MCR-82-1307
Contract NAS5-26496

NASA CR- Final Report 170576 April 1982

15-Meter Diameter Mechanically Scanned Deployable Antenna

(NASA-CR-170576) THE 15-METER DIAMETER MECHANICALLY SCANNED DEPLOYABLE ANTENNA Final Report (Martin Marietta Corp.) 220 p HC A10/MF A01 CSCL 09C

N83-34123

Unclas
G3/32 36562

ORIGINAL PAGE IS
OF POOR QUALITY

MARTIN MARIETTA

MCR-82-1307
Contract NAS5-26496 | Final Report | April 1982

15-METER DIAMETER MECHANICALLY SCANNED DEPLOYABLE ANTENNA

Prepared by

J.V. Coyner,
J.J. Herbert,
E.E. Bachtell

Approved

F.R. Schwartzberg,
Manager,
Large Space Systems

MARTIN MARIETTA CORPORATION
DENVER AEROSPACE
P. O. Box 179
Denver, Colorado 80201

FOREWORD

This report was prepared by Martin Marietta Denver Aerospace under contract NAS5-26496. The contract was administered by the Goddard Space Flight Center of the National Aeronautics and Space Administration, Greenbelt, Maryland. The study was performed from April 1981 to March 1982, and the NASA-GSFC project manager was Mr. L.R. Dod.

The authors wish to acknowledge the contributions of the following individuals to this program: Mr. R.J. Richardson and Ms. D.A. Strange for their radio frequency analysis; and Mr. J.R. Postuchow and Mr. D.C. Rudolph for their design creativity.

CONTENTS

I. SUMMARY

The objectives of this study were to provide a preliminary design with structural model data and thermal-performance estimates of a 15-meter mechanically scanned deployable antenna (MSDA) that could be launched onboard a Shuttle Orbiter to provide radiometric brightness temperature maps of the Earth and oceans in selected bands over a frequency range from 1.4 to 11 GHz. This study assumed that this antenna will be attached to a spinning platform (360 deg; 6 rpm; 35-deg conical scan axis) on a free-flyer spacecraft in a 700-km altitude, 12:00 Sun-synchronous orbit. Table I-1 summarizes the design requirements and specifications that were involved in this study.

The study objectives were met through the design of a unique, integrated, offset feed mast and reflector design that uses the deployable box-truss structure as a building block (Fig. I-1). The performance of this system is summarized in Table I-2. Figure I-2 presents the all graphite-epoxy, 4.57-meter prototype cube that was completed in 1981 and is proposed for this reflector and feed mast design.

Table I-1 MSDA Design Requirements and Specifications

Requirements and Specifications
Deployable 15-m-dia Effective Circular Aperture, Offset-Fed Parabolic Reflector and Feed Structure
Dynamically Balanced, Conically Scanned (35-deg Nadir Angle, 6-rpm) System
90% efficiency on all beams, which are:

	Channel, GHz			
	1.414	4.3	5.1	11.0
Beamwidth, deg	1.07	0.35	0.3	0.35
Beams in Track	3.0	10.0	12.0	10.0
RF Bandwidth	28.0	200.0	100.0	100.0

Mount on Spinning Platform on Generic Free-Flyer Spacecraft
Operational Orbit*: 700-km Altitude, 12:00 Sun-synchronous
Launch in Shuttle Orbiter
Antenna/feed assembly stows in volume not to exceed 4-m-dia cylinder, 7-m long.
Stowed-system structural resonant frequency must be 25 Hz.
Scanning (deployed, rotating) system resonant frequency should be 12 Hz.
* Inclination of 99%, 99-min Period, Orbital Plane Precesses to Remain Aligned with Subsolar Point

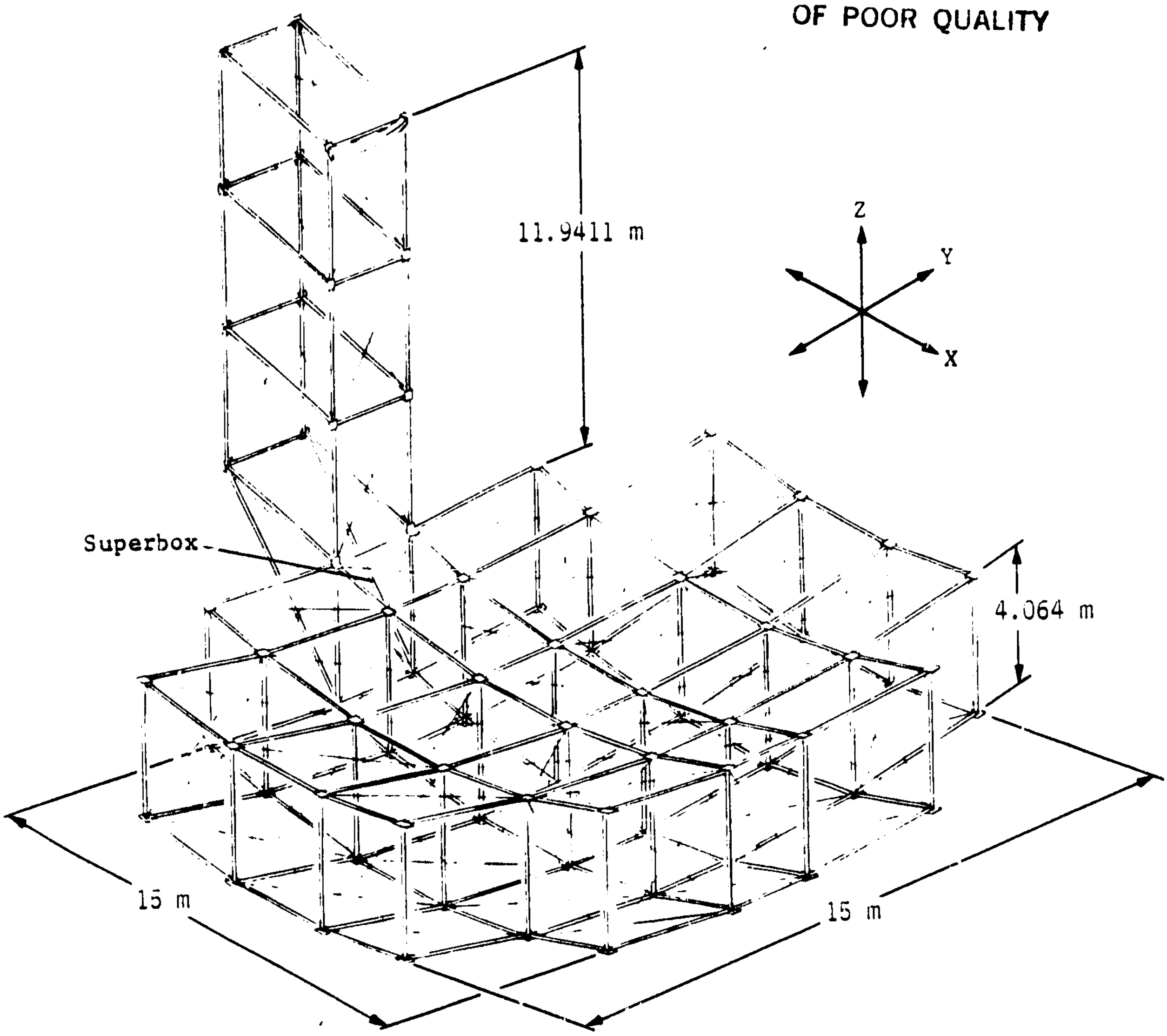
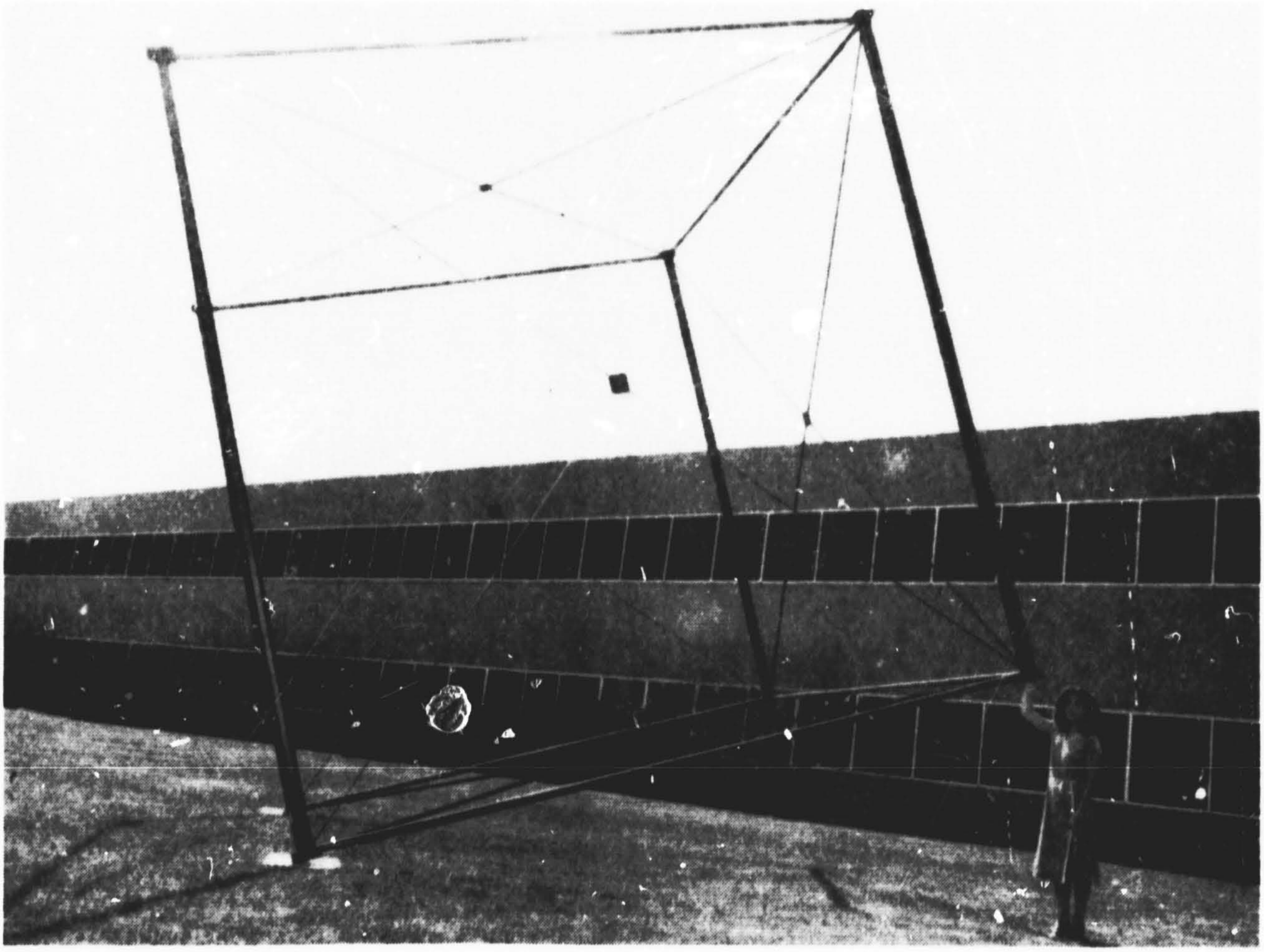


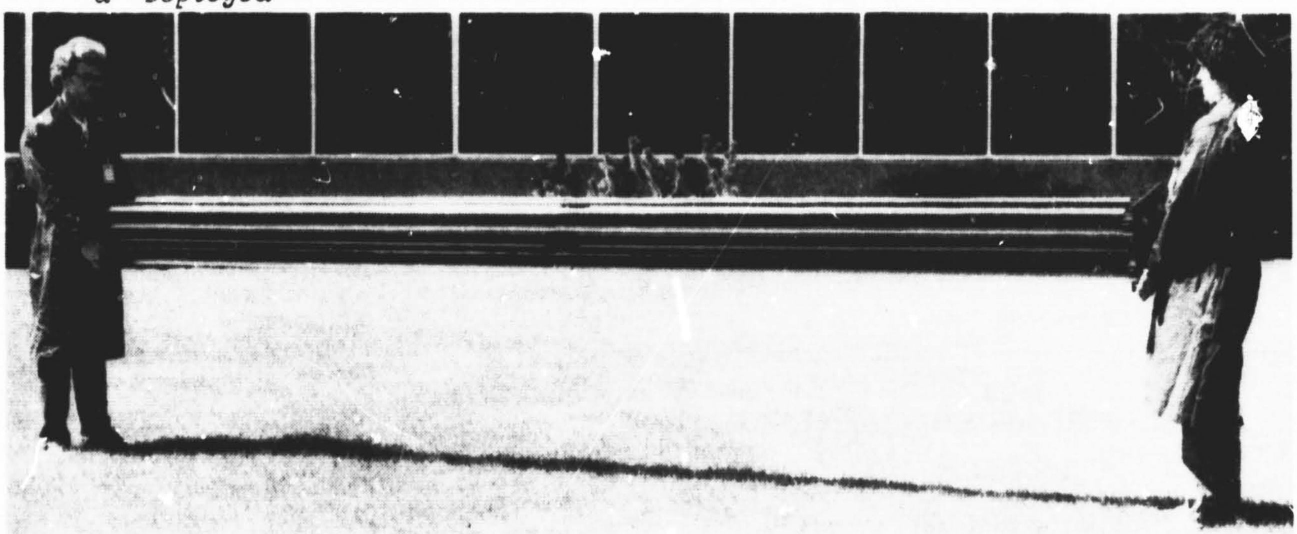
Figure I-1
15-m-diameter Offset Feed-Box Truss Antenna
(All Dimensions in Meters)

Table I-2 Antenna Performance Summary

11.941-m Focal Length	
Reflector Diameter, m	15.0
Focal Length, m	11.941
Reflector and Feed Support Mast, kg	400.07
Feed Mass Allocation, kg	27.14
Ballast Mass, kg	22.68
Deployed Frequency, Hz	
- Mode 1	12.55
- Mode 2	12.75
- Mode 3	13.19
Stowed Envelope, m	3.84x4.47 dia
Stowed Frequency, Hz	17.2
Surface Accuracy (rms) Worst-Case, cm	0.097
Feed Location Accuracy (Axial), cm	0.024
(Centrifugal Corrected) (Lateral), cm	0.051
18.000-m Focal Length	
Reflector Diameter, m	15.0
Focal Length, m	18.0
Reflector and Feed Support Mast, kg	484.99
Feed Mass Allocation, kg	27.14
Ballast Mass, kg	22.68
Deployed Frequency, Hz	
- Mode 1	7.071
- Mode 2	8.174
- Mode 3	13.05
Stowed Envelope, m	4.04x4.47 dia
Surface Accuracy (rms) Worst-Case, cm	0.097



a Deployed



b Stowed

Figure I-2 Deployable Box-Truss Bay

II. INTRODUCTION

The 15-mete: dia mechanically scanned deployable antenna (MSDA) is designed using the deplcyable box-truss structure to form the parabolic dish and feed mast. This truss comprises a deployable frame consisting of two equal-length structural members ("verticals"), two structural members hinged in the middle ("surface tubes") that connect the ends of the verticals and fold inward to stow between the adjoining verticals, and telescoping diagonal braces that lie in, and control the shape of, the deployed frame (Fig. II-1). Prototype hardware has been fabricated with all-composite tubes and fittings, and low-cost manufacturing processes are being developed for all repetitive components.

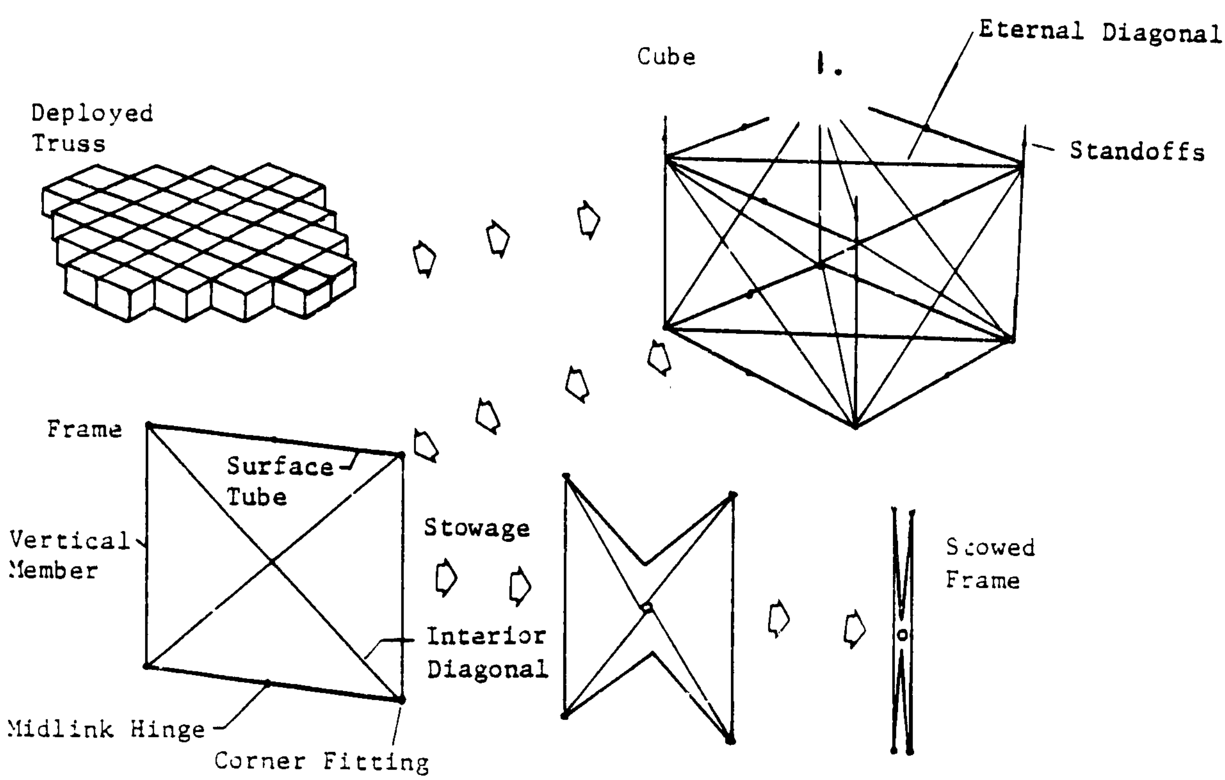


Figure II-1 Deployable Box-Truss Schematic

The shape of a box-truss reflector and feed mast is controlled by the diagonal tension braces in each frame face. The diagonals are multiple-ply graphite-epoxy tapes that telescope for stowage and deployment. Both diagonal tapes in each frame face lie flat in the plane of the frame, thereby equalizing solar input to the two tapes and minimizing thermal distortions.

A key feature of the truss is the hinge and latch in the middle of each folding surface tube. All moving parts are in the hinge and latch interior. This eliminates protuberances that could interfere with the diagonal braces or an antenna surface during deployment. Redundant coil springs in the hinge are sized to produce the desired deployment rate. The spring-driven over-center latch increases in mechanical advantage when the deploying tube is approximately 10 deg from full deployment. The latch spring is sized to meet diagonal brace and antenna surface tensioning requirements. A redundant mechanical latch functions in parallel with the over-center latch.

The structure is deployed in a controlled sequence of steps. Feed beams are deployed one cube at a time and trusses are deployed one row of cubes at a time. In the latter case, the steps are accomplished in a preselected sequence in the two orthogonal deployment directions. This type of deployment is compatible with flat, cylindrical, and parabolic trusses, and virtually any beam shape.

The 5-bay by 5-bay antenna support structure has an extremely high stiffness-to-weight ratio and excellent thermal stability. Because of the box truss configuration, the structure easily stows within the allotted envelope. This 5x5 offset feed box truss design exceeds all requirements listed in Table I-1 with the exception of the 25-Hz stowed requirement. All structural members are made of thermally stable and stiff graphite-epoxy composite layup.

A unique deployable feed mast has been developed for the offset feed space deployable antenna. The novel feature of this design is that it uses an extension of the reflector truss structure rather than adding appendages. The design features efficient stowage, simple integration to the reflector structure, excellent thermal stability, lightweight, and very high stiffness and dynamic stability. These features are achieved by using the efficiency and features of a deep truss structure. Previous offset feed masts were appendages added to the reflector structure and had less efficient packaging, more difficult integration, and substantially lower dynamic stability. Because of the high strength and stiffness, this mast can easily accommodate the more complicated and massive advanced feeds (e.g., line feeds, array feeds, and multifrequency multibeam feeds).

III. ANTENNA DESIGN AND ANALYSIS

The antenna support structure (Fig. I-1) shows the center row of bays radiating out from the feed support to make up the strongback for the structure. The strongback is a very stiff area of the structure that provides the load paths between spacecraft and the antenna support structure. The focal length for this antenna configuration is 11.941 meters with an integrated-offset feed. The feed mast structure is an extension of the antenna support structure.

A. PARABOLIC STRUCTURE DESIGN

The parabolic box-truss design is an accurate truss with all the force lines of action going through a coincident point. This design feature is shown in Figure III-1. The cube-corner fitting attachment point for the surface tube is adjusted so the surface tube line of action goes through a coincident point with all the other surface tubes and diagonal members of that particular cube-corner fitting. The depth of the cube-corner fitting (Fig. III-2) was increased relative to the original cube-corner fitting (Fig. III-3) to accommodate these changes of attachment points. Moving the attachment points to eliminate end moments on the vertical members dramatically increases the fundamental mode of the entire structure. Along with movement of attachment of the surface tube, specific surface member lengths must be kept identical in any row or column of the structure. This design feature ensures the structure remains orthogonal during sequential deployment in either direction. Identical member lengths are made possible by the geometric property that any cutting plane through the surface and parallel to the vertex axis will show an identical parabola through the intersection points.

Note:

All force vectors (lines of action) intersect at a single point of action. This eliminates and moments on the vertical members, thus increasing the structure's overall natural frequency.

ORIGINAL PAGE IS OF POOR QUALITY

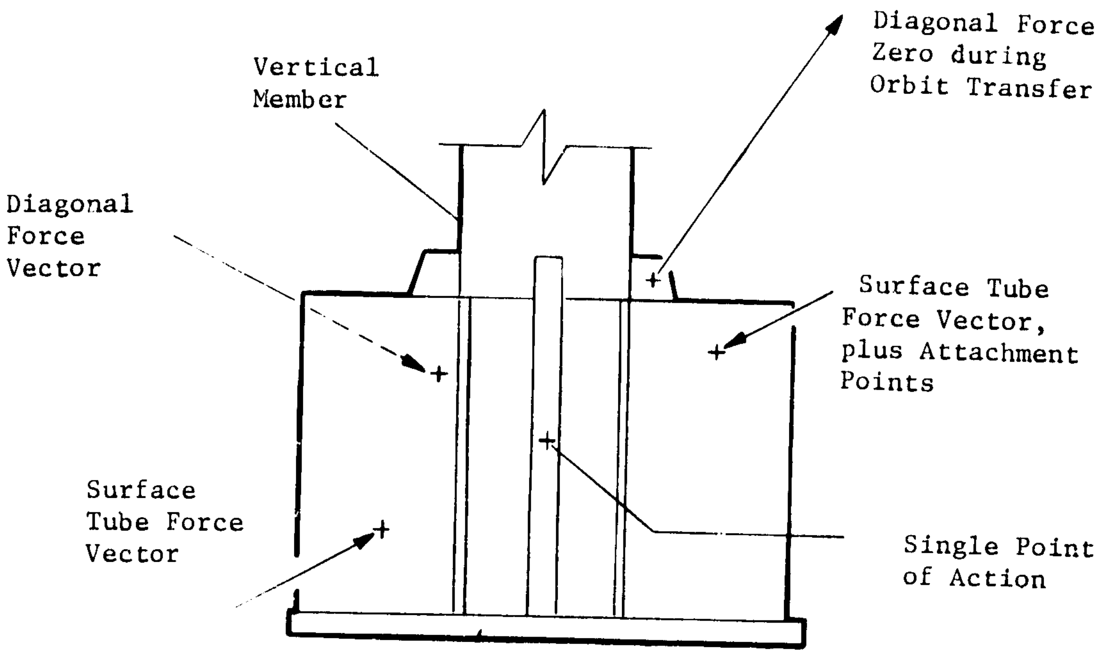


Figure III-1 Lines of Forces Through Cube Corner Fitting

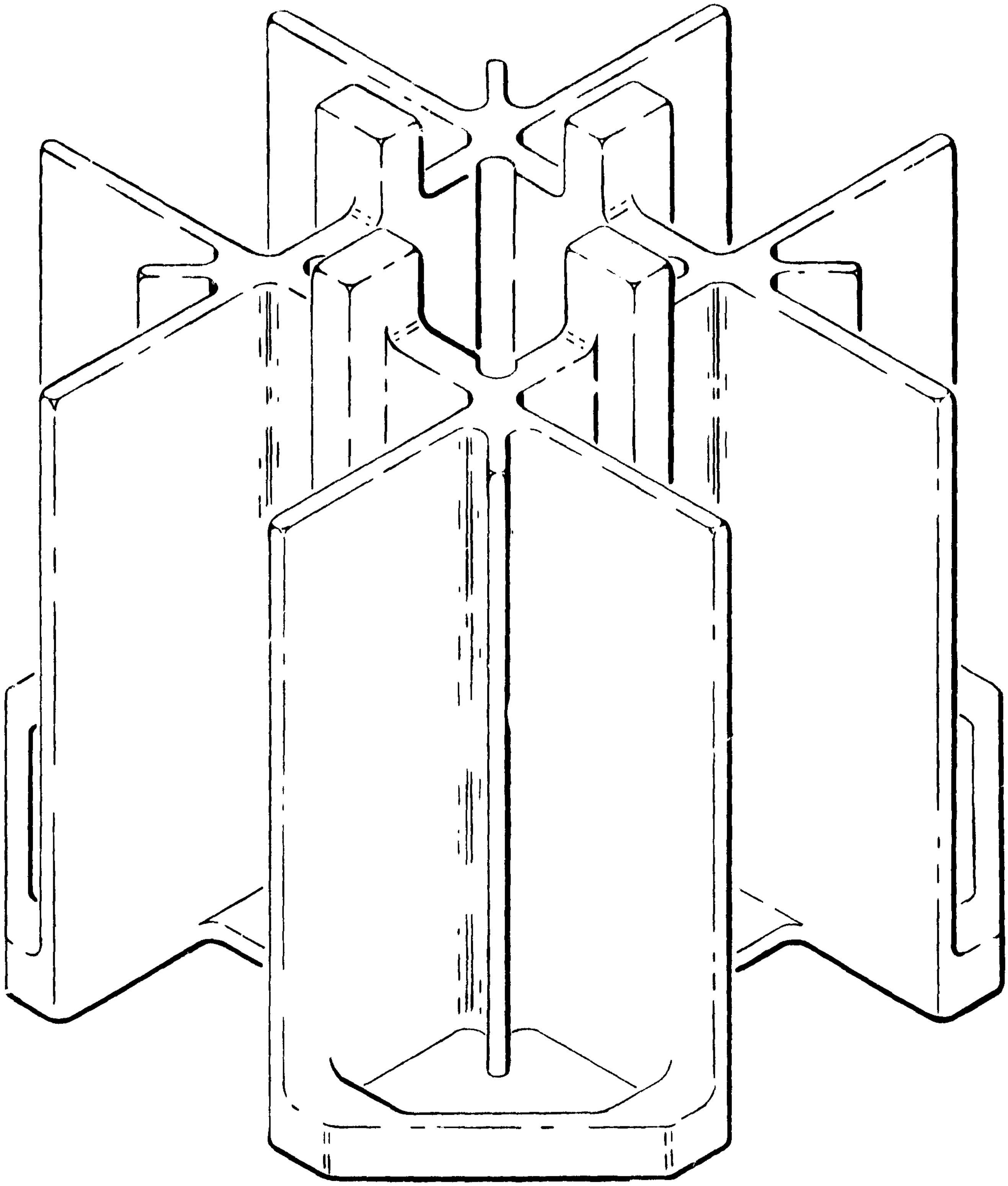


Figure III-2 Parabolic Cube-Corner Fitting

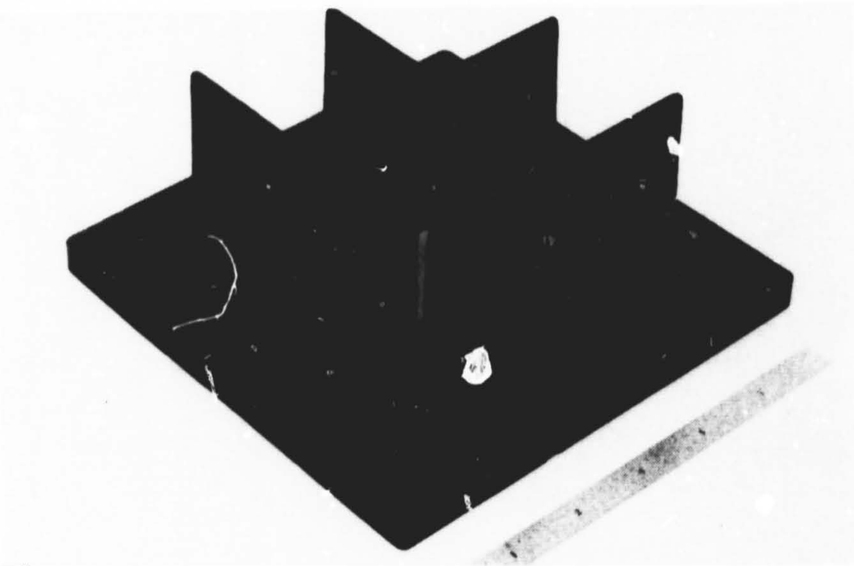


Figure III-3
Compression-Molded Graphite-Fiber Reinforced Corner Fittings Join Box-Truss Structural Members (Flat Truss)

The cube-corner fitting (Fig. III-3) forms the structural ties between the cube's vertical members, surface tubes, and diagonal braces. The cube-corner fitting is made of 1.25-cm compression-molded chopped graphite-fiber in an epoxy matrix to give rigidity and thermal stability to the structure. Since the cube-corner fitting is a repetitive identical part, the part can be molded at low cost. Pin locations are drilled depending on the location of the cube-corner fitting in the structure. Since some pin locations in the cube-corner fitting require less depth, excess material will be trimmed from the fitting as a weight savings. To save additional weight in edge areas of the antenna structure where only partial fittings are needed, the cube-corner fitting is trimmed to the needed size.

Strongback and Superbox - The structural members in the strongback region have increased cross-sectional area to provide local stiffness. The increased cross-sectional areas were determined in an iterative process using the strain distribution in the structural modes obtained from the finite element dynamic computer runs. This process optimized member sizes by defining high stiffness members in areas of high-strain energy and low-stiffness (weight) members in areas of low-strain energy.

The heart of the strongback section is the "superbox" as shown in Figure III-4. The 2x2x4-meter superbox is extremely stiff and provides the interface points between the spacecraft and the antenna via the spin adapter structure (Fig. III-5). The superbox does not deploy and uses rectangular tubes for the diagonal members. The superbox allows the structure to meet the 12-Hz fundamental frequency requirement through its rigidity at the interface point. The spin adapter structure will be constructed of graphite-epoxy, although its exact dimensional characteristics have yet to be determined.

Member Properties - The different section and material properties of the structural member are listed in Table III-I. The locations in the structure for the different member types are shown in Figures III-6a through -6d. The graphite-epoxy layups and cross-sectional dimensions for the members are contained in Appendix A. As can be seen in Table III-1, many different member types exist; therefore, only a general description of each major class will be discussed. All surface and vertical members were designed with a factor of safety of 1.25, and a 0.9 knockdown factor for nonstraightness of members (manufacturing and thermal). All members were designed based on deployed stiffness of the antenna system because applied loads on the antenna are small.

Vertical Tube - These structural members are called "verticals" because they span from top to bottom in the box-truss bays (Fig. III-7). These members are 3.81-cm square, are made of a graphite-epoxy laminate, and, for MSDA, do not have fins as shown in Figure III-7. In the MSDA structure, most verticals are closed sections (Types 10 and 11), with the exception of the feed support structure at the antenna-structure interface where channels are used. The nonfinned vertical members are bonded in the cube-corner fitting and extend through the fitting on the top surface to create 30.48-cm standoffs above the box-truss structure for the mesh tie system.

Surface Tubes - The surface tubes span the top and bottom surfaces of the antenna support structure. Tube diameters are 4.45 cm and vary in wall thickness according to their location in the structure. They contain a graphite-epoxy hinge and deployment mechanism, located at midspan, that allows them to fold for stowage. The surface tubes have integral end fittings with increased thickness to provide for improved bearing strength through the pin holes. This feature eliminates special fabrication and bonding of separate end fittings. The integral end fitting (Fig. III-8) is less expensive and has lower CTE than alternate end-fitting designs.

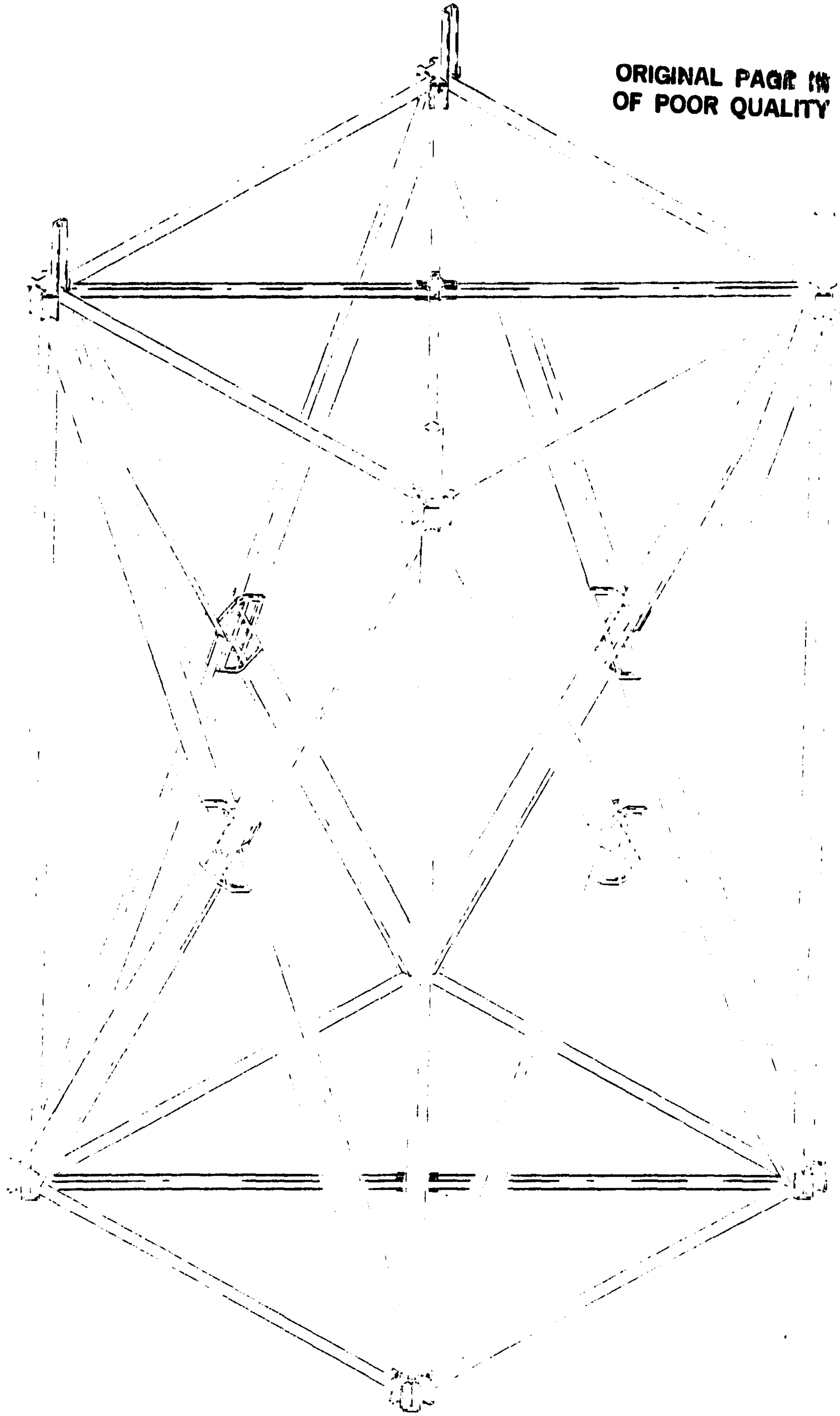


Figure III-4 Superbox

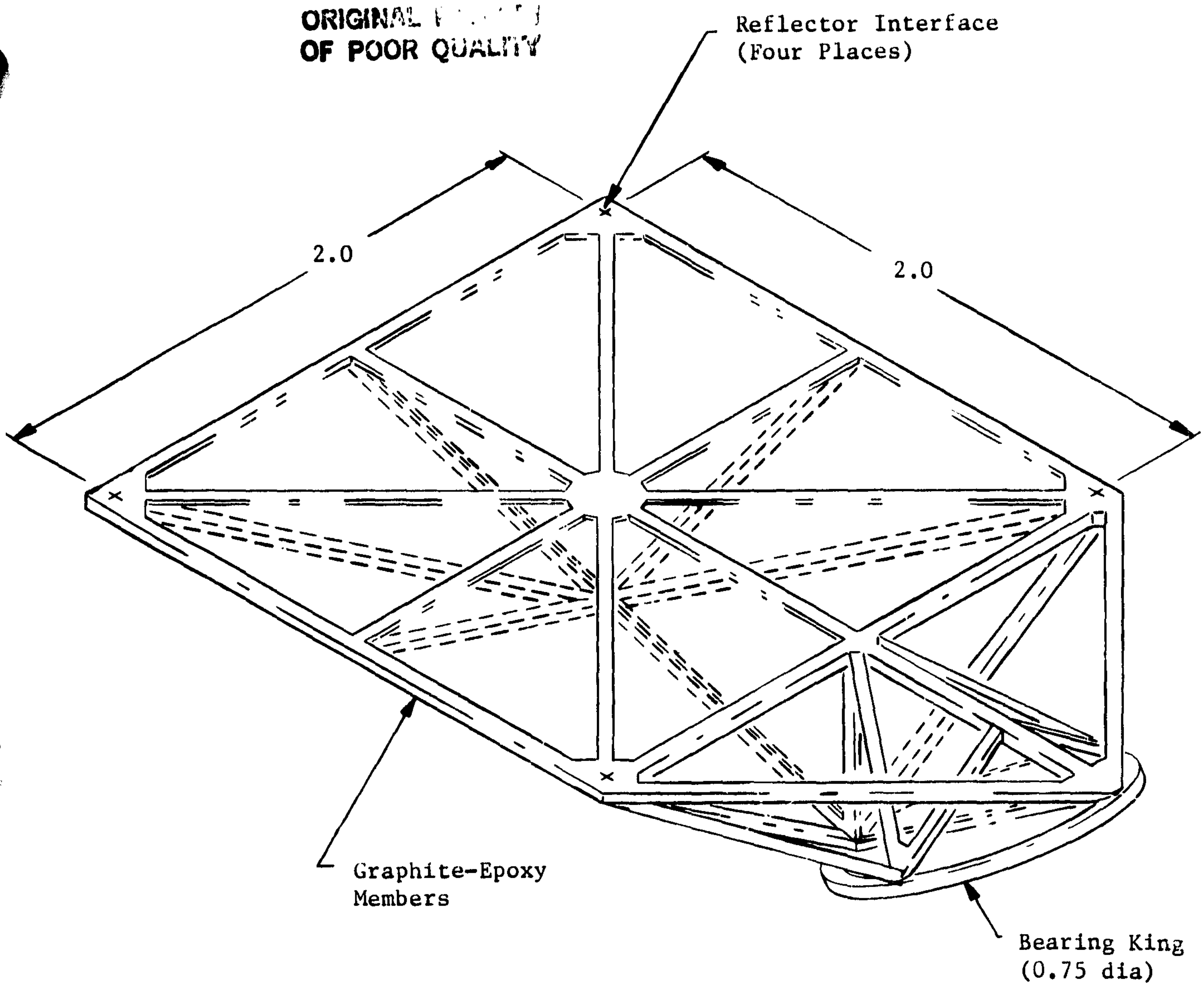


Figure III-5 Spin Adapter Structure (All Dimensions in Meters)

ORIGINAL PAGE IS OF POOR QUALITY

Table III-1 MSDA Section and Material Properties

Member Type	Section Type No	Material Type No.	Area, m^2	I_y, m^4	I_z, m^4	Torsonal Constant, m^4	Nonstructural Mass/Unit Length kg/m
Surface, 4.45-cm dia	1	1	7.01E-5	1.69E-8	1.69E-8	3.39E-8	2.85E-2
	2	2	1.72E-4	4.02E-8	4.02E-8	8.03E-8	2.85E-2
	3	3	2.51E-4	5.71E-8	5.71E-8	1.14E-7	2.85E-2
	4	11	4.64E-4	1.35E-7	1.35E-7	2.01E-7	2.85E-2
Vertical, 3.81-cm sq	10	10	1.32E-4	3.06E-8	3.06E-8	4.58E-8	
	11	11	5.34E-4	2.06E-7	2.06E-7	3.08E-7	
Channels	20	20	4.24E-4	2.53E-7	2.33E-7	2.58E-10	
	21	21	1.35E-3	1.12E-6	4.88E-7	2.57E-8	
Deployable Interior Tapes	30	30	3.79E-5				1.48E-2
	31	31	6.01E-5				1.48E-2
	32	32	1.14E-4				1.48E-2
Nondeployable Interior Members	33	33	3.74E-5				1.48E-2
	34	33	7.48E-5				1.48E-2
	35	35	1.41E-4				1.48E-2
	36	10	3.64E-4				
	37	37	6.97E-4				
	38	37	9.61E-4				
	39	37	1.28E-3				
Deployable Exterior Tapes	40	33	9.10E-6				
	41	33	1.82E-5				
	42	42	2.07E-4				
	43	43	2.59E-4				
Rectangular	50	37	1.02E-3	2.01E-6	3.73E-7	4.16E-7	

Note: All properties are in member coordinate system.

Material Type	E_L Nt/m^2	G_{LT} Nt/m^2	μ_{lt}	Density, kg/m^2	CTE m/m/°C
1	1.64E11	1.30E10	0.193	1.61E3	-0.25E-6
2	1.85E11	1.14E10	0.198	1.61E3	-0.38E-6
3	1.86E11	1.05E10	0.154	1.61E3	-0.32E-6
10	1.78E11	1.29E10	0.243	1.69E3	-0.38E-6
11	1.94E11	9.50E9	0.136	1.69E3	-0.36E-6
20	1.87E11	1.16E10	0.225	1.69E3	-0.41E-6
21	1.85E11	1.14E10	0.190	1.69E3	-0.38E-6
30	1.20E11			1.55E3	0.33E-6
31	1.17E11			1.55E3	0.34E-6
32	1.36E11			1.55E3	0.34E-6
33	1.88E11			1.58E3	0.34E-6
35	2.01E11			1.67E3	-0.27E-6
37	1.85E11			1.67E3	-0.34E-6
42	1.44E11			1.69E3	-0.32E-6
43	1.82E11			1.60E3	0.20E-6
				1.60E3	-0.31E-6

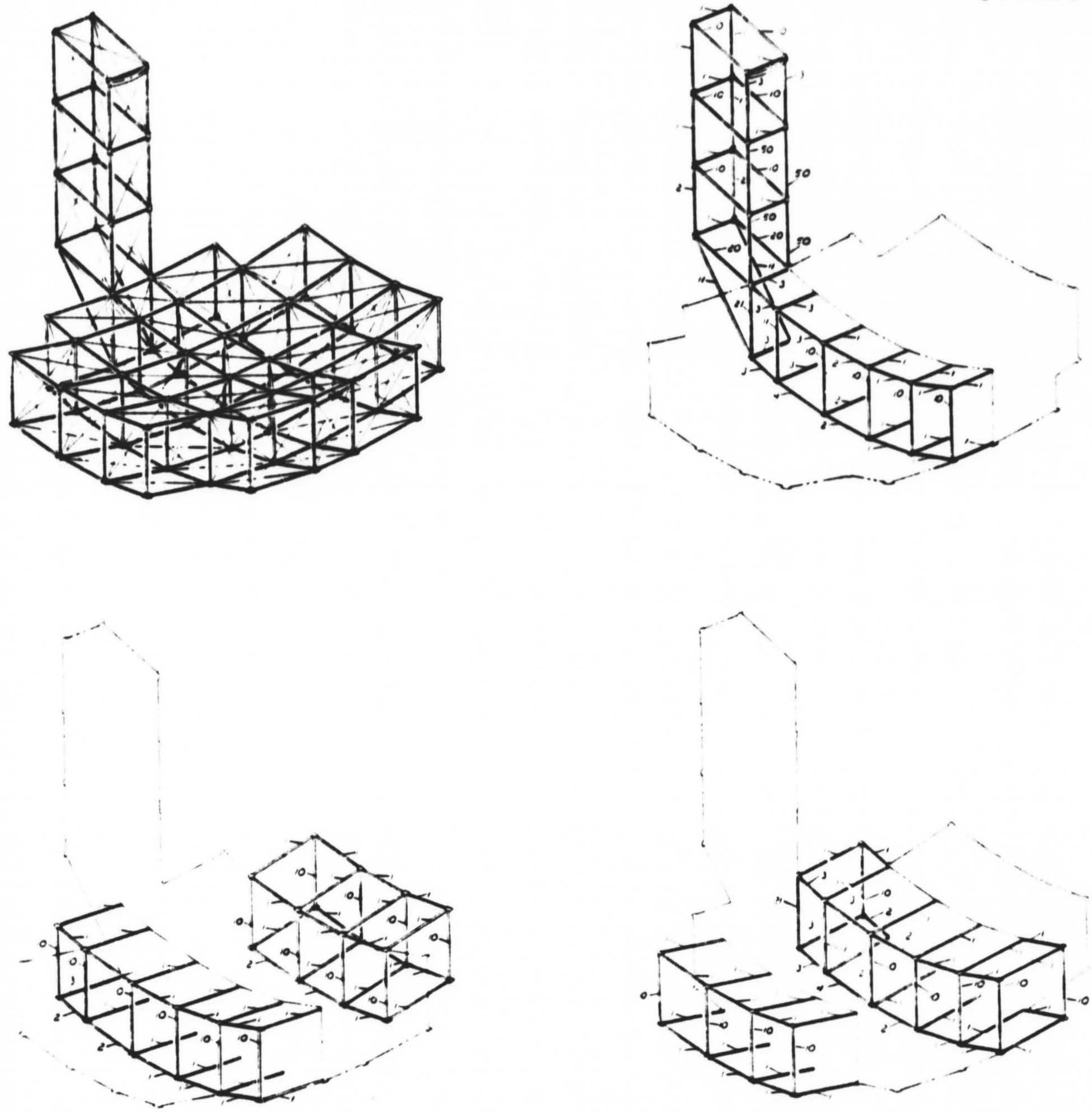


Figure III-6a   MSDA Section Properties Numbers

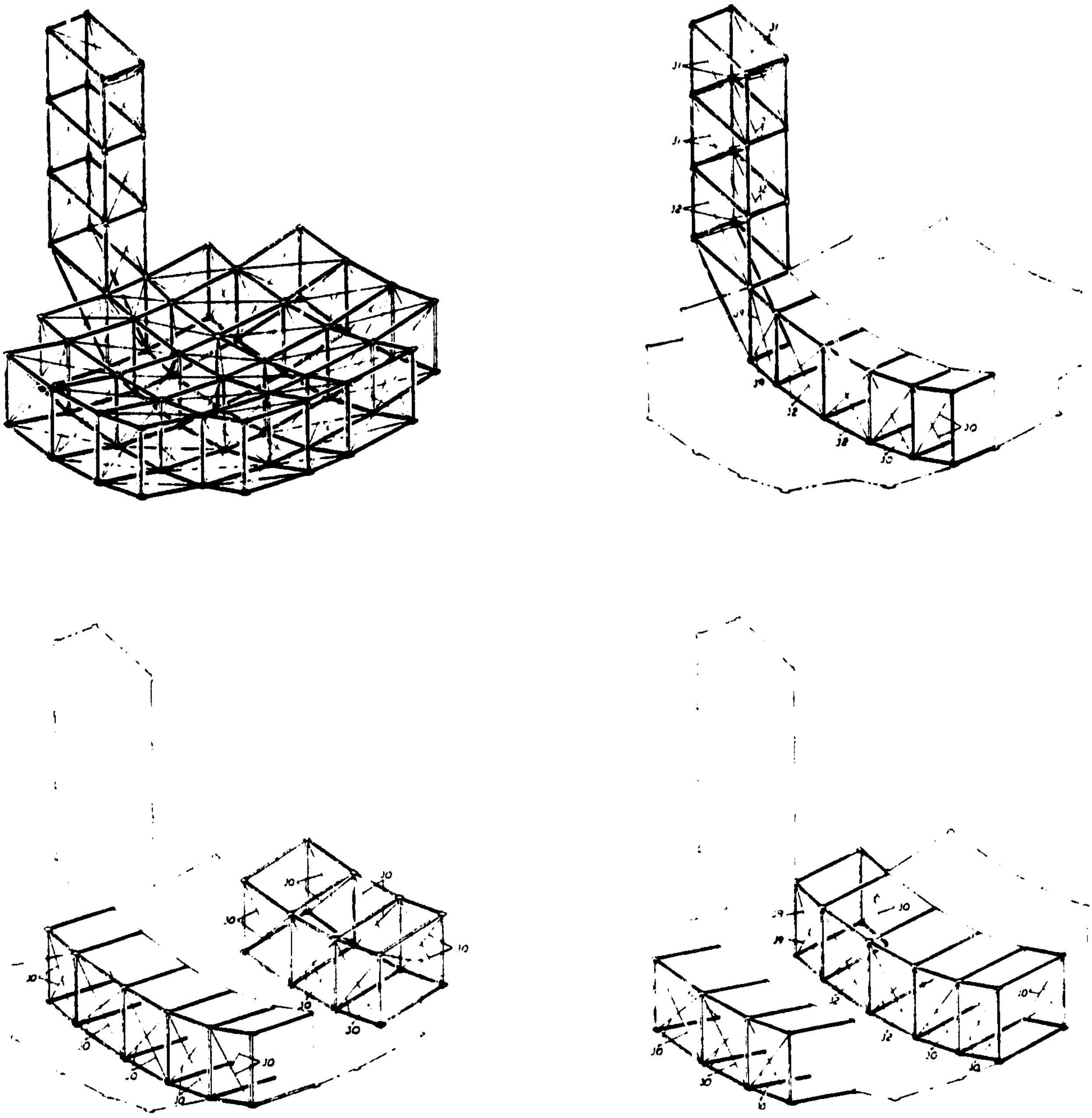


Figure III-6b MSDA Section Properties Numbers

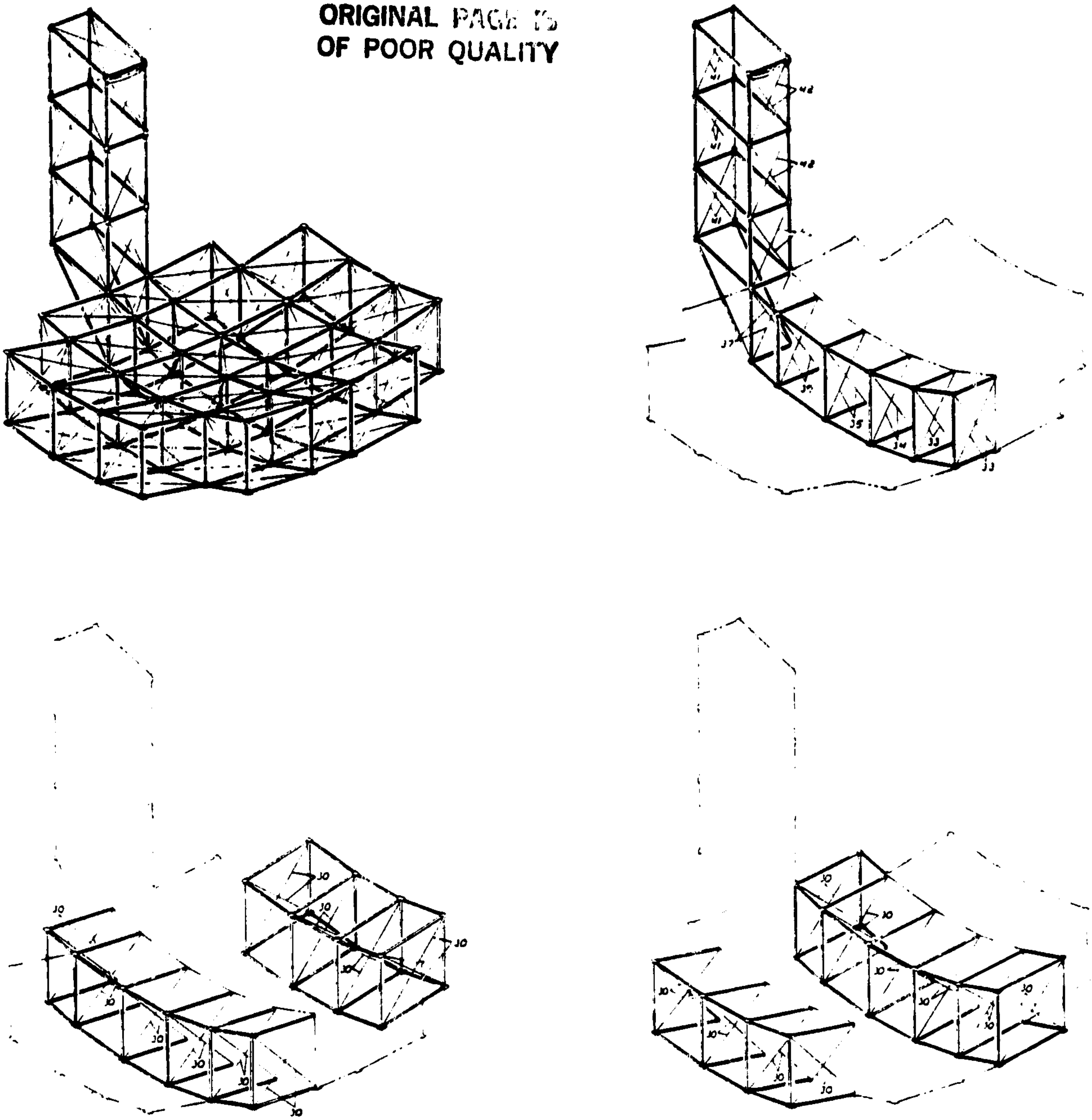


Figure III-6c MSDA Section Properties Numbers

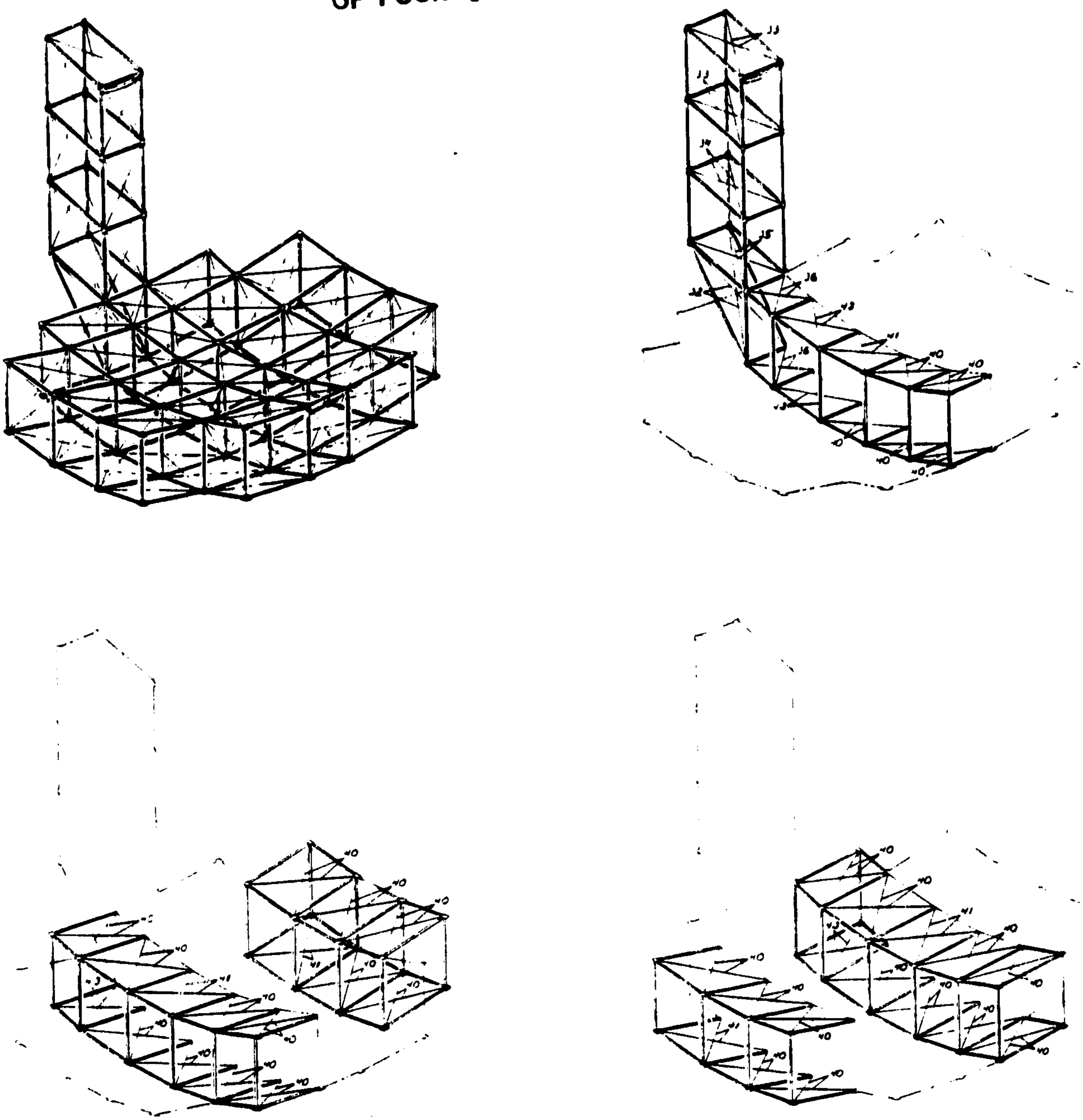
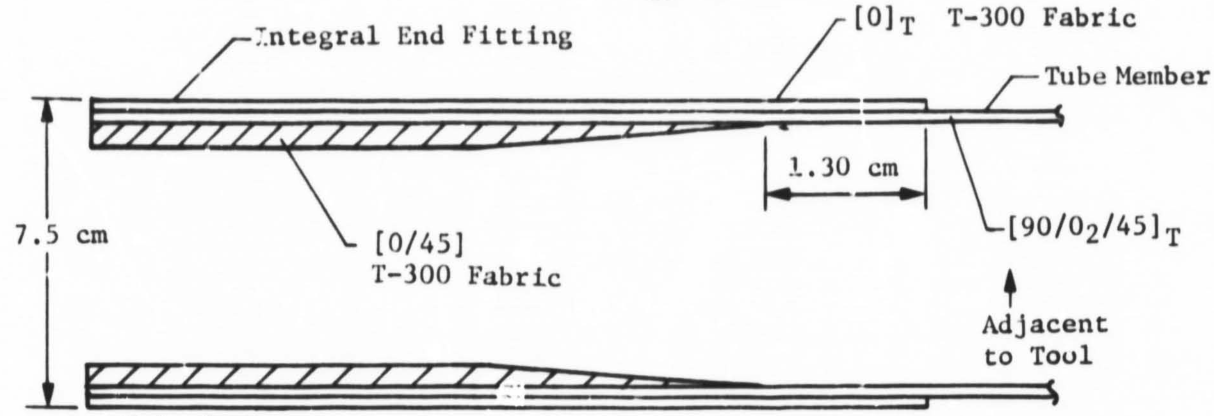


Figure III-6d MSDA Section Properties Numbers

The vertical member's column allowables can be varied easily by varying the fin construction.

Figure III-7 Graphite-Epoxy Vertical Member

Interior Diagonals - The interior diagonals span the interior faces of the box truss bays. These tension members are a two-part design made up of a tape and a mating flattened tube as demonstrated in Figure III-9. This unique construction scheme is used to permit the member to telescope for stowage. The interior diagonals are pretensioned from 89 to 445 N in deployed configuration (depending on location within the structure). The pretension level is selected to maintain tension in all diagonals under the combined effects of thermal distortions, manufacturing errors, and centrifugal forces. The interior diagonals set the box truss to a parabolic shape by prescribing their lengths through predetermined parameters depending on focal length and location within the truss. First, the box truss is assembled without the diagonals. Next, the truss is deployed and positioned to the desired shape and the diagonals are installed and tensioned. The diagonals are then bonded while under tension. This procedure minimizes manufacturing tolerance buildup and ensures proper tension levels. The diagonal members are packaged flat against the vertical member in the stowed configuration. During deployment, the interior diagonal members rotate 90 deg so they will lay flat in the plane of the interior bay face. This will enable the interior members to be heated and cooled more equally by the solar radiation and thus reduce thermal deflection. The interior diagonals are connected at midspan by a crossover fitting (Fig. III-10). This fitting acts as a load path during stowage because it is in intimate contact between two parallel vertical members. The crossover fitting is a square plate that has cavities machined in the plate for weight reduction.



Tube Layup

$[90/0_2/45]_T$

- 90 - T-300 Tape
- 0 - Pitch 75 Tape
- 45 - T-300 Fabric

Composite Properties

$E1 = 15.6 \times 10^6$ N/cm^2 (22.6 MSI)
$E+ = 4.4 \times 10^6$ N/cm^2 (6.4 MSI)
$G_{I+} = 1.2 \times 10^6$ N/cm^2 (1.7 MSI)
$V_{LT} = 0.21$

CTE = $-0.20 \times 10^{-6}/^{\circ}C$

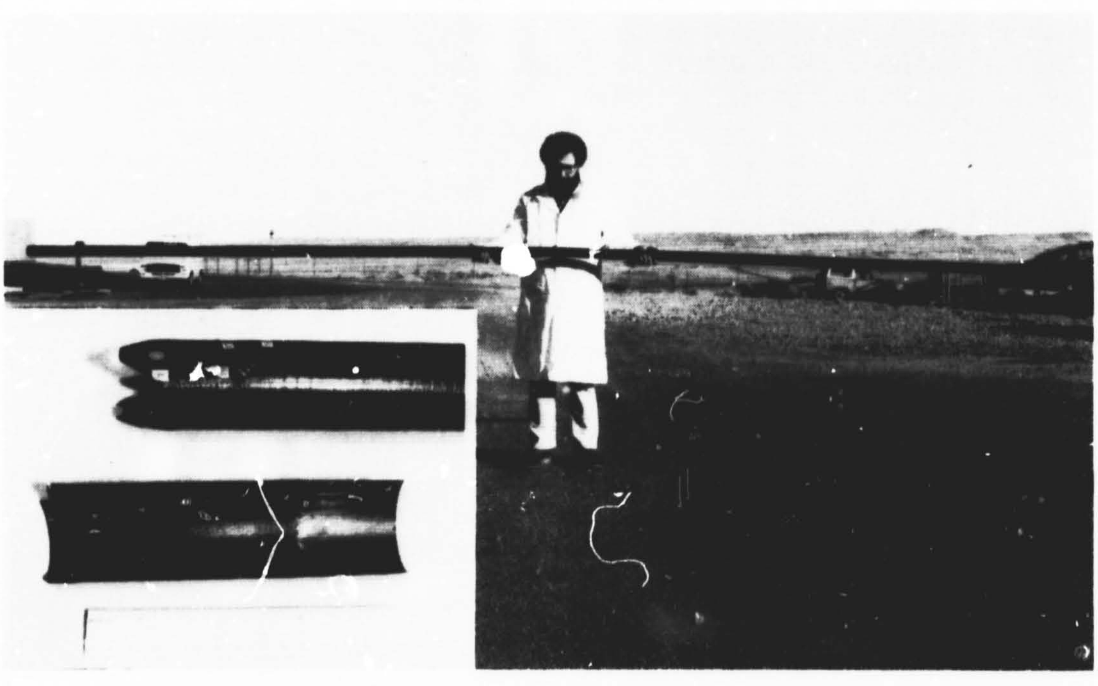
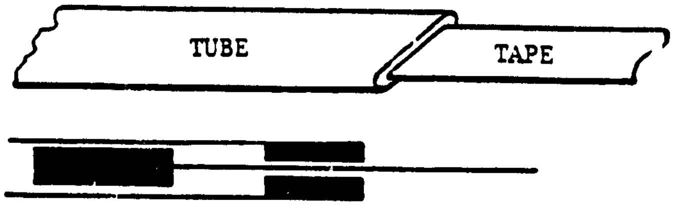


Figure III-8 Low-Cost, Integally Molded End Fitting



Tube Member

Width = 5.0 cm
Depth = 0.7 cm
Thickness = 0.07 cm
[0_2, 90, 0_2]

0 - Pitch 75 Tape
90 - T-300 Tape

Tape Member

Width = 4.75 cm
Thickness = 0.14 cm
[0,90,0_2,90,0_2,90,0]

0 - Pitch 75 Tape
90 - T-300 Tape

Figure III-9 Telescoping Interior Diagonal Member

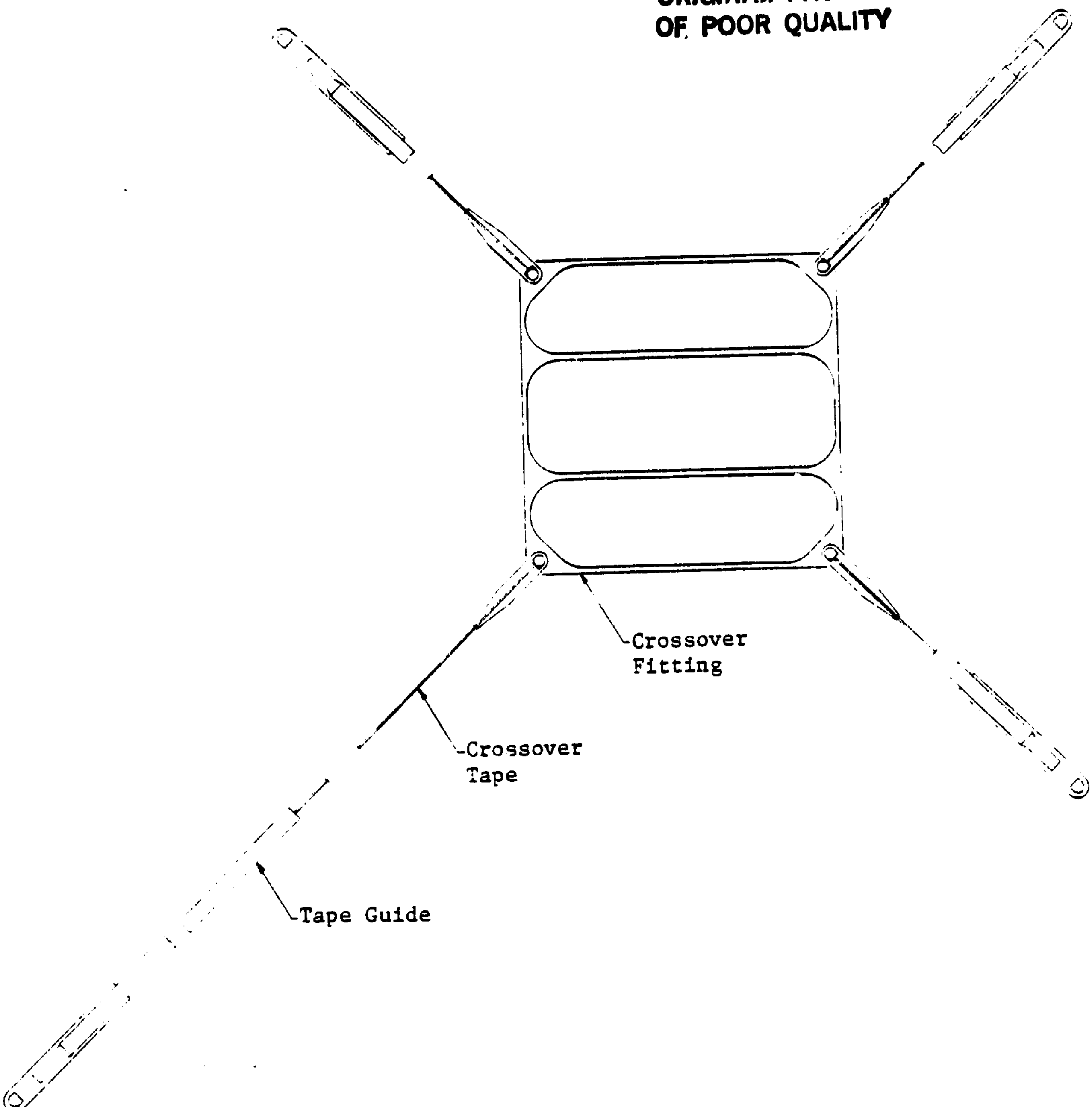


Figure III-10 Graphite-Epoxy Crossover Fitting

Exterior Diagonals Members - The exterior diagonals members lie in the surface faces of the box-truss bays. These members must deploy in both directions and yet be fabricated of a very high modulus of elasticity material. The basic exterior diagonal (Sect. 40) is a tape configuration. The exterior diagonal members are connected at midspan with a crossover fitting similar to the one used with the interior diagonals. This fitting alleviates any bending of the tapes during stowage. These members are pretensioned in a manner similar to that of the interior diagonal members.

Exterior diagonals located in the strongback portion of the antenna support system required an increased cross-sectional area because of the higher stiffness required. These diagonals employed a tape/tube configuration similar to that used in the interior diagonal members because they only need to deploy in one direction.

Midlink Hinge Design - As mentioned earlier, each surface member uses a midlink hinge that allows the surface tube to fold for stowage. The midlink hinge must meet three requirements: (1) hinge action for stowage and deployment, (2) torsion springs to supply deployment drive torques, and (3) a rigid structural link between the deployed tube halves. Figure III-11 is a photograph of the all graphite-epoxy (except springs and pins) midlink hinge assembly. The torsion spring driving the overcenter latch has a high mechanical advantage. This assists in overcoming static and startup resistance forces and the completion impulse provides the force required to tension the reflector surface and truss diagonal members. The deployed structural link across the midlink hinge consists of the bearing surfaces on the hinge halves, which are held in place by the hinge axis pins and the overcenter links and pins.

Figure III-11
The Graphite-Epoxy Midlink Hinge Assembly in Each Surface Tube Containing an Overcenter Hinge that Drive Deployment and Locks Tube Straight

Offset Feed Support Hinge Design - The connection point between the feed mast and the antenna support structure is a unique design. Fourteen different members' lines of force must converge through a coincident point. The fitting assembly (Fig. III-12) is a 3-dimensional joint with feed box trusses rotating out and up during deployment. The brace structural members fold up inside the interlocking vertical channels during stowage. The channels are of different thickness in the flanges and web so their centroidal planes intersect at deployment, maintaining a true truss configuration. The end fitting for the surface tubes in the feed mast is bonded to the back of the feed mast vertical channel (Sect. 20). The other channel that is part of the superbox is section type 21. This complex fitting is fabricated from several smaller graphite-epoxy laminates that are bonded and mechanically fastened into a single, unique hinged cube-corner fitting. The structural diagonal tubes of the superbox are pinned into this fitting. The advantage of a box-truss feed mast are longer focal lengths and larger feeds because of higher system fundamental modes resulting from the integrated design.

B. STOWED CONFIGURATION

The MSDA stowed configuration is shown in Figure III-13. All of the structural members compactly stow about the superbox thus allowing the antenna to easily meet the stowage requirement outlined in Table I-1. In the stowed condition, the cube-corner fittings butt against each other, forming a plane at the top and bottom surfaces. The plane formed by the cube-corner fittings provides a load path for loads incurred during launch with inplane shearing loads handled by interlocking pins between the fittings.

