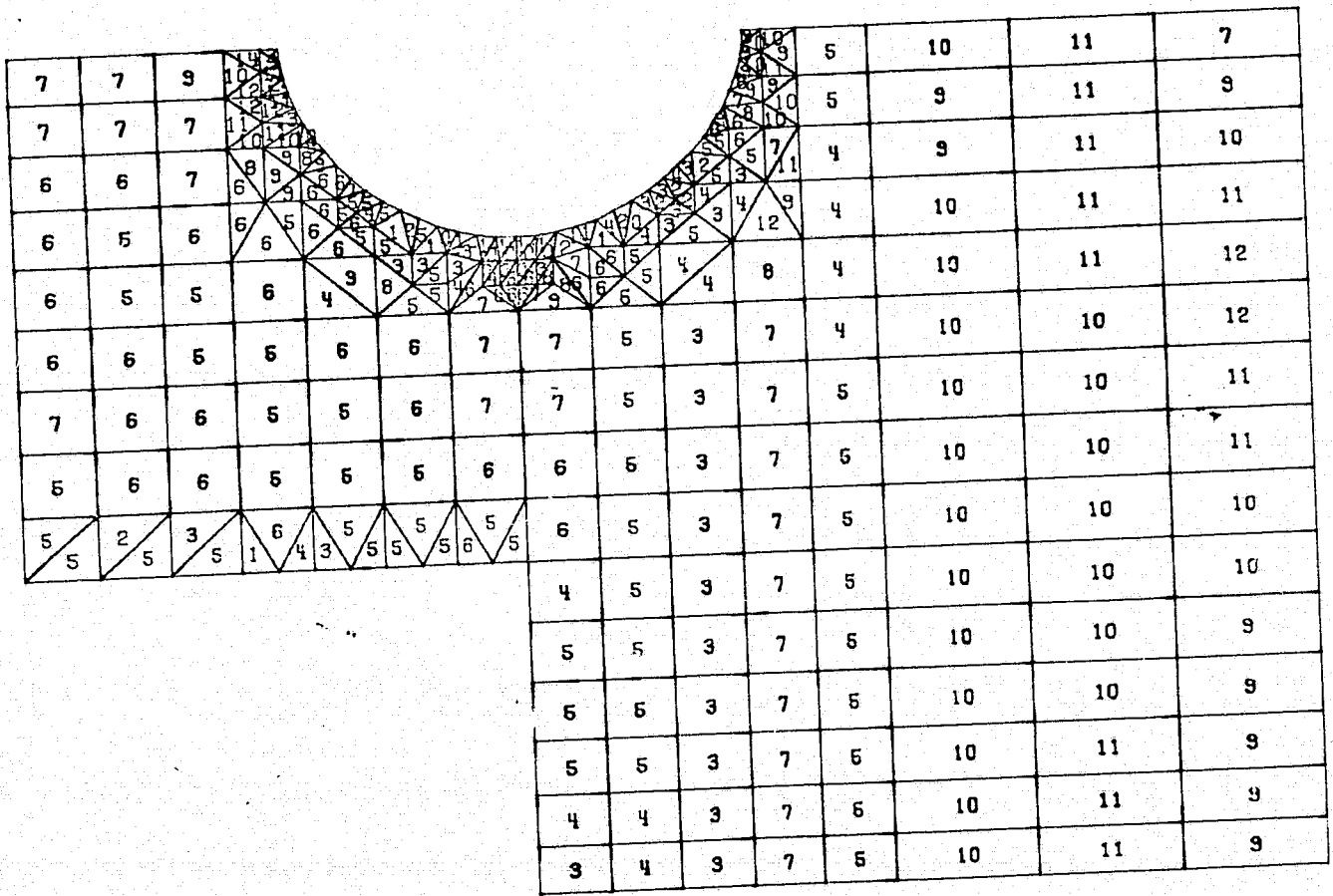
0 SCALE 55

Figure 22

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

10/1/1

DISPLAY= PS2 /1000 , NODE= 1, SURFACE= 2



SPEC 3.1

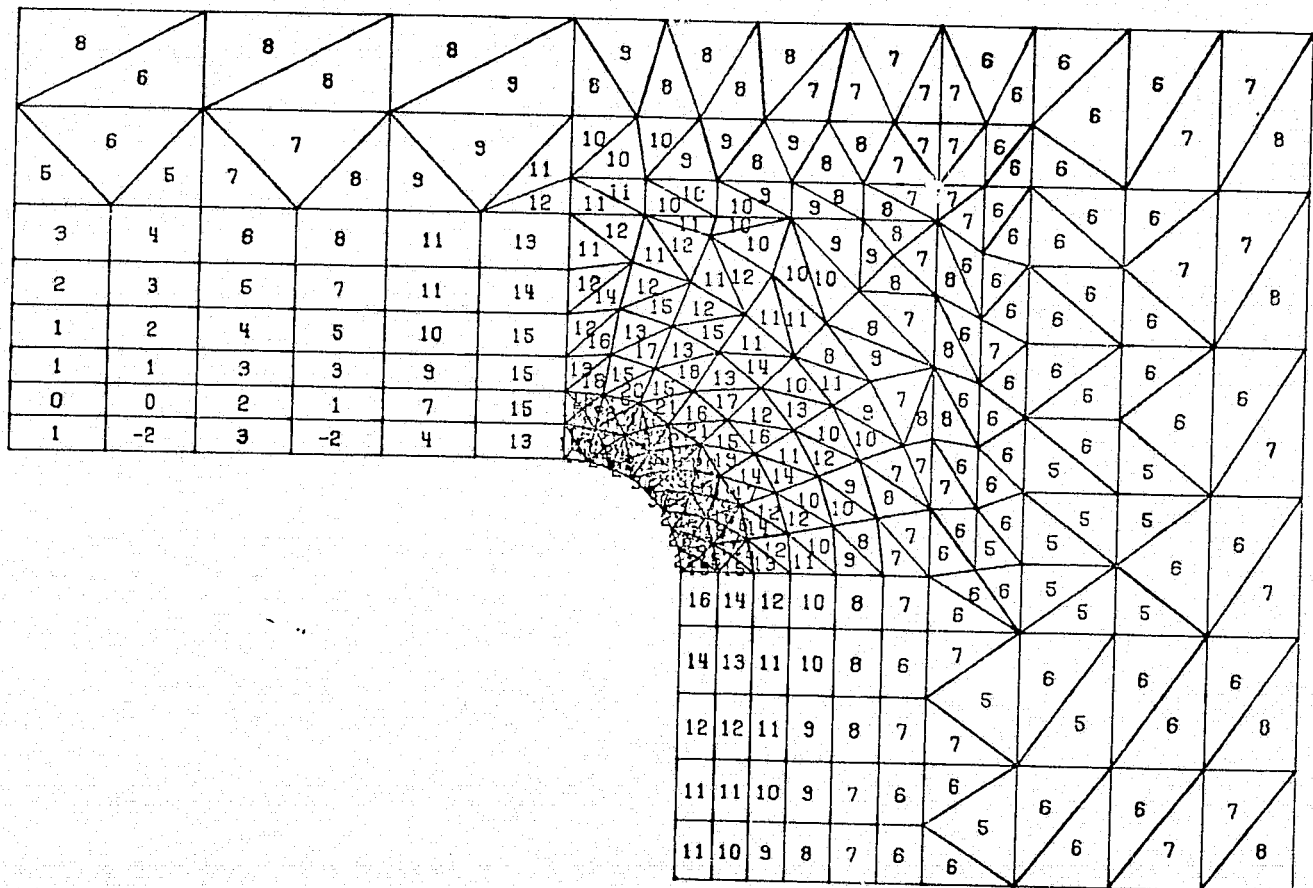
NTF 9 X 12 ACCESS OPENING SHELL

Q SCALE 55

Figure 25

DISPLAY= PS1 /1000 , NODE= 1 , SURFACE= 0

10/1/1



SPEC
4.1

NTF 9 X 12 ACCESS OPENING
SHELL

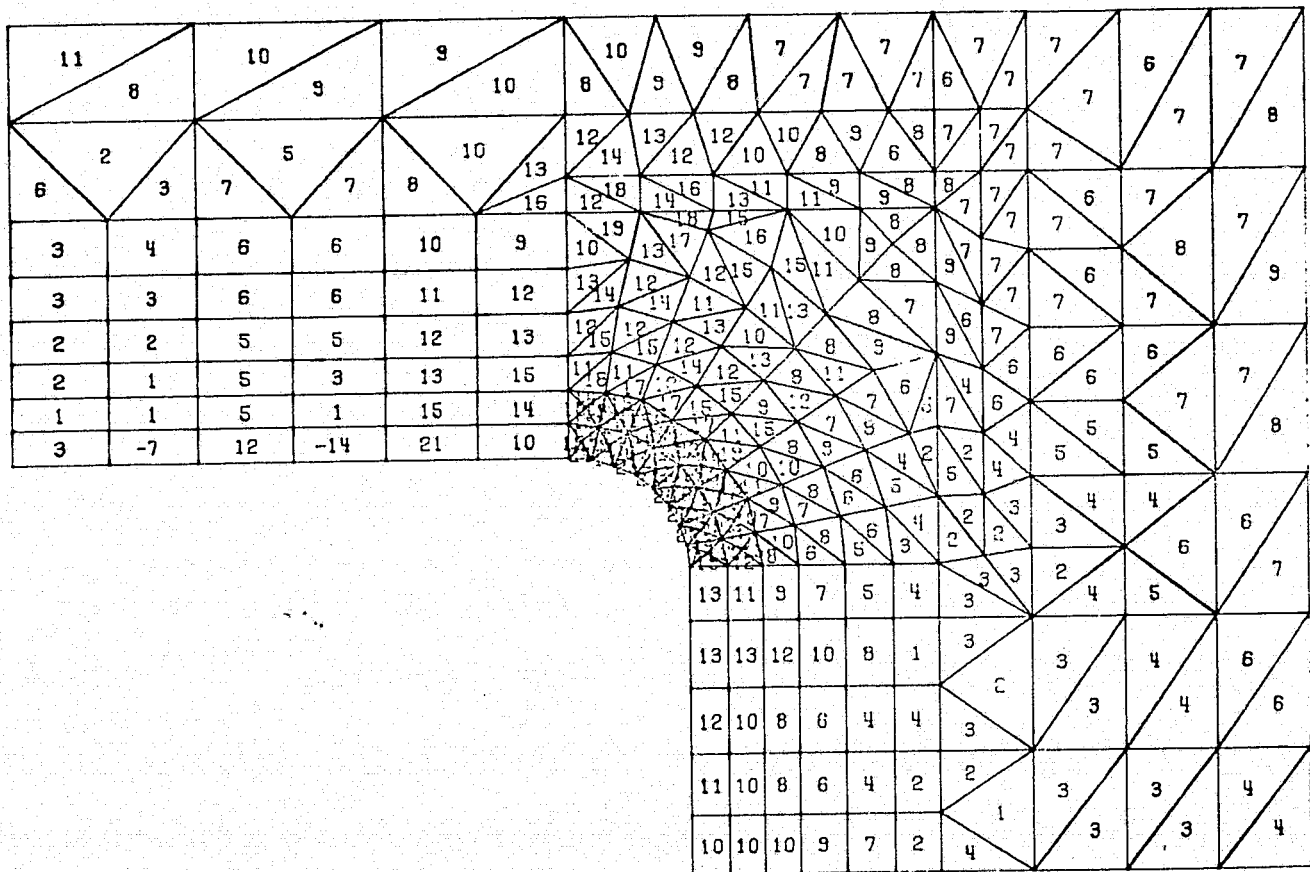
0 SCALE 21

Figure 26

REPRODUCIBILITY OF THE
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10/1/1

DISPLAY= PS1 /1000 , NODE= 1, SURFACE= 1



SPEC
4.1

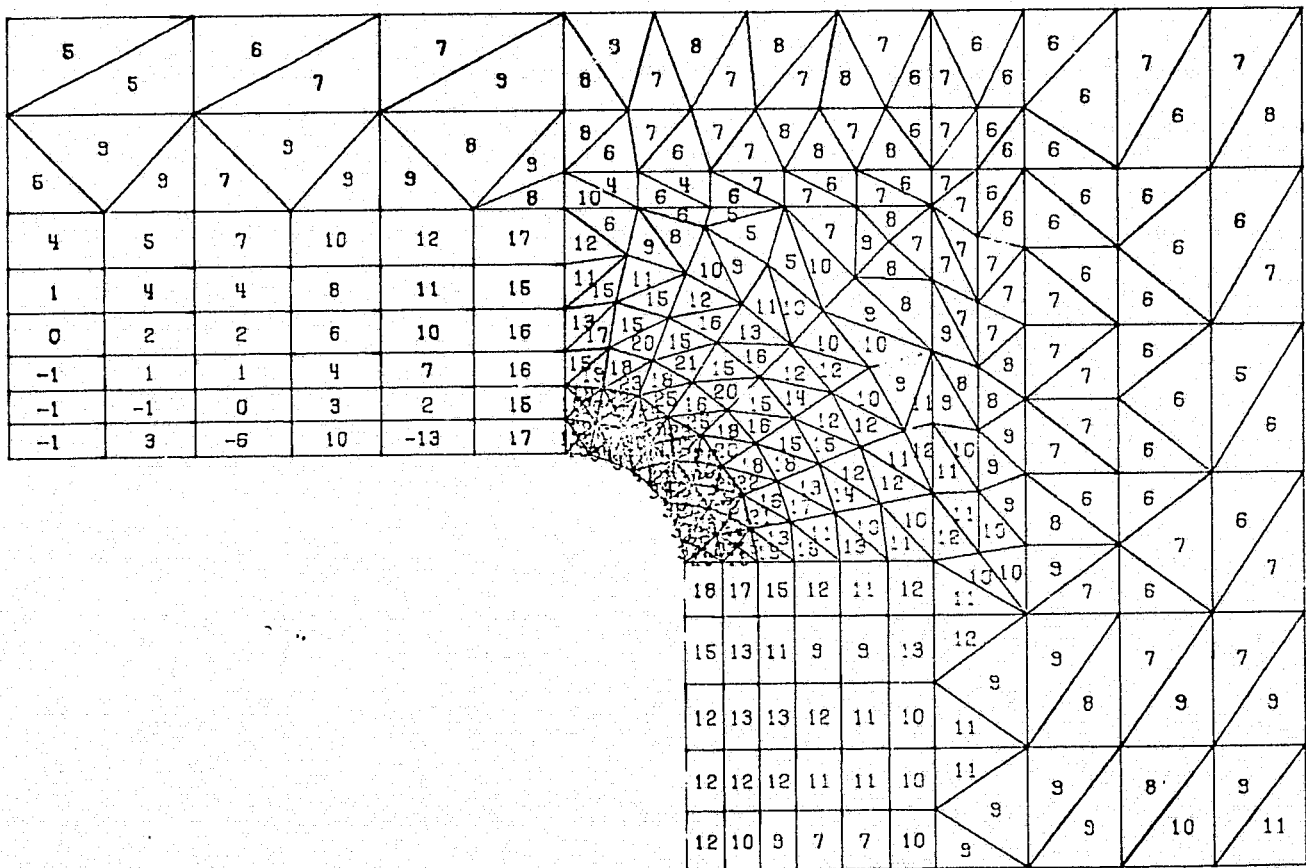
NTF 9 X 12 ACCESS OPENING
SHELL

0 SCALE 21

Figure 27

10/1/1

DISPLAY= PS1 /1000 , NODE= 1, SURFACE= 2



SPEC
4.1

NTF 9 X 12 ACCESS OPENING
SHELL

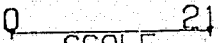
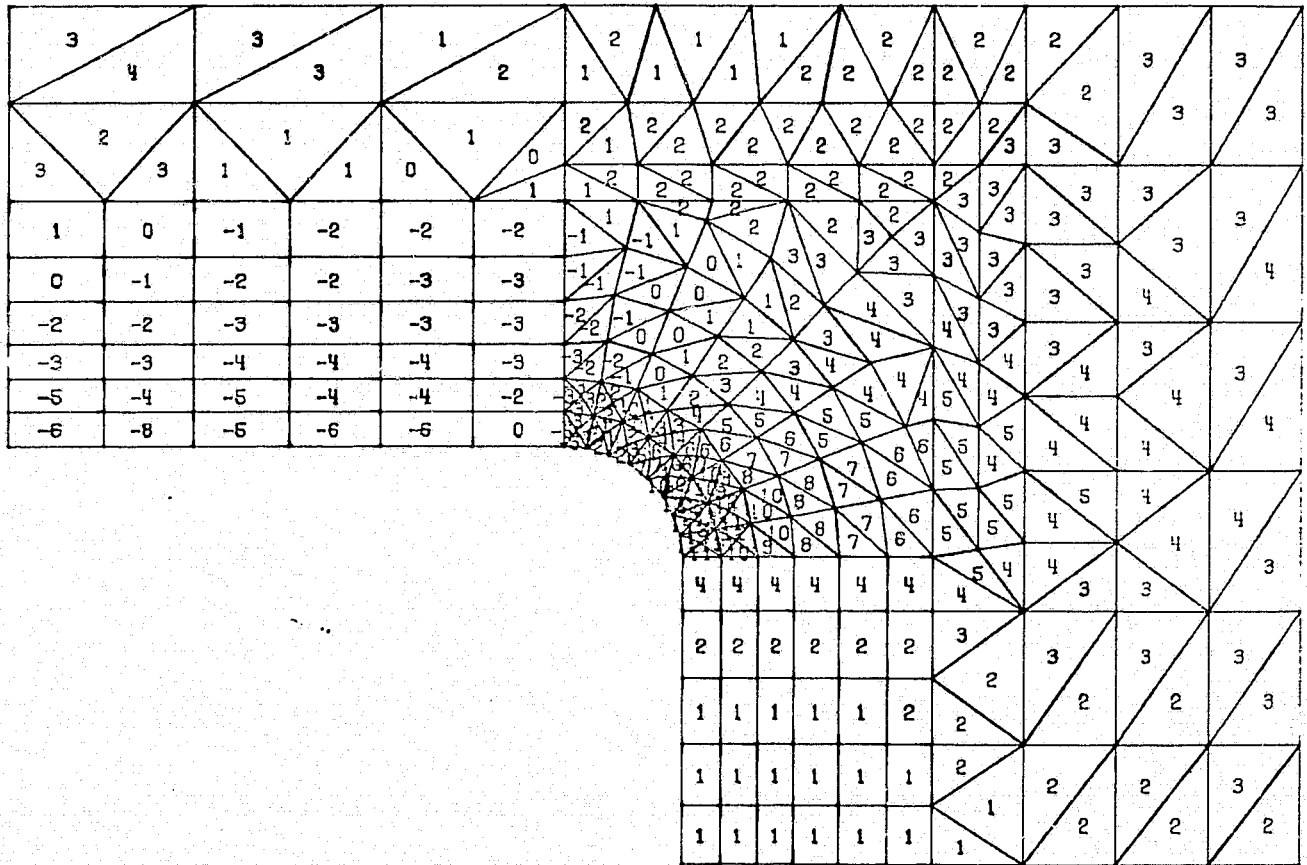
0  21
SCALE