The dynamic characteristics of the MSDA in the stowed configuration were analyzed with the NASA Structural Analysis (NASTRAN) Finite Element Program. The model was conservative in the sense that it only contained the superbox stiffness with the rest of the masses lumped at the model's eight nodes. The first fundamental frequency obtained was 17.2 Hz, but this number is extremely conservative considering that the model did not take into account the stiffness added by the members being pinned and supported together during stowage. An additional restraint ring would readily permit attainment of the 25-Hz requirement.

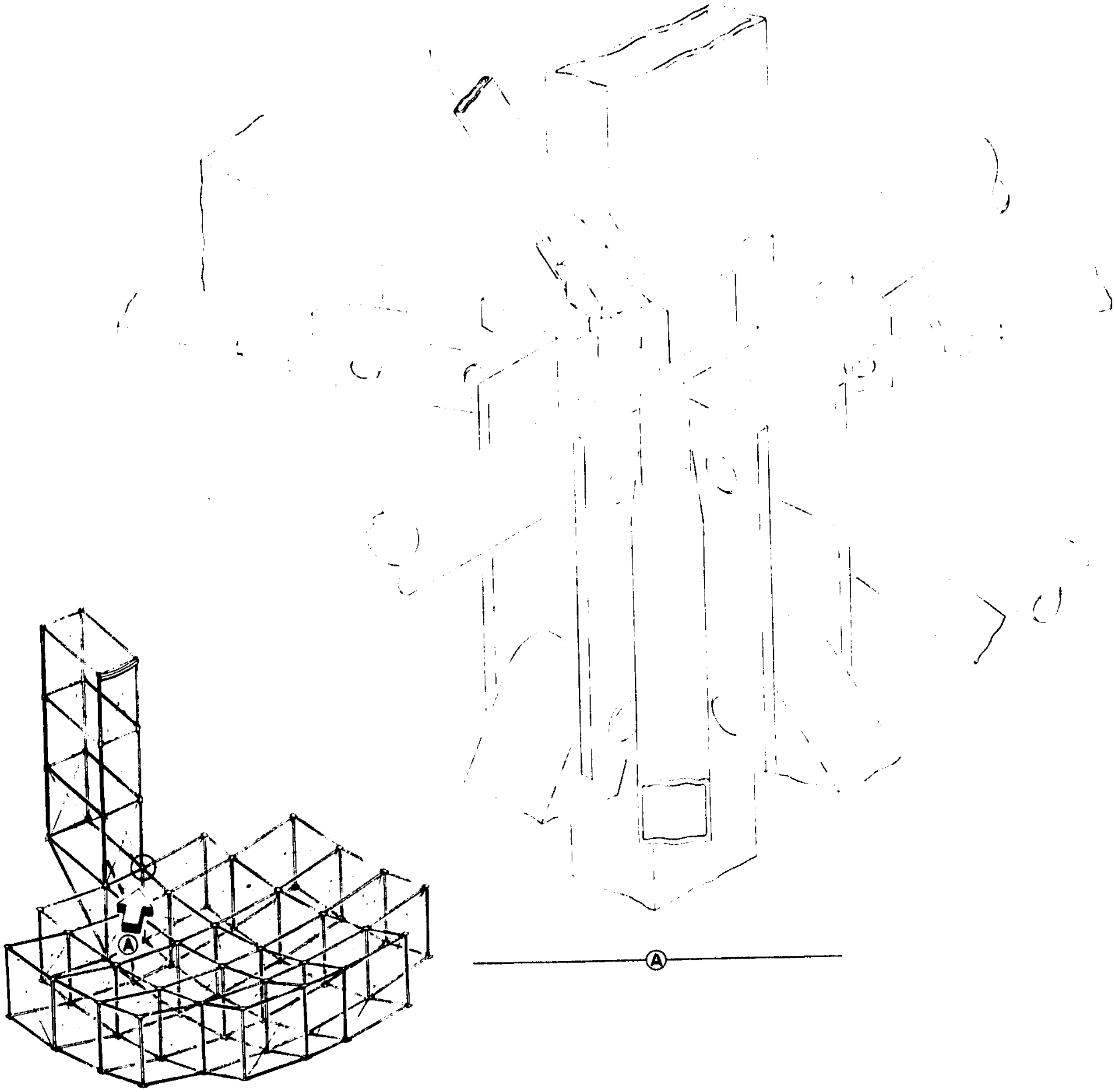


Figure III-12 Integral Offset Feed Hinge Joint

ORIGINAL PAGE IS
OF POOR QUALITY

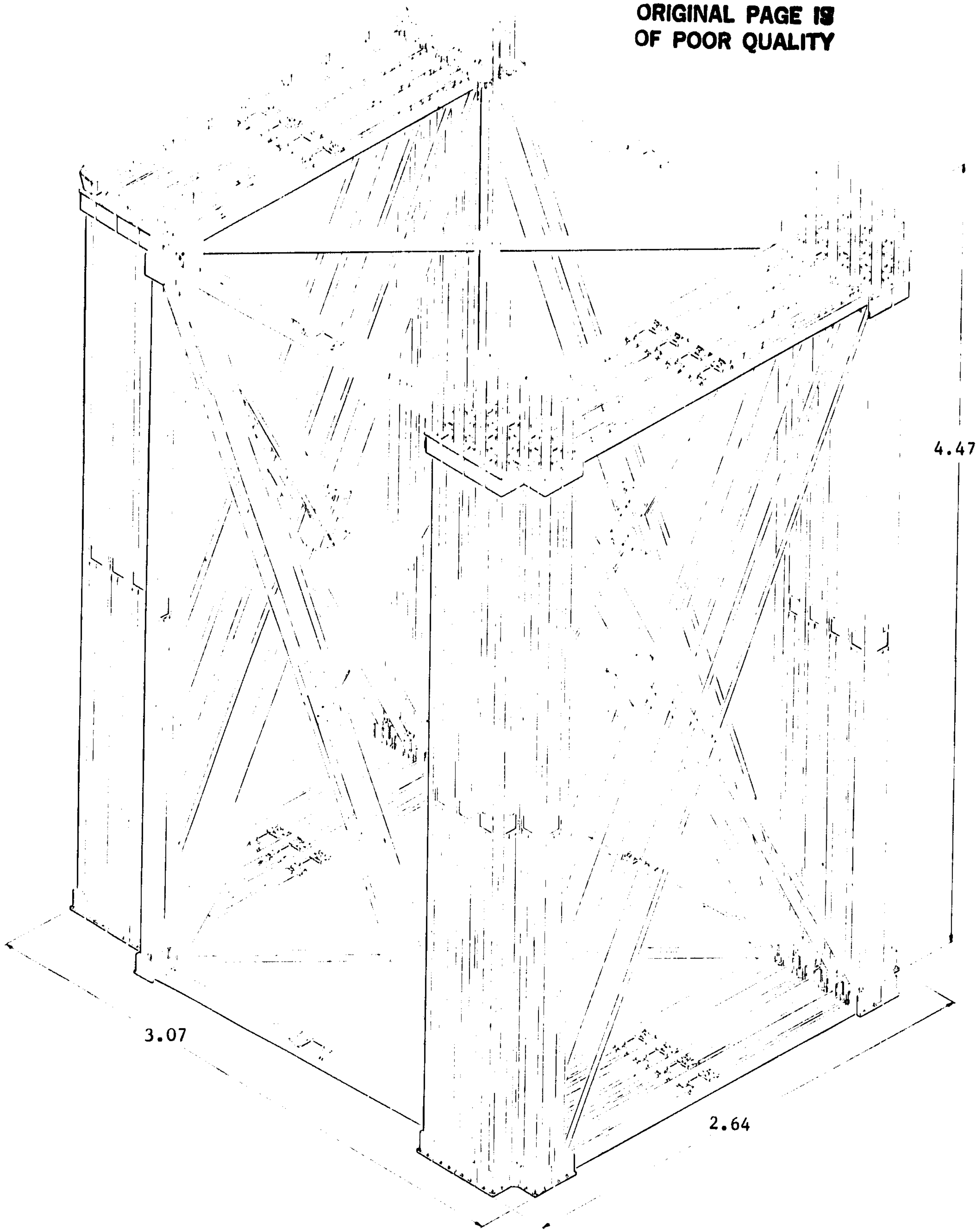
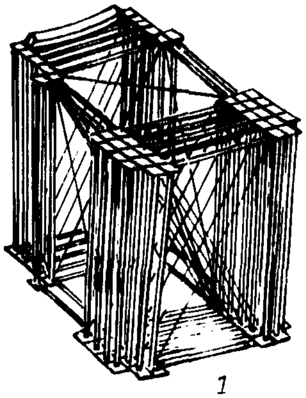


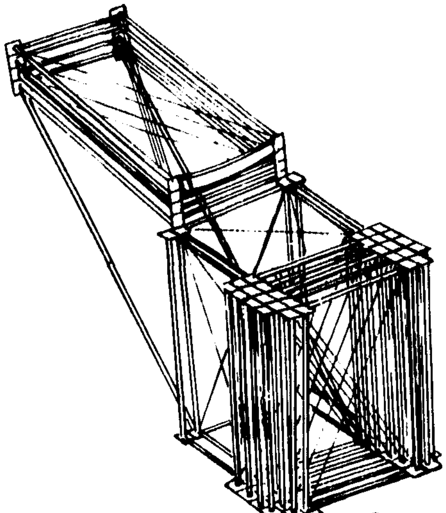
Figure III-13 MSDA Stowed Configuration (All Dimensions in Meters)

C. DEPLOYMENT

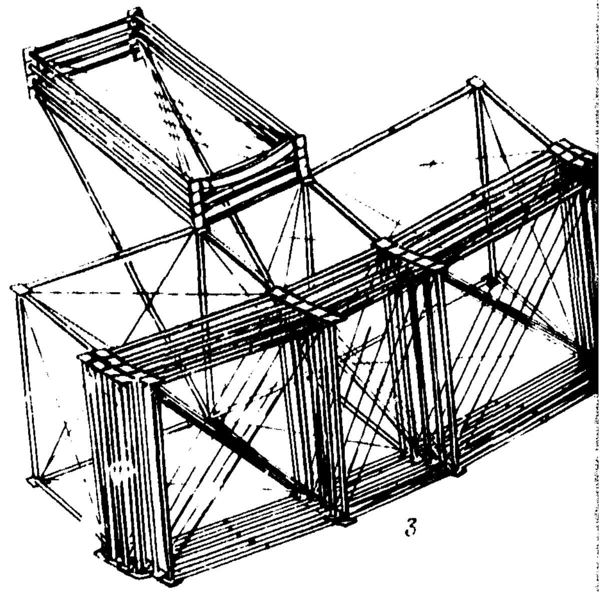
As shown in Figure III-14, the feed mast flips up first, after which the boxes on either side of the superbox deploy outward. The bays on either side of the middle deployed three are then deployed. Following this sequence, an entire row of five bays is deployed outward away from the feed mast. This is followed by each row deploying outward until the antenna support structure is fully self-deployed. The feed mast will then deploy its three boxes upward for the completion of the entire sequence. The deployment is controlled by latches between the cube-corner fittings. These latches release by remote control in proper sequence, initiating deployment of each section of the antenna support structure. The sequential nature of the deployment process dissipates the deployment energy in an incremental manner, thereby reducing the possibility of producing structural failure in the deploying truss.



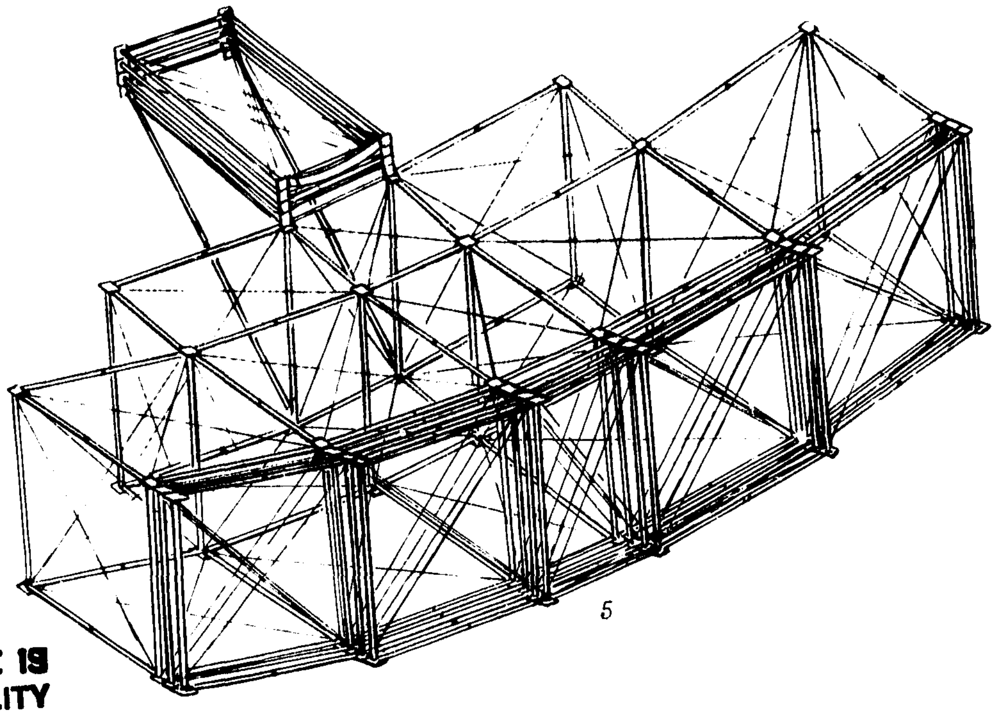
1



2



3



5

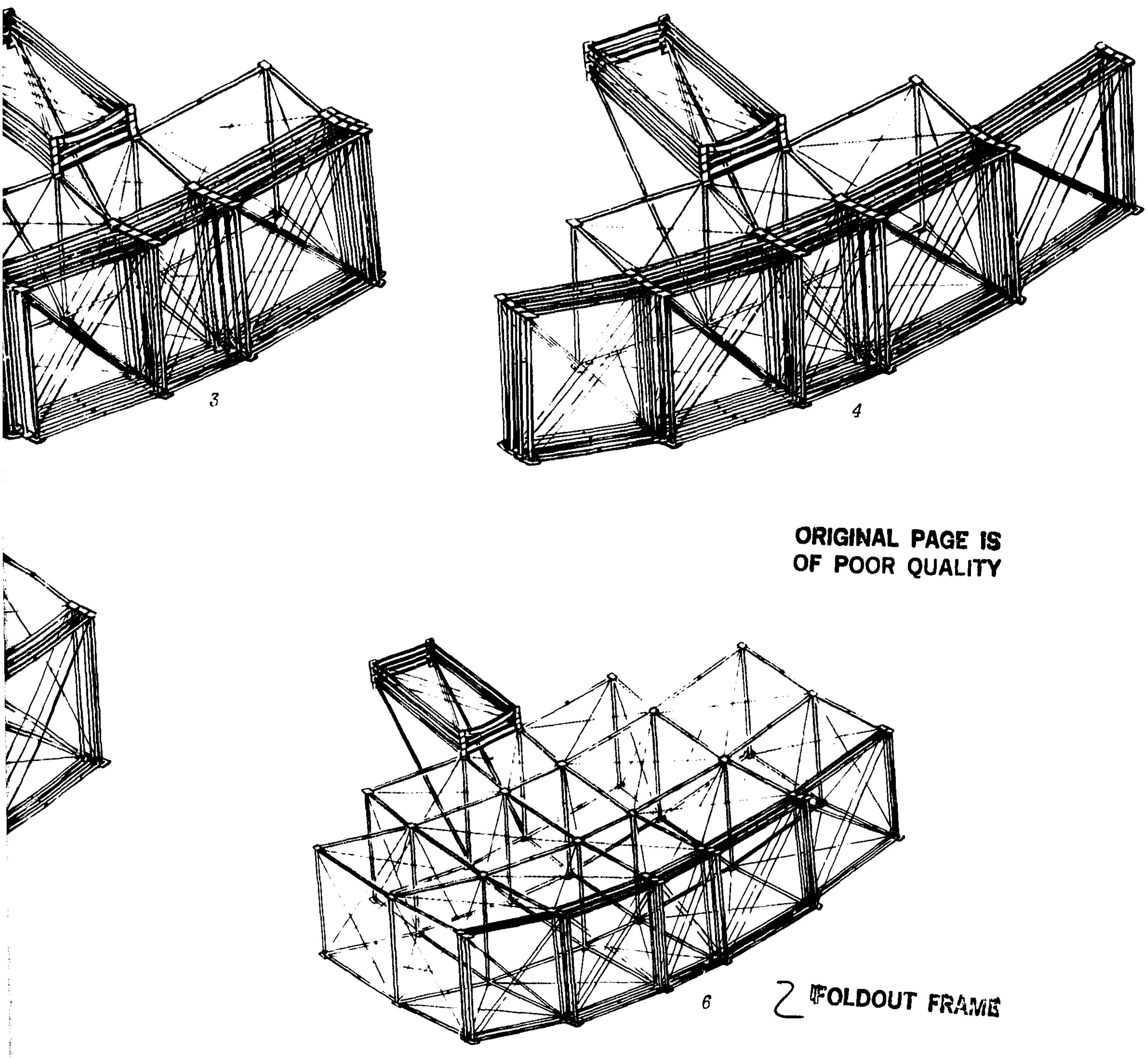
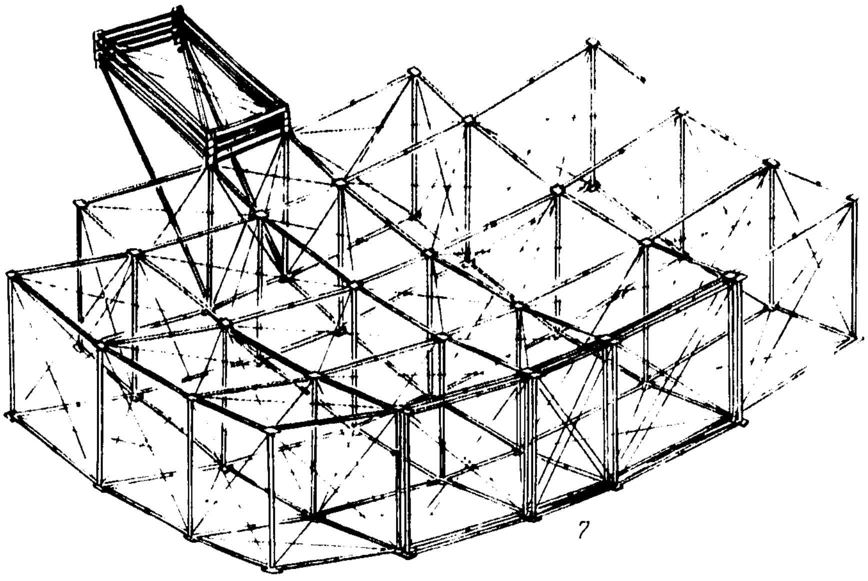
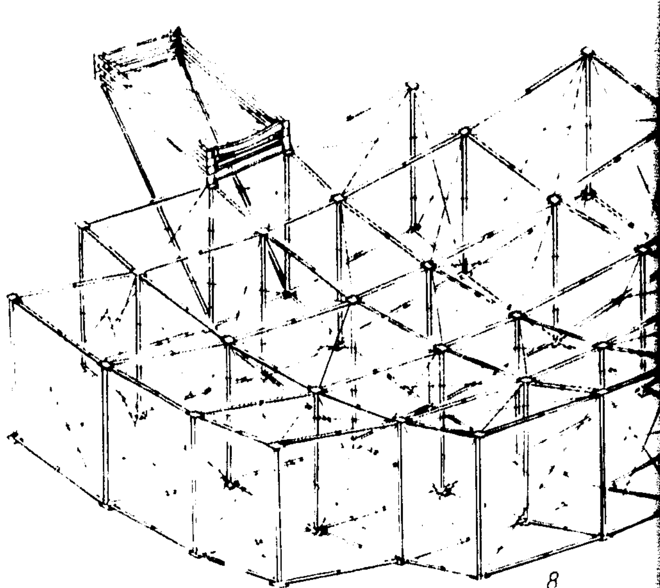


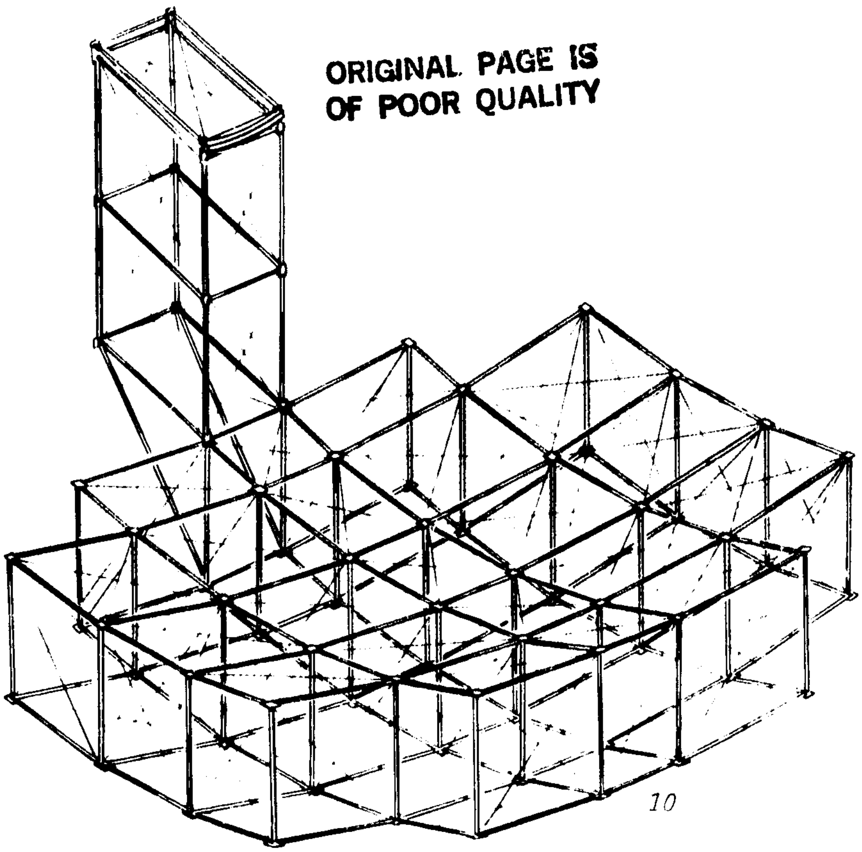
Figure III-14a MSDA Deployment Sequence



7



8



10

FOLDOUT FRAME

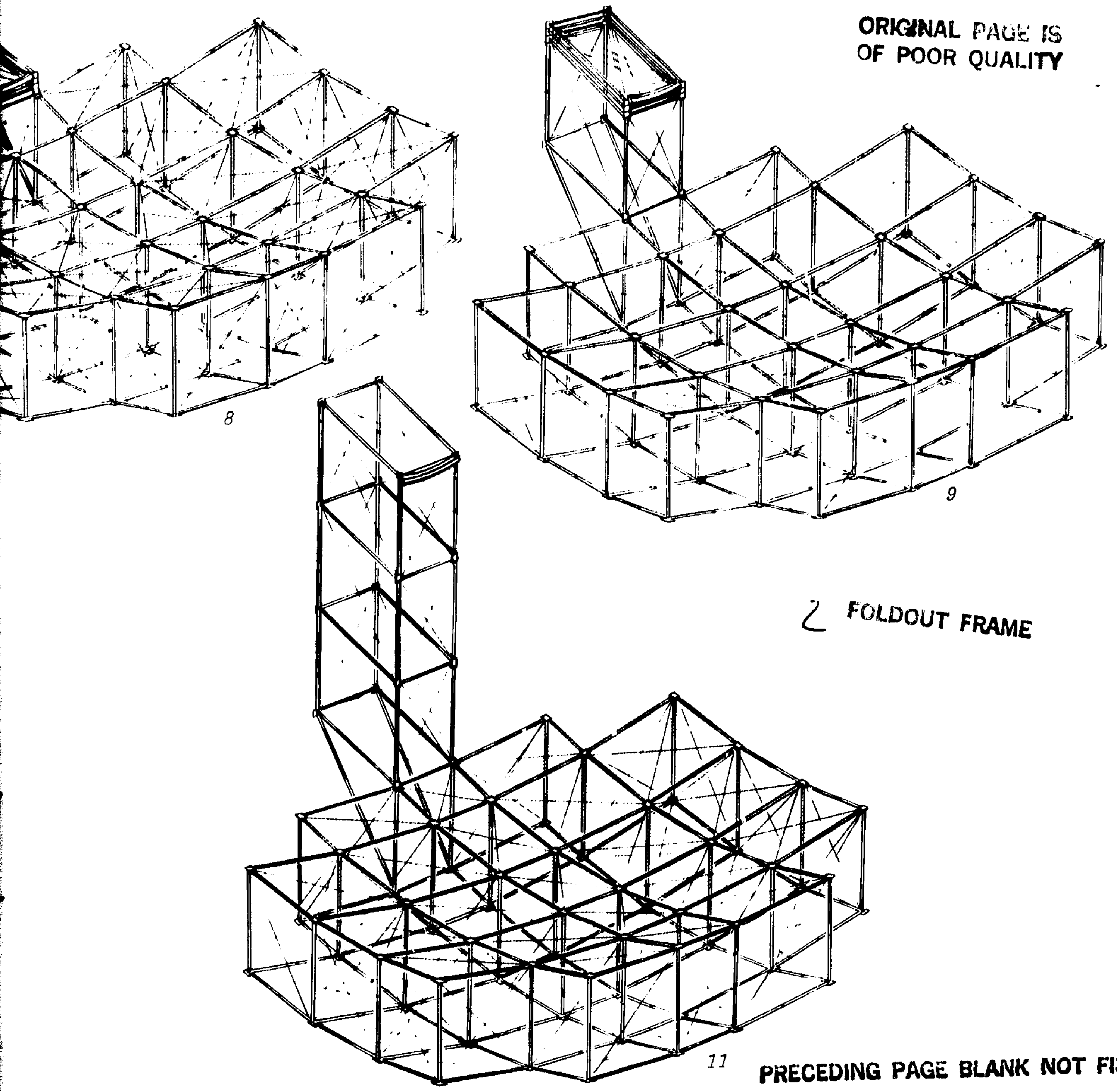


Figure III-14b MSDA Deployment Sequence

D. DEPLOYED DYNAMIC ANALYSIS

The MSDA dynamic analysis was performed using beams and rods to model the antenna support structure and the feed mast. The model contained 78 active nodes that connected 386 structural members. Each node has 0 deg of freedom, except for the four nodes (nodes 43, 44, 49, and 50) at the bottom of the superbox that were constrained in 6 deg of freedom to the spin adapter structure and the spacecraft. The node numbering is shown in Figure III-15, while the element numbering system is displayed in Figures III-16a through -16d. The element numbering system is consistent throughout the dynamic, static, and thermal analysis. The NASTRAN data listing is contained in Appendix B along with the dynamics run containing the first three modes.

The surface and vertical members were modeled with beam elements, while the interior and exterior diagonals were represented by rod elements. Because the surface members are pinned at either end, this degree of freedom is released in the rotational direction along the axis of those pins in the model. The diagonal members are represented by rods that were free to rotate along any axis. A lumped mass was placed at all the node points to simulate the mass of the cube-corner fitting and the integral end fittings in the tubes. A lumped mass was placed on Nodes 1 through 32 to simulate standoff and mesh mass. The midlink hinge mass and the crossover fitting mass were distributed along the length of their respective members because no node existed at that point. The feed and ballast were modeled with a 27.12-kg lumped mass divided between Nodes 67 and 70 at the top and front of the feed mast. Node 79 was the origin of the coordinate system. Node 80 was the center of gravity of the structure through which the spin axis rotated. These nodes have no structural significance. The standoff masses and the reflective mesh, including the tie system, were lumped on the top surface nodes of the antenna support structure. The 22.68-kg rear ballast mass was lumped at Nodes 44 and 50 and divided evenly.

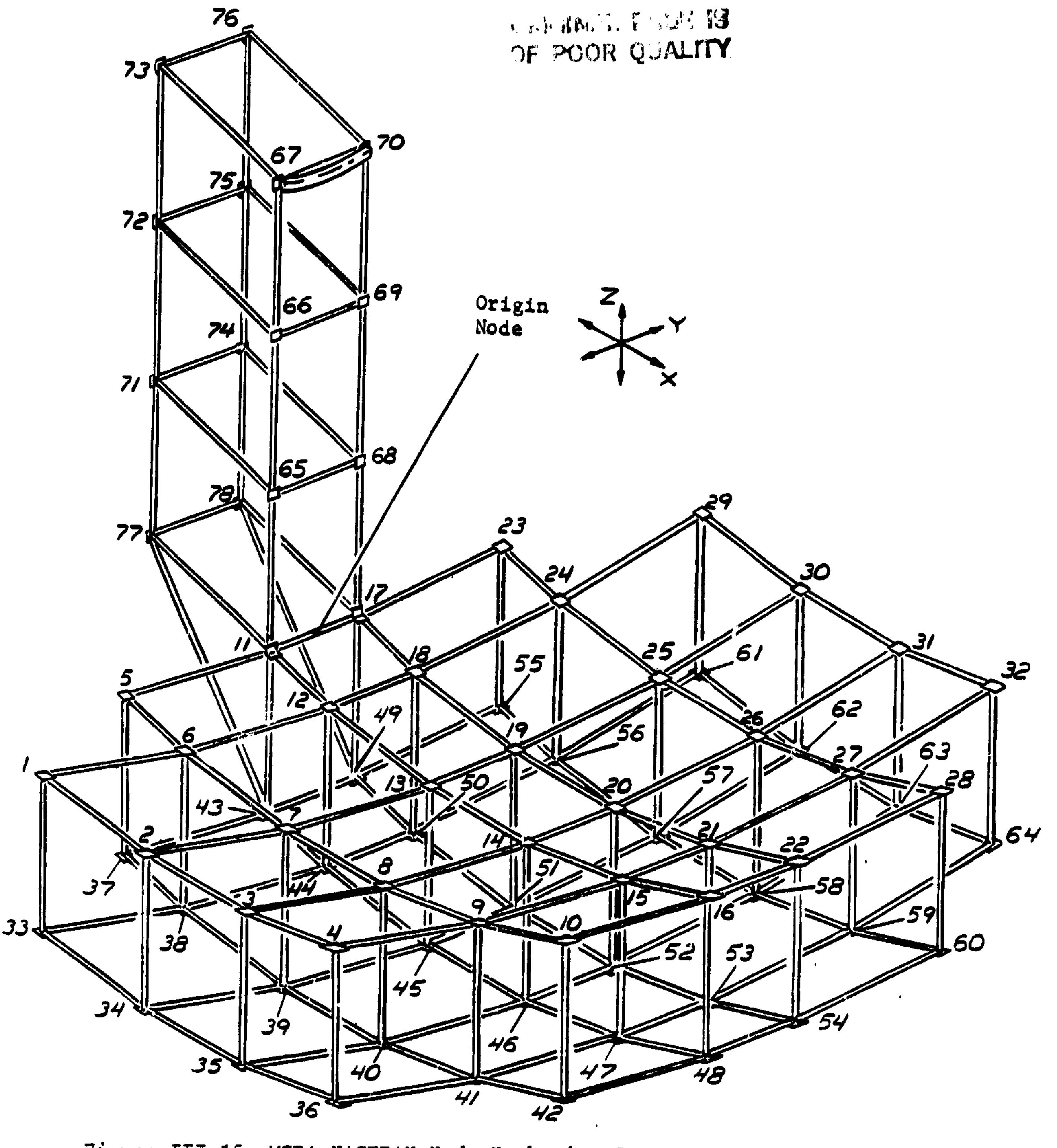


Figure III-15 MSDA NASTRAN Node Numbering System

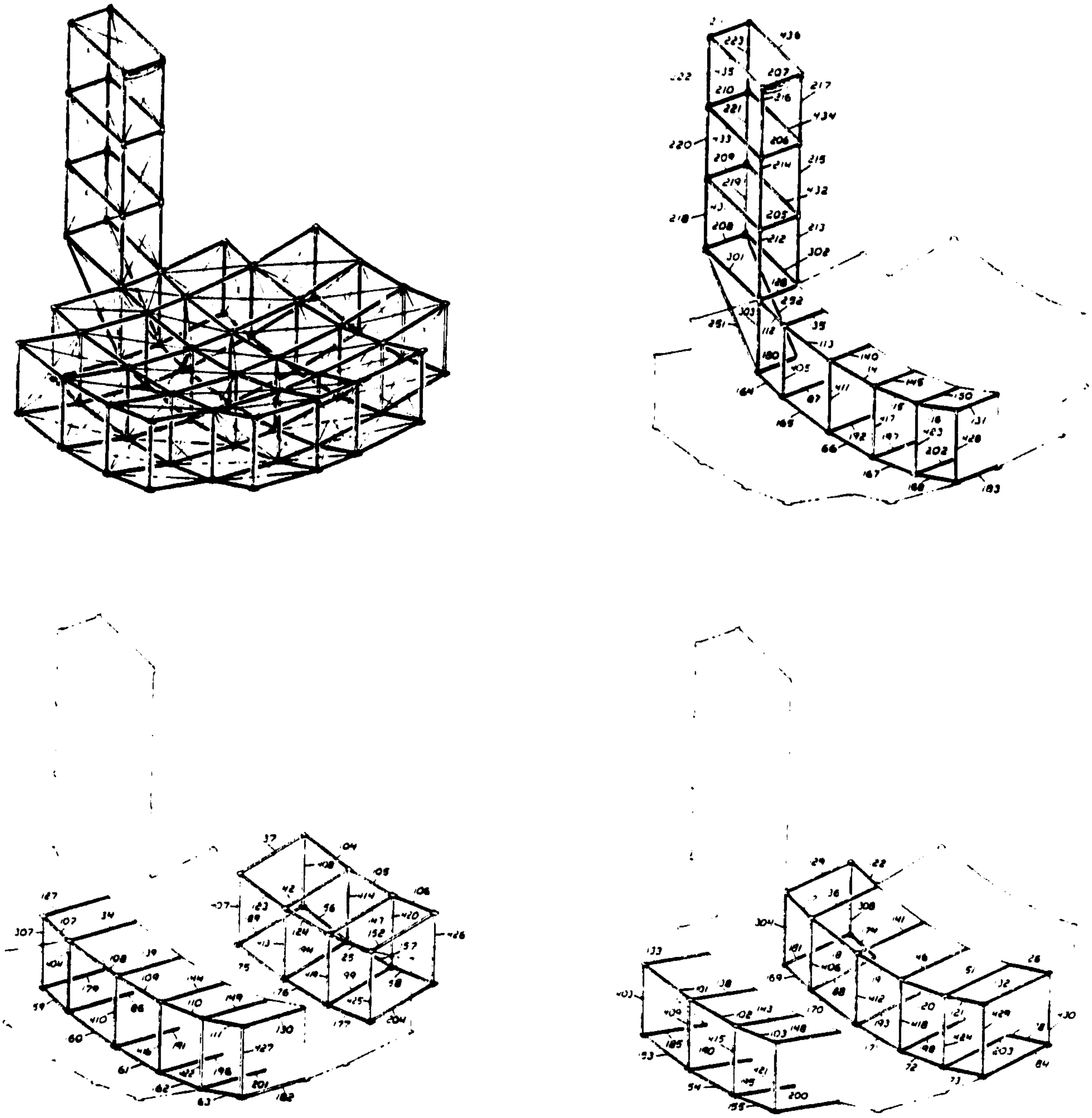


Figure III-16a MSDA NASTRAN Element Numbers

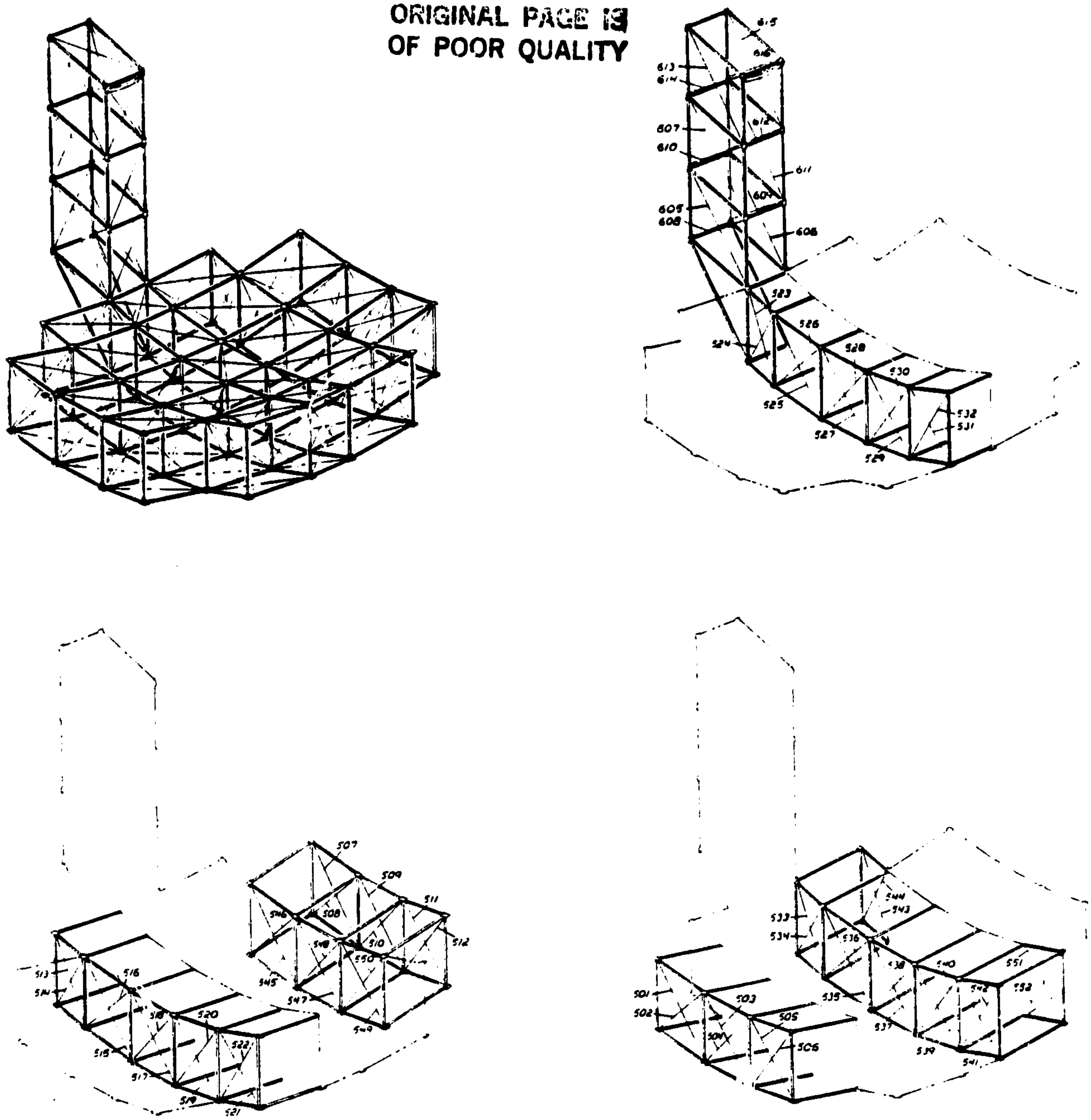


Figure III-16b MSDA NASTRAN Element Numbers

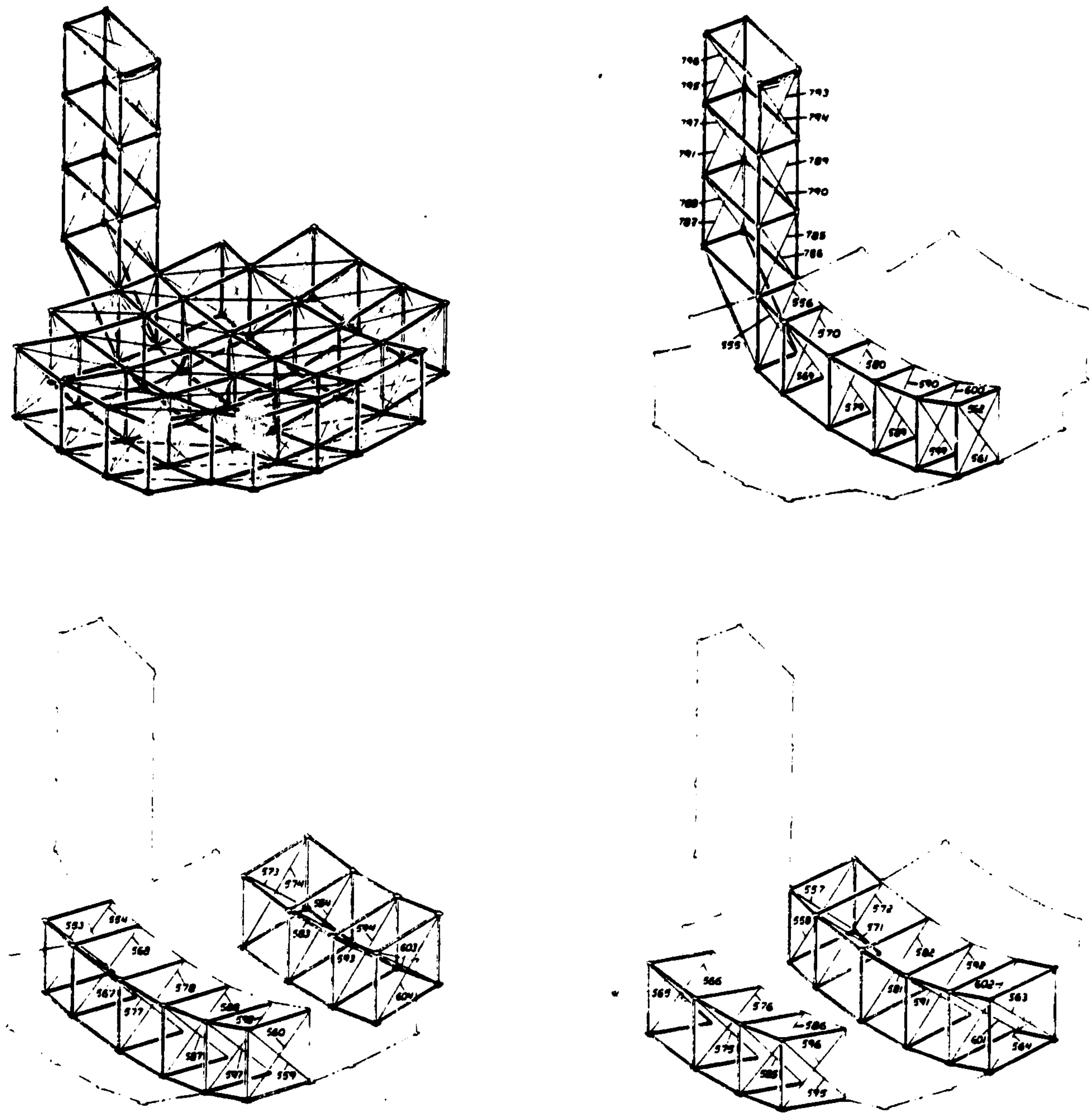


Figure III-16c MSDA NASTRAN Element Numbers

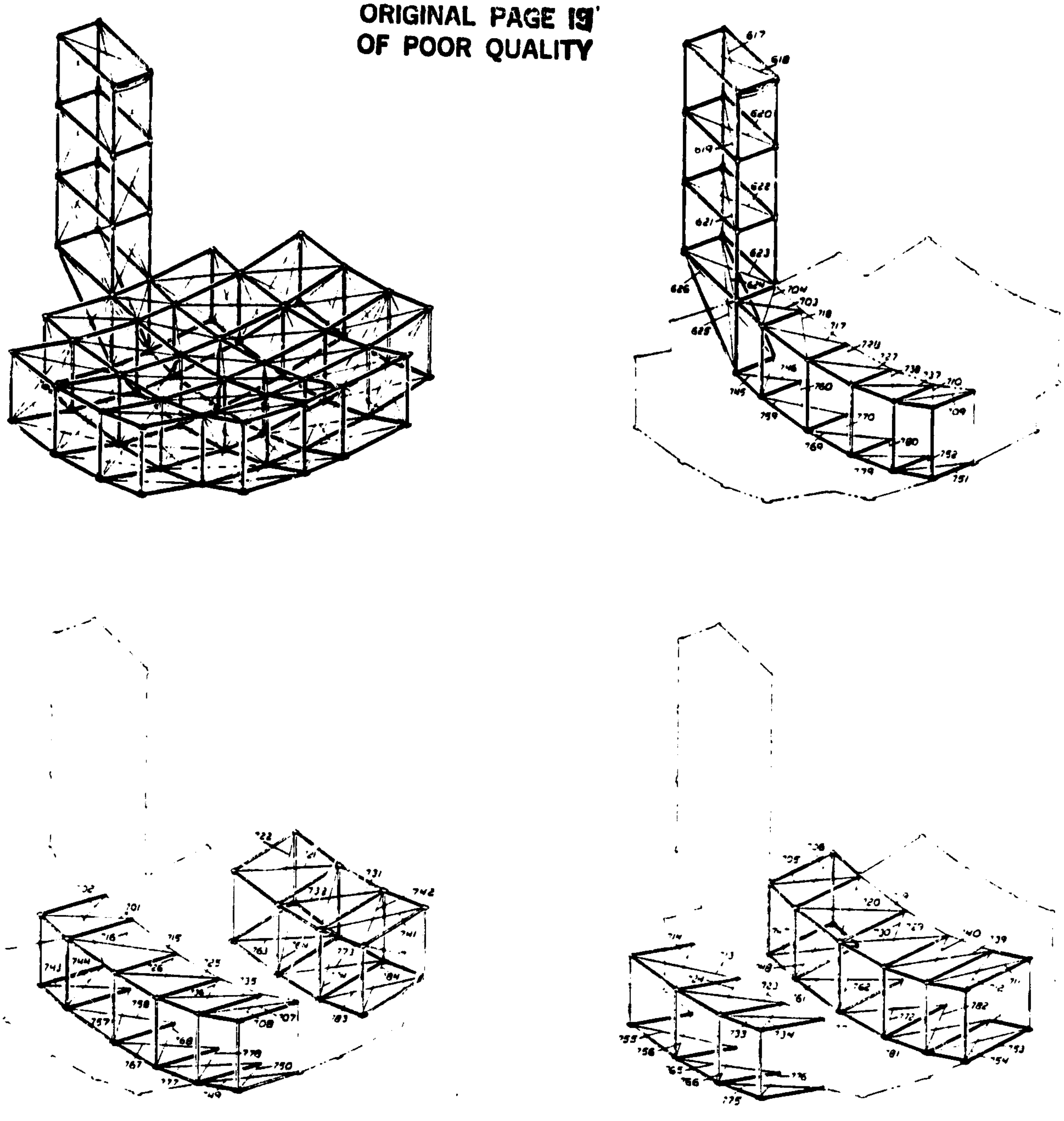


Figure III-16d NSDA NASTRAN Element Numbers

The dynamic computer model was run several times in an iterative process to satisfy the 12-Hz requirements. The original model was a 4x4-bay structure; this concept was abandoned early in the project in favor of a 5x5-bay structure that gives the system a much better interface between the antenna structure and the spacecraft. The Astromast feed was also discarded early in the study in favor of the offset box-truss integral feed mast that has the higher stiffness needed to meet the 12 Hz-requirement. If the dynamic analysis had used a free-free structure, the frequency requirement could have been easily met, but the structure was analyzed in a more realistic situation in which the antenna support structure was anchored to the much heavier spacecraft, thus dramatically driving down the fundamental frequency. By increasing the stiffness in those members carrying the highest strain energies, in several iterative steps, the first fundamental frequency of the structure was increased to 12.55 Hz. The first mode, shown in Figure III-17, is a bending mode about the y axis with its root at the base of the superbox. The second fundamental frequency of 12.75 Hz (Fig. III-18) is a twisting mode on the superbox base about the x axis and z axis where the feed mast and antenna structure are twisting in phase. The third mode (Fig. III-19) is very similar to the second mode with a frequency of 13.19 Hz. Table III-2 summarizes the dynamic data.

Dynamic Balancing - The dynamic balancing of the MSDA antenna involved attaching ballast at various points in the structure. The objective was to align the spin axis with one of the principal inertial axis as seen in Figure III-20. Early in the project, the antenna configuration had the spin axis 35 deg to the other side of the z axis, but it was found that a much smaller amount of ballast had to be added in its present configuration. The ballast mass and location were determined by a Martin Marietta computer program written using the weight generator from the NASTRAN finite model. The balancing computer program recalculated the principal inertias, including ballast of the structure, so an iterative process was used to determine the optimum ballast location and minimum mass. The theory and listing of the program are given in Appendix C. The locations and magnitudes for the four ballast masses are two 11.34-kg masses at the base of the superbox (Nodes 44 and 50) and two 7.9-kg masses, each located on either side of the feed (Nodes 67 and 70). The feed location has the advantage of allowing extra feed mass allocation for a total of 27.14 kg to be used instead of ballast. The ballast location at the bottom of the superbox has the advantage of allowing the use of heavier members in that area without any penalty of lowering the fundamental frequency. These ballast locations are illustrated in Figure III-20. Spin balance was easily achieved with minimal added mass to the structure.

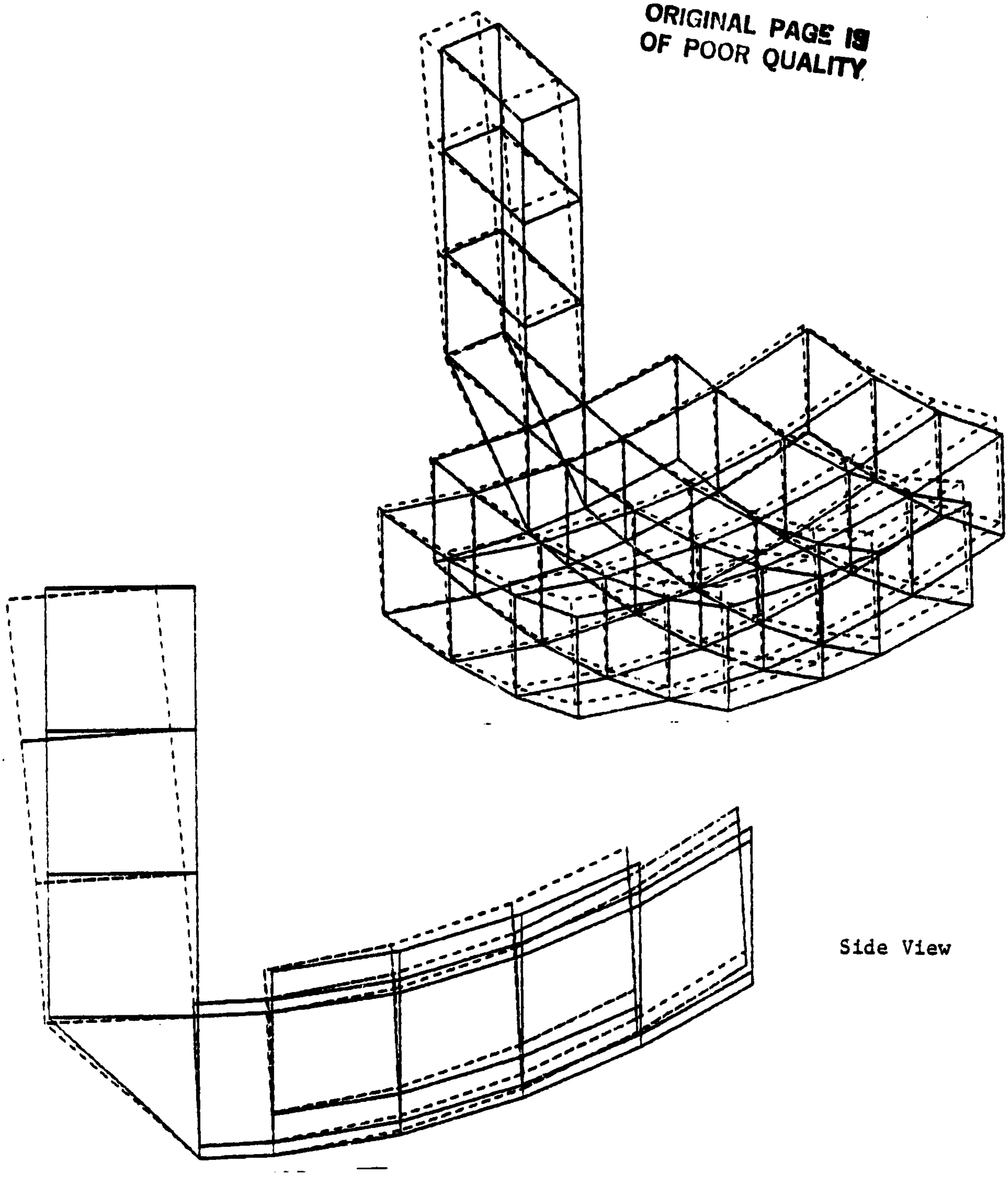


Figure III-17 First Modal Frequency - 12.55 Hz

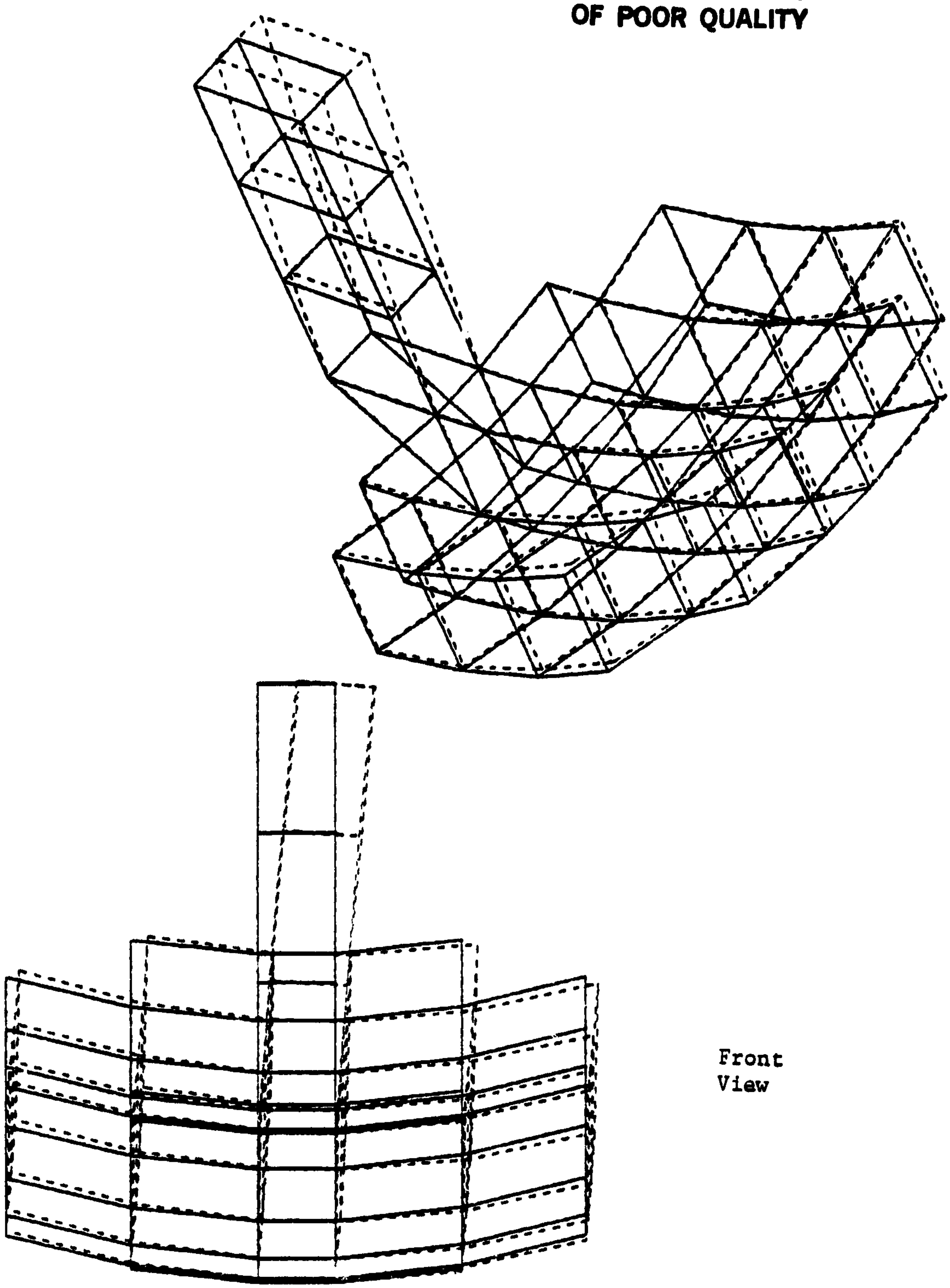


Figure III-18 Second Modal Frequency - 12.75 Hz

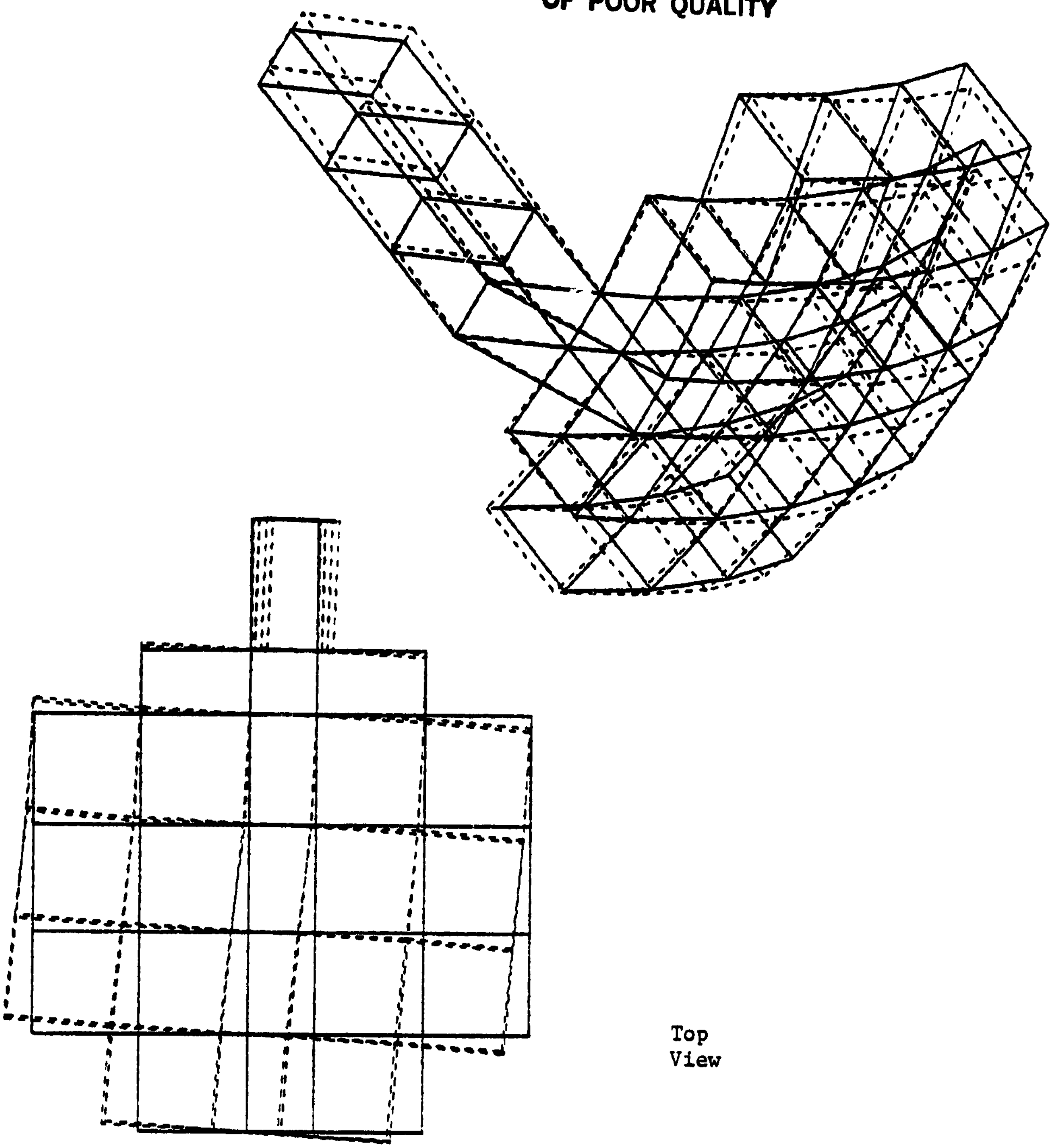


Figure III-19 Third Modal Frequency - 13.19 Hz

Table III-2 Modal Characteristics Summary

Mode	Freq, Hz	Description
1	12.55	Bending about y axis.
2	12.75	Torsional mode about x axis and z axis
3	13.19	Torsional mode about x axis and z axis

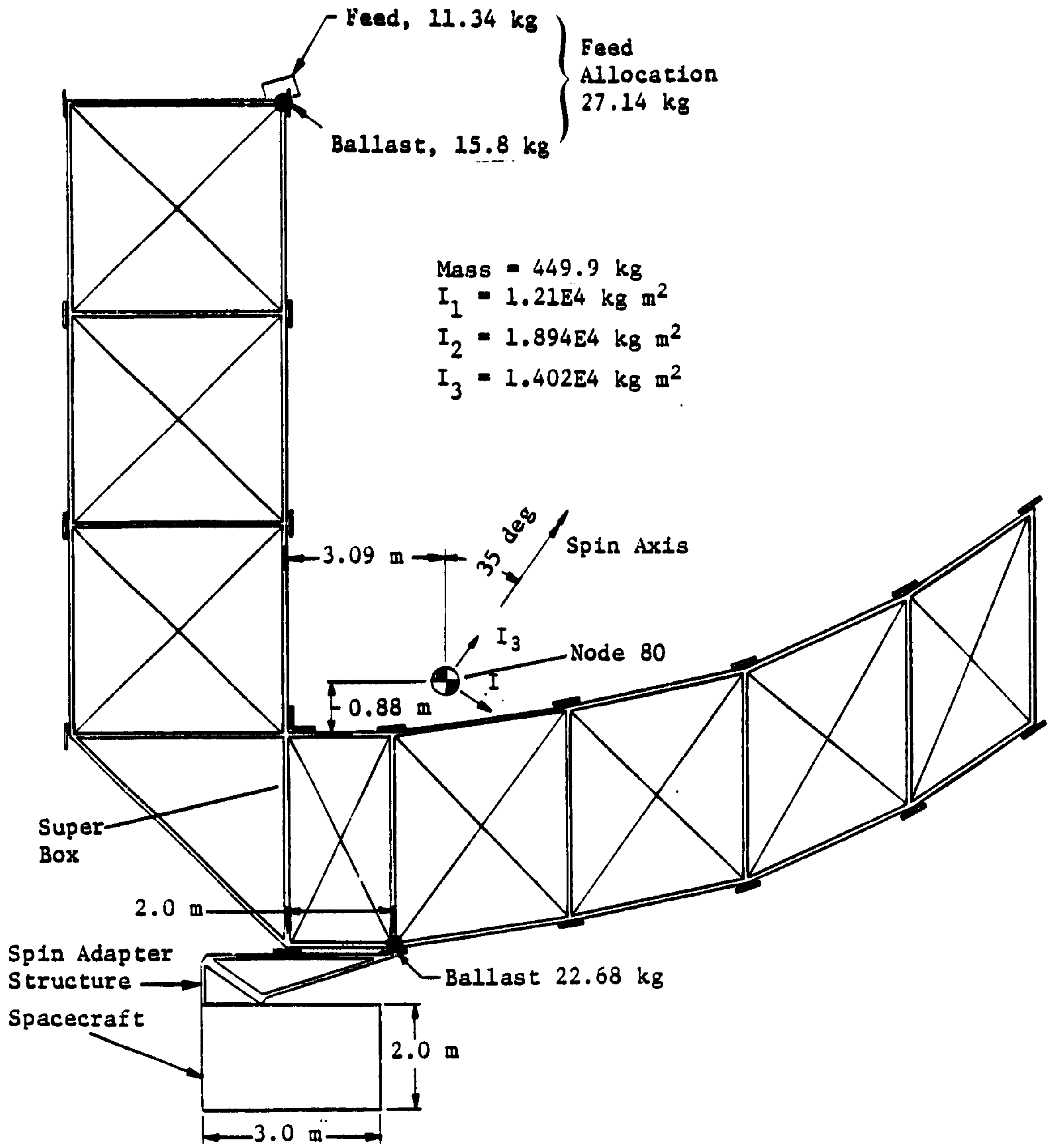


Figure III-20
Ballast and Spacecraft Location and Inertial Properties

E. MESH TIE-SYSTEM DESIGN

The mesh tie-system design proposed for the MSDA antenna is a double-catenary cord system. This cord system is made up of three types of cords--upper surface cords, drop cords, and rear cords. The upper surface cords, which are continuous cords across the total mesh surface, rest on the mesh surface and are spaced evenly between the box-truss standoffs. The point at which two surface cords cross is then pulled down into shape by drop cords that then attach to a rear cord catenary. The rear cord catenary system spans individual box-truss cube standoffs. Figure III-21 is an illustration of this cord system for a single box-truss section. The total mesh surface is formed by individually tensioning mesh panels (sized for compatibility with truss cube) and then sewing them together. The mesh is then attached to the deployed truss standoffs. The mesh attachment points were located and marked while the mesh panels were on the mesh stretching table. The surface cords with attachment beads and drop cords are then strung across the surface of the mesh. The rear cords are then strung and the drop cords are loosely fastened to the rear attachment beads. At this point mesh setting is started. During the setting process, a constant force is maintained in the front surface cords. Each upper surface attachment point will be adjusted to match the parabolic shape required. Coordinates for these points are in Appendix D. Figure III-22 shows the location of the tie points with respect to the overall antenna. An actual model of this tie system was made under Martin Marietta Independent Research and Development (IR&D) Project D-54D and is shown in Figure III-23. This model will be used to verify manufacturing methods and to identify surface distortions due to pillowing effects. The pillowing effects are discussed later. Under the same IR&D project, two mesh tie-system designs were evaluated. The proposed double-catenary cord system was selected over the direct mesh tie system used on the 4x4-bay reflector model (Fig. III-24) because of its thermoelastic stability and ease of setting.

The direct tie design used upper surface cords similar to the proposed design, but instead of drop cords and rear catenaries, tie-backs were used that attached to the base of the standoffs on the box-truss structure (Fig. III-25). This direct tie system has limitations when incorporating it into large MSDA-size reflective surfaces because the tie-backs that shape the surface at the center of a box-truss section are almost parallel to the surface cords for a typical standoff of 30.48 cm. To pull the surface into shape, tie-backs would have to be highly tensioned or the standoffs would have to be two to three times longer. The highly tensioned tie-backs would make setting the surface very difficult, while the longer standoffs would increase the stowed truss length.

The selected double-catenary design decreased the coupling effect of the tie-back system. It also alleviated the problem of long standoffs of highly tensioned tie-backs because all the drop cords are normal to the reflective surface.

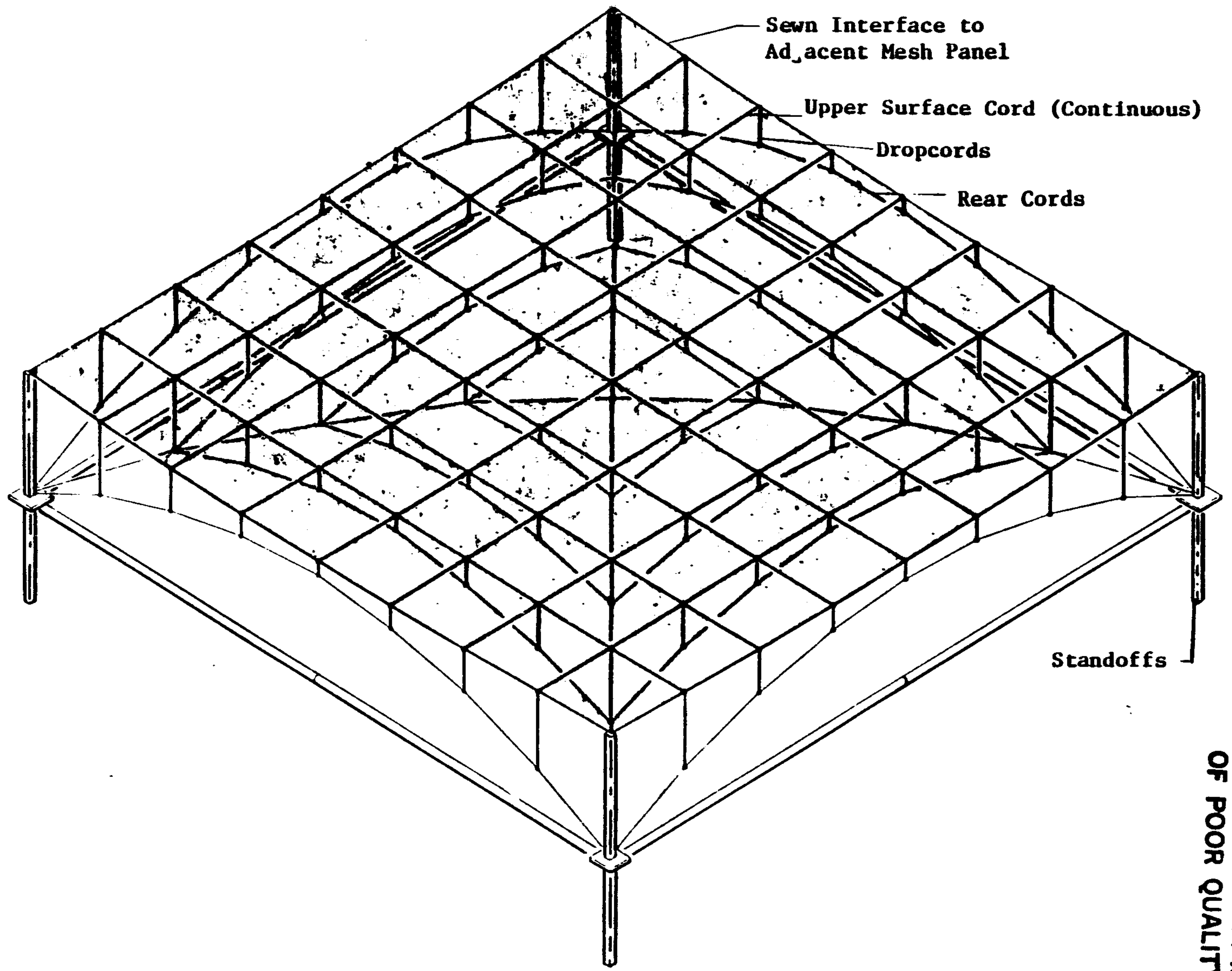


Figure III-21 MSDA Mesh Tie System

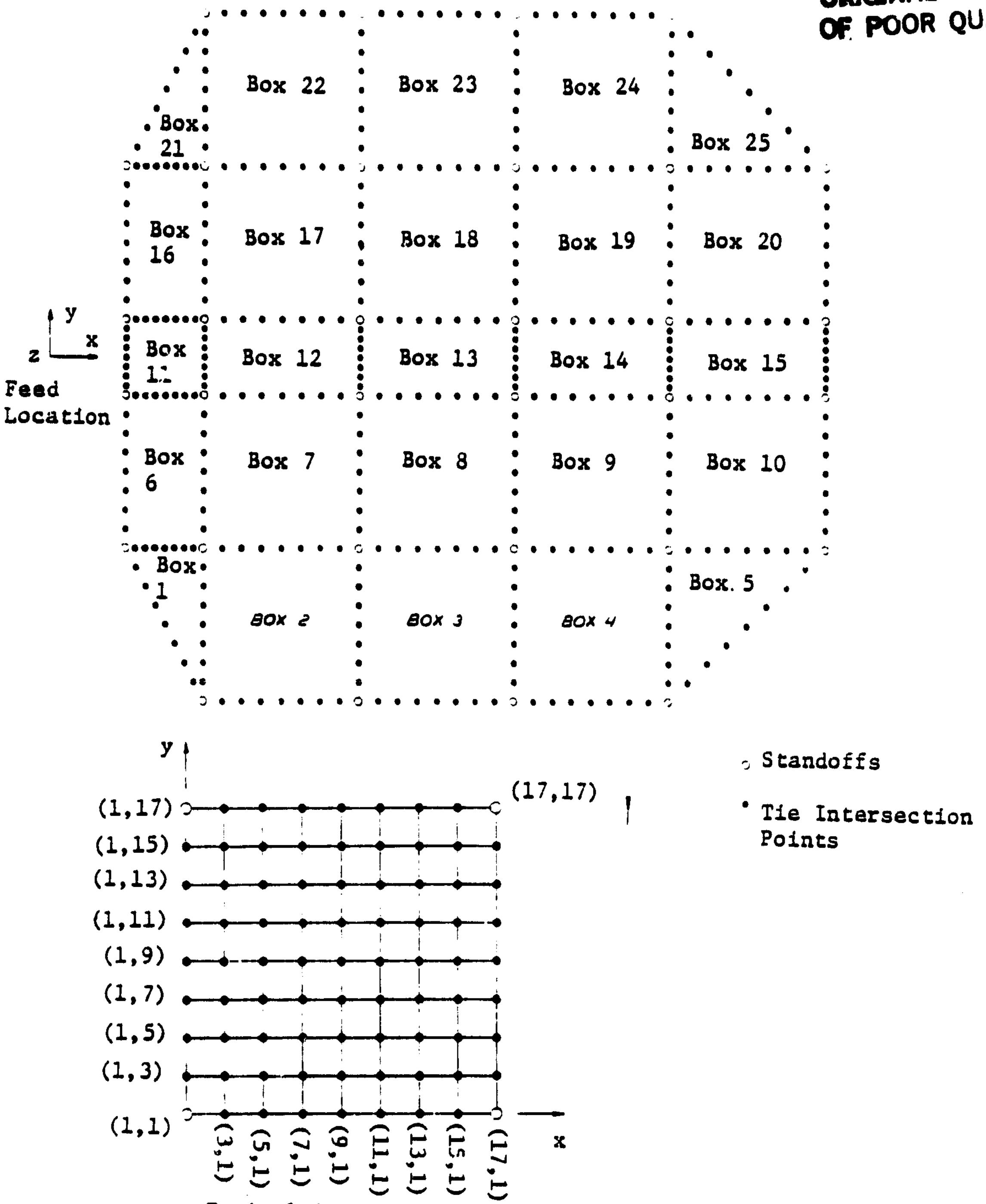


Figure III-22 Mesh Numbering System

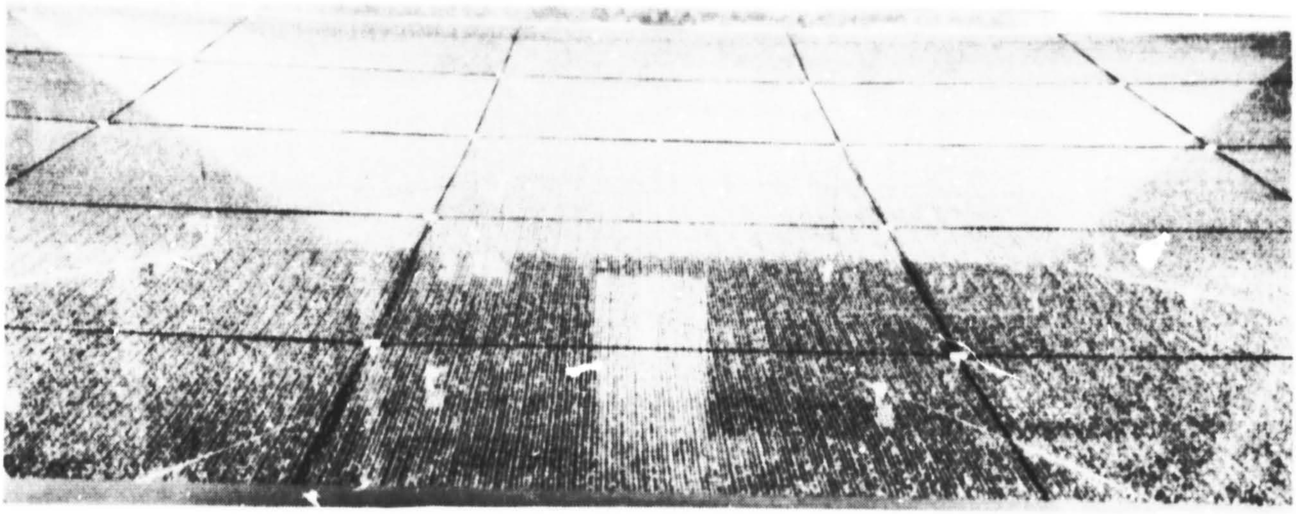


Figure III-23 Double-Catenary Mesh Model

Mesh Surface Pillowing - Under IR&D Project D-54D, a major activity was initiated to design and understand a parabolic mesh reflector. This activity included fabrication of mesh models and surface distortion measurements. The shape of the reflector surface using the double-catenary cord system is defined by several factors--mesh tension and compliance, upper surface cord pattern (spacing), tension and stiffness, drop-cord stiffness and length, rear cord stiffness and length, and local radius of curvature. Further, geometric saddling effects (pillowing) due to biaxially tensioned mesh and the upper surface cord pattern cause local deformations. Figure III-26 shows a scale test model of a reflector surface. Measurements were made to determine pillow shape versus mesh tension and cord tension. When the panel's shape is duplicated and scaled to a mesh surface on a 15-meter reflector with an 11.94-meter focal length and average drop-cord spacing of 42.8 cm, the rms surface errors (best-fit mesh saddles relative to the ideal parabola) are 0.020 cm, and the worst-case deflections (drop-cord attachment points) are 0.067 cm behind the ideal parabola. Assuming 1/40 of a wavelength can be assigned to rms mesh distortions, the mesh surface design proposed would be appropriate for frequencies of 11 GHz.

RF Reflective Mesh - The radio-frequency (rf) reflective surface is formed by suspending a tricot-knitted, 0.003-cm-dia, gold-plated, molybdenum monofilament wire mesh. This design has the desirable properties of high rf reflectivity, corrosion resistance, low weight, wrinkle resistance, low spring rate, puncture resistance, and radiation resistance. Figure III-27 illustrates the mesh knit. The weave size is varied depending on the frequency of operation to ensure adequate rf reflectivity. Figure III-28 presents an estimate of mesh rf reflectivity for a mesh with 5.5 openings per centimeter. These data were obtained from literature published by Harris ESD. Actual mesh tensions were not specified but typical values of 1.5 to 3.0 N/m were assumed.

ORIGINAL PAGE IS
OF POOR QUALITY

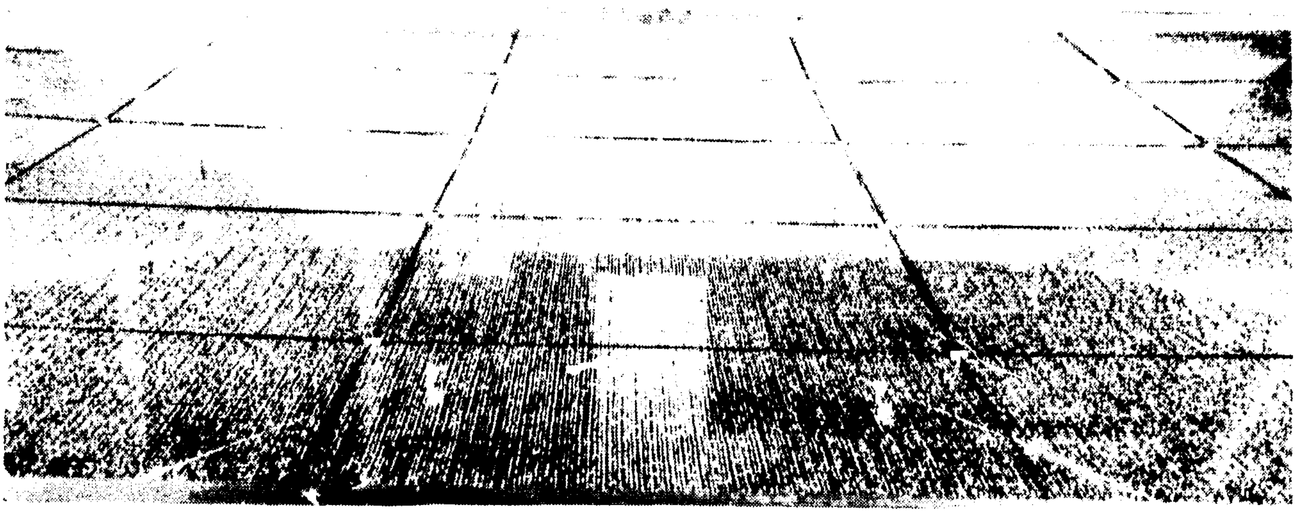


Figure III-23 Double-Catenary Mesh Model

Mesh Surface Pillowing - Under IR&D Project D-54D, a major activity was initiated to design and understand a parabolic mesh reflector. This activity included fabrication of mesh models and surface distortion measurements. The shape of the reflector surface using the double-catenary cord system is defined by several factors--mesh tension and compliance, upper surface cord pattern (spacing), tension and stiffness, drop-cord stiffness and length, rear cord stiffness and length, and local radius of curvature. Further, geometric saddling effects (pillowing) due to biaxially tensioned mesh and the upper surface cord pattern cause local deformations. Figure III-26 shows a scale test model of a reflector surface. Measurements were made to determine pillow shape versus mesh tension and cord tension. When the panel's shape is duplicated and scaled to a mesh surface on a 15-meter reflector with an 11.94-meter focal length and average drop-cord spacing of 42.8 cm, the rms surface errors (best-fit mesh saddles relative to the ideal parabola) are 0.020 cm, and the worst-case deflections (drop-cord attachment points) are 0.067 cm behind the ideal parabola. Assuming 1/40 of a wavelength can be assigned to rms mesh distortions, the mesh surface design proposed would be appropriate for frequencies of 11 GHz.

RF Reflective Mesh - The radio-frequency (rf) reflective surface is formed by suspending a tricot-knitted, 0.003-cm-dia, gold-plated, molybdenum monofilament wire mesh. This design has the desirable properties of high rf reflectivity, corrosion resistance, low weight, wrinkle resistance, low spring rate, puncture resistance, and radiation resistance. Figure III-27 illustrates the mesh knit. The weave size is varied depending on the frequency of operation to ensure adequate rf reflectivity. Figure III-28 presents an estimate of mesh rf reflectivity for a mesh with 5.5 openings per centimeter. These data were obtained from literature published by Harris ESD. Actual mesh tensions were not specified but typical values of 1.5 to 3.0 N/m were assumed.

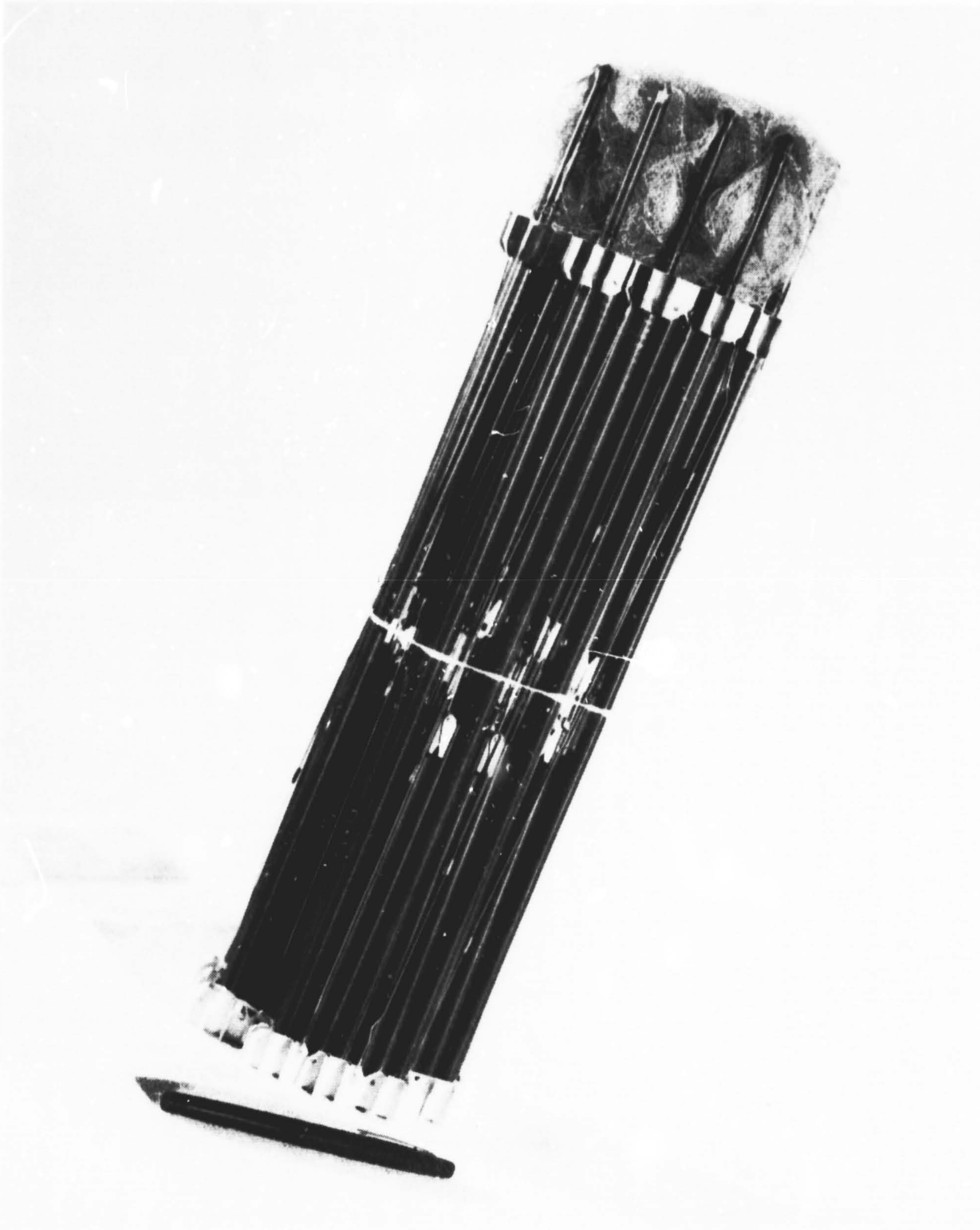


Figure III-24a 4 x 4-Bay Reflector Model Stowed

ORIGINAL PAGE IS
OF POOR QUALITY

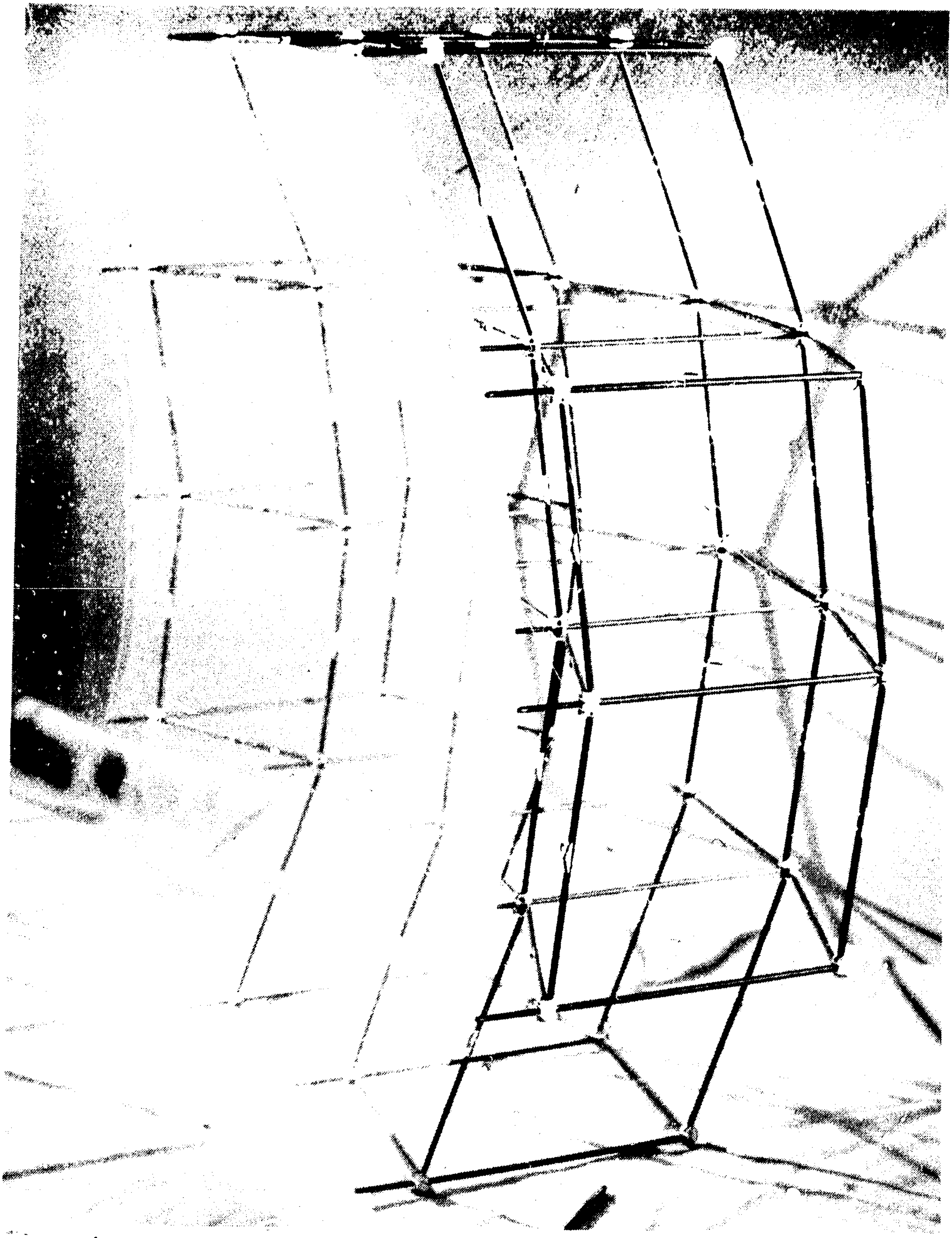


Figure III-24b 4 x 4-Bay Reflector Model Deployed

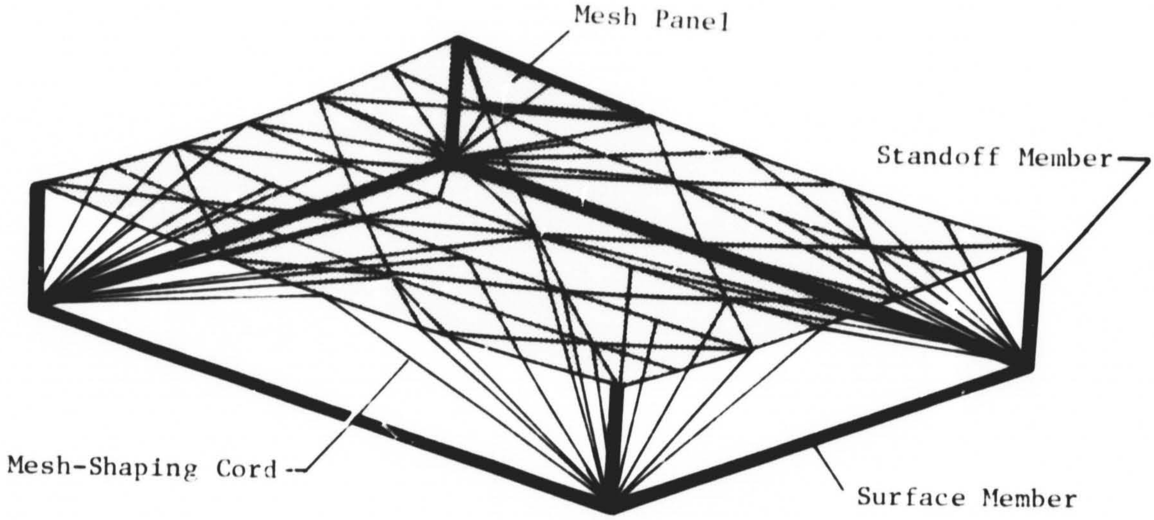


Figure III-25
Optional Direct Tie System (Not Selected for This Application)

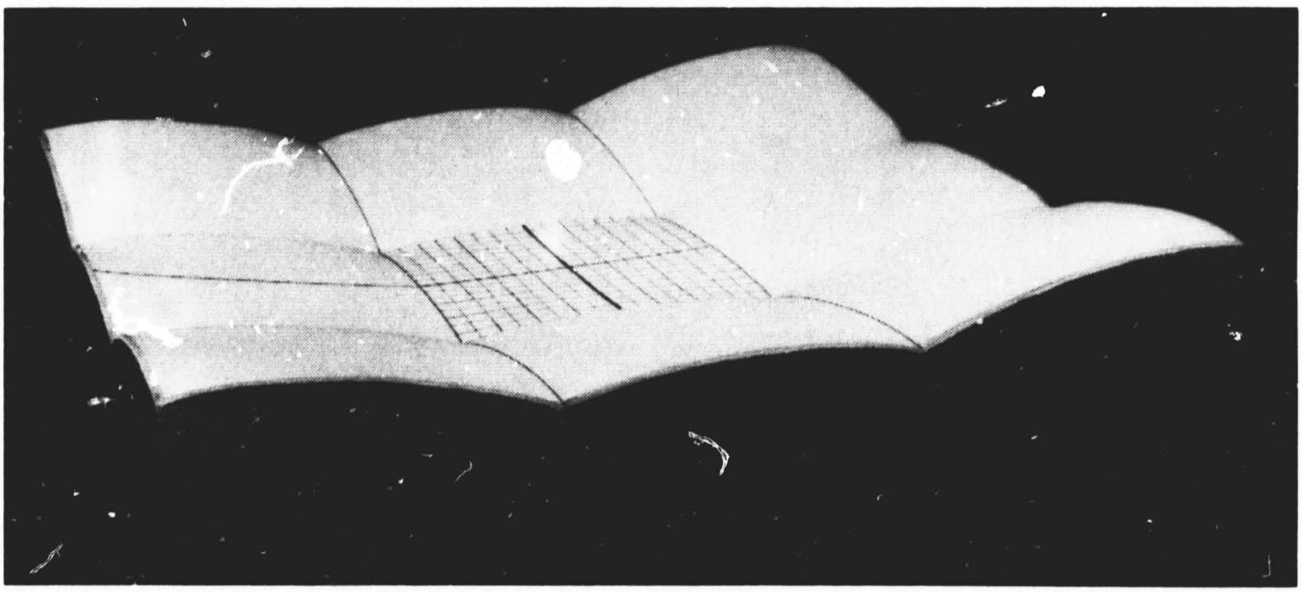


Figure III-26 Mesh Pillowing Model

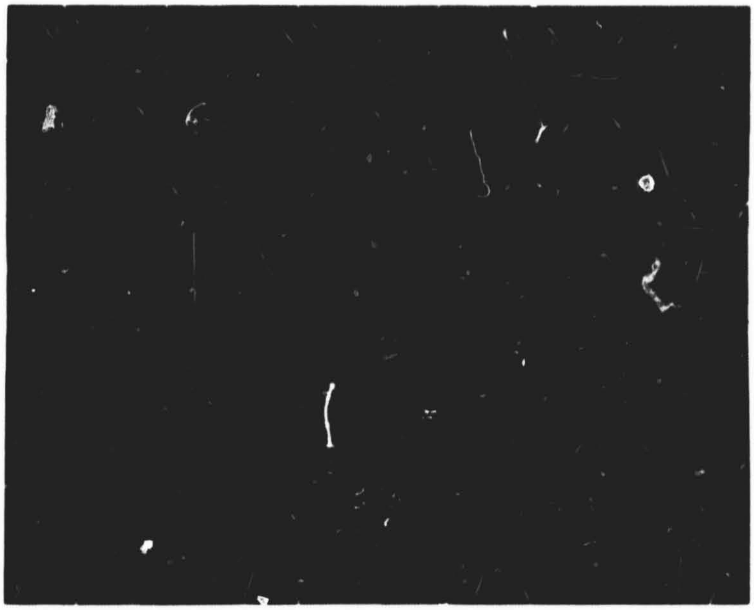


Figure III-27 Tricot Knit Weave

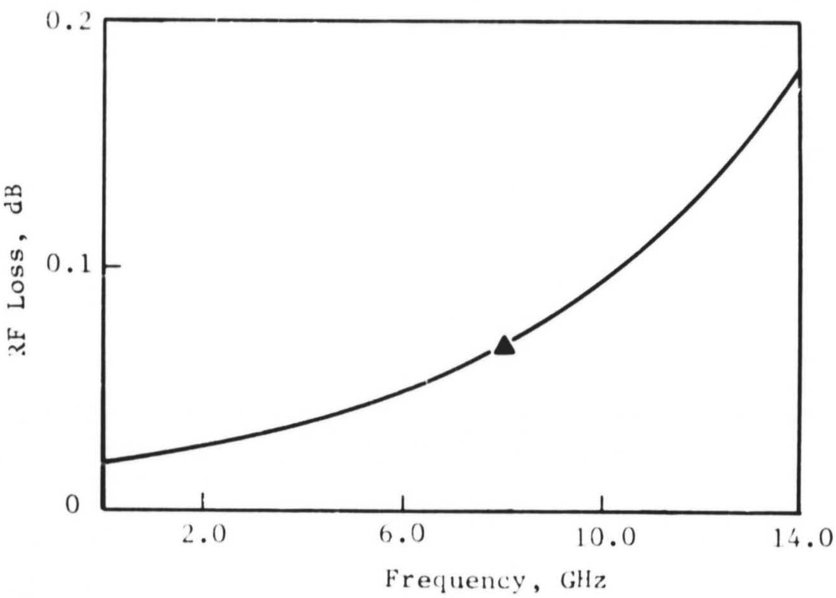


Figure III-28
RF Reflectivity Loss of 5.5 Openings per Centimeter Tricot Mesh

F. THERMAL/THERMOELASTIC ANALYSIS

A thermal analysis of the MSDA structure was performed to provide temperature data as input to a thermal deformation analysis. Results are presented in this section.

The thermal/thermoelastic model that was used for this analysis included the total box-truss structure for the feed mast and reflector, the complete mesh as a shadower of the truss structure, and a 2-meter tall by 3-meter-dia spacecraft as a shadower. This provided a rigorous definition of temperatures and thermal deflections of the truss structure that supports the mesh surface under the varying thermal environments. The mesh model, however, was a simplified single box mesh and tie system. Although this did not provide a total thermal distortion profile over the total reflector, it did provide a conservative thermal distortion rms error. This rms error included the effects of the mesh tie distortion relative to the truss, plus the distortion of the truss relative to its nominal shape.

To perform analyses, math models were built to use our standard thermal analysis computer programs--Thermal Radiation Analysis System (TRASYS) and Martin Marietta Interactive Thermal Analysis System (MITAS). Because MSDA has such a large number of members (more than 450), it was expedient to create utility programs that would use the MSDA NASTRAN data base to create both the TRASYS surface data description inputs and the MITAS thermal node description inputs. This technique used the same node identification number for all three analysis programs, as well as ensuring that all three programs used the same physical and spatial description of the MSDA members. Figures III-15 and III-16 show the identification numbers used for all of the MSDA analyses.

MSDA TRASYS Model - The TRASYS program is used to provide both the radiation interchange factors (f) between surfaces, as well as the environmental heating from the Sun and the Earth. The surface description model for the MSDA included all of the structural members and diagonal tapes, the rf reflective mesh surface, mesh standoffs, and the spacecraft. Figure III-29 is a TRASYS surface drawing showing the feed support structure and the structural extensions to support the mesh. The diagonal tape members have been omitted for clarity. The reflective mesh surface is shown in Figure III-30. The main structure has been omitted for clarity. This figure also shows the detail that was added in three areas of the rf mesh to give some representative temperature data for the mesh shaping cords. Figure III-31 is a typical mesh zone with all of the required support cords. The cords that were included in the thermal detail model have been accentuated. These three sets of front, back, and vertical shaping cords were chosen to give data in the center of the rf mesh (Zone 13) and near both the inboard (Zone 16) and outboard (Zone 20) edges. (Zones are shown in Fig. III-22.) These data could then be used for other zones that are in the same relation to the edge of the rf mesh.

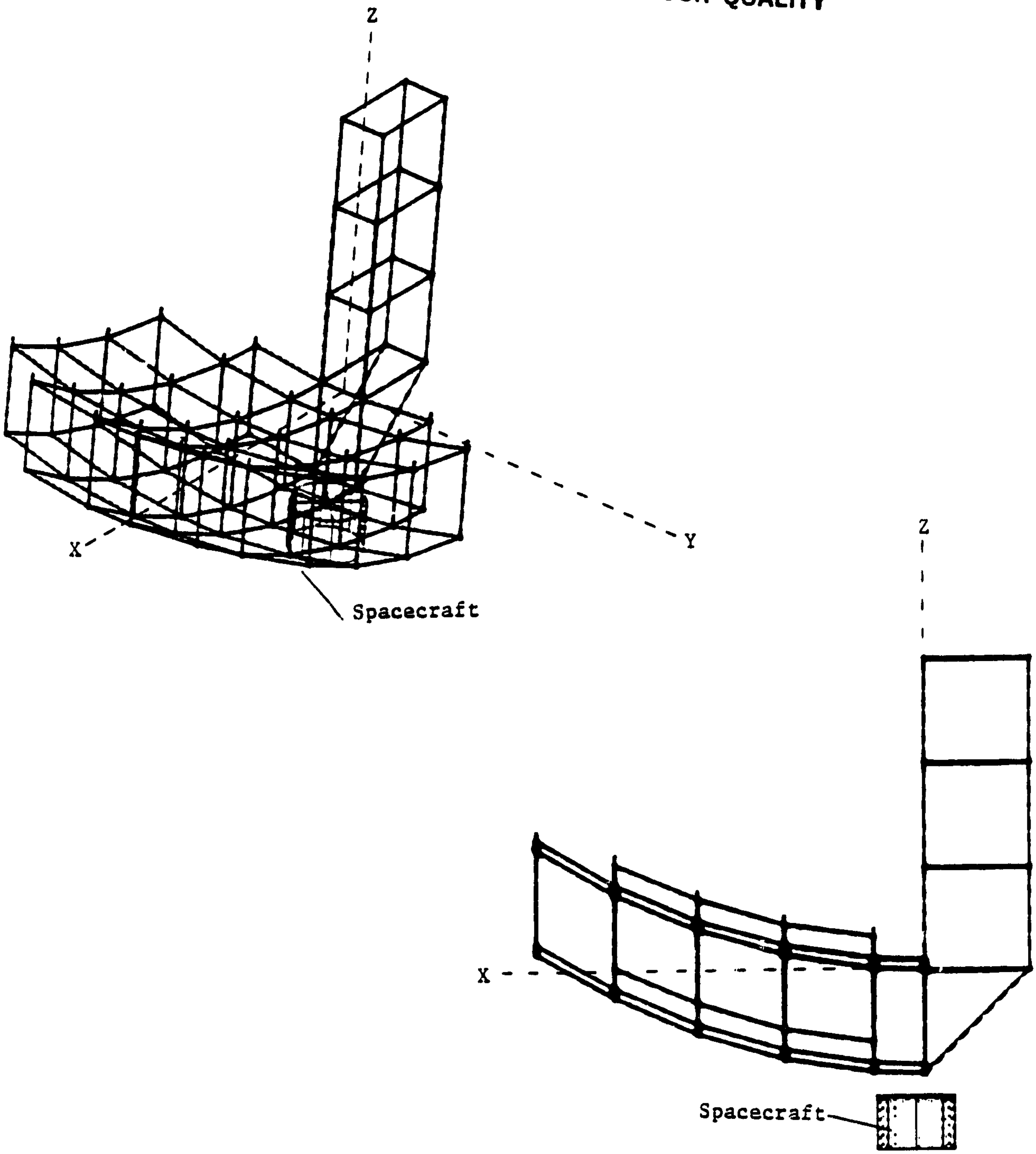


Figure III-29 TRASYS Thermal Computer Model

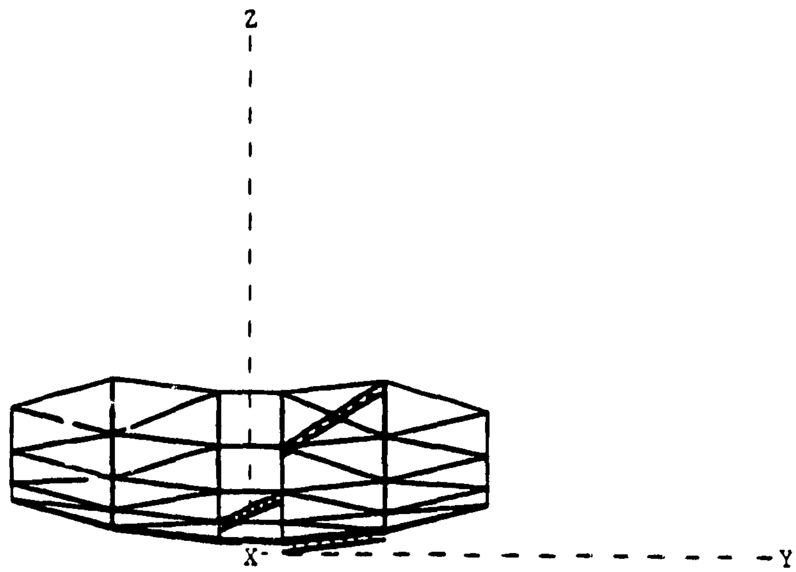


Figure III-30 TRASYS Drawing of MSDA Reflective Surface

The spacecraft used in the thermal analysis was assumed to be 3 m in diameter and 2-meter deep, located 85 cm below the tower and structure. The relation of the spacecraft to the MSDA is shown in Figure III-29. For this analysis, it was assumed that the spacecraft and MSDA were locked together and both spinning about MSDA's spin axis. This assumption simplified the TRASYS analysis in that the view factors between the spacecraft (S/C) and MSDA were then not a function of the spin position.

The TRASYS program has undergone some modifications that allow large space structures (LSS) to be more economically analyzed. Surfaces can be further identified as either being ELEM or TAPE. A surface identified as such undergoes a different treatment in the program. Our experience has led us to conclude that, for LSS, the radiation interchange factors between structural members and diagonal tapes can be ignored with little difference in the resulting temperatures.

This is illustrated in the plot of Figure III-32. Thus, surfaces identified as ELEM and/or TAPE do not have view factors computed to other surfaces that are identified as either ELEM or TAPE. This subset of the surfaces does have view factors to non-ELEM/TAPE surfaces, such as the rf reflective mesh and spacecraft. All of the structural members (surface type ELEM) were represented as being cylindrical in cross section. For those MSDA members that have rectangular cross sections, an effective cylindrical radius was used. This radius was the cross section width plus depth divided by π. The effective radius results in the member's projected area being the average projected area. Because the MSDA is spinning, the area exposed to either the solar or Earth IR flux would be the average projected, and, thus, for MSDA and the current version of TRASYS, this is a good approximation.

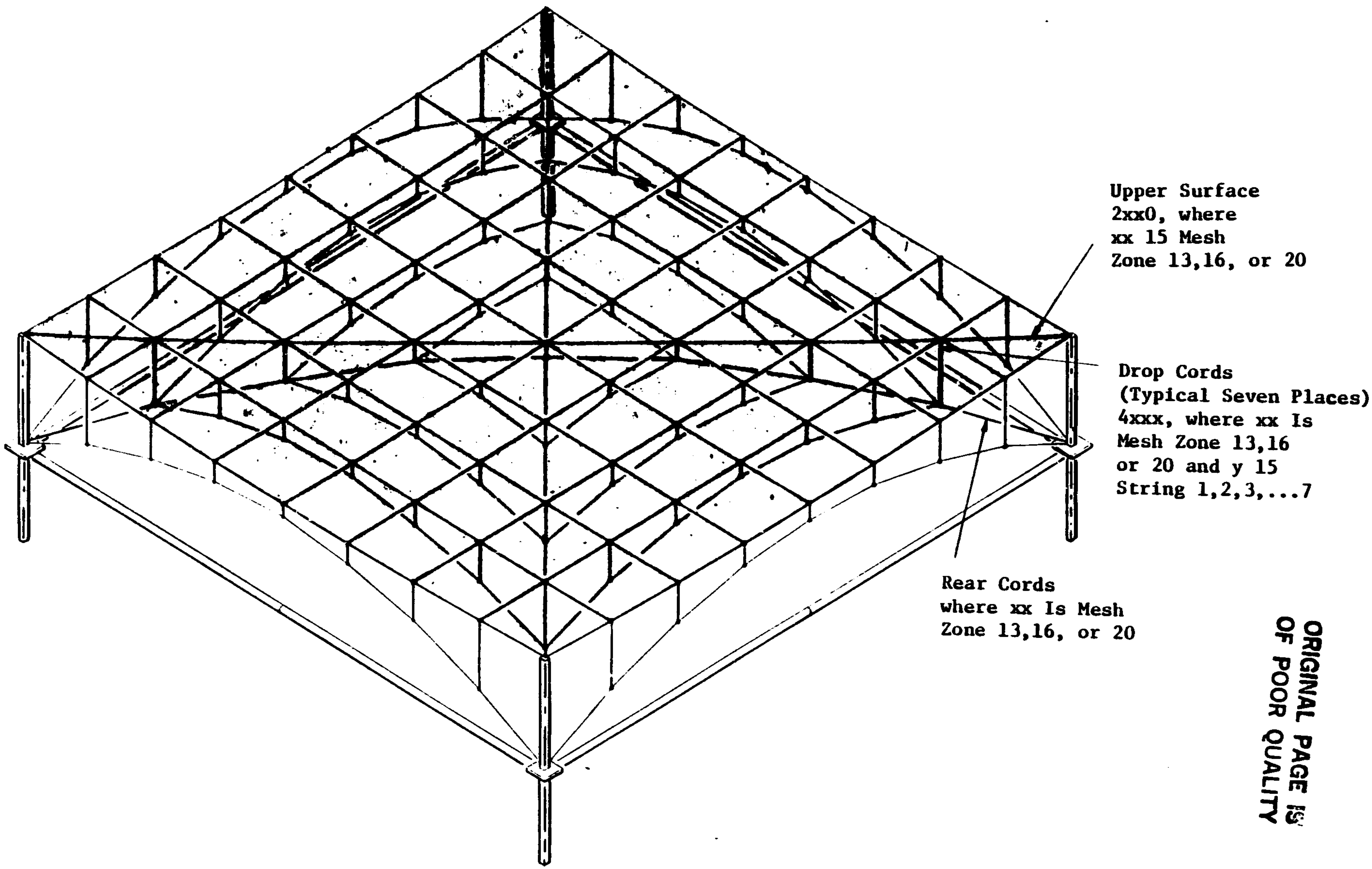


Figure III-31a Thermal Element Numbering in Mesh Tie System

ORIGINAL PAGE IS
OF POOR QUALITY

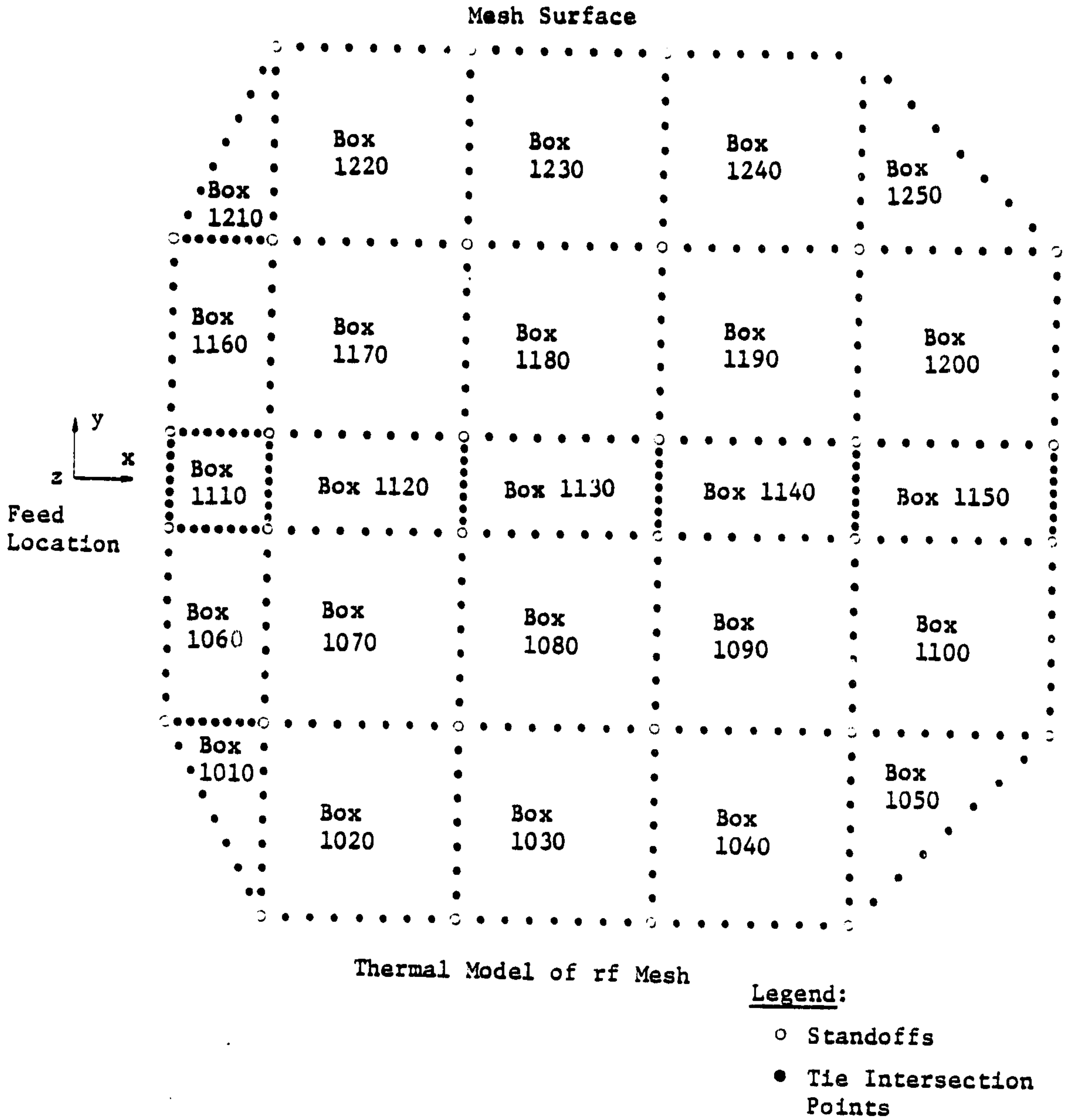


Figure III-31b Thermal Element Numbering in rf Surface

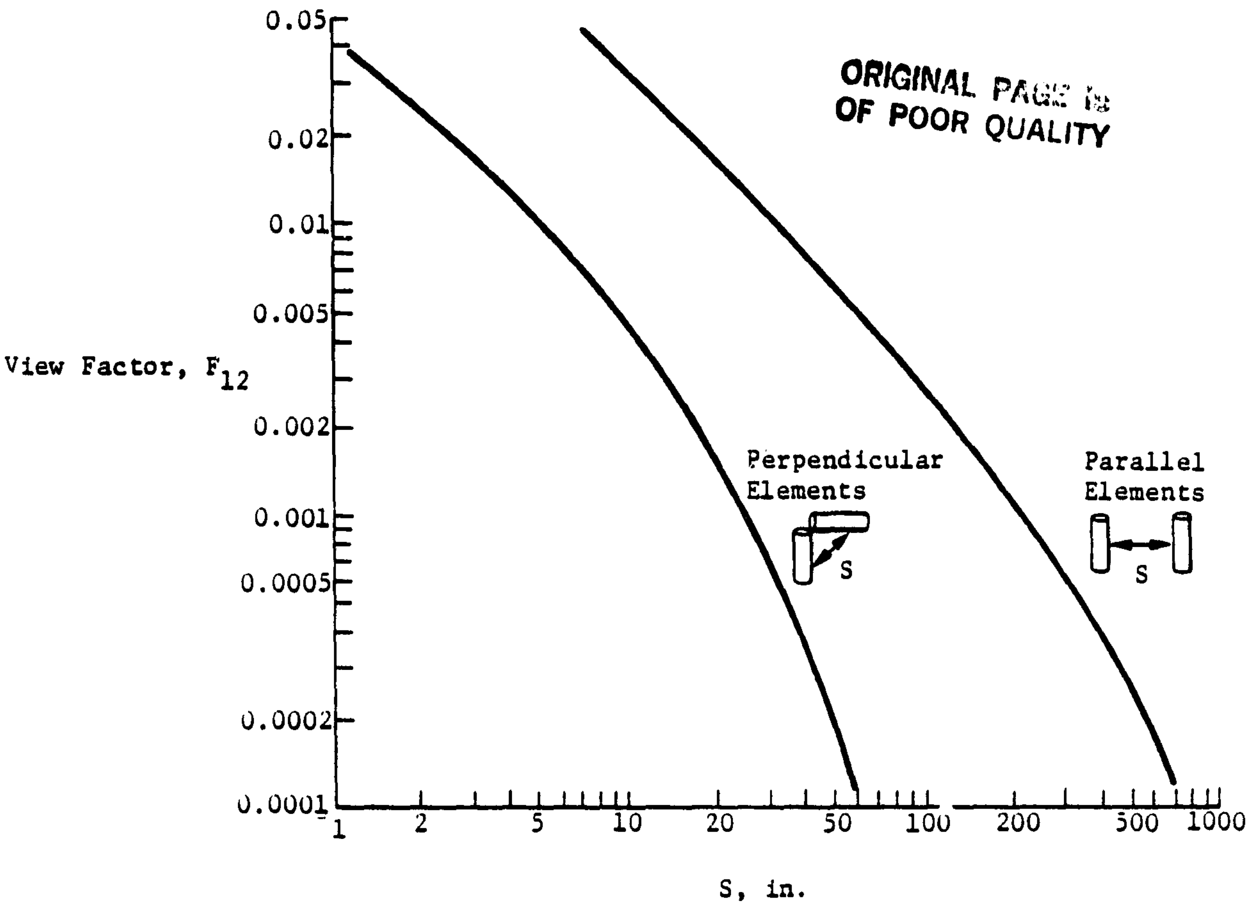


Figure III-32 Element-to-Element View Factors

The rf reflective mesh was modeled as a series of planes, none of which was coplanar, to approximate the actual contour of the rf surface. Because the mesh itself is composed of woven 0.003-cm gold-deposited molybdenum wire, it can absorb and reflect any incident solar or IR heat flux as well as permit a portion of the flux to pass through it to the underlaying surfaces. This transparency also comes into play when the mesh is in between two surfaces for which the view factor is being calculated. Typical data for a tricot woven mesh of 5.5 openings per centimeter are given in Figure III-33, and are the data used in the TRASYS MSDA model.

The resulting TRASYS MSDA model had 548 nodes to represent all of the different areas of MSDA and the spacecraft. Of this, there were 43 surfaces (non-ELEM/TAPE) that represented the rf mesh surface and spacecraft.

The optical properties of the structural members and diagonal tapes were $\alpha = 0.875$ and $\varepsilon = 0.875$, where α is absorbtivity and ε is emittance. This is representative of unpainted graphite-epoxy. The values used on the gold-deposited woven RF mesh were $\alpha = 0.034$, and $\varepsilon = 0.04$, with the transparency ranging from 0.88 at 0-deg incident angle to 0.0 at an 89-deg angle. The spacecraft was assumed to be painted white, for which typical data of $\alpha = 0.3$ and $\varepsilon = 0.85$ were used.

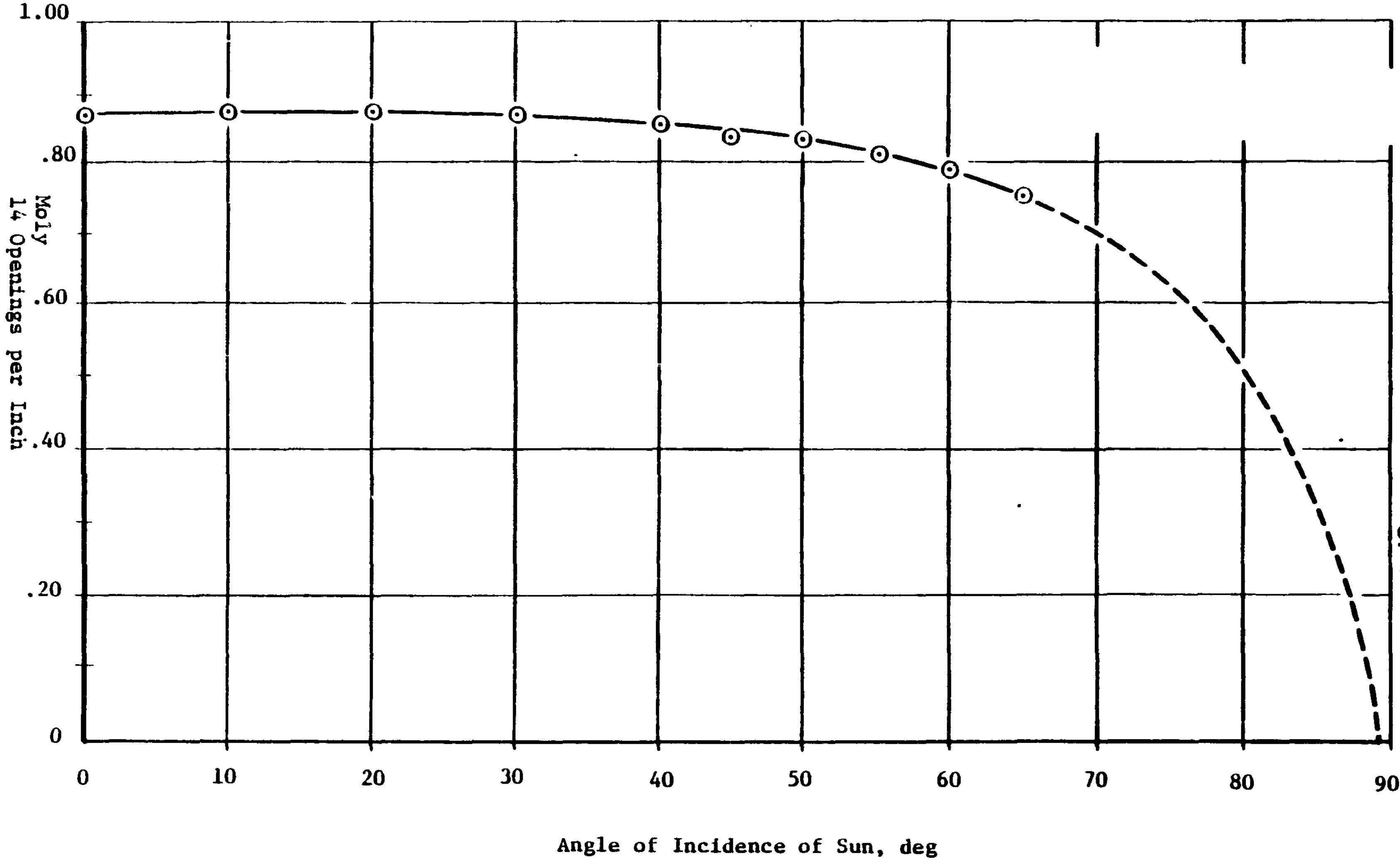
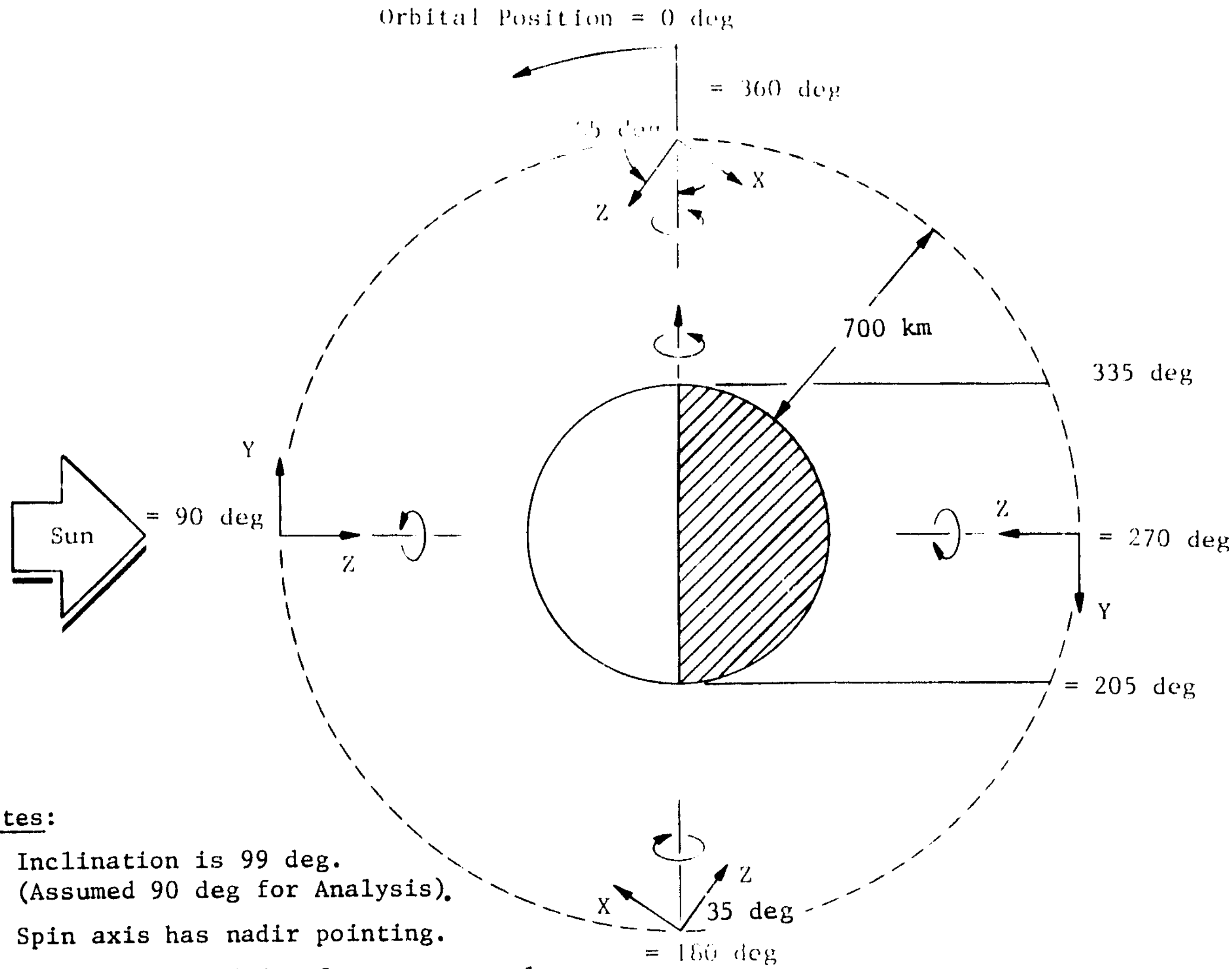


Figure III-33
Optical Transmissivity of 5.5 Openings per Centimeter Tricot Mesh

After the view factors and resulting radiation interchange factors had been computed for the MSDA model, the same model was used to generate the environmental heating that would be experienced while in Earth orbit. The orbit used was a circular one with an altitude of 700 km. The actual orbital inclination is 99 deg, but for reasons of economy it was assumed to be 90 deg. A polar orbit introduces symmetry with respect to the sunlit portion of the Earth and permits heat flux to be calculated at selected positions of the orbit and reused at symmetrical positions, thus precluding another calculation. The orbit used was such that the Sun vector was in the orbit plane as shown in Figure III-34. This orbit gives rise to both the highest (at the sun-solar point) and lowest (in the Earth's shadow) flux levels and will generate the largest temperature change during an orbit. Flux data were computed for ten positions in the orbit measured from the North Pole: the North and South Pole positions, the subsolar and antisolar positions, 45-deg and 135-deg positions, and immediately before and immediately after entering and exiting the Earth's shadow.



Notes:

1. Inclination is 99 deg. (Assumed 90 deg for Analysis).
2. Spin axis has nadir pointing.
3. Spin axis is 35 deg from structural z axis.
4. Spin rate is 6 rpm.

**ORIGINAL PAGE IS
OF POOR QUALITY**

The MSDA is nadir pointing and spinning about the pointing axis at 6 rpm. This pointing axis was assumed to be 35 deg from the z axis in the x-z plane. To simulate the spin, the MSDA TRASYS model was run through the same orbit four times. Each of these four cases represented one particular orientation during a revolution about the spin axis and was spaced 90 deg of a spin revolution apart, thus representing 0, 90, 180, 270 and 360 deg of a spin revolution. The resulting flux data were averaged at each orbital position to generate an average flux table as a function of time for each node.

During this calculation or orbital heating flux, another effect of designating surfaces as either ELEM or TAPE comes into play. For these surface types, TRASYS has been modified so the slight angle (1.5 deg) of the Sun's rays will be taken into account. Figure III-35 shows the effect of considering the umbra and penumbra effect with varying member sizes and separation distances. The MSDA structure has S/D ratios ranging from about 40 to 200; and, in that range, the umbra effect is significant.

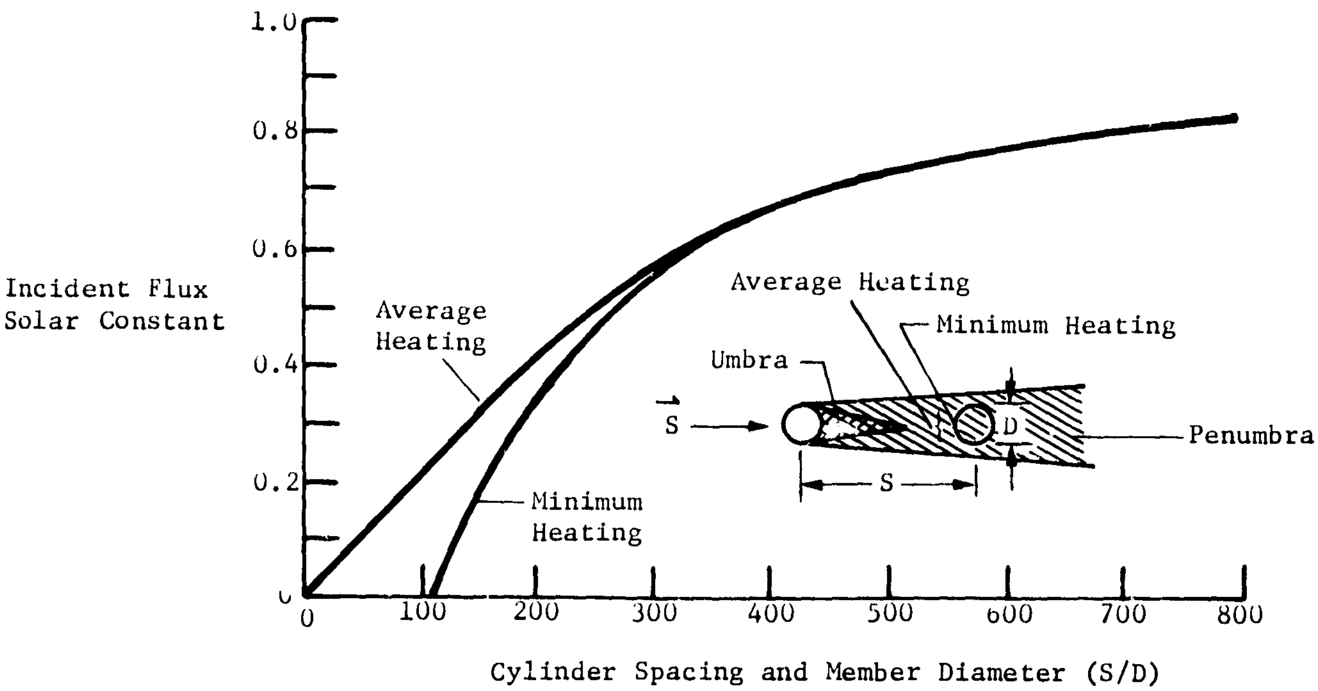


Figure III-35 Umbra and Penumbra Shadowing Effects

<u>MSDA MITAS Model</u> - The MITAS program is used to provide either the steady-state or transient temperature solutions of a model. The radiation interchange factors (f) generated by TRASYS are used as radiation couplings between nodes of the model, while the time-versus-orbital heat flux is used to impress heating onto nodes of the model.

Similarly to the utility program used to generate the TRASYS surface decriptions, a utility program was created to use the MSDA NASTRAN data base and create the MITAS node description input data. This program was used to ensure that the nodes had the proper length, cross-sectional area, and member identification. This ensures that the identification label will be consistent across the structural/dynamic/thermoelastic/environmental/thermal analysis spectrum.

All of the nodes of the MITAS model were given a mass, except the mesh shaping cords. These were so small (1.14×10^{-2}-cm radius) that their thermal capacitance was ignored. The specific heat for the graphite-epoxy members and tapes was assumed to be a function of temperature. The data for this function ranged from 376.7 J/Kg-K at 93.3°C to 12,138 at 176.7°C in a nearly linear fashion. Data were taken from the Rockwell Internal Report TD-75-46, Determination of Graphite-Epoxy Thermo-Physical Properties, as being representative of the composite of the MSDA members.

The bulk of the node-node heat transfer is via the radiation interchange factors provided by TRASYS. The structural members are pinned at the corners presenting a high-thermal resistance and precluding any significant conduction heat transfer across the pin joint. The only place where there is a solid path for conduction is along the structural vertical members into the structural extensions used to support the rf reflective mesh. These 32 members pass through the corner fittings and are not pinned for deployment. These conductive paths were included for completeness. The longitudinal (along the graphite fiber) conductance representative of the MSDA graphite-epoxy composition is 97,800 J/HR-m-K.

The members have been represented in the TRASYS model as encompassing 360 deg in the circumferential direction; thus, the model will not predict any circumferential temperature gradient. The 10 seconds per revolution spin rate will also preclude any appreciable temperature gradient from being established on the perimeter of a member because all sides will be exposed to a comparable environmental flux level.

Five analyses were run with the MITAS MSDA model. The first of these used the four instantaneous environmental heating tables that were averaged to generate average heating data. These four cases do not represent a real case because the MSDA is constantly spinning but represent a boundary case for the environmental and temperature data. To further increase the extremes of the temperature results, a steady-state solution was employed. This removes any damping provided by the thermal capacitance and yields limiting temperatures. A series of steady-state solutions were generated at different positions in the orbit for each of the four different instantaneous spin positions. A representative set of results is presented in Figures III-36a through 36d and for the structural members.

The last analysis that was run on the model is the one that more nearly represents what MSDA will experience in orbit. This case uses the averaged flux data for an orbital position created from the four different instantaneous positions of a spin revolution. In addition, the damping effects imparted by thermal capacitance were included, i.e., transient temperature solution versus steady-state. Figure III-37 gives a representative sample of the total MSDA results.