Figure 28

REPRODUCIBILITY OF THE
ORIGINAL PAGE IS POOR

DISPLAY= PS2 /1000 , NODE= 1, SURFACE= 0

10/1/1



SPEC
4.1

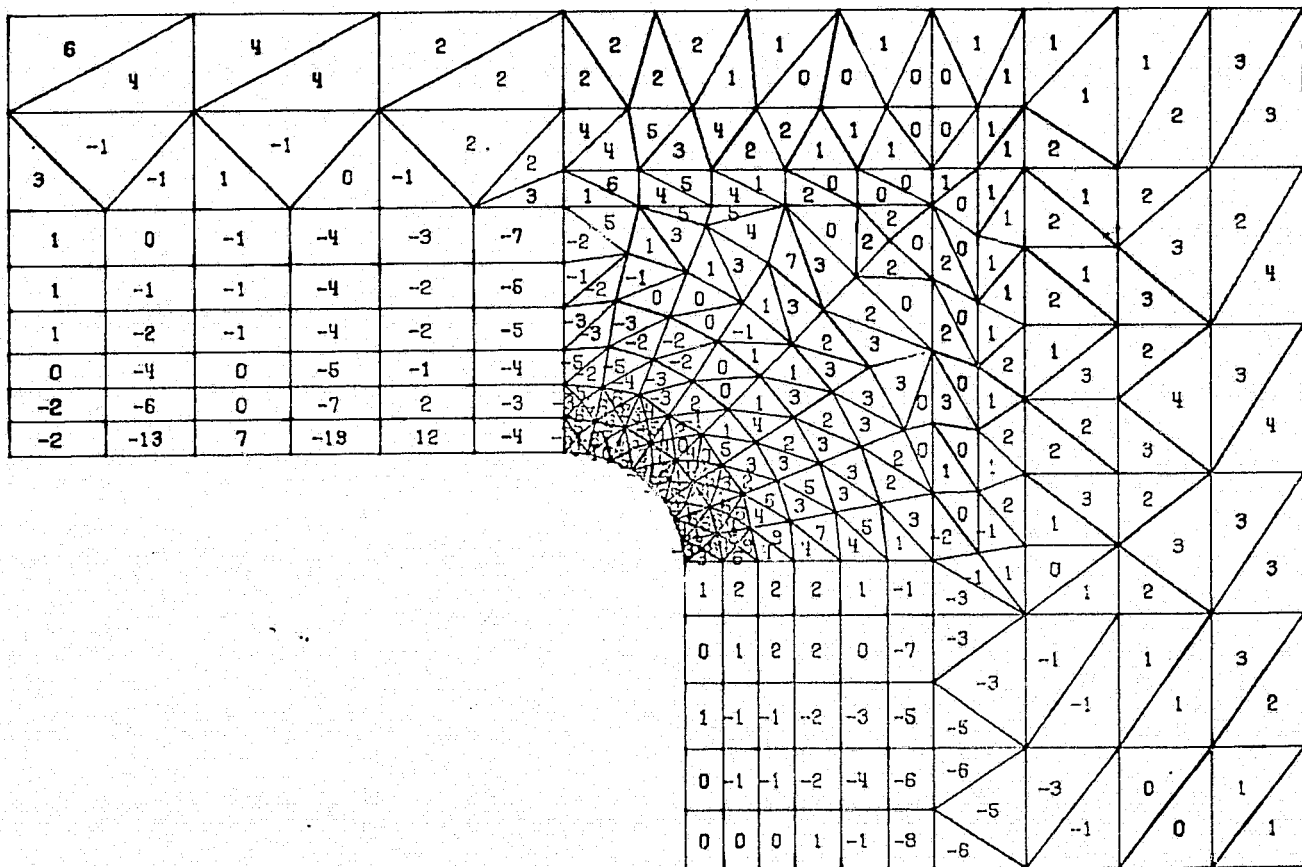
NTF 9 X 12 ACCESS OPENING
SHELL

0 SCALE 21

Figure 29

10/1/1

DISPLAY= PS2 /1000 , NODE= 1, SURFACE= 1



SPEC
4.1

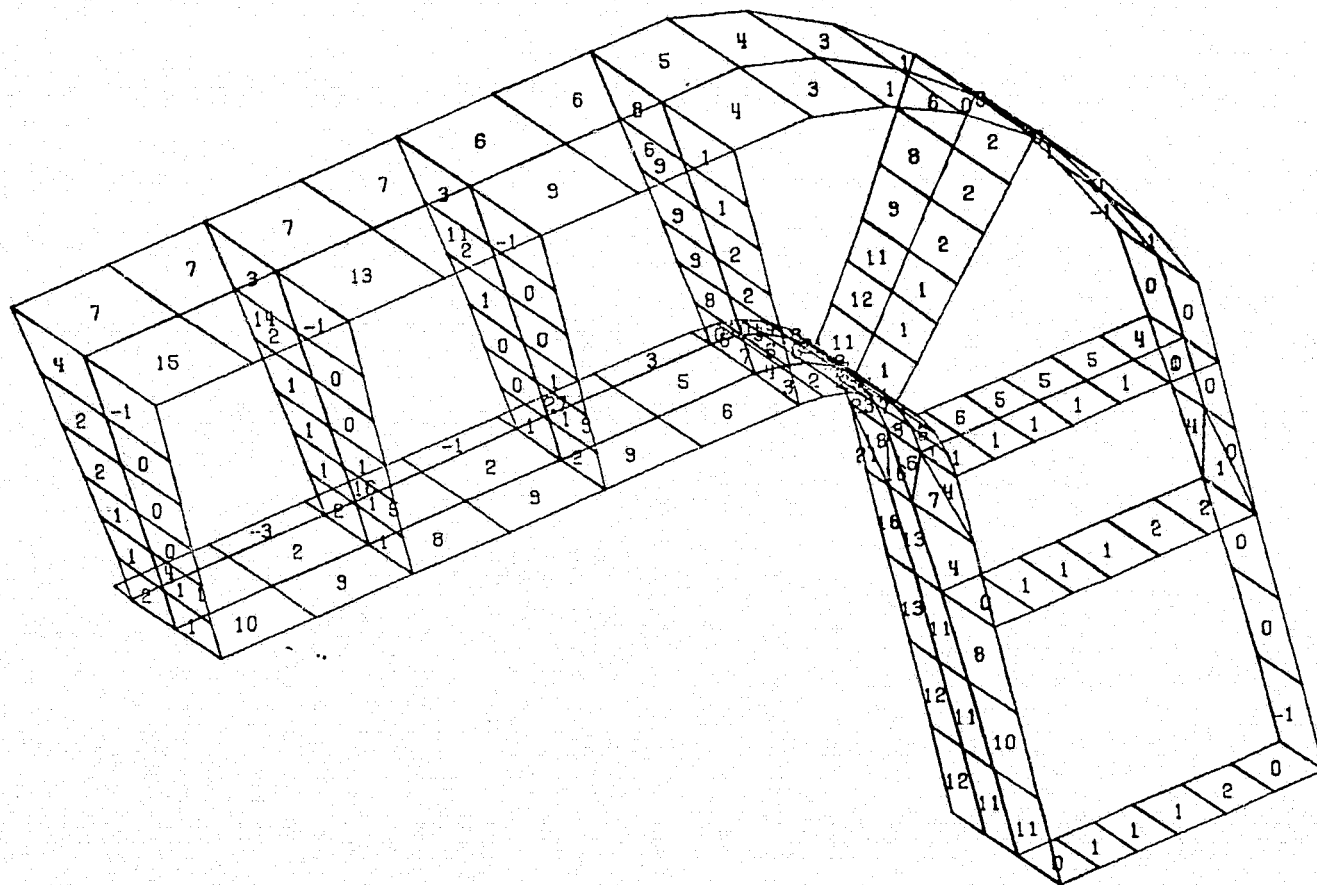
NTF 9 X 12 ACCESS OPENING
SHELL

0 SCALE 21

Figure 30

10/1/1

DISPLAY= PS1 /1000 , NODE= 1, SURFACE= 0



SPEC
5.1

NTF 9X12 ACCESS OPENING
GUSSET

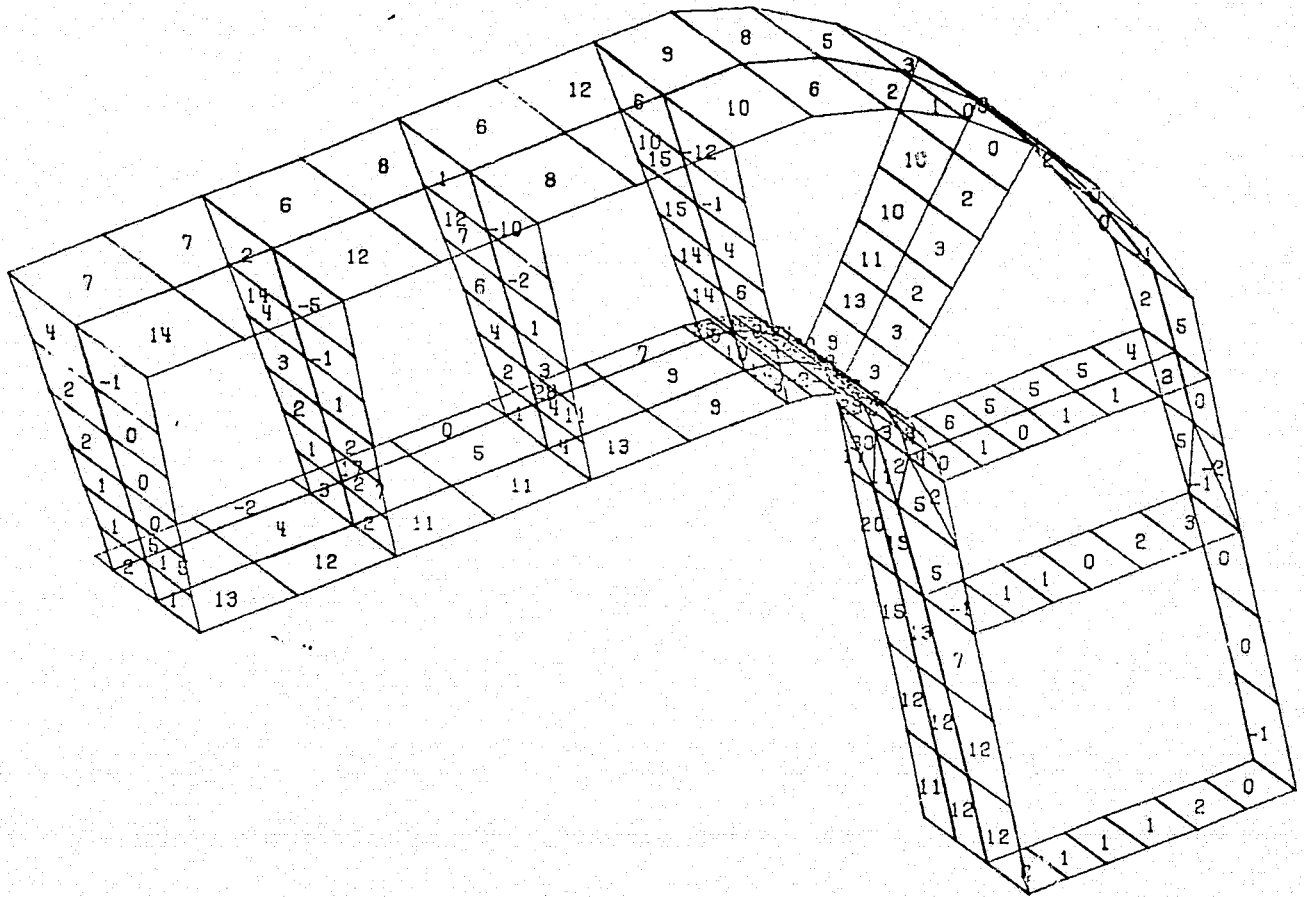
0 ——— 18
SCALE

Figure 32

REPRODUCIBILITY OF THE
ORIGINAL PAGE IS POOR

DISPLAY= PS1 /1000 , NODE= 1 , SURFACE= 1

10/1/1



SPEC
5.1

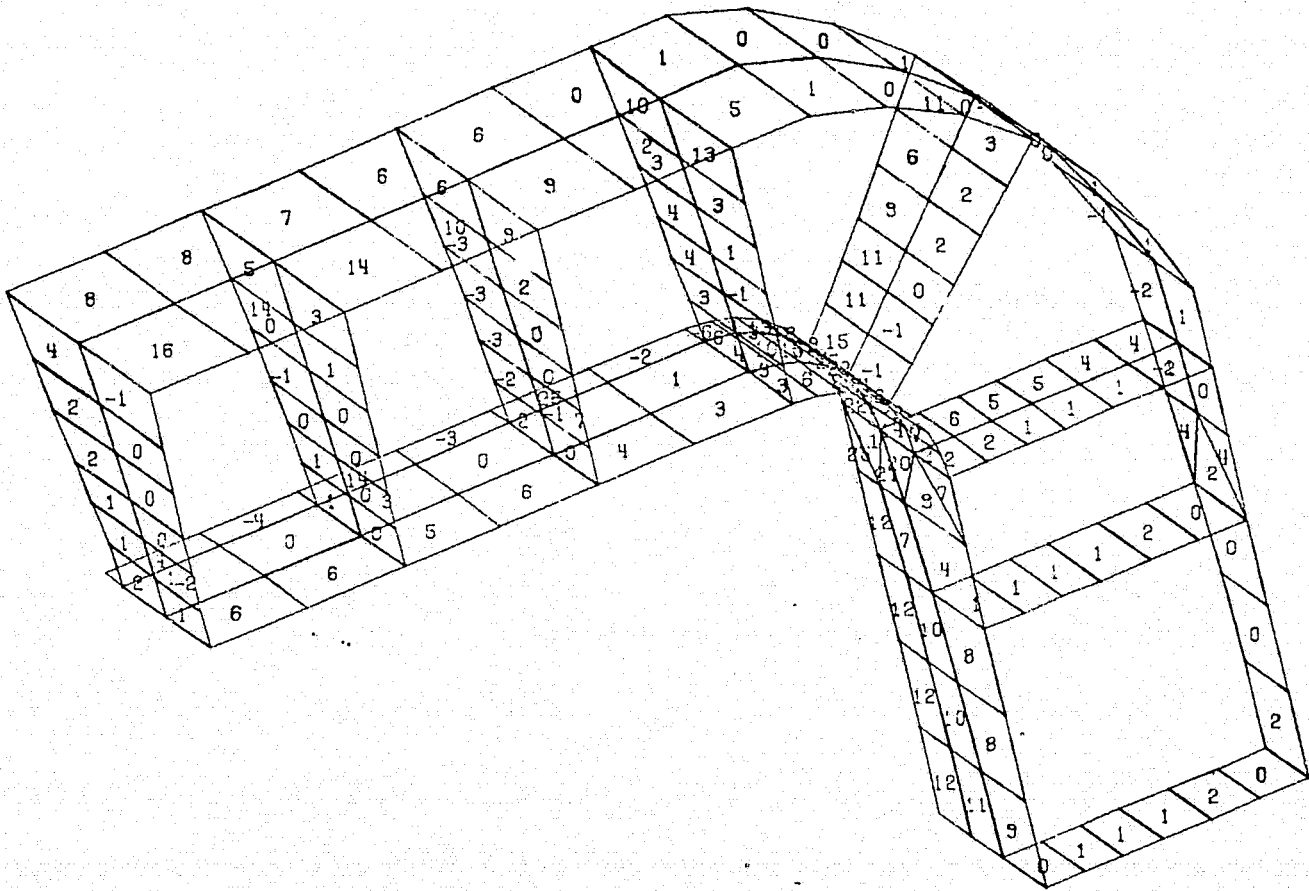
NTF 9X12 ACCESS OPENING
GUSSET

0 SCALE 18

Figure 33

10/1/1

DISPLAY= PS1 /1000 , NCDE= 1 , SURFACE= 2



SPEC
5.1

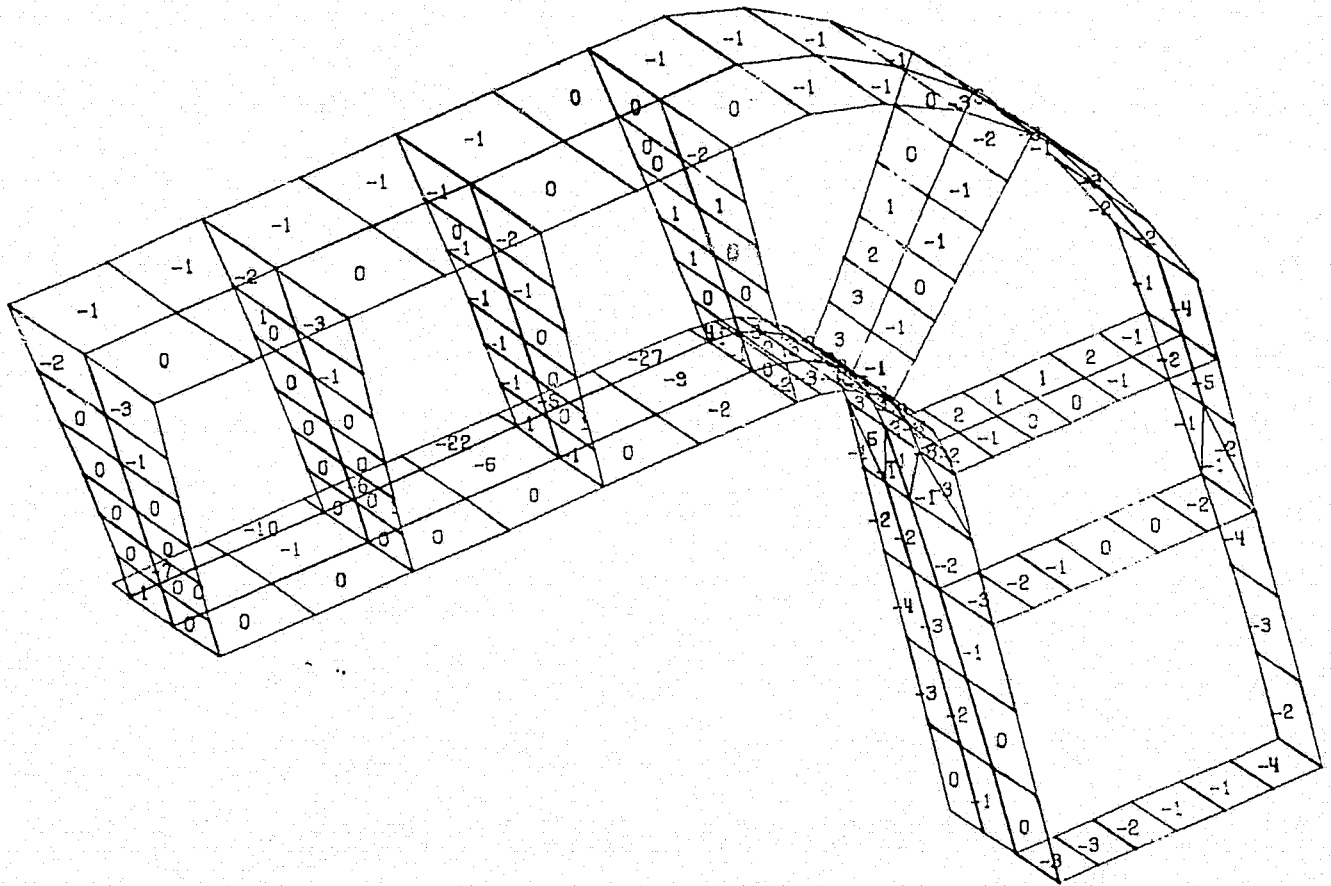
NTF 9X12 ACCESS OPENING
GUSSET

0 SCALE 18

Figure 34

10/1/1

DISPLAY= PS2 /1000 , NODE= 1, SURFACE= 0



SPEC
5.1

NTF 9X12 ACCESS OPENING
GUSSET

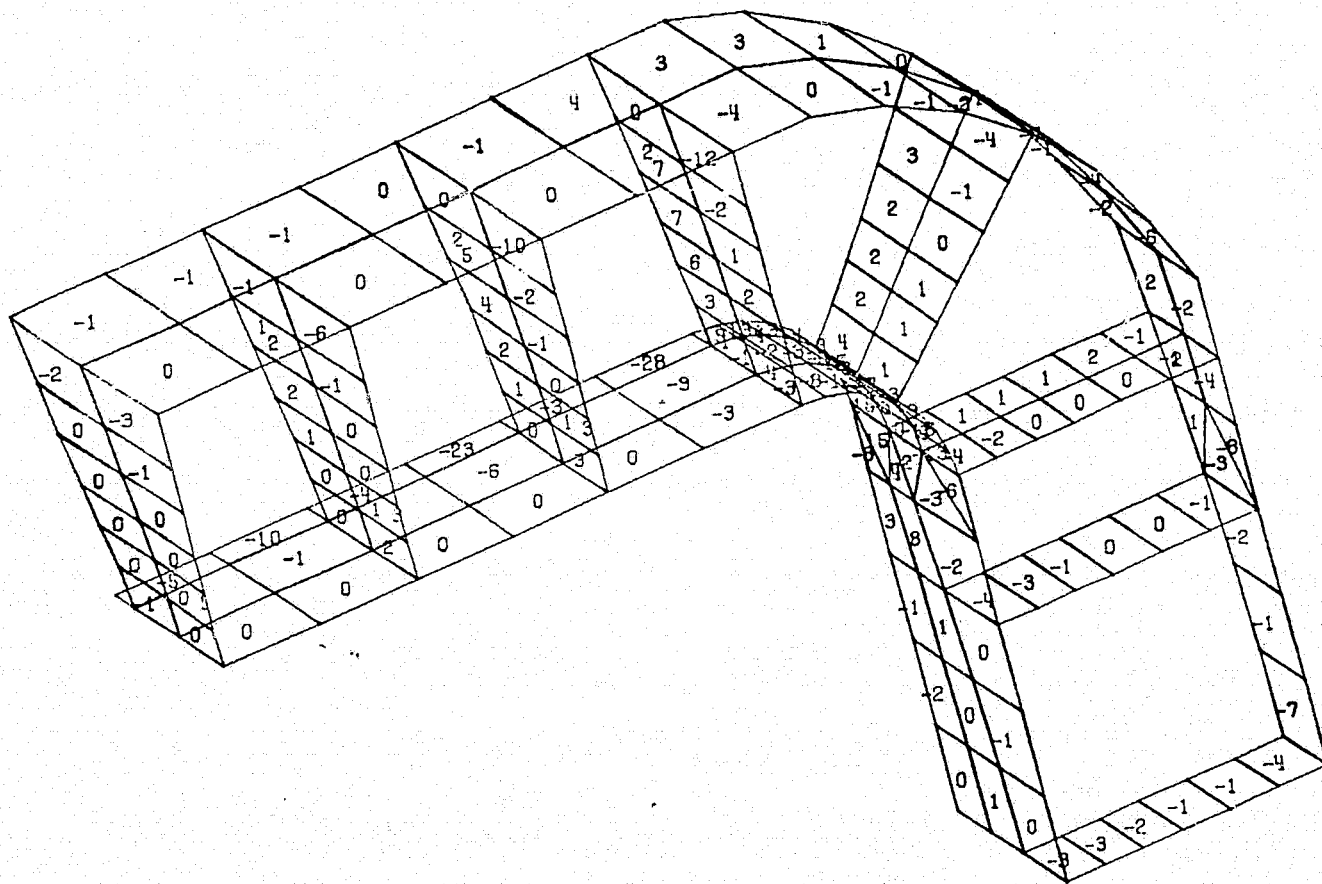
0 18
SCALE

Figure 35

REPRODUCIBILITY OF THE
ORIGINAL PAGE IS POOR

10/1/1

DISPLAY= PS2 /1000 , NODE= 1 , SURFACE= 1



SPEC
5.1

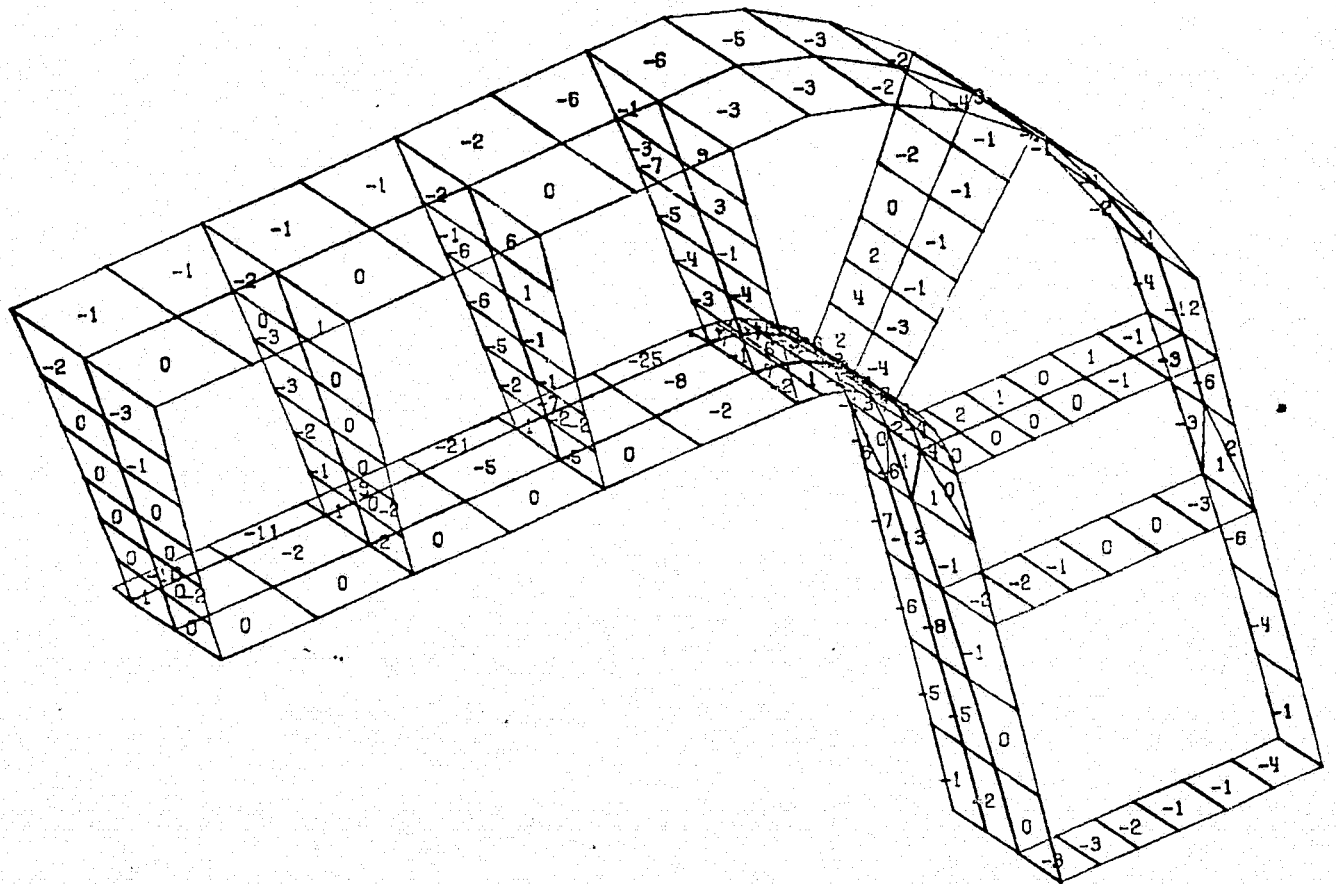
NTF 9X12 ACCESS. OPENING
GUSSET

Figure 36

0 SCALE 18

10/1/1

DISPLAY= PS2 /1000 , NODE= 1, SURFACE= 2



SPEC
5.1

NTF 9X12 ACCESS OPENING
GUSSET

0 SCALE 18

Figure 37

DISPLAY= PS1 /1000 , NODE= 1, SURFACE= 0

10/1/1

12	11	11
12	11	10
13	11	8
16	13	4
21	16	7
18	16	4
23	8	1
23	7	1
23	7	1
21	7	1
18	7	1
14	6	2
10	6	2
10	7	3
3	5	6
27	9	9
-1	2	9
16	5	8
-3	2	9
4	1	10