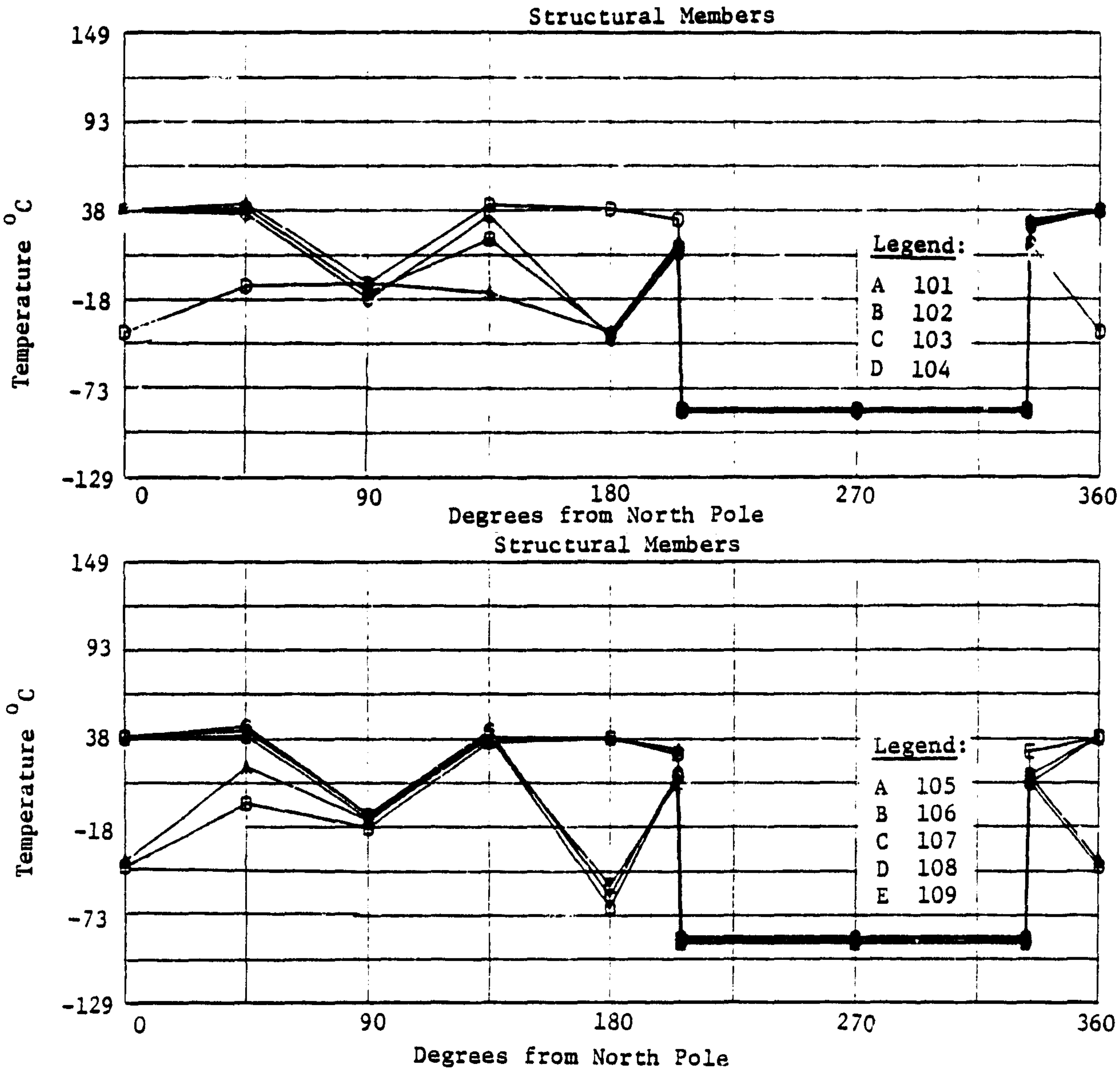
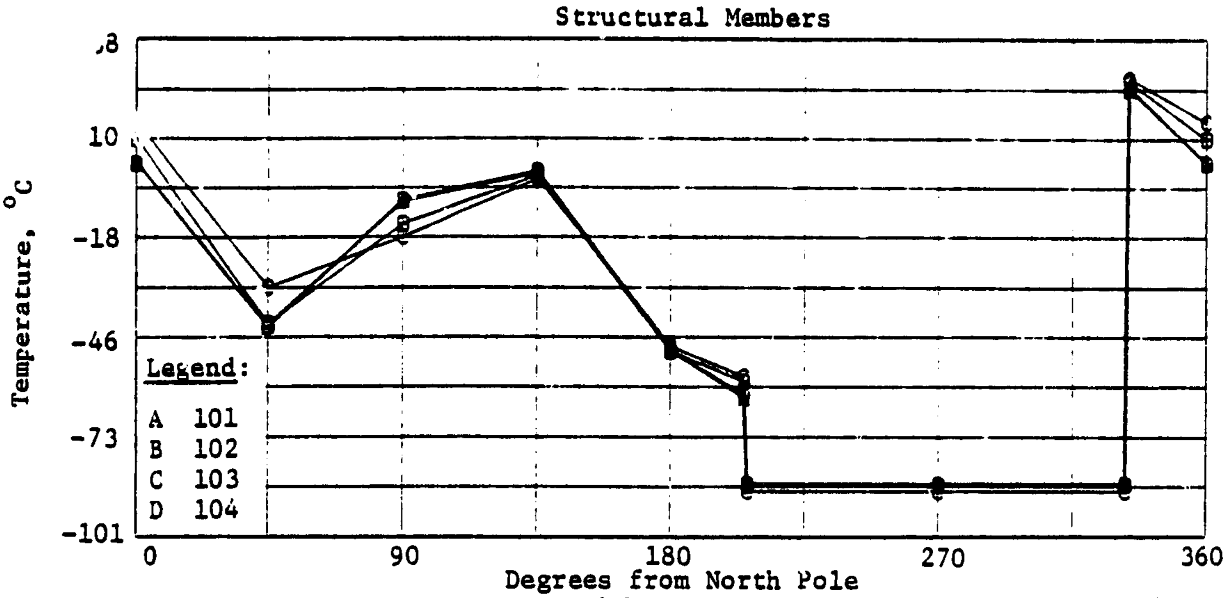


Figure III-36a
MSDA Steady-State - Spin Angle 0-deg Temperature Results



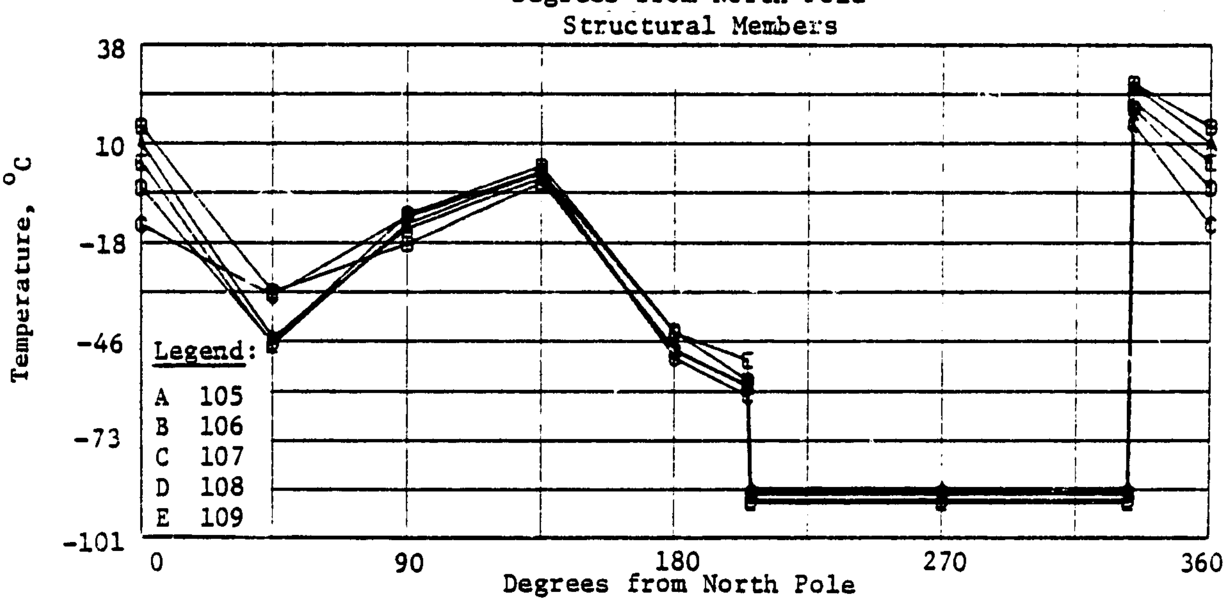


Figure III-36b
MSDA Steady-State - Spin Angle 90-deg Temperature Results

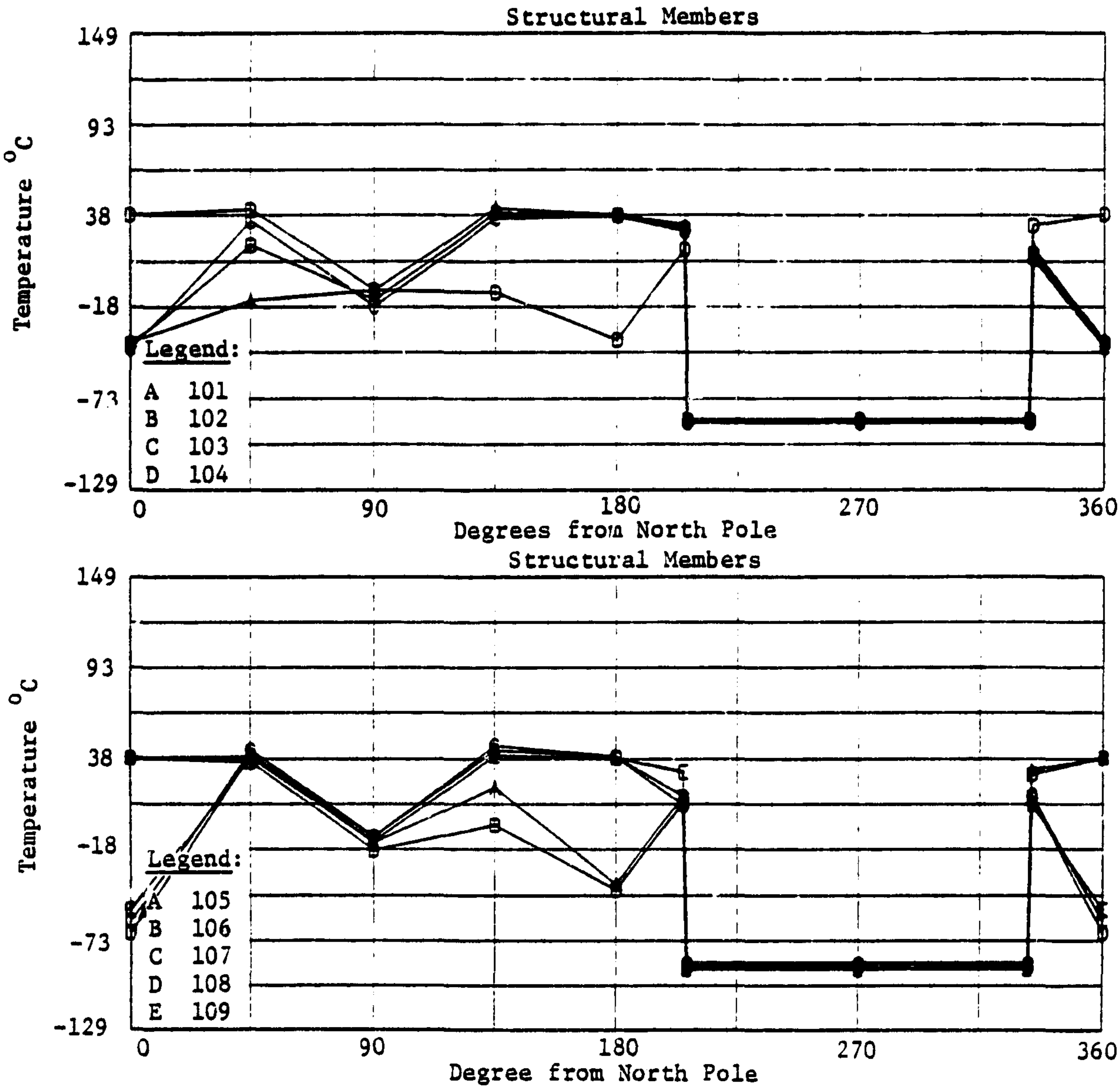
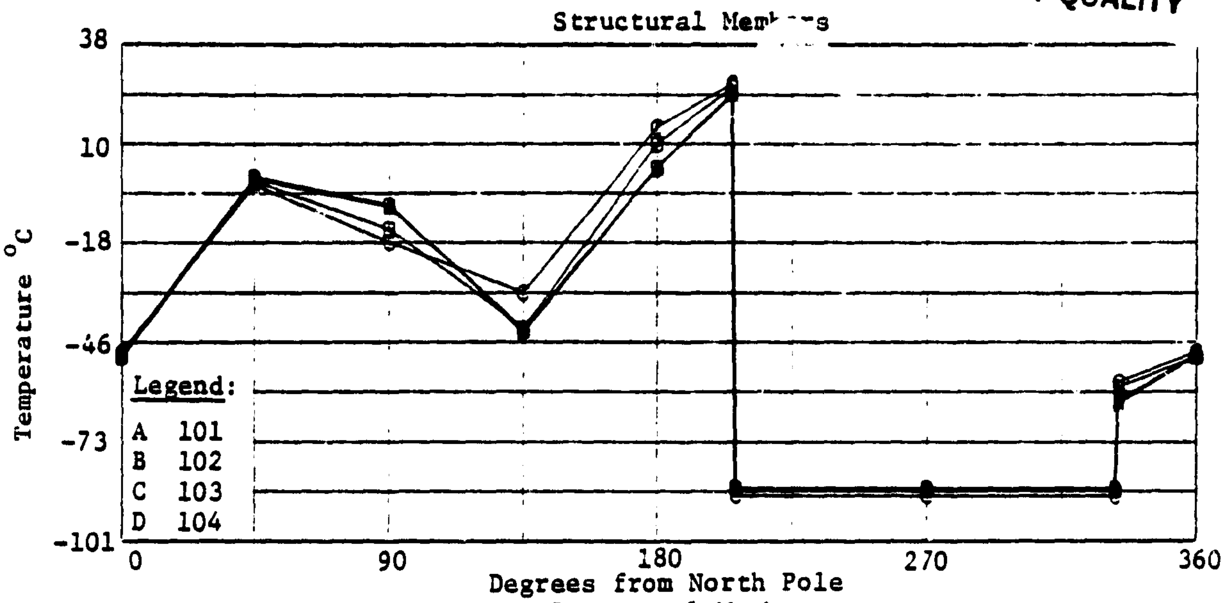


Figure III-36c
MSDA Steady-State - Spin Angle 180-deg Temperature Results



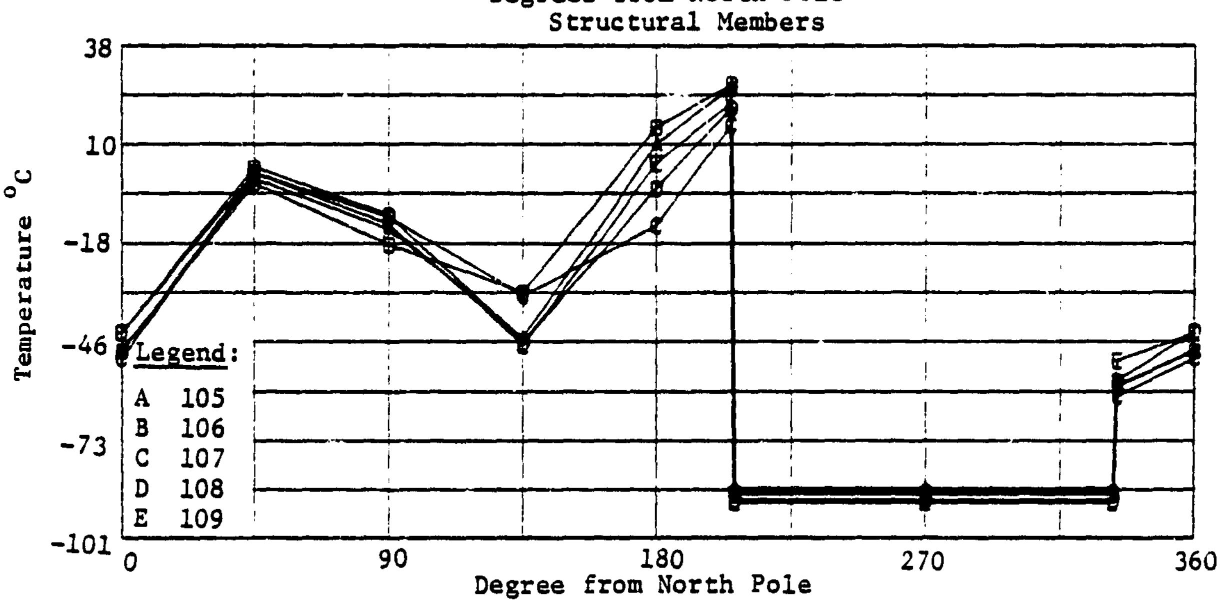
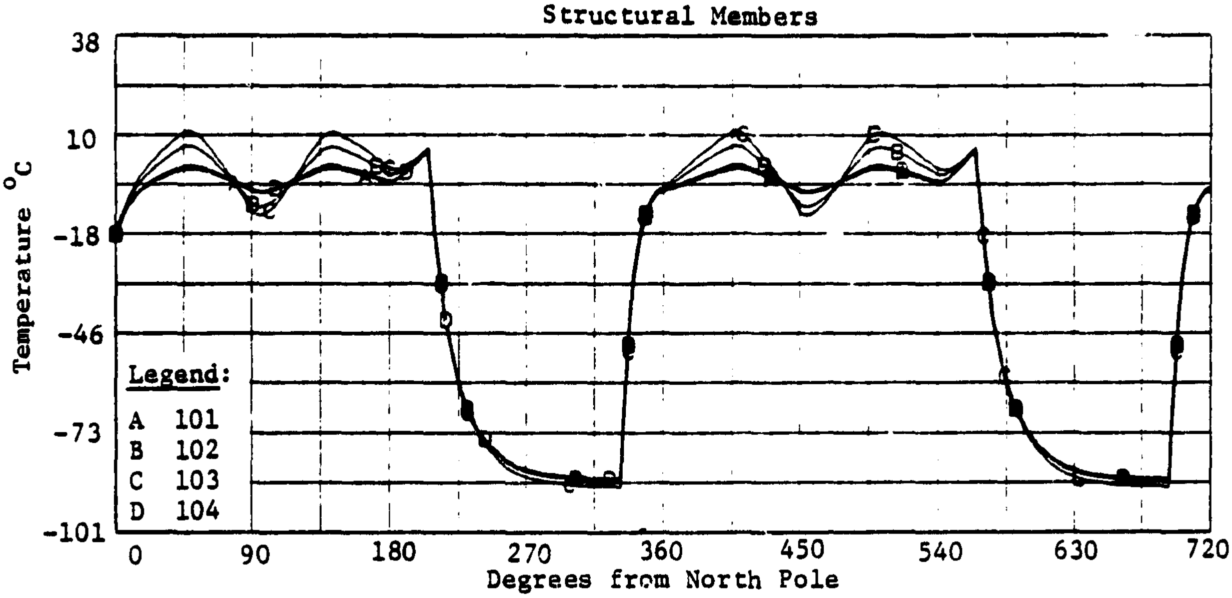


Figure III-36d
MSDA Steady-State - Spin Angle 270-deg Temperature Results

ORIGINAL PAGE IS
OF POOR QUALITY



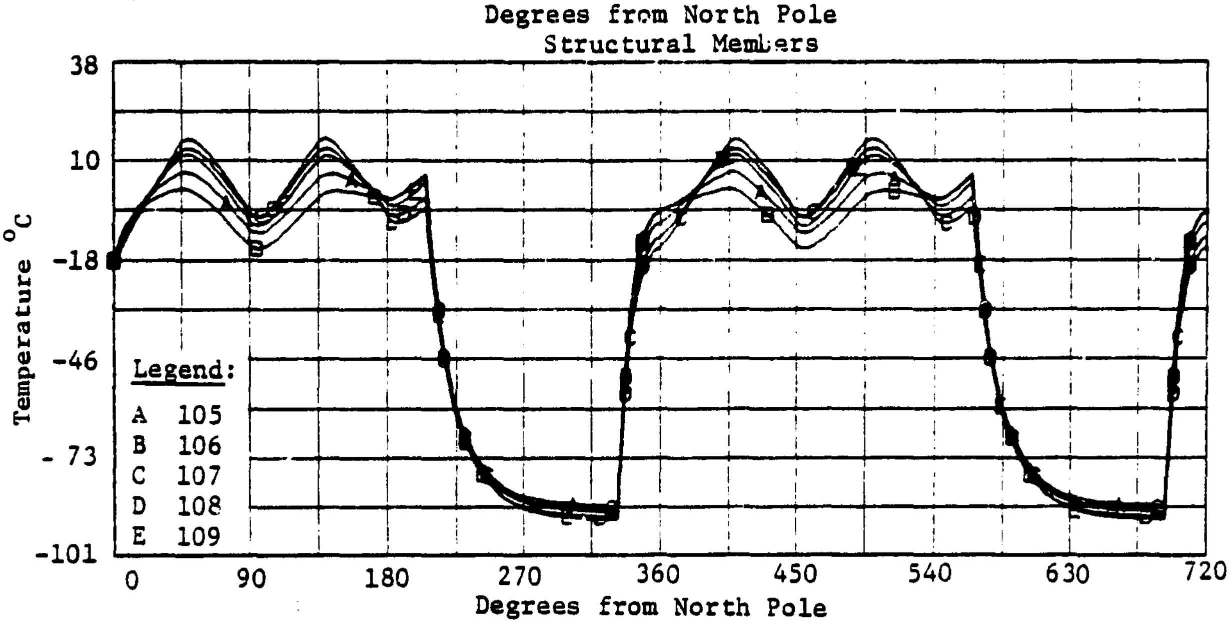


Figure III-37 MSDA Transient - Average Flux Temperature Results

The starting temperatures for the transient results were picked to be close to the expected results after one orbit. This was true in some cases and not in others. For this reason, the simulation was run for two orbits to allow the nodes to attain a state of equilibrium, i.e., the temperature at an orbit position will be the same for all successive orbits. The structure has low-thermal mass and so much exposed surface area that two orbits were sufficient for this equilibrium to be achieved.

The reflective mesh surface is by far the hottest surface (about 187.7°C) in the MSDA. This is caused by the optical properties of the gold-deposited wire. The emittance of this surface is only about 0.04, and, thus, it can not readily reradiate any absorbed energy.

The structural member temperatures were all less than 65.5°C, which is within the 90°C operation temperature limit for this graphite-epoxy composition. The minimum temperature of -97°C is within the minimum operation limit of -125°C. The shadows cast by both the members and the spacecraft cause a wide variation in the member temperatures. As a result, in some cases, peak temperatures are not achieved at the subsolar position of the orbit but on either side of it.

<u>Thermal and Centrifugal Deformations</u> - The temperatures derived from the TRASYS/MITAS programs were applied to a static NASTRAN model of the structure. Because the thermal analysis provided a multitude of temperatures, a statistical inspection was performed to determine approximately what were the worst-case thermal loads. Some of the criteria used were the largest temperature differential between any two members in the face of one of the bays and the largest deviation in the entire structure. From this analysis, three cases were selected to run in NASTRAN. The two extremes in average temperatures were analyzed, plus a third case that had some large temperature differentials within the structure due to shadowing effects. The hottest temperature in the antenna support structure was 72°C at the 90-deg point in the orbit and the coldest temperature was -77.5°C at the 270-deg orbital position (orbit position defined in Figure III-34). The three thermal cases used along with frequency plots of the temperatures in the structure are summarized in Figure III-38.

The three temperature cases were input into NASTRAN and combined with the centrifugal loading case of 6 rpm. The initial temperature for all the materials was set at 22°C, which is the fabrication temperature of the structure. Table III-3 summarizes the deflection at the feed for the three thermal cases combined with centrifugal deflection. Figures III-39 through 42 are computer plots of the different box-truss loading cases with x,y, and z deflections of each node of the structure for both thermal and centrifugal loads. The centrifugal deflection can be corrected in design because it is a steady-state condition. The deflections of the box-truss antenna support structure were then input into the single-box ANSYS stress-stiffened mesh model to determine thermal and spin effects on the rf surface.

Case	Orbital Position (deg)	Temp, °C, min	Temp, °C, Max	Temp, °C, Mean	Standard °C Deviation
I	90	-36.57	72.17	19.41	29.97
II	225	-86.16	.76	-53.9	17.99
III	270	-98.5	-22.19	-77.5	13.98

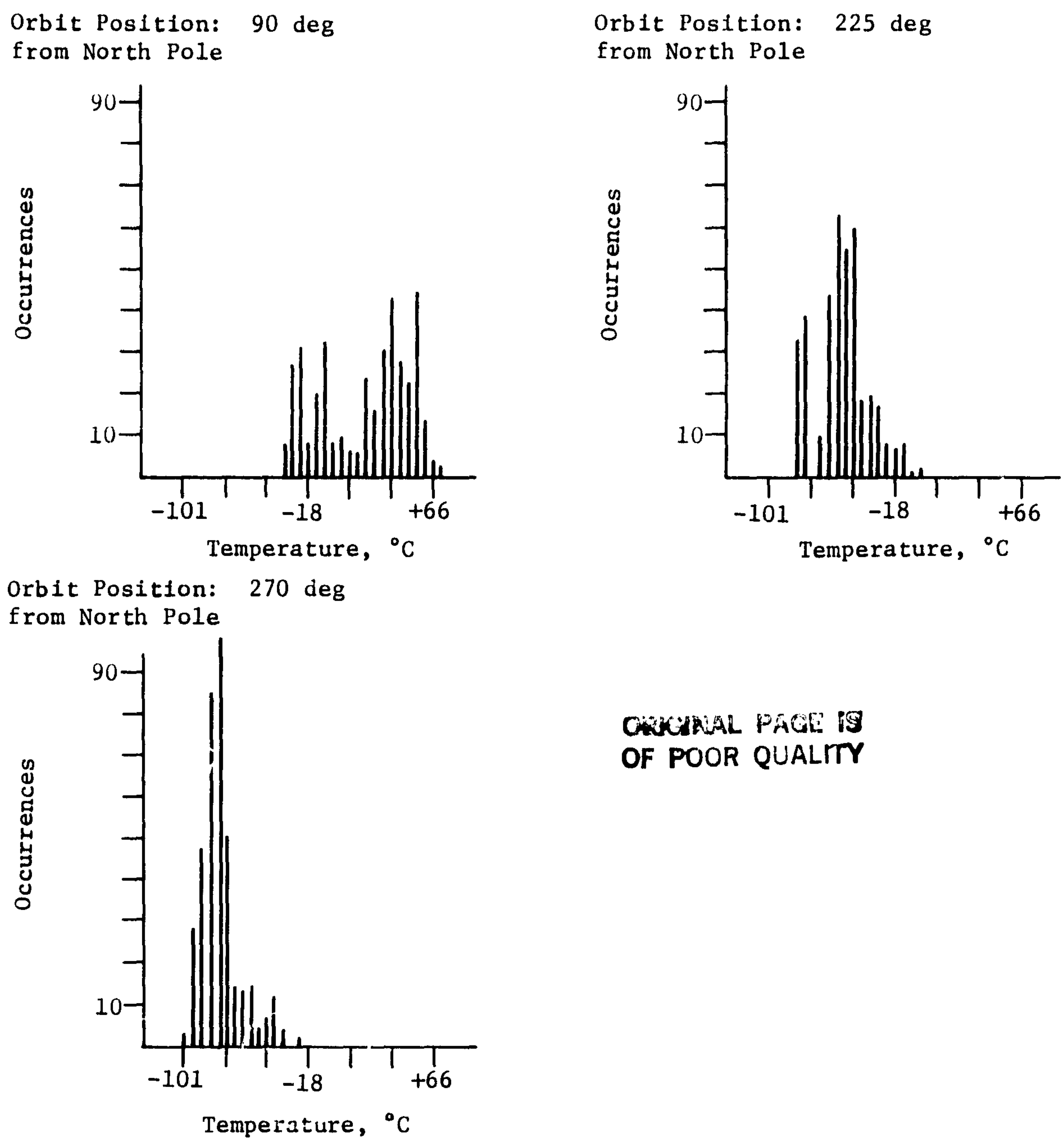


Figure III-38
Temperature Range and Mean in Antenna Support Structure for Different Thermal Load Cases

ORIGINAL PAGE IS
OF POOR QUALITY

Table III-3 Deflection of Feed during Thermal and Centrifugal Loading

Load Case	Deflection at Feed (Nodes 67 and 70 Avg)					
	X, cm	Y, cm	Z, cm	ROT x Rad	ROT y Rad	ROT z Rad
- Centrifugal	-0.0372	0.00014	0.00136	3.45E-6	2.44E-4	1.27E-7
- Thermal I 90-deg Orbital Position	-0.0504	0.00118	0.0183	-7.32E-10	-6.42E-5	-1.49E-6
- Thermal II 225-deg Orbital Position	-0.0142	0.00323	0.0176	1.01E-7	-9.18E-6	3.85E-6
- Thermal III 270-deg Orbital Position	-0.0162	0.00340	0.0248	-4.81E-7	-1.52E-5	3.00E-6
- Thermal I and Centrifugal	-0.0876	0.00132	0.01966	3.45E-6	1.80E-4	-1.36E-6
- Thermal II and Centrifugal	-0.054	0.00337	0.0190	3.55E-6	2.35E-4	3.98E-6
- Thermal III and Centrifugal	-0.0534	0.00354	0.0262	2.97E-6	2.29E-4	3.13E-6

Thermal Distortions of Mesh Tie System - A problem inherent in desiging any LSS structure is verifying the reflector surface design under varying thermal environments. Modeling of the surface used ANSYS stress stiffening techniques. The model used cable elements to represent the mesh tie-system. ANSYS cable elements have the capability to be initially strained before the stiffness matrix is formed. This strain was determined by assuming a pretension in the mesh of 0.0175 N/cm. The 0.0175-N/cm pretension is the minimum tension required to give a flat reflective surface. Because of the enormous number of cable elements necessary to model the entire reflector surface, a single box-truss section was used. The analysis cost of the mesh tie-system model was reduced even further by halving the number of cable elements. This reduction in elements did not give a dramatic change in thermal distortion of the surface and gave a reasonable initial estimate of thermal distortions in the mesh tie-system. The mesh box section selected (Box 20 as shown in Figure III-22) had the greatest curvature and, therefore, gives a worst-case analysis for thermoelastic distortions of the mesh surface plus truss. Figure III-43 shows the node points for the ANSYS model. The model's initial geometry was adjusted for prestrain deflections. Therefore, when the prestrain was applied to the cable elements, the mesh tie-points deflected to form the parabolic surface required. This prestrained model was then subjected to three worst-case thermal environments. The thermal cases also included box-truss standoff deflections due to thermoelastic deformations and inertial spinning of the antenna box-truss structure. The first thermal case included local shadowing effects of the spacecraft on the back catenary system. The second thermal case was the maximum temperature case, and the third thermal case was the minimum temperature case. Table III-4 gives the temperature values for each of the thermal cases. Results of the three thermal cases showed the maximum deflection of the upper surface mesh tie-system is 0.0356 cm at Node 41 with an rms deflection of 0.0137 cm. This occurred with the minimum temperature case (Thermal Case III). Table III-5 gives the maximum deflection and rms deflection of all three thermal cases. Appendix E gives the delta-x, delta-y, and delta-z deflections for the single-panel reflector surface for each thermal case. Using 1/40 of a wavelength for rms distortions, the mesh surface design proposed would be appropriate for frequencies of 11 GHz. Table III-6 summarizes the total distortions of the mesh due to pillowing, thermal effects, and manufacturing.

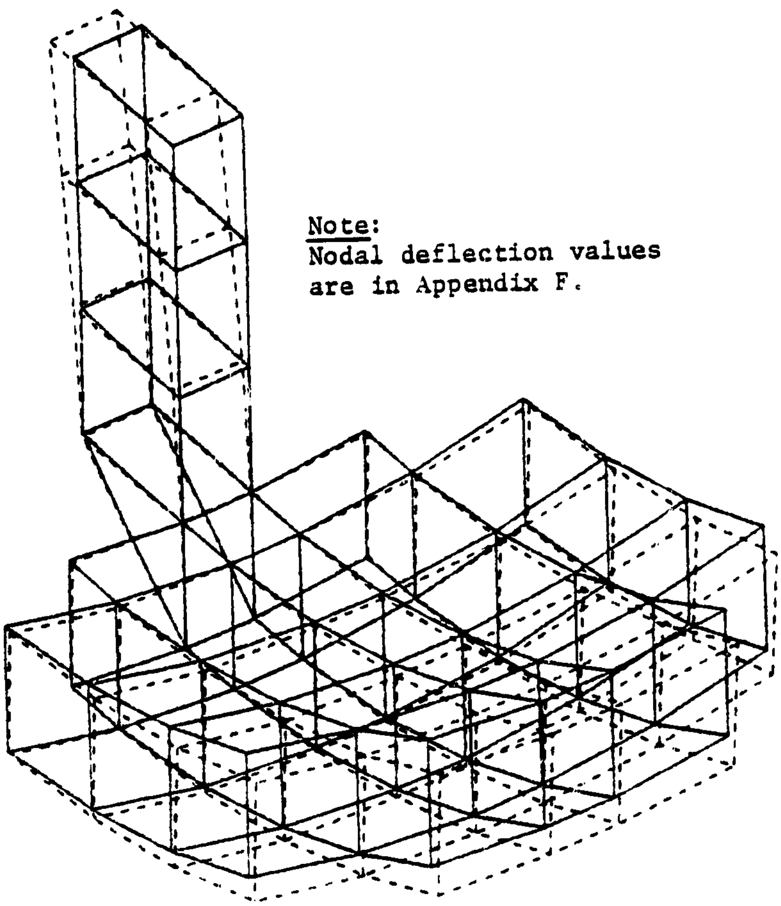


Figure III-39
Structural Deflection Plot Centrifugal Load

ORIGINAL PAGE IS
OF POOR QUALITY

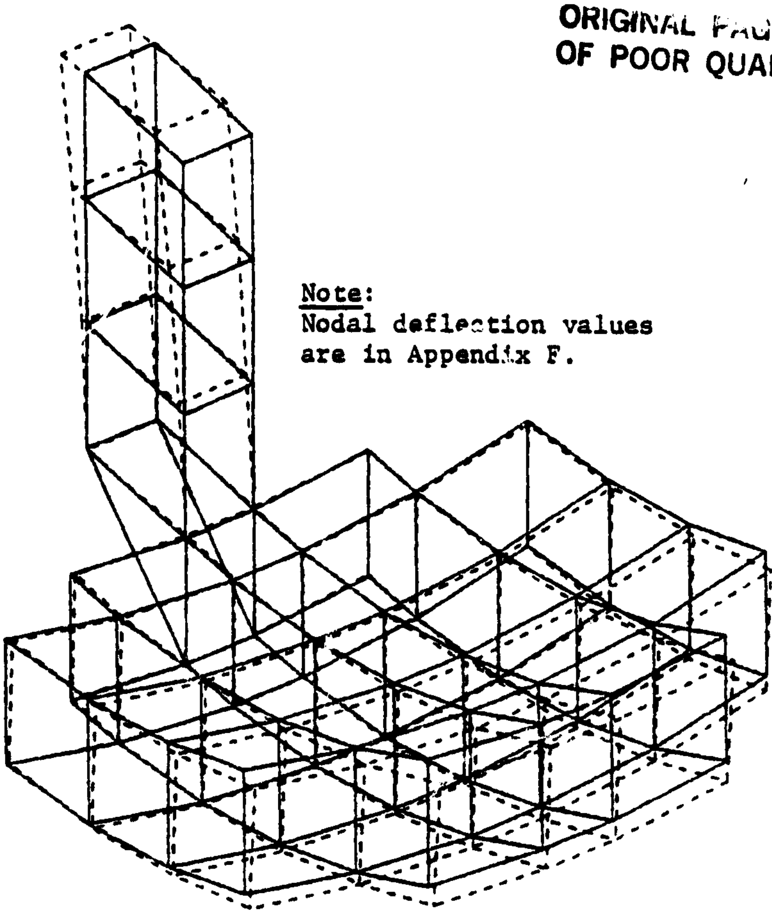


Figure III-40
Structural Deflection Plot - Thermal Load Case I and Centrifugal Load

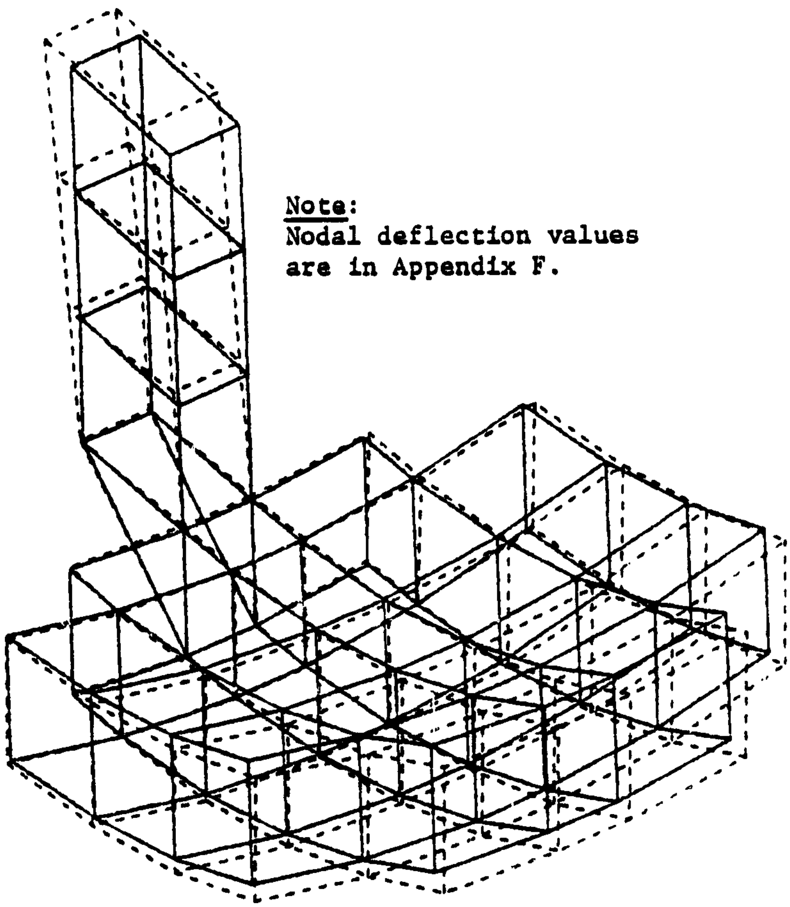


Figure III-41
Structural Deflection Plot - Thermal Load Case II and Centrifugal Load

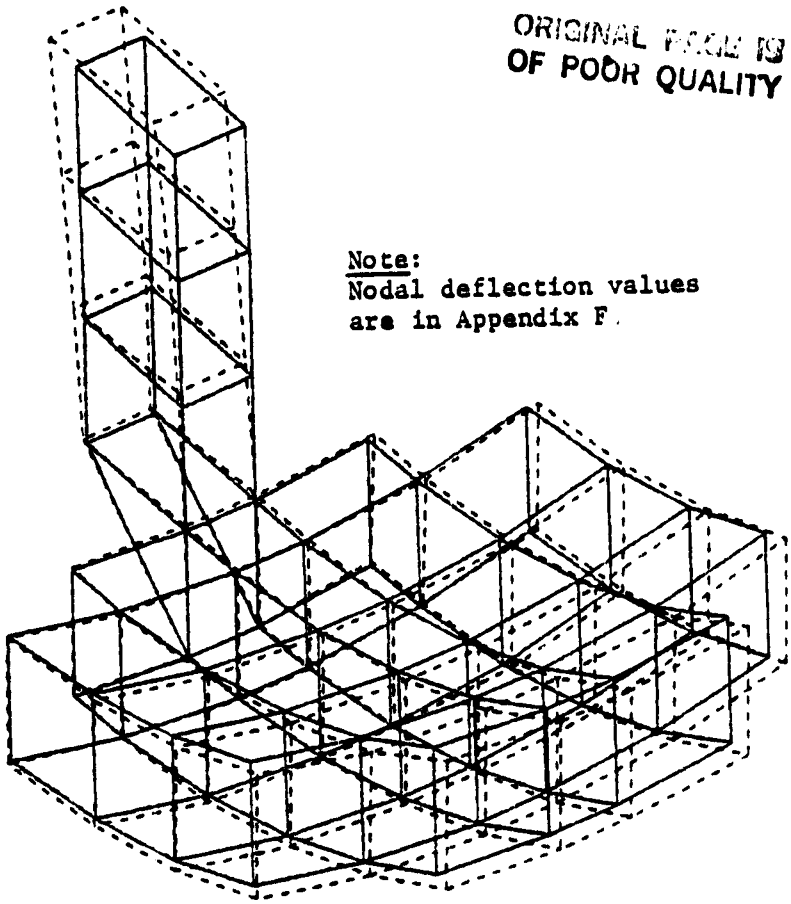


Figure III-42
Structural Deflection Plot - Thermal Load Case III and Centrifugal Load

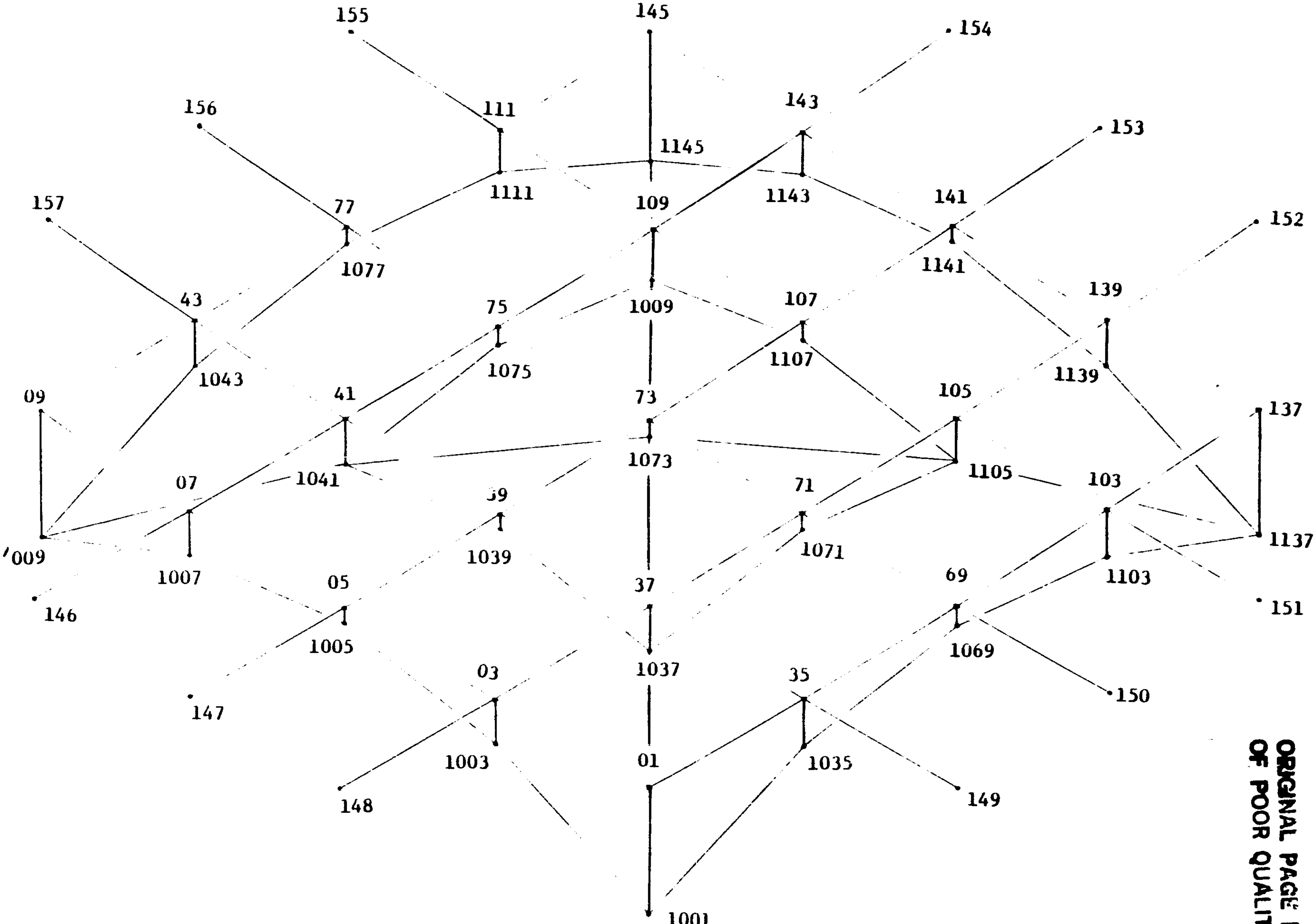


Figure III-43 ANSYS Mesh Model Numbering System

Table III-4
Temperature Values on Single Panel Mesh Support System

Thermal Case	Upper Surface Cord	Drop Cord	Rear Cord
Local Shadow Effect - 90°C	283°C Unshadowed	31°C for Shadowed Cords and 58° for Unshadowed Cords	52° for Shadowed Cords and 79°C for Unshadowed Cords
Maximum Temp Case 90°	302°C	66°C	89°C
Minimum Temp Case 270°	170°C	-41°C	-28°C
Note: Reference temperature = 22.2°C.			

Table III-5
Maximum and rms Deflection of Single Mesh Panel, Plus Box-Truss, Support System due to Temperature Change and Centrifugal Force

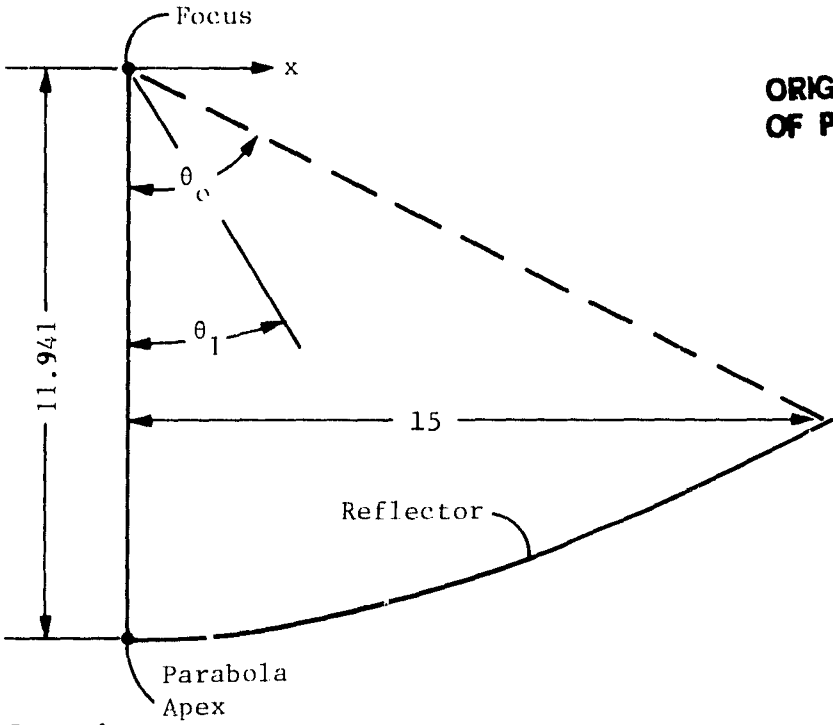
Thermal Case	Maximum Deflection, cm	Rms Deflection, cm
Local Shadow Effect	-0.0210	0.0123
Maximum Temperature	0.0295	0.0102
Minimum Temperature Case	0.0356	0.0137

Table III-6
Summary of Total Distortions of Total Reflector Mesh due to Pillowing and Thermal Effects, and Manufacturing Tolerances

Saddle Distortions	=	0.020-cm rms
Spin + Thermal Distortion	=	0.013-cm rms
Manufacturing	=	0.064-cm rms
Worst-Case Total rms	=	0.097-cm rms

G. RF EVALUATION USING APERTURE DISTRIBUTION TECHNIQUES

The present baseline design for the MSDA reflector (Fig. III-44) is offset-fed, with a diameter of 15 m and a focal length of 11.941 m. This focal length was selected based on structural considerations. It is the length given by a full-size three-bay feed support structure. A computer simulation of the antenna rf performance was made to establish the feed design and to determine if this focal length is adequate to meet performance requirements.



ORIGINAL PAGE IS
OF POOR QUALITY

Legend:

θ_o 64.24 deg = Angle from parabola apex to reflector edge

θ_1 33.0 deg = Feed boresight offset angle

f 11.941 m = 203.01 λ

D 15 m = 255.02 λ

λ 5.882 cm (Frequency = 5.1 GHz)

Figure III-44
Reflector Geometry (All Dimensions in Meters)

Performance at only one of the specified frequency, 5.1 GHz, was examined. The key rf requirements for the antenna at 5.1 GHz are:

- Number of feeds = 12;

- 3-dB beamwidth $\geq$ 0.3 deg;

- Angular spacing between feeds = 0.3 deg;

- Beam efficiency $\geq$ 0.90.

Beam efficiency is defined as the ratio of main beam power (null to null) to total power in the radiation pattern.

Two antenna parameters must be selected based on tradeoffs between conflicting requirements. These are (1) reflector illumination taper, and (2) reflector focal length. The performance considerations entering into the tradeoff are (1) a tapered illumination is needed to meet the beam efficiency requirement and to hold down the side-lobe levels, but if the taper is excessive, the 0.3-deg beamwidth requirement will not be met; and (2) a long focal length also helps to meet the beam efficiency requirement by reducing the coma distortion for off-axis beams. Also, it reduces main beam broadening of the off-axis beams. But if the focal length is excessive, it causes structural, packaging, and weight problems in the design of the feed support tower. These tradeoffs are best made iteratively by varying the parameters and observing the results.

An initial design was made of the feed system. This was not fully optimized but is adequate to give approximate values for beam efficiency and to show the degradation of the off-axis beams.

The selected feed horn design is shown in Figure III-45. A conventional smooth-walled pyramidal horn was selected for this initial design. Aperture diameter and horn height were selected to give a predicted reflector illumination taper of approximately 16 dB. The feeds are pointed 33 deg away from the parabola axis, which is slightly outboard from the reflector center. This was done to compensate for the space loss at the reflector outer edge, which is equal to 2.0 dB. The feed spacing, Δ, for a 0.3-deg spacing between beams can be found from

$$\Delta = K_B \cdot f \cdot \tan (0.3 \text{ deg})$$

where f is the focal length, 1104.1 cm, and K_B is the beam steering factor. The reflector configuration of Figure III-44 has an effective (two-sided) f/D of 0.398, which corresponds to beam factor $K_B \sim$ 0.85. Using this value gives $\Delta = 7.356$ cm. This is smaller than the feed horn aperture size, so the staggered arrangement shown in Figure III-46 is used for the 12 feed horns. Given the direction of beam sweep across the terrain being mapped, this staggered arrangement gives the desired contiguous sweeps. As shown in Figure III-46, there could be some blockage effects between adjacent horns due to the 33-deg tilt, but this is expected to be negligible. Horn arrays at the other frequencies would be scaled from this design, and all arrays would be located side by side near the reflector focus.

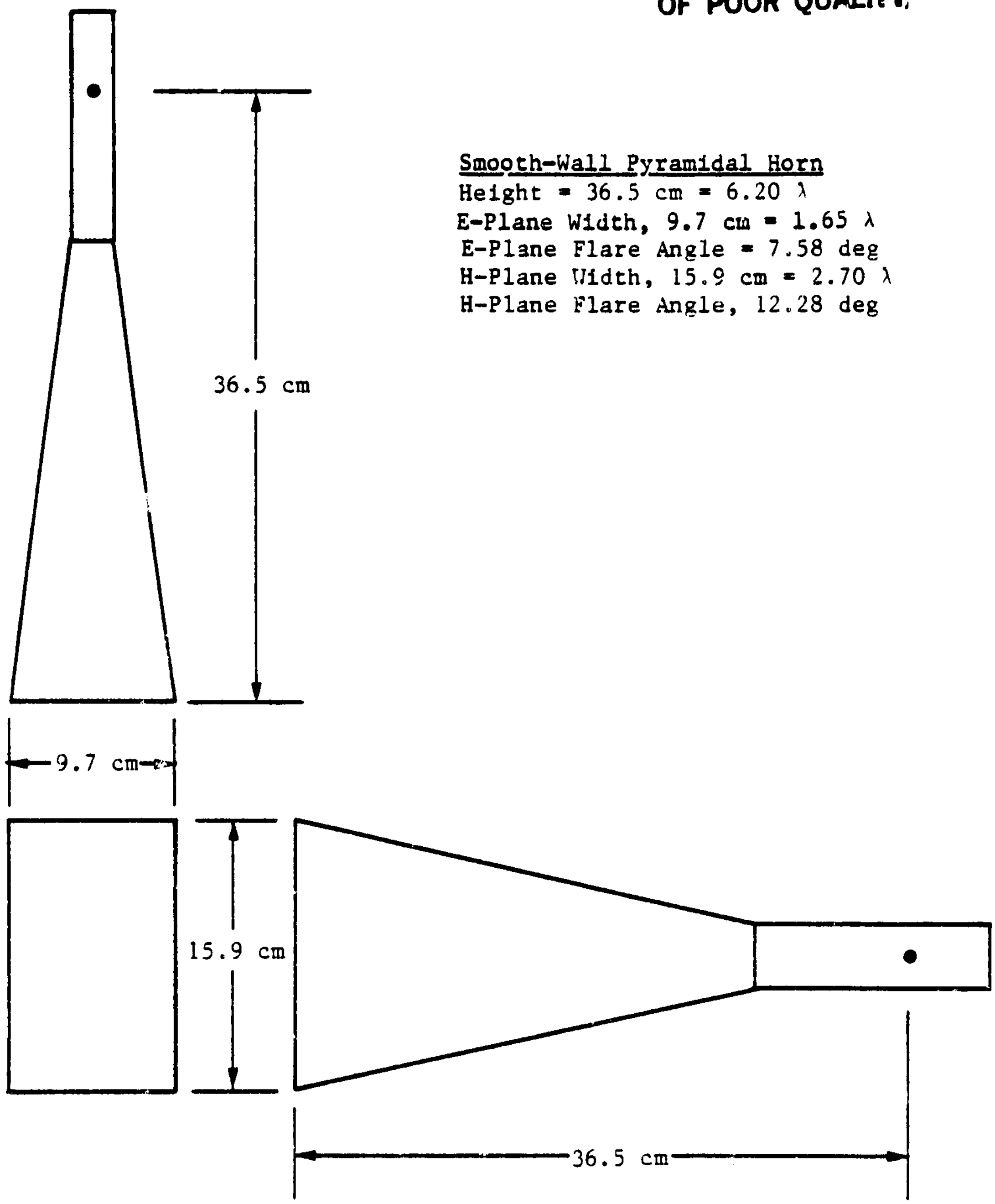


Figure III-45 Feed Horn - 5.1 GHz

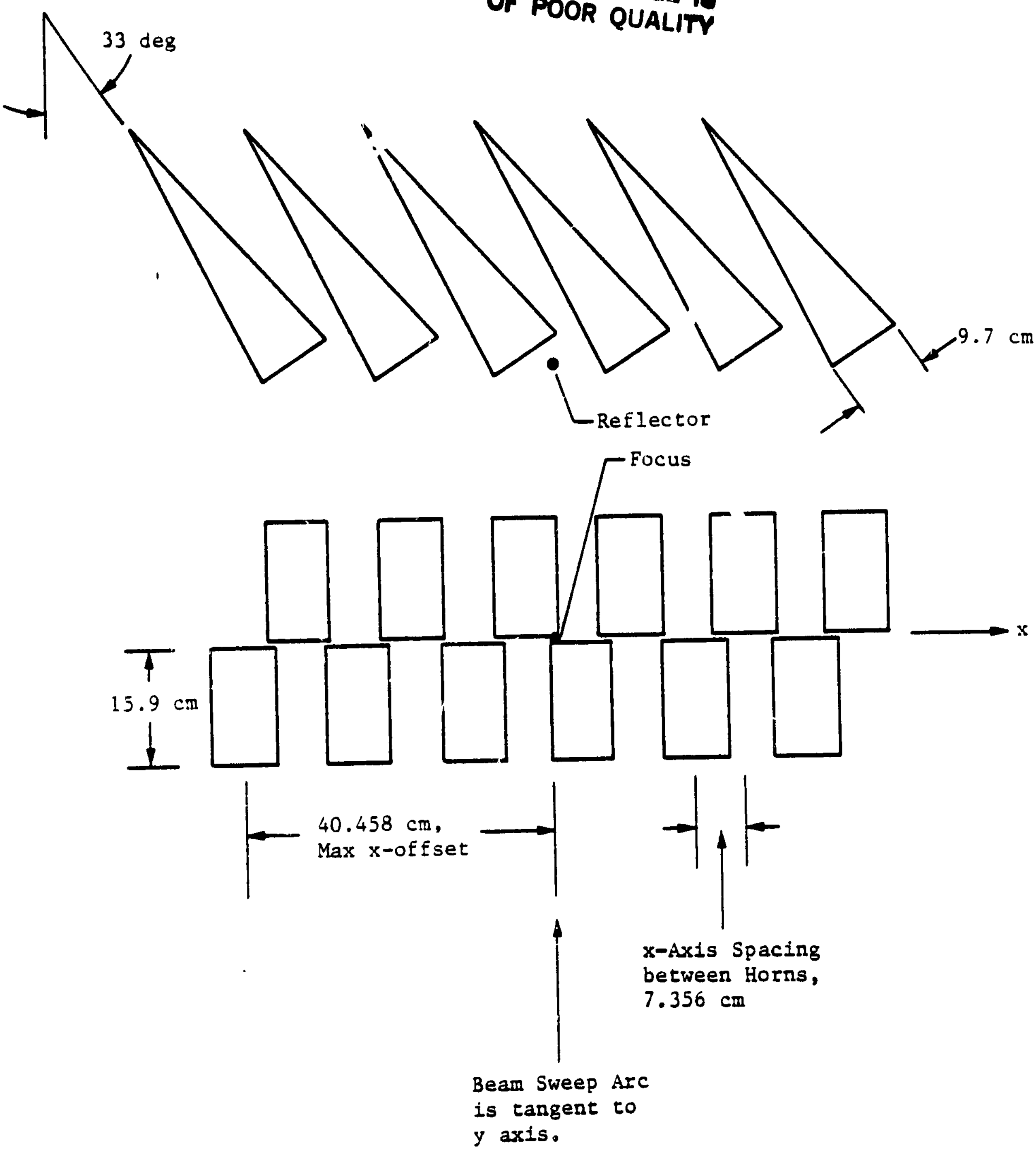
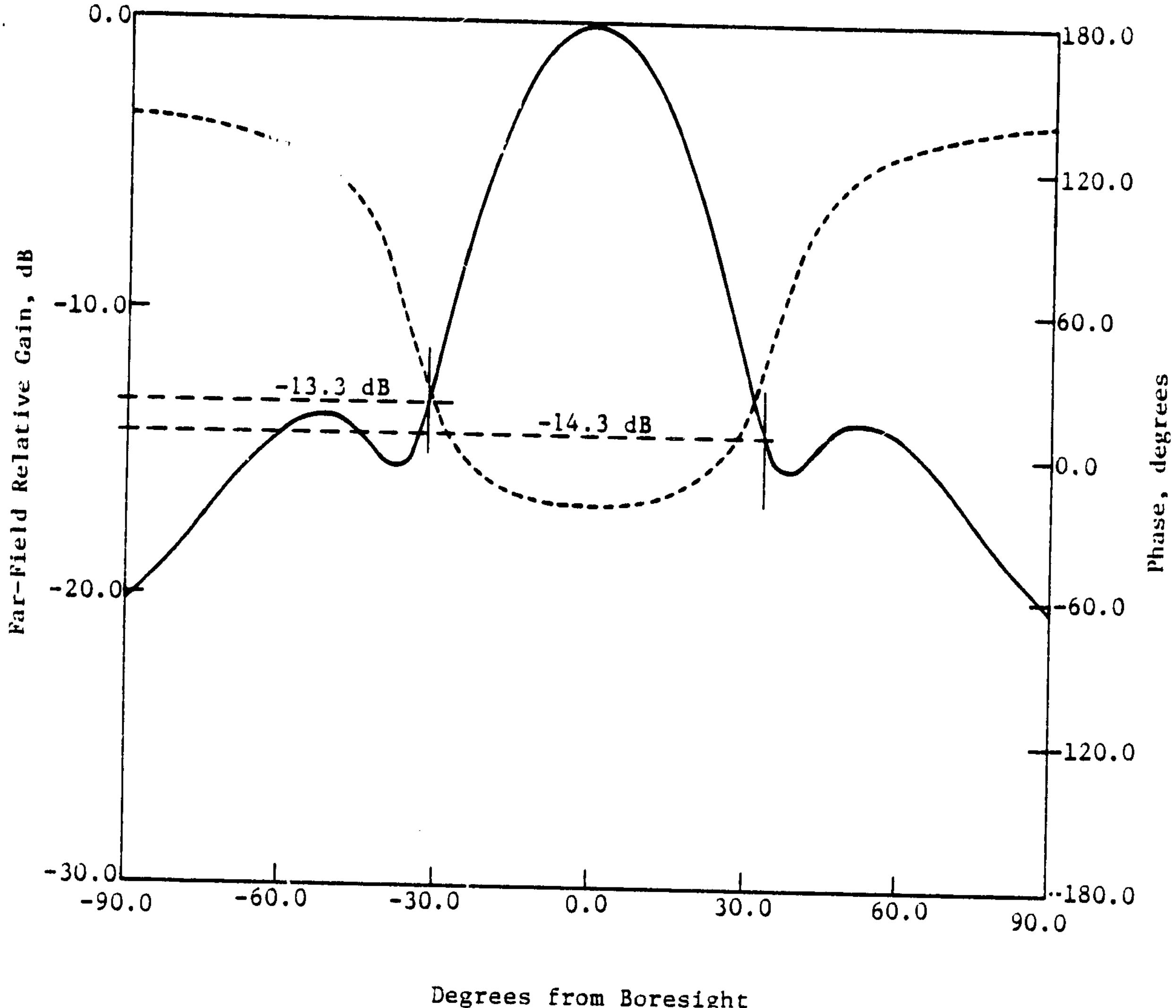


Figure III-46 Feed Array - 5.1 GHz

The horn parameters of Figure III-45 were input into our program FPTRNP, which computes horn far-field patterns and formats them into a radiation density grid. The resulting pattern (E- and H-plane cuts) are shown in Figures III-47 and 48. As shown, the selected horn parameters did not give exactly the desired results. A longer horn could be used to reduce phase errors and give deeper nulls in the E-plane. This, together with a slightly larger E-plane horn aperture, would give a much lower edge taper. Also, the 33-deg tilt only gave a 1-dB differential on the inner and outer reflector edges, instead of the desired 2.9 dB. A slightly greater tilt should have been used. Edge taper, including path loss, is -14.3 dB at the inner edge and -16.2 dB at the outer edge. The H-plane pattern is slightly too narrow, giving an edge taper (including path loss) of -28.3 dB in the H-plane. This could also be adjusted in the final design to make it equal to the E-plane taper. However, the average taper was -18.3 dB, or approximately the level desired initially. A final design of the system was not undertaken at this time. A corrugated horn could be used in this design to give equal E- and H-plane beamwidths and no feed side-lobes. This is the recommended approach for a final design.

This horn pattern was then input as the feed into our reflector program VICTORS, together with the reflector geometry of Figure III-44. VICTORS is an aperture integration program that assumes an ideal reflector surface. The effects of surface irregularities are analyzed later in this report on a configuration that is slightly different from that shown in Figure III-44 and that uses our surface current integration program, FIRE.

VICTORS computes reflector secondary patterns and the following losses--illumination taper, blockage, phase error, and spillover. Two patterns were run--one with the feed on the focus, and one with a feed lateral offset of 41.24 cm (the maximum offset of Figure III-46). Results, for both the principal-plane cuts and the contour plots, are shown in Figures III-49 through III-54. Contour data were then integrated to find the beam efficiency. This result does not include the feed spillover loss and does not include the far-out side-lobes (beyond approximately seven beamwidths) that are not computed by VICTORS and are not given accurately by an aperture integration program. Results were 99.69% at boresight and 99.59% at 41.24-cm offset. These numbers drop to 94.9% and 95.1%, respectively, if spillover is included. Effects of the far-out side-lobes are difficult to predict because they depend on factors such as manufacturing errors that are not easy to model. The 3-dB beamwidths were found to be 0.29 x 0.31 deg at boresight and 0.62 x 0.38 deg at 41.24-cm offset, with the first (x) dimension being along the feed-array axis. Beam spacing with the feed geometry (Fig. III-46) is found to be 0.287 deg.



Legend:

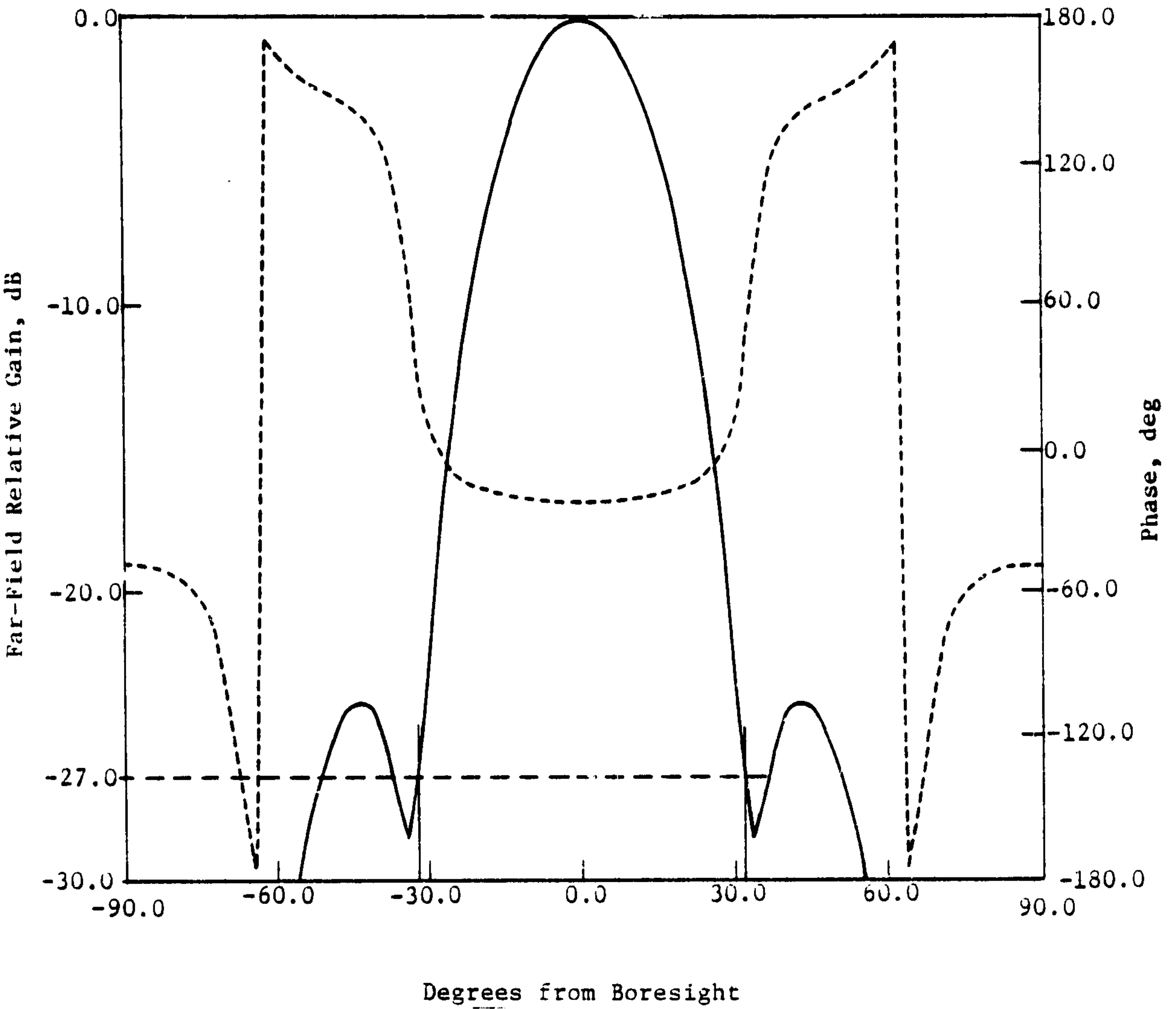
Standard Horn Construction

Horn ID (X-dim) = 2.70 WL
Horn ID (Y-dim) = 1.65 WL
Horn Angle (X-dim) = 12.28 deg
Horn Angle (Y-dim) = 7.58 deg
Peak Gain = 8.16 db
Phi = 90.00 deg

Horn Placement

X 0.000
Y 0.000
Z 0.000

Figure III-47 Feed Horn Pattern - F-Plane



Legend:

Standard Horn Construction

Horn ID (X-dim) = 2.70 WL
Horn ID (Y-dim) = 1.65 WL
Horn Angle (X-dim) = 12.28 deg
Horn Angle (Y-dim) = 7.58 deg
Peak Gain = 8.16 dB
Phi = 0.00 deg

Horn Placement

X 0.000
Y 0.000
Z 0.000

Figure III-48 Feed Horn Pattern - H-Plane

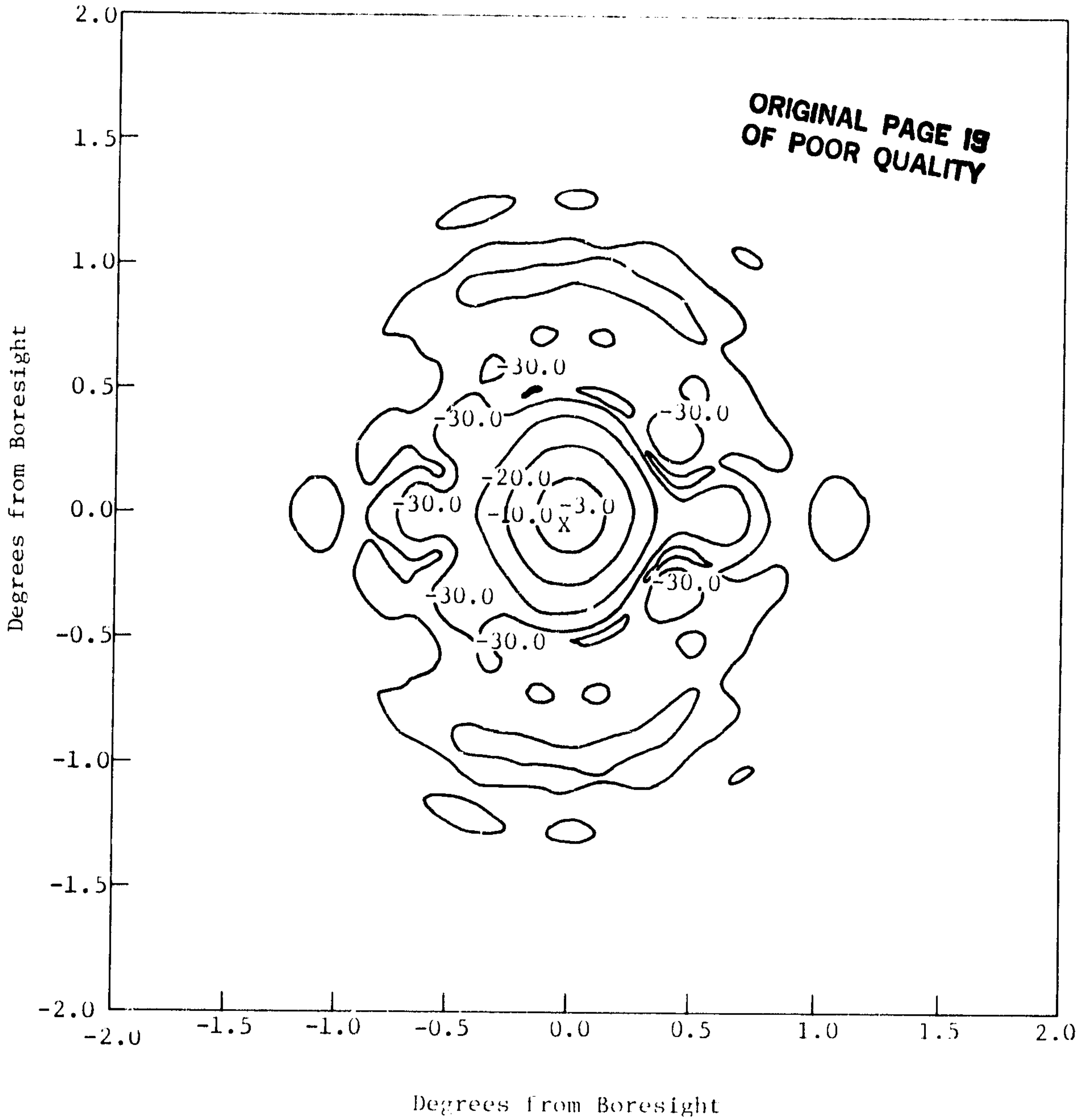


Figure III-49 Contour Plot - On-Axis Beam

Computed secondary patterns are shown in Figures III-49 through III-54. The first three figures show a contour plot and the two principal plane patterns for the on-axis beam. The y axis is the symmetric cut and the x axis is the asymmetric cut given by the offset feeding arrangement. The second three figures show the same patterns for the beam steered 1.61-deg off-axis. As shown, the beam broadens a slightly in the y or nonsteered axis and substantially in the x or steered axis. The coma lobe, at -19 dB, less pronounced than might be expected, and is merged into the main beam as a shoulder lobe. The low level is due to the very high-illumination taper given by the selected feed. The merging of the main and coma lobels is probably due to the feed phase distortion shown in Figure III-47.