SPEC
6.1

NTF 9X12 REINF.
INNER RING

Q SCALE 14

Figure 38

10/1/1

DISPLAY= PS1 /1000 , NODE= 1 , SURFACE= 1

11	12	12
12	12	12
15	13	7
20	19	5
17	11	5
30	12	2
29	3	4
26	0	3
28	-2	2
30	-4	2
24	-3	0
20	-2	-1
18	2	-2
25	10	3
7	9	9
28	11	13
0	5	11
17	7	11
-2	4	12
6	5	13

SPEC
6.1

NTF 9X12 REINF.
INNER RING

0 SCALE 14

Figure 39

DISPLAY= PS1 /1000 . NODE= 1, SURFACE= 2

10/1/1

12	11	9
12	10	8
12	10	8
12	7	4
25	21	9
11	20	7
22	14	-2
26	19	0
25	21	3
19	22	8
18	19	7
13	15	7
4	10	6
-6	4	3
-2	1	3
26	7	4
-3	0	6
14	3	5
-4	0	6
4	-2	6

SPEC
6.1

NTF 9X12 REINF.
INNER RING

0 SCALE 14

Figure 40

DISPLAY= PS2 /1000 , NODE= 1 , SURFACE= 0

10/1/1

0	-1	0
-3	-2	0
-4	-3	-1
-2	-2	-2
-1	-1	-1
5	-1	-3
3	2	-8
0	3	-8
0	3	-8
0	2	-7
0	3	-6
0	3	-4
-1	2	-3
4	-1	-2
-27	-9	-2
-5	1	0
-22	-8	0
-6	1	0
-10	-1	0
-7	0	0

SPEC
6.1

NTF 9X12 REINF.
INNER RING

0 SCALE 14

Figure 41

DISPLAY= PS2 /1000 , NODE= 1, SURFACE= 1

10/1/1

0	1	0
-2	0	-1
-1	1	0
3	8	-2
-8	4	-3
15	-2	-6
15	0	-13
13	-5	-16
16	-7	-19
19	-8	-23
14	-6	-17
13	-3	-12
13	-2	-8
19	-1	-3
-28	-3	-3
-3	3	0
-23	-6	0
-4	3	0
-10	-1	0
-6	1	0

SPEC
6.1

NTF 9X12 REINF.
INNER RING

0 SCALE 14

Figure 42

10/1/1

DISPLAY= PS2 /1000 , NODE= 1 , SURFACE= 2

-1	-2	0
-5	-5	0
-6	-8	-1
-7	-13	-1
6	-6	1
-10	1	0
-19	2	-4
-19	7	-1
-23	8	0
-26	9	0
-20	8	1
-16	8	1
-15	6	1
-11	-1	-2
-25	-8	-2
-7	-2	0
-21	-5	0
-9	-2	0
-11	-2	0
-10	-2	0

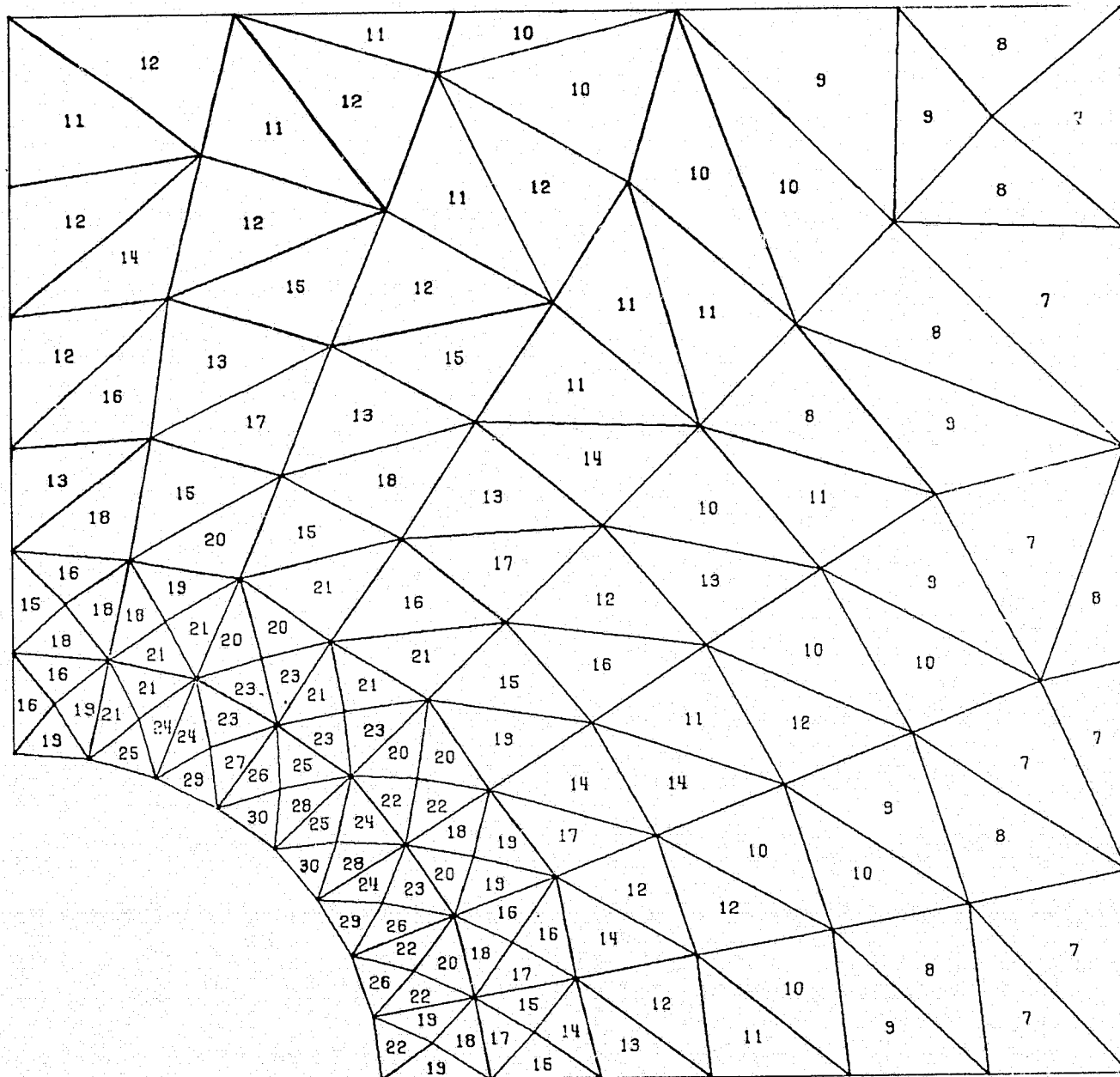
SPEC 6.1 NTF 9X12 REINF. INNER RING

0 SCALE

Figure 43

10/1/1

DISPLAY= PS1 /1000 , NODE= 1 , SURFACE= 0



SPEC
8.1

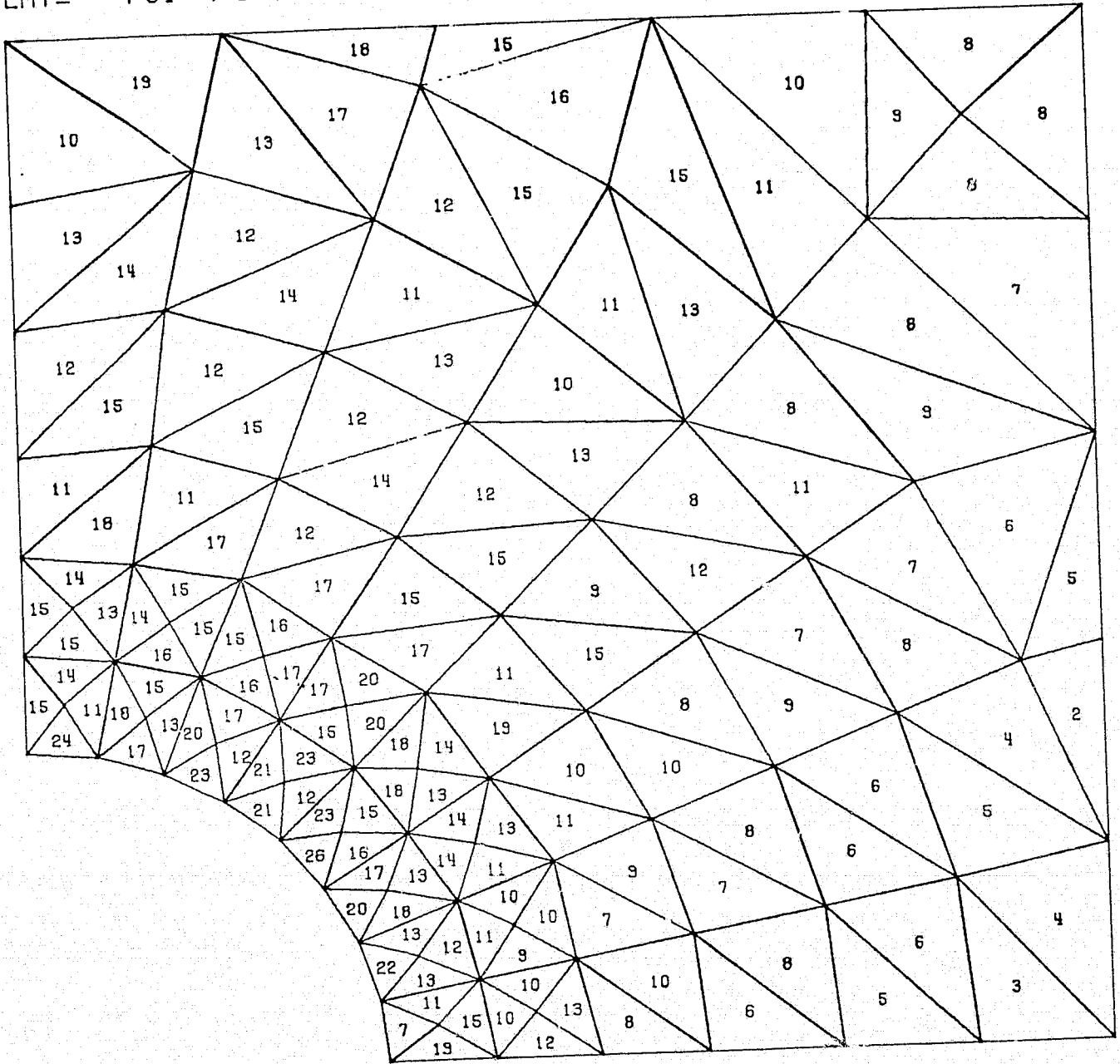
NTF 9 X 12 REINF
CENTER TRIANGLES

0 ——— 6
SCALE

Figure 44

10/1/1

DISPLAY= PS1 /1000 , NODE= 1 , SURFACE= 1



SPEC
8.1

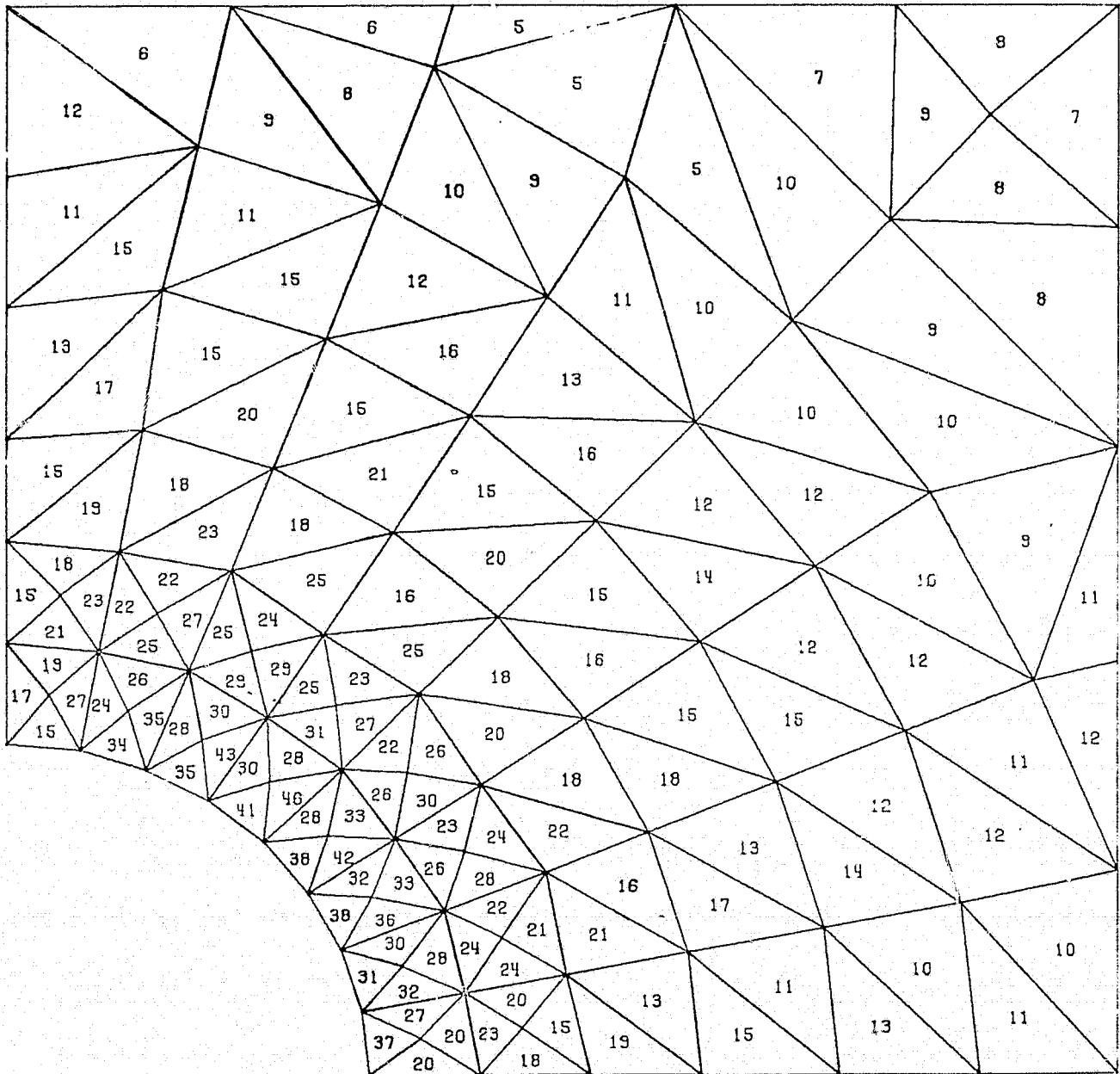
NTF 9 X 12 REINF
CENTER TRIANGLES

0 SCALE 6

Figure 45

DISPLAY= PS1 /1000 , NODE= 1, SURFACE= 2

10/1/1



SPEC
8.1

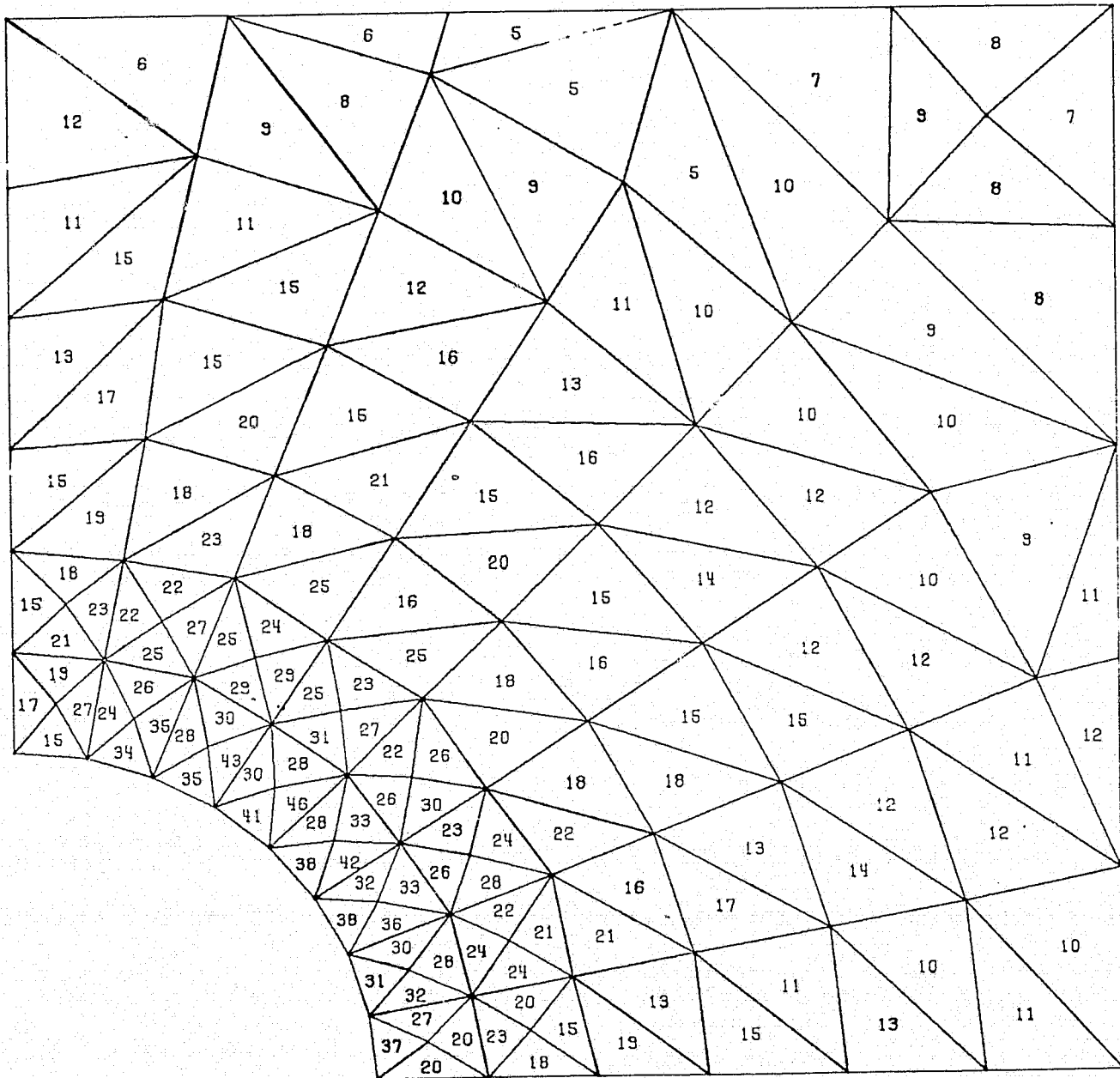
NTF 9 X 12 REINF
CENTER TRIANGLES

0 SCALE 6

Figure 46

10/1/1

DISPLAY= PS1 /1000 , NODE= 1 , SURFACE= 2



SPEC
8.1

NTF 9 X 12 REINF
CENTER TRIANGLES

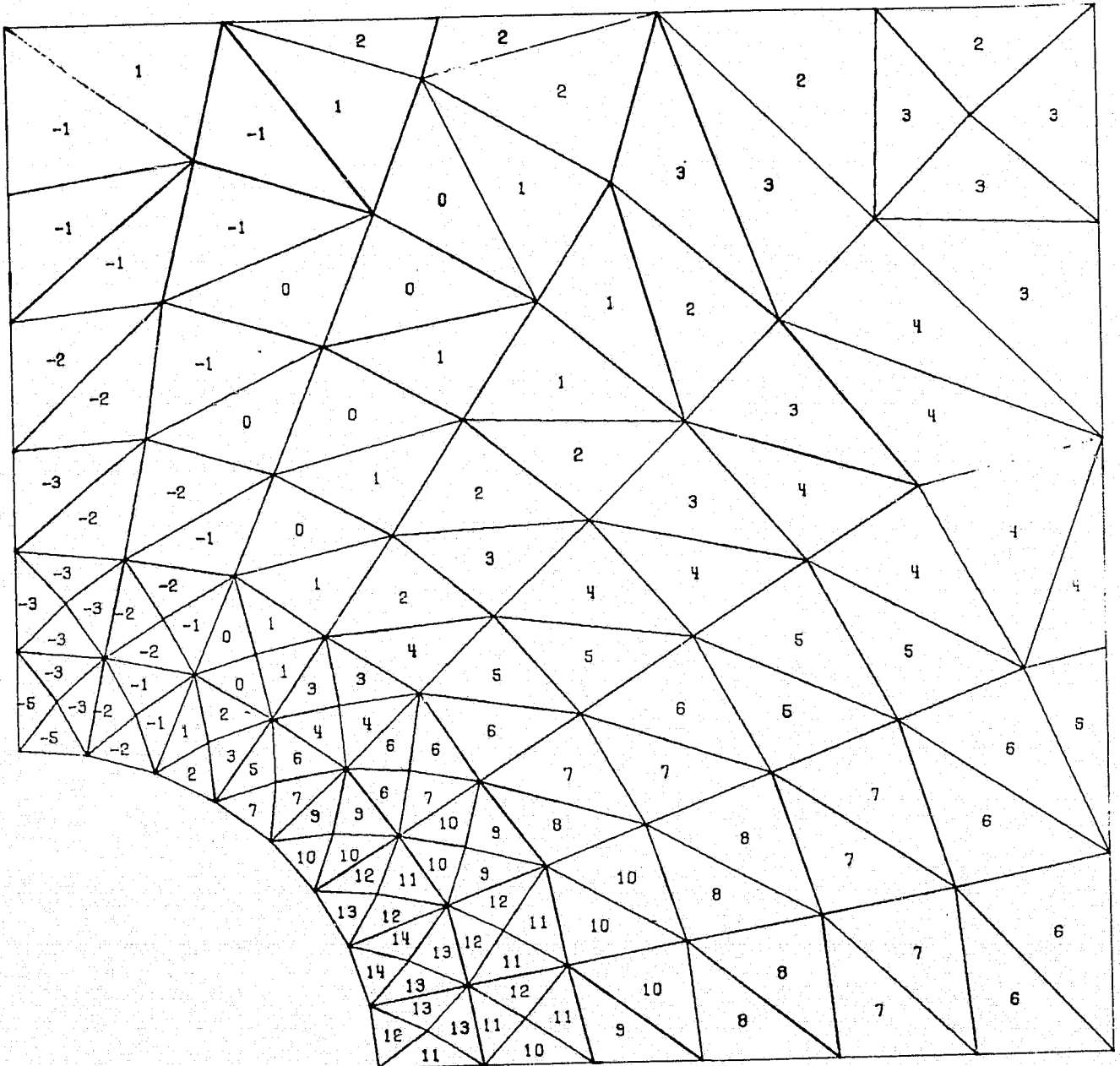
0 SCALE 6

Figure 46

22

10/1/1

DISPLAY= PS2 /1000 , NODE= 1, SURFACE= 0



SPEC
8.1

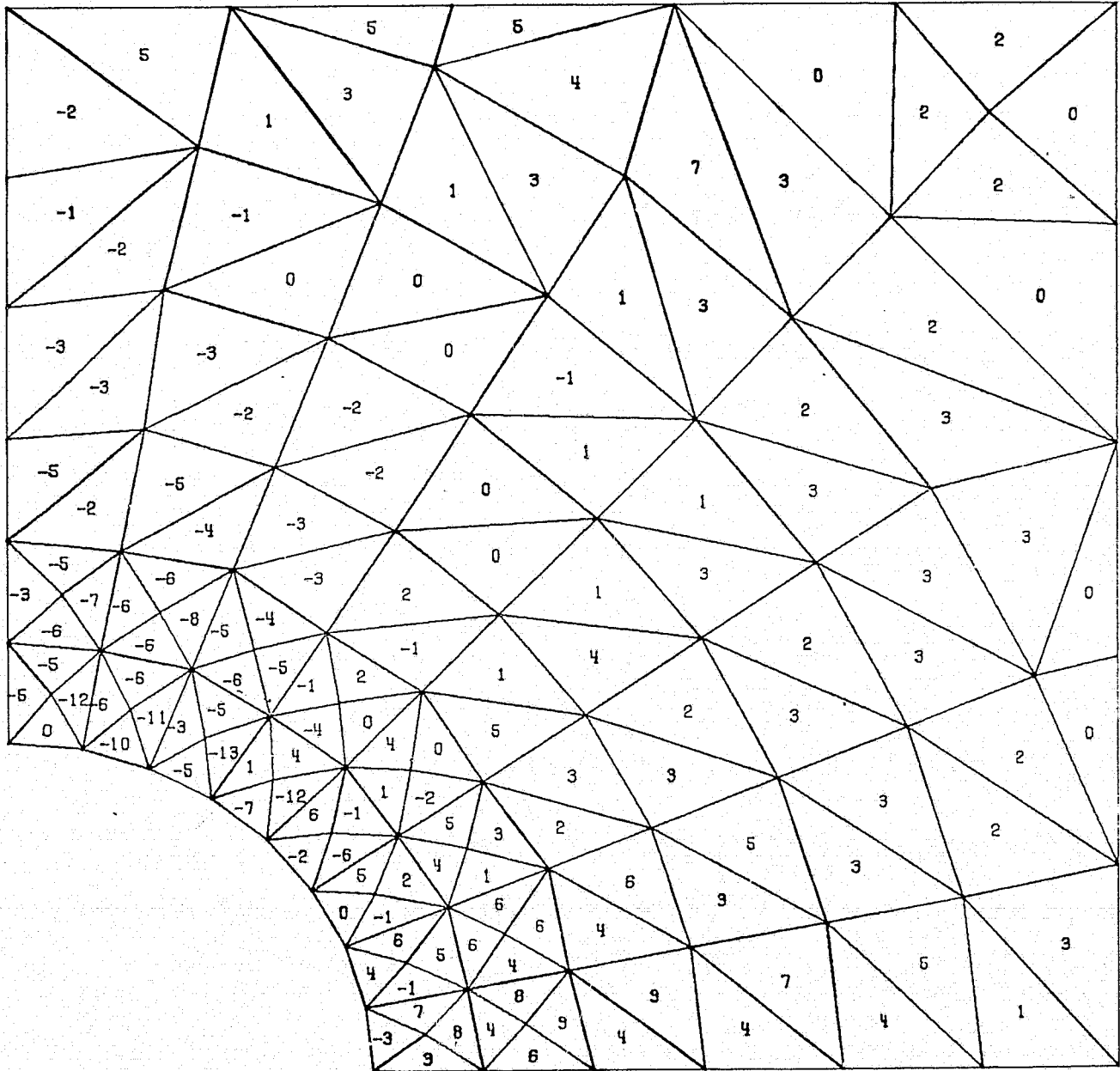
NTF 9 X 12 REINF
CENTER TRIANGLES

0 SCALE 6

Figure 47

10/1/1

DISPLAY= PS2 /1000 , NODE= 1 , SURFACE= 1



SPEC
8.1

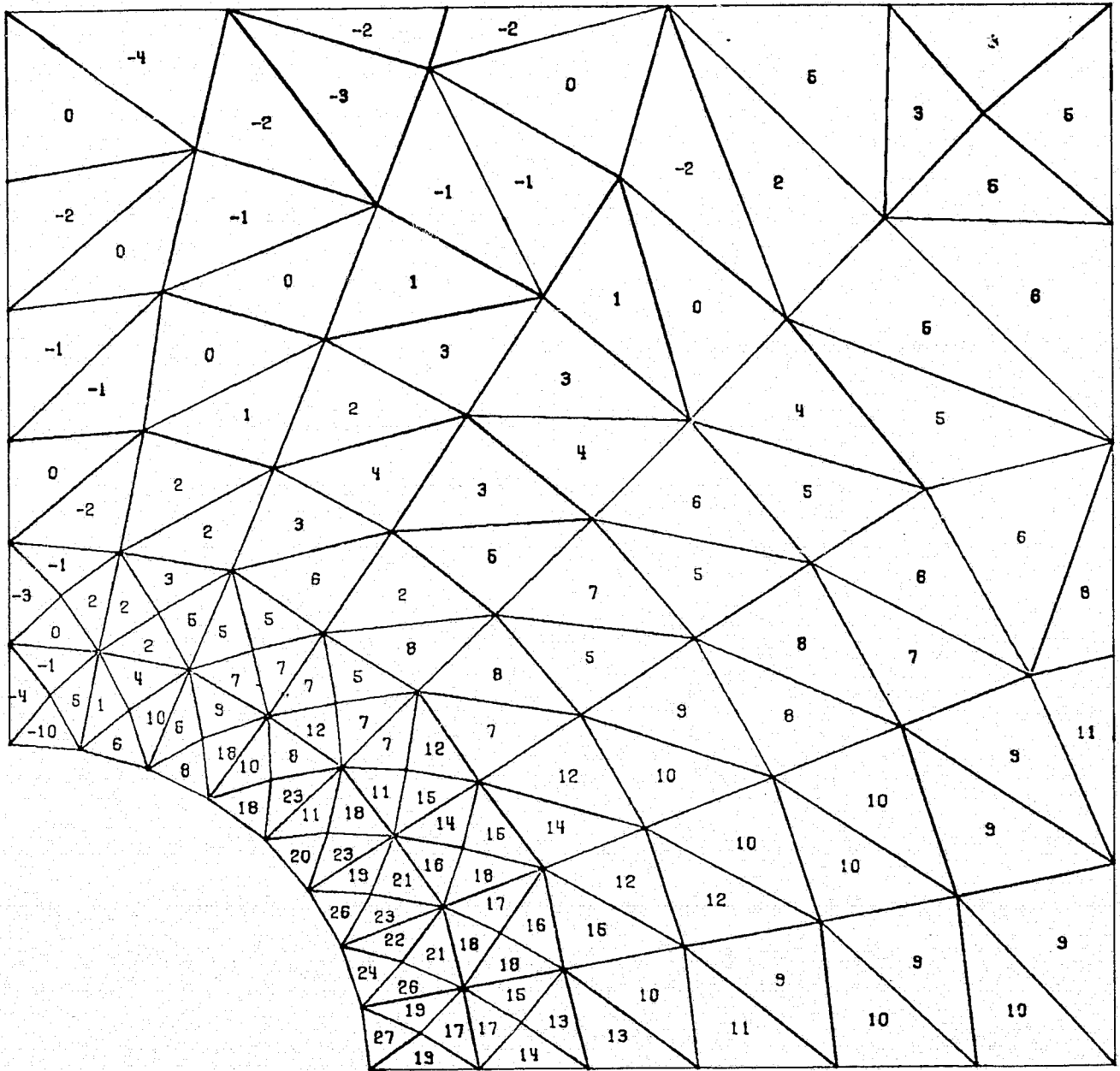
NIF 9 X 12 REINF
CENTER TRIANGLES

0 SCALE 6

Figure 48

DISPLAY= PS2 /1000 , NODE= 1, SURFACE= 2

10/1/1



SPEC
8.1

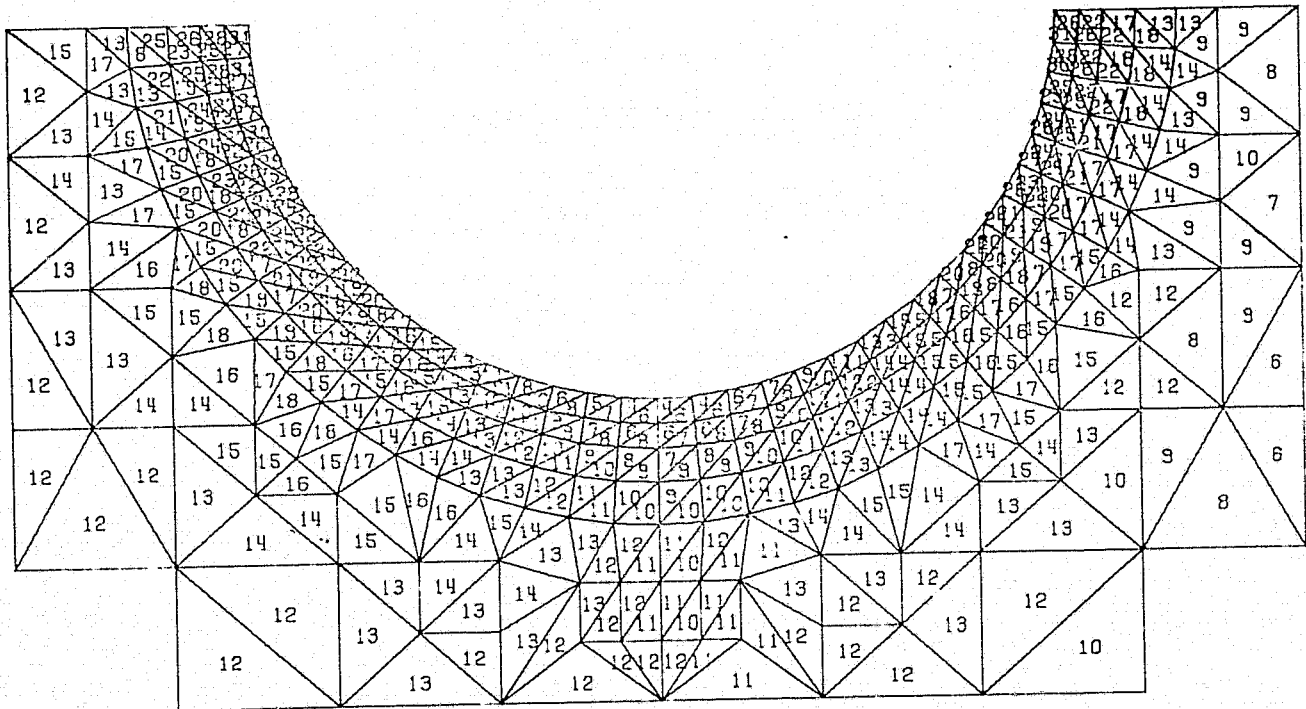
NTF 9 X 12 REINF
CENTER TRIANGLES

0 SCALE 6

Figure 49

10/1/1

DISPLAY= PS1 /1000 , NODE= 1, SURFACE= 0



SPEC
9.1

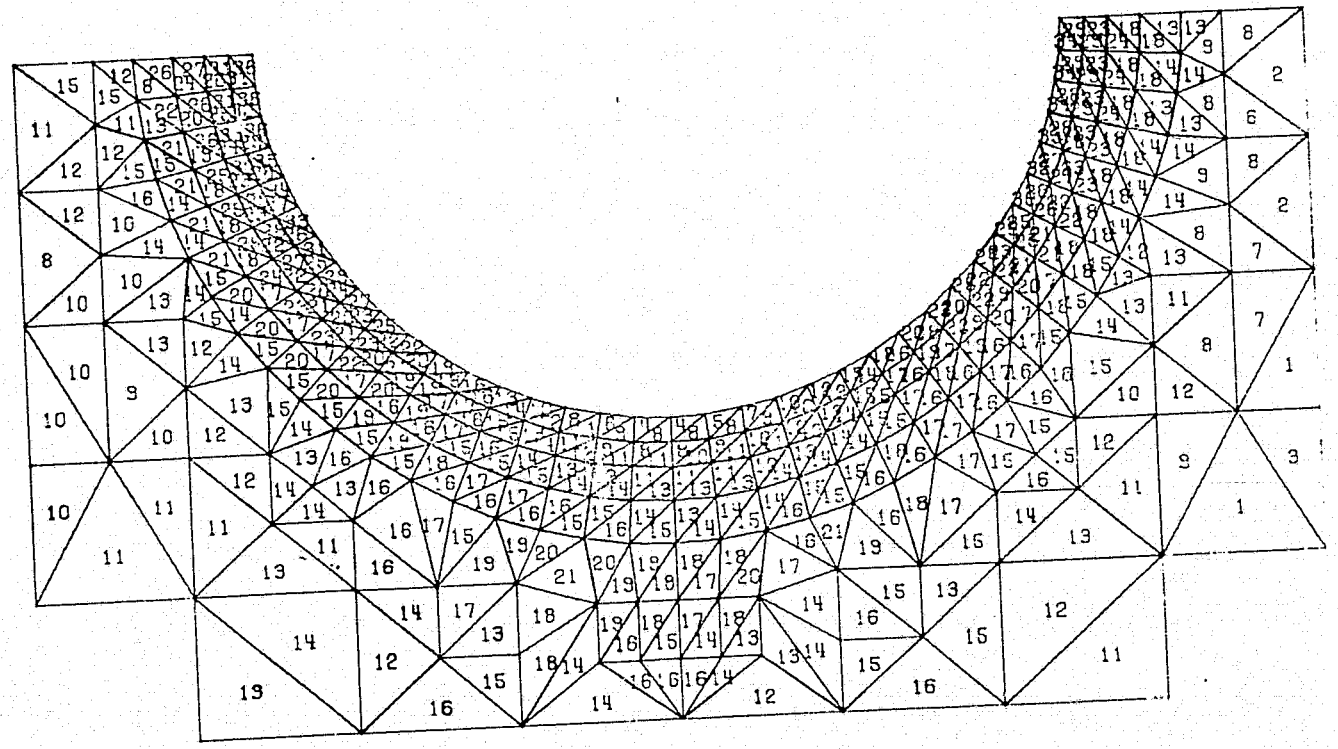
9 X 12 REINF WITH 9 FT HOLE
TRIANGLES AROUND 9 FT HOLE

Q SCALE 24

Figure 50

10/1/1

DISPLAY= PS1 /1000 , NODE= 1 , SURFACE= 1



SPEC
9.1

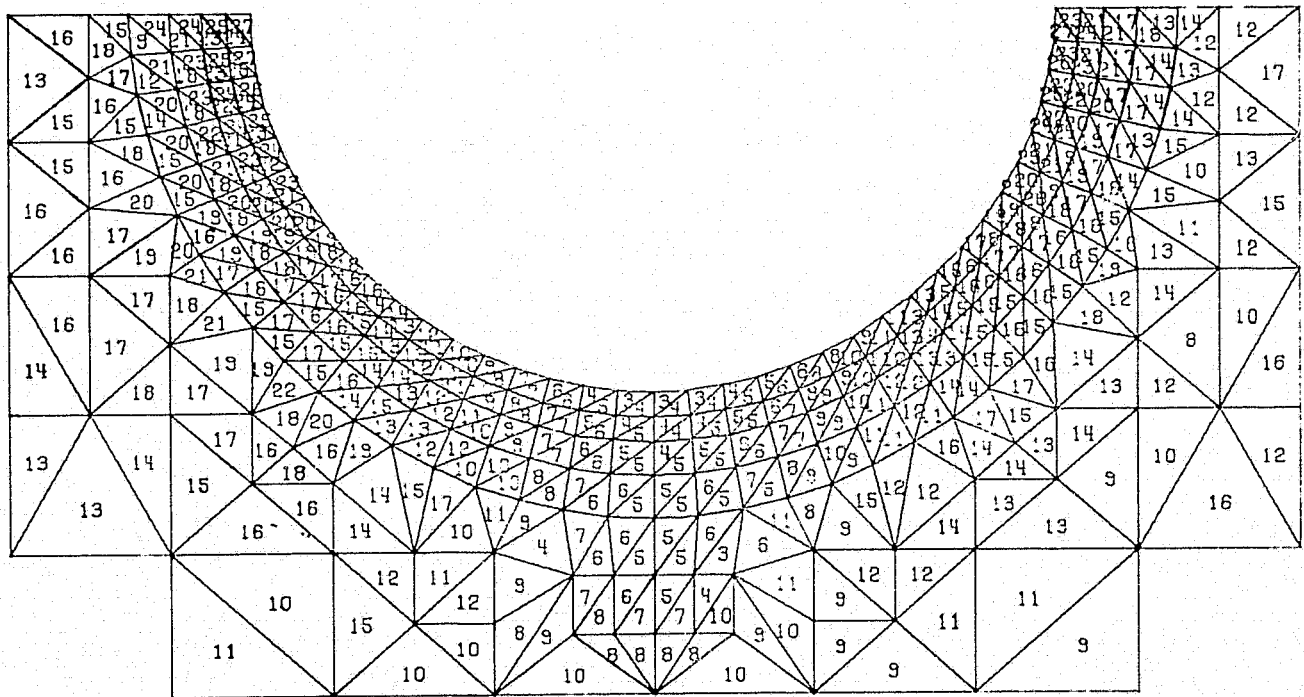
9 X 12 REINF WITH 9 FT HOLE
TRIANGLES AROUND 9 FT HOLE