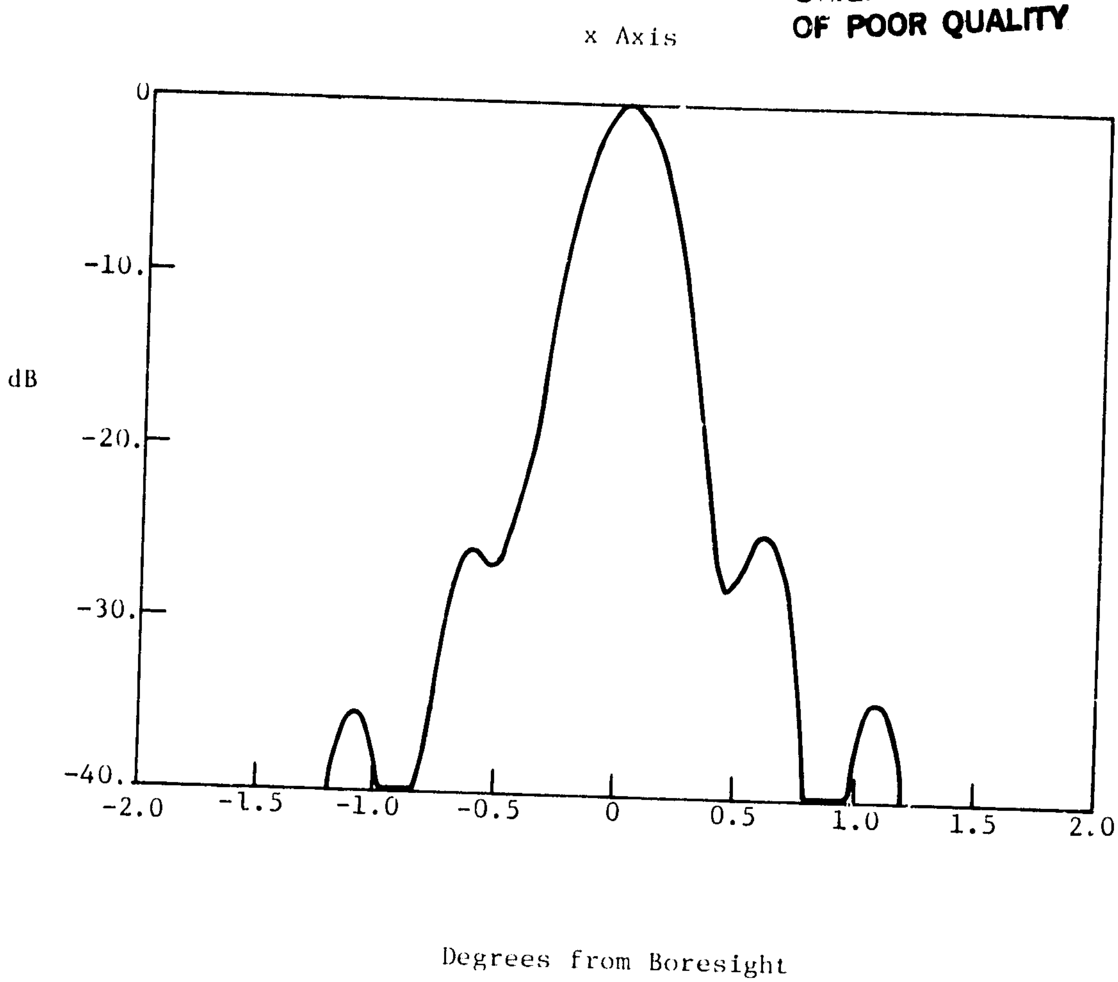


Figure III-50 *Principal Plane, X-Axis, On-Axis Beam*

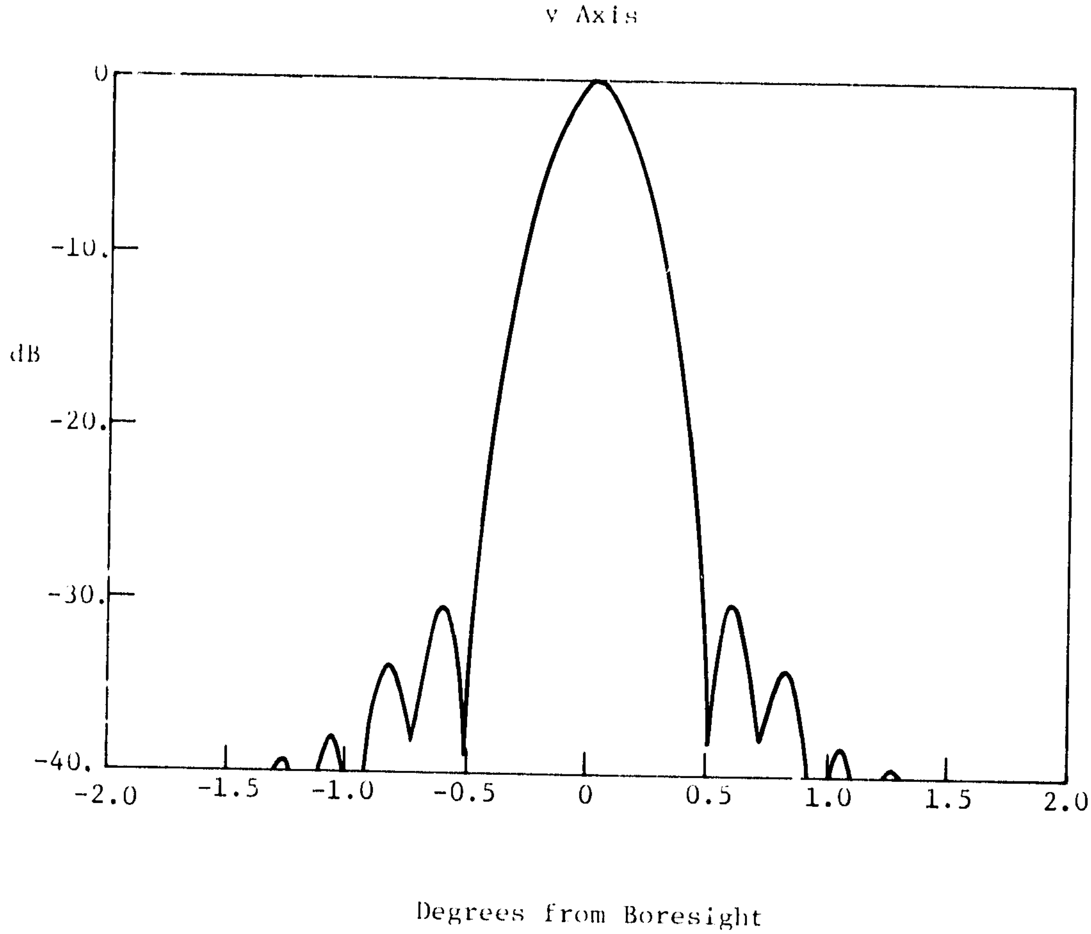


Figure III-51 Principal Plane, Y-Axis, On-Axis Beam

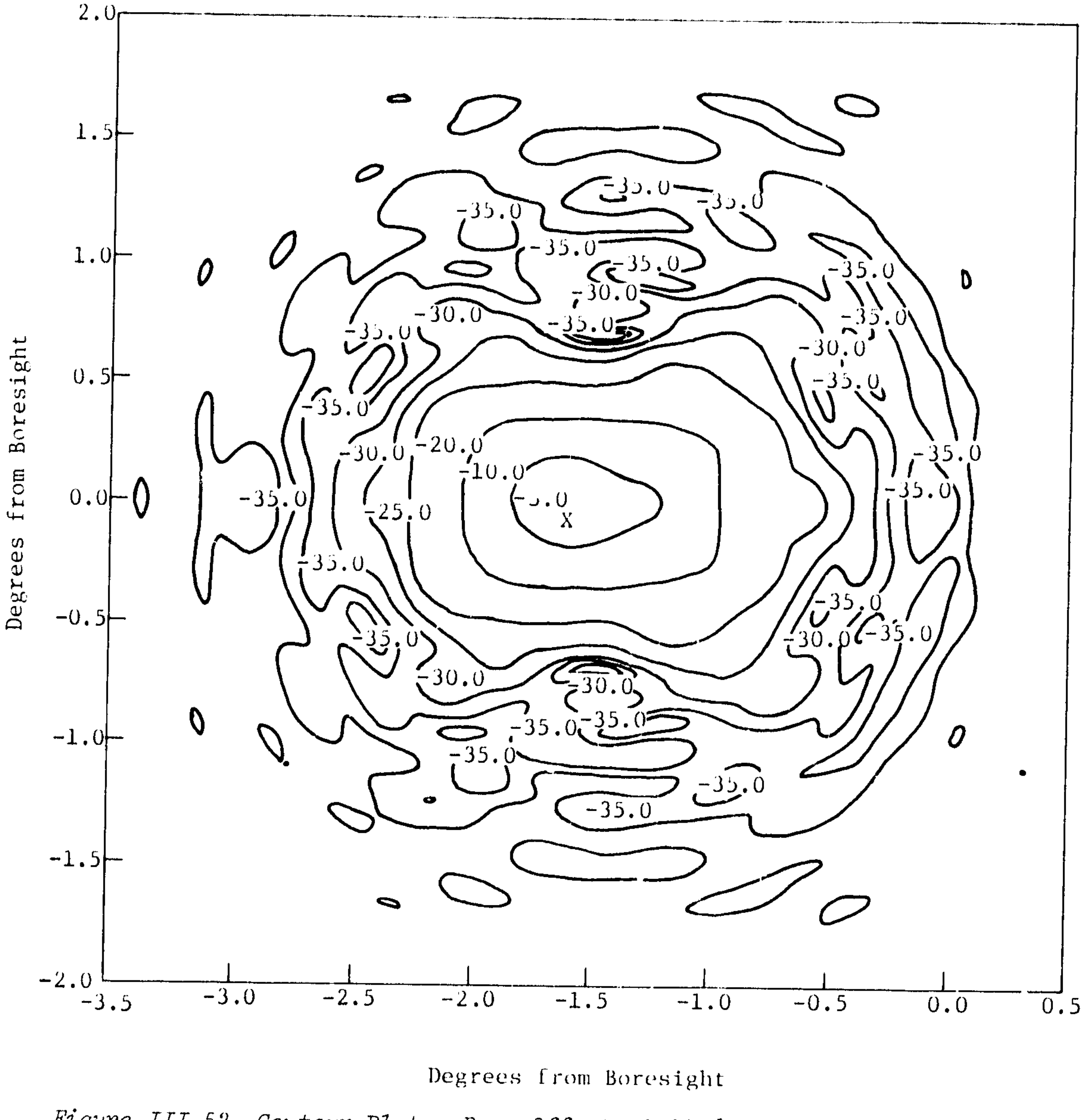


Figure III-52 Contour Plot - Beam Offset -1.61 deg

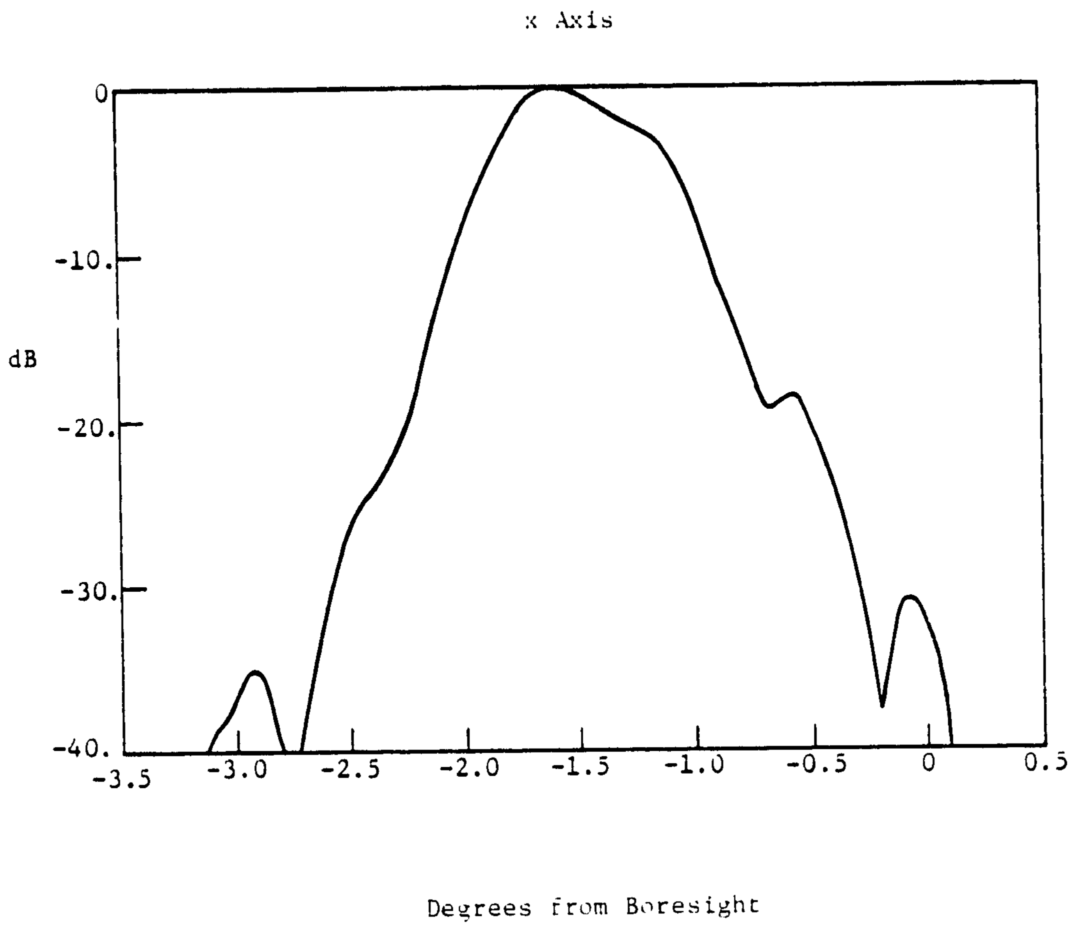


Figure III-53 Principal Plane, X Axis - Beam Offset -1.61 deg

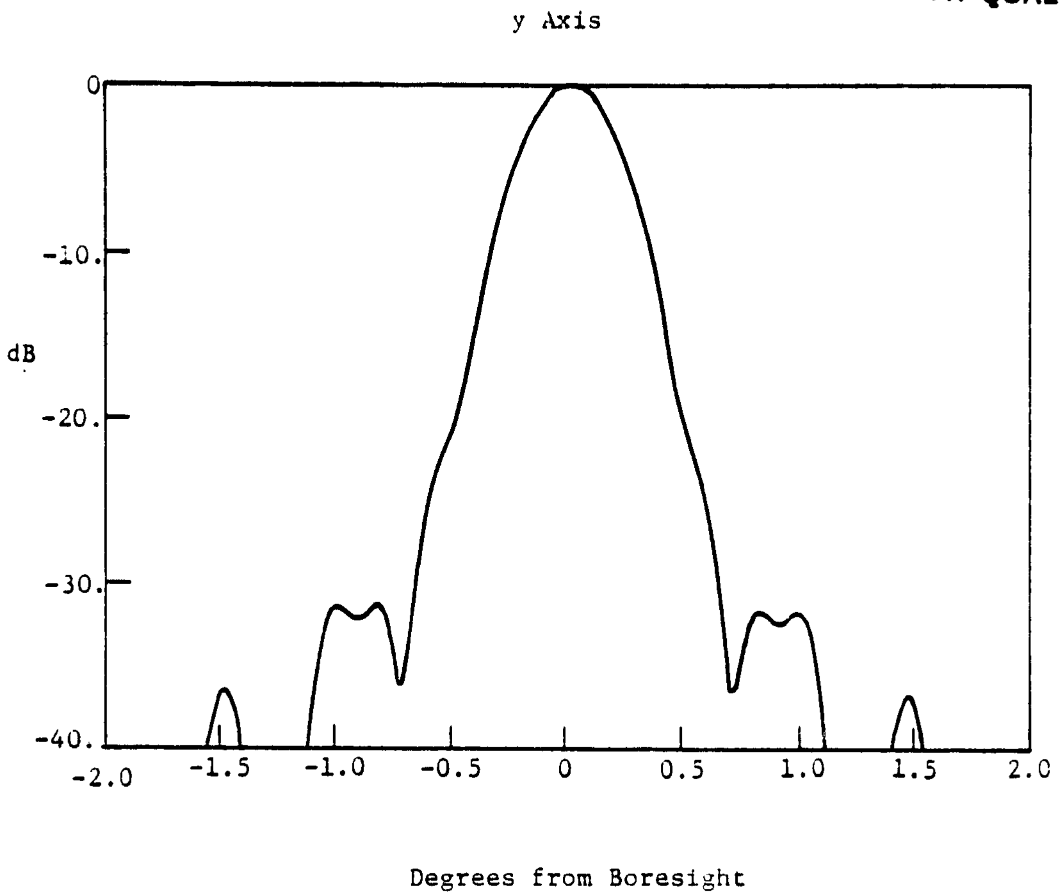


Figure III-54 Principal Plane, Y-Axis, Beam Offset -1.61 deg

Several conclusions can be drawn from these results. First, the horn spacing should be increased slightly. The most important result is the large growth of the x-dimension of the main beam for off-axis beams, reachi- .ble its on-axis dimension at the outer limit of the horn array. This is a problem that is not easily overcome. Assuming, for example, an on-axis beamwidth of 0.26 deg, it is estimated that if the focal length were increased to double the present length of 11.941 meters, the outer beam would have a beamwidth of 0.31 deg across the x axis. This is what would be required to approximate the 0.3-deg specification for all beams. This seems like an undesirable solution to the problem. It would be preferable to go to an aberration-correcting feed system, possibly combined with some increase in the focal length. It is estimated that a simple aberration-correcting feed (consisting of a controlled coupling of a small amount of energy between adjacent horns) could reduce the beamwidth shown in Figure III-43 to around 0.45-deg with an acceptable growth in the side-lobe level. A more detailed analysis would be required to determine the limits of this type of aberration-correcting feed system. The off-axis aberration problem will be much less severe at the lower operating frequencies.

H. RF EVALUATION USING SURFACE CURRENT INTEGRATION TECHNIQUES

To accommodate some of the recommended changes of the aperture distribution analysis, the focal length of the MSDA antenna was increased from 11.94 to 18 meters for the surface current integration analysis. The operating frequency of 4.3 GHz remained unchanged.

The mesh tie-system design remains unchanged, but the coordinates for the upper surface attachment points have been revised. The average drop-cord spacing has changed from 42.8 cm for the 11.94-meter focal-length antenna to 41.3 cm for the 18-meter focal length antenna. The revised reflective mesh coordinates include an rms manufacturing error of 0.60 cm and the 0.067-cm deflection of the attachment point behind the ideal parabolic surface to minimize the rms surface error due to geometric saddling effects (pillowing).

The manufacturing error was randomly added to each reflective mesh coordinate using a Gaussian distribution of N(0, 0.0423).

Patterns determined from the surface current integration analysis used a 2λ (13.95-cm) grid pattern of points on the reflective mesh surface, which included pillowing effects between surface attachment points. The points do not include edge catenary effects. The pillow shape was derived by replacing the cloth on the existing mesh pillow model (Fig. III-26) with actual reflective mesh. The pillow height was measured and then scaled to match the tie-spacing and surface cord tension proposed for the MSDA reflective surface. Knowing the height of the pillow at the center and at the center at each edge, equations were derived that closely approximate the pillow shape. An example of the derived shape is shown in Figure III-55. The pillow height in Figure III-55 has been magnified to show the pillow shape. Actual pillow heights used are in Table III-7. Scaled-pillow heights versus derived-pillow heights at various locations are shown in Figure III-56.

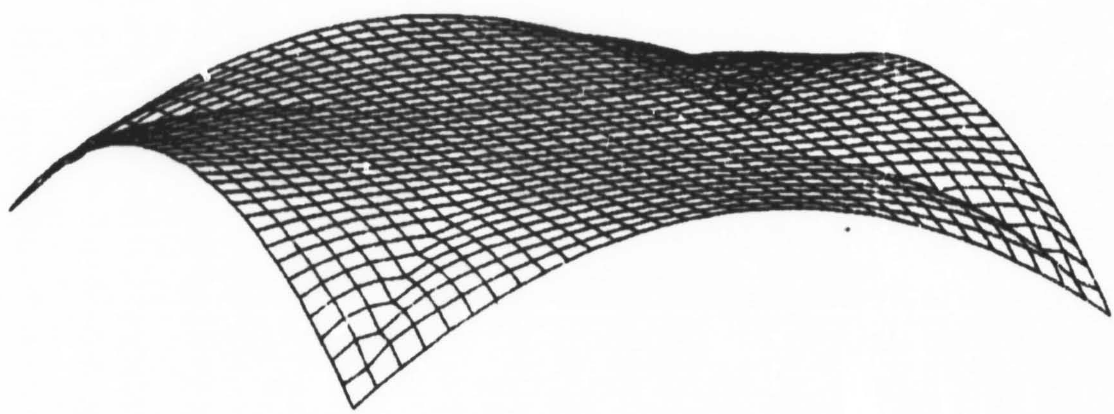


Figure III-55 41.3x41.3-m Pillow Shape

Table III-7 Pillow Heights Used to Derive Pillow Shape

Pillow Type	Size, cm	Height at Center, cm	Height at Center of Edge 1, cm	Height at Center of Edge 2, cm
1 (square)	41.3x41.3	0.038	0.041	0.041
2 (square)	25x25	0.019	0.020	0.020
3 (rectangular)	41.3x25	0.030	0.033	0.025
4 (rectangular)	25x41.3	0.030	0.025	0.33

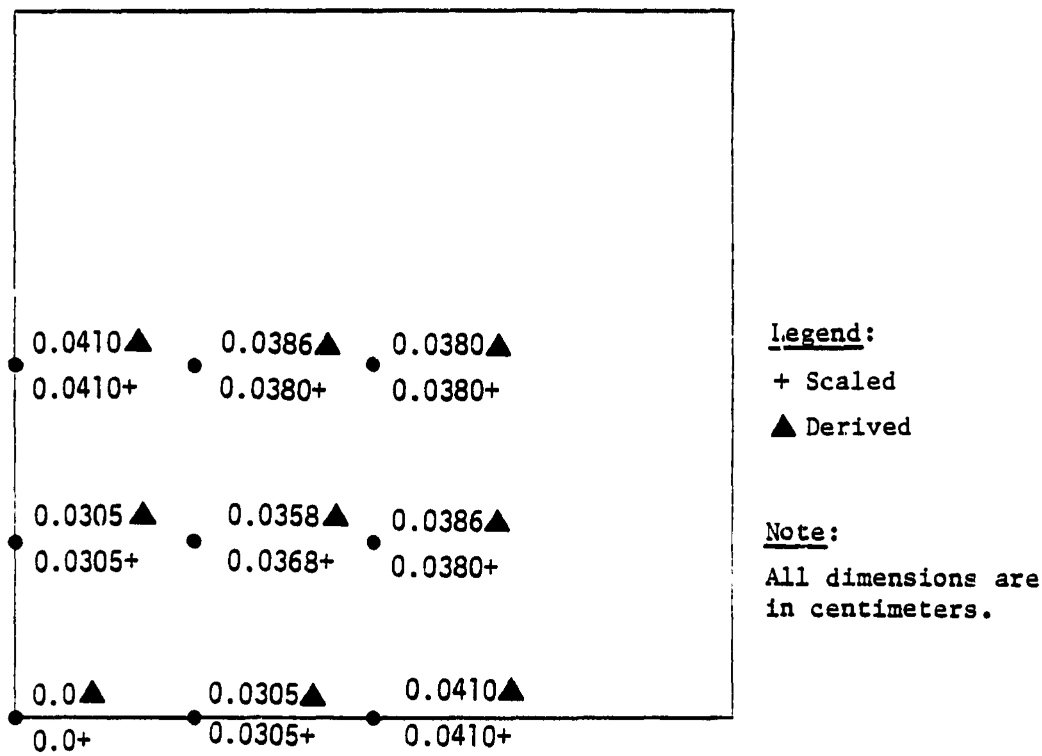


Figure III-56
Scaled Pillow Heights versus Derived Pillow Heights for 41.3x41.3-cm Pillow Shape

Due to the nature of the periodic and nonperiodic surface irregularities on the reflective surface caused by pillowing and manufacturing errors, surface current integration was selected. Surface current integration analysis was performed using Martin Marietta's Fast Integral RF Evaluation (FIRE) computer program. The program comprises a vector

C-2

integration of the surface current density over the reflective surface. This method is superior to the aperture distribution technique because no restraint, e.g., such as parabolic smoothness or only-random surface irregularities, is required.

The 2λ surface sampling used for the MSDA analysis is a rather coarse sample increment. This increment is approximately three times larger than the normal recommended increment. The feed power pattern used was of the form $(\cos[\theta])^{23.274}$, offset 29 deg along the y axis. This gives an illumination edge taper of -8.4 dB.

Several far-field patterns were computed. Principal-plane cuts ±3 deg from boresight were run in the symmetric and asymmetric planes for three reflective surface cases. The cases are (1) an ideal parabolic surface, (2) a surface containing pillowing effects only, and (3) a surface containing pillowing effects plus random manufacturing errors. These patterns are shown in Figures III-57 through 62.

The rms surface error due to pillowing-only and pillowing-plus-random-manufacturing errors is shown in Table III-8. A comparison of the loss in gain due to surface irregularities with that given in the Ruze expression,

$$\text{Loss (db)} = 686 \left(\frac{\zeta}{\lambda}\right)^2,$$

is also presented in Table III-8. As shown, agreement is reasonably good for the pillowing-only surface but not so good for the pillowing-plus-manufacturing surface. This may be explained by the undersampling of the surface. Also, the Ruze expression is only approximate and it assumes random rather than periodic irregularities.

Grating lobes can be generated if the pillowing is repetitive on a rectangular grid. The pillowing assumed for this model is not perfectly regular, but there is a substantial area that is nearly repetitive over the tie spacing of 41.3 cm. This should give a grating lobe in the region of

$$\sin^{-1}(6.975/41.3) = 9.72^{\theta}$$

A portion of the symmetric cut in this region is given in Figure III-63, which shows the patterns associated with the ideal surface and the pillowing-plus-manufacturing surface. The grating lobe is broken up by the surface curvature and the randomness of the surface, but, as shown, there is a region in the vicinity of 9.72 deg where the sidelobe level is significantly higher than that given by the ideal surface.

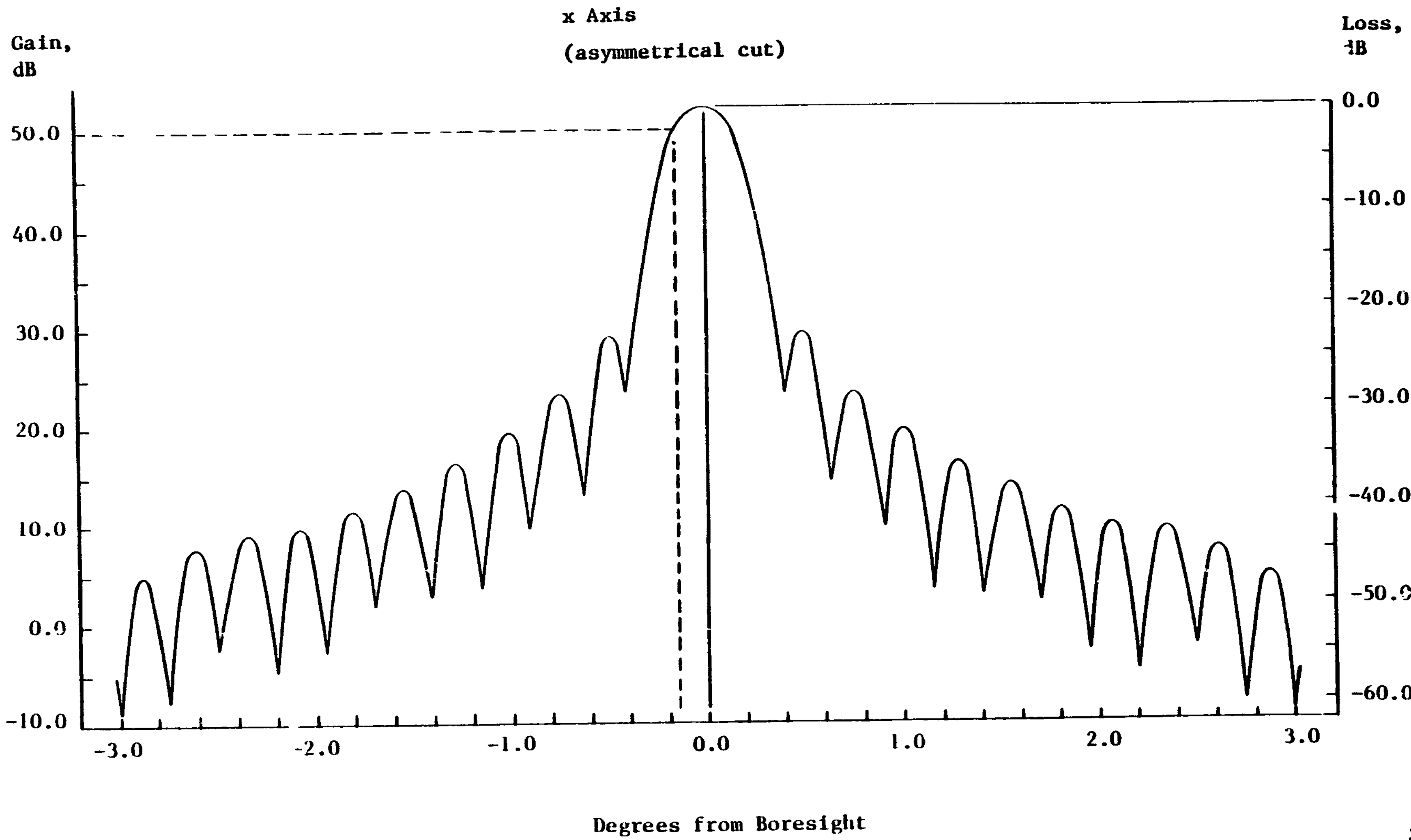


Figure III-57 Principal Plane, Asymmetrical Cut, Ideal Surface

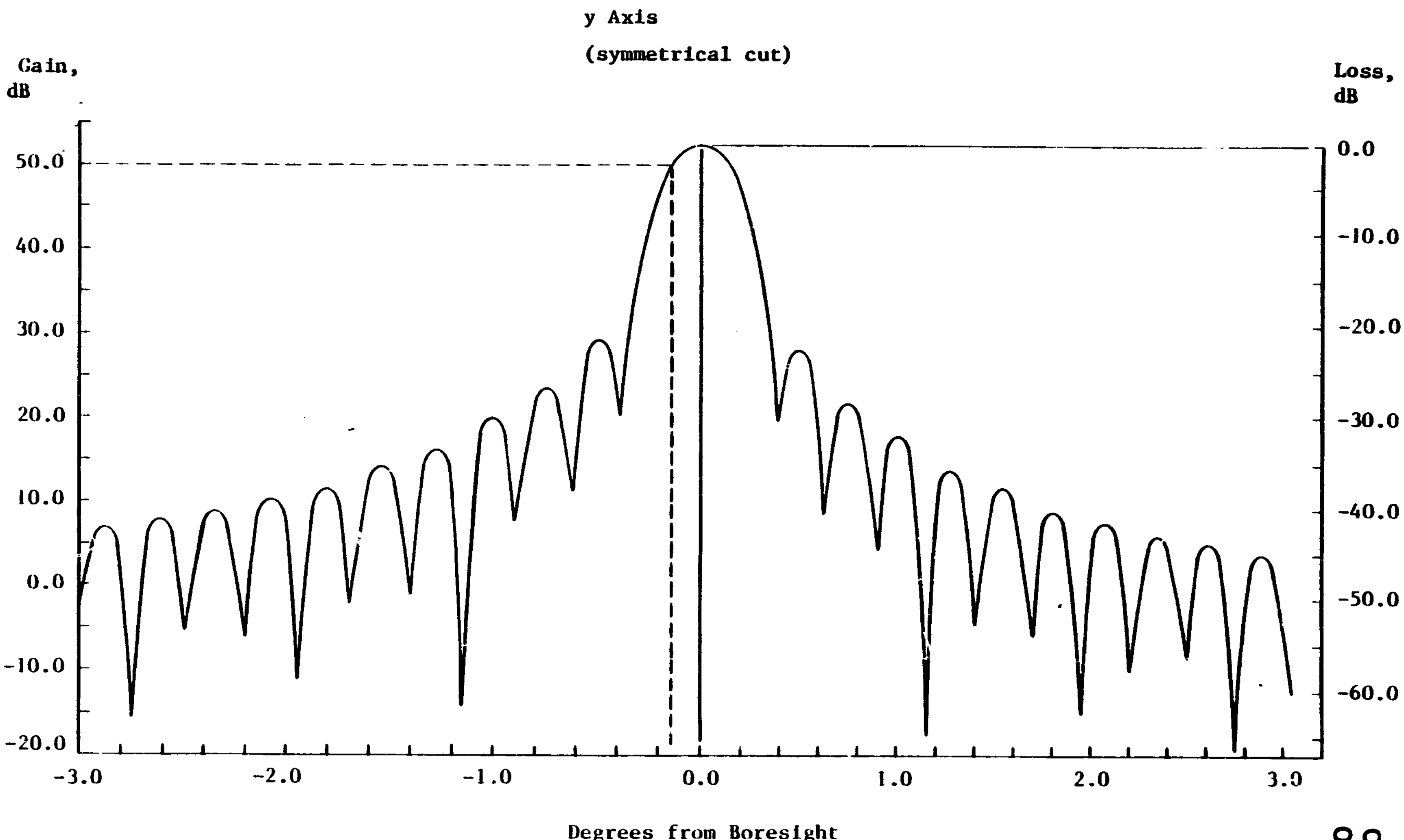


Figure III-58 Principal Plane, Symmetrical Cut, Ideal Surface

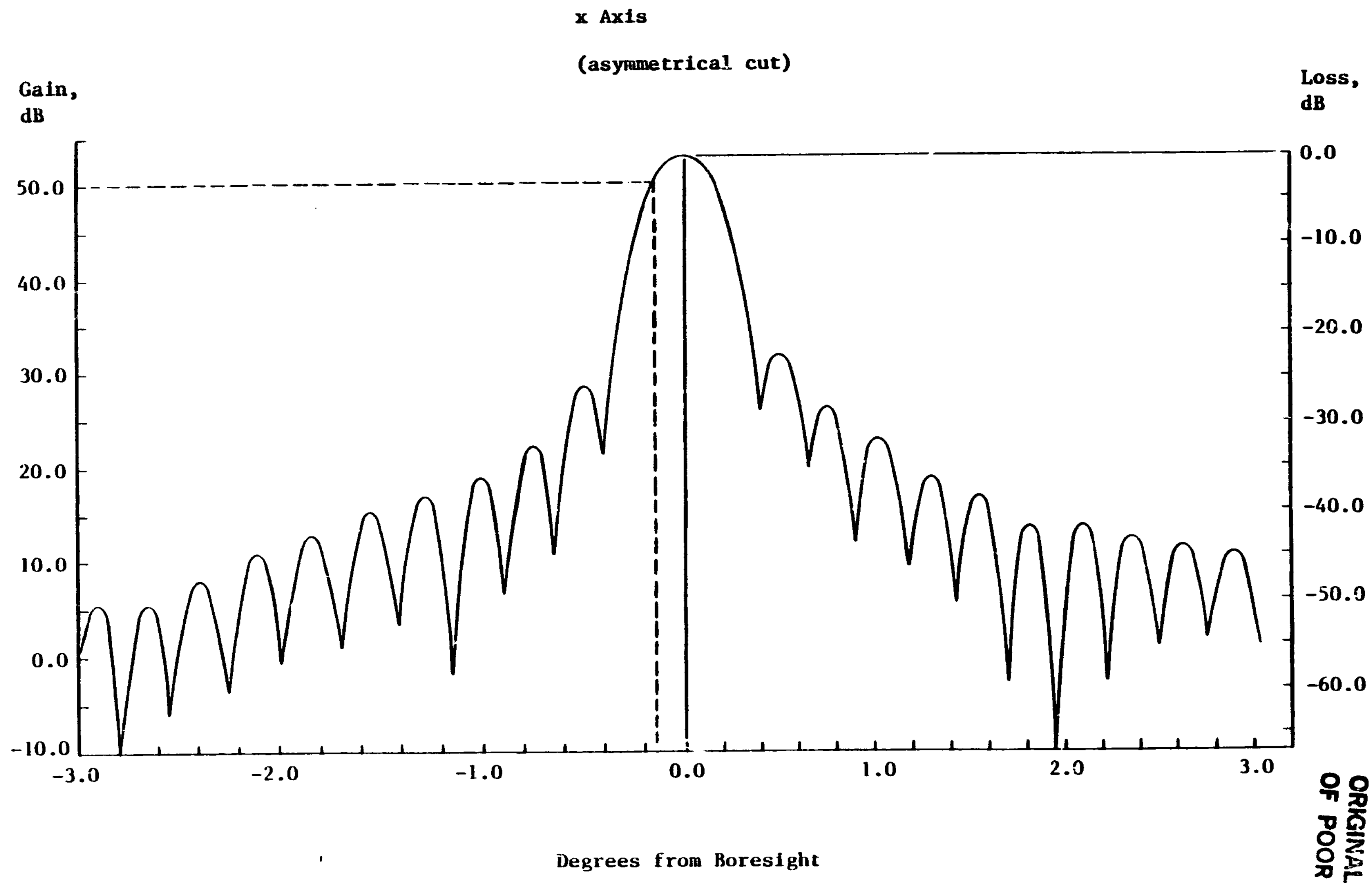


Figure III-59 Principal Plane, Asymmetrical Cut, Pillowing-Only Surface

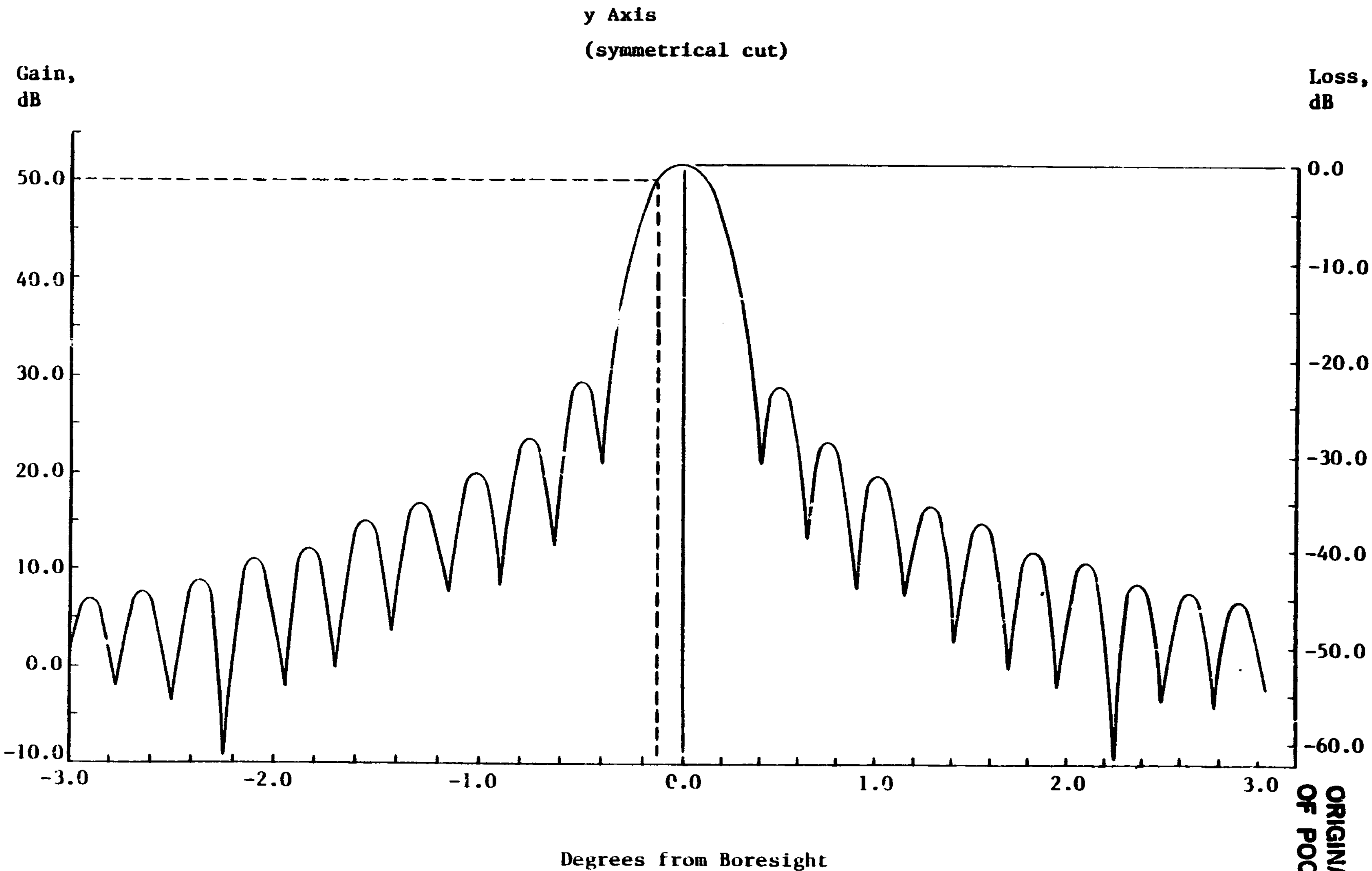


Figure III-60 Principal Plane, Symmetrical Cut, Pillowing-Only Surface

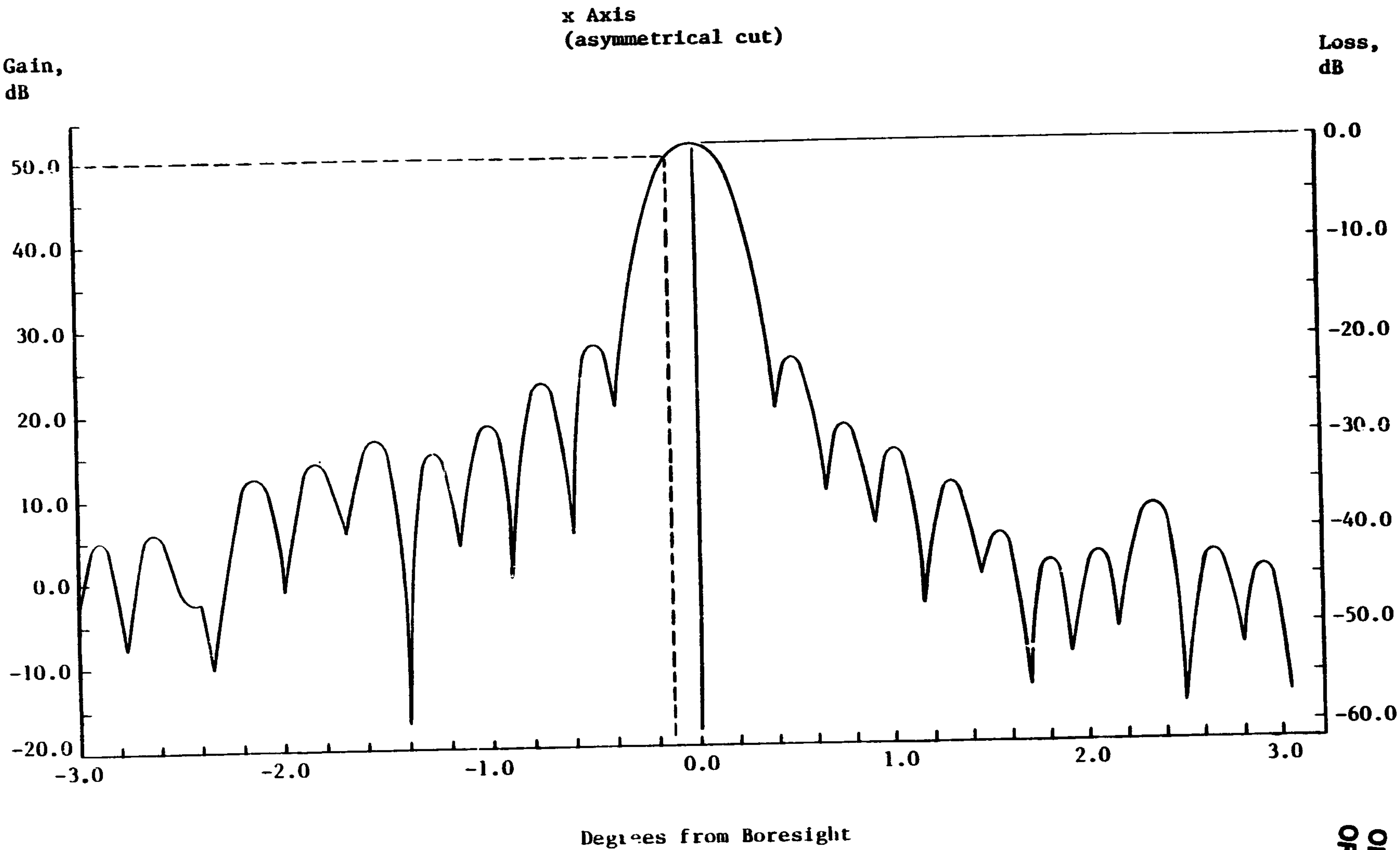


Figure III-61
Principal Plane, Asymmetrical Cut, Pillowing and Manufacturing Surface

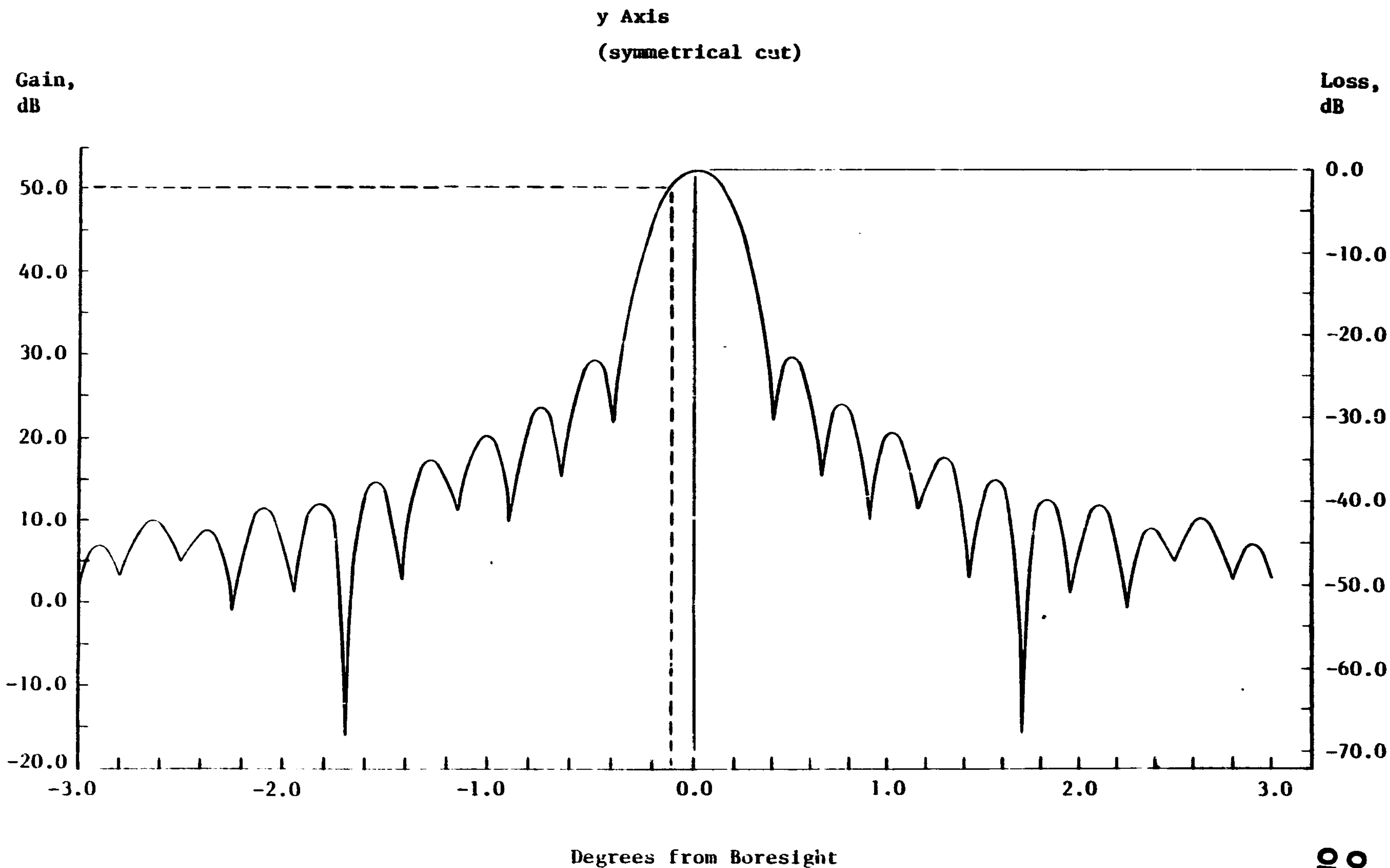


Figure III-62 Principal Plane, Symmetrical Cut, Pillowing and Manufacturing Surface

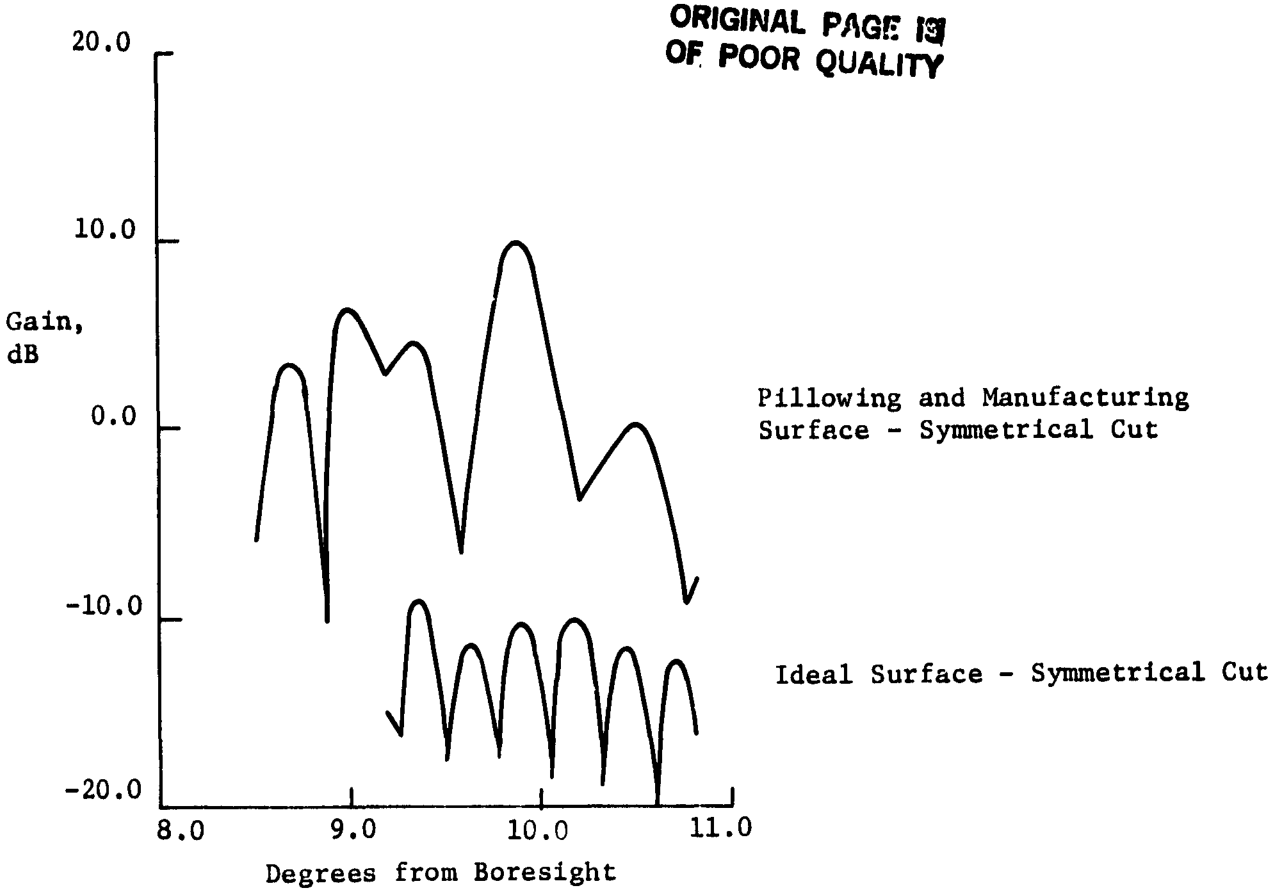


Figure III-63 Grating Lobe of Pillowing and Manufacturing Surface

Table III-8 Gain Loss Due to Surface Irregularities

Surface	σ, RMS Irregularities, cm	Fire Loss, dB	Ruze Loss, dB
Pillows-Only	0.046	0.025	0.029
Pillows-plus-Manufacturing	0.024	0.032	0.076
Note: Wavelength-λ at 4.3 GHz is 6.977 cm.			

An examination of the three symmetrical cuts (Fig. III-58, -60, -62) does not show any unexpected results. The pattern given due to the ideal surface is symmetric with the first side-lobe at -23.2 dB (Fig. III-58). Side-lobes on the pillowing-only surface cut are slightly higher and slightly more irregular, and these differences are accentuated slightly in the pillowing and manufacturing surface cut (Fig. III-60 and III-62, respectively). The ideal surface, asymmetrical cut, shows little asymmetry (Fig. III-57). The asymmetry is more pronounced in the pillowing-only cut (Fig. III-59). The pillowing-plus-manufacturing cut shows an unusual lobe at 2.35 deg (Fig. III-61). This is apparently an artifact of the large sample increment, and would disappear if a smaller increment was used.

I. RECOMMENDATIONS FOR FURTHER STUDY

Five areas of investigation are recommended for further study:

1) Optimization of antenna configuration (focal length and feed design);

2) Spacecraft control system design and angular momentum cancellation device;

3) Refined manufacturing tolerance analysis;

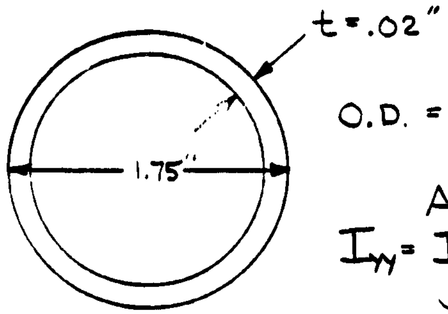
4) Feed integration;

5) Cable integration and rotating joint design for signal and power between S/C and feed.

Appendix A—
Member Properties

MSDA MEMBER DEFINITION

SURFACE MEMBER   MEMBER 1



O.D. = 1.75"

Area = .1087 IN^2
$I_{yy} = I_{zz}$ = .04067 IN^4
J = .08134 IN^4

MEMBER 1

Lay-up [OF/OT$_2$/45F]   T=TAPE
F=FABRIC

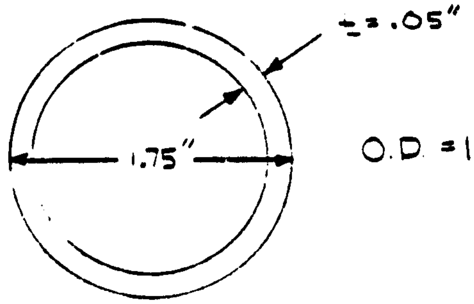
Materials Used
TAPE - PITCH75
FABRIC - T300

E_L = 24 MSI
E_T = 4.2 MSI
G_{LT} = 1.9 MSI
ν_{LT} = 0.193
CTE_L = -0.14×10^{-6} IN/IN/F°
ε_{ULT} = .001 IN/IN
$F_{TU} = F_{CU}$ = 24 KSI

E_L = LONGITUDINAL MODULUS
E_T = TRANSVERSE MODULUS
G_{LT} = SHEAR MODULUS
ν_{LT} = POISSON'S RATIO
CTE_L = COEFFICIENT OF THEMAL EXPANSION IN LONGITUDINAL DIR.

MSDA MEMBER DEFINITION

SURFACE MEMBER   MEMBER 2



O.D. = 1.75"

Area = .2670 IN^2

$I_{yy} = I_{zz}$ = .0965 IN^4

J = .1931 IN^4

MEMBER 2

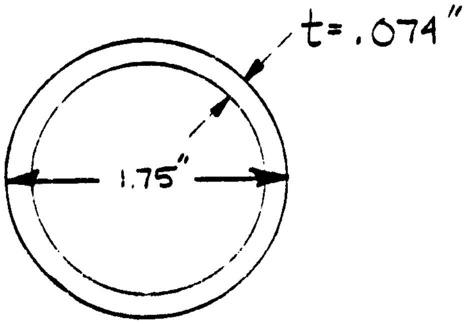
Lay-up [45F/0T₂/0F/0T₂/0F/0T₂/45F]   T= TAPE
F= FABRIC

Materi 's Used
TAPE - PITCH 75
FABRIC - T300

E_L = 27.06 MSI
E_T = 3.51 MSI
G_{LT} = 1.67 MSI
ν_{LT} = 0.198
CTE_L = -0.21×10^{-6} IN/IN/F°
$\varepsilon_{u,T}$ = .001 IN/IN
$F_{Tu} = F_{cu}$ = 27 KSI

MSDA MEMBER DEFINITION

SURFACE MEMBER   MEMBER 3



AREA = .3896 IN^2

$I_{YY} = I_{ZZ} =$ .1371 IN^4

J = .2741 IN^4

MEMBER 3

Lay-up [45F/0T₂/0F/0T₂/0F/0T/0F/0T₂/0F/0T₂/45F]

Materials Used

TAPE - PITCH 75

FABRIC - T300

$E_L = 27.25 \times 10^6$ psi

$E_T = 3.65 \times 10^6$ psi

$G_{LT} = 1.53 \times 10^6$ psi

$\nu_{LT} = .154$

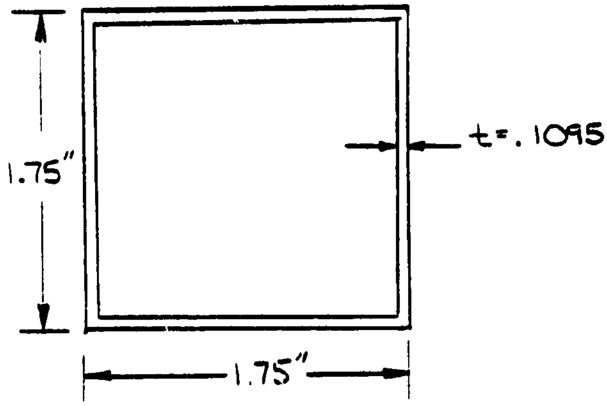
$CTE_L = -.186 \times 10^{-6}$ IN/IN/F°

$\varepsilon_{ULT} = .001$

$F_{TU} = F_{CU} = 27$ KSI

MSDA MEMBER DEFINITION

SURFACE MEMBER — MEMBER 4



Area = .7185 IN^2

$I_{yy} = I_{zz}$ = .3237 IN^4

J = .4834 IN^4

MEMBER 4

Lay-up $[45F/(0T_2/0F)_6/0T_2/45F]$

Material Used

TAPE - PITCH

FABRIC - T300

E_L = 28.36 × 10^6 psi

E_T = 3.44 × 10^6 psi

G_{LT} = 1.39 × 10^6 psi

ν_{LT} = 0.136

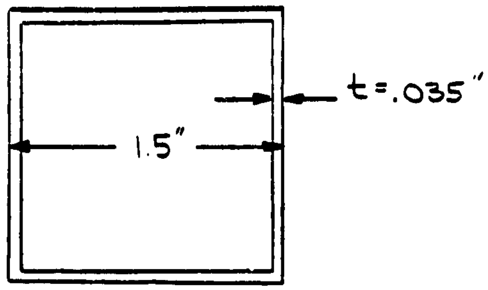
CTE_L = −0.20 × 10^{-6} IN/IN/F°

ε_{ULT} = .001

$F_{tu} = F_{cu}$ = 28 KSI

MSDA MEMBER DEFINITION

VERTICAL MEMBER — MEMBER 10



Area = .2051 IN^2
$I_{yy} = I_{zz}$ = .0734 IN^4
J = .1100 IN^4

MEMBER 10

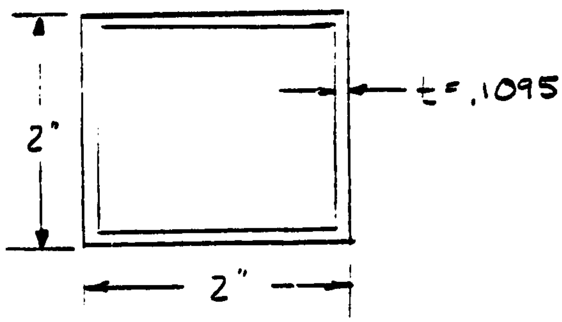
Lay-up [45F/0T_2/90F/0T_2/45F]

Material Used
TAPE - PITCH 75
FABRIC - T300

E_L = 25.99 MSI
E_T = 3.58 MSI
G_{LT} = 1.89 MSI
ν_{LT} = 0.243
CTE_L = -0.21×10^{-6} IN/IN/F°
ε_{ULT} = .001 IN/IN
F_{tu} = F_{cu} = 26 KSI

MSDA MEMBER DEFINITON
VERTICAL MEMBER

MEMBER 11



AREA = .8280 IN^2

$I_{yy} = I_{zz} = .495\ IN^4$

$J = .7399\ IN^4$

MEMBER 11

Lay-up $[45F/(0T_2/0F)_6/0T_2/45F]$

Material Used

TAPE - PITCH

FABRIC - T300

$E_L = 28.36 \times 10^6$ psi

$E_T = 3.44 \times 10^6$ psi

$G_{LT} = 1.39 \times 10^6$ psi

$\nu_{LT} = .136$

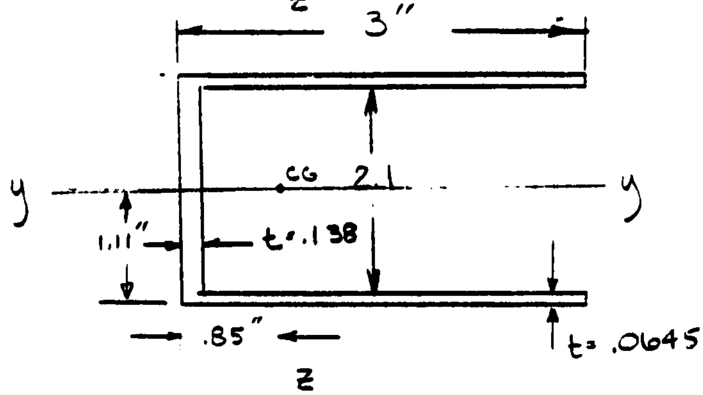
$CTE_L = -0.20 \times 10^{-6}$ IN/IN/F°

$\varepsilon_{ULT} = .001$

$F_{TU} = F_{CU} = 28$ KSI

MSDA MEMBER DEFINITION
CHANNEL MEMBER

MEMBER 20



Area = .6569 IN^2 (NORMALIZED TO E = 27.4 MSI)
I_{yy} = .5352 IN^4 I_{zz} = .6074 IN^4
J ≅ .00062 IN^4

MEMBER 20

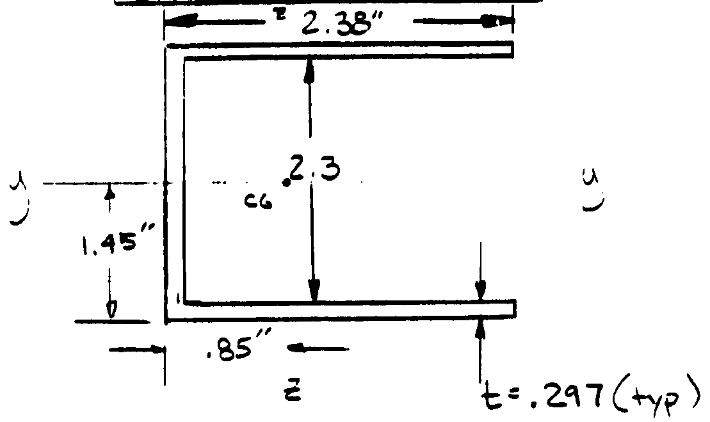
Lay-up Flange [45F/0T_2/90F/0T_2/45F/0T_2/90F/0T_2/45F]
Web [(45F/0T_2/90F/0T_2/45F$)_4$]

Material Used
TAPE - PITCH 75
FABRIC - T300

Flange
E_L = 27.4 MSI
E_T = 3.34 MSI
G_{LT} = 1.7 MSI
ν_{LT} = .225
CTE_L = -0.23×10^{-6} IN/IN/F°
ε_{ULT} = .001
$F_{TU} = F_{CU}$ = 27 KSI

Web
E_L = 25.99 MSI
E_T = 3.58 MSI
G_{LT} = 1.9 MSI
ν_{LT} = .243
CTE_L = -0.21×10^{-6} IN/IN/F°
ε_{ULT} = .001
$F_{TU} = F_{CU}$ = 26 KSI

MSDA MEMBER DEFINITION
CHANNEL MEMBER



MEMBER 21

Area = 2.097 IN^2
I_{yy} = 2.694 IN^4 I_{zz} = 1.172 IN^4
J = .0617 IN^4

MEMBER 21

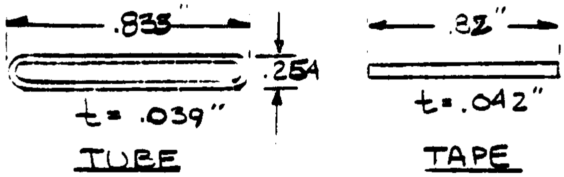
Lay-up $[(45F/0T_2/0F/0T_2/0F/0T_2/45F)_6]$

Materials Used
TAPE - PITCH 75
FABRIC - T300

E_L = 27.06 MSI
E_T = 3.51 MSI
G_{LT} = 1.67 MSI
ν_{LT} = .198
$CTE_L = -0.21 \times 10^{-6}$ IN/IN/F°
ε_{ULT} = .001
$F_{TU} = F_{CU}$ = 27 KSI

MSDA MEMBER DEFINITION

INTERIOR TELESCOPING DIAGONAL MEMBER — MEMBER 30



Area of Tube = .0787 IN^2
Area of Tape = .0344 IN^2
$Area_{eff}$ = .0629 IN^2 *
E_{eff} = 14.137 × 10^6 psi *
ρ_{eff} = .0561 LB/IN^3 *
64.5% TUBE LENGTH
35.5% TAPE LENGTH
CTE_{eff} = 0.186 × 10^{-6} IN/IN/F° *
T = TAPE

MEMBER 30

TUBE

Lay-up [90F/0T_2/90F/0T_2/90F]

Material Used
TAPE - T300
FABRIC - T300

E_L = 14.72 MSI
E_T = 4.45 MSI
G_{LT} = 1.24 MSI
ν_{LT} = 0.087
CTE_L = 0.367 × 10^{-6} IN/IN/F°
ε_{ULT} = .0045
F_{TU} = F_{CU} = 66 KSI

* $Area_{eff}$, E_{eff}, ρ_{eff} and CTE_{eff} are combination of Tube & Tape in a 64.5/35.5 ratio by length

TAPE

T = TAPE
F = FABRIC

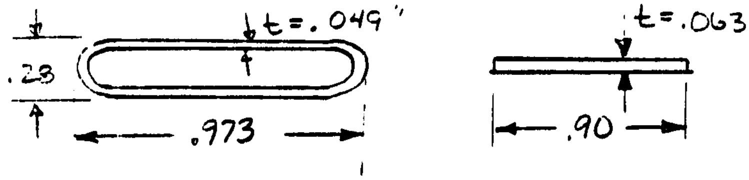
Lay-up [0T/90F/0T/90F/0T_2/90F/0T/90F/0T]

Material Used
TAPE - PITCH 75
FABRIC - T300

E_L = 27.54 MSI
E_T = 3.97 MSI
G_{LT} = 1.26 MSI
ν_{LT} = 0.0734
CTE_L = -0.15 × 10^{-6} IN/IN/F°
ε_{ULT} = .001
F_{TU} = F_{CU} = 28 KSI

MCDA MEMBER DEFINITION

INTERIOR TELESCOPING DIAGONAL MEMBER — MEMBER 31



Area of Tube = .1132 IN^2
Area of Tape = .0567 IN^2
A_{eff} = .09314 IN^2 *
E_{eff} = 17.17×10^6 psi *
64.5% TUBE LENGTH
35.5% TAPE LENGTH
CTE_{eff} = 0.187 $\times 10^{-6}$ IN/IN/F° *
ρ_{eff} = .056 LB/IN^3 *

MEMBER 31

TUBE

Lay-up [90T/0T/0T*/90T/0T*/90T/0T*/0T/90T]

T = TAPE

Materials Used
TAPE - T300
TAPE * - PITCH 75

* $Area_{eff}$, E_{eff}, ρ_{eff} and CTE_{eff} are combination of Tube and Tape in a 64.5/35.5 ratio by length.

E_L = 16.99 MSI
E_T = 8.76 MSI
G_{LT} = .65 MSI
ν_{LT} = 0.039
CTE = 0.37 $\times 10^{-6}$ IN/IN/F°
ε_{ULT} = .001
F_{tu} = F_{cu} = 17 KSI

TAPE

T = TAPE
F = FABRIC

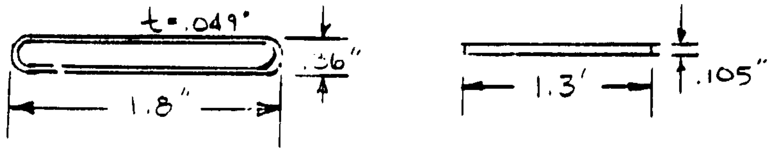
Lay-up [0T/90F/0T/90F/$0T_2$/90F/0T/90F/$0T_2$/90F/0T/90F/0T]

Materials Used
TAPE - PITCH 75
FABRIC - T300

E_L = 27.54 MSI
E_T = 3.97 MSI
G_{LT} = 1.26 MSI
ν_{LT} = 0.0734
CTE_L = -0.15×10^{-6} IN/IN/F°
ε_{ULT} = .001
F_{tu} = F_{cu} = 28 KSI

MSDA MEMBER DEFINITION

INTERIOR TELESCOPING DIAGONAL MEMBER — MEMBER 32



Area of Tube = .262 IN^2
Area of Tape = .1365 IN^2
A_{eff} = .17738 *
E_{eff} = 19.96 E6 *
64.5 % TUBE LENGTH
35.5 % TAPE LENGTH
CTE_{eff} = 0.187×10^{-6} IN/IN/F° ρ_{eff} = .057 LB/IN^3

MEMBER 32

TUBE

Lay-up [90T/0T/0T*/90T/0T*/90T/0T*/0T/90T]

Material Used
TAPE - T300
TAPE* - PITCH 75

E_L = 16.99 MSI
E_T = 8.76 MSI
G_{LT} = .65 MSI
ν_{LT} = 0.039
CTE_L = 0.37×10^{-6} IN/IN/F°
ε_{ULT} = .001
F_{TU} = F_{CU} = 17 KSI

* $Area_{eff}$, E_{eff}, ρ_{eff} and CTE_{eff}, are combination of Tube and Tape in a 64.5/35.5 ratio by length

TAPE

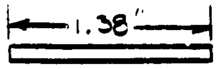
Lay-up [(0T/90F/0T/90F/0T)$_S$]

Material Used
TAPE - PITCH 75
FABRIC - T300

E_L = 27.54 MSI
E_T = 3.97 MSI
G_{LT} = 1.26 MSI
ν_{LT} = 0.0734
CTE_L = -0.15×10^{-6} IN/IN/F°
ε_{ULT} = .001
F_{TU} = F_{CU} = 28 KSI

MSDA MEMBER DEFINITION

NON-DEPLOYED INTERIOR DIAGONAL — MEMBER 33



t = .042" — Area = .05796 IN^2

MEMBER 33

Lay-up [0T/90F/0T/90F/$0T_2$/90F/0T/90F/0T]

Material Used

TAPE - PITCH 75

FABRIC - T300

E_L = 27.54 MSI

E_T = 3.97 MSI

G_{LT} = 1.26 MSI

ν_{LT} = 0.0734

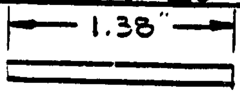
CTE_L = -0.15×10^{-6} IN/IN/F°

ε_{ult} = .001

F_{TU} = F_{CU} = 28 KSI

MSDA MEMBER DEFINITION

NON-DEPLOYED INTERIOR DIAGONAL **MEMBER 34**



$t = .084$ Area = .1159 IN^2

MEMBER 34

Lay-up $[(0T/90F/0T/90F/0T)_4]$

Material Used

TAPE - PITCH 75

FABRIC - T300

E_L = 27.54 MSI

E_T = 3.97 MSI

G_{LT} = 1.26 MSI

ν_{LT} = 0.0734

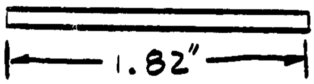
CTE_L = -0.15×10^{-6} IN/IN/F°

ε_{ULT} = .001

$F_{TU} = F_{CU}$ = 28 KSI

MSDA MEMBER DEFINITION

NON-DEPLOYED INTERIOR DIAGONAL MEMBER 35



t = .12

Area = .2184 IN²

MEMBER 35

Lay-up $[(CT/90F/0T_2/90F/0T)_4]$

Material Used

TAPE - PITCH 75

FABRIC - T300

E_L = 29.37 MSI

E_T = 3.43 MSI

G_{LT} = 1.165 MSI

ν_{LT} = .0825

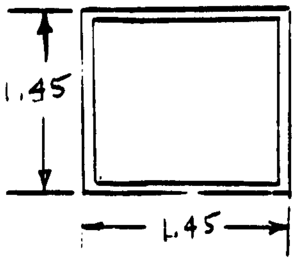
CTE_L = -0.195×10^{-6} IN/IN/F°

ε_{ULT} = .001

F_{tu} = F_{cu} = 29 KSI

MSDA MEMBER DEFINITION

NON-DEPLOYED INTERIOR DIAGONAL — MEMBER 36



Area = .5649 IN^2

MEMBER 36

Lay-up $[(45F/0T_2/90F/0T_2/45F)_3]$

Material Used

TAPE - PITCH 75

FABRIC - T300

E_L = 25.99 MSI

E_T = 3.59 MSI

G_{LT} = 1.89 MSI

ν_{LT} = 0.243

CTE_L = -0.21×10^{-6} IN/IN/F°

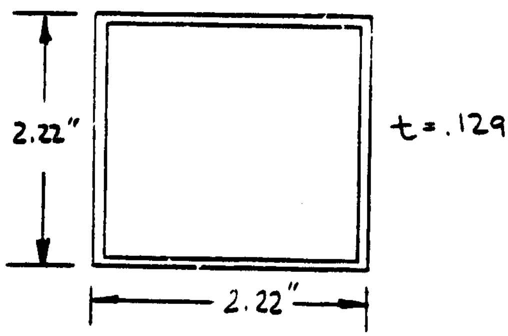
ε_{ULT} = .001

F_{TU} = F_{CU} = 26 KSI

ORIGINAL PAGE IS
OF POOR QUALITY

MSCA MEMBER DEFINITION

NON-DEPLOYED INTERIOR DIAGONAL MEMBER 37



Area = 1.08 IN^2

MEMBER 37

Lay-up $[45F/(0T_2/90F/0T_2/90F)_4/45F]$

Material Used

TAPE - PITCH 75

FABRIC - T300

E_L = 27.8 MSI

E_T = 3.68 MSI

G_{LT} = 1.40 MSI

ν_{LT} = .121

$CTE_L = -0.182 \times 10^{-6}$ IN/IN/F°

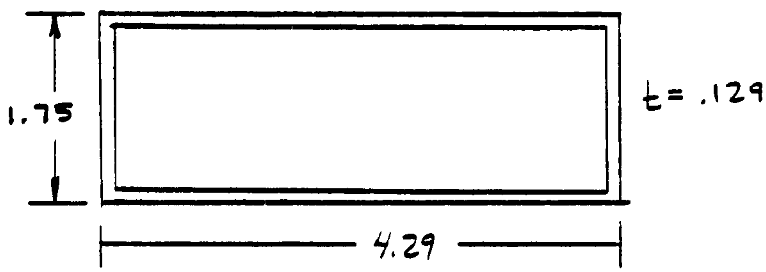
ε_{ULT} = .001

$F_{TU} = F_{CU}$ = 28 KSI

ORIGINAL PAGE IS
OF POOR QUALITY

MSCA MEMBER DEFINITION

NON-DEPLOYED INTERIOR DIAGONAL MEMBER 38



Area = 1.49 IN^2

MEMBER 38

Lay-up $[45F/(0T_2/90F/0T_2/90F)_4/45F]$

Material Used

TAPE - PITCH 75

FABRIC - T300

E_L = 27.8 MSI

E_T = 3.68 MSI

G_{LT} = 1.40 MSI

ν_{LT} = .121

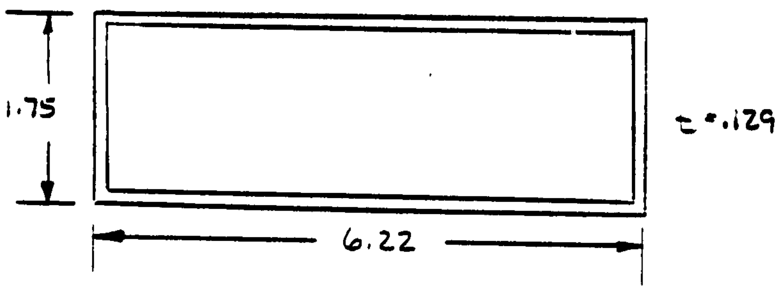
CTE_L = -0.182×10^{-6} IN/IN/F°

ε_{ult} = .001

F_{tu} = F_{cu} = 28 KSI

MSDA MEMBER DEFINITION

NON-DEPLOYED INTERIOR DIAGONAL — MEMBER 39



Area = 1.99 IN^2

MEMBER 39

Lay-up $[45F/(0T_2/90F/0T_2/90F)_4/45F]$

Material Used

TAPE - PITCH 75

FABRIC - T300

E_L = 27.8 MSI

E_T = 3.68 MSI

G_{LT} = 1.40 MSI

ν_{LT} = .121

CTE_L = -0.182×10^{-6} IN/IN/F°

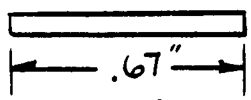
ε_{uLT} = .001

F_{tu} = F_{cu} = 28 KSI

MSDA MEMBER DEFINITION

EXTERIOR DIAGONAL

MEMBER 40



t = .021

Area = .0141 IN^2

MEMBER 40

Lay-up [0T/90F/0T/90F/0T]

Material Used

TAPE – PITCH75

FABRIC – T300

E_L = 27.54 MSI

E_T = 3.97 MSI

G_{LT} = 1.26 MSI

ν_{LT} = 0.0734

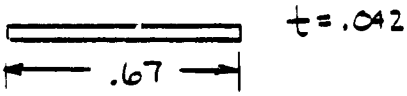
$CTE_L = -0.15 \times 10^{-6}$ IN/IN/F°

ε_{ULT} = .001

$F_{TU} = F_{CU}$ = 28 KSI

MSDA MEMBER DEFINITION

EXTERIOR DIAGONAL   MEMBER 41



Area = .02814 IN^2

MEMBER 41

Lay-up [OT/90F/OT/90F/OT_2/90F/OT/90F/OT]

Material Used

TAPE - PITCH 75

FABRIC - T300

E_L = 27.54 MSI

E_T = 3.97 MSI

G_{LT} = 1.26 MSI

ν_{LT} = 0.0734

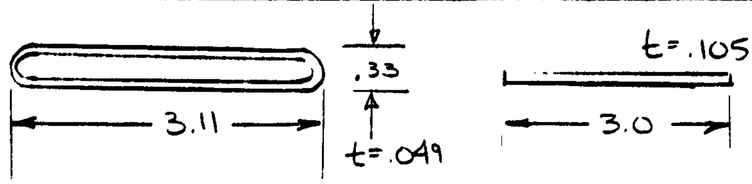
CTE_L = -0.15×10^{-6} IN/IN/F°

ε_{ULT} = .001

F_{TU} = F_{CU} = 28 KSI

MSDA MEMBER DEFINITION

HALF-DEPLOYED EXTERIOR DIAGONAL — MEMBER 42



Area of Tube = .328 IN^2

Area of Tape = .315 IN^2

A_{eff} = .3215 IN^2 *

E_{eff} = 21.1 $\times 10^6$ psi *

50% TUBE LENGTH
50% TAPE LENGTH

ρ_{eff} = .05769 LB/IN^3 *

MEMBER 42

TUBE

Lay-up [90T/0T/0T*/90T/0T*/90T/0T*/0T/90T]

Materials Used
TAPE - T300
TAPE* - PITCH 75

E_L = 16.99 MSI
E_T = 8.76 MSI
G_{LT} = .65 MSI
ν_{LT} = 0.039
CTE_T = 0.37 $\times 10^{-6}$ IN/IN/F°
ε_{ult} = .001
$F_{tu} = F_{cu}$ = 17 KSI

* A_{eff}, E_{eff} and ρ_{eff} are combination of Tube and Tape in a 50.0/50.0 ratio by length

TAPE

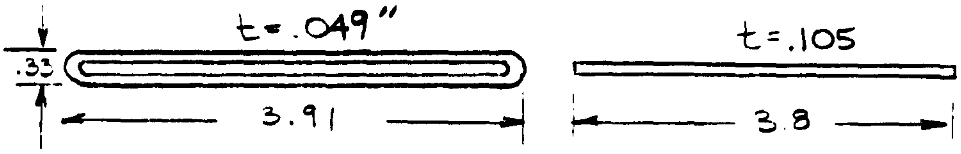
Lay-up [(0T/90F/0T/90F/0T$)_5$]

Materials Used
TAPE - PITCH 75
FABRIC - T300

E_L = 27.54 MSI
E_T = 3.97 MSI
G_{LT} = 1.26 MSI
ν_{LT} = 0.0734
CTE_L = −0.15 * 10^{-6} IN/IN/F°
ε_{ult} = .001
$F_{tu} = F_{cu}$ = 28 KSI

MSDA MEMBER DEFINITION

HALF-DEPLOYED EXTERIOR DIAGONAL — MEMBER 43



Area of Tube = .406 IN^2
Area of Tape = .399 IN^2
A_{eff} = .402 IN^2 *
E_{eff} = 26.6×10^6 psi *
ρ_{eff} = .0578 LB/IN^3 *
50% Tube Length
50% Tape Length

MEMBER 43

TUBE

Lay-up $[90F/0T_2/45F/0T/45F/0T_2/90F]$

Material Used
- FABRIC T300
- TAPE PITCH 75

$E_L = 25.74 \times 10^6$ psi
$E_T = 3.94 \times 10^6$ psi
$G_{LT} = 1.79 \times 10^6$ psi
$\nu_{LT} = .196$
$CTE_L = -0.176 \times 10^{-6}$ IN/IN/F°
$\varepsilon_{ULT} = .001$
$F_{TU} = F_{CU} = 26$ KSI

* A_{eff}, E_{eff} and ρ_{eff} are combination of Tube and Tape in a 50/50 ratio by length

TAPE

Lay-up $[(0T/90F/0T/90F/0T)_5]$

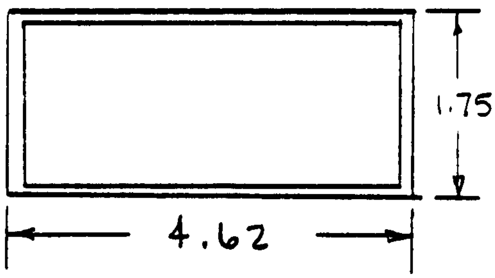
Material Used
- TAPE - PITCH 75
- FABRIC - T300

$E_L = 27.54 \times 10^6$ PSI
$E_T = 3.97 \times 10^6$ PSI
$G_{LT} = 1.26 \times 10^6$ PSI
$\nu_{LT} = 0.0734$
$CTE_L = -0.15 \times 10^{-6}$ IN/IN/F°
$\varepsilon_{ULT} = .001$
$F_{TU} = F_{CU} = 28$KSI

MCDA MEMBER DEFINITION

SURFACE MEMBER

MEMBER 50



Area = 1.58 IN^2

MEMBER 50

Lay-up $[45F/(0T_2/90F/0T_2/90F)_4/45F]$

Material Used

TAPE - PITCH 75

FABRIC - T300

E_L = 27.8 MSI

E_T = 3.68 MSI

G_{LT} = 1.40 MSI

ν_{LT} = .121

CTE_L = -0.182×10^{-6} IN/IN/F°

ε_{ulT} = .001

F_{tu} = F_{cu} = 28 KSI

Appendix B—
NASTRAN Dynamic Model

OGR.

Appendix B—
NASTRAN Dynamic Model

N A S T R A N   E X E C U T I V E   C O N T R O L   D F C K   E C H O

```
ID, MSDA5X5,DYNAMIC
CHKPNT YES
SOL 3
TIME 13
DIAG 8,9,13,14,19,21,22
CEND
```

ECHO OF FIRST CARD IN CHECKPOINT DICTIONARY TO BE PUNCHED OUT FOR THIS PROBLEM

MSDA DYNAMIC MODEL 5X5 2M. NEW SPIN AXIS W/BALLAST
LITESTRONGBACK 2M. NEW SPIN AXIS W/BALLAST

MODEL 29

C A S E   C O N T R O L   D E C K   E C H O

CARD COUNT	
1	TITLE= MSDA DYNAMIC MODEL 5X5 2M. NEW SPIN AXIS W/BALLAST
2	SUBTITLE=LITESTRONGBACK 2M. NEW SPIN AXIS W/BALLAST
3	LABEL= MODEL 29
4	ESE=ALL
5	METHOD=6
6	SPC=1
7	SET 1=43,44,49,50
8	SPCFORCE=1
9	OUTPUT(PLOT)
10	CSCALE 1.8
11	PLOTTER NAST
12	SET 1=BAR
13	PAPER SIZE 26. X 20.
14	VIEW,34.27,40.17,30.
15	FIND SCALE,ORIGIN 1,SET 1
16	PLOT SET 1
17	PLOT MODAL DEFORMATION 0, SET 1, ORIGIN 1, SHAPE
18	VIEW,0.0,90.0,0.0
19	FIND SCALE,ORIGIN 1,SET 1
20	PLOT SET 1
21	PLOT MODAL DEFORMATION 0, SET 1, ORIGIN 1, SHAPE
22	VIEW,90.,0.0,0.0
23	FIND SCALE,ORIGIN 1,SET 1
24	PLOT SET 1
25	PLOT MODAL DEFORMATION 0, SET 1, ORIGIN 1, SHAPE
26	VIEW,0.0,0.0,0.0
27	FIND SCALE,ORIGIN 1,SET 1
28	PLOT SET 1
29	PLOT MODAL DEFORMATION 0, SET 1, ORIGIN 1, SHAPE
30	BEGIN BULK

INPUT BULK DATA CARD COUNT = 699

MSDA DYNAMIC MODEL 5X5 2M. NEW SPIN AXIS W/BALLAST
LITESTRONGBACK 2M. NEW SPIN AXIS W/BALLAST

MODEL 29

S O R T E D   B U L K   D A T A   E C H O

CARD COUNT	. 1 ..	2 ..	3 ..	4 ..	5 ..	6 ..	7 ..	8 ..	9 ..	10 .
1-	CBAR	101	1	1	2	1.	0.	1.		+101
2-	+101	6	6							
3-	CBAR	102	1	2	3	1.	0.	1.		+102
4-	+102	6	6							
5-	CBAR	103	1	3	4	1.	0.	1.		+103
6-	+103	6	6							
7-	CBAR	104	1	29	30	1.	0.	1.		+104
8-	+104	6	6							
9-	CBAR	105	1	30	31	1.	0.	1.		+105
10-	+105	6	6							
11-	CBAR	106	1	31	32	1.	0.	1.		+106
12-	+106	6	6							
13-	CBAR	107	1	5	6	1.	0.	1.		+107
14-	+107	6	6							
15-	CBAR	108	1	6	7	1.	0.	1		+108
16-	+108	6	6							
17-	CBAR	109	1	7	8	1.	0.	1.		+109
18-	+109	6	6							
19-	CBAR	110	1	8	9	1.	0.	1.		+110
20-	+110	6	6							
21-	CBAR	111	1	9	10	1.	0.	1.		+111
22-	+111	6	6							
23-	CBAR	112	3	11	12	1.	0.	1.		+112
24-	+112	6	6							
25-	CBAR	113	3	12	13	1.	0.	1.		+113
26-	+113	6	6							
27-	CBAR	114	2	13	14	1.	0.	1.		+114
28-	+114	6	6							
29-	CBAR	115	1	14	15	1.	0.	1.		+115
30-	+115	6	6							
31-	CBAR	116	1	15	16	1.	0.	1.		+116
32-	+116	6	6							
33-	CBAR	117	3	17	18	1.	0	1		+117
34	+117	6	6							
35	CBAR	118	3	18	19	1.	0	1		+118
36-	+118	6	6							
37-	CBAR	119	2	19	20	1.	0.	1.		+119
38-	+119	6	6							
39-	CBAR	120	1	20	21	1.	0.	1.		+120
40-	+120	6	6							
41-	CBAR	121	1	21	22	1.	0.	1.		+121
42-	+121	6	6							
43-	CBAR	122	1	23	24	1.	0.	1.		+122
44-	+122	6	6							
45-	CPAR	123	1	24	25	1.	0.	1.		+123
46-	+123	6	6							
47-	CBAR	124	1	25	26	1.	0	1		+124
48-	+124	6	6							
49-	CBAR	125	1	26	27	1.	0	1.		+125
50-	+125	6	6							

ORIGINAL PAGE IS
OF POOR QUALITY

MSDA DYNAMIC MODEL 5X5 2M. NEW SPIN AXIS W/BALLAST
LITESTRONGBACK 2M. NEW SPIN AXIS W/BALLAST

MODEL 29

SORTED BULK DATA ECHO

CARD COUNT	. 1 ..	. 2 .	. 3 ..	. 4 .	. 5 .	. 6 .	. 7 .	. 8 .	. 9 .	. 10 .
51-	CBAR	126	1	27	28	1.	0	1.		+126
52-	+126	6	6							
53-	CBAR	127	1	5	11	0.	1	1		+127
54-	+127	S	6							
55-	CBAR	128	3	11	17	0.	1	1.		
56-	CBAR	129	1	17	23	0.	1	1.		+129
57-	+129	6	6							
58-	CBAR	130	1	10	16	0	1.	1.		+130
59-	+130	6	6							
60-	CBAR	131	1	16	22	0.	1.	1.		
61	CBAR	132	1	22	28	0.	1	1		+132
62-	+132	6	6							
63-	CBAR	133	1	1	6	0.	1.	1.		+133
64	+133	6	6							
65-	CBAR	134	1	6	12	0.	1.	1.		+134
66-	+134	6	6							
67-	CBAR	135	3	12	18	0.	1	1.		
68-	CBAR	136	1	18	24	0	1	1		+136
69-	+136	6	6							
70-	CBAR	137	1	24	29	0.	1.	1.		+137
71-	+137	6	6							
72-	CBAR	138	1	2	7	0.	1.	1.		+138
73-	+138	6	6							
74-	CBAR	139	1	7	13	0.	1	1.		+139
75-	+139	6	6							
76-	CBAR	140	1	13	19	0.	1	1		
77-	CBAR	141	1	19	25	0.	1	1.		+141
78-	+141	6	6							
79-	CBAR	142	1	25	30	0	1.	1		+142
80-	+142	6	6							
81-	CBAR	143	1	3	8	0.	1	1		+143
82-	+143	6	6							
83-	CBAR	144	1	8	14	0.	1.	1		+144
84-	+144	6	6							
85-	CBAR	145	1	14	20	0	1	1.		
86-	CBAR	146	1	20	26	0.	1	1.		+146
87-	+146	6	6							
88-	CBAR	147	1	26	31	0.	1	1		+147
89-	+147	6	6							
90	CBAR	148	1	4	9	0	1.	1		+148
91-	+148	6	6							
92-	CBAR	149	1	9	15	0.	1	1.		+149
93-	+149	6	6							
94-	CBAR	150	1	15	21	0.	1	1		
95-	CBAR	151	1	21	27	0.	1	1.		+151
96-	+151	6	6							
97	CBAR	152	1	27	32	0.	1.	1.		+152
98-	+152	6	6							
99-	CBAR	153	1	33	34	1.	0	1.		+153
100	+153	6	6							

MSDA DYNAMIC MODEL 5X5 2M. NEW SPIN AXIS W/BALLAST
LITESTRONGBACK 2M. NEW SPIN AXIS W/BALLAST

MODEL 29

S O R T E D   B U L K   D A T A   E C H O

CARD COUNT	. 1 ..	2 ..	3 ..	4 ..	5 ..	6 ..	7 ..	8 ..	9 ..	10 .
101-	CBAR	154	1	34	35	1.	0.	1.		+154
102	+154	6	6							
103-	CBAR	155	1	35	36	1.	0.	1.		+155
104-	+155	6	6							
105-	CBAR	156	1	61	62	1.	0.	1.		+156
106-	+156	6	6							
107-	CBAR	157	1	62	63	1.	0.	1.		+157
108-	+157	6	6							
109-	CBAR	158	1	63	64	1.	0.	1.		+158
110-	+158	6	6							
111-	CBAR	159	2	37	38	1.	0.	1.		+159
112-	+159	6	6							
113-	CBAR	160	2	38	39	1.	0.	1		+160
114-	+160	6	6							
115-	CBAR	161	1	39	40	1.	0	1		+161
116-	+161	6	6							
117-	CBAR	162	1	40	41	1.	0.	1.		+162
118-	+162	6	6							
119-	CBAR	163	1	41	42	1.	0.	1.		+163
120-	+163	6	6							
121-	CBAR	164	3	43	44	1.	0.	1.		+164
122-	+164	6	6							
123-	CBAR	165	4	44	45	1.	0	1.		+165
124-	+165	6	6							
125-	CBAR	166	2	45	46	1.	0	1.		+166
126-	+166	6	6							
127-	CBAR	167	1	46	47	1.	0.	1.		+167
128-	+167	6	6							
129-	CBAR	168	1	47	48	1.	0	1.		+168
130-	+168	6	6							
131-	CBAR	169	3	49	50	1.	0.	1.		+169
132-	+169	6	6							
133	CBAR	170	4	50	51	1	0.	1		+170
134-	+170	6	6							
135-	CBAR	171	2	51	52	1.	0.	1		+171
136-	+171	6	6							
137-	CBAR	172	1	52	53	1.	0	1		+172
138-	+172	6	6							
139-	CBAR	173	1	53	54	1	0	1.		+173
140-	+173	6	6							
141-	CBAR	174	2	55	56	1.	0	1.		+174
142-	+174	6	6							
143-	CBAR	175	2	56	57	1.	0.	1.		+175
144-	+175	6	6							
145-	CBAR	176	1	57	58	1.	0	1		+176
146-	+176	6	6							
147	CBAR	177	1	58	59	1.	0.	1.		+177
148-	+177	6	6							
149-	CBAR	178	1	59	60	1.	0	1.		+178
150-	+178	6	6							

ORIGINAL PAGE IS
OF POOR QUALITY

MSDA DYNAMIC MODEL 5X5 2M. NEW SP.N AXIS W/BALLAST
LITESTRONGBACK 2M. NEW SPIN AXIS W/BALLAST

MODEL 29

S O R T E D   B U L K   D A T A   E C H O

CARD COUNT	1	2	3	4	5	6	7	8	9	10
151-	CBAR	179	3	37	43	0.	1.	1.		+179
152-	+179	6	6							
153-	CBAR	180	3	43	49	0	1.	1.		
154-	CBAR	181	3	49	55	0.	1.	1.		+181
155-	+181	6	6							
156-	CBAR	182	1	42	48	0.	1.	1.		+182
157-	+182	6	6							
158-	CBAR	183	1	48	54	0.	1.	1.		
159-	CBAR	184	1	54	60	0.	1.	1.		+184
160-	+184	6	6							
161-	CBAR	185	1	33	38	0.	1.	1.		+185
162-	+185	6	6							
163-	CBAR	186	2	38	44	0.	1.	1.		+186
164-	+186	6	6							
165-	CBAR	187	3	44	50	0.	1	1.		
166-	CBAR	188	2	50	56	0	1.	1.		+188
167-	+188	6	6							
168-	CBAR	189	1	56	61	0	1	1.		+189
169-	+189	6	6							
170-	CBAR	190	1	34	39	0	1.	1.		+190
171-	+190	6	6							
172-	CBAR	191	1	39	45	0.	1	1.		+191
173-	+191	6	6							
174-	CBAR	192	2	45	51	0	1.	1.		
175-	CBAR	193	1	51	57	0.	1.	1.		+193
176-	+193	6	6							
177-	CBAR	194	1	57	62	0	1.	1.		+194
178-	+194	6	6							
179-	CBAR	195	1	35	40	0.	1.	1.		+195
180-	+195	6	6							
181-	CBAR	196	1	40	46	0.	1.	1.		+196
182-	+196	6	6							
183-	CBAR	197	1	46	52	0	1	1		
184-	CBAR	198	1	52	58	0.	1.	1.		+198
185-	+198	6	6							
186-	CBAR	199	1	58	63	0.	1	1.		+199
187-	+199	6	6							
188-	CBAR	200	1	36	41	0	1.	1.		+200
189-	+200	6	6							
190-	CBAR	201	1	41	47	0	1.	1.		+201
191-	+201	6	6							
192-	CBAR	202	1	47	53	0.	1	1.		
193-	CBAR	203	1	53	59	0.	1	1.		+203
194-	+203	6	6							
195-	CBAR	204	1	59	64	0.	1	1.		+204
196-	+204	6	6							
197-	CBAR	205	2	65	68	0	1	1.		
198-	CBAR	206	1	66	69	0	1.	1.		
199-	CBAR	207	1	67	70	0	1	1.		
200	CBAR	208	2	77	78	0.	1.	1.		

ORIGINAL PAGE IS
OF POOR QUALITY

MSDA DYNAMIC MODEL 5X5 2M. NEW SPIN AXIS W/BALLAST
LITESTRONGBACK 2M. NEW SPIN AXIS W/BALLAST

MODEL 29

SORTED BULK DATA ECHO

CARD COUNT	. 1 ..	2 ..	3 ..	4 ..	5 ..	6 ..	7 ..	8 ..	9 ..	10 .
201-	CBAR	209	2	71	74	0.	1.	1.		
202-	CBAR	210	1	72	75	0.	1.	1.		
203-	CBAR	211	1	73	76	0.	1.	1.		
204-	CBAR	212	50	11	65	-1.	0.	1.		+212
205-	+212	6	6							
206-	CBAR	213	50	17	68	-1.	0.	1.		+213
207-	+213	6	6							
208-	CBAR	214	50	65	66	-1.	0.			+214
209-	+214	6	6							
210-	CBAR	215	50	68	69	-1.	0.	1.		+215
211-	+215	6	6							
212-	CBAR	216	3	66	67	-1.	0.	1.		+216
213-	+216	6	6							
214-	CBAR	217	3	69	70	-1.	0.	1.		+217
215-	+217	6	6							
216-	CBAR	218	2	77	71	-1.	0.	1.		+218
217-	+218	6	6							
218-	CBAR	219	2	78	74	-1.	0.	1.		+219
219-	+219	6	6							
220-	CBAR	220	1	71	72	-1.	0.	1.		+220
221-	+220	6	6							
222-	CBAR	221	1	74	75	-1.	0.	1.		+221
223-	+221	6	5							
224-	CBAR	222	1	72	73	-1.	0.	1.		+222
225-	+222	6	6							
226	CBAR	223	1	75	76	-1.	0.	1.		+223
227-	+223	6	6							
228-	CBAR	251	11	77	43	-1.	0.	1.		+251
229-	+251	6	6							
230-	CBAR	252	11	78	49	-1.	0	1.		+252
231-	+252	6	6							
232-	CBAR	301	20	11	77	-1.	0.	1.		+301
233-	+301	6								
234-	CBAR	302	20	17	78	-1.	0.	1.		+302
235-	+302	6								
236-	CBAR	303	21	11	43	1.	0.	-1.		
237-	CBAR	304	21	17	49	1.	0.	-1.		
238-	CBAR	307	10	5	37	1.	0.	-1.		
239-	CBAR	308	10	23	55	1.	0.	-1.		
240-	CBAR	403	10	1	33	-1.	0.	-1.		
241-	CBAR	404	10	6	38	-1.	0.	-1.		
242-	CBAR	405	11	12	44	-1.	0.	-1.		
243-	CBAR	406	11	18	50	-1.	0.	-1.		
244-	CBAR	407	10	24	56	-1.	0.	-1.		
245-	CBAR	408	10	29	61	-1.	0	-1.		
246-	CBAR	409	10	2	34	-1.	0.	-1.		
247-	CBAR	410	10	7	39	-1.	0.	-1.		
248	CBAR	411	10	13	45	-1.	0	-1.		
249-	CBAR	412	10	19	51	-1.	0.	-1.		
250	CBAR	413	10	25	57	-1.	0	-1.		

MSDA DYNAMIC MODEL 5X5 2M. NEW SPIN AXIS W/BALLAST
LITESTRONGBACK 2M. NEW SPIN AXIS W/BALLAST

MODEL 29

S O R T E D   B U L K   D A T A   E C H O

CARD COUNT	. 1	.. 2	.. 3	.. 4	.. 5	.. 6	.. 7	.. 8	.. 9	.. 10
251-	CBAR	414	10	30	62	-1.	0	-1.		
252-	CBAR	415	10	3	35	-1	0	-1.		
253-	CBAR	416	10	8	40	-1.	0.	-1.		
254-	CBAR	417	10	14	46	-1.	0	-1.		
255-	CBAR	418	10	20	52	-1	0.	-1.		
256-	CBAR	419	10	26	58	-1.	0	-1.		
257-	CBAR	420	10	31	63	-1.	0.	-1.		
258-	CBAR	421	10	4	36	-1.	0	-1.		
259-	CBAR	422	10	9	41	-1.	0.	-1.		
260-	CBAR	423	10	15	47	-1	0.	1.		
261-	CBAR	424	10	21	53	-1.	0.	-1		
262-	CBAR	425	10	27	59	-1.	0.	-1		
263-	CBAR	426	10	32	64	-1.	0.	-1.		
264-	CBAR	427	10	10	42	-1.	0	-1.		
265-	CBAR	428	10	16	48	-1.	0.	-1.		
266-	CBAR	429	10	22	54	-1.	0.	-1.		
267-	CBAR	430	10	28	60	-1.	0.	-1.		
268-	CBAR	431	11	65	71	-1.	0.	-1.		
269-	CBAR	432	11	68	74	-1.	0.	-1.		
270-	CBAR	433	10	66	72	-1.	0.	-1.		
271-	CBAR	434	10	69	75	-1.	0	-1		
272-	CBAR	435	10	67	73	-1.	0.	-1.		
273-	CBAR	436	10	70	76	-1	0.	1.		
274-	CONM2	2001	1	0	.003870					
275-	CONM2	2002	2	0	.004835					
276-	CONM2	2003	3	0	.004835					
277-	CONM2	2004	4	0	.003870					
278-	CONM2	2005	5	0	.002385					
279-	CONM2	2006	6	0	.007260					
280-	CONM2	2007	7	0	.006895					
281-	CONM2	2008	8	0	.006895					
282	CONM2	2009	9	0	.007260					
283-	CONM2	2010	10	0	.003870					
284-	CONM2	2011	11	0	.005435					
285-	CONM2	2012	12	0	.006895					
286-	CONM2	2013	13	0	.005922					
287-	CONM2	2014	14	0	.005922					
288-	CONM2	2015	15	0	.006895					
289-	CONM2	2016	16	0	.004835					
290	CONM2	2017	17	0	.005435					
291-	CONM2	2018	18	0	.006895					
292-	CONM2	2019	19	0	.005922					
293-	CONM2	2020	20	0	.005922					
294	CONM2	2021	21	0	.006895					
295-	CONM2	2022	22	0	.004835					
296-	CONM2	2023	23	0	.002385					
297-	CONM2	2024	24	0	.007260					
298	CONM2	2025	25	0	.006895					
299	CONM2	2026	26	0	.006895					
300-	CONM2	2027	27	0	.007260					

MSDA DYNAMIC MODEL 5X5 2M. NEW SPIN AXIS W/BALLAST
LITESTRONGBACK 2M. NEW SPIN AXIS W/BALLAST

MODEL 29

S O R T E D   B U L K   D A T A   E C H O

CARD COUNT	1	2	3	4	5	6	7	8	9	10
301-	CONM2	2028	28	0	.003870					
302-	CONM2	2029	29	0	.003870					
303-	CONM2	2030	30	0	.004835					
304-	CONM2	2031	31	0	.004835					
305-	CONM2	2032	32	0	.003870					
306-	CONM2	2033	33	0	.002385					
307-	CONM2	2034	34	0	.002985					
308-	CONM2	2035	35	0	.002985					
309-	CONM2	2036	36	0	.002385					
310-	CONM2	2037	37	0	.002385					
311-	CONM2	2038	38	0	.003585					
312-	CONM2	2039	39	0	.003585					
313-	CONM2	2040	40	0	.003585					
314-	[illegible]	2041	41	[illegible]	.003585					
315	[illegible]	2042	42	0	.002385					
316-	CONM2	[illegible]	43	0	[illegible]					
317-	CONM2	[illegible]	44	0	[illegible]					
318-	CONM2	[illegible]	45	0	[illegible]					
319-	CONM2	[illegible]	[illegible]	[illegible]	[illegible]					
320-	CONM2	[illegible]	[illegible]	[illegible]	[illegible]					
321-	CONM2	2048	[illegible]	[illegible]	[illegible]					
322-	CONM2	2049	[illegible]	[illegible]	[illegible]					
323-	CONM2	2050	[illegible]	[illegible]	[illegible]					
324-	CONM2	2051	51	0	[illegible]					
325-	CONM2	2052	52	0	.003585					
326-	CONM2	2053	53	0	.003585					
327-	CONM2	2054	54	0	.002985					
328-	CONM2	2055	55	0	.002385					
329-	CONM2	2056	56	0	.003585					
330-	CONM2	2057	57	0	.003585					
331-	CONM2	2058	58	0	.003585					
332-	CONM2	2059	59	0	.003585					
333-	CONM2	2060	60	0	.002385					
334-	CONM2	2061	61	0	.002385					
335-	CONM2	2062	62	0	.002985					
336-	CONM2	2063	63	0	.002985					
337-	CONM2	2064	64	0	.002385					
338-	CONM2	2065	65	0	.002985					
339-	CONM2	2066	66	0	.002985					
340-	CONM2	2067	67	0	.0799365					
341-	CONM2	2068	68	0	.002985					
342-	CONM2	2069	69	0	.002985					
343-	CONM2	2070	70	0	.0799365					
344-	CONM2	2071	71	0	.002985					
345-	CONM2	2072	72	0	.002985					
346-	CONM2	2073	73	0	.002385					
347-	CONM2	2074	74	0	.002985					
348	CONM2	2075	75	0	.002985					
349	CONM2	2076	76	0	.002385					
350-	CONM2	2077	77	0	.002985					

ORIGINAL PAGE IS
OF POOR QUALITY

MSDA DYNAMIC MODEL 5X5 2M NEW SPIN AXIS W/BALLAST
LITESTRONGBACK 2M. NEW SPIN AXIS W/BALLAST

MODEL 29

SORTED BULK DATA ECHO

CARD COUNT	1	2	3	4	5	6	7	8	9	10
351-	CONM2	2078	78	0	.002985					
352-	CROD	501	30	1	34					
353-	CROD	502	30	33	2					
354-	CROD	503	30	2	35					
355-	CROD	504	30	34	3					
356-	CROD	505	30	3	36					
357-	CROD	506	30	35	4					
358-	CROD	507	30	29	62					
359-	CROD	508	30	61	30					
360-	CROD	509	30	30	63					
361-	CROD	510	30	62	31					
362-	CROD	511	30	31	64					
363-	CROD	512	30	63	32					
364-	CROD	513	30	5	38					
365-	CROD	514	30	37	6					
366-	CROD	515	30	6	39					
367-	CROD	516	30	38	7					
368-	CROD	517	30	7	40					
369-	CROD	518	30	39	8					
370-	CROD	519	30	8	41					
371-	CROD	520	30	40	9					
372-	CROD	521	30	9	42					
373-	CROD	522	30	41	10					
374-	CROD	523	39	11	44					
375-	CROD	524	39	43	12					
376-	CROD	525	32	12	45					
377-	CROD	526	32	44	13					
378-	CROD	527	32	13	46					
379-	CROD	528	32	45	14					
380-	CROD	529	30	14	47					
381-	CROD	530	30	46	15					
382-	CROD	531	30	15	48					
383-	CROD	532	30	47	16					
384-	CROD	533	39	17	50					
385-	CROD	534	39	49	18					
386-	CROD	535	32	18	51					
387-	CROD	536	32	50	19					
388-	CROD	537	32	19	52					
389-	CROD	538	32	51	20					
390-	CROD	539	30	20	53					
391-	CROD	540	30	52	21					
392-	CROD	541	30	21	54					
393-	CROD	542	30	53	22					
394-	CROD	543	30	23	56					
395-	CROD	544	30	55	24					
396-	CROD	545	30	24	57					
397-	CROD	546	30	56	25					
398-	CROD	547	30	25	58					
399-	CROD	548	30	57	26					
400-	CROD	549	30	26	59					

MSDA DYNAMIC MODEL 5X5 2M. NEW SPIN AXIS W/BALLAST
LITESTRONGBACK 2M. NEW SPIN AXIS W/BALLAST

MODEL 29

S O R T E D B U L K D A T A E C H O

CARD COUNT	. 1 ..	2 ..	3 ..	4 ..	5 ..	6 .. 7 .. 8 .. 9 .. 10 .
401-	CROD	550	30	58	27	
402-	CROD	551	30	27	60	
403-	CROD	552	30	59	28	
404-	CROD	553	30	5	43	
405-	CROD	554	30	37	11	
406-	CROD	555	37	11	49	
407-	CROD	556	37	43	17	
408-	CROD	557	30	17	55	
409-	CROD	558	30	49	23	
410	CROD	559	30	10	48	
411-	CROD	560	30	42	16	
412-	CROD	561	33	16	54	
413-	CROD	562	33	48	22	
414-	CROD	563	30	22	60	
415-	CROD	564	30	54	28	
416-	CROD	565	30	1	38	
417-	CROD	566	30	33	6	
418-	CROD	567	30	6	44	
419-	CROD	568	30	38	12	
420-	CROD	569	39	12	50	
421-	CROD	570	39	44	18	
422-	CROD	571	30	18	56	
423-	CROD	572	30	50	24	
424-	CROD	573	30	24	61	
425-	CROD	574	30	56	29	
426-	CROD	575	30	2	39	
427-	CROD	576	30	34	7	
428-	CROD	577	30	7	45	
429-	CROD	578	30	39	13	
430-	CROD	579	35	13	51	
431-	CROD	580	35	45	19	
432-	CROD	581	30	19	57	
433	CROD	582	30	51	25	
434-	CROD	583	30	25	62	
435	CROD	584	30	57	30	
436-	CROD	585	30	3	40	
437-	CROD	586	30	35	8	
438-	CROD	587	30	8	46	
439-	CROD	588	30	40	14	
440-	CROD	589	34	14	52	
441-	CROD	590	34	46	20	
442-	CROD	591	30	20	58	
443-	CROD	592	30	52	26	
444	CROD	593	30	26	63	
445-	CROD	594	30	58	31	
446-	CROD	595	30	4	41	
447-	CROD	596	30	36	9	
448-	CROD	597	30	9	47	
449	CROD	598	30	41	15	
450-	CROD	599	33	15	53	

ORIGINAL PAGE IS OF POOR QUALITY

MSDA DYNAMIC MODEL 5X5 2M. NEW SPIN AXIS W/BALLAST
LITESTRONGBACK 2M. NEW SPIN AXIS W/BALLAST

MODEL 29

S O R T E D   B U L K   D A T A   E C H O

CARD COUNT	. 1 ..	2 ..	3 ..	4 ..	5 ..	6 ..	7 .	8 .	9 ..	10 .
451-	CROD	600	33	47	21					
452-	CROD	601	30	21	59					
453-	CROD	602	30	53	27					
454-	CROD	603	30	27	64					
455-	CROD	604	30	59	32					
456-	CROD	605	32	11	71					
457-	CROD	606	32	17	74					
458-	CROD	607	31	65	72					
459-	CROD	608	32	77	65					
460-	CROD	609	32	68	78					
461-	CROD	610	31	71	66					
462-	CROD	611	31	68	75					
463-	CROD	612	31	74	69					
464-	CROD	613	31	66	73					
465-	CROD	614	31	72	67					
466-	CROD	615	31	69	76					
467-	CROD	616	31	75	70					
468-	CROD	617	33	67	76					
469-	CROD	618	33	70	73					
470-	CROD	619	33	66	75					
471-	CROD	620	33	69	72					
472-	CROD	621	34	65	74					
473-	CROD	622	34	68	71					
474-	CROD	623	35	17	77					
475-	CROD	624	35	11	78					
476-	CROD	625	32	43	78					
477-	CROD	626	32	49	77					
478-	CROD	701	40	5	12					
479-	CROD	702	40	6	11					
480-	CROD	703	36	11	18					
481-	CROD	704	36	12	17					
482-	CROD	705	40	17	24					
483-	CROD	706	40	18	23					
484-	CROD	707	40	9	16					
485-	CROD	708	40	10	15					
486-	CROD	709	40	15	22					
487-	CROD	710	40	16	21					
488-	CROD	711	40	21	28					
489-	CROD	712	40	22	27					
490	CROD	713	40	1	7					
491-	CROD	714	40	2	6					
492	CROD	715	40	6	13					
493-	CROD	716	40	7	12					
494-	CROD	717	43	12	19					
495-	CROD	718	43	13	18					
496-	CROD	719	40	18	25					
497	CROD	720	40	19	24					
498-	CROD	721	40	24	30					
499-	CROD	722	40	25	29					
500	CROD	723	40	2	8					

ORIGINAL PAGE IS
OF POOR QUALITY

MSDA DYNAMIC MODEL 5X5 2M. NEW SPIN AXIS W/BALLAST
LITESTRONGBACK 2M. NEW SPIN AXIS W/BALLAST

MODEL 29

S O R T E D   B U L K   D A T A   E C H O

CARD COUNT	. 1 ..	2 ..	3 ..	4 ..	5 ..	6 ..	7 ..	8 ..	9 ..	10 .
501-	CROD	724	40	3	7					
502-	CROD	725	41	7	14					
503-	CROD	726	41	8	13					
504-	CROD	727	41	13	20					
505-	CROD	728	41	14	19					
506-	CROD	729	41	19	26					
507-	CROD	730	41	20	25					
508-	CROD	731	40	25	31					
509-	CROD	732	40	26	30					
510-	CROD	733	40	3	9					
511-	CROD	734	40	4	8					
512-	CROD	735	40	8	15					
513-	CROD	736	40	9	14					
514-	CROD	737	40	14	21					
515-	CROD	738	40	15	20					
516-	CROD	739	40	20	27					
517-	CROD	740	40	21	26					
518-	CROD	741	40	26	32					
519-	CROD	742	40	27	31					
520-	CROD	743	43	37	44					
521-	CROD	744	43	38	43					
522-	CROD	745	36	43	50					
523-	CROD	746	36	44	49					
524-	CROD	747	43	49	56					
525-	CROD	748	43	50	55					
526-	CROD	749	40	41	48					
527-	CROD	750	40	42	47					
528-	CROD	751	40	47	54					
529-	CROD	752	40	48	53					
530-	CROD	753	40	53	60					
531-	CROD	754	40	54	59					
532-	CROD	755	41	33	39					
533-	CROD	756	41	34	38					
534-	CROD	757	40	38	45					
535-	CROD	758	40	39	44					
536-	CROD	759	43	44	51					
537-	CROD	760	43	45	50					
538-	CROD	761	40	50	57					
539-	CROD	762	40	51	56					
540-	CROD	763	41	56	62					
541-	CROD	764	41	57	61					
542-	CROD	765	40	34	40					
543-	CROD	766	40	35	39					
544-	CROD	767	40	39	46					
545-	CROD	768	40	40	45					
546-	CROD	769	40	45	52					
547-	CROD	770	40	46	51					
548-	CROD	771	40	51	58					
549-	CROD	772	40	52	57					
550-	CROD	773	40	57	63					

MSDA DYNAMIC MODEL 5X5 2M. NEW SPIN AXIS W/BALLAST
LITESTRONGBACK 2M NEW SPIN AXIS W/BALLAST

MODEL 29

S O R T E D   B U L K   D A T A   E C H O

CARD COUNT	1	2	3	4	5	6	7	8	9	10
551-	CROD	774	40	58	62					
552-	CROD	775	40	35	41					
553-	CROD	776	40	36	40					
554-	CROD	777	40	40	47					
555-	CROD	778	40	41	46					
556-	CROD	779	40	46	53					
557-	CROD	780	40	47	52					
558-	CROD	781	40	52	59					
559-	CROD	782	40	53	58					
560-	CROD	783	40	58	64					
561-	CROD	784	40	59	63					
562-	CROD	785	42	11	[illegible]9					
563-	CROD	786	42	17	65					
564-	CROD	787	41	77	74					
565-	CROD	788	41	78	71					
566-	CROD	789	42	65	69					
567-	CROD	790	42	68	66					
568-	CROD	791	41	71	75					
569-	CROD	793	42	66	70					
570-	CROD	794	42	69	67					
571-	CROD	795	41	72	76					
572-	CROD	796	41	75	73					
573-	CROD	797	41	72	74					
574-	EIGR	6	MGIV				5			45678
575-	+5678	MASS								
576-	GRID	1	0	78.740	-295.27648.104					
577-	GRID	2	0	214.155	-295.27668.912					
578-	GRID	3	0	345.509	-295.276107.732					
579-	GRID	4	0	471.212	-295.276162.022					
580-	GRID	5	0	0.000	-168.82413.829					
581-	GRID	6	0	78.740	-168.82416.896					
582-	GRID	7	0	214.155	-168.82437.704					
583	GRID	8	0	345.509	-168.82476.524					
584-	GRID	9	0	471.212	-168.824130.814					
585-	GRID	10	0	590.551	-168.824200.533					
586-	GRID	11	0	0.000	-39.370 -.504					
587-	GRID	12	0	78.740	-39.370 2.564					
588-	GRID	13	0	214.155	-39.370 23.372					
589-	GRID	14	0	345.509	-39.370 62.192					
590-	GRID	15	0	471.212	-39.370 116.482					
591-	GRID	16	0	590.551	-39.370 186.200					
592-	GRID	17	0	0.000	39.370 -.504					
593-	GRID	18	0	78.740	39.370 2.564					
594	GRID	19	0	214.155	39.370 23.372					
595	GRID	20	0	345.509	39.370 62.192					
596	GRID	21	0	471.212	39.370 116.482					
597-	GRID	22	0	590.551	39.370 186.200					
598-	GRID	23	0	0.000	168.824 13.829					
599	GRID	24	0	78.740	168.824 16.896					
600-	GRID	25	0	214.155	168.824 37.704					

ORIGINAL PAGE IS OF POOR QUALITY

MSDA DYNAMIC MODEL 5X5 2M NEW SPIN AXIS W/BALLAST
LITESTRONGBACK 2M NEW SPIN AXIS W/BALLAST

MODEL 29

S O R T E D   B U L K   D A T A   E C H O

CARD COUNT	. 1 ..	2 ..	3 ..	4 ..	5 ..	6 ..	7 ..	8 ..	9 ..	10 .
601-	GRID	26	0	345.509	168.824	76.524				
602-	GRID	27	0	471.212	168.824	130.814				
603-	GRID	28	0	590.551	168.824	200.533				
604-	GRID	29	0	78.740	295.276	48.104				
605-	GRID	30	0	214.155	295.276	68.912				
606-	GRID	31	0	345.509	295.276	107.732				
607-	GRID	32	0	471.212	295.276	162.022				
608-	GRID	33	0	78.740	-295.276-109.000					
609-	GRID	34	0	214.155	-295.276-87.682					
610	GRID	35	0	345.509	-295.276-48.305					
611-	GRID	36	0	471.212	-295.2766.564					
612-	GRID	37	0	0.000	-168.824-143.682					
613-	GRID	38	0	78.740	-168.824-140.208					
614-	GRID	39	0	214.155	-168.824-118.890					
615-	GRID	40	0	345.509	-168.824-79.512					
616-	GRID	41	0	471.212	-168.824-24.644					
617-	GRID	42	0	590.551	-168.82442.998					
618-	GRID	43	0	0.000	-39.370	-158.014				
619-	GRID	44	0	78.740	-39.370	-154.540				
620-	GRID	45	0	214.155	-39.370	-133.222				
621-	GRID	46	0	345.509	-39.370	-93.845				
622-	GRID	47	0	471.212	-39.370	-38.976				
623-	GRID	48	0	590.551	-39.370	28.666				
624-	GRID	49	0	0.000	39.370	-158.014				
625-	GRID	50	0	78.740	39.370	-154.540				
626-	GRID	51	0	214 155	39.370	-133.222				
627-	GRID	52	0	345.509	39.370	-93.845				
628-	GRID	53	0	471.212	39.370	-38.976				
629-	GRID	54	0	590.551	39.370	28.666				
630-	GRID	55	0	0.000	168.824	-143.682				
631-	GRID	56	0	78 740	168.824	-140.208				
632-	GRID	57	0	214.155	168.824	-118.890				
633	GRID	58	0	345.509	168.824	-79.512				
634-	GRID	59	0	471.212	168.824	-24.644				
635-	GRID	60	0	590.551	168.824	42.998				
636	GRID	61	0	78.740	295.276	-109.000				
637-	GRID	62	0	214.155	295.276	-87.682				
638-	GRID	63	0	345.509	295.276	-48.305				
639-	GRID	64	0	471.212	295.276	6.564				
640	GRID	65	0	0.00	-39.37	155.44				
641-	GRID	66	0	0.00	-39.37	312.78				
642	GRID	67	0	0.00	-39.37	470.12				
643	GRID	68	0	0.00	39.37	155.44				
644-	GRID	69	0	0.00	39.37	312.78				
645	GRID	70	0	0.00	39.37	470 12				
646-	GRID	71	0	-160.00	-39.37	155.44				
647	GRID	72	0	-160.00	-39.37	312.78				
648-	GRID	73	0	-160.00	-39.37	470.12				
649	GRID	74	0	-160.00	39.37	155.44				
650-	GRID	75	0	-160.00	39.37	312.78				

ORIGINAL PAGE IS
OF POOR QUALITY

MSDA DYNAMIC MODEL 5X5 2M. NEW SPIN AXIS W/BALLAST
LITESTRONGBACK 2M. NEW SPIN AXIS W/BALLAST

MODEL 29

S O R T E D   B U L K   D A T A   E C H O

CARD COUNT	. 1 ..	2 ..	3 ..	4	5 ..	6 .	7 ..	8 ..	9	10 .
651-	GRID	76	0	-160.00	39 37	470 12				
652-	GRID	77	0	-160.00	-39.37	-.504				
653-	GRID	78	0	160.00	39.37	- 504				
654-	GRID	79	0	0.0	0.0	0.0	0	123456		
655-	GRID	80	0	121.717	0.0	35.2646	0	123456		
656-	MAT1	1	24.E6	1.90E6	.193	1.502E-4	- 14E-6	72.		
657-	MAT1	2	27.06E6	1.67E6	.198	1.502E-4	21E-6	72		
658-	MAT1	3	27.25E6	1.53E6	.154	1.502E-4	-.18E-6	72.		
659-	MAT1	10	25.99E6	1.89E6	.243	1.581E-4	- 21E-6	72.		
660-	MAT1	11	28.36E6	1.39E6	136	1.581E-4	- 2E-6	72.		
661-	MAT1	20	27.4E6	1.7E6	225	1.581E-4	-.23E-6	72.		
662-	MAT1	21	27 06E6	1.67E6	198	1.581E-4	- 21E 6	72		
663-	MAT1	30	17 52E6	0.0	0 0	1.454E-4	583E 6	72		
664-	MAT1	31	17 15E6	0.0	0 0	1.454E-4	187E 6	72		
665-	MAT1	32	19 96E6	0.0	0.0	1.474E-4	187E-6	72.		
666-	MAT1	33	27 54E6	0 0	0.0	1.567E-4	- .15E 6	72		
667-	MAT1	35	29 37E6	0 0	0.0	1.567E-4	- 19E-6	72		
668-	MAT1	37	27.E6	0 0	0.0	1.581E-4	- 18E 6	72		
669-	MAT1	42	21 1E6	0.0	0.0	1.494E-4	11E-6	72		
670-	MAT1	43	26.0E6	0.0	0.0	1.494E-4	.11E-6	72.		
671-	PARAM	ASING	-1							
672-	PARAM	COUPMASS	1							
673	PARAM	GRDPNT	79							
674-	PBAR	1	1	.10869	.04067	.04067	08134	4 14E-6		
675-	PBAR	2	2	267	.0965	.0965	193	4.14E-6		
676-	PBAR	3	3	.3896	1371	.1371	.2741	4.144E-6		
677-	PBAR	4	11	.7	3	.3	3	4.14E-6		
678	PBAR	10	10	.2051	.0734	.0734	110			
679-	PBAR	11	11	.828	495	495	7399			
680	PBAR	20	20	.6569	.5352	.6074	.00062			
681-	PBAR	21	21	2.097	1.172	2.694	0617			
682-	PBAR	50	37	1 58	897	4.83	1 0			
683-	PROD	30	30	.0587	0.	0	2 152E 6			
684	PROD	31	31	.0931	0	0	2 152E 6			
685-	PROD	32	32	.1774	0	0	2 152E-6			
686	PROD	33	33	0579	0	0	2 152E 6			
687-	PROD	34	33	.1159	0.	0.	2 152E 6			
688-	PROD	35	35	.2184	0.	0	2 152E 6			
689	PROD	36	10	5649	0	0.				
690-	PROD	37	37	1.08	0.	0				
691	PROD	38	37	1 49	0	0.				
692	PROD	39	37	1.99	0.	0.				
693-	PROD	40	33	.0141	0	0.				
694-	PROD	41	33	02814	0.	0.				
695	PROD	42	42	.3215	0.0	0 0				
696	PROD	43	43	.4	0.0	0.0				
697	RFORCE	1	80	0	1	57357	0 0	.819152 2		
698-	SPC1	1	123456	43	44	49	50			
	ENDDATA									

TOTAL COUNT= 699

*** USER WARNING MESSAGE 2251A. ONE OR MORE MAT1 CARDS HAVE UNREASONABLE OR INCONSISTENT VALUES OF E,G OR NU.
ID OF FIRST ONE = 1

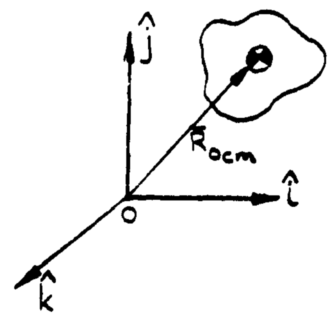
OGR.

Appendix C— Dynamic Balancing

This appendix describes the methodology that was employed to ballast the basic MSDA structural configuration in order to orient the principal inertial axes with the desired spin axis. In general, ballast can be used to change the structural inertial axes to any desired orientation; the obvious solution is to use the minimum amount of ballast.

Given a finite element model, the basic structural rigid-body mass (inertial) properties can be expressed as:

$$\mathbb{M}_o = \left[\begin{array}{c|c} M_o & S_o \\ \hline S_o^T & J_o \end{array}\right]$$



where

$$[M_o] = \begin{bmatrix} M_o & & \\ & M_o & \\ & & M_o \end{bmatrix}, \quad M_o = \int_{VOLUME} dm \quad (dm \equiv \text{incremental mass})$$

$$[S_o] = \begin{bmatrix} 0 & S_{oz} & -S_{oy} \\ -S_{oz} & 0 & S_{ox} \\ S_{oy} & -S_{ox} & 0 \end{bmatrix}, \quad S_{ox} = \int_{VOLUME} x\,dm, \text{ etc.}$$

$$[J_o] = \begin{bmatrix} J_{oxx} & J_{oxy} & J_{oxz} \\ J_{oxy} & J_{oyy} & J_{oyz} \\ J_{oxz} & J_{oyz} & J_{ozz} \end{bmatrix}, \quad J_{oxx} = \int_{VOLUME} (y^2 + z^2)\,dm, \quad J_{oxy} = -\int_{VOLUME} xy\,dm$$

and where the volume integrals are defined with respect to an arbitrary reference point, 0. The system mass center is defined as:

$$\overline{R}_{ocm} = \lfloor \hat{i}\ \hat{j}\ \hat{k} \rfloor \left(1/M_o\right) \begin{Bmatrix} S_{ox} \\ S_{oy} \\ S_{oz} \end{Bmatrix} = \lfloor \hat{i}\ \hat{j}\ \hat{k} \rfloor \begin{Bmatrix} \overline{X}_o \\ \overline{Y}_o \\ \overline{Z}_o \end{Bmatrix}$$

and the inertial properties, with respect to the mass center, are

$$M_{o_{cm}} = \begin{bmatrix} I & 0 \\ B^T & I \end{bmatrix} \begin{bmatrix} M_o & S_o \\ S_o^T & J_o \end{bmatrix} \begin{bmatrix} I & B \\ 0 & I \end{bmatrix} = \begin{bmatrix} M_o & 0 \\ 0 & J_{o_{cm}} \end{bmatrix}$$

with $B = \begin{bmatrix} 0 & -\bar{z}_o & \bar{y}_o \\ \bar{z}_o & 0 & -\bar{x}_o \\ -\bar{y}_o & \bar{x}_o & 0 \end{bmatrix}$. The principal inertial properties are then

found using an eigensolution as:

$$\left[J_{op} \right] = \left[Q_o^T \right] \left[J_{o_{cm}} \right] \left[Q_o \right]$$

where the orthonormal rotation transformation $[Q_o]$ defines the orientation of the principal axes with respect to the basic axiosystem.

An examination of the procedure to ballast the configuration follows from examination of a single ballast mass; the extension to multiple masses is obvious. Given the basic system as defined previously, the addition of a ballast mass yields:

$$M_i = \begin{bmatrix} I & 0 \\ R_i^T & I \end{bmatrix} \begin{bmatrix} M_i & \\ 0 & J_i \end{bmatrix} \begin{bmatrix} I & R_i \\ 0 & I \end{bmatrix}$$

where $\left[M_i \right]$ and $\left[J_i \right]$ define the inertial characteristics of the i^{th} ballast mass about its own mass center and where, for $\bar{R}_i = \lfloor \hat{i} \; \hat{j} \; \hat{k} \rfloor \begin{Bmatrix} x_i \\ y_i \\ z_i \end{Bmatrix}$,

$$\left[R_i \right] = \begin{bmatrix} 0 & z_i & -y_i \\ -z_i & 0 & x_i \\ y_i & -x_i & 0 \end{bmatrix},$$

defines the location of the i^{th} ballast mass with respect to the arbitrary reference point, 0.

Given the above, the <u>total system inertial</u> properties can be represented as:

$$M_T = M_o + \sum_{i=1}^{n} M_i = \begin{bmatrix} M_T & S_T \\ S_T^T & J_T \end{bmatrix}$$

from which the composite mass center for the ballasted configuration becomes

$$\bar{R}_{cm} = \lfloor \hat{i}\ \hat{j}\ \hat{k} \rfloor \left(1/M_T\right) \begin{Bmatrix} S_{T_x} \\ S_{T_y} \\ S_{T_z} \end{Bmatrix} = \lfloor \hat{i}\ \hat{j}\ \hat{k} \rfloor \begin{Bmatrix} \bar{X}_T \\ \bar{Y}_T \\ \bar{Z}_T \end{Bmatrix}$$

The total system inertia properties, with respect to this new mass center location, follow as:

$$M_{cm} = \begin{bmatrix} I & \\ B^T & I \end{bmatrix} \begin{bmatrix} M_T & S_T \\ S_T^T & J_T \end{bmatrix} \begin{bmatrix} I & B \\ & I \end{bmatrix} = \begin{bmatrix} M_T & \\ & J_{o_{cm}} \end{bmatrix}$$

with

$$B = \begin{bmatrix} 0 & -\bar{Z}_T & \bar{Y}_T \\ \bar{Z}_T & 0 & -\bar{X}_T \\ -\bar{Y}_T & \bar{X}_T & 0 \end{bmatrix}$$

and the new ballasted principal inertial properties are:

$$\left[J_{T_p} \right] = \left[Q_T^T \right] \left[J_{T_{cm}} \right] \left[Q_T \right] .$$

```
      PROGRAM DYNBAL(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT,TAPE2,FILMPL)
C
C
      DIMENSION AMO(6,6),W(6,6),XYZBAL(20,3),R(6,6),AMT(6,6)
      DIMENSION AMB(6,6,10),ISEL(10,2),XYZB(3),B(6,6)
      DIMENSION APRIN(3),AROT(3,3),AMP(3,3),XYZREF(3)
C
C
  999 CALL START
C
C  READ BASIC STRUCTURE MASS WRT REFERENCE POINT
C  THIS IS MO MATRIX IN NASTRAN NOTATION
      CALL READ(AMO,NR,NC,6,6)
C
C  READ REF POINT WRT BASIC COORDINATES
C  THIS DEFINES LOCATION OF NASTRAN REF POINT
      CALL READ(XYZREF,N1,N3,1,3)
C
C  READ CANDIDATE BALLAST LOCATIONS AND MASS WRT BASIC COORDINATES
      CALL READ(XYZBAL,NBALP,NC,20,3)
      READ(5,10) NBALM
   10 FORMAT(16I5)
      DO 85 K=1,NBALM
   85 CALL READ(AMB(1,1,K),NR,NC,6,6)
C
C  LOOP ON CASES
C
      READ(5,10) NCASES
      DO 600 KCASE = 1,NCASES
      WRITE(6,22) KCASE
   22 FORMAT(///,20X,* CASE = *,I3)
C
C  READ TABLE OF DESIRED BALLAST LOCATIONS AND MASSES
      CALL READIM(ISEL,NBALL,2,10,2)
C
C  SET UP FOR BALLAST SUMMATION
      CALL UNITY(R,6,6)
      DO 87 I=1,6
      DO 87 J=1,6
   87 AMT(I,J) = AMO(I,J)
C
      DO 100 K=1,NBALL
      ISEP = ISEL(K,1)
      ISEM = ISEL(K,2)
      R(1,5) =  XYZBAL(ISEP,3) - XYZREF(3)
      R(1,6) =-(XYZBAL(ISEP,2) - XYZREF(2))
      R(2,4) =-(XYZBAL(ISEP,3) - XYZREF(3))
      R(2,6) =  XYZBAL(ISEP,1) - XYZREF(1)
      R(3,4) =  XYZBAL(ISEP,2) - XYZREF(2)
      R(3,5) =-(XYZBAL(ISEP,1) - XYZREF(1))
      CALL BTAB(AMB(1,1,ISEM),R,W,6,6,6,6)
      DO 101 I=1,6
      DO 101 J=1,6
  101 AMT(I,J) = AMT(I,J) + W(I,J)
  100 CONTINUE
C
      CALL WRITE(AMT,6,6,3HAMT,6)
C
C  EXTRACT CM LOCATION WRT REFERENCE POINT
      XYZB(1) = AMT(2,6)/AMT(1,1)
      XYZB(2) = AMT(3,4)/AMT(1,1)
      XYZB(3) = AMT(1,5)/AMT(1,1)
```

```
C
      CALL WRITE(XYZB,1,3,6HCMLOC ,1)
C
C  TRANSFORM MASS TO CM
      CALL UNITY(B,6,6)
      B(1,5) = -XYZB(3)
      B(1,6) =  XYZB(2)
      B(2,4) =  XYZB(3)
      B(2,6) = -XYZB(1)
      B(3,4) = -XYZB(2)
      B(3,5) =  XYZB(1)
      CALL BTABA(AMT,B,6,6,6,6)
      CALL WRITE(AMT,6,6,6HAMTCM ,6)
C
C  EXTRACT PRINCIPAL INERTIAS
      DO 103 I=1,3
      DO 103 J=1,3
  103 AMP(I,J) = AMT(I+3,J+3)
      CALL EIGN1(AMP,APRIN,AROT,3,0.,3)
      CALL WRITE(APRIN,1,3,6HPRINER,1)
      CALL WRITE(AROT ,3,3,6HPRINRT,3)
      ALPHA = ATAN2(2.*AMT(4,6),(AMT(6,6)-AMT(4,4)))
      ALPHA = (ALPHA/2.)*57.3
      WRITE(6,28) ALPHA
   28 FORMAT(//,30X,*ALPHA (DEG)  = *,F10.3)
C
  600 CONTINUE
      GO TO 999
      END
```

```
MSDA14
MSDA CONFIG 14
BALLAST EQUALS 10, 25,  50 LBS AT PTS 86, 69, 51, 45
AMO          6     6
       1     1   1.9538            0.          0.           0.
       1     5   269.64            0.
       2     1   0.                1.9538      0.           -269.64
       2     5   C.                -260.90
       3     1   0.                0.          1.9538       0.
       3     5   260.90            0.
       4     1   0.                -269.54     0.           118117.
       4     5   0.                45967.
       5     1   269.64            0.          260.9        0.
       5     5   208328.           0.
       6     1   0.                -260.9      0.           45967.
       6     5   0.                162968.
0000000000
XYZREF       1     3
       1     1   307.03            0.          -97.7335
0000000000
XYZ          5     3
       1     1   0.                -48.        312.78
       2     1   0.                 48.        312.78
       3     1   259.032           -48.        -121.424
       4     1   259.032            48.        -121.424
0000000000
       4
AMB1         6     6
0000000000
AMB2         6     6
       1     1   .026
       2     2   .026
       3     3   .026
0000000000
AMB3         6     6
       1     1   .065
       2     2   .065
       3     3   .065
0000000000
AMB4         6     6
       1     1   .130
       2     2   .130
       3     3   .130
0000000000
       4
ISEL1        4     2
       1     1     1     1
       2     1     2     1
       3     1     3     1
       4     1     4     1
0000000000
ISEL2        4     2
       1     1     1     2
       2     1     2     2
       3     1     3     2
       4     1     4     2
0000000000
ISEL3        4     2
       1     1     1     3
       2     1     2     3
       3     1     3     3
       4     1     4     3
```

ORIGINAL PAGE IS
OF POOR QUALITY

```
0000000000
ISEL4     4     2
    1     1     1     4
    2     1     ?     4
    3     ?     ?     4
    4     1     ?     4
0000000000
STOP
MSDA14
MSDA CONFIG 14
BALLAST EQUALS 20, 50, 100 LBS AT PTS 34, 62
AMO       6     6
    1     1  1.9538              0.                 0.                 0.
    1     5  269.64              0.
    2     1  0.                  1.9538             0.                 -269.64
    2     5  0.                  -260.90
    3     1  0.                  0.                 1.9538             0.
    3     5  260.90              0.
    4     1  0.                  -269.64            0.                 118117.
    4     5  0.                  45967.
    5     1  269.64              0.                 260.9              0.
    5     5  208328.             0.
    6     1  0.                  -260.9             0.                 45967.
    6     5  0.                  162968.
0000000000
XYZREF    1     3
    1     1  307.03              0.                 -97.7335
0000000000
XYZ       5     3
    1     1  259.032             -295.276           -76.284
    2     1  259.032              295.276           -76.284
0000000000
    4
AMB1      6     6
0000000000
AMB2      6     6
    1     ?  .052
    2     2  .052
    3     3  .052
0000000000
AMB3      6     6
    1     1  .13
    2     2  .13
    3     3  .13
0000000000
AMB4      6     6
    1     1  .259
    2     2  .259
    3     3  .259
0000000000
    4
ISEL1     2     2
    1     1     1     1
    2     1     2     1
0000000000
ISEL2     2     2
    1     1     1     2
    2     1     2     2
0000000000
ISEL3     2     2
    1     1     1     3
    2     1     2     3
0000000000
ISEL4     2     2
```

ORIGINAL PAGE IS
OF POOR QUALITY

```
     1     1     1     4
     2     1     2     4
0000000000
MSDA14
MSDA CONFIG 14
BALLAST EQUALS 20. 50. 100 LBS AT PTS 35. 63
AMO        6     6
     1     1  1.9538              0.                 0.                 0.
     1     5  269.64              0.
     2     1  0.                  1.9538             0.                 -269.64
     2     5  0.                  -260.90
     3     1  0.                  0.                 1.9538             0.
     3     5  260.90              0.
     4     1  0.                  -269.64            0.                 118117.
     4     5  0.                  45967.
     5     1  269.64              0.                 260.9              0.
     5     5  208328.             0.
     6     1  0.                  -260.9             0.                 45967
     6     5  0.                  162968.
0000000000
XYZREF     1     3
     1     1   307.03              0.                -97.7335
0000000000
XYZ        5     3
     1     1  355.032             -295.276           -44.698
     2     1  355.032              295.276           -44.698
0000000000
     4
AMB1       6     6
0000000000
AMB2       6     6
     1     1  .052
     2     2  .052
     3     3  052
0000000000
AMB3       6     6
     1     1  .13
     2     2  .13
     3     3  .13
0000000000
AMB4       6     6
     1     1  .259
     2     2  .259
     3     3  .259
0000000000
     4
ISEL1      2     2
     1     1     1     1
     2     1     2     1
0000000000
ISEL2      2     2
     1     1     1     2
     2     1     2     2
0000000000
ISEL3      2     2
     1     1     1     3
     2     1     2     3
0000000000
ISEL4      2     2
     1     1     1     4
     2     1     2     4
0000000000
STOP
```

OGR.