0 SCALE 24

Figure 51

DISPLAY= PS1 /1000 , NODE= 1 , SURFACE= 2

10/1/1



SPEC
9.1

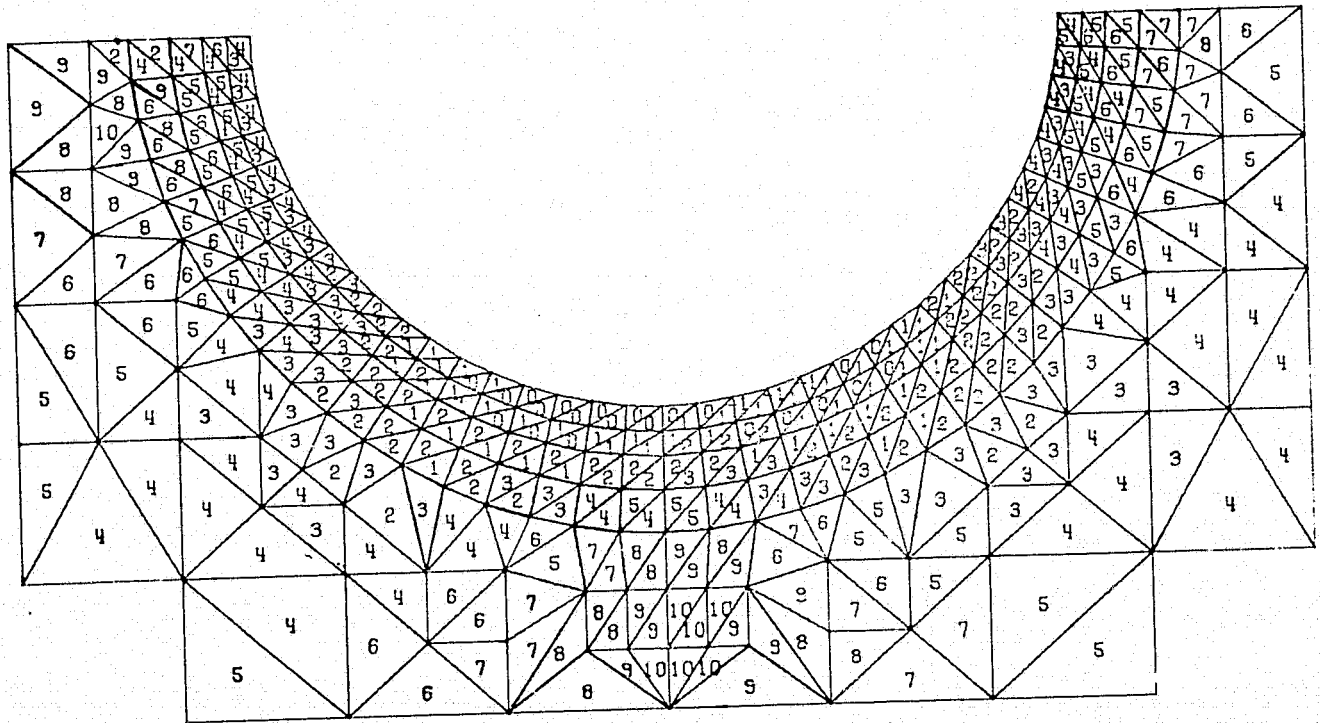
9 X 12 REINF WITH 9 FT HOLE
TRIANGLES AROUND 9 FT HOLE

0 SCALE 24

Figure 52

10/1/1

DISPLAY= PS2 /1000 , NODE= 1, SURFACE= 0



SPEC
9.1

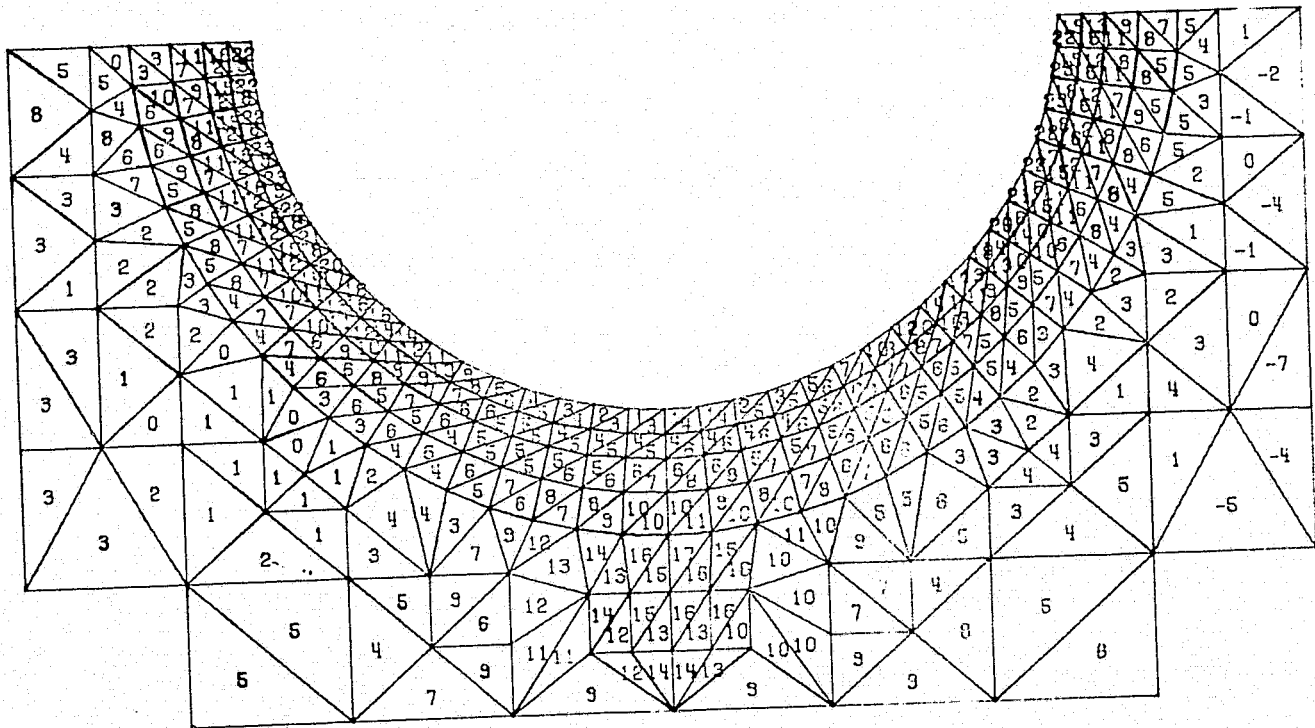
9 X 12 REINF WITH 9 FT HOLE
TRIANGLES AROUND 9 FT HOLE

0 ——— 24
SCALE

Figure 53

10/1/1

DISPLAY= PS2 /1000 , NODE= 1, SURFACE= 1



SPEC
9.1

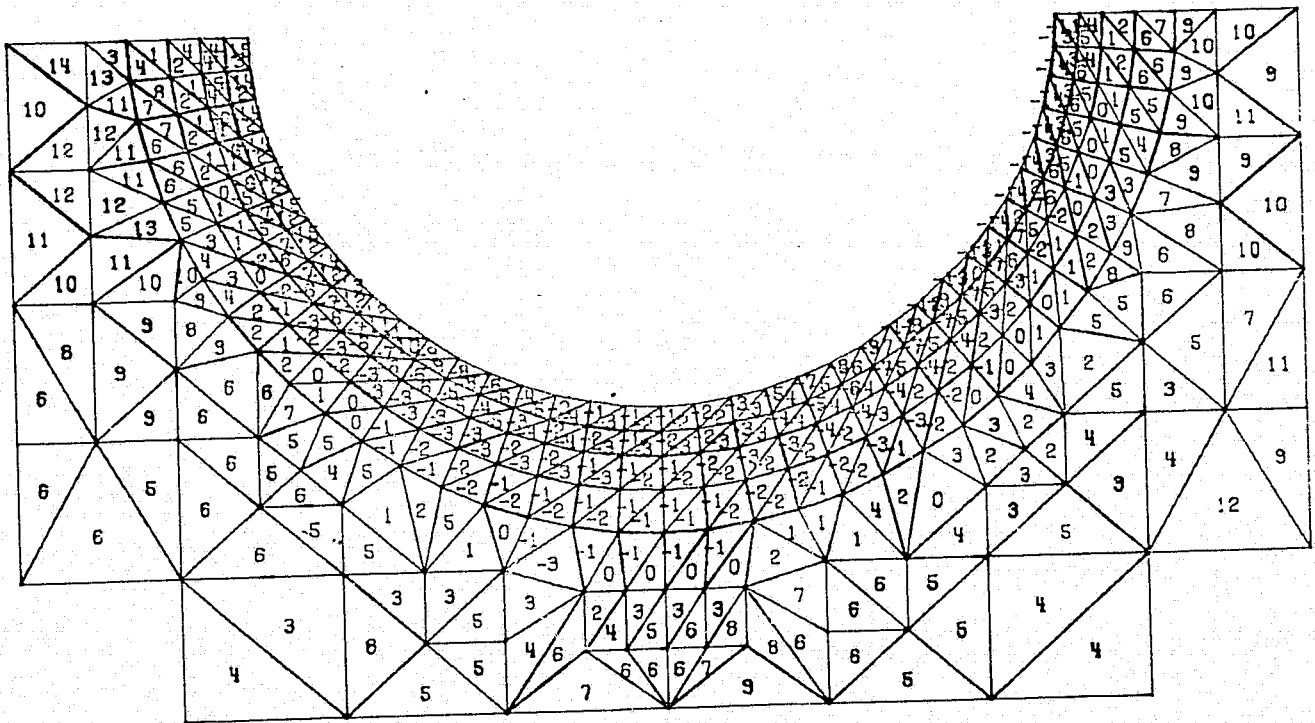
9 X 12 REINF WITH 9 FT HOLE
TRIANGLES AROUND 9 FT HOLE

0 ——— 24
SCALE

Figure 54

10/1/1

DISPLAY= PS2 /1000 , NODE= 1, SURFACE= 2



SPEC
9.1

9 X 12 REINF WITH 9 FT HOLE
TRIANGLES AROUND 9 FT HOLE

0 SCALE 24

Figure 55

DISPLAY= PS1 /1000 , NODE= 1 , SURFACE= 0

10/1/1

2	2	3	3	3	3	3	4	4	4	5	5	6	6	7	7	7	7
3	3	3	3	3	4	4	4	5	6	7	8	9	10	11	12	13	13
4	4	4	4	5	6	6	7	9	10	12	14	15	17	18	20	20	21
3	4	4	6	8	10	12	14	16	19	21	23	25	26	27	28	29	30

SPEC
10.1

9 X 12 REINF WITH 9 FT HOLE
9 FT PIPE SECTION 1

0 SCALE 11

Figure 56

10/1/1

DISPLAY= PS1 /1000 , NODE= 1, SURFACE= 1

4	4	4	4	4	4	5	5	5	5	5	5	5	5	5	5	4	4
2	2	2	1	1	1	1	1	1	1	2	3	5	6	7	8	9	9
5	5	5	5	5	5	6	7	8	9	11	13	14	16	18	19	20	20
5	6	7	9	11	14	17	20	22	25	27	29	30	32	33	34	35	33

SPEC
10.1

9 X 12 REINF WITH 9 FT HOLE
9 FT PIPE SECTION 1

Q SCALE 11

Figure 57

10/1/1

DISPLAY= PS1 /1000 , NODE= 1 , SURFACE= 2

1	1	1	2	2	2	3	3	4	4	5	6	7	6	9	10	10	10
4	4	5	6	7	9	11	13	15	16	18	19	19	19	20	20	20	19
3	3	3	4	5	6	7	8	10	11	13	15	16	18	19	20	21	22
1	1	2	3	4	5	7	9	11	13	15	17	19	21	22	23	23	23

SPEC
10.1

9 X 12 REINF WITH 9 FT HOLE
9 FT PIPE SECTION 1

0 SCALE 11

Figure 58

10/1/1

DISPLAY= PS2 /1000 , NCDE= 1 , SURFACE= 0

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

SPEC
10.1

9 X 12 REINF WITH 9 FT HOLE
9 FT PIPE SECTION 1

0 SCALE 11

Figure 59

10/1/1

DISPLAY= PS2 /1000 , NODE= 1 , SURFACE= 1

3	2	2	2	2	2	2	2	2	2	3	3	3	3	4	4	4	4	4
-7	-7	-7	-8	-8	-8	-8	-8	-8	-8	-8	-8	-7	-7	-6	-6	-6	-5	-5
-2	-2	-2	-1	-1	0	0	0	0	1	1	2	3	3	4	5	5	5	6
0	1	3	5	7	9	12	14	16	17	19	20	21	22	23	23	24	24	24

SPEC
10.1

9 X 12 REINF WITH 9 FT HOLE
9 FT PIPE SECTION 1

Q SCHLE 11

Figure 60

10/1/1

DISPLAY= PS2 /1000 , NODE= 1 , SURFACE= 2

-7	-7	-6	-5	-4	-3	-2	0	1	3	4	5	5	6	6	7	7	7
1	2	3	4	5	6	7	8	9	10	11	12	13	15	16	16	17	17
0	0	0	0	0	1	1	1	2	2	1	1	1	0	0	-1	-1	-1
-2	-3	-4	-6	-7	-9	-11	-13	-14	-16	-17	-18	-19	-19	-20	-20	-20	-20

SPEC
10.1

9 X 12 REINF WITH 9 FT HOLE
9 FT PIPE SECTION 1

0 SCALE 11

Figure 61

DISPLAY= PS1 /1000 , NODE= 1, SURFACE= 0

10/1/1

7	7	7	7	6	6	5	5	4	4	4	3	3	3	3	3	2	2
13	13	12	12	11	10	8	7	6	5	5	4	4	3	3	3	3	3
22	21	20	19	18	16	14	13	11	9	8	7	6	5	5	4	4	4
31	31	30	29	28	27	25	23	21	19	16	14	11	9	7	5	4	3

SPEC
11.1

9 X 12 REINF WITH 9 FT HOLE
9 FT PIPE SECTION 2

0 SCALE 11

Figure 32

DISPLAY= PS1 /10CC , NODE= 1 , SURFACE= 1

10/1/1

4	5	5	5	6	6	6	7	7	7	7	7	6	6	6	5	5	4
9	9	8	7	7	6	5	4	3	3	2	2	2	2	2	2	2	2
21	21	20	19	17	16	14	12	11	9	8	7	6	6	5	5	5	5
35	36	36	35	34	33	31	29	27	24	21	18	15	12	10	8	6	5

SPEC
11.1

9 X 12 REINFC WITH 9 FT HOLE
9 FT PIPE SECTION 2

0 SCALE 1

Figure 63

DISPLAY= PS1 /1000 , NODE= 1 , SURFACE= 2

10/1/1

11	10	9	8	7	6	4	3	2	2	1	1	0	0	0	0	0	1
21	21	21	21	20	19	18	17	15	13	11	9	7	6	4	4	3	3
22	22	21	20	18	16	15	13	11	9	8	7	6	5	4	3	3	3
26	26	25	24	23	21	19	17	15	13	11	9	8	6	4	3	2	2

SPEC
11.1

9 X 12 REINF WITH 9 FT HOLE
9 FT PIPE SECTION 2

0 SCALE 11

Figure 64

10/1/1

DISPLAY= PS2 /1000 , NODE= 1 , SURFACE= 0

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

SPEC
11.1

9 X 12 REINF WITH 9 FT HOLE
9 FT PIPE SECTION 2

0 SCALE 11

Figure 65

DISPLAY= PS2 /100C , NODE= 1, SURFACE= 1

10/1/1'

4	4	4	4	4	5	5	5	5	5	4	4	4	4	4	3	3	3
-7	-7	-7	-6	-6	-6	-7	-7	-7	-7	-7	-7	-7	-7	-7	-7	-7	-7
5	5	5	4	3	2	1	0	-1	-1	-2	-3	-3	-3	-3	-3	-3	-3
23	23	23	23	23	22	21	20	18	16	13	11	8	5	3	2	0	0

SPEC
11.1

9 X 12 REINF WITH 9 FT HOLE
9 FT PIPE SECTION 2

0 SCALE 11

Figure 66

DISPLAY= PS2 /1000 , NODE= 1, SURFACE= 2

10/1/1

7	7	6	6	5	4	3	2	1	-1	-3	-4	-5	-6	-7	-8	-8	-8
18	17	17	16	14	13	12	10	9	8	6	5	4	4	3	2	1	1
0	0	1	1	2	3	3	4	4	4	4	4	4	3	2	1	1	0
-19	-19	-19	-19	-19	-18	-17	-16	-15	-13	-11	-9	-7	-5	-4	-3	-2	-2

SPEC
11.1

9 X 12 REINF WITH 9 FT HOLE
9 FT PIPE SECTION 2

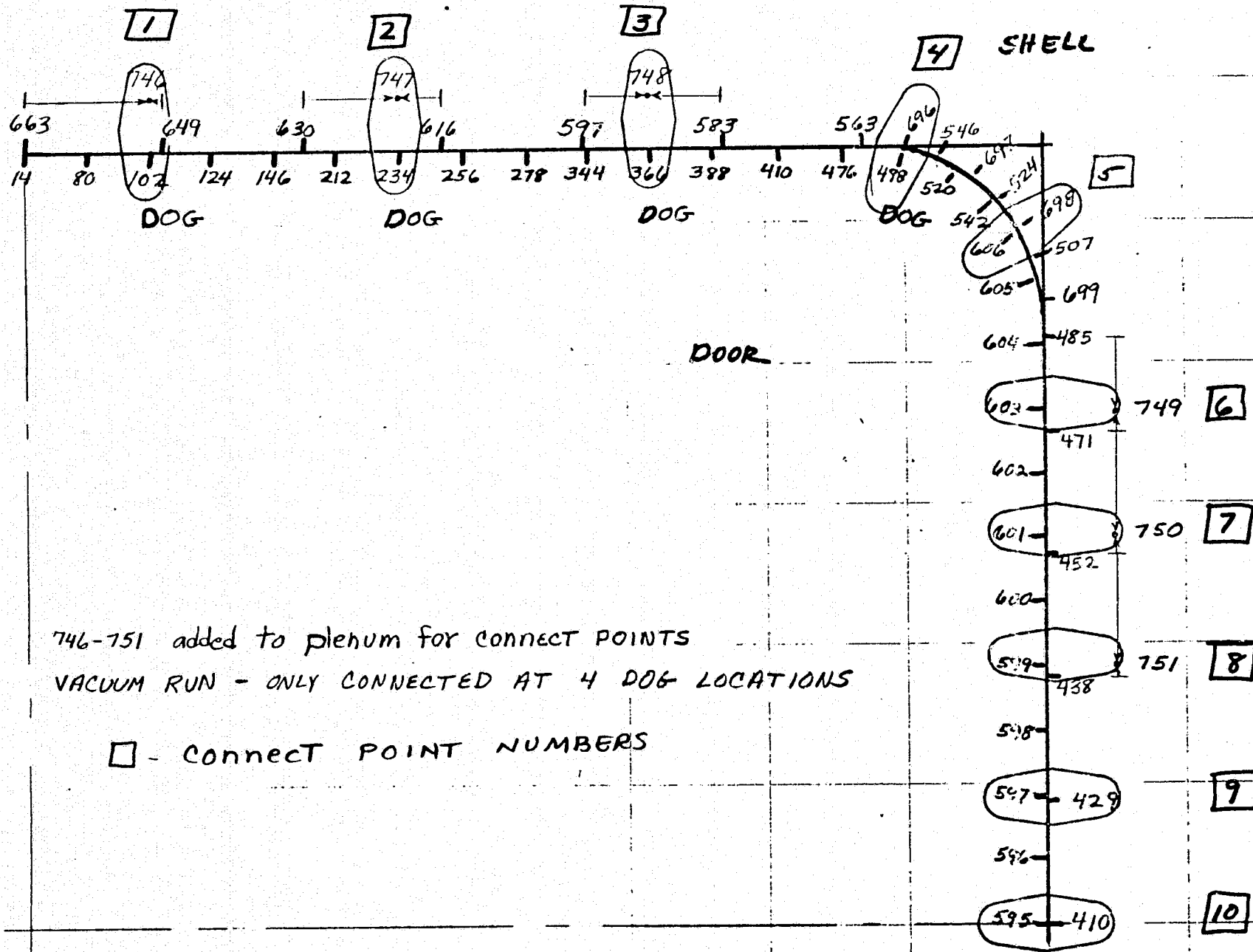
0 SCALE 11

Figure 67

JOB NO 7-19-76

CHKD. BY

DATE



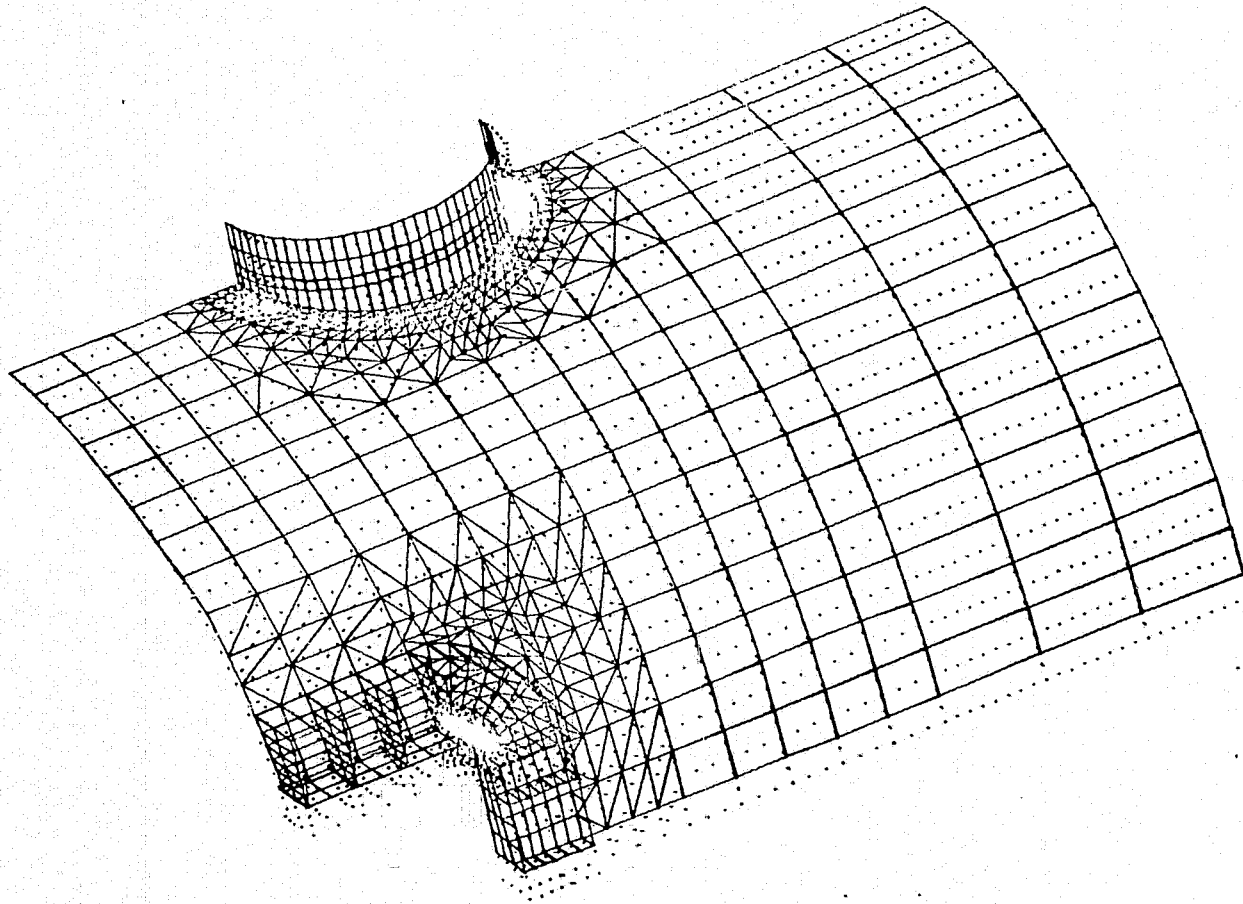
746-751 added to plenum for connect points
 VACUUM RUN - ONLY CONNECTED AT 4 DOG LOCATIONS