Appendix D—
Reflective Mesh Coordinates

Appendix D—
Reflective Mesh Coordinates

****

COORDINATES OF MESH NODAL POINTS

****

(11.941-meter Focal Length)

(Inches)

BOX NUMBER 1

COORDINATES	X	Y	Z
(1,17)	0.00000	-168.82440	27.15654
(3,15)	9.85383	-184.83509	30.21928
(3,17)	9.85383	-168.82440	27.20818
(5,13)	19.70658	-200.79436	33.64691
(5,15)	19.70658	-184.83509	30.37416
(5,17)	19.70658	-168.82440	27.36306
(7,11)	29.55717	-216.69850	37.43590
(7,13)	29.55717	-200.79436	33.90497
(7,15)	29.55717	-184.83509	30.63222
(7,17)	29.55717	-168.82440	27.62112
(9, 9)	39.40451	-232.54399	41.58246
(9,11)	39.40451	-216.69850	37.79702
(9,13)	39.40451	-200.79436	34.26609
(9,15)	39.40451	-184.83509	30.99334
(9,17)	39.40451	-168.82440	27.98224
(11, 7)	49.24755	-248.32750	46.08259
(11, 9)	49.24755	-232.54399	42.04649
(11,11)	49.24755	-216.69850	38.26105
(11,13)	49.24755	-200.79436	34.73012
(11,15)	49.24755	-184.83509	31.45737
(11,17)	49.24755	-168.82440	28.44627
(13, 5)	59.08520	-264.04587	50.93209
(13, 7)	59.08520	-248.32750	46.64933
(13, 9)	59.08520	-232.54399	42.61323
(13,11)	59.08520	-216.69850	38.82779
(13,13)	59.08520	-200.79436	35.29686
(13,15)	59.08520	-184.83509	32.02411
(13,17)	59.08520	-168.82440	29.01301
(15, 3)	68.91642	-279.69616	56.12656
(15, 5)	68.91642	-264.04587	51.60129
(15, 7)	68.91642	-248.32750	47.31852
(15, 9)	68.91642	-232.54399	43.28242
(15,11)	68.91642	-216.69850	39.49698
(15,13)	68.91642	-200.79436	35.96605
(15,15)	68.91642	-184.83509	32.69330
(15,17)	68.91642	-168.82440	29.68220
(17, 1)	78.74015	-295.27559	61.66144
(17, 3)	78.74015	-279.69616	56.89792
(17, 5)	78.74015	-264.04537	52.37265
(17, 7)	78.74015	-248.32750	48.08989
(17, 9)	78.74015	-232.54399	44.05379
(17,11)	78.74015	-216.69850	40.26835
(17,13)	78.74015	-200.79436	36.73742
(17,15)	78.74015	-184.83509	33.46467
(17,17)	78.74015	-168.82440	30.45357

ORIGINAL PAGE IS OF POOR QUALITY

FORM 2401/

BOX NUMBER 2

COORDINATES	X	Y	Z
(1, 1)	78.74015	-295.27559	61.66144
(1, 3)	78.74015	-279.69616	56.89792
(1, 5)	78.74015	-264.04587	52.37265
(1, 7)	78.74015	-248.32750	48.08989
(1, 9)	78.74015	-232.54399	44.05379
(1,11)	78.74015	-216.69850	40.26835
(1,13)	78.74015	-200.79436	36.73742
(1,15)	78.74015	-184.83509	33.46467
(1,17)	78.74015	-168.82440	30.45357
(3, 1)	95.81158	-295.27559	63.24606
(3, 3)	95.81158	-279.69616	58.48254
(3, 5)	95.81158	-264.04587	53.95726
(3, 7)	95.81158	-248.32750	49.67450
(3, 9)	95.81158	-232.54399	45.63840
(3,11)	95.81158	-216.69850	41.85296
(3,13)	95.81158	-200.79436	38.32203
(3,15)	95.81158	-184.83509	35.04928
(3,17)	95.81158	-168.82440	32.03818
(5, 1)	112.85181	-295.27559	65.13688
(5, 3)	112.85181	-279.69616	60.37336
(5, 5)	112.85181	-264.04587	55.84809
(5, 7)	112.85181	-248.32750	51.56533
(5, 9)	112.85181	-232.54399	47.52923
(5,11)	112.85181	-216.69850	43.74379
(5,13)	112.85181	-200.79436	40.21286
(5,15)	112.85181	-184.83509	36.94011
(5,17)	112.85181	-168.82440	33.92901
(7, 1)	129.85558	-295.27559	67 33150
(7, 3)	129.85558	-279.69616	62.56798
(7, 5)	129.85558	-264.04587	58.04270
(7, 7)	129.85558	-248.32750	53.75994
(7, 9)	129.85558	-232.54399	49.72384
(7,11)	129.85558	-216.69850	45.93840
(7,13)	129.85558	-200.79436	42.40747
(7,15)	129.85558	-184.83509	39.13472
(7,17)	129.85558	-168.82440	36.12362
(9, 1)	146.81780	-295.27559	69.82712
(9, 3)	146.81780	-279.69616	65.06360
(9, 5)	146.81780	-264.04587	60.53833
(9, 7)	146.81780	-248.32750	56.25557
(9, 9)	146.81780	-232.54399	52.21947
(9,11)	146.81780	-216.69850	48.43403
(9,13)	146.81780	-200.79436	44.90310
(9,15)	146.81780	-184.83509	41.63035
(9,17)	146.81780	-168.82440	38.61925
(11, 1)	163.73351	-295.27559	72.62065
(11, 3)	163.73351	-279.69616	67.65714
(11, 5)	163.73351	-264.04587	63.33186
(11, 7)	163.73351	-248.32750	59.04910
(11, 9)	163.73351	-232.54399	55.01300
(11,11)	163.73351	-216.69850	51.22756
(11,13)	163.73351	-200.79436	47.69663
(11,15)	163.73351	-184.83509	44.42388
(11,17)	163.73351	-168.82440	41.41278
(13, 1)	180.59795	-295.27559	75.70866

(13, 5)	180.59795	-264.04587	66.41987
(13, 7)	180.59795	-248.32750	62.13711
(13, 9)	180.59795	-232.54399	58.10100
(13,11)	180.59795	-216.69850	54.31557
(13,13)	180.59795	-200.79436	50.78464
(13,15)	180.59795	-184.83509	47.51189
(13,17)	180.59795	-168.82440	44.50079
(15, 1)	197.40655	-295.27559	79.08743
(15, 3)	197.40655	-279.69616	74.32391
(15, 5)	197.40655	-264.04587	69.79863
(15, 7)	197.40655	-248.32750	65.51587
(15, 9)	197.40655	-232.54399	61.47977
(15,11)	197.40655	-216.69850	57.69433
(15,13)	197.40655	-200.79436	54.16340
(15,15)	197.40655	-184.83509	50.89065
(15,17)	197.40655	-168.82440	47.87955
(17, 1)	214.15496	-295.27559	82.75297
(17, 3)	214.15496	-279.69616	77.98945
(17, 5)	214.15496	-264.04587	73.46417
(17, 7)	214.15496	-248.32750	69.18141
(17, 9)	214.15496	-232.54399	65.14531
(17,11)	214.15496	-216.69850	61.35987
(17,13)	214.15496	-200.79436	57.82894
(17,15)	214.15496	-184.83509	54.55619
(17,17)	214.15496	-168.82440	51.54509

BOX NUMBER 3

COORDINATES	X	Y	Z
(1, 1)	214.15496	-295.27559	82.75297
(1, 3)	214.15496	-279.69616	77.98945
(1, 5)	214.15496	-264.04587	73.46417
(1, 7)	214.15496	-248.32750	69.18141
(1, 9)	214.15496	-232.54399	65.14531
(1,11)	214.15496	-216.69850	61.35987
(1,13)	214.15496	-200.79436	57.82894
(1,15)	214.15496	-184.83509	54.55619
(1,17)	214.15496	-168.82440	51.54509
(3, 1)	230.83674	-295.27559	86.70049
(3, 3)	230.83674	-279.69616	81.93697
(3, 5)	230.83674	-264.04587	77.41169
(3, 7)	230.83674	-248.32750	73.12893
(3, 9)	230.83674	-232.54399	69.09283
(3,11)	230.83674	-216.69850	65.30739
(3,13)	230.83674	-200.79436	61.77646
(3,15)	230.83674	-184.83509	58.50371
(3,17)	230.83674	-168.82440	55.49261
(5, 1)	247.45028	-295.27559	90.92601
(5, 3)	247.45028	-279.69616	86.16249
(5, 5)	247.45028	-264.04587	81.63722
(5, 7)	247.45028	-248.32750	77.35445
(5, 9)	247.45028	-232.54399	73.31835
(5,11)	247.45028	-216.69850	69.53291
(5,13)	247.45028	-200.79436	66.00198
(5,15)	247.45028	-184.83509	62.72923
(5,17)	247.45028	-168.82440	59.71813
(7, 1)	263.99190	-295.27559	95.42489
(7, 3)	263.99190	-279.69616	90.66137
(7, 5)	263.99190	-264.04587	86.13609
(7, 7)	263.99190	-248.32750	81.85333
(7, 9)	263.99190	-232.54399	77.81723
(7,11)	263.99190	-216.69850	74.03179
(7,13)	263.99190	-200.79436	70.50086
(7,15)	263.99190	-184.83509	67.22811
(7,17)	263.99190	-168.82440	64.21701
(9, 1)	280.45815	-295.27559	100.19230
(9, 3)	280.45815	-279.69616	95.42878
(9, 5)	280.45815	-264.04587	90.90350
(9, 7)	280.45815	-248.32750	86.62074
(9, 9)	280.45815	-232.54399	82.58464
(9,11)	280.45815	-216.69850	78.79920
(9,13)	280.45815	-200.79436	75.26827
(9,15)	280.45815	-184.83509	71.99552
(9,17)	280.45815	-168.82440	68.98442
(11, 1)	296.84580	-295.27559	105.22326
(11, 3)	296.84580	-279.69616	100.45974
(11, 5)	296.84580	-264.04587	95.93446
(11, 7)	296.84580	-248.32750	91.65170
(11, 9)	296.84580	-232.54399	87.61560
(11,11)	296.84580	-216.69850	83.83016
(11,13)	296.84580	-200.79436	80.29923
(11,15)	296.84580	-184.83509	77.02648
(11,17)	296.84580	-168.82440	74.01538
(13, 1)	313.15188	-295.27559	110.51267

(13, 5)	313.15188	-264.04587	101.22388
(13, 7)	313.15188	-248.32750	96.94111
(13, 9)	313.15188	-232.54399	92.90501
(13,11)	313.15188	-216.69850	89.11957
(13,13)	313.15188	-200.79436	85.58864
(13,15)	313.15188	-184.83509	82.31589
(13,17)	313.15188	-168.82440	79.30479
(15, 1)	329.37363	-295.27559	116.05532
(15, 3)	329.37363	-279.69616	111.29181
(15, 5)	329.37363	-264.04587	106.76653
(15, 7)	329.37363	-248.32750	102.48377
(15, 9)	329.37363	-232.54399	98.44767
(15,11)	329.37363	-216.69850	94.66223
(15,13)	329.37363	-200.79436	91.13130
(15,15)	329.37363	-184.83509	87.85855
(15,17)	329.37363	-168.82440	84.84745
(17, 1)	345.50854	-295.27559	121.84593
(17, 3)	345.50854	-279.69616	117.08241
(17, 5)	345.50854	-264.04587	112.55714
(17, 7)	345.50854	-248.32750	108.27438
(17, 9)	345.50854	-232.54399	104.23828
(17,11)	345.50854	-216.69850	100.45284
(17,13)	345.50854	-200.79436	96.92191
(17,15)	345.50854	-184.83509	93.64916
(17,17)	345.50854	-168.82440	90.63806

BOX NUMBER 4

COORDINATES	X	Y	Z
(1, 1)	345.50854	-295.27559	121.84593
(1, 3)	345.50854	-279.69616	117.08241
(1, 5)	345.50854	-264.04587	112.55714
(1, 7)	345.50854	-248.32750	108.27438
(1, 9)	345.50854	-232.54399	104.23828
(1,11)	345.50854	-216.69850	100.45284
(1,13)	345.50854	-200.79436	96.92191
(1,15)	345.50854	-184.83509	93.64916
(1,17)	345.50854	-168.82440	90.63806
(3, 1)	361.55178	-295.27559	127.87817
(3, 3)	361.55178	-279.69616	123.11465
(3, 5)	361.55178	-264.04587	118.58938
(3, 7)	361.55178	-248.32750	114.30661
(3, 9)	361.55178	-232.54399	110.27051
(3,11)	361.55178	-216.69850	106.48507
(3,13)	361.55178	-200.79436	102.95415
(3,15)	361.55178	-184.83509	99.68139
(3,17)	361.55178	-168.82440	96.67029
(5, 1)	377.50385	-295.27559	134.14754
(5, 3)	377.50385	-279.69616	129.38402
(5, 5)	377.50385	-264.04587	124.85874
(5, 7)	377.50385	-248.32750	120.57598
(5, 9)	377.50385	-232.54399	116.53988
(5,11)	377.50385	-216.69850	112.75444
(5,13)	377.50385	-200.79436	109.22351
(5,15)	377.50385	-184.83509	105.95076
(5,17)	377.50385	-168.82440	102.93966
(7, 1)	393.36289	-295.27559	140.64863
(7, 3)	393.36289	-279.69616	135.88511
(7, 5)	393.36289	-264.04587	131.35983
(7, 7)	393.36289	-248.32750	127.07707
(7, 9)	393.36289	-232.54399	123.04097
(7,11)	393.36289	-216.69850	119.25553
(7,13)	393.36289	-200.79436	115.72460
(7,15)	393.36289	-184.83509	112.45185
(7,17)	393.36289	-168.82440	109.44075
(9, 1)	409.12727	-295.27559	147.37601
(9, 3)	409.12727	-279.69616	142.61249
(9, 5)	409.12727	-264.04587	138.08722
(9, 7)	409.12727	-248.32750	133.80446
(9, 9)	409.12727	-232.54399	129.76836
(9,11)	409.12727	-216.69850	125.98292
(9,13)	409.12727	-200.79436	122.45199
(9,15)	409.12727	-184.83509	119.17924
(9,17)	409.12727	-168.82440	116.16814
(11, 1)	424.79555	-295.27559	154.32429
(11, 3)	424.79555	-279.69616	149.56077
(11, 5)	424.79555	-264.04587	145.03549
(11, 7)	424.79555	-248.32750	140.75273
(11, 9)	424.79555	-232.54399	136.71663
(11,11)	424.79555	-216.69850	132.93119
(11,13)	424.79555	-200.79436	129.40026
(11,15)	424.79555	-184.83509	126.12751
(11,17)	424.79555	-168.82440	123.11641
(13, 1)	440.36648	-295.27559	161.48806

(13, 5)	440.36648	-264.04587	152.19926
(13, 7)	440.36648	-248.32750	147.91650
(13, 9)	440.36648	-232.54399	143.88040
(13,11)	440.36648	-216.69850	140.09496
(13,13)	440.36648	-200.79436	136.56403
(13,15)	440.36648	-184.83509	133.29128
(13,17)	440.36648	-168.82440	130.28018
(15, 1)	455.83902	-295.27559	168.86199
(15, 3)	455.83902	-279.69616	164.09847
(15, 5)	455.83902	-264.04587	159.57319
(15, 7)	455.83902	-248.32750	155.29043
(15, 9)	455.83902	-232.54399	151.25433
(15,11)	455.83902	-216.69850	147.46889
(15,13)	455.83902	-200.79436	143.93796
(15,15)	455.83902	-184.83509	140.66521
(15,17)	455.83902	-168.82440	137.65411
(17, 1)	471.21226	-295.27559	176.44076
(17, 3)	471.21226	-279.69616	171.67724
(17, 5)	471.21226	-264.04587	167.15196
(17, 7)	471.21226	-248.32750	162.86920
(17, 9)	471.21226	-232.54399	158.83310
(17,11)	471.21226	-216.69850	155.04766
(17,13)	471.21226	-200.79436	151.51673
(17,15)	471.21226	-184.83509	148.24398
(17,17)	471.21226	-168.82440	145.23288

BOX NUMBER 5

COORDINATES	X	Y	Z
(1, 1)	471.21226	-295.27559	176.44076
(1, 3)	471.21226	-279.69616	171.67724
(1, 5)	471.21226	-264.04587	157.15196
(1, 7)	471.21226	-248.32750	162.86920
(1, 9)	471.21226	-232.54399	158.83310
(1,11)	471.21226	-216.69850	155.04766
(1,13)	471.21226	-200.79436	151.51673
(1,15)	471.21226	-184.83509	148.24398
(1,17)	471.21226	-168.82440	145.23288
(3, 3)	486.48335	-279.69616	179.45451
(3, 5)	486.48335	-264.04587	174.97923
(3, 7)	486.48335	-248.32750	170.6[illegible]647
(3, 9)	486.48335	-232.54399	166.6[illegible]037
(3,11)	486.48335	-216.69850	162.82493
(3,13)	486.48335	-200.79436	159.29400
(3,15)	486.48335	-184.83509	156.02125
(3,17)	486.48335	-168.82440	153.01015
(5, 5)	501.65388	-264.04587	182.90088
(5, 7)	501.65388	-248.32750	178.61812
(5, 9)	501.65388	-232.54399	174.58201
(5,11)	501.65388	-216.69850	170.79657
(5,13)	501.65388	-200.79436	167.26565
(5,15)	501.65388	-184.83509	163.99290
(5,17)	501.65388	-168.82440	160.98180
(7, 7)	516.72345	-248.32750	186.77904
(7, 9)	516.72345	-232.54399	182.74294
(7,11)	516.72345	-216.69850	178.95750
(7,13)	516.72345	-200.79436	175.42657
(7,15)	516.72345	-184.83509	172.15382
(7,17)	516.72345	-168.82440	169.14272
(9, 9)	531.69176	-232.54399	191.08812
(9,11)	531.69176	-216.69850	187.30268
(9,13)	531.69176	-200.79436	183.77175
(9,15)	531.69176	-184.83509	180.49900
(9,17)	531.69176	-168.82440	177.48790
(11,11)	546.55866	-216.69850	195.82719
(11,13)	546.55866	-200.79436	192.29627
(11,15)	546.55866	-184.83509	189.02352
(11,17)	546.55866	-168.82440	186.01241
(13,13)	561.32412	-200.79436	200.99529
(13,15)	561.32412	-184.83509	197.72254
(13,17)	561.32412	-168.82440	194.71144
(15,15)	575.98824	-184.83509	206.59135
(15,17)	575.98824	-168.82440	203.58025
(17,17)	590.55119	-168.82440	212.61422

BOX NUMBER 6

COORDINATES	X	Y	Z
(1, 1)	0.00000	-168.82440	27.15654
(1, 3)	0.00000	-152.76453	24.41009
(1, 5)	0.00000	-136.66113	21.93161
(1, 7)	0.00000	-120.51839	19.72389
(1, 9)	0.00000	-104.34063	17.78944
(1,11)	0.00000	-88.13230	16.13047
(1,13)	0.00000	-71.89798	14.74893
(1,15)	0.00000	-55.64232	13.64642
(1,17)	0.00000	-39.37008	12.82426
(3, 1)	9.85383	-168.82440	27.20818
(3, 3)	9.85383	-152.76453	24.46172
(3, 5)	9.85383	-136.66113	21.98325
(3, 7)	9.85383	-120.51839	19.77553
(3, 9)	9.85383	-104.34063	17.84108
(3,11)	9.85383	-88.13230	16.18211
(3,13)	9.85383	-71.89798	14.80056
(3,15)	9.85383	-55.64232	13.69805
(3,17)	9.85383	-39.37008	12.87589
(5, 1)	19.70658	-168.82440	27.36306
(5, 3)	19.70658	-152.76453	24.61660
(5, 5)	19.70658	-136.66113	22.13813
(5, 7)	19.70658	-120.51839	19.93041
(5, 9)	19.70658	-104.34063	17.99596
(5,11)	19.70658	-88.13230	16.33699
(5,13)	19.70658	-71.89798	14.95544
(5,15)	19.70658	-55.64232	13.85293
(5,17)	19.70658	-39.37008	13.03077
(7, 1)	29.55717	-168.82440	27.62112
(7, 3)	29.55717	-152.76453	24.87466
(7, 5)	29.55717	-136.66113	22.39619
(7, 7)	29.55717	-120.51839	20.18847
(7, 9)	29.55717	-104.34063	18.25401
(7,11)	29.55717	-88.13230	16.59505
(7,13)	29.55717	-71.89798	15.21350
(7,15)	29.55717	-55.64232	14.11099
(7,17)	29.55717	-39.37008	13.28883
(9, 1)	39.40451	-168.82440	27.98224
(9, 3)	39.40451	-152.76453	25.23578
(9, 5)	39.40451	-136.66113	22.75731
(9, 7)	39.40451	-120.51839	20.54959
(9, 9)	39.40451	-104.34063	18.61514
(9,11)	39.40451	-88.13230	16.95617
(9,13)	39.40451	-71.89798	15.57462
(9,15)	39.40451	-55.64232	14.47212
(9,17)	39.40451	-39.37008	13.64995
(11, 1)	49.24755	-168.82440	28.44627
(11, 3)	49.24755	-152.76453	25.69982
(11, 5)	49.24755	-136.66113	23.22134
(11, 7)	49.24755	-120.51839	21.01362
(11, 9)	49.24755	-104.34063	19.07917
(11,11)	49.24755	-88.13230	17.42020
(11,13)	49.24755	-71.89798	16.03866
(11,15)	49.24755	-55.64232	14.93615
(11,17)	49.24755	-39.37008	14.11399
(13, 1)	59.08520	-168.82440	29.01301

(13, 3)	59.08520	-152.76453	26.26655
(13, 5)	59.08520	-136.66113	23.78808
(13, 7)	59.08520	-120.51839	21.58036
(13, 9)	59.08520	-104.34063	19.64591
(13,11)	59.08520	-88.13230	17.98694
(13,13)	59.08520	-71.89798	16.60539
(13,15)	59.08520	-55.64232	15.50289
(13,17)	59.08520	-39.37008	14.68072
(15, 1)	68.91642	-168.82440	29.68220
(15, 3)	68.91642	-152.76453	26.93575
(15, 5)	68.91642	-136.66113	24.45727
(15, 7)	68.91642	-120.51839	22.24956
(15, 9)	68.91642	-104.34063	20.31510
(15,11)	68.91642	-88.13230	18.65614
(15,13)	68.91642	-71.89798	17.27459
(15,15)	68.91642	-55.64232	16.17208
(15,17)	68.91642	-39.37008	15.34992
(17, 1)	78.74015	-168.82440	30.45357
(17, 3)	78.74015	-152.76453	27.70711
(17, 5)	78.74015	-136.66113	25.22864
(17, 7)	78.74015	-120.51839	23.02092
(17, 9)	78.74015	-104.34063	21.08647
(17,11)	78.74015	-88.13230	19.42750
(17,13)	78.74015	-71.89798	18.04595
(17,15)	78.74015	-55.64232	16.94344
(17,17)	78.74015	-39.37008	16.12128

BOX NUMBER 7

COORDINATES	X	Y	Z
(1, 1)	78.74015	-168.82440	30.45357
(1, 3)	78.74015	-152.76453	27.70711
(1, 5)	78.74015	-136.66113	25.22864
(1, 7)	78.74015	-120.51839	23.02092
(1, 9)	78.74015	-104.34063	21.08647
(1,11)	78.74015	-88.13230	19.42750
(1,13)	78.74015	-71.89798	18.04595
(1,15)	78.74015	-55.64232	16.94344
(1,17)	78.74015	-39.37008	16.12128
(3, 1)	95.81158	-168.82440	32.03818
(3, 3)	95.81158	-152.76453	29.29172
(3, 5)	95.81158	-136.66113	26.81325
(3, 7)	95.81158	-120.51839	24.60553
(3, 9)	95.81158	-104.34063	22.67108
(3,11)	95.81158	-88.13230	21.01211
(3,13)	95.81158	-71.89798	19.63057
(3,15)	95.81158	-55.64232	18.52806
(3,17)	95.81158	-39.37008	17.70590
(5, 1)	112.85181	-168.82440	33.92901
(5, 3)	112.85181	-152.76453	31.18255
(5, 5)	112.85181	-136.66113	28.70408
(5, 7)	112.85181	-120.51839	26.49636
(5, 9)	112.85181	-104.34063	24.56191
(5,11)	112.85181	-88.13230	22.90294
(5,13)	112.85181	-71.89798	21.52139
(5,15)	112.85181	-55.64232	20.41888
(5,17)	112.85181	-39.37008	19.59672
(7, 1)	129.85558	-168.82440	36.12362
(7, 3)	129.85558	-152.76453	33.37716
(7, 5)	129.85558	-136.66113	30.89869
(7, 7)	129.85558	-120.51839	28.69097
(7, 9)	129.85558	-104.34063	26.75652
(7,11)	129.85558	-88.13230	25.09755
(7,13)	129.85558	-71.89798	23.71600
(7,15)	129.85558	-55.64232	22.61350
(7,17)	129.85558	-39.37008	21.79133
(9, 1)	146.81780	-168.82440	38.61925
(9, 3)	146.81780	-152.76453	35.87279
(9, 5)	146.81780	-136.66113	33.39432
(9, 7)	146.81780	-120.51839	31.18660
(9, 9)	146.81780	-104.34063	29.25215
(9,11)	146.81780	-88.13230	27.59318
(9,13)	146.81780	-71.89798	26.21163
(9,15)	146.81780	-55.64232	25.10912
(9,17)	146.81780	-39.37008	24.28696
(11, 1)	163.73351	-168.82440	41.41278
(11, 3)	163.73351	-152.76453	38.66632
(11, 5)	163.73351	-136.66113	36.18785
(11, 7)	163.73351	-120.51839	33.98013
(11, 9)	163.73351	-104.34063	32.04568
(11,11)	163.73351	-88.13230	30.38671
(11,13)	163.73351	-71.89798	29.00516
(11,15)	163.73351	-55.64232	27.90265
(11,17)	163.73351	-39.37008	27.08049
(13, 1)	180.59795	-168.82440	44.50079

FORM 2401/

(13, 3)	180.59795	-152.76453	41.75433
(13, 5)	180.59795	-136.66113	39.27585
(13, 7)	180.59795	-120.51839	37.06814
(13, 9)	180.59795	-104.34063	35.13368
(13,11)	180.59795	-88.13230	33.47472
(13,13)	180.59795	-71.89798	32.09317
(13,15)	180.59795	-55.64232	30.99066
(13,17)	180.59795	-39.37008	30.16850
(15, 1)	197.40655	-168.82440	47.87955
(15, 3)	197.40655	-152.76453	45.13310
(15, 5)	197.40655	-136.66113	42.65462
(15, 7)	197.40655	-120.51839	40.44690
(15, 9)	197.40655	-104.34063	38.51245
(15,11)	197.40655	-88.13230	36.85348
(15,13)	197.40655	-71.89798	35.47194
(15,15)	197.40655	-55.64232	34.36943
(15,17)	197.40655	-39.37008	33.54727
(17, 1)	214.15496	-168.82440	51.54509
(17, 3)	214.15496	-152.76453	48.79863
(17, 5)	214.15496	-136.66113	46.32016
(17, 7)	214.15496	-120.51839	44.11244
(17, 9)	214.15496	-104.34063	42.17799
(17,11)	214.15496	-88.13230	40.51302
(17,13)	214.15496	-71.89798	39.13748
(17,15)	214.15496	-55.64232	38.03497
(17,17)	214.15496	-39.37008	37.21281

BOX NUMBER 8

COORDINATES	X	Y	Z
(1, 1)	214.15496	-168.82440	51.54509
(1, 3)	214.15496	-152.76453	48.79863
(1, 5)	214.15496	-136.66113	46.32016
(1, 7)	214.15496	-120.51839	44.11244
(1, 9)	214.15496	-104.34063	42.17799
(1,11)	214.15496	-88.13230	40.51902
(1,13)	214.15496	-71.89798	39.13748
(1,15)	214.15496	-55.64232	38.03497
(1,17)	214.15496	-39.37008	37.21281
(3, 1)	230.83674	-168.82440	55.49261
(3, 3)	230.83674	-152.76453	52.74615
(3, 5)	230.83674	-136.66113	50.26768
(3, 7)	230.83674	-120.51839	48.05996
(3, 9)	230.83674	-104.34063	46.12551
(3,11)	230.83674	-88.13230	44.46654
(3,13)	230.83674	-71.89798	43.08499
(3,15)	230.83674	-55.64232	41.98249
(3,17)	230.83674	-39.37008	41.16032
(5, 1)	247.45028	-168.82440	59.71813
(5, 3)	247.45028	-152.76453	56.97168
(5, 5)	247.45028	-136.66113	54.49320
(5, 7)	247.45028	-120.51839	52.28549
(5, 9)	247.45028	-104.34063	50.35103
(5,11)	247.45028	-88.13230	48.69207
(5,13)	247.45028	-71.89798	47.31052
(5,15)	247.45028	-55.64232	46.20801
(5,17)	247.45028	-39.37008	45.38585
(7, 1)	263.99190	-168.82440	64.21701
(7, 3)	263.99190	-152.76453	61.47056
(7, 5)	263.99190	-136.66113	58.99208
(7, 7)	263.99190	-120.51839	56.78436
(7, 9)	263.99190	-104.34063	54.84991
(7,11)	263.99190	-88.13230	53.19094
(7,13)	263.99190	-71.89798	51.80940
(7,15)	263.99190	-55.64232	50.70689
(7,17)	263.99190	-39.37008	49.88473
(9, 1)	280.45815	-168.82440	68.98442
(9, 3)	280.45815	-152.76453	66.23796
(9, 5)	280.45815	-136.66113	63.75949
(9, 7)	280.45815	-120.51839	61.55177
(9, 9)	280.45815	-104.34063	59.61732
(9,11)	280.45815	-88.13230	57.95835
(9,13)	280.45815	-71.89798	56.57681
(9,15)	280.45815	-55.64232	55.47430
(9,17)	280.45815	-39.37008	54.65214
(11, 1)	296.84580	-168.82440	74.01538
(11, 3)	296.84580	-152.76453	71.26893
(11, 5)	296.84580	-136.66113	68.79045
(11, 7)	296.84580	-120.51839	66.58273
(11, 9)	296.84580	-104.34063	64.64828
(11,11)	296.84580	-88.13230	62.98931
(11,13)	296.84580	-71.89798	61.60777
(11,15)	296.84580	-55.64232	60.50526
(11,17)	296.84580	-39.37008	59.68310
(13, 1)	313.15188	-168.82440	79.30479

ORIGINAL PAGE IS
OF POOR QUALITY

FORM 2401/

(13, 3)	313.15188	-152.76453	76.55834
(13, 5)	313.15188	-136.66113	74.07986
(13, 7)	313.15188	-120.51839	71.87215
(13, 9)	313.15188	-104.34063	69.93769
(13,11)	313.15188	-88.13230	68.27873
(13,13)	313.15188	-71.89798	66.89718
(13,15)	313.15188	-55.64232	65.79467
(13,17)	313.15188	-39.37008	64.97251
(15, 1)	329.37363	-168.82440	84.84745
(15, 3)	329.37363	-152.76453	82.10099
(15, 5)	329.37363	-136.66113	79.62252
(15, 7)	329.37363	-120.51839	77.41480
(15, 9)	329.37363	-104.34063	75.48035
(15,11)	329.37363	-88.13230	73.82138
(15,13)	329.37363	-71.89798	72.43983
(15,15)	329.37363	-55.64232	71.33732
(15,17)	329.37363	-39.37008	70.51516
(17, 1)	345.50854	-168.82440	90.63806
(17, 3)	345.50854	-152.76453	87.89160
(17, 5)	345.50854	-136.66113	85.41313
(17, 7)	345.50854	-120.51839	83.20541
(17, 9)	345.50854	-104.34063	81.27095
(17,11)	345.50854	-88.13230	79.61199
(17,13)	345.50854	-71.89798	78.23044
(17,15)	345.50854	-55.64232	77.12793
(17,17)	345.50854	-39.37008	76.30577

BOX NUMBER 9

COORDINATES	X	Y	Z
(1, 1)	345.50854	-168.82440	90.63806
(1, 3)	345.50854	-152.76453	87.89160
(1, 5)	345.50854	-136.66113	85.41313
(1, 7)	345.50854	-120.51839	83.20541
(1, 9)	345.50854	-104.34063	81.27095
(1,11)	345.50854	-88.13230	79.61199
(1,13)	345.50854	-71.89798	78.23044
(1,15)	345.50854	-55.64232	77.12793
(1,17)	345.50854	-39.37008	76.30577
(3, 1)	361.55178	-168.82440	96.67029
(3, 3)	361.55178	-152.76453	93.92384
(3, 5)	361.55178	-136.66113	91.44536
(3, 7)	361.55178	-120.51839	89.23765
(3, 9)	361.55178	-104.34063	87 30319
(3,11)	361.55178	-88.13230	85.64423
(3,13)	361.55178	-71.89798	84.26268
(3,15)	361.55178	-55.64232	83 16017
(3,17)	361.55178	-39.37008	82.33801
(5, 1)	377.50385	-168.82440	102.93966
(5, 3)	377.50385	-152.76453	100.19321
(5, 5)	377.50385	-136.66113	97.71473
(5, 7)	377.50385	-120.51839	95.50701
(5, 9)	377.50385	-104.34063	93.57256
(5,11)	377.50385	-88.13230	91.91359
(5,13)	377.50385	-71.89798	90.53205
(5,15)	377.50385	-55.64232	89.42954
(5,17)	377.50385	-39.37008	88.60738
(7, 1)	393.36289	-168.82440	109.44075
(7, 3)	393.36289	-152.76453	106.69429
(7, 5)	393.36289	-136.66113	104.21582
(7, 7)	393.36289	-120.51839	102.00810
(7, 9)	393.36289	-104.34063	100.07365
(7,11)	393.36289	-88.13230	98.41468
(7,13)	393.36289	-71.89798	97.03313
(7,15)	393.36289	-55.64232	95.93063
(7,17)	393.36289	-39.37008	95.10846
(9, 1)	409.12727	-168.82440	116 16814
(9, 3)	409.12727	-152.76453	113.42168
(9, 5)	409.12727	-136.66113	110.94321
(9, 7)	409.12727	-120.51839	108.73549
(9, 9)	409.12727	-104.34063	106.80104
(9,11)	409.12727	-88.13230	105.14207
(9,13)	409.12727	-71.89798	103.76052
(9,15)	409.12727	-55.64232	102.65801
(9,17)	409.12727	-39.37008	101.83585
(11, 1)	424.79555	-168.82440	123.11641
(11, 3)	424.79555	-152.76453	120.36995
(11, 5)	424.79555	-136.66113	117.89148
(11, 7)	424.79555	-120.51839	115.68376
(11, 9)	424.79555	-104.34063	113.74931
(11,11)	424.79555	-88.13230	112 09034
(11,13)	424.79555	-71.89798	110.70879
(11,15)	424.79555	-55.64232	109.60629
(11,17)	424.79555	-39.37008	108.78412
(13, 1)	440.36648	-168.82440	130.28018

(13, 3)	440.36648	-152.76453	127.53372
(13, 5)	440.36648	-136.66113	125.05525
(13, 7)	440.36648	-120.51839	122.84753
(13, 9)	440.36648	-104.34063	120.91308
(13,11)	440.36648	-88.13230	119.25411
(13,13)	440.36648	-71.89798	117.87257
(13,15)	440.36648	-55.64232	116.77006
(13,17)	440.36648	-39.37008	115.94790
(15, 1)	455.83902	-168.82440	137.65411
(15, 3)	455.83902	-152.76453	134.90765
(15, 5)	455.83902	-136.66113	132.42918
(15, 7)	455.83902	-120.51839	130.22146
(15, 9)	455.83902	-104.34063	128.28701
(15,11)	455.83902	-88.13230	126.62804
(15,13)	455.83902	-71.89798	125.24649
(15,15)	455.83902	-55.64232	124.14399
(15,17)	455.83902	-39.37008	123.32182
(17, 1)	471.21226	-168.82440	145.23288
(17, 3)	471.21226	-152.76453	142.48642
(17, 5)	471.21226	-136.66113	140.00795
(17, 7)	471.21226	-120.51839	137.80023
(17, 9)	471.21226	-104.34063	135.86578
(17,11)	471.21226	-88.13230	134.20681
(17,13)	471.21226	-71.89798	132.82527
(17,15)	471.21226	-55.64232	131.72276
(17,17)	471.21226	-39.37008	130.90060

BOX NUMBER 10

COORDINATES	X	Y	Z
(1, 1)	471.21226	-168.82440	145.23288
(1, 3)	471.21226	-152.76453	142.48642
(1, 5)	471.21226	-136.66113	140.00795
(1, 7)	471.21226	-120.51839	137.80023
(1, 9)	471.21226	-104.34063	135.86578
(1,11)	471.21226	-88.13230	134.20681
(1,13)	471.21226	-71.89798	132.82527
(1,15)	471.21226	-55.64232	131.72276
(1,17)	471.21226	-39.37008	130.90060
(3, 1)	486.48335	-168.82440	153.01015
(3, 3)	486.48335	-152.76453	150.26369
(3, 5)	486.48335	-136.66113	147.78522
(3, 7)	486.48335	-120.51839	145.57750
(3, 9)	486.48335	-104.34063	143.64305
(3,11)	486.48335	-88.13230	141.98408
(3,13)	486.48335	-71.89798	140.60254
(3,15)	486.48335	-55.64232	139.50003
(3,17)	486.48335	-39.37008	138.67787
(5, 1)	501.65388	-168.82440	160.98180
(5, 3)	501.65388	-152.76453	158.23534
(5, 5)	501.65388	-136.66113	155.75686
(5, 7)	501.65388	-120.51839	153.54915
(5, 9)	501.65388	-104.34063	151.61469
(5,11)	501.65388	-88.13230	149.95573
(5,13)	501.65388	-71.89798	148.57418
(5,15)	501.65388	-55.64232	147.47167
(5,17)	501.65388	-39.37008	146.64951
(7, 1)	516.72345	-168.82440	169.14272
(7, 3)	516.72345	-152.76453	166.39626
(7, 5)	516.72345	-136.66113	163.91779
(7, 7)	516.72345	-120.51839	161.71007
(7, 9)	516.72345	-104.34063	159.77561
(7,11)	516.72345	-88.13230	158.11665
(7,13)	516.72345	-71.89798	156.73510
(7,15)	516.72345	-55.64232	155.63259
(7,17)	516.72345	-39.37008	154.81043
(9, 1)	531.69176	-168.82440	177.48790
(9, 3)	531.69176	-152.76453	174.74144
(9, 5)	531.69176	-136.66113	172.26297
(9, 7)	531.69176	-120.51839	170.05525
(9, 9)	531.69176	-104.34063	168.12080
(9,11)	531.69176	-88.13230	166.46183
(9,13)	531.69176	-71.89798	165.08028
(9,15)	531.69176	-55.64232	163.97777
(9,17)	531.69176	-39.37008	163.15561
(11, 1)	546.55866	-168.82440	186.01241
(11, 3)	546.55866	-152.76453	183.26596
(11, 5)	546.55866	-136.66113	180.78748
(11, 7)	546.55866	-120.51839	178.57977
(11, 9)	546.55866	-104.34063	176.64531
(11,11)	546.55866	-88.13230	174.98635
(11,13)	546.55866	-71.89798	173 60480
(11,15)	546.55866	-55.64232	172.50229
(11,17)	546.55866	-39.37008	171.68013
(13, 1)	561.32412	-168.82440	194.71144

FORM 2401.

(13, 3)	561.32412	-152.76453	191.96498
(13, 5)	561.32412	-136.66113	189.48651
(13, 7)	561.32412	-120.51839	187.27879
(13, 9)	561.32412	-104.34063	185.34434
(13,11)	561.32412	-88.13230	183.68537
(13,13)	561.32412	-71.89798	182.30383
(13,15)	561.32412	-55.64232	181.20132
(13,17)	561.32412	-39.37008	180.37916
(15, 1)	575.98824	-168.82440	203.58025
(15, 3)	575.98824	-152.76453	200.83379
(15, 5)	575.98824	-136.66113	198.35532
(15, 7)	575.98824	-120.51839	196.14760
(15, 9)	575.98824	-104.34063	194.21315
(15,11)	575.98824	-88.13230	192.55418
(15,13)	575.98824	-71.89798	191.17263
(15,15)	575.98824	-55.64232	190.07013
(15,17)	575.98824	-39.37008	189.24796
(17, 1)	590.55119	-168.82440	212.61422
(17, 3)	590.55119	-152.76453	209.86776
(17, 5)	590.55119	-136.66113	207.38929
(17, 7)	590.55119	-120.51839	205.18157
(17, 9)	590.55119	-104.34063	203.24711
(17,11)	590.55119	-88.13230	201.58815
(17,13)	590.55119	-71.89798	200.20660
(17,15)	590.55119	-55.64232	199.10409
(17,17)	590.55119	-39.37008	198.28193

BOX NUMBER 11

COORDINATES	X	Y	Z
(1, 1)	0.00000	-39.37008	12.82426
(1, 3)	0.00000	-29.53133	12.46376
(1, 5)	0.00000	-19.68935	12.20615
(1, 7)	0.00000	-9.84522	12.05154
(1, 9)	0.00000	0.00000	12.00000
(1,11)	0.00000	9.84522	12.05154
(1,13)	0.00000	19.68935	12.20615
(1,15)	0.00000	29.53133	12.46376
(1,17)	0.00000	39.37008	12.82426
(3, 1)	9.85383	-39.37008	12.87589
(3, 3)	9.85383	-29.53133	12.51540
(3, 5)	9.85383	-19.68935	12.25779
(3, 7)	9.85383	-9.84522	12.10318
(3, 9)	9.85383	0.00000	12.05163
(3,11)	9.85383	9.84522	12.10318
(3,13)	9.85383	19.68935	12.25779
(3,15)	9.85383	29.53133	12.51540
(3,17)	9.85383	39.37008	12.87589
(5, 1)	19.70658	-39.37008	13.03077
(5, 3)	19.70658	-29.53133	12.67028
(5, 5)	19.70658	-19.68935	12.41267
(5, 7)	19.70658	-9.84522	12.25806
(5, 9)	19.70658	0.00000	12.20652
(5,11)	19.70658	9.84522	12.25806
(5,13)	19.70658	19.68935	12.41267
(5,15)	19.70658	29.53133	12.67028
(5,17)	19.70658	39.37008	13.03077
(7, 1)	29.55717	-39.37008	13.28883
(7, 3)	29.55717	-29.53133	12.92834
(7, 5)	29.55717	-19.68935	12.67073
(7, 7)	29.55717	-9.84522	12.51612
(7, 9)	29.55717	0.00000	12.46457
(7,11)	29.55717	9.84522	12.51612
(7,13)	29.55717	19.68935	12.67073
(7,15)	29.55717	29.53133	12.92834
(7,17)	29.55717	39.37008	13.28883
(9, 1)	39.40451	-39.37008	13.64995
(9, 3)	39.40451	-29.53133	13.28946
(9, 5)	39.40451	-19.68935	13.03185
(9, 7)	39.40451	-9.84522	12.87724
(9, 9)	39.40451	0.00000	12.82570
(9,11)	39.40451	9.84522	12.87724
(9,13)	39.40451	19.68935	13.03185
(9,15)	39.40451	29.53133	13.28946
(9,17)	39.40451	39.37008	13.64995
(11, 1)	49.24755	-39.37008	14.11399
(11, 3)	49.24755	-29.53133	13.75349
(11, 5)	49.24755	-19.68935	13.49588
(11, 7)	49.24755	-9.84522	13.34127
(11, 9)	49.24755	0.00000	13.28973
(11,11)	49.24755	9.84522	13.34127
(11,13)	49.24755	19.68935	13.49588
(11,15)	49.24755	29.53133	13.75349
(11,17)	49.24755	39.37008	14.11399
(13, 1)	59.08520	-39.37008	14.68072

(13, 3)	59.08520	-29.53133	14.32023
(13, 5)	59.08520	-19.68935	14.06262
(13, 7)	59.08520	-9.84522	13.90801
(13, 9)	59.08520	0.00000	13.85647
(13,11)	59.08520	9.84522	13.90801
(13,13)	59.08520	19.68935	14.06262
(13,15)	59.08520	29.53133	14.32023
(13,17)	59.08520	39.37008	14.68072
(15, 1)	68.91642	-39.37008	15.34992
(15, 3)	68.91642	-29.53133	14.98942
(15, 5)	68.91642	-19.68935	14.73182
(15, 7)	68.91642	-9.84522	14.57721
(15, 9)	68.91642	0.00000	14.52566
(15,11)	68.91642	9.84522	14.57721
(15,13)	68.91642	19.68935	14.73182
(15,15)	68.91642	29.53133	14.98942
(15,17)	68.91642	39.37008	15.34992
(17, 1)	78.74015	-39.37008	16.12128
(17, 3)	78.74015	-29.53133	15.76079
(17, 5)	78.74015	-19.68935	15.50318
(17, 7)	78.74015	-9.84522	15.34857
(17, 9)	78.74015	0.00000	15.29702
(17,11)	78.74015	9.84522	15.34857
(17,13)	78.74015	19.68935	15.50318
(17,15)	78.74015	29.53133	15.76079
(17,17)	78.74015	39.37008	16.12128

BOX NUMBER 12

COORDINATES	X	Y	Z
(1, 1)	78.74015	-39.37008	16.12128
(1, 3)	78.74015	-29.53133	15.76079
(1, 5)	78.74015	-19.68935	15.50318
(1, 7)	78.74015	-9.84522	15.34857
(1, 9)	78.74015	0.00000	15.29702
(1,11)	78.74015	9.84522	15.34857
(1,13)	78.74015	19.68935	15.50318
(1,15)	78.74015	29.53133	15.76079
(1,17)	78.74015	39.37008	16.12128
(3, 1)	95.81158	-39.37008	17.70590
(3, 3)	95.81158	-29.53133	17.34540
(3, 5)	95.81158	-19.68935	17.08779
(3, 7)	95.81158	-9.84522	16.93318
(3, 9)	95.81158	0.00000	16.88164
(3,11)	95.81158	9.84522	16.93318
(3,13)	95.81158	19.68935	17.08779
(3,15)	95.81158	29.53133	17.34540
(3,17)	95.81158	39.37008	17.70590
(5, 1)	112.85181	-39.37008	19.59672
(5, 3)	112.85181	-29.53133	19.23623
(5, 5)	112.85181	-19.68935	18.97862
(5, 7)	112.85181	-9.84522	18.82401
(5, 9)	112.85181	0.00000	18.77246
(5,11)	112.85181	9.84522	18.82401
(5,13)	112.85181	19.68935	18.97862
(5,15)	112.85181	29.53133	19.23623
(5,17)	112.85181	39.37008	19.59672
(7, 1)	129.85558	-39.37008	21.79133
(7, 3)	129.85558	-29.53133	21.43084
(7, 5)	129.85558	-19.68935	21.17323
(7, 7)	129.85558	-9.84522	21.01862
(7, 9)	129.85558	0.00000	20.96708
(7,11)	129.85558	9.84522	21.01862
(7,13)	129.85558	19.68935	21.17323
(7,15)	129.85558	29.53133	21.43084
(7,17)	129.85558	39.37008	21.79133
(9, 1)	146.81780	-39.37008	24.28696
(9, 3)	146.81780	-29.53133	23.92647
(9, 5)	146.81780	-19.68935	23.66886
(9, 7)	146.81780	-9.84522	23.51425
(9, 9)	146.81780	0.00000	23.46271
(9,11)	146.81780	9.84522	23.51425
(9,13)	146.81780	19.68935	23.66886
(9,15)	146.81780	29.53133	23.92647
(9,17)	146.81780	39.37008	24.28696
(11, 1)	163.73351	-39.37008	27.08049
(11, 3)	163.73351	-29.53133	26.72000
(11, 5)	163.73351	-19.68935	26.46239
(11, 7)	163.73351	-9.84522	26.30778
(11, 9)	163.73351	0.00000	26.25624
(11,11)	163.73351	9.84522	26.30778
(11,13)	163.73351	19.68935	26.46239
(11,15)	163.73351	29.53133	26.72000
(11,17)	163.73351	39.37008	27.08049
(13, 1)	180.59795	-39.37008	30.16650

ORIGINAL PAGE IS
OF POOR QUALITY

FORM 2401/

(13, 3)	180.59795	-29.53133	29.80801
(13, 5)	180.59795	-19.68935	29.55040
(13, 7)	180.59795	-9.84522	29.39579
(13, 9)	180.59795	0.00000	29.34424
(13,11)	180.59795	9.84522	29.39579
(13,13)	180.59795	19.68935	29.55040
(13,15)	180.59795	29.53133	29.80801
(13,17)	180.59795	39.37008	30.16850
(15, 1)	197.40655	-39.37008	33.54727
(15, 3)	197.40655	-29.53133	33.18677
(15, 5)	197.40655	-19.68935	32.92916
(15, 7)	197.40655	-9.84522	32.77455
(15, 9)	197.40655	0.00000	32.72301
(15,11)	197.40655	9.84522	32.77455
(15,13)	197.40655	19.68935	32.92916
(15,15)	197.40655	29.53133	33.18677
(15,17)	197.40655	39.37008	33.54727
(17, 1)	214.15496	-39.37008	37.21281
(17, 3)	214.15496	-29.53133	36.85231
(17, 5)	214.15496	-19.68935	36.59470
(17, 7)	214.15496	-9.84522	36.44009
(17, 9)	214.15496	0.00000	36.38855
(17,11)	214.15496	9.84522	36.44009
(17,13)	214.15496	19.68935	36.59470
(17,15)	214.15496	29.53133	36.85231
(17,17)	214.15496	39.37008	37.21281

BOX NUMBER 13

COORDINATES	X	Y	Z
(1, 1)	214.15496	-39.37008	37.21281
(1, 3)	214.15496	-29.53133	36.85231
(1, 5)	214.15496	-19.68935	36.59470
(1, 7)	214.15496	-9.84522	36.44009
(1, 9)	214.15496	0.00000	36.38855
(1,11)	214.15496	9.84522	36.44009
(1,13)	214.15496	19.68935	36.59470
(1,15)	214.15496	29.53133	36.85231
(1,17)	214.15496	39.37008	37.21281
(3, 1)	230.83674	-39.37008	41.16032
(3, 3)	230.83674	-29.53133	40.79983
(3, 5)	230.83674	-19.68935	40.54222
(3, 7)	230.83674	-9.84522	40.38761
(3, 9)	230.83674	0.00000	40.33607
(3,11)	230.83674	9.84522	40.38761
(3,13)	230.83674	19.68935	40.54222
(3,15)	230.83674	29.53133	40.79983
(3,17)	230.83674	39.37008	41.16032
(5, 1)	247.45028	-39.37008	45.38585
(5, 3)	247.45028	-29.53133	45.02535
(5, 5)	247.45028	-19.68935	44.76775
(5, 7)	247.45028	-9.84522	44.61314
(5, 9)	247.45028	0.00000	44.56159
(5,11)	247.45028	9.84522	44.61314
(5,13)	247.45028	19.68935	44.76775
(5,15)	247.45028	29.53133	45.02535
(5,17)	247.45028	39.37008	45.38585
(7, 1)	263.99190	-39.37008	49.88473
(7, 3)	263.99190	-29.53133	49.52423
(7, 5)	263.99190	-19.68935	49.26662
(7, 7)	263.99190	-9.84522	49.11201
(7, 9)	263.99190	0.00000	49.06047
(7,11)	263.99190	9.84522	49.11201
(7,13)	263.99190	19.68935	49.26662
(7,15)	263.99190	29.53133	49.52423
(7,17)	263.99190	39.37008	49.88473
(9, 1)	280.45815	-39.37008	54.65214
(9, 3)	280.45815	-29.53133	54.29164
(9, 5)	280.45815	-19.68935	54.03403
(9, 7)	280.45815	-9.84522	53.87942
(9, 9)	280.45815	0.00000	53.82788
(9,11)	280.45815	9.84522	53.87942
(9,13)	280.45815	19.68935	54.03403
(9,15)	280.45815	29.53133	54.29164
(9,17)	280.45815	39.37008	54.65214
(11, 1)	296.84580	-39.37008	59.68310
(11, 3)	296.84580	-29.53133	59.32260
(11, 5)	296.84580	-19.68935	59.06499
(11, 7)	296.84580	-9.84522	58.91038
(11, 9)	296.84580	0.00000	58.85884
(11,11)	296.84580	9.84522	58.91038
(11,13)	296.84580	19.68935	59.06499
(11,15)	296.84580	29.53133	59.32260
(11,17)	296.84580	39.37008	59.68310
(13, 1)	313.15188	-39.37008	64.97251

ORIGINAL PAGE IS
OF POOR QUALITY

FORM 2401/

(13, 3)	313.15188	-29.53133	64.61201
(13, 5)	313.15188	-19.68935	64.35441
(13, 7)	313.15188	-9.84522	64.19980
(13, 9)	313.15188	0.00000	64.14825
(13,11)	313.15188	9.84522	64.19980
(13,13)	313.15188	19.68935	64.35441
(13,15)	313.15188	29.53133	64.61201
(13,17)	313.15188	39.37008	64.97251
(15, 1)	329.37363	-39.37008	70.51516
(15, 3)	329.37363	-29.53133	70.15467
(15, 5)	329.37363	-19.58935	69.89706
(15, 7)	329.37363	-9.84522	69.74245
(15, 9)	329.37363	0.00000	69.69091
(15,11)	329.37363	9.84522	69.74245
(15,13)	329.37363	19.68935	69.89706
(15,15)	329.37363	29.53133	70.15467
(15,17)	329.37363	39.37008	70.51516
(17, 1)	345.50854	-39.37008	76.30577
(17, 3)	345.50854	-29.53133	75.94528
(17, 5)	345.50854	-19.68935	75.68767
(17, 7)	345.50854	-9.84522	75.53306
(17, 9)	345.50854	0.00000	75.48151
(17,11)	345.50854	9.84522	75.53306
(17,13)	345.50854	19.68935	75.68767
(17,15)	345.50854	29.53133	75.94528
(17,17)	345.50854	39.37008	76.30577

BOX NUMBER 14

COORDINATES	X	Y	Z
(1, 1)	345.50854	-39.37008	76.30577
(1, 3)	345.50854	-29.53133	75.94528
(1, 5)	345.50854	-19.68935	75.68767
(1, 7)	345.50854	-9.84522	75.53306
(1, 9)	345.50854	0.00000	75.48151
(1,11)	345.50854	9.84522	75.53306
(1,13)	345.50854	19.68935	75.68767
(1,15)	345.50854	29.53133	75.94528
(1,17)	345.50854	39.37008	76.30577
(3, 1)	361.55178	-39.37008	82.33801
(3, 3)	361.55178	-29.53133	81.97751
(3, 5)	361.55178	-19.68935	81.71991
(3, 7)	361.55178	-9.84522	81.56530
(3, 9)	361.55178	0.00000	81.51375
(3,11)	361.55178	9.84522	81.56530
(3,13)	361.55178	19.68935	81.71991
(3,15)	361.55178	29.53133	81.97751
(3,17)	361.55178	39.37008	82.33801
(5, 1)	377.50385	-39.37008	88.60738
(5, 3)	377.50385	-29.53133	88.24688
(5, 5)	377.50385	-19.68935	87.98927
(5, 7)	377.50385	-9.84522	87.83466
(5, 9)	377.50385	0.00000	87.78312
(5,11)	377.50385	9.84522	87.83466
(5,13)	377.50385	19.68935	87.98927
(5,15)	377.50385	29.53133	88.24688
(5,17)	377.50385	39.37008	88.60738
(7, 1)	393.36289	-39.37008	95.10846
(7, 3)	393.36289	-29.53133	94.74797
(7, 5)	393.36289	-19.68935	94.49036
(7, 7)	393.36289	-9.84522	94.33575
(7, 9)	393.36289	0.00000	94.28421
(7,11)	393.36289	9.84522	94.33575
(7,13)	393.36289	19.68935	94.49036
(7,15)	393.36289	29.53133	94.74797
(7,17)	393.36289	39.37008	95.10846
(9, 1)	409.12727	-39.37008	101.83585
(9, 3)	409.12727	-29.53133	101.47536
(9, 5)	409.12727	-19.68935	101.21775
(9, 7)	409.12727	-9.84522	101.06314
(9, 9)	409.12727	0.00000	101.01160
(9,11)	409.12727	9.84522	101.06314
(9,13)	409.12727	19.68935	101.21775
(9,15)	409.12727	29.53133	101.47536
(9,17)	409.12727	39.37008	101.83585
(11, 1)	424.79555	-39.37008	108.78412
(11, 3)	424.79555	-29.53133	108.42363
(11, 5)	424.79555	-19.68935	108.16602
(11, 7)	424.79555	-9.84522	108.01141
(11, 9)	424.79555	0.00000	107.95987
(11,11)	424.79555	9.84522	108.01141
(11,13)	424.79555	19.68935	108.16602
(11,15)	424.79555	29.53133	108.42363
(11,17)	424.79555	39.37008	108.78412
(13, 1)	440.36648	-39.37008	115.94790

(13, 3)	440.36648	-29.53133	115.58740
(13, 5)	440.36648	-19.68935	115.32979
(13, 7)	440.36648	-9.84522	115.17518
(13, 9)	440.36648	0.00000	115.12364
(13,11)	440.36648	9.84522	115.17518
(13,13)	440.36648	19.68935	115.32979
(13,15)	440.36648	29.53133	115.58740
(13,17)	440.36648	39.37008	115.94790
(15, 1)	455.83902	-39.37008	123 32182
(15, 3)	455.83902	-29.53133	122.96133
(15, 5)	455.83902	-19.68935	122.70372
(15, 7)	455.83902	-9.84522	122.54911
(15, 9)	455.83902	0.00000	122.49757
(15,11)	455.83902	9.84522	122.54911
(15,13)	455.83902	19.68935	122.70372
(15,15)	455.83902	29.53133	122.96133
(15,17)	455.83902	39.37008	123.32182
(17, 1)	471.21226	-39.37008	130.90060
(17, 3)	471.21226	-29.53133	130.54010
(17, 5)	471.21226	-19.68935	130.28249
(17, 7)	471.21226	-9.84522	130.12788
(17, 9)	471.21226	0.00000	130.07634
(17,11)	471.21226	9.84522	130.12788
(17,13)	471.21226	19.68935	130.28249
(17,15)	471.21226	29.53133	130.54010
(17,17)	471.21226	39.37008	130.90060

BOX NUMBER 15

COORDINATES	X	Y	Z
(1, 1)	471.21226	-39.37008	130.90060
(1, 3)	471.21226	-29.53133	130.54010
(1, 5)	471.21226	-19.68935	130.28249
(1, 7)	471.21226	-9.84522	130.12788
(1, 9)	471.21226	0.00000	130.07634
(1,11)	471.21226	9.84522	130.12788
(1,13)	471.21226	19.68935	130.28249
(1,15)	471.21226	29.53133	130.54010
(1,17)	471.21226	39.37008	130.90060
(3, 1)	486.48335	-39.37008	138.67787
(3, 3)	486.48335	-29.53133	138.31737
(3, 5)	486.48335	-19.68935	138.05976
(3, 7)	486.48335	-9.84522	137.90515
(3, 9)	486.48335	0.00000	137.85361
(3,11)	486.48335	9.84522	137.90515
(3,13)	486.48335	19.68935	138.05976
(3,15)	486.48335	29.53133	138.31737
(3,17)	486.48335	39.37008	138.67787
(5, 1)	501.65388	-39.37008	146.64951
(5, 3)	501.65388	-29.53133	146.28902
(5, 5)	501.65388	-19.68935	146.03141
(5, 7)	501.65388	-9.84522	145.87680
(5, 9)	501.65388	0.00000	145.82525
(5,11)	501.65388	9.84522	145.87680
(5,13)	501.65388	19.68935	146.03141
(5,15)	501.65388	29.53133	146.28902
(5,17)	501.65388	39.37008	146.64951
(7, 1)	516.72345	-39.37008	154.81043
(7, 3)	516.72345	-29.53133	154.44994
(7, 5)	516.72345	-19.68935	154.19233
(7, 7)	516.72345	-9.84522	154.03772
(7, 9)	516.72345	0.00000	153.98617
(7,11)	516.72345	9.84522	154.03772
(7,13)	516.72345	19.68935	154.19233
(7,15)	516.72345	29.53133	154.44994
(7,17)	516.72345	39.37008	154.81043
(9, 1)	531.69176	-39.37008	163.15561
(9, 3)	531.69176	-29.53133	162.79512
(9, 5)	531.69176	-19.68935	162.53751
(9, 7)	531.69176	-9.84522	162.38290
(9, 9)	531.69176	0.00000	162.33136
(9,11)	531.69176	9.84522	162.38290
(9,13)	531.69176	19.68935	162.53751
(9,15)	531.69176	29.53133	162.79512
(9,17)	531.69176	39.37008	163.15561
(11, 1)	546.55866	-39.37008	171.68013
(11, 3)	546.55866	-29.53133	171.31963
(11, 5)	546.55866	-19.68935	171.06203
(11, 7)	546.55866	-9.84522	170.90742
(11, 9)	546.55866	0.00000	170.85587
(11,11)	546.55866	9.84522	170.90742
(11,13)	546.55866	19.68935	171.06203
(11,15)	546.55866	29.53133	171.31963
(11,17)	546.55866	39.37008	171.68013
(13, 1)	561.32412	-39.37008	180.37916

ORIGINAL PAGE IS
OF POOR QUALITY

FORM 2401/

(13, 3)	561.32412	-29.53133	180.01866
(13, 5)	561.32412	-19.68935	179.76105
(13, 7)	561.32412	-9.84522	179.60644
(13, 9)	561.32412	0.00000	179.55490
(13,11)	561.32412	9.84522	179.60644
(13,13)	561.32412	19.68935	179.76105
(13,15)	561.32412	29.53133	180.01866
(13,17)	561.32412	39.37008	180.37916
(15, 1)	575.98824	-39.37008	189.24796
(15, 3)	575.98824	-29.53133	188.88747
(15, 5)	575.98824	-19.68935	188.62986
(15, 7)	575.98824	-9.84522	188.47525
(15, 9)	575.98824	0.00000	188.42371
(15,11)	575.98824	9.84522	188.47525
(15,13)	575.98824	19.68935	188.62986
(15,15)	575.98824	29.53133	188.88747
(15,17)	575.98824	39.37008	189.24796
(17, 1)	590.55119	-39.37008	198.28193
(17, 3)	590.55119	-29.53133	197.92144
(17, 5)	590.55119	-19.68935	197.66383
(17, 7)	590.55119	-9.84522	197.50922
(17, 9)	590.55119	0.00000	197.45767
(17,11)	590.55119	9.84522	197.50922
(17,13)	590.55119	19.68935	197.66383
(17,15)	590.55119	29.53133	197.92144
(17,17)	590.55119	39.37008	198.28193

BOX NUMBER 16

COORDINATES	X	Y	Z
(1, 1)	0.00000	39.37008	12.82426
(1, 3)	0.00000	55.64232	13.64642
(1, 5)	0.00000	71.89798	14.74893
(1, 7)	0.00000	88.13230	16.13047
(1, 9)	0.00000	104.34063	17.78944
(1,11)	0.00000	120.51839	19.72389
(1,13)	0.00000	136.66113	21.93161
(1,15)	0.00000	152.76453	24.41009
(1,17)	0.00000	168.82440	27.15654
(3, 1)	9.85383	39.37008	12.87589
(3, 3)	9.85383	55.64232	13.69805
(3, 5)	9.85383	71.89798	14.80056
(3, 7)	9.85383	88.13230	16.18211
(3, 9)	9.85383	104.34063	17.84108
(3,11)	9.85383	120.51839	19.77553
(3,13)	9.85383	136.66113	21.98325
(3,15)	9.85383	152.76453	24.46172
(3,17)	9.85383	168.82440	27.20818
(5, 1)	19.70658	39.37008	13.03077
(5, 3)	19.70658	55.64232	13.85293
(5, 5)	19.70658	71.89798	14.95544
(5, 7)	19.70658	88.13230	16.33699
(5, 9)	19.70658	104.34063	17.99596
(5,11)	19.70658	120.51839	19.93041
(5,13)	19.70658	136.66113	22.13813
(5,15)	19.70658	152.76453	24.61660
(5,17)	19.70658	168.82440	27.36306
(7, 1)	29.55717	39.37008	13.28883
(7, 3)	29.55717	55.64232	14.11099
(7, 5)	29.55717	71.89798	15.21350
(7, 7)	29.55717	88.13230	16.59505
(7, 9)	29.55717	104.34063	18.25401
(7,11)	29.55717	120.51839	20.18847
(7,13)	29.55717	136.66113	22.39619
(7,15)	29.55717	152.76453	24.87466
(7,17)	29.55717	168.82440	27.62112
(9, 1)	39.40451	39.37008	13.64995
(9, 3)	39.40451	55.64232	14.47212
(9, 5)	39.40451	71.89798	15.57462
(9, 7)	39.40451	88.13230	16.95617
(9, 9)	39.40451	104.34063	18.61514
(9,11)	39.40451	120.51839	20.54959
(9,13)	39.40451	136.66113	22.75731
(9,15)	39.40451	152.76453	25.23578
(9,17)	39.40451	168.82440	27.98224
(11, 1)	49.24755	39.37008	14.11399
(11, 3)	49.24755	55.64232	14.93615
(11, 5)	49.24755	71.89798	16.03866
(11, 7)	49.24755	88.13230	17.42020
(11, 9)	49.24755	104.34063	19.07917
(11,11)	49.24755	120.51839	21.01362
(11,13)	49.24755	136.66113	23.22134
(11,15)	49.24755	152.76453	25.69982
(11,17)	49.24755	168.82440	28.44627
(13, 1)	59.08520	39.37008	14.68072

(13, 3)	59.08520	55.64232	15.50289
(13, 5)	59.08520	71.89798	16.60539
(13, 7)	59.08520	88.13230	17.98694
(13, 9)	59.08520	104.34063	19.64591
(13,11)	59.08520	120.51839	21.58036
(13,13)	59.08520	136.66113	23.78808
(13,15)	59.08520	152.76453	26.26655
(13,17)	59.08520	168.82440	29.01301
(15, 1)	68.91642	39.37008	15.34992
(15, 3)	68.91642	55.64232	16.17208
(15, 5)	68.91642	71.89798	17.27459
(15, 7)	68.91642	88.13230	18.65614
(15, 9)	68.91642	104.34063	20.31510
(15,11)	68.91642	120.51839	22.24956
(15,13)	[illegible].91642	136.66113	24.45727
(15,15)	68.91642	152.76453	26.93575
(15,17)	68.91642	168.82440	29.68220
(17, 1)	78.74015	39.37008	16.12128
(17, 3)	78.74015	55.64232	16.94344
(17, 5)	78.74015	71.89798	18.04595
(17, 7)	78.74015	88.13230	19.42750
(17, 9)	78.74015	104.34063	21.08647
(17,11)	78.74015	120.51839	23.02092
(17,13)	78.74015	136.66113	25.22864
(17,15)	78.74015	152.76453	27.70711
(17,17)	78.74015	168.82440	30.45357

BOX NUMBER 17

COORDINATES	X	Y	Z
(1, 1)	78.74015	39.37008	16.12128
(1, 3)	78.74015	55.64232	16.94344
(1, 5)	78.74015	71.89798	18.04595
(1, 7)	78.74015	88.13230	19.42750
(1, 9)	78.74015	104.34063	21.08647
(1,11)	78.74015	120.51839	23.02092
(1,13)	78.74015	136.66113	25.22864
(1,15)	78.74015	152.76453	27.70711
(1,17)	78.74015	168.82440	30.45357
(3, 1)	95.81158	39.37008	17.70590
(3, 3)	95.81158	55.64232	18.52806
(3, 5)	95.81158	71.89798	19.63057
(3, 7)	95.81158	88.13230	21.01211
(3, 9)	95.81158	104.34063	22.67108
(3,11)	95.81158	120.51839	24.60553
(3,13)	95.81158	136.66113	26.81325
(3,15)	95.81158	152.76453	29.29172
(3,17)	95.81158	168.82440	32.03818
(5, 1)	112.85181	39.37008	19.59672
(5, 3)	112.85181	55.64232	20.41888
(5, 5)	112.85181	71.89798	21.52139
(5, 7)	112.85181	88.13230	22.90294
(5, 9)	112.85181	104.34063	24.56191
(5,11)	112.85181	120.51839	26.49636
(5,13)	112.85181	136.66113	28.70408
(5,15)	112.85181	152.76453	31.18255
(5,17)	112.85181	168.82440	33.92901
(7, 1)	129.85558	39.37008	21.79133
(7, 3)	129.85558	55.64232	22.61350
(7, 5)	129.85558	71.89798	23.71600
(7, 7)	129.85558	88.13230	25.09755
(7, 9)	129.85558	104.34063	26.75652
(7,11)	129.85558	120.51839	28.69097
(7,13)	129.85558	136.66113	30.89869
(7,15)	129.85558	152.76453	33.37716
(7,17)	129.85558	168.82440	36.12362
(9, 1)	146.81780	39.37008	24.28696
(9, 3)	146.81780	55.64232	25.10912
(9, 5)	146.81780	71.89798	26.21163
(9, 7)	146.81780	88.13230	27.59318
(9, 9)	146.81780	104.34063	29.25215
(9,11)	146.81780	120.51839	31.18660
(9,13)	146.81780	136.66113	33.39432
(9,15)	146.81780	152.76453	35.87279
(9,17)	146.81780	168.82440	38.61925
(11, 1)	163.73351	39.37008	27.08049
(11, 3)	163.73351	55.64232	27.90265
(11, 5)	163.73351	71.89798	29.00516
(11, 7)	163.73351	88.13230	30.38671
(11, 9)	163.73351	104.34063	32.04568
(11,11)	163.73351	120.51839	33.98013
(11,13)	163.73351	136.66113	36.18785
(11,15)	163.73351	152.76453	38.66632
(11,17)	163.73351	168.82440	41.41278
(13, 1)	180.59795	39.37008	30.16850

D-32

(13, 3)	180.59795	55.64232	30.99066
(13, 5)	180.59795	71.89798	32.09317
(13, 7)	[illegible].59795	88.13230	33.47472
(13, 9)	180.59795	104.34063	35.13368
(13,11)	180.59795	120.51839	37.06814
(13,13)	180.59795	136.66113	39.27585
(13,15)	180.59795	152.76453	41.75433
(13,17)	180.59795	168.82440	44.50079
(15, 1)	197.40655	39.37008	33.54727
(15, 3)	197.40655	55.64232	34.36943
(15, 5)	197.40655	71.89798	35.47194
(15, 7)	197.40655	88.13230	36.85348
(15, 9)	197.40655	104.34063	38.51245
(15,11)	197.40655	120.51839	40.44690
(15,13)	197.40655	136.66113	42.65462
(15,15)	197.40655	152.76453	45.13310
(15,17)	197.40655	168.82440	47.87955
(17, 1)	214.15496	39.37008	37.21281
(17, 3)	214.15496	55.64232	38.03497
(17, 5)	214.15496	71.89798	39.13748
(17, 7)	214.15496	88.13230	40.51902
(17, 9)	214.15496	104.34063	42.17799
(17,11)	214.15496	120.51839	44.11244
(17,13)	214.15496	136.66113	46.32016
(17,15)	214.15496	152.76453	48.79863
(17,17)	214.15496	168.82440	51.54509

BOX NUMBER 18

COORDINATES	X	Y	Z
(1, 1)	214.15496	39.37008	37.21281
(1, 3)	214.15496	55.64232	38.03497
(1, 5)	214.15496	71.89798	39.13748
(1, 7)	214.15496	88.13230	40.51902
(1, 9)	214.15496	104.34063	42.17799
(1,11)	214.15496	120.51839	44.11244
(1,13)	214.15496	136.66113	46.32016
(1,15)	214.15496	152.76453	48.79863
(1,17)	214.15496	168.82440	51.54509
(3, 1)	230.83674	39.37008	41.16032
(3, 3)	230.83674	55.64232	41.98249
(3, 5)	230.83674	71.89798	43.08499
(3, 7)	230.83674	88.13230	44.46654
(3, 9)	230.83674	104.34063	46.12551
(3,11)	230.83674	120.51839	48.05996
(3,13)	230.83674	136.66113	50.26768
(3,15)	230.83674	152.76453	52.74615
(3,17)	230.83674	168.82440	55.49261
(5, 1)	247.45028	39.37008	45.38585
(5, 3)	247.45028	55.64232	46.20801
(5, 5)	247.45028	71.89798	47.31052
(5, 7)	247.45028	88.13230	48.69207
(5, 9)	247.45028	104.34063	50.35103
(5,11)	247.45028	120.51839	52.28549
(5,13)	247.45028	136.66113	54.49320
(5,15)	247.45028	152.76453	56.97168
(5,17)	247.45028	168.82440	59.71813
(7, 1)	263.99190	39.37008	49.88473
(7, 3)	263.99190	55.64232	50.70689
(7, 5)	263.99190	71.89798	51.80940
(7, 7)	263.99190	88.13230	53.19094
(7, 9)	263.99190	104.34063	54.84991
(7,11)	263.99190	120.51839	56.78436
(7,13)	263.99190	136.66113	58.99208
(7,15)	263.99190	152.76453	61.47056
(7,17)	263.99190	168.82440	64.21701
(9, 1)	280.45815	39.37008	54.65214
(9, 3)	280.45815	55.64232	55.47430
(9, 5)	280.45815	71.89798	56.57681
(9, 7)	280.45815	88.13230	57.95835
(9, 9)	280.45815	104.34063	59.61732
(9,11)	280.45815	120.51839	61.55177
(9,13)	280.45815	136.66113	63.75949
(9,15)	280.45815	152.76453	66.23796
(9,17)	280.45815	168.82440	68.98442
(11, 1)	296.84580	39.37008	59.68310
(11, 3)	296.84580	55.64232	60.50526
(11, 5)	296.84580	71.89798	61.60777
(11, 7)	296.84580	88.13230	62.98931
(11, 9)	296.84580	104.34063	64.64828
(11,11)	296.84580	120.51039	66.58273
(11,13)	296.84580	136.66113	68.79045
(11,15)	296.84580	152.76453	71.26893
(11,17)	296.84580	168.82440	74.01538
(13, 1)	313.15188	39.37008	64.97251

(13, 3)	313.15188	55.64232	65.79467
(13, 5)	313.15188	71.89798	66.89718
(13, 7)	313.15188	88.13230	68.27873
(13, 9)	313.15188	104.34063	69.93769
(13,11)	313.15188	120.51839	71.872[illegible]5
(13,13)	313.15188	136.66113	74.07986
(13,15)	313.15188	152.76453	76.55834
(13,17)	313.15188	168.82440	79.30479
(15, 1)	329.37363	39.37008	70.51516
(15, 3)	329.37363	55.64232	71.33732
(15, 5)	329.37363	71.89798	72.43983
(15, 7)	329.37363	88.13230	73.82138
(15, 9)	329.37363	104.34063	75.48035
(15,11)	329.37363	120.51839	77.41480
(15,13)	329.37363	136.66113	79.62252
(15,15)	329.37363	152.76453	82.10099
(15,17)	329.37363	168.82440	84.84745
(17, 1)	345.50854	39.37008	76.30577
(17, 3)	345.50854	55.64232	77.12793
(17, 5)	345.50854	71.89798	78.23044
(17, 7)	345.50854	88.13230	79.61199
(17, 9)	345.50854	104.34063	81.27095
(17,11)	345.50854	120.51839	83.20541
(17,13)	345.50854	136.66113	85.41313
(17,15)	345.50854	152.76453	87.89160
(17,17)	345.50854	168.82440	90.63806

BOX NUMBER 19

COORDINATES	X	Y	Z
(1, 1)	345.50854	39.37008	76.30577
(1, 3)	345.50854	55.64232	77 12793
(1, 5)	345.50854	71.89798	78.23044
(1, 7)	345.50854	88.13230	79.61199
(1, 9)	345.50854	104.34063	81.27095
(1,11)	345.50854	120.51839	83.20541
(1,13)	345.50854	136.66113	85.4131[illegible]
(1,15)	345.50854	152.76453	87 89160
(1,17)	345.50854	168.82440	90.63806
(3, 1)	361.55178	39.37008	82.33801
(3, 3)	361.55178	55.64232	83.16017
(3, 5)	361.55178	71.89798	84.26268
(3, 7)	361.55178	88.13230	85.64423
(3, 9)	361.55178	104.34063	87 30319
(3,11)	361.55178	120.51839	89.23765
(3,13)	361.55178	136.66113	91 44536
(3,15)	361.55178	152.76453	93.92384
(3,17)	361.55178	168.82440	96.67029
(5, 1)	377.50385	39.37008	88.60738
(5, 3)	377.50385	55.64232	89.42954
(5, 5)	377.50385	71.89798	90.53205
(5, 7)	377.50385	88.13230	91.91359
(5, 9)	377.50385	104.34063	93.57256
(5,11)	377.50385	120.51839	95.50701
(5,13)	377.50385	136.66113	97.71473
(5,15)	377.50385	152.76453	100.19321
(5,17)	377.50385	168.82440	102.93966
(7, 1)	393.36289	39.37008	95.10846
(7, 3)	393.36289	55.64232	95.93063
(7, 5)	393.36289	71.89798	97 03313
(7, 7)	393.36289	88.13230	98.41468
(7, 9)	393.36289	104.34063	100.07365
(7,11)	393.36289	120.51839	102.00810
(7,13)	393.36289	136.66113	104.21582
(7,15)	393.36289	152.76453	106.69429
(7,17)	393.36289	168.82440	109.44075
(9, 1)	409.12727	39.37008	101.83585
(9, 3)	409.12727	55.64232	102.65801
(9, 5)	409.12727	71.89798	103.76052
(9, 7)	409.12727	88.13230	105.14207
(9, 9)	409.12727	104.34063	106.80104
(9,11)	409.12727	120.51839	108.73549
(9,13)	409.12727	136.66113	110.94321
(9,15)	409.12727	152.76453	113.42168
(9,17)	409.12727	168.82440	116.16814
(11, 1)	424.79555	39.37008	108.78412
(11, 3)	424.79555	55.64232	109.60629
(11, 5)	424.79555	71.89798	110.70879
(11, 7)	424.79555	88.13230	112.09034
(11, 9)	424.79555	104.34063	113.74931
(11,11)	424.79555	120.51839	115.68376
(11,13)	424.79555	136.66113	117.89148
(11,15)	424.79555	152.76453	120.36[illegible]95
(11,17)	424.79555	168.82440	123.11641
(13, 1)	440.36648	39.37008	115.94790

ORIGINAL PAGE IS
OF POOR QUALITY

FORM 2401.

(13, 3)	440.36648	55.64232	116.77006
(13, 5)	440.36648	71.89798	117.87257
(13, 7)	440.36648	88.13230	119.25411
(13, 9)	440.36648	104.34063	120.91308
(13,11)	440.36648	120.51839	122.84753
(13,13)	440.36648	136.66113	125.05525
(13,15)	440.36648	152.76453	127.53372
(13,17)	440.36648	168.82440	130.28018
(15, 1)	455.83902	39.37008	123.32182
(15, 3)	455.83902	55.64232	124.14399
(15, 5)	455.83902	71.89798	125.24649
(15, 7)	455.83902	88.13230	126.62804
(15, 9)	455.83902	104.34063	128.28701
(15,11)	455.83902	120.51839	130.22146
(15,13)	455.83902	136.66113	132.42918
(15,15)	455.83902	152.76453	134.90765
(15,17)	455.83902	168.82440	137.65411
(17, 1)	471.21226	39.37008	130.90060
(17, 3)	471.21226	55.64232	131.72276
(17, 5)	471.21226	71.89798	132.82527
(17, 7)	471.21226	88.13230	134.20681
(17, 9)	471.21226	104.34063	135.86578
(17,11)	471.21226	120.51839	137.80023
(17,13)	471.21226	136.66113	140.00795
(17,15)	471.21226	152.76453	142.48642
(17,17)	471.21226	168.82440	145.23288

C-3

BOX NUMBER 20

COORDINATES	X	Y	Z
(1, 1)	471.21226	39.37008	130.90060
(1, 3)	471.21226	55.64232	131.72276
(1, 5)	471.21226	71.89798	132.82527
(1, 7)	471.21226	88.13230	134.20681
(1, 9)	471.21226	104.34063	135.86578
(1,11)	471.21226	120.51839	137.80023
(1,13)	471.21226	136.66113	140.00795
(1,15)	471.21226	152.76453	142.48642
(1,17)	471.21226	168.82440	145.23288
(3, 1)	486.48335	39.37008	138.67787
(3, 3)	486.48335	55.64232	139.50003
(3, 5)	486.48335	71.89798	140.60254
(3, 7)	486.48335	88.13230	141.98408
(3, 9)	486.48335	104.34063	143.64305
(3,11)	486.48335	120.51839	145.57750
(3,13)	486.48335	136.66113	147.78522
(3,15)	486.48335	152.76453	150.26369
(3,17)	486.48335	168.82440	153.01015
(5, 1)	501.65388	39.37008	146.64951
(5, 3)	501.65388	55.64232	147.47167
(5, 5)	501.65388	71.89798	148.57418
(5, 7)	501.65388	88.13230	149.95573
(5, 9)	501.65388	104.34063	151.61469
(5,11)	501.65388	120.51839	153.54915
(5,13)	501.65388	136.66113	155.75686
(5,15)	501.65388	152.76453	158.23534
(5,17)	501.65388	168.82440	160.98180
(7, 1)	516.72345	39.37008	154.81043
(7, 3)	516.72345	55.64232	155.63259
(7, 5)	516.72345	71.89798	156.73510
(7, 7)	516.72345	88.13230	158.11665
(7, 9)	516.72345	104.34063	159.77561
(7,11)	516.72345	120.51839	161.71007
(7,13)	516.72345	136.66113	163.91779
(7,15)	516.72345	152.76453	166.39626
(7,17)	516.72345	168.82440	169.14272
(9, 1)	531.69176	39.37008	163.15561
(9, 3)	531.69176	55.64232	163.97777
(9, 5)	531.69176	71.89798	165.08028
(9, 7)	531.69176	88.13230	166.46183
(9, 9)	531.69176	104.34063	168.12080
(9,11)	531.69176	120.51839	170.05525
(9,13)	531.69176	136.66113	172.26297
(9,15)	531.69176	152.76453	174.74144
(9,17)	531.69176	168.82440	177.46790
(11, 1)	546.55866	39.37008	171.68013
(11, 3)	546.55866	55.64232	172.50229
(11, 5)	546.55866	71.89798	173.60480
(11, 7)	546.55866	88.13230	174.98635
(11, 9)	546.55866	104.34063	176.64531
(11,11)	546.55866	120.51839	178.57977
(11,13)	546.55866	136.66113	180.78748
(11,15)	546.55866	152.76453	183.26596
(11,17)	546.55866	168.82440	186.01241
(13, 1)	561.32412	39.37008	180.37916

(13, 3)	561.32412	55.64232	181.20132
(13, 5)	561.32412	71.89798	182.30383
(13, 7)	561.32412	88.13230	183.68537
(13, 9)	561.32412	104.34063	185.34434
(13,11)	561.32412	120.51839	187.27879
(13,13)	561.32412	136.66113	189.48651
(13,15)	561.32412	152.76453	191.96498
(13,17)	561.32412	168.82440	194.71144
(15, 1)	575.98824	39.37008	189.24796
(15, 3)	575.98824	55.64232	190.07013
(15, 5)	575.98824	71.89798	191.17263
(15, 7)	575.98824	88.13230	192.55418
(15, 9)	575.98824	104.34063	194.21315
(15,11)	575.98824	120.51839	196.14760
(15,13)	575.98824	136.66113	198.35532
(15,15)	575.98824	152.76453	200.83379
(15,17)	575.98824	168.82440	203.58025
(17, 1)	590.55119	39.37008	198.28193
(17, 3)	590.55119	55.64232	199.10409
(17, 5)	590.55119	71.89798	200.20660
(17, 7)	590.55119	88.13230	201.58815
(17, 9)	590.55119	104.34063	203.24711
(17,11)	590.55119	120.51839	205.18157
(17,13)	590.55119	136.66113	207.38929
(17,15)	590.55119	152.76453	209.86776
(17,17)	590.55119	168.82440	212.61422

BOX NUMBER 21

COORDINATES	X	Y	Z
(1, 1)	0.00000	168.82440	27.15654
(3, 1)	9.85383	168.82440	27.20818
(3, 3)	9.85383	184.83509	30.21928
(5, 1)	19.70658	168.82440	27.36306
(5, 3)	19.70658	184.83509	30.37416
(5, 5)	19.70658	200.79436	33.64691
(7, 1)	29.55717	168.82440	27.62112
(7, 3)	29.55717	184.83509	30.63222
(7, 5)	29.55717	200.79436	33.90497
(7, 7)	29.55717	216.69850	37.43590
(9, 1)	39.40451	168.82440	27.98224
(9, 3)	39.40451	184.83509	30.99334
(9, 5)	39.40451	200.79436	34.26609
(9, 7)	39.40451	216.69850	37.79702
(9, 9)	39.40451	232.54399	41.58246
(11, 1)	49.24755	168.82440	28.44627
(11, 3)	49.24755	184.83509	31.45737
(11, 5)	49.24755	200.79436	34.73012
(11, 7)	49.24755	216.69850	38.26105
(11, 9)	49.24755	232.54399	42.04649
(11,11)	49.24755	248.32750	46.08259
(13, 1)	59.08520	168.82440	29.01301
(13, 3)	59.08520	184.83509	32.02411
(13, 5)	59.08520	200.79436	35.29686
(13, 7)	59.08520	216.69850	38.82779
(13, 9)	59.08520	232.54399	42.61323
(13,11)	59.08520	248.32750	46.64933
(13,13)	59.08520	264.04587	50.93209
(15, 1)	68.91642	168.82440	29.68220
(15, 3)	68.91642	184.83509	32.69330
(15, 5)	68.91642	200.79436	35.96605
(15, 7)	68.91642	216.69850	39.49698
(15, 9)	68.91642	232.54399	43.28242
(15,11)	68.91642	248.32750	47.31852
(15,13)	68.91642	264.04587	51.60129
(15,15)	68.91642	279.69616	56.12656
(17, 1)	78.74015	168.82440	30.45357
(17, 3)	78.74015	184.83509	33.46467
(17, 5)	78.74015	200.79436	36.73742
(17, 7)	78.74015	216.69850	40.26835
(17, 9)	78.74015	232.54399	44.05379
(17,11)	78.74015	248.32750	48.08989
(17,13)	78.74015	264.04587	52.37265
(17,15)	78.74015	279.69616	56.89792
(17,17)	78.74015	295.27559	61.66144

FORM 2401

BOX NUMBER 22

COORDINATES	X	Y	Z
(1, 1)	78.74015	168.82440	30.45357
(1, 3)	78.74015	184.83509	33.46467
(1, 5)	78.74015	200.79436	36.73742
(1, 7)	78.74015	216.69850	40.26835
(1, 9)	78.74015	232.54399	44.05379
(1,11)	78.74015	248.32750	48.08989
(1,13)	78.74015	264.04587	52.37265
(1,15)	78.74015	279.69616	56.89792
(1,17)	78.74015	295.27559	51.66144
(3, 1)	95.81158	168.82440	32.03818
(3, 3)	95.81158	184.83509	35 04928
(3, 5)	95.81158	200.79436	38.32203
(3, 7)	95.81158	216.69850	41.85296
(3, 9)	95.81158	232.54399	45.63840
(3,11)	95.81158	248.32750	49.67450
(3,13)	95.81158	264.04587	53.95726
(3,15)	95.81158	279.69616	58 48254
(3,17)	95.81158	295.27559	63.24606
(5, 1)	112.85181	168.82440	33.92901
(5, 3)	112.85181	184.83509	36.94011
(5, 5)	112.85181	200.79436	40.21286
(5, 7)	112.85181	216.69850	43.74379
(5, 9)	112.85181	232.54399	47.52923
(5,11)	112.85181	248.32750	51.56533
(5,13)	112.85181	264.04587	55.84809
(5,15)	112.85181	279.69616	60.37336
(5,17)	112.85181	295.27559	65.13688
(7, 1)	129.85558	168.82440	36.12362
(7, 3)	129.85558	184.83509	39.13472
(7, 5)	129.85558	200.79436	42.40747
(7, 7)	129.85558	216.69850	45.93840
(7, 9)	129.85558	232.54399	49.72384
(7,11)	129.85558	248.32750	53.75994
(7,13)	129.85558	264.04587	58.04270
(7,15)	129.85558	279.69616	62.56798
(7,17)	129.85558	295.27559	67.33150
(9, 1)	146.81780	168.82440	38.61925
(9, 3)	146.81780	184.83509	41.63035
(9, 5)	146.81780	200.79436	44.90310
(9, 7)	146.81780	216.69850	48.43403
(9, 9)	146.81780	232.54399	52.21947
(9,11)	146.81780	248.32750	56.25557
(9,13)	146.81780	264.04587	60.53833
(9,15)	146.81780	279.69616	65.06360
(9,17)	146.81780	295.27559	69.82712
(11, 1)	163.73351	168.82440	41.41278
(11, 3)	163.73351	184.83509	44.42388
(11, 5)	163.73351	200.79436	47.69663
(11, 7)	163.73351	216.69850	51.22756
(11, 9)	163.73351	232.54399	55.01300
(11,11)	163.73351	248.32750	59.04910
(11,13)	163.73351	264.04587	63.33186
(11,15)	163.73351	279.69616	67.85714
(11,17)	163.73351	295.27559	72.62065
(13, 1)	180.59795	168.82440	44.50079

ORIGINAL PAGE IS OF POOR QUALITY

(13, 5)	180.59795	200.79436	50.78464
(13, 7)	180.59795	216.69850	54.31557
(13, 9)	180.59795	232.54399	58.10100
(13,11)	180.59795	248.32750	62.13711
(13,13)	180.59795	264.04587	66.41987
(13,15)	180.59795	279.69616	70.94514
(13,17)	180.59795	295.27559	75.70866
(15, 1)	197.40655	168.82440	47.87955
(15, 3)	197.40655	184.83509	50.89065
(15, 5)	197.40655	200.79436	54.16340
(15, 7)	197.40655	216.69850	57.69433
(15, 9)	197.40655	232.54399	61.47977
(15,11)	197.40655	248.32750	65.51587
(15,13)	197.40655	264.04587	69 79863
(15,15)	197.40655	279.69616	74.32391
(15,17)	197.40655	295.27559	79.08743
(17, 1)	214.15496	168.82440	51.54509
(17, 3)	214.15496	184.83509	54.55619
(17, 5)	214.15496	200.79436	57.82894
(17, 7)	214.15496	216.69850	61.35987
(17, 9)	214.15496	232.54399	65.14531
(17,11)	214.15496	248.32750	69.18141
(17,13)	214.15496	264.04587	73.46417
(17,15)	214.15496	279.69616	77.98945
(17,17)	214.15496	295.27559	82.75297

BOX NUMBER 23

COORDINATES	X	Y	Z
(1, 1)	214.15496	168.82440	51.54509
(1, 3)	214.15496	184.83509	54.55619
(1, 5)	214.15496	200.79436	57.82894
(1, 7)	214.15496	216.69850	61.35987
(1, 9)	214.15496	232.54399	65.14531
(1,11)	214.15496	248.32750	69.18141
(1,13)	214.15496	264.04587	73.46417
(1,15)	214.15496	279.69616	77.98945
(1,17)	214.15496	295.27559	82.75297
(3, 1)	230.83674	168.82440	55.49261
(3, 3)	230.83674	184.83509	58.50371
(3, 5)	230.83674	200.79436	61.77646
(3, 7)	230.83674	216.69850	65.30739
(3, 9)	230.83674	232.54399	69.09283
(3,11)	230.83674	248.32750	73.12893
(3,13)	230.83674	264.04587	77.41169
(3,15)	230.83674	279.69616	81.93697
(3,17)	230.83674	295.27559	86.70049
(5, 1)	247.45028	168.82440	59.71813
(5, 3)	247.45028	184.83509	62.72923
(5, 5)	247.45028	200.79436	66.00198
(5, 7)	247.45028	216.69850	69.53291
(5, 9)	247.45028	232.54399	73.31835
(5,11)	247.45028	248.32750	77.35445
(5,13)	247.45028	264.04587	81.63722
(5,15)	247.45028	279.69616	86.16249
(5,17)	247.45028	295.27559	90.92601
(7, 1)	263.99190	168.82440	64.21701
(7, 3)	263.99190	184.83509	67.22811
(7, 5)	263.99190	200.79436	70.50086
(7, 7)	263.99190	216.69850	74.03179
(7, 9)	263.99190	232.54399	77.81723
(7,11)	263.99190	248.32750	81.85333
(7,13)	263.99190	264.04587	86.13609
(7,15)	263.99190	279.69616	90.66137
(7,17)	263.99190	295.27559	95.42489
(9, 1)	280.45815	168.82440	68.98442
(9, 3)	280.45815	184.83509	71.99552
(9, 5)	280.45815	200.79436	75.26827
(9, 7)	280.45815	216.69850	78.79920
(9, 9)	280.45815	232.54399	82.58464
(9,11)	280.45815	248.32750	86.62074
(9,13)	280.45815	264.04587	90.90350
(9,15)	280.45815	279.69616	95.42878
(9,17)	280.45815	295.27559	100.19230
(11, 1)	296.84580	168.82440	74.01538
(11, 3)	296.84580	184.83509	77.02648
(11, 5)	296.84580	200.79436	80.29923
(11, 7)	296.84580	216.69850	83.83016
(11, 9)	296.84580	232.54399	87.61560
(11,11)	296.84580	248.32750	91.65170
(11,13)	296.84580	264.04587	95.93446
(11,15)	296.84580	279.69616	100.45974
(11,17)	296.84580	295.27559	105.22326
(13, 1)	313.15188	168.82440	79.30479

(13, 5)	313.15188	200.79436	85.58864
(13, 7)	313.15188	216.69850	89.11957
(13, 9)	313.15188	232.54399	92.90501
(13,11)	313.15188	248.32750	96.94111
(13,[illegible])	313.15188	264.04587	101.22388
(13,15)	313.15189	279.69616	105.74915
(13,17)	313.15188	295.27559	110.51267
(15, 1)	329.37363	168.82440	84.84745
(15, 3)	329.37363	184.83509	87.85855
(15, 5)	329.37363	200.79436	91.13130
(15, 7)	329.37363	216.69850	94.66223
(15, 9)	329.37363	232.54399	98.44767
(15,11)	329.37363	248.32750	102.48377
(15,13)	329.37363	264.04587	106.76653
(15,15)	329.37363	279.69616	111.29181
(15,17)	329.37363	295.27559	116.05532
(17, 1)	345.50854	168.82440	90.63806
(17, 3)	345.50854	184.83509	93.64916
(17, 5)	345.50854	200.79436	96.92191
(17, 7)	345.50854	216.69850	100.45284
(17, 9)	345.50854	232.54399	104.23828
(17,11)	345.50854	248.32750	108.27438
(17,13)	345.50854	264.04587	112.55714
(17,15)	345.50854	279.69616	117.08241
(17,17)	345.50854	295.27559	121.84593

BOX NUMBER 24

COORDINATES	X	Y	Z
(1, 1)	345.50854	168.82440	90.63806
(1, 3)	345.50854	184.83509	93.64916
(1, 5)	345.50854	200.79436	96.92191
(1, 7)	345.50854	216.69850	100.45284
(1, 9)	345.50854	232.54399	104.23828
(1,11)	345.50854	248.32750	108.27438
(1,13)	345.50854	264.04587	112.55714
(1,15)	345.50854	279.69616	117.08241
(1,17)	345.50854	295.27559	121.84593
(3, 1)	361.55178	168.82440	96.67029
(3, 3)	361.55178	184.83509	99.68139
(3, 5)	361.55178	200.79436	102.95415
(3, 7)	361.55178	216.69850	106.48507
(3, 9)	361.55178	232.54399	110.27051
(3,11)	361.55178	248.32750	114.30661
(3,13)	361.55178	264.04587	118.58938
(3,15)	361.55178	279.69616	123.11465
(3,17)	361.55178	295.27559	127.87817
(5, 1)	377.50385	168.82440	102.93966
(5, 3)	377.50385	184.83509	105.95076
(5, 5)	377.50385	200.79436	109.22351
(5, 7)	377.50385	216.69850	112.75444
(5, 9)	377.50385	232.54399	116.53988
(5,11)	377.50385	248.32750	120.57598
(5,13)	377.50385	264.04587	124.85874
(5,15)	377.50385	279.69616	129.38402
(5,17)	377.50385	295.27559	134.14754
(7, 1)	393.36289	168.82440	109.44075
(7, 3)	393.36289	184.83509	112.45185
(7, 5)	393.36289	200.79436	115.72460
(7, 7)	393.36289	216.69850	119.25553
(7, 9)	393.36289	232.54399	123.04097
(7,11)	393.36289	248.32750	127.07707
(7,13)	393.36289	264.04587	131.35983
(7,15)	393.36289	279.69616	135.88511
(7,17)	393.36289	295.27559	140.64863
(9, 1)	409.12727	168.82440	116.16814
(9, 3)	409.12727	184.83509	119.17924
(9, 5)	409.12727	200.79436	122.45199
(9, 7)	409.12727	216.69850	125.98292
(9, 9)	409.12727	232.54399	129.76836
(9,11)	409.12727	248.32750	133.80446
(9,13)	409.12727	264.04587	138.08722
(9,15)	409.12727	279.69616	142.61249
(9,17)	409.12727	295.27559	147 37601
(11, 1)	424.79555	168.82440	123.11641
(11, 3)	424.79555	184.83509	126.12751
(11, 5)	424.79555	200.79436	129.40026
(11, 7)	424.79555	216.69850	132.93119
(11, 9)	424.79555	232.54399	136.71663
(11,11)	424.79555	248.32750	140.75273
(11,13)	424.79555	264.04587	145.03549
(11,15)	424.79555	279.69616	149.56077
(11,17)	424.79555	295.27559	154.32429
(13, 1)	440.36648	168.82440	130.28018

(13, 5)	440.36648	200.79436	136.56403
(13, 7)	440.36648	216.69850	140.09496
(13, 9)	440.36648	232.54399	143.88040
(13,11)	440.36648	248.32750	147.91650
(13,13)	440.36648	264.04587	152.19926
(13,15)	440.36648	279.69616	156.72454
(13,17)	440.36648	295.27559	161.48806
(15, 1)	455.83902	168.82440	137.65411
(15, 3)	455.83902	184.83509	140.66521
(15, 5)	455.83902	200.79436	143.93796
(15, 7)	455.83902	216.69850	147.46889
(15, 9)	455.83902	232.54399	151.25433
(15,11)	455.83902	248.32750	155.29043
(15,13)	455.83902	264.04587	159.57319
(15,15)	455.83902	279.69616	164 09847
(15,17)	455.83902	295.27559	16[illegible].86199
(17, 1)	471.21226	168.82440	145.23288
(17, 3)	471.21226	184.83509	148.24398
(17, 5)	471.21226	200.79436	151.51673
(17, 7)	471.21226	216.69850	155.04766
(17, 9)	471.21226	232.54399	158.83310
(17,11)	471.21226	248.32750	162.86920
(17,13)	471.21226	264.04587	167.15196
(17,15)	471.21226	279.69616	171.67724
(17,17)	471.21226	295.27559	176.44076

BOX NUMBER 25

COORDINATES	X	Y	Z
(1, 1)	471.21226	168.82440	145.23288
(1, 3)	471.21226	184.83509	148.24398
(1, 5)	471.21226	200.79436	151.51673
(1, 7)	471.21226	216.69850	155.04766
(1, 9)	471.21226	232.54399	158.83310
(1,11)	471.21226	248.32750	162.86920
(1,13)	471.21226	264.04587	167.15196
(1,15)	471.21226	279.69616	171.67724
(1,17)	471.21226	295.27559	176.44076
(3, 1)	486.48335	168.82440	153.01015
(3, 3)	486.48335	184.83509	156.02125
(3, 5)	486.48335	200.79436	159.29400
(3, 7)	486.48335	216.69850	162.82493
(3, 9)	486.48335	232.54399	166.61037
(3,11)	486.48335	248.32750	170.64647
(3,13)	486.48335	264.04587	174.92923
(3,15)	486.48335	279.69616	179.45451
(5, 1)	501.65388	168.82440	160.98180
(5, 3)	501.65388	184.83509	163.99290
(5, 5)	501.65388	200.79436	167.26565
(5, 7)	501.65388	216.69850	170.79657
(5, 9)	501.65388	232.54399	174.58201
(5,11)	501.65388	248.32750	178.61812
(5,13)	501.65388	264.04587	182.90088
(7, 1)	516.72345	168.82440	169.14272
(7, 3)	516.72345	184.83509	172.15382
(7, 5)	516.72345	200.79436	175.42657
(7, 7)	516.72345	216.69850	178.95750
(7, 9)	516.72345	232.54399	182.74294
(7,11)	516.72345	248.32750	186.77904
(9, 1)	531.69176	168.82440	177.48790
(9, 3)	531.69176	184.83509	180.49900
(9, 5)	531.69176	200.79436	183.77175
(9, 7)	531.69176	216.69850	187.30268
(9, 9)	531.69176	232.54399	191.08812
(11, 1)	546.55866	168.82440	186.01241
(11, 3)	546.55866	184.83509	189.02352
(11, 5)	546.55866	200.79436	192.29627
(11, 7)	546.55866	216.69850	195.82719
(13, 1)	561.32412	168.82440	194.71144
(13, 3)	561.32412	184.83509	197.72254
(13, 5)	561.32412	200.79436	200.99529
(15, 1)	575.98824	168.82440	203.58025
(15, 3)	575.98824	184.83509	206.59135
(17, 1)	590.55119	168.82440	212.61422

```
12.47.22.UCLP, A355,      2.466KLNS.
12.47.22.ICSR,       1.082UNTS.


******    AHAIGJZ    ******
******    AHAIGJZ    ******
```

ORIGINAL PAGE IS
OF POOR QUALITY

FORM 2401,

Appendix E— Mesh Deflections of Single Panel★

★ **Mesh Support System Deflections, plus Box-Truss Deflections**

Appendix E—
Mesh Deflections of
Single Panel

ORIGINAL PAGE IS
OF POOR QUALITY

MESH SUPPORT SYSTEM

***** DISPLACEMENT SOLUTION ***** TIME 0

NODE	UX	UY	UZ
1	.267231E-02	.292133E-03	-.899672E-03
3	.171156E-02	.509136E-03	-.237202E-02
5	.335819E-02	.935061E-03	-.545317E-02
7	.240080E-02	.834076E-03	-.353869E-02
9	.279395E-02	.577845E-03	-.101977E-02
35	.439345E-02	.449292E-03	-.397678E-02
37	-.992094E-03	-.966906E-04	.227965E-02
39	.147107E-02	.157996E-03	-.226807E-02
41	.113959E-02	-.965428E-04	-.159721E-02
43	.401011E-02	.208075E-04	-.333896E-02
69	.647203E-02	.683823E-03	-.749721E-02
71	.216174E-02	.435989E-03	-.397825E-02
73	.453155E-02	.794929E-03	-.825584E-02
75	.306541E-02	.414036E-03	-.554668E-02
77	.601142E-02	.609504E-03	-.689129E-02
103	.594964E-02	.608266E-03	-.627969E-02
105	.190174E-02	.398851E-03	-.398832E-02
107	.266435E-02	.462080E-03	-.539054E-02
109	.121067E-02	.614851E-04	-.275093E-02
111	.508566E-02	.394439E-03	-.515632E-02
137	.537662E-02	.657777E-03	-.496970E-02
139	.324002E-02	.616393E-03	-.658267E-02
141	.264826E-02	.397131E-03	-.565509E-02
143	.297306E-02	.311538E-03	-.598657E-02
145	.516581E-02	.447335E-04	-.509056E-02

Local Shadow Effect

ORIGINAL PAGE IS
OF POOR QUALITY

MESH SUPPORT SYSTEM

***** DISPLACEMENT SOLUTION ***** TIME = 0.

NODE	UX	UY	UZ
1	.536027E-03	-.352387E-03	.266033E-02
3	-.108958E-02	-.607201E-03	.210711E-02
5	-.166386E-03	-.721806E-03	.296651E-03
7	-.147581E-02	-.133796E-02	.291721E-02
9	.326468E-02	-.144959E-02	.190023E-02
35	.317913E-02	.412302E-04	-.192834E-02
37	.853391E-03	-.547750E-04	-.181599E-02
39	-.125099E-02	-.530240E-03	.235263E-02
41	-.605163E-02	-.180414E-02	.116313E-01
43	.357176E-02	-.211484E-03	.130912E-02
69	.515199E-02	.212664E-03	-.499487E-02
71	-.112244E-03	.884473E-06	-.173873E-03
73	.242080E-02	.462564E-03	-.433716E-02
75	.102337E-02	.100870E-03	-.134816E-02
77	.631568E-02	.624151E-03	-.361498E-02
103	.346803E-02	.486857E-04	-.152034E-02
105	-.610414E-02	-.650403E-03	.100608E-01
107	.375887E-03	.355670E-03	-.762891E-03
109	.414774E-02	.113824E-02	-.676970E-02
111	.575635E-02	.468119E-03	-.252586E-02
137	.153490E-02	-.140350E-03	.226031E-02
139	-.114213E-02	-.397563E-03	.191966E-02
141	-.517290E-03	-.567834E-03	.802869E-03
143	.409770E-03	-.650328E-03	-.666021E-03
145	.343503E-02	-.126002E-02	.114943E-02

Maximum Temperature Case

MESH SUPPORT SYSTEM

***** DISPLACEMENT SOLUTION ***** TIME = 0.

NODE	UX	UY	UZ
1	-.183238E-04	.119911E-02	.370032E-02
3	-.155476E-02	.166494E-02	.302489E-02
5	-.105932E-02	.218970E-02	.203837E-02
7	-.228489E-02	.231716E-02	.449786E-02
9	.218812E-02	.279082E-02	.437021E-02
35	.126814E-02	-.143097E-03	.231363E-02
37	.295351E-03	-.154166E-03	-.788741E-03
39	-.291442E-02	-.931625E-03	.543712E-02
41	-.759790E-02	-.229180E-02	.144966E-01
43	-.401037E-03	-.161975E-02	.912115E-02
69	.268861E-02	-.663742E-04	.778741E-03
71	-.251980E-02	-.387760E-03	.413277E-02
73	-.155208E-02	-.387512E-03	.279198E-02
75	-.248733E-02	-.787325E-03	.494589E-02
77	.920224E-03	-.115922E-02	.649997E-02
103	.177867E-02	-.166510E-03	.340259E-02
105	-.764177E-02	-.866292E-03	.127605E-01
107	-.202560E-02	-.140882E-03	.347512E-02
109	.213224E-02	.583892E-03	-.321076E-02
111	.154950E-02	-.916533E-03	.522947E-02
137	.251887E-02	.171384E-02	.326031E-02
139	-.967582E-03	.235096E-02	.169544E-02
141	-.318814E-03	.300648E-02	.583742E-03
143	.794795E-03	.379962E-02	-.[illegible]1092E-02
145	.368171E-02	.391947E-02	.159946E-02

Minimum Temperature Case

Appendix F—
Nodal Deflections for Thermal
and Centrifugal Cases on
Antenna Support Structures

OGR.

Appendix F—
Nodal Deflections for Thermal and Centrifugal Cases on the Antenna Support Structures

MSDA THERMOELASTIC MODEL 5X5 2M. NEW SPIN AXIS W/BALLAST
THERMOELASTIC BEHAVOIR MODEL

CENTRIFUGAL LOAD 6 RPM SURCASE 1

D I S P L A C E M E N T   V E C T O R

POINT ID.	TYPE	Δx (inches)	Δy (inches)	Δz (inches)	θx (radians)	θy (radians)	θz (radians)
1	G	3.706227E-03	-2.783268E-04	-5.574797E-04	-3.058087E-04	2.764618E-05	7.095983E-05
2	G	4.145374E-03	-4.484137E-04	-3.096691E-03	-2.900233E-04	-4.652959E-05	-2.890349E-05
3	G	5.022275E-03	-6.032640E-04	-5.749521E-03	-2.616346E-04	-1.001230E-04	-8.483725E 05
4	G	6.180902E-03	-4.233985E-04	-8.321891E-03	-2.886101E-04	-1.804508E-04	8.320552E-06
5	G	2.115724E-03	8.398682E-05	4.928196E-04	-1.700018E-04	5.270436E-05	4.684896E-07
6	G	2.213638E-03	-1.298116E-04	-4.114297E-04	-1.615332E-04	-2.783390E-06	-5.947085E-06
7	G	2.775720E-03	-2.221626E-04	-2.530503E-03	-1.489452E-04	-6.106067E-05	-2.022796E-06
8	G	3.777880E-03	-3.484991E-04	-5.035188E-03	-1.285763E-04	-1.148764E-04	4.201915E-06
9	G	5.151709E-03	-2.262625E-04	-7.842593E-03	-1.127964E-04	-1.634443E-04	-7.138893E-06
10	G	6.669278E-03	3.592340E-05	-1.033618E-02	-1.687855E-04	-2.713586E-04	-4.962463E-05
11	G	-2.671497E-04	1.303417E-04	9.731782E-05	-2.666396E-06	-5.776564E-06	1.093262E-05
12	G	8.529487E-05	1.113358E-04	-3.354701E-05	-2.182637E-05	-1.221469E-05	-5.033830E-06
13	G	7.908832E-04	5.329057E-05	-1.739772E-03	-2.277026E-05	-8.839822E-05	2.534009E-06
14	G	1.899976E-03	-3.394988E-06	-3.848331E-03	-2.463520E-05	-1.497877E-04	9.514746E-06
15	G	3.894992E-03	3.885395E-05	-7.202990E-03	-1.691493E-05	-1.925166E-04	1.583839E-05
16	G	5.685821E-03	1.134160E-04	-1.002354E-02	-2.738344E-05	-2.749534E-04	5.300958E-05
17	G	-2.768636E-04	-2.697571E-05	9.702026E-05	2.859425E-06	-5.834484E-06	-1.063263E-05
18	G	7.493224E-05	1.354888E-05	-3.029321E-05	2.468244E-05	-1.218553E-05	5.407219E-06
19	G	7.795710E-04	7.888824E-05	-1.737415E-03	2.364503E-05	-8.822158E-05	-2.211370E-06
20	G	1.888058E-03	2.055424E-04	-3.845257E-03	1.573904E-05	-1.496668E-04	-1.055472E-05
21	G	3.882403E-03	2.006198E-04	-7.199274E-03	2.281060E-06	-1.925241E-04	-1.806297E-05
22	G	5.672814E-03	1.625030E-04	-1.001929E-02	7.638382E-06	-2.750016E-04	-5.450686E-05
23	G	2.058484E-03	1.764134E-05	4.977895E-04	1.836640E-04	5.274860E-05	1.451965E-07
24	G	2.156315E-03	2.535096E-04	-4.016277E-04	1.738161E-04	-2.274392E-06	6.822311E-06
25	G	2.717939E-03	3.834614E-04	-2.516208E-03	1.429733E-04	-6.049399E-05	1.708598E-06
26	G	3.719199E-03	5.490137E-04	-5.017440E-03	1.112070E-04	-1.146554E-04	-6.991010E-06
27	G	5.091764E-03	4.638346E-04	-7.821906E-03	8.692579E-05	-1.635340E-04	1.530666E-06
28	G	6.607898E-03	2.379961E-04	-1.031301E-02	1.539547E-04	-2.714163E-04	4.476826E-05
29	G	3.607469E-03	3.991075E-04	-5.369305E-04	3.070837E-04	2.782357E-05	8.019619E-05
30	G	4.045572E-03	6.067774E-04	-3.069777E-03	2.847693E-04	-4.626375E-05	2.853654E-05
31	G	4.920640E-03	8.000920E-04	-5.716636E-03	2.509299E-04	-1.000304E-04	8.232534E-0[illegible]
32	G	6.077004E-03	6.567418E-04	-8.283716E-03	2.735083E-04	-1.304918E-04	-9.847758E-06
33	G	7.864332E-04	-1.603831E-04	-5.507726E-04	3.007337E-04	3.737891E-05	-5.228812E-05
34	G	1.190461E-03	-1.288812E-04	-3.081453E-03	2.736687E-04	1.116109E-04	3.202679E-05
35	G	1.992980E-03	-1.074336E-04	-5.726817E-03	2.336266E-04	1.873759E-04	2.351980E-05
36	G	3.133113E-03	-6.601210E-05	-8.306256E-03	2.115280E-04	2.087657E-04	3.314235E-05
37	G	-1.068837E-04	-5.303757E-06	4.945016E-04	1.691386E-04	-1.658776E-05	-3.537285E-06
38	G	-6.229460E-05	-7.847213E-05	-4.039859E-04	1.590825E-04	6.866719E-05	-2.310784E-06
39	G	2.500264E-04	2.209919E-05	-2.508583E-03	1.392974E-04	1.329463E-04	2.926099E-05
40	G	9.190944E-04	8.657904E-05	-4.991675E-03	1.126878E-04	2.187296E-04	-4.266386E-06
41	G	2.093285E-03	7.233068E-05	-7.797637E-03	7.970548E-05	2.863264E-04	-7.779073E-06
42	G	3.527319E-03	1.331459E-04	-1.032064E-02	8.721986E-05	3.111383E-04	-3.418330E-05
43	G	0.0	0.0	0.0	8.757772E-06	-5.678831E-06	1.504010E-05
44	G	-2.677513E-04	0.0	0.0	2.061392E-05	2.668981E-05	-2.986844E-06
45	G	-3.125767E-04	6.689089E-05	-1.707952E-03	1.943847E-05	1.852971E-04	3.059024E-06
46	G	-4.816531E-05	1.449777E-04	-3.747289E-03	2.621559E-05	2.412785E-04	1.594802E-05
47	G	1.038661E-03	1.353624E-04	-7.104434E-03	2.[illegible]71032E-05	3.162052E-04	1.314308E-05
48	G	2.579969E-03	1.570141E-04	-9.984384E-03	2.068657E-05	3.297511E-04	3.032106E-05
49	G	0.0	1.001984E-04	0.0	-9.096014E-06	-5.745585E-06	-1.487873E 05
50	G	-2.781665E-04	1.332849E-04	0.0	-2.577507E-05	2.663858E-05	3.125674E-06

MSDA THERMOELASTIC MODEL 5X5 2M. NEW SPIN AXIS W/BALLAST
THERMOELASTIC BEHAVOIR MODEL

CENTRIFUGAL LOAD 6 RPM SUBCASE 1

DISPLACEMENT VECTOR

POINT ID.	TYPE	Δx (inches)	Δy (inches)	Δz (inches)	θx (radians)	θy (radians)	θz (radians)
51	G	-3.238257E-04	1.047493E-04	-1.705370E-03	-4.718389E-05	1.848724E-04	-5.457833E-06
52	G	-5.952066E-05	6.827673E-05	-3.744406E-03	-5.359992E-05	2.405993E-04	-2.085454E-05
53	G	1.026889E-03	1.160005E-04	-7.100817E-03	-5.380804E-05	3.154396E-04	-1.822012E-05
54	G	2.567856E-03	1.319669E-04	-9.980223E-03	-5.942769E-05	3.292137E-04	-3.363900E-05
55	G	-1.623696E-04	1.072936E-04	4.995348E-04	-1.839804E-04	-1.668767E-05	3.739399E-06
56	G	-1.173563E-04	2.105929E-04	-3.939577E-04	-1.971622E-04	6.772147E-05	4.233797E-07
57	G	1.949177E-04	1.488389E-04	-2.494333E-03	-1.781479E-04	1.312945E-04	-3.470455E-05
58	G	8.636737E-04	1.248844E-04	-4.974040E-03	-1.592139E-04	2.163885E-04	-3.791724E-06
59	G	2.036748E-03	1.770939E-04	-7.777119E-03	-1.316889E-04	2.835893E-04	-4.180002E-06
60	G	3.469282E-03	1.5380[illegible]0E-04	-1.029743E-02	-1.169372E-04	3.103750E-04	2.470341E-05
61	G	6.941455E-04	2.901040E-04	-5.302278E-04	-3.167566E-04	3.694478E-05	5.160432E-05
62	G	1.097090E-03	2.968146E-04	-3.054552E-03	-2.952420E-04	1.106387E-04	-3.450288E-05
63	G	1.897753E-03	3.150650E-04	-5.693963E-03	-2.590639E-04	1.857965E-04	-2.982563E-05
64	G	3.035665E-03	3.110317E-04	-8.268115E-03	-2.415339E-04	2.073024E-04	-3.685188E-05
65	G	-3.891458E-03	8.790582E-05	2.780691E-04	1.464516E-06	-5.503145E-04	2.636252E-05
66	G	-9.269314E-03	9.193277E-05	3.878278E-04	-2.177434E-06	-1.381034E-05	2.955909E-05
67	G	-1.464590E-02	5.767577E-05	5.347973E-04	-1.294441E-05	2.444616E-04	3.232045E-05
68	G	-3.900879E-03	1.773247E-05	2.775192E-04	-1.498638E-06	-5.503285E-04	-2.612852E-05
69	G	-9.278556E-03	1.638312E-05	3.871977E-04	2.210912E-06	-1.381780E-05	-2.932891E-05
70	G	-1.465597E-02	5.260577E-05	5.340814E-04	1.983900E-05	2.444540E-04	-3.206642E-05
71	G	-3.906645E-03	-8.558710E-06	-2.253408E-03	3.579671E-06	9.577243E-05	-8.925541E-06
72	G	-9.289145E-03	6.127434E-06	-3.109423E-03	1.238394E-05	-2.305508E-04	-5.595606E-06
73	G	-1.454003E-02	2.136703E-05	-3.342134E-03	1.225420E-06	-3.003031E-04	-2.585857E-06
74	G	-3.916059E-03	7.799017E-05	-2.256329E-03	1.003307E-06	9.575839E-05	9.152917E-06
75	G	-9.298349E-03	6.631941E-05	-3.111313E-03	-7.296981E-06	-2.305583E-04	5.824669E-06
76	G	-1.455011E-02	4.837757E-05	-3.344125E-03	2.974497E-05	-3.003107E-04	2.840500E-06
77	G	-7.089047E-04	5.365488E-05	-1.519139E-03	-1.933651E-05	-6.552282E-05	-1.743951E-05
78	G	-7.169458E-04	1.720406E-05	-1.523684E-03	2.078668E-05	-6.554399E-05	1.735752E-05
79	G	0.0	0.0	0.0	0.0	0.0	0.0
80	G	0.0	0.0	0.0	0.0	0.0	0.0

F-2

ORIGINAL PAGE IS
OF POOR QUALITY

MSDA THERMOELASTIC MODEL 5X5 2M. NEW SPIN AXIS W/BALLAST
THERMOELASTIC BEHAVOIR MODEL

90 DEGREE ORBITAL POSITION (AVE. TEMP.) SUBCASE 2

DISPLACEMENT VECTOR

POINT ID.	TYPE	Δx (inches)	Δy (inches)	Δz (inches)	θx (radians)	θy (radians)	θz (radians)
1	G	3.182630E-03	2.573115E-03	1.621822E-03	-4.960921E-06	1.093044E-05	1.289829E-06
2	G	3.543188E-03	2.359679E-03	9.474088E-04	-7.981681E-07	1.803920E-05	1.395799E-09
3	G	4.520842E-03	2.470084E-03	-9.987882E-04	-1.234367E-06	2.633308E-05	6.212310E-07
4	G	6.117453E-03	2.390813E-03	-3.444982E-03	-1.042567E-06	3.312388E-05	-8.126002E-07
5	G	2.063315E-03	1.672273E-03	1.687663E-03	-5.838933E-06	9.558985E-06	5.890874E-06
6	G	2.310584E-03	1.740426E-03	1.991705E-03	-5.460463E-06	1.253159E-05	1.254981E-06
7	G	2.645848E-03	1.203323E-03	1.006726E-03	1.857295E-06	1.676242E-05	2.333882E-06
8	G	3.566056E-03	1.535825E-03	-7.650679E-04	-1.553510E-06	2.337179E-05	-4.705405E-07
9	G	5.130047E-03	1.478691E-03	-3.182865E-03	-2.209531E-07	3.072871E-05	-9.366734E-07
10	G	7.389262E-03	1.386961E-03	-5.900314E-03	-6.789739E-08	3.614362E-05	-1.177246E-06
11	G	8.405265E-04	7.504559E-04	2.579653E-03	-2.640430E-06	4.101169E-06	-3.733645E-07
12	G	1.355363E-03	5.456373E-04	2.438229E-03	-3.184995E-06	4.129424E-06	-3.758435E-06
13	G	1.812357E-03	1.024308E-04	8.113332E-04	1.798044E-06	9.413086E-06	4.269300E-08
14	G	3.553692E-03	5.472459E-04	-1.111088E-03	-6.502730E-07	2.285239E-05	2.595877E-06
15	G	4.883813E-03	5.632329E-04	-3.194735E-03	9.518708E-07	2.812582E-05	5.391637E-07
16	G	6.979290E-03	4.322319E-04	-5.639668E-03	9.647341E-07	3.338463E-05	5.203022E-07
17	G	7.394248E-04	-4.356033E-04	2.568690E-03	1.666021E-07	4.665161E-06	-2.319640E-06
18	G	1.534907E-03	-2.678117E-04	2.301783E-03	1.507886E-06	5.119328E-06	3.033512E-06
19	G	1.947839E-03	6.140396E-04	7.152514E-04	-2.962798E-06	9.854884E-06	1.131393E-06
20	G	3.372261E-03	-4.992863E-05	-1.247238E-03	2.141743E-06	2.160673E-05	-1.090171E-06
21	G	4.615069E-03	-2.648156E-04	-3.175254E-03	2.234831E-06	2.647602E-05	3.895263E-06
22	G	6.765117E-03	-4.057116E-04	-5.770120E-03	1.927990E-06	3.284126E-05	4.631945E-06
23	G	116629E-03	-1.358333E-03	1.411316E-03	3.537603E-06	4.330258E-06	-2.067472E-06
24	G	71475E-03	-1.405192E-03	1.854886E-03	4.513760E-06	6.997355E-06	2.527071E-06
25	G	1.007662E-03	-5.336726E-04	8.914616E-04	-1.718671E-06	1.268573E-05	2.538515E-06
26	G	2.536226E-03	-1.029816E-03	-6.904287E-04	2.354049E-06	1.895987E-05	3.513901E-06
27	G	3.932322E-03	-1.216245E-03	-2.782512E-03	2.705318E-06	2.619155E-05	3.839235E-06
28	G	6.069463E-03	-1.416220E-03	-5.378558E-03	2.839038E-06	3.293758E-05	5.724266E-06
29	G	1.341052E-03	-2.169655E-03	1.268161E-03	3.652544E-06	4.095673E-06	2.850984E-06
30	G	1.633970E-03	-1.692360E-03	8.421298E-04	2.387210E-07	1.064071E-05	1.703931E-06
31	G	2.498292E-03	-1.969561E-03	-7.064074E-04	1.028994E-06	1.871404E-05	-1.511779E-07
32	G	4.007944E-03	-2.175502E-03	-2.797985E-03	1.662893E-06	2.647244E-05	3.087788E-06
33	G	1.563814E-03	1.718218E-03	1.940648E-03	-5.434147E-06	1.032672E-05	6.018932E-06
34	G	8.132139E-04	2.196914E-03	-3.009060E-04	-1.263615E-06	1.698285E-05	4.985203E-07
35	G	4.625256E-04	2.185607E-03	-1.940010E-03	-2.241418E-06	2.568078E-05	-1.337779E-06
36	G	1.008926E-03	2.151138E-03	-4.551986E-03	-2.032615E-06	3.251971E-05	-2.271692E-06
37	G	6.069717E-04	7.191197E-04	2.168190E-03	-6.018341E-06	9.674859E-06	5.130539E-07
38	G	5.701533E-04	6.082466E-04	1.071406E-03	-8.521621E-06	1.022830E-05	-2.946715E-07
39	G	2.079742E-04	1.325104E-03	-7.144812E-05	-9.540273E-07	1.414320E-05	2.485212E-06
40	G	-5.529934E-05	1.302535E-03	-1.802469E-03	-1.882383E-06	2.305937E-05	-1.879491E-06
41	G	4.016949E-04	1.353751E-03	-4.067015E-03	-2.149650E-06	2.996631E-05	-2.352985E-06
42	G	1.701698E-03	1.319187E-03	-6.950641E-03	-1.352612E-06	3.585589E-05	-3.566777E-06
43	G	0.0	0.0	0.0	-5.856338E-06	4.124003E-06	8.591383E-07
44	G	7.403369E-04	0.0	0.0	-3.790972E-06	3.805819E-06	-2.459961E-07
45	G	4.994005E-04	4.855229E-04	3.240084E-04	1.402263E-06	7.575913E-06	1.695412E-06
46	G	-8.165772E-05	5.169475E-04	-1.011695E-03	-8.659466E-08	2.332036E-05	-2.686651E-07
47	G	5.072700E-04	5.312915E-04	-3.703652E-03	-1.159845E-06	2.793475E-05	-1.538934E-06
48	G	1.735886E-03	4.830887E-04	-6.395849E-03	-1.508322E-07	3.306323E-05	-7.549291E-07
49	G	0.0	-1.425704E-04	0.0	2.451288E-06	4.746838E-06	-7.619589E-07
50	G	7.388156E-04	5.000427E-05	0.0	2.304569E-06	4.972251E-06	2.021072E-06

MSDA THERMOELASTIC MODEL 5X5 2M. NEW SPIN AXIS W/BALLAST
THERMOELASTIC BEHAVOIR MODEL

90 DEGREE ORBITAL POSITION (AVE. TEMP.) SUBCASE 2

D I S P L A C E M E N T   V E C T O R

POINT ID.	TYPE	Δx (inches)	Δy (inches)	Δz (inches)	θx (radians)	θy (radians)	θz (radians)
51	G	4.602049E-04	-2.856156E-05	1.150104E-04	-2.537946E-06	8.574228E-06	-4.041978E-07
52	G	-1.219071E-04	-2.095826E-04	-1.241052E-03	-9.871548E-07	2.229271E-05	2.358920E-07
53	G	4.680030E-04	-2.363473E-04	-4.024043E-03	9.590990E-07	2.633007E-05	2.639846E-06
54	G	1.551364E-03	-3.008089E-04	-6.501267E-03	1.475902E-06	3.284431E-05	4.817294E-06
55	G	3.599705E-04	-8.168249E-04	1.879991E-03	3.321006E-06	5.820803E-06	1.804722E-06
56	G	3.065386E-04	-5.191017E-04	8.736212E-04	6.556219E-06	6.660790E-06	2.626703E-06
57	G	-2.825290E-04	-8.794971E-04	-1.692361E-04	-5.439338E-07	1.139195E-05	-5.706094E-07
58	G	-5.918732E-04	-1.041076E-03	-1.748284E-03	6.513934E-C7	1.978848E-05	3.148363E-06
59	G	-2.411199E-04	-1.129831E-03	-3.854889E-03	2.289781E-06	2.632612E-05	4.463566E-06
60	G	8.390814E-04	-1.190745E-03	-6.416811E-03	2.489386E-06	3.297591E-05	6.132584E-06
61	G	7.308752E-04	-1.561931E-03	1.5931[illegible]4E-03	3.755725E-06	4.129961E-06	-2.669950E-06
62	G	-4.996403E-05	-1.730887E-03	-3.940119E-04	-2.380397E-08	1.055142E-05	-3.977540E-07
63	G	-5.255493E-04	-1.966923E-03	-1.640044E-03	4.723067E-07	1.910673E-05	3.343958E-07
64	G	-1.735694E-04	-2.028871E-03	-3.889786E-03	1.340527E-06	2.664783E-05	3.548607E-06
65	G	-4.648534E-03	9.558732E-04	4.266190E-03	-4.118768E-07	-3.402170E-05	6.428566E-08
66	G	-1.102201E-02	9.684505E-04	5.974658E-03	9.222187E-08	-5.052575E-05	-7.595659E-07
67	G	-1.988672E-02	9.066239E-04	7.195455E-03	5.386353E-07	-6.412767E-05	-1.255455E-06
68	G	-4.608814E-03	-3.039308E-04	4.273601E-03	-1.331312E-06	-3.488949E-05	-2.221480E-06
69	G	-1.094496E-02	-9.932324E-05	5.970354E-03	-1.274697E-06	-5.086614E-05	-2.177333E-06
70	G	-1.979353E-02	2.566348E-05	7.207074E-03	-5.400987E-07	-6.444089E-05	-1.726757E-06
71	G	-3.632897E-03	9.879362E-04	-1.173473E-03	-1.425923E-07	-3.402170E-05	-1.271457E-07
72	G	-1.070130E-02	1.130236E-03	-2.107967E-03	-7.730316E-07	-5.052575E-05	-7.786926E-07
73	G	-1.995268E-02	1.152021E-03	-3.063598E-03	1.967320E-07	-6.412767E-05	-1.320269E-06
74	G	-3.572546E-03	2.258416E-04	-1.312527E-03	3.405552E-07	-3.488949E-05	-2.511157E-06
75	G	-1.061944E-02	3.762102E-04	-2.169722E-03	-8.830358E-07	-5.086614E-05	-2.246092E-06
76	G	-1.985441E-02	3.653006E-04	-3.104843E-03	4.915060E-07	-6.444089E-05	-1.760448E-06
77	G	-6.337300E-04	8.187483E-04	-3.465478E-04	-3.593187E-06	-1.829760E-05	-6.641706E-07
78	G	-4.810036E-04	3.454518E-04	-5.586081E-04	5.676708E-07	-1.953677E-05	-5.795802E-06
79	G	0.0	0.0	0.0	0.0	0.0	0.0
80	G	0.0	0.0	0.0	0.0	0.0	0.0

MSDA THERMOELASTIC MODEL 5X5 2M. NEW SPIN AXIS W/BALLAST
THERMOELASTIC BEHAVOIR MODEL

225 DEGREE ORBITAL POSITION (AVE. TEMP.) SUBCASE 3

D I S P L A C E M E N T V E C T O R

POINT ID.	TYPE	Δx (inches)	Δy (inches)	Δz (inches)	θx (radians)	θy (radians)	θz (radians)
1	G	9.519919E-04	-3.259703E-03	3.224751E-03	4.971461E-05	6.838284E-06	-1.865926E-06
2	G	2.759750E-03	-3.529604E-03	3.289509E-03	-4.187178E-07	7.239491E-06	-4.213185E-06
3	G	4.460463E-03	-3.774533E-03	4.141870E-03	-2.255506E-06	7.229355E-06	-2.249869E-06
4	G	5.787636E-03	-3.434599E-03	5.846800E-03	-3.181681E-06	5.984818E-06	-6.382133E-06
5	G	-1.040669E-04	-1.486361E-03	2.707439E-03	8.801215E-06	4.329424E-06	-4.956046E-06
6	G	1.201553E-03	-1.844739E-03	1.780010E-03	6.726635E-06	6.783904E-06	-4.197184E-06
7	G	3.267679E-03	-1.891487E-03	1.794881E-03	-9.359652E-07	4.798033E-06	9.920425E-08
8	G	5.142921E-03	-2.227654E-03	2.444513E-03	-1.258396E-06	6.897695E-06	-2.247925E-06
9	G	6.900523E-03	-2.195067E-03	3.736997E-03	-1.314513E-06	7.796614E-06	-1.827940E-06
10	G	7.858849E-03	-1.883019E-03	6.095062E-03	-2.764758E-07	5.746957E-06	2.610729E-06
11	G	3.388965E-04	2.062557E-04	2.831454E-03	-5.831021E-06	2.158256E-06	6.277812E-07
12	G	1.890020E-03	1.650718E-04	2.504995E-03	-1.234279E-06	5.726137E-06	-1.241231E-06
13	G	2.592839E-03	1.640509E-04	8.559393E-04	-1.292903E-06	9.665818E-06	-1.051926E-06
14	G	4.738899E-03	-4.543164E-04	1.477669E-03	-1.732549E-07	1.088376E-05	-2.007264E-06
15	G	6.338635E-03	-3.591773E-04	3.446091E-03	1.591077E-08	8.626381E-06	2.723454E-06
16	G	7.647685E-03	-3.931558E-04	5.662969E-03	3.611113E-07	8.175087E-06	-3.355308E-08
17	G	1.986510E-04	4.053843E-04	2.795070E-03	2.733604E-06	1.331023E-06	2.150663E-06
18	G	1.865105E-03	7.259990E-04	2.414884E-03	-3.005853E-07	6.215286E-06	3.249233E-06
19	G	2.589454E-03	1.050830E-03	6.901427E-04	-5.872068E-07	9.633824E-06	1.874961E-06
20	G	4.672001E-03	1.671367E-03	1.347124E-03	-9.081050E-07	1.037398E-05	2.242563E-06
21	G	6.271679E-03	1.492502E-03	3.365673E-03	2.218827E-07	8.055578E-06	-2.233613E-06
22	G	7.584542E-03	1.284485E-03	5.609825E-03	8.043442E-07	7.730950E-06	1.226828E-06
23	G	-3.217042E-04	2.107443E-03	2.591330E-03	-1.113272E-05	9.871331E-06	8.610736E-06
24	G	1.033471E-03	2.855993E-03	1.238394E-03	-8.673878E-06	1.184898E-05	7.407450E-06
25	G	3.083306E-03	3.145090E-03	1.187597E-03	-9.117305E-07	4.549240E-07	2.072495E-07
26	G	4.953705E-03	3.461510E-03	2.091001E-03	-1.516265E-07	3.670989E-06	2.324686E-06
27	G	6.677511E-03	3.334261E-03	3.639145E-03	1.146958E-06	4.854319E-06	1.756262E-06
28	G	7.525716E-03	2.744997E-03	6.189995E-03	1.350240E-06	2.936154E-06	-2.561068E-06
29	G	6.229654E-04	4.353015E-03	2.420622E-03	-6.587419E-06	4.109254E-06	2.583113E-06
30	G	2.422655E-03	4.812937E-03	2.552548E-03	-1.950958E-06	5.115703E-06	4.600559E-06
31	G	4.045086E-03	5.036464E-03	3.661596E-03	6.209956E-07	4.142076E-06	1.663594E-06
32	G	5.255134E-03	4.611683E-03	5.623743E-03	1.971127E-06	2.745262E-06	7.016267E-06
33	G	-2.116309E-04	-2.406629E-03	7.821196E-04	5.784079E-06	8.130901E-06	-4.624360E-06
34	G	1.531784E-03	-3.551718E-03	1.395182E-03	-4.767424E-07	7.671615E-06	-8.173104E-06
35	G	3.238543E-03	-3.946547E-03	2.286023E-03	-2.476301E-06	6.920828E-06	-3.441849E-06
36	G	4.714378E-03	-3.693625E-03	3.519738E-03	-2.633268E-06	6.402338E-06	-5.119394E-06
37	G	-7.732740E-04	-9.540219E-05	3.990025E-04	8.669054E-06	3.804621E-06	-6.959293E-06
38	G	4.702284E-05	-6.704502E-04	6.076120E-04	7.986513E-06	7.717084E-06	-8.741587E-06
39	G	2.408249E-03	-1.976009E-03	3.746135E-04	1.242417E-06	6.491646E-06	-3.962437E-06
40	G	4.024285E-03	-2.378225E-03	1.009921E-03	-8.046891E-07	6.713762E-06	-1.711860E-07
41	G	5.549610E-03	-2.232893E-03	2.452194E-03	-8.430437E-07	8.135256E-06	-9.866946E-07
42	G	6.942353E-03	-1.839826E-03	3.849649E-03	3.970508E-07	5.923645E-06	5.144491E-06
43	G	0.0	0.0	0.0	8.733501E-07	2.104805E-06	-1.879327E-06
44	G	9.953217E-04	0.0	0.0	-9.522239E-07	5.552627E-06	-1.499846E-06
45	G	1.054097E-03	-1.403959E-04	4.811312E-04	5.174456E-07	1.091177E-05	5.793791E-07
46	G	3.043672E-03	-6.183246E-04	2.294604E-04	5.242095E-07	1.139400E-05	-2.807833E-07
47	G	5.015790E-03	-4.655984E-04	1.203732E-03	-4.414061E-07	8.621345E-06	2.215311E-06
48	G	6.337512E-03	-3.834448E-04	3.139286E-03	2.884421E-07	8.425888E-06	1.478926E-06
49	G	0.0	2.854650E-04	0.0	-2.516776E-06	1.157251E-06	4.521394E-06
50	G	9.062767E-04	6.744897E-04	0.0	-3.148568E-07	5.830363E-06	5.583030E-06

MSDA THERMOELASTIC MODEL 5X5 2M. NEW SPIN AXIS W/BALLAST
THERMOELASTIC BEHAVOIR MODEL

225 DEGREE ORBITAL POSITION (AVE. TEMP.) SUBCASE 3

D I S P L A C E M E N T   V E C T O R

POINT ID.	TYPE	Δx (inches)	Δy (inches)	Δz (inches)	θx (radians)	θy (radians)	θz (radians)
51	G	1.003096E-03	1.036510E-03	3.604783E-04	-2.265361E-06	1.156495E-05	-5.015480E-07
52	G	3.030132E-03	1.495120E-03	9.577343E-05	-3.064960E-06	1.125196E-05	-5.839824E-07
53	G	5.015427E-03	1.390896E-03	1.129046E-03	-1.494579E-06	8.337695E-06	-2.866625E-06
54	G	6.314318E-03	1.281797E-03	3.094537E-03	-6.369751E-07	8.273821E-06	-1.436031E-06
55	G	-1.767342E-03	3.847762E-04	3.177576E-04	-1.045681E-05	7.680518E-06	1.491460E-05
56	G	-9.543523E-04	1.408970E-03	1.606114E-04	-9.328502E-06	1.336456E-05	1.275635E-05
57	G	2.923922E-03	2.887742E-03	-1.557057E-04	-3.703430E-06	1.965235E-06	2.767503E-06
58	G	4.304389E-03	3.276925E-03	7.354237E-04	-1.655378E-06	3.667405E-06	-6.528114E-07
59	G	5.726185E-03	3.135074E-03	2.326117E-03	-1.158588E-06	5.592050E-06	3.990499E-07
60	G	7.025987E-03	2.710205E-03	3.961340E-03	-9.464038E-07	3.438679E-06	-6.421731E-06
61	G	-1.798988E-04	3.209856E-03	2.973620E-05	-8.262529E-06	7.219899E-06	-2.517551E-06
62	G	1.548652E-03	4.469866E-03	7.077294E-04	-1.470297E-06	4.974848E-06	1.135817E-05
63	G	3.279728E-03	4.910913E-03	1.802789E-03	9.469988E-07	3.728043E-06	3.082327E-06
64	G	4.650748E-03	4.625600E-03	3.323668E-03	1.230211E-06	3.296059E-06	5.717198E-06
65	G	-2.293747E-03	1.292263E-03	4.444526E-03	-5.414423E-06	-1.245024E-05	1.086673E-05
66	G	-3.933151E-03	1.686407E-03	6.151787E-03	-9.483541E-07	-1.344574E-05	1.054918E-05
67	G	-5.414066E-03	1.086207E-03	6.944734E-03	6.120377E-06	-9.053629E-06	7.077269E-06
68	G	-2.514291E-03	-3.482312E-05	4.412678E-03	8.410436E-08	-1.279934E-05	-6.057340E-06
69	G	-4.241248E-03	5.409668E-04	6.095181E-03	-5.536029E-06	-1.367015E-05	-3.343284E-06
70	G	-[illegible].740521E-03	1.459155E-03	6.895443E-03	-5.918732E-06	-9.297105E-06	6.168484E-07
71	G	-3.789084E-03	-8.329662E-04	2.454020E-03	5.056943E-06	-1.245024E-05	1.055244E-05
72	G	-6.217628E-03	-3.580677E-04	4.001453E-03	-4.577397E-06	-1.344574E-05	1.059204E-05
73	G	-8.308409E-03	-1.483861E-04	5.497223E-03	5.798224E-07	-9.053629E-06	6.956132E-06
74	G	-4.019445E-03	1.445258E-03	2.363250E-03	-7.352766E-06	-1.279934E-05	-5.603033E-06
75	G	-6.516691E-03	1.549211E-03	3.906972E-03	1.374065E-06	-1.367015E-05	-3.586775E-06
76	G	-8.634753E-03	1.559015E-03	5.406838E-03	-1.036172E-06	-9.297105E-06	7.421415E-07
77	G	-2.328874E-03	8.934012E-05	6.662011E-04	1.817117E-06	-1.353522E-05	3.303888E-07
78	G	-2.491577E-03	2.361972E-04	5.755441E-04	-4.060768E-06	-1.386965E-05	1.322831E-06
79	G	0.0	0.0	0.0	0.0	0.0	0.0
80	G	0.0	0.0	0.0	0.0	0.0	0.0

FORM 2401/

MSDA THERMOELASTIC MODEL 5X5 2M. NEW SPIN AXIS W/BALLAST
THERMOELASTIC BEHAVOIR MODEL

270 DEGREE ORBITAL POSITION (AVE. TEMP.) SUBCASE 4

D I S P L A C E M E N T V E C T O R

POINT ID.	TYPE	Δx (inches)	Δy (inches)	Δz (inches)	θx (radians)	θy (radians)	θz (radians)
1	G	1.820487E-03	-3.542979E-03	4.761889E-03	3.262873E-06	3.785239E-06	[illegible]27793E-07
2	G	3.806532E-03	-3.583780E-03	5.101566E-03	-1.109617E-06	5.853263E-06	-4.249886E-06
3	G	5.544345E-03	-3.845245E-03	6.730957E-03	-2.584029E-06	5.504458E-06	-1.797083E-06
4	G	6.582587E-03	-3.250061E-03	9.790731E-03	-4.653889E-06	2.44[illegible]352E-06	-7.709171E-06
5	G	5.457235E-04	-1.670468E-03	3.894526E-03	8.566635E-06	9.974062E-06	-3.314518E-06
6	G	2.096[illegible]E-03	-2.133[illegible]3E-03	2.282585E-03	6.336135E-06	1.028613E-05	-4.736638E-06
7	G	4.398907E-03	-1.[illegible]36397E-03	2.823269E-03	-1.974270E-06	1.103070E-06	1.718821E-06
8	G	5.408382E-03	-2.190725E-03	4.392518E-03	-1.103621E-06	4.323223E-06	-2.836016E-06
9	G	8.158735E-03	-2.034210E-03	6.719044E-03	-1.733821E-06	5.247497E-06	-1.849513E-06
10	G	8.441872E-03	-1.393165E-03	1.095596E-02	-1.113780E-06	2.932220E-07	4.067142E-06
11	G	3.437022E-04	1.585859E-04	3.642575E-03	-1.0[illegible]008E-05	2.230114E-06	-4.981776E-07
12	G	2.601336E-03	1.212768E-04	3.345082E-03	-1.149[illegible]02E-06	6.735852E-06	2.796551E-07
13	G	3.465422E-03	5.202251E-04	1.635744E-03	-2.578734E-06	1.048503E-05	6.431204E-07
14	G	6.155133E-03	-2.190795E-04	3.221530E-03	1.550836E-07	9.817942E-06	-3.093197E-06
15	G	7.573015E-03	3.462683E-05	6.384215E-03	-3.401904E-07	6.106372E-06	3.870041E-06
16	G	8.295239E-03	1.775431E-04	1.016533E-02	-1.238680E-07	3.468813E-06	2.436769E-07
17	G	1.883890E-04	1.116003E-03	3.607105E-03	7.658319E-06	1.292958E-06	3.780297E-06
18	G	2.520159E-03	1.452563E-03	3.306015E-03	3.[illegible]10E-07	6.915171E-06	2.680514E-06
19	G	3.389506E-03	1.495041E-03	1.502367E-03	1.[illegible]543E-06	1.032279E-05	1.608332E-06
20	G	6.049878E-03	2.426247E-03	3.114081E-03	-9.018897E-07	9.421268E-06	4.803039E-06
21	G	7.464842E-03	2.306107E-03	6.301683E-03	2.712189E-07	5.703863E-06	-1.811961E-06
22	G	8.180256E-03	2.217531E-03	1.010038E-02	3.270496E-07	3.098450E-06	2.409085E-06
23	G	4.492362E-05	2.917445E-03	3.874268E-03	-9.837999E-06	1.309378E-05	7.829146E-06
24	G	1.619835E-03	3.779540E-03	2.005048E-03	-7.579506E-06	1.306997E-05	9.654356E-06
25	G	3.935870E-03	3.863700E-03	2.479615E-03	5.209567E-07	-1.6186[illegible]8E-06	2.310238E-07
26	G	5.946405E-03	4.406878E-03	4.183184E-03	1.024342E-07	2.211608E-06	4.647593E-06
27	G	7.662734E-03	4.379858E-03	6.628215E-03	1.478349E-06	3.386777E-06	3.561504E-06
28	G	7.880453E-03	3.770632E-03	1.097783E-02	1.281308E-06	-1.305785E-06	-2.133547E-06
29	G	1.040220E-03	5.239537E-03	4.321696E-03	-4.338168E-06	2.017904E-06	2.465446E-06
30	G	3.022019E-03	5.626438E-03	4.670793E-03	-6.531711E-07	4.395157E-06	6.161701E-06
31	G	4.718753E-03	6.086056E-03	6.420556E-03	1.312515E-06	3.595380E-06	2.955261E-06
32	G	5.690100E-03	5.620820E-03	9.620303E-03	3.688951E-06	4.536916E-07	9.524895E-06
33	G	1.057742E-03	-2.916000E-03	1.221027E-03	4.767385E-06	6.591525E-06	3.220749E-06
34	G	2.817280E-03	-3.751422E-03	2.631650E-03	-1.986628E-06	5.466528E-06	-1.014714E-05
35	G	4.588864E-03	-4.034136E-03	4.263556E-03	-3.127766E-06	4.773350E-06	-3.388658E-06
36	G	5.998182E-03	-3.637265E-03	6.333908E-03	-3.542973E-06	3.236321E-06	-5.974406E-06
37	G	-9.294045E-04	-3.431863E-04	5.848109E-04	8.174896E-06	8.390783E-06	-8.465968E-06
38	G	3.221425E-04	-1.004360E-03	1.057565E-03	7.492603E-06	1.201588E-05	-9.22240[illegible]E-06
39	G	4.132517E-03	-2.076190E-03	1.184926E-03	5.611288E-07	2.546930E-06	-7.809144E-07
40	G	5.699775E-03	-2.285881E-03	2.732152E-03	-7.863357E-07	3.772638E-06	-1.647795E-07
41	G	7.131111E-03	-1.997032E-03	5.200049E-03	-6.989783E-07	5.911997E-06	-9.112654E-07
42	G	8.369905E-03	-1.392369E-03	7.530262E-03	1.932638E-07	5.907512E-07	6.864734E-06
43	G	0.0	0.0	0.0	3.287392E-06	2.12[illegible]224E-06	-3.119583E-06
44	G	1.556076E-03	0.0	0.0	-5.842959E-07	6.427316E-06	-1.726812E-06
45	G	1.740762E-03	-6.943063E-05	1.221522E-03	-9.015041E-07	1.258937E-05	2.336133E-06
46	G	4.621653E-03	-3.439130E-04	1.761608E-03	5.605381E-07	1.037102E-05	7.720665E-07
47	G	6.643516E-03	-6.566002E-05	3.530230E-03	-4.482160E-07	6.065665E-06	2.806332E-06
48	G	7.712494E-03	1.467740E-04	6.563402E-03	8.749364E-09	3.823225E-06	2.100144E-06
49	G	0.0	1.066448E-03	0.0	-4.064011E-06	1.092319E-06	5.844192E-06
50	G	1.454879E-03	1.460657E-03	0.0	-5.123336E-08	6.461083E-06	5.874330E-06

ORIGINAL PAGE IS
OF POOR QUALITY

MSDA THERMOELASTIC MODEL 5X5 2M. NEW SPIN AXIS W/BALLAST
THERMOELASTIC BEHAVOIR MODEL

270 DEGREE ORBITAL POSITION (AVE. TEMP.) SUBCASE 4

D I S P L A C E M E N T   V E C T O R

POINT ID.	TYPE	Δx (inches)	Δy (inches)	Δz (inches)	θx (radians)	θy (radians)	θz (radians)
51	G	1.658101E-03	1.822939E-03	1.106468E-03	-5.504534E-07	1.289772E-05	-9.798015E-07
52	G	4.555274E-03	2.296895E-03	1.651208E-03	-2.427578E-06	1.021700E-05	2.937394E-07
53	G	6.579232E-03	2.227827E-03	3.449789E-03	-8.941659E-07	5.825281E-06	-1.553206E-06
54	G	7.639589E-03	2.168074E-03	6.499372E-03	-6.307320E-07	3.566567E-06	-3.870419E-07
55	G	-1.852379E-03	1.416806E-03	5.691610E-04	-9.017619E-06	1.024090E-05	1.551157E-05
56	G	-5.993231E-04	2.481434E-03	8.199703E-04	-8.183437E-06	1.488889E-05	1.324945E-05
57	G	4.107051E-03	3.837582E-03	8.747396E-04	-2.301289E-06	-3.742430E-07	1.644104E-06
58	G	5.539410E-03	4.255116E-03	2.545436E-03	-9.040024E-07	1.785629E-06	1.513662E-06
59	G	6.886176E-03	4.160353E-03	5.104620E-03	-5.326503E-07	4.259807E-06	2.239918E-06
60	G	8.043892E-03	3.694300E-03	7.559340E-03	-7.836042E-07	-8.630622E-07	-5.583978E-06
61	G	5.231551E-04	4.427368E-03	7.944276E-04	-6.291233E-06	5.787304E-06	-5.942554E-06
62	G	2.274541E-03	5.519211E-03	2.216408E-03	4.850046E-07	3.627196E-06	1.354695E-05
63	G	4.042119E-03	6.043294E-03	3.953764E-03	1.923367E-06	2.795650E-06	4.803519E-06
64	G	5.392379E-03	5.819899E-03	6.172037E-03	2.468892E-06	1.317668E-06	7.851963E-06
65	G	-2.739367E-03	2.041926E-03	5.935514E-03	-8.061516E-06	-1.076095E-05	1.470621E-05
66	G	-4.314406E-03	2.252653E-03	8.484871E-03	2.100499E-06	-1.662388E-05	1.301997E-05
67	G	-6.237223E-03	1.333993E-03	9.790432E-03	7.615023E-06	-1.511175E-05	8.040430E-06
68	G	-2.975276E-03	-2.591558E-04	5.899378E-03	4.357566E-06	-1.115218E-05	-9.591015E-06
69	G	-4.559571E-03	1.250218E-04	8.433620E-03	-5.879660E-06	-1.682429E-05	-7.651481E-06
70	G	-6.499218E-03	1.344081E-03	9.744035E-03	-8.578011E-06	-1.532353E-05	-2.048640E-06
71	G	-4.444701E-03	-8.752320E-04	4.2154[illegible]0E-03	7.553905E-06	-1.076095E-05	1.402097E-05
72	G	-7.228923F-03	-3.716887E-04	5.825930E-03	-5.414187E-06	-1.662388E-05	1.320307E-05
73	G	-1.032124E-02	-1.381247E-04	7.373509E-03	8.354167E-07	-1.511175E-05	7.866970E-06
74	G	-4.683032E-03	1.985877E-03	4.113312E-03	-9.756187E-06	-1.115218E-05	-8.913850E-06
75	G	-7.473564E-03	2.038194E-03	5.740854E-03	2.566080E-06	-1.682429E-05	-7.857479E-06
76	G	-1.058292E-02	1.963839E-03	7.290355E-03	-9.724239E-07	-1.532953E-05	-1.870844E-06
77	G	-3.680876E-03	4.340846E-04	1.436156E-03	2.326326E-06	-1.379364E-05	-2.920039E-06
78	G	-3.844932E-03	4.400052E-04	1.320701E-03	-3.770377E-06	-1.428651E-05	5.315812E-06
79	G	0.0	0.0	0.0	0.0	0.0	0.0
80	G	0.0	0.0	0.0	0.0	0.0	0.0

FORM 2401/