FIGURE 68

BUCKLING MODE, CRITICAL LOAD

.119957 X10⁺⁰²

1/7/1



SPEC
1.1

NTF 9 X 12 ACCESS OPENING

Fig 69

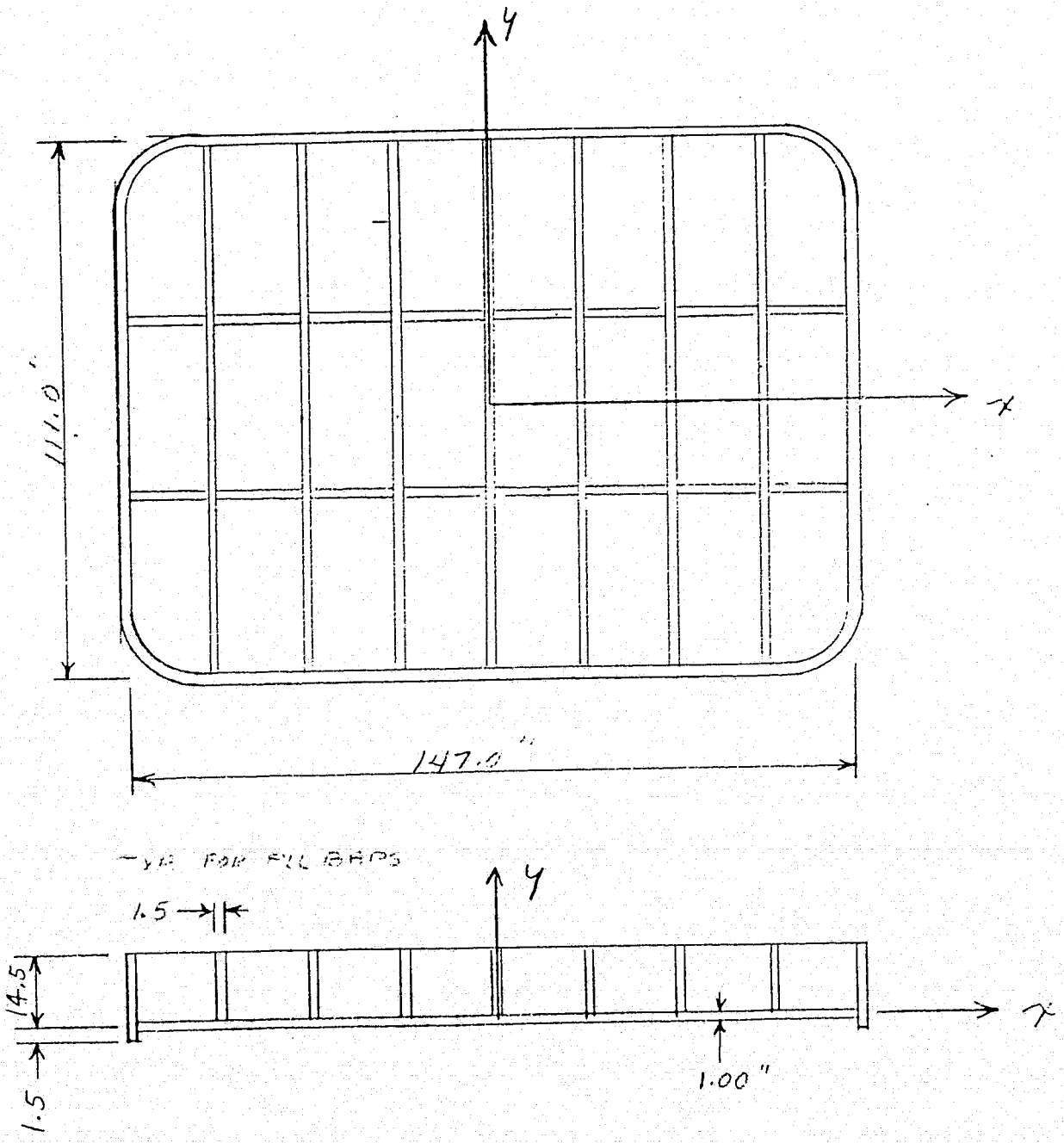
0 SCALE 67

BY _____ DATE _____
CHKD. BY _____ DATE _____

SUBJECT NTF
Finite Element Analysis of
Side Access Door

SHEET NO. 1 OF _____
JOB NO. _____

Reference Drawing LE944471
97% Ni



SPAR (a finite element computer code developed & maintained by Engineering Information System, Inc. under NASA contract NAS8-30536 and NAS 1-13977) was used to analyse this region of the pressure shell. The region was modeled using, triangular and quadrilateral, membrane plus bending flat anisotropic elements

The final configuration shown on LE 944471 is slightly different from the configuration modeled.

The plate is now the sealing surface with all the stiffener height above the plate (Total height plate + stiffener = 17") rather than a 1.5" high stiffener for the sealing surface and 14.5" high stiffeners on opposite side of the plate.

The total height (sealing stiffener + plate + stiffener) is 17.0".

It was judged that these discrepancies would have min. effect on the

Door / Plenum results.

One-quarter of the door was modeled.

The horizontal and vertical $\frac{1}{2}$ of the door were planes of symmetry.

A computer plot of the door is shown in Fig 1A. The model consists of 606 joints with 6 DOF at each joint except where boundary conditions were applied and rotation about an axis \perp to a plate element was restricted as required.

BY _____ DATE _____
CHKD. BY _____ DATE _____

SUBJECT _____

SHEET NO. 4 OF _____

JOB NO. _____

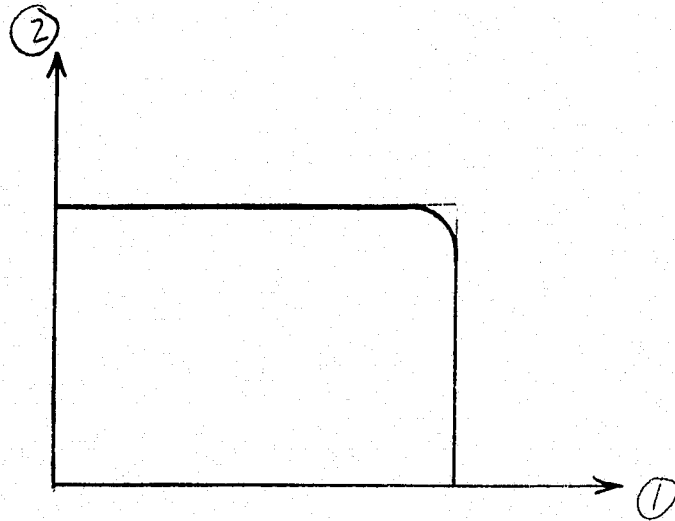
The joint numbers and shell section properties are shown in Fig 2 thru 11

The section properties and thicknesses are listed below

Shell Section	Property	Thickness
1		1.0
2		1.5
3		1.5
4		1.5
5		0.75
6		1.50
7		1.50

REPRODUCIBILITY OF THE ORIGINAL DRAWING IS POOR

Boundary Condition



Plane 1 3 is plane of symmetry

Plane 2 3 is plane of symmetry

Force displacements (in the 3 direction) obtained from combining the Door & Plenum models were applied to the edge of the Door
see DISCUSSION ON COMBINED ANALYSES
(p. 9 Plenum Analyses)

Loading

$P = 119$ psi (design pressure) was applied as nodal pressure to the joints of the pressure surface.

For vacuum condition, -15 psi was applied as nodal pressure to the joints of the pressure surface.

Combined Door + Plenum Analyses

See discussion in Finite Element Analysis of Access Door Reinforcement (Plenum) (p. 9 Vol. 3 Part 1)

BY _____ DATE _____
CHKD. BY _____ DATE _____

SUBJECT _____

SHEET NO. 7 OF _____

JOB NO. _____

Results

Nodal stresses are presented in Fig 12 thru 69.

The max principal stress (PS1) or min. principal stress (PS2) are given for the mid-surface (surface 0), the stiffener bar side of the plate (surface 1), and the sealing surface side of the plate (surface 2).

The stresses plotted are for joint 1 at the element. As an example (reference Fig 2), for the element defined by joint 1, 67, 66, 2 joint 1 for that element is 1.

Nodal stresses for one joint are given from 4 elements (for quadrilateral elements). If any discrepancies exist in the stresses for a joint, the large value is used in the evaluation of the results.

Normal Stresses in Plate ($P = 119 \text{ psi}$)

Max. at joint 1 (Fig 12)

$$\sigma_1 = 13.47 \text{ KSI}$$

$$\sigma_2 = 1.15 \text{ KSI}$$

$$\sigma_3 = -\frac{.119}{2} = -.06 \text{ KSI}$$

$$S_{12} = 13.47 - 1.15 = 12.32 \text{ KSI}$$

$$S_{23} = 1.15 - (-0.06) = 1.21 \text{ KSI}$$

$$S_{31} = -0.06 - 12.32 = -12.38 \text{ KSI}$$

$$P_m = |-12.38| = 12.38 \text{ KSI}$$

$$P_m \leq S_m$$

$$12.38 < 31.7 \text{ KSI} \quad 0.1$$

Bending Stress in Plate (P = 119 psf)

Max at joint 233 (not shown on plots)

$$\sigma_1 = 21.12 \text{ KSI}$$

$$\sigma_2 = 13.55 \text{ KSI}$$

$$\sigma_3 = -.119 \text{ KSI}$$

$$S_{12} = 21.12 - 13.55 = 7.57 \text{ KSI}$$

$$S_{23} = 13.55 - .12 = 13.43 \text{ KSI}$$

$$S_{31} = -.12 - 21.12 = -21.24 \text{ KSI}$$

$$P_b = |-21.24| = 21.24 \text{ KSI}$$

$$P_b = 1.5 S_m$$

$$21.24 < 1.5(=1.7) = 41.5 \text{ KSI O.K.}$$

BY _____ DATE _____
CHKD. BY _____ DATE _____

SUBJECT _____

SHEET NO. 10 OF _____
JOB NO. _____

Inner Bar

Max stress Joint 54 (not shown on stress plot)
(P = 119 psig) (Bar A)

$$\sigma_1 = 0.10 \text{ KSI}$$

$$\sigma_2 = -37.52 \text{ KSI}$$

$$\sigma_3 = 0$$

$$\sigma_{11} = 0.10 - (-37.52) = 37.62 \text{ KSI}$$

$$\sigma_{22} = -37.52 - 0 = -37.52 \text{ KSI}$$

$$\sigma_{33} = 0 - 0.10 = -0.10 \text{ KSI}$$

$$P_b = |37.62| = 37.62 \text{ KSI}$$

$$P_b \leq 1.5 S_m$$

$$37.62 \leq 1.5(31.1) = 47.5 \text{ KSI} \quad \text{OK}$$

BY _____ DATE _____
CHKD. BY _____ DATE _____

SUBJECT _____

SHEET NO. 11 OF _____

JOB NO. _____

For relative displacement between the sealing surfaces of the door and plenum opening for internal $P = 119$ psi see Table 1 p. 12 of Finite Element Analyses of Access Door Reinforcement (Plenum).

For relative displacement between sealing surfaces of the door and plenum opening for vacuum along with dog loads under vacuum, see Table 2 p. 14 of Finite Element Analysis of Access Reinforcement (Plenum).

Hydro Test

The max primary stress in the Door at $P = 119$ psig is 21.12 KSI

Pressure on Door during hydro test.

$$P_H = 1.5(119) + 62.4 \left(\frac{1}{144} \right) \left[\frac{41}{2} + 4.5 \right]$$

$$P_H = 178.5 + 10.83$$

$$P_H = 189.3 \text{ psi}$$

stress at hydro

$$S = \frac{189.3}{119} (21.12) = 33.59 \text{ psi}$$

$$S < .8 \sigma_{yp}$$

$$33.59 < .8 (52.5) = 42 \text{ KSI (auto weld)}$$

The Door meets the hydro test criteria.

JRR

7/12/76

BUCKLING OF S112 DOOR STEEFNER'S

use simply supported beam analysis

for 18" section of door:-

$$M = \frac{w l^2}{8} = \frac{(119 \frac{lb}{in^2})(18 in)(102 in)^2}{8} = 3,123 \times 10^6 \dots lb$$

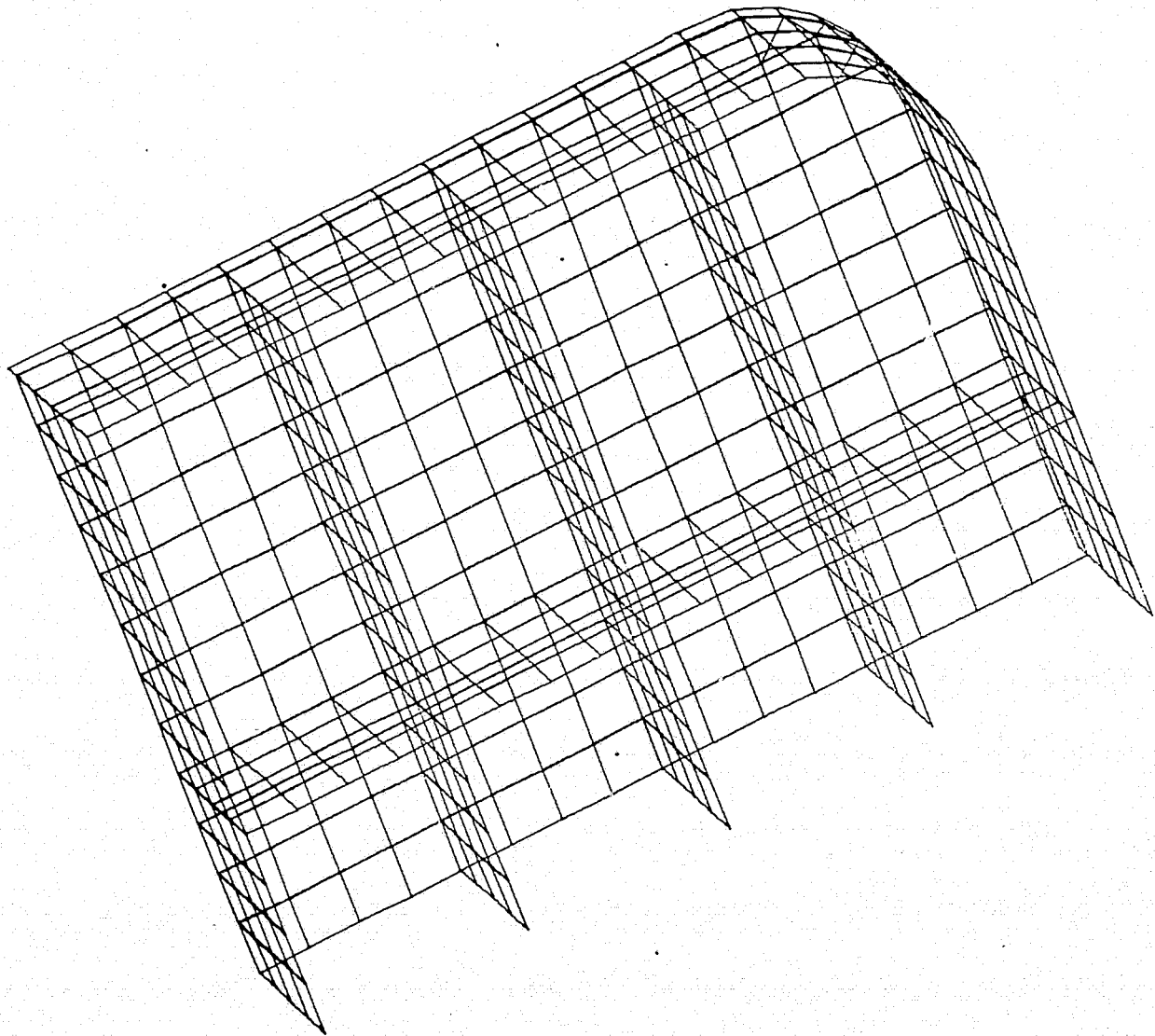
From Roark Case 15 Sect XV p. 100
with ends held vertically fixed in horizontal plane

$$M' = \frac{\pi^2 b^3}{6} \cdot \frac{EG (1 - \nu^2)}{b}$$

$$\frac{(11.5 in)^3}{6} = \frac{(29 \times 10^6 \frac{lb}{in^2})(11.5 in)^3}{6} (1 - \frac{163}{12})$$

$$M' = 1.198 \times 10^7 \dots lb$$

moment is less than critical moment.
It is conservative because it neglects restraint
on plates.



SPEC
1.1

NTF 9 X 12 DOORS

0 SCALE 13

GRAPHIC CENTER [mirrored text]

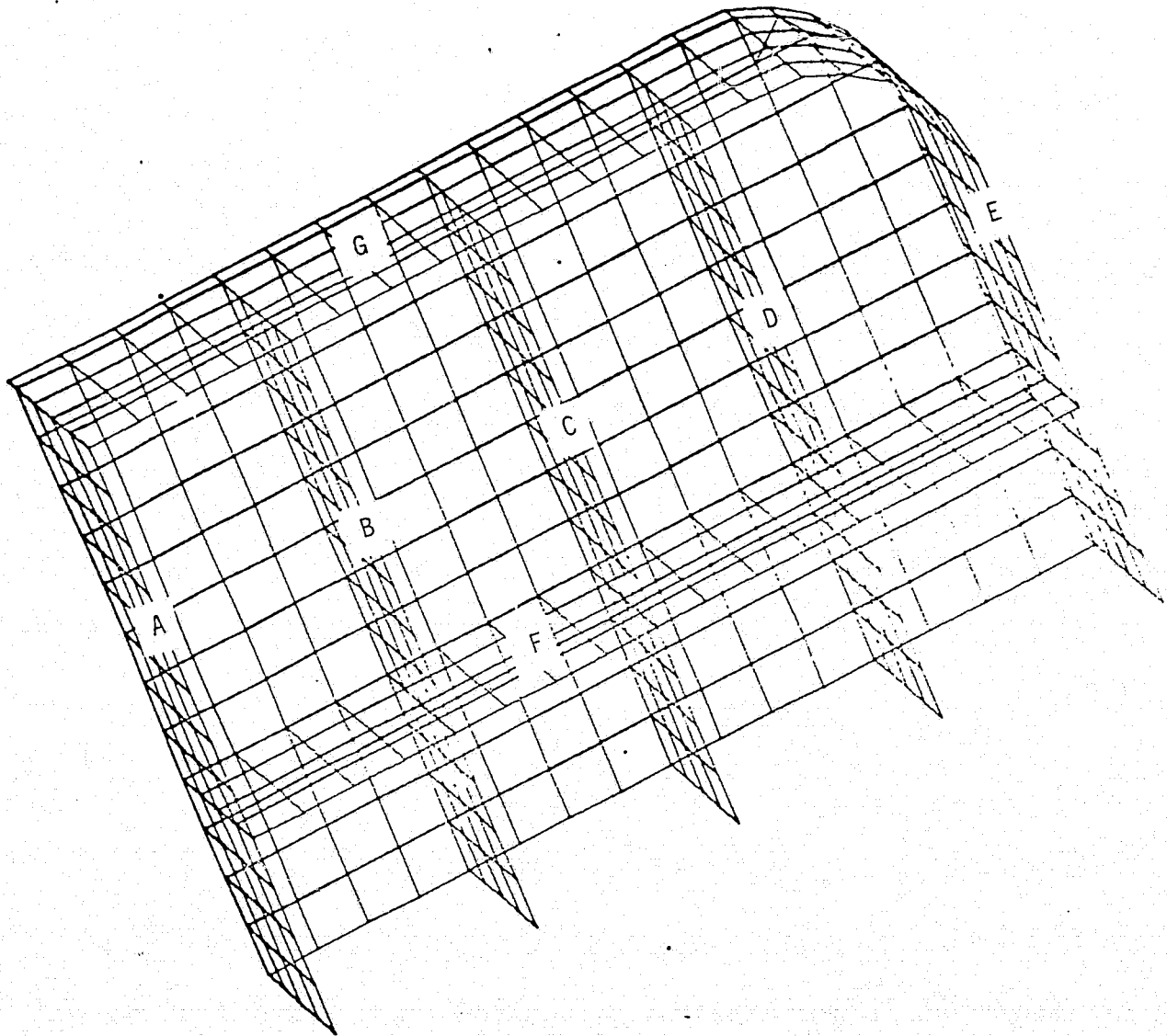
No. 00

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Figure 1 A



SPEC
1.1

NTF 9 X 12 DOORS

0 SCALE 13

GRAPHIC CONTROL

No. 00

Figure 1 B

	13	79	101	123	146	211	233	256	277	343	365	387	409	475	497	
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	519
12	78	100	122	144	210	232	254	276	342	364	386	408	474	496	518	
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	540
11	77	99	121	143	209	231	253	275	341	363	385	407	473	495	517	539
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
10	76	98	120	142	208	230	252	274	340	362	384	406	472	494	516	538
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
9	75	97	119	141	207	229	251	273	339	361	383	405	471	493	515	537
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
8	74	96	118	140	206	228	250	272	338	360	382	404	470	492	514	536
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
7	73	95	117	139	205	227	249	271	337	359	381	403	469	491	513	535
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
6	72	94	116	138	204	226	248	270	336	358	380	402	468	490	512	534
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
5	71	93	115	137	203	225	247	269	335	357	379	401	467	489	511	533
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
4	70	92	114	136	202	224	246	268	334	356	378	400	466	488	510	532
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
3	69	91	113	135	201	223	245	267	333	355	377	399	465	487	509	531
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
2	68	90	112	134	200	222	244	266	332	354	376	398	464	486	508	530
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
1	67	89	111	133	199	221	243	265	331	353	375	397	463	485	507	629

ELEMENT SECTION PROPERTY GROUPS

SPEC
2.1

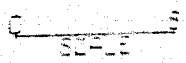
NTF 9 X 12 DOORS
PLATE ONLY

0 SCALE 1

Figure 2

54	55	56	57	58	59	60	61	62	63	64	65
4	4	4	4	4	4	4	4	4	4	4	4
41	42	43	44	45	46	47	48	49	50	51	52
4	4	4	4	4	4	4	4	4	4	4	4
28	29	30	31	32	33	34	35	36	37	38	39
4	4	4	4	4	4	4	4	4	4	4	4
15	16	17	18	19	20	21	22	23	24	25	26
4	4	4	4	4	4	4	4	4	4	4	4
1	2	3	4	5	6	7	8	9	10	11	12

SPEC 3.1 NTF 9 X 12 DOORS
STIFFENER BAR A



ELEMENT SECTION NUMBER GROUPS

Figure 3

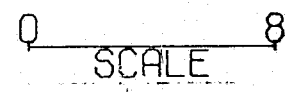
186	187	188	189	190	191	192	193	194	195	196	197	198
7	7	7	7	7	7	7	7	7	7	7	7	7
173	174	175	176	177	178	179	180	181	182	183	184	185
7	7	7	7	7	7	7	7	7	7	7	7	7
160	161	162	163	164	165	166	167	168	169	170	171	172
7	7	7	7	7	7	7	7	7	7	7	7	7
147	148	149	150	151	152	153	154	155	156	157	158	159
7	7	7	7	7	7	7	7	7	7	7	7	7
133	134	135	136	137	138	139	140	141	142	143	144	145

ELEMENT SECTION PROPERTY GROUPS

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

SPEC 4.1

NTF 9 X 12 DOORS
STIFFENER BAR B



ENCLOSING CHARTS] GIVING ELEMENTS IDENTIFICATION BUILDING NO. 100

318	319	320	321	322	323	324	325	326	327	328	329	330
7	7	7	7	7	7	7	7	7	7	7	7	7
305	306	307	308	309	310	311	312	313	314	315	316	317
7	7	7	7	7	7	7	7	7	7	7	7	7
292	293	294	295	296	297	298	299	300	301	302	303	304
7	7	7	7	7	7	7	7	7	7	7	7	7
279	280	281	282	283	284	285	286	287	288	289	290	291
7	7	7	7	7	7	7	7	7	7	7	7	7
265	266	267	268	269	270	271	272	273	274	275	276	277

SPEC
5.1

NTF 9 X 12 DOORS
STIFFENER BAR C

0 SCALE

ELEMENT SECTION PROPERTY GROUPS

Figure 3

No. 00

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450	451	452	453	454	455	456	457	458	459	460	461	462
6	6	6	6	6	6	6	6	6	6	6	6	6
437	438	439	440	441	442	443	444	445	446	447	448	449
5	5	5	5	5	5	5	5	5	5	5	5	5
424	425	426	427	428	429	430	431	432	433	434	435	436
6	6	6	6	6	6	6	6	6	6	6	6	6
411	412	413	414	415	416	417	418	419	420	421	422	423
5	5	5	5	5	5	5	5	5	5	5	5	5
400	401	402	403	404	405	406	407	408	409	410	411	412

SPEC
6.1

NTF 9 X 12 DOORS
STIFFENER BAR D

0 SCALE 8

Figure 6

ELEMENT SECTION PROPERTY GROUPS

562	563	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580	581
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
569	570	571	572	573	574	575	576	577	578	579	580	581							
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
566	567	568	569	570	571	572	573	574	575	576	577	578	579	580	581	582	583	584	585
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
543	544	545	546	547	548	549	550	551	552	553	554	555							
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
529	530	531	532	533	534	535	536	537	538	539	540	541							
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
595	596	597	598	599	600	601	602	603	604	605	606	607							

SPEC
7.1

NTF 9 X 12 DOORS
STIFFENER BAR E



ELEMENT SECTION PROPERTY GROUPS

Figure 7

533	547	560	573	586
6	6	6	6	
511	521	523	525	527
6	6	6	6	
489	499	501	503	505
6	6	6	6	
467	477	479	481	483
6	6	6	6	
401	415	428	441	454
6	6	6	6	
379	389	391	393	395
6	6	6	6	
357	367	369	371	373
6	6	6	6	
335	345	347	349	351
6	6	6	6	
269	283	236	309	322
6	6	6	6	
247	257	259	261	263
6	6	6	6	
225	235	237	239	241
6	6	6	6	
203	213	215	217	219
6	6	6	6	
137	151	164	177	190
6	6	6	6	
115	125	127	129	131
6	6	6	6	
93	103	105	107	109
6	6	6	6	
71	81	83	85	87
6	6	6	6	
5	19	32	45	58

SPEC
8.1

NTF 9 X 12 DOORS
STIFFENER BAR F

0 SCALE 1

ELEMENT SECTION PROPERTY GROUPS

REVISIONS CHART

No. 00

10/11/83

10/11/83

Figure 8

542	541	555	568	581	594
2	3	3	3	3	
520	519	522	524	526	528
2	3	3	3	3	
498	497	500	502	504	506
2	3	3	3	3	
478	475	478	480	482	484
2	3	3	3	3	
410	409	423	436	449	462
2	3	3	3	3	
388	387	390	392	394	396
2	3	3	3	3	
368	365	368	370	372	374
2	3	3	3	3	
344	343	346	348	350	352
2	3	3	3	3	
278	277	291	304	317	330
2	3	3	3	3	
256	255	258	260	262	264
2	3	3	3	3	
234	233	236	238	240	242
2	3	3	3	3	
218	211	214	216	218	220
2	3	3	3	3	
148	145	153	172	185	198
2	3	3	3	3	
124	123	126	128	130	132
2	3	3	3	3	
102	101	104	106	108	110
2	3	3	3	3	
80	79	82	84	86	88
2	3	3	3	3	
14	13	27	40	53	66

ELEMENT SECTION PROPERTY GROUPS

SPEC 9.1 NTF 9 X 12 DOORS STIFFENER BAR G

0 SCALE 11

Figure 9

542541
 2
 520519
 2
 498497
 2
 476475
 2
 410409
 2
 388387
 2
 366365
 2
 344343
 2
 278277
 2
 256255
 2
 234233
 2
 212211
 2
 148145
 2
 124123
 2
 102101
 2
 8079
 2
 1413

ELEMENT SECTION PROPERTY GROUPS

EC
J.1

NTF 9 X 12 DOORS
SEAL FLANGE - TOP

0 11
SCALE

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Figure 10

S29	S30	S31	S32	S33	S34	S35	S36	S37	S38	S39	S40	S41
595 2	596 2	597 2	598 2	599 2	600 2	601 2	602 2	603 2	604 2	605 2	606 2	642

SPEC
11.1

NIF 9 X 12 DOORS
SEAL FLANGE - SIDE

0 ——— 8
SCALE

ELEMENT SECTION PROPERTY GROUPS

Figure 11

DISPLAY= PS1 /1000 , NODE= 1 , SURFACE= 0

10/1/1

2	2	1	2	3	3	1	1	4	3	2	1	3	2	2	1	2
5	3	3	4	5	4	3	3	5	4	3	2	4	3	2	2	2
6	5	4	5	7	6	4	4	6	5	4	3	5	4	3	2	2
8	6	6	6	8	6	5	5	7	6	5	4	6	5	4	3	3
9	8	7	8	9	7	7	6	8	7	6	5	7	5	4	3	3
10	9	9	9	10	9	8	7	9	7	6	6	7	6	5	4	4
11	10	10	10	11	9	9	8	9	8	7	6	7	6	5	5	5
12	11	11	10	11	10	9	9	10	8	8	7	7	7	6	5	5
13	12	11	11	12	11	10	10	10	9	8	7	6	5	5	4	4
13	12	12	12	12	11	11	10	10	9	8	8	7	6	5	4	4
13	13	12	12	13	12	11	11	11	9	9	8	7	6	5	3	3
13	13	12	12	13	12	11	11	11	10	9	8	8	6	5	3	3

SPEC 2.1

NTF 9 X 12 DOORS
PLATE ONLY

0 SCALE 11

ALCOHOLIC BEVERAGES CORPORATION BUFFALO NEW YORK

Figure 12

10/1/1

DISPLAY= PS1 /1000 , NODE= 1 , SURFACE= 1

4	0	-2	2	5	0	-2	1	6	1	-1	1	6	-1	1	-1	1
14	-2	-2	1	14	-2	-3	1	14	-1	-3	0	13	-2	-2	4	1
18	1	-1	3	18	1	-1	2	18	1	-1	1	18	-1	-3	0	0
19	3	1	4	19	3	0	3	19	3	0	2	20	1	-3	0	0
18	5	2	4	19	5	1	3	19	4	0	2	20	2	-3	0	0
16	6	2	5	17	6	1	3	17	5	0	2	17	3	-2	0	0
12	8	5	5	12	8	4	4	12	7	3	2	10	6	1	2	2
7	14	19	13	7	13	19	12	6	13	17	11	4	14	19	9	9
14	7	6	8	14	6	5	7	11	4	3	5	7	1	1	3	3
16	6	6	8	16	6	4	7	14	4	2	5	14	-1	-1	2	2
18	8	6	9	17	7	5	8	17	5	3	6	18	1	-2	1	1
18	9	6	9	18	8	5	8	17	6	3	6	19	2	-2	0	0

SPEC
2.1

NTF 9 X 12 DOORS
PLATE ONLY

0 SCALE 11

Fig 13

10/1/1

DISPLAY= PS1 /1000 , NODE= 1, SURFACE= 2

1	5	5	3	2	6	5	2	2	6	5	2	1	6	3	4	2	1
-1	8	8	6	-1	9	8	5	-1	9	9	4	-1	8	8	3	3	3
1	8	10	8	1	9	11	6	1	9	11	5	-1	9	12	5		
3	9	12	9	3	9	12	8	2	9	12	6	0	9	13	6		
5	11	13	11	4	10	13	10	3	10	13	8	1	9	13	7		
7	12	15	13	6	12	14	12	5	10	13	10	2	9	13	8		
10	12	15	14	10	11	13	13	9	9	11	10	7	7	10	8		
17	8	2	8	16	7	0	6	14	5	0	3	11	3	-3	3		
11	17	16	15	10	16	15	13	8	13	12	9	5	10	8	5		
10	18	18	15	9	17	17	13	7	15	14	10	3	12	12	8		
10	17	18	16	10	16	17	14	8	13	14	10	3	11	14	6		
10	16	18	16	10	15	17	14	8	13	14	11	3	10	14	6		

SPEC 2.1

NTF 9 X 12 DOORS
PLATE ONLY

0 SCALE 11

GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK

Figure 14

10/1/1

DISPLAY= PS2 /1000 , NODE= 1, SURFACE= 0

-3	-1	-1	-2	-4	-2	-1	-1	-4	-2	-1	0	-3	-1	-1	-1
-2	-1	0	-1	-3	-1	0	0	-3	-2	-1	0	-2	-1	-1	-1
-1	0	0	-1	-2	-1	0	0	-2	-1	0	0	-2	-1	-1	0
-1	0	0	0	-1	0	0	0	-1	0	0	0	-1	-1	0	0
0	0	1	0	-1	0	1	1	-1	0	1	1	-1	0	0	0
0	1	1	0	0	1	1	1	0	1	1	1	0	0	0	-1
0	1	1	1	1	1	1	2	1	1	2	2	0	0	0	-1
1	1	1	1	1	2	2	2	1	2	2	2	1	0	0	-1
1	1	1	1	1	2	2	2	2	2	2	2	2	1	1	1
1	1	1	1	1	2	2	1	1	2	2	1	1	1	1	0
1	1	1	1	1	1	2	1	1	2	1	1	1	1	1	0
1	1	1	1	1	2	2	1	1	1	1	1	1	1	1	0

SPEC 2.1

NTF 9 X 12 DOORS
PLATE ONLY

0 SCALE 11

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Figure 15

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

10/1/1

DISPLAY= PS2 /1000 , NODE= 1 , SURFACE= 1

-1	-4	-3	-2	-2	-4	-4	-1	-2	-5	-4	-1	0	-5	0	-4	-1	-1
6	-5	-8	-5	5	-6	-8	-4	5	-6	-8	-3	5	-7	-8	-1	-1	-1
8	-4	-10	-5	8	-5	-10	-4	7	5	-10	-4	7	7	-11	-3	-3	-3
10	-4	-11	-4	9	-4	11	4	8	-5	-11	3	9	6	-12	-4	-4	-4
11	-4	-10	-4	11	-4	-10	4	10	-4	-10	-3	9	-5	12	-5	-5	-5
11	-3	-9	-4	11	3	-8	-4	10	-3	8	-4	8	4	-10	-6	-6	-6
8	-1	-5	-4	8	0	4	-3	7	0	-4	-3	4	-1	-6	-5	-5	-5
-1	0	5	2	-1	0	6	4	-1	1	6	4	-3	2	7	1	1	1
7	-2	-3	-2	7	-2	-3	-1	7	-2	-2	-1	5	-3	-4	-1	-1	-1
14	-4	-8	-3	14	-4	-7	-3	13	-4	-7	-2	11	-6	-10	-5	-5	-5
16	-4	-10	-4	16	-4	-10	-3	14	-4	-10	-3	12	-6	-13	-6	-6	-6
17	-3	-10	-4	16	-3	-10	-3	14	-4	-10	-3	12	-6	-14	-6	-6	-6

SPEC 2.1

NTF 9 X 12 DOORS
PLATE ONLY

0 11" SCALE

Figure 16

10/1/1

DISPLAY= PS2 /1000 , NODE= 1 , SURFACE= 2

-5	1	0	-1	-6	0	0	0	-7	0	1	1	-6	2	-2	2	-2	0
-14	3	7	2	-14	3	7	3	-14	3	6	3	-13	4	5	-4	0	0
-17	4	9	3	-17	3	9	4	-17	3	8	4	-17	4	8	2	0	0
-18	4	11	4	-18	4	10	4	-17	4	9	4	-19	4	8	4	0	0
17	5	11	4	-17	4	11	5	-16	4	10	5	18	4	9	4	0	0
-14	5	10	5	-14	5	11	6	-13	4	10	6	-14	4	9	4	0	0
-8	2	7	6	-8	3	7	6	-7	3	7	6	-6	1	5	3	0	0
3	3	-2	-1	3	3	-2	0	4	1	-4	0	5	-5	-11	-4	0	0
-5	5	6	4	-5	5	6	4	-3	6	6	4	-2	5	5	2	0	0
-12	6	10	6	-12	7	11	6	-11	7	11	5	-12	7	10	5	0	0
-15	6	13	6	-15	7	13	6	-14	7	12	5	-16	7	11	5	0	0
-16	6	13	6	-15	6	13	6	-14	7	13	5	-17	7	11	6	0	0

SPEC 2.1

NTF 9 X 12 DOORS
PLATE ONLY

0 SCALE 11

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Fig 17

DISPLAY= PS1 /1000 , NODE= 1 , SURFACE= 0

10/1/1

0	0	0	1	-3	1	0	1	1	1	1	2
0	0	1	0	-1	1	2	2	3	3	4	5
1	2	2	3	3	4	5	5	6	6	7	6
14	13	13	13	12	12	11	11	10	9	8	6

SPEC
3.1

NTF 9 X 12 DOORS
STIFFENER BAR A

0 ——— 8
SCALE

Figure 13

DISPLAY= PS1 /1000 , NODE= 1 , SURFACE= 1

10/1/1

0	0	0	1	-3	1	0	1	1	1	1	2
0	0	1	0	-1	1	2	2	3	3	4	5
1	2	2	3	3	4	5	5	6	6	7	6
14	13	13	13	12	12	11	11	10	9	8	6

SPEC
3.1

TF 9 X 12 DOORS
STIFFENER BAR A

0 SCALE 8

Figure 19

DISPLAY= PS1 /1000 , NODE= 1 , SURFACE= 2

10/1/1

0	0	0	1	-3	1	0	1	1	1	1	2
0	0	1	0	-1	1	2	2	3	3	4	5
1	2	2	3	3	4	5	5	6	6	7	6
14	13	13	13	12	12	11	11	10	9	8	6

SPEC
3.1

NTF 9 X 12 DOORS
STIFFENER BAR A

0 ——— 8
SCALE

Figure 20

10/1/1

DISPLAY= PS2 /1000 , NODE= 1 , SURFACE= 0

-24	-24	-24	-22	-21	-20	-17	-15	-12	-9	-6	-3
-12	-12	-11	-11	-11	-10	-9	-8	-8	-7	-6	-5
1	0	-1	-2	-2	-3	-3	-4	-4	-5	-6	-7
1	1	1	0	1	0	0	-1	-2	-3	-4	-6

SPEC
3.1

NTF 9 X 12 DOORS
STIFFENER BAR A

0 SCALE 8

Figure 21

REPRODUCIBILITY OF THIS
ORIGINAL PAGE IS POOR

DISPLAY= PS2 /1000 , NODE= 1, SURFACE= 1

10/1/1

-24	-24	-24	-22	-21	-20	-17	-15	-12	-9	-6	-3
-12	-12	-11	-11	-11	-10	-9	-8	-8	-7	-6	-5
1	0	-1	-2	-2	-3	-3	-4	-4	-5	-6	-7
1	1	1	0	1	0	0	-1	-2	-3	-4	-6

SPEC
3.1

NTF 9 X 12 DOORS
STIFFENER BAR A

0 SCALE 8

Figure 22

10/1/1

DISPLAY= PS2 /1000 , NODE= 1 , SURFACE= 2

-24	-24	-24	-22	-21	-20	-17	-15	-12	-9	-6	-3
-12	-12	-11	-11	-11	-10	-9	-8	-8	-7	-6	-5
1	0	-1	-2	-2	-3	-3	-4	-4	-5	-6	-7
1	1	1	0	1	0	0	-1	-2	-3	-4	-6

SPEC
3.1

NIF 9 X 12 DOORS
STIFFENER BAR A

0 SCALE 8

Figure 23

DISPLAY= PS1 /1000 , NODE= 1, SURFACE= 1

10/1/1

0	0	0	0	-2	1	1	1	1	1	1	2
0	1	1	0	0	1	2	2	3	3	4	4
1	2	2	2	3	4	4	5	6	6	6	6
13	13	12	12	11	11	11	10	9	9	8	6

SPEC
4.1

NTF 9 X 12 DOORS
STIFFENER BAR B

0 ——— 8
SCALE

Figure 25

10/1/1

DISPLAY= PS1 /1000 , NODE= 1 , SURFACE= 2

0	0	0	1	-3	0	0	1	1	1	1	2
0	0	0	0	-1	0	1	2	2	3	4	5
1	1	2	2	3	4	4	5	6	6	6	6
13	13	12	12	12	11	11	10	9	9	8	6

SPEC
4.1

NIF 9 X 12 DOORS
STIFFENER BAR B

0 ——— 8
SCALE

Figure 26

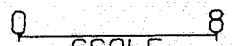
10/1/1

DISPLAY= PS2 /1000 , NODE= 1 , SURFACE= 0

-23	-23	-23	-21	-20	-19	-17	-14	-12	-9	-6	-3
-11	-11	-11	-10	-10	-9	-9	-8	-7	-7	-6	-5
0	0	-1	-2	-2	-3	-3	-4	-4	-5	-5	-6
1	1	1	0	0	0	0	-1	-2	-2	-4	-5

SPEC
4.1

NTF 9 X 12 DOORS
STIFFENER BAR B

0  8
SCALE

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Figure 27

10/1/1

DISPLAY= PS2 /1000 , NODE= 1 , SURFACE= 1

-23	-23	-22	-21	-19	-18	-16	-14	-12	-9	-6	-4
-11	-11	-11	-10	-9	-9	-9	-8	-7	-7	-6	-6
1	0	-1	-2	-2	-2	-3	-3	-4	-5	-5	-6
2	1	1	0	0	0	0	-1	-1	-2	-4	-5

PEC
.1

NTF 9 X 12 DOORS
STIFFENER BAR B

0 ——— 8
SCALE

Figure 28

PRODUCIBILITY OF THE

10/1/1

DISPLAY= PS2 /1000 , NODE= 1 , SURFACE= 2

-23	-23	-23	-21	-21	-19	-17	-14	-12	-9	-6	-3
-11	-11	-11	-10	-11	-10	-9	-8	-7	-7	-6	-5
0	0	-1	-2	-2	-3	-3	-4	-4	-5	-6	-6
1	1	1	0	1	0	0	-1	-2	-3	-4	-5

SPEC
4.1

NTF 9 X 12 DOORS
STIFFENER BAR B

0 SCALE 8

ENGINEERING DIVISION [REDACTED] BUFFALO, NEW YORK

Figure 29

DISPLAY= PS1 /1000 , NODE= 1, SURFACE= 0

10/1/1

0	0	0	0	-2	1	0	1	1	1	1	2
0	0	1	0	0	1	1	2	2	3	4	4
1	2	2	2	2	3	3	4	5	5	6	5
11	11	10	9	9	9	9	9	8	8	7	5

REPRODUCIBILITY OF THE
ORIGINAL PAGE IS POOR

SPEC
5.1

NTF 9 X 12 DOORS
STIFFENER BAR C

0 8"
SCALE

Figure 30

10/1/1

DISPLAY= PS1 /1000 , NODE= 1 , SURFACE= 1

0	0	0	0	-1	1	1	1	1	1	1	1
1	1	1	0	0	1	1	2	2	3	3	4
1	2	2	2	2	3	4	4	5	5	6	5
11	11	10	9	8	9	9	9	8	8	7	5

SPEC
5.1

NTF 9 X 12 DOORS
STIFFENER BAR C

0 ——— 8
SCALE

Figure 31

10/1/1

DISPLAY= PS1 /1000 , NODE= 1, SURFACE= 2

0	0	0	1	-2	0	0	0	1	1	1	2
0	0	0	0	0	0	1	1	2	3	4	5
1	1	2	2	2	2	3	4	5	5	6	6
10	10	10	9	10	9	9	8	8	7	6	5

SPEC
5.1

NIF 9 X 12 DOORS
STIFFENER BAR C

0 SCALE 8

Figure 32

DISPLAY= PS2 /1000 , NODE= 1 , SURFACE= 0

10/1/1

-19	-19	-19	-10	-16	-15	-14	-12	-10	-8	-5	-3
-9	-9	-9	-9	-8	-8	-7	-7	-6	-6	-5	-5
0	0	-1	-2	-1	-2	-2	-3	-3	-4	-5	-5
1	1	1	0	0	0	0	0	-1	-2	-3	-5

SPEC
5.1

NTF 9 X 12 DOORS
STIFFENER BAR C

0 SCALE 8

Figure 33

DISPLAY= PS2 /1000 , NODE= 1, SURFACE= 1

10/1/1

-19	-19	-19	-18	-14	-14	-13	-12	-10	-8	-6	-4
-9	-9	-9	-9	-7	-7	-7	-6	-6	-6	-6	-5
1	0	0	-1	-2	-2	-2	-3	-3	-4	-5	-6
2	2	2	0	0	0	0	0	-1	-2	-3	-5

SPEC
5.1

NTF 9 X 12 DOORS
STIFFENER BAR C

0 SCALE 8

Figure 34

10/1/1

DISPLAY= PS2 /1000 , NODE= 1 , SURFACE= 2

-20	-19	-19	-17	-19	-17	-15	-12	-10	-7	-4	-2
-10	-10	-9	-8	-9	-9	-8	-7	-6	-6	-5	-4
0	-1	-1	-2	-1	-2	-3	-3	-4	-4	-5	-5
0	0	0	0	1	0	0	-1	-1	-2	-4	-4

SPEC
5.1

NTF 9 X 12 DOORS
STIFFENER BAR C

0  8
SCALE

THE ENGINEERING COMPANIES CORPORATION BUFFALO, NEW YORK

Figure 35

DISPLAY= PS1 /1000 , NODE= 1 , SURFACE= 0

10/1/1 *

0	0	0	0	-1	0	0	0	0	1	1	1
0	1	1	1	0	0	1	1	1	2	3	3
1	2	2	2	1	1	2	3	3	4	4	4
8	8	7	6	5	6	6	6	6	6	5	4

SPEC
6.1

NTF 9 X 12 DOORS
STIFFENER BAR D

0 SCALE 8 *

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Figure 36

DISPLAY= PS1 /1000 , NODE= 1 , SURFACE= 1

10 / 1 / 1

0	0	0	0	0	1	0	0	0	1	1	1
1	1	1	0	-1	1	1	1	1	2	2	2
2	2	3	2	0	2	2	3	3	4	4	4
8	8	7	7	3	7	6	6	6	6	6	4

SPEC
6.1

NTF 9 X 12 DOORS
STIFFENER BAR D

0 SCALE 8

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Figure 37

DISPLAY= PS1 /1000 , NODE= 1, SURFACE= 2

10/1/1

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

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

SPEC 6.1

NTF 9 X 12 DOORS
STIFFENER BAR D

0 SCALE 8

Figure 38

10/1/1

DISPLAY= PS2 /1000 , NODE= 1 , SURFACE= 0

-13	-12	-12	-11	-10	-10	-9	-8	-7	-6	-4	-2
-5	-6	-6	-5	-5	-5	-4	-4	-4	-4	-4	-3
1	0	-1	-1	0	0	-1	-1	-2	-2	-3	-4
1	1	1	0	0	0	1	0	0	-1	-2	-3

SPEC
6.1

NTF 9 X 12 DOORS
STIFFENER BAR D

0 SCALE 8

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Figure 39

10/1/1

DISPLAY= PS2 /1000 , NODE= 1, SURFACE= 1

-12	-12	-12	-11	-6	-8	-8	-8	-7	-6	-5'	-4
-6	-6	-6	-6	-3	-3	-4	-4	-4	-4	-4	-5
1	0	0	-1	-1	0	0	-1	-2	-2	-3	-4
2	2	2	1	0	1	1	0	0	0	-1	-3

SPEC
6.1

NTF 9 X 12 DOORS
STIFFENER BAR D

0 SCALE 8

PRINTED IN U.S.A. HOFFMAN ENGINEERING CORPORATION HOFFMAN ENGINEERING CORPORATION HOFFMAN ENGINEERING CORPORATION

Figure 40

10/1/1

DISPLAY= PS2 /1000 , NODE= 1, SURFACE= 2

-13	-13	-12	-10	-14	-12	-10	-9	-7	-5	-3	-1
-6	-6	-6	-5	-7	-6	-5	-5	-4	-4	-3	-2
0	-1	-1	-2	1	-1	-1	-1	-2	-3	-3	-3
1	1	0	-2	0	0	1	1	0	-1	-3	-3

SPEC
6.1

NTF 9 X 12 DOORS
STIFFENER BAR D

0 ——— 8
SCALE

PRINTED IN U.S.A. BUFFALO, NEW YORK ENGINEERING INFORMATION CENTER 10/1/1

Figure 41

DISPLAY= PS1 /1000 , NODE= 1 , SURFACE= 0

10/1/1

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

SPEC
7.1

NTF 9 X 12 DOORS
STIFFENER BAR E

0 SCALE 8

Figure 42

10/1/1

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

3	3	2	0	3	2	1	1	1	-1	-2	-2
3	3	3	1	0	3	3	2	2	1	-1	-1
4	4	4	3	-1	4	5	5	6	5	3	2
6	7	5	6	0	4	7	9	12	8	7	6
2	2	4	5	5	5	1	7	7	4	4	3

SPEC
7.1

NIF 9 X 12 DOORS
STIFFENER BAR E

0 ——— 8
SCALE

Figure 43

DISPLAY= PS1 /1000 , NODE= 1 , SURFACE= 2

10/1/1

-1	-1	0	1	0	-1	-1	-1	0	3	5	5
-2	-1	0	2	2	-1	-1	-1	-1	2	3	4
-1	-1	0	2	5	1	0	-1	-2	-1	0	1
-1	-1	-1	1	8	0	2	1	1	0	-1	0
2	2	3	5	-1	6	1	6	7	5	6	7

SPEC
7.1

NTF 9 X 12 DOORS
STIFFENER BAR E

0 SCALE 8

Figure 44

10/1/1

DISPLAY= PS2 /1000 , NODE= 1 , SURFACE= 0

0	0	0	-1	0	-1	-1	-2	-2	-2	-1	-1
0	0	-1	-1	0	-1	-1	-1	-1	-2	-2	-1
0	0	-1	-2	-2	-2	-1	0	0	-1	-2	-2
-1	0	-2	0	-5	-1	-2	0	3	0	0	0
-3	0	-5	0	-15	2	-5	0	5	-1	0	0

SPEC
7.1

NTF 9 X 12 DOORS
STIFFENER BAR E

0 SCALE 8

Figure 45

DISPLAY= PS2 /1000 , NODE= 1 , SURFACE= 1

10/1/1

1	1	0	-2	0	1	0	0	-3	-6	-8	-7
2	2	1	-2	-2	0	1	1	-1	-4	-5	-5
4	3	2	-1	-3	0	2	2	1	0	-2	-3
4	4	4	4	-5	2	3	4	5	6	4	3
-3	0	-6	-1	-15	2	-5	0	4	-1	0	0

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

SPEC 7.1

NTF 9 X 12 DOORS STIFFENER BAR E

0 SCALE 8"

Figure 46

10 / 1 / 1

DISPLAY= PS2 /1000 , NODE= 1, SURFACE= 2

-2	-2	-1	0	-3	-3	-3	-3	-1	1	2	2
-2	-2	-2	-1	1	-2	-3	-3	-2	0	0	1
-4	-4	-4	-2	0	-3	-4	-4	-3	-4	-3	-2
-7	-6	-8	-4	-6	-4	-8	-7	-4	-7	-7	-6
-3	0	-5	1	-15	2	-5	1	5	-1	0	0

SPEC
7.1

NTF 9 X 12 DOORS
STIFFENER BAR E

0 SCALE 8

Figure 47

DISPLAY= PS1 /1000 , NODE= 1 , SURFACE= 0

10/1/1 =

5	3	2	1
5	4	2	1
4	2	1	0
3	2	1	1
2	1	0	0
2	1	0	0
1	0	0	0
0	0	1	2
1	0	0	0
1	1	0	0
1	1	0	0
-1	0	1	3
1	1	0	0
1	1	0	0
1	1	1	0
-2	0	1	3

SPEC
8.1

NTF 9 X 12 DOORS
STIFFENER BAR F

0 SCALE 11

Figure 48

DISPLAY= PS1 /1000 , NODE= 1 , SURFACE=

10/1/1

6	3	1	0
5	4	2	1
5	3	2	1
2	2	1	1
3	1	0	-1
3	1	0	0
2	1	1	0
-1	-1	1	2
2	0	0	-1
2	1	0	0
2	1	0	0
-1	-1	1	2
2	1	0	-1
2	1	0	0
2	1	0	-1
0	-1	1	2

SPEC
8.1

NTF 9 X 12 DOORS
STIFFENER BAR F

0 SCALE 11

Figure 49

10/1/11

DISPLAY= PS1 /1000 , NODE= 1 , SURFACE= 2

4	3	3	2
4	3	2	1
3	2	1	0
4	2	1	0
2	1	1	1
2	1	0	0
0	0	0	-1
1	1	1	2
0	0	1	0
1	1	0	0
0	0	0	0
0	1	2	3
0	1	1	0
0	1	0	0
0	0	1	0
-1	1	2	4

SPEC
8.1

NTF 9 X 12 DOORS
STIFFENER BAR F

0 SCALE 11

Figure 50

10/1/1

DISPLAY= PS2 /1000 , NODE= 1 , SURFACE= 0

-4	-4	-3	-2
-2	-4	-4	-3
-2	-3	-4	-5
-2	-3	-5	-7
-1	-2	-4	-7
0	-3	-5	-8
0	-3	-5	-8
-1	-3	-6	-9
-1	-3	-6	-9
0	-4	-6	-8
-1	-4	-6	-8
-2	-3	-6	-8
-2	-4	-6	-8
-2	-4	-6	-8
-2	-4	-6	-8
-3	-4	-6	-8

SPEC
8.1

NTF 9 X 12 DOORS
STIFFENER BAR F

0  11
SCALE

Figure 51

DISPLAY= PS2 /1000 , NODE= 1 , SURFACE= 1

10/1/1

-4	-4	-4	-4
-1	-4	-4	-4
-1	-2	-3	-4
-3	-3	-3	-3
0	-2	-5	-8
0	-2	-5	-8
1	-2	-5	-7
-2	-3	-5	-7
0	-3	-6	-9
0	-3	-6	-8
0	-3	-6	-8
-4	-5	-6	-8
-1	-3	-6	-8
-1	-4	-6	-8
-1	-4	-6	-8
-4	-5	-6	-8

SPEC
8.1

NTF 9 X 12 DOORS
STIFFENER BAR F

0 SCALE 11

Figure 52

10/1/1

DISPLAY= PS2 /1000 , NODE= 1 , SURFACE=

-5	-4	-2	0
-3	-5	-4	-3
-2	-4	-5	-7
-2	-3	-6	-10
-1	-2	-4	-7
-1	-3	-5	-8
-1	-3	-6	-9
-2	-2	-6	-10
-2	-3	-5	-8
-1	-4	-6	-8
-2	-4	-5	-9
-3	-2	-6	-9
-3	-4	-6	-8
-2	-5	-6	-8
-3	-5	-6	-8
-3	-2	-5	-8

SPEC
8.1

NTF 9 X 12 DOORS
STIFFENER BAR F

0 SCALE 11

Figure 53

DISPLAY= PS1 /1000 , NODE= 1, SURFACE= 0

10/1/1

4	2	1	0	0
0	1	0	0	0
2	1	0	0	1
3	1	0	1	1
5	3	3	3	3
-7	0	3	3	4
5	1	2	3	4
4	1	1	2	5
7	3	3	4	6
-11	-1	3	5	7
6	2	3	5	7
5	2	3	5	7
7	3	2	5	7
-11	-1	3	5	8
6	2	3	5	8
5	3	4	5	8

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

SPEC 9.1

NTF 9 X 12 DOORS
STIFFENER BAR G

0 11
SCALE

Figure 54

DISPLAY= PS1 /1000 , NODE= 1 , SURFACE= 1

10/1/1

4	4	1	0	0
-1	3	2	2	3
2	3	2	2	3
2	-1	-1	0	2
6	6	3	3	2
-8	4	5	4	4
4	4	3	4	5
2	0	0	1	6
7	7	4	4	6
-11	3	5	6	7
6	5	4	5	8
2	1	1	3	7
7	6	3	5	7
-11	2	5	6	9
5	5	4	6	8
2	2	2	3	7

SPEC 9.1

NTF 9 X 12 DOORS
STIFFENER BAR G

0 SCALE 11

Figure 55

10/1/1

DISPLAY= PS1 /1000 , NODE= 1 , SURFACE= 2

4	0	0	1	0
2	-1	-1	-1	-1
2	-1	-1	0	0
5	4	2	2	1
5	1	3	4	4
7	-3	1	2	3
5	-2	0	2	3
7	4	3	3	4
7	0	3	5	6
10	-5	1	4	6
6	-1	1	4	7
8	5	5	6	7
7	-1	2	5	7
10	-5	1	4	8
6	-1	2	5	8
8	5	6	7	9

SPEC
9.1

NTF 9 X 12 DOORS
STIFFENER BAR G

0  11
SCALE

Figure 56

10/1/1

DISPLAY= PS2 /1000 , NODE= 1 , SURFACE= 0

1	-1	-2	-1	0
-7	-4	-2	-1	0
-1	0	0	0	0
-2	0	0	0	0
5	-4	-5	-3	-1
-22	-12	-5	-2	-1
-10	-3	-1	-1	0
-3	-1	-1	0	1
5	-6	-6	-3	-1
-30	-16	-7	-3	-1
-15	-5	-2	-1	0
-3	-3	-3	0	1
5	-5	-5	-2	-1
-23	-15	-6	-2	-1
-15	-6	-3	-1	0
-3	-4	-3	0	1

SPEC
9.1

NTF 9 X 12 DOORS
STIFFENER BAR G

0 SCALE 11

Figure 57

10/1/1

DISPLAY= PS2 /1000 , NODE= 1 , SURFACE= 1

1	1	-2	-1	0
-7	0	0	0	1
0	2	1	0	0
-2	-2	-2	-1	-1
5	-2	-5	-4	-2
-21	-7	-4	-2	-1
-9	-1	0	-1	0
-3	-5	-4	-1	0
6	-2	-6	-4	-2
-29	-10	-5	-3	-1
-14	-3	-1	-1	-1
-3	-7	-5	-1	0
6	-1	-5	-3	-2
-29	-9	-5	-3	-1
-19	-3	-1	-2	-1
-3	-7	-6	-2	0

SPEC
B.1

NTF 9 X 12 DOORS
STIFFENER BAR G

0 SCALE 11

Figure 58

DISPLAY= PS2 /1000 . NODE= 1, SURFACE= 2

10/1/1

1	-4	-3	-1	0
-6	-8	-3	-2	-2
-2	-2	-1	-1	-2
-2	1	1	1	0
4	-7	-6	-3	0
-22	-18	-7	-3	0
-11	-5	-3	-1	-1
-3	0	1	2	2
4	-5	-7	-3	0
-30	-23	-8	-3	0
-17	-8	-3	-1	0
-4	-1	0	1	2
3	-8	-6	-2	0
-23	-22	-8	-2	0
-16	-8	-4	-1	0
-4	-2	-1	1	2

SPEC
9.1

NTF 9 X 12 DOORS
STIFFENER BAR G

0 SCALE 11

STANDARD CHARTEER GRAPHIC ENGINEERING CORPORATION BUFFALO, NEW YORK

Figure 59

DISPLAY= PS1 /1000 , NODE= 1 , SURFACE= 0

10 / L / 1

4
0
2
3
5
-7
5
4
7
-11
6
5
7
-11
6
5

SPEC
10-1

NTF 9 X 12 DOORS
SEAL FLANGE - TOP

0 SCALE 11

NO. 30

Figure 60

Handwritten signature or initials

DISPLAY= PS1 /1000 , NODE= 1 , SURFACE= 1

10/1/1

4
-1
2
2
6
8
4
2
7
11
6
2
7
11
5
2

SPEC
10.1

NTF 9 X 12 DOORS
SEAL FLANGE - TOP

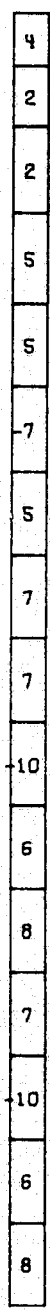
0 SCALE 11

PRINTED IN U.S.A. BOSTON, MASSACHUSETTS CORPORATION BOSTON, MASSACHUSETTS CORPORATION BOSTON, MASSACHUSETTS CORPORATION

Figure 61

DISPLAY= PS1 /1000 , NODE= 1 , SURFACE= 2

10/1/1



SPEC
10.1

NTF 9 X 12 DOORS
SEAL FLANGE - TOP

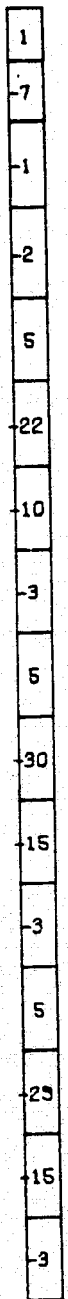


PRINTED IN U.S.A. REPAIRED NEW YORK GRAPHIC CONSULTING CORPORATION

Figure 62

10/1/1

DISPLAY= PS2 /1000 , NODE= 1 , SURFACE=



SPEC
10.1

NTF 9 X 12 DOORS
SEAL FLANGE - TOP

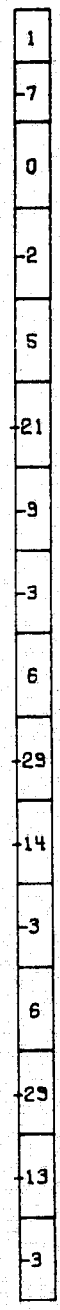
0 ——— 11
SCALE

PRINTED IN U.S.A. BUFFALO, NEW YORK

Figure 63

10/1/1

DISPLAY= PS2 /1000 , NODE= 1 , SURFACE= 1



SPEC
10.1

NTF 9 X 12 DOORS
SEAL FLANGE - TOP

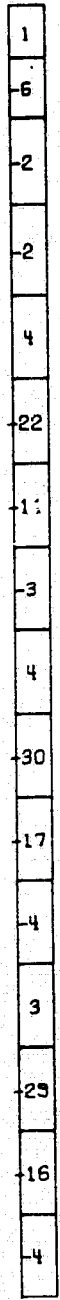
0 SCALE 11

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Figure 64

10/1/1

DISPLAY= PS2 /1000 , NODE= 1 , SURFACE= 2



SPEC
10.1

NTF 9 X 12 DOORS
SEAL FLANGE - TOP

0 SCALE 11

ENGINEERING CONTROL SYSTEMS CORPORATION BUFFALO, NEW YORK

Figure 65

DISPLAY= PS1 /1000 , NODE= 1 , SURFACE= 0

10/1/1

2	2	4	5	2	6	1	7	7	5	5	5
---	---	---	---	---	---	---	---	---	---	---	---

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR.

SPEC
11-1

NTF 9 X 12 DOORS
SEAL FLANGE - SIDE

0 8
SCALE

6902043

NO ON

Figure 66

10/1/1

DISPLAY= PS1 /1000 , NODE= 1 , SURFACE= 1

2	2	4	5	5	5	1	7	7	4	4	3
---	---	---	---	---	---	---	---	---	---	---	---

SPEC
11.1

NTF 9 X 12 DOORS
SEAL FLANGE - SIDE

0 ——— 8
SCALE

Figure 67

DISPLAY= PS1 /1000 , NODE= 1 , SURFACE= 2

10/1/1

2	2	3	5	-1	6	1	6	7	5	6	7
---	---	---	---	----	---	---	---	---	---	---	---

SPEC
11.1

NTF 9 X 12 DOORS
SEAL FLANGE - SIDE

0 ——— 8
SCALE

Figure 68

DISPLAY= PS2 /1000 , NODE= 1, SURFACE= 0

10/1/1

-3	0	-5	0	-15	2	-5	0	5	-1	0	0
----	---	----	---	-----	---	----	---	---	----	---	---

SPEC
11.1

NTF 9 X 12 DOORS
SEAL FLANGE - SIDE

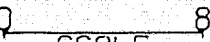
0  8
SCALE

Figure 69

10/1/1

DISPLAY= PS2 /1000 , NODE= 1, SURFACE= 1

-3	0	-6	-1	-15	2	-5	0	4	-1	0	0
----	---	----	----	-----	---	----	---	---	----	---	---

SPEC
11.1

NTF 9 X 12 DOORS
SEAL FLANGE - SIDE

0 SCALE 8

THE ENGINEERING COMPANY BUFFALO, NEW YORK

Figure 70

DISPLAY= PS2 /1000 , NODE= 1 , SURFACE= 2

10/1/1

-3	0	-5	1	-15	2	-5	1	5	-1	0	0
----	---	----	---	-----	---	----	---	---	----	---	---

SPEC
1.1

NTF 9 X 12 DOORS
SEAL FLANGE - SIDE

0  8
SCALE

RECORDING (SMALL) [5] GRAPHIC TERMINALS CORPORATION BIRFIELD NEW YORK

Figure 71