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Technical Memorandum 33-518

Radial Rib Antenna Surface Deviation Analysis Program

John V. Coyner, Jr.

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Preface

The work described in this report was done for the Telecommunications Division by the Engineering Mechanics Division of the Jet Propulsion Laboratory. The author wishes to thank Dr. Ron Ross for his help in developing the optimization routine used in the program.

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Abstract

A digital computer program has been developed which analyzes any radial rib antenna which has ribs radiating from a center hub. The program has the capability to; calculate the antenna surface contour (reversed pillowing effect), calculate the optimum rib shape which minimizes the RMS surface error, calculate the actual RMS surface error, compensate for rib deflection due to mesh tension and catenary cable tension, and determine the pattern from which the mesh gores are cut.

I. INTRODUCTION

This report describes the program capabilities, mathematical formulation, numerical solution, program usage and requirements, and typical printout of the radial rib antenna analysis program (RRAMRO).

The radial rib antenna analysis program calculates the antenna surface contour of the mesh that is stretched between two radial ribs (reverse pillowing effect), calculates the optimum radial rib shape which minimizes the RMS surface error, compensates for the rib deflection produced by the mesh tension and catenary cable tension, and determines the pattern from which the mesh gores are cut. The program is designed to run on the JPL Univac 1108, EXEC 8 system and is written in Fortran V language.

II. PROGRAM DESCRIPTION

Program Capabilities

RRAMRO is a radial rib antenna analysis program which is designed to provide antenna mesh contours, RMS surface errors, optimum rib shapes, rib deflections due to mesh and catenary cable tensions, and mesh cutting patterns for any radial rib antenna (Figure 1). The program's major capabilities and requirements are described in the following sections.

Mesh Contour Determination: The computer program will calculate the antenna mesh contour for any radial rib antenna. The user must specify the mesh unit tensions in the two orthogonal directions. The first unit tension (radial) is parallel to a centerline between the ribs, and the second unit tension (circumferential) is perpendicular to this centerline. The tension parallel to the centerline produces the reversed pillowing effect, while the tension perpendicular to the centerline tends to flatten the mesh.

RMS Surface Error Calculation: The computer program will determine the RMS surface error of the calculated antenna mesh contour with respect to the desired ideal parabolic antenna. The RMS error may be weighted by the antenna surface area associated with each node or the projected surface area associated with each node. The projected surface area is determined by projecting the actual antenna surface area on a plane normal to the antenna axis of symmetry. The RMS error may also be weighted by an illumination factor "E" which describes the intensity of illumination at each point on the antenna. For constant illumination intensity, this factor equals 1.0 at all points. The illumination weighting function used in the program is

$$E = \left(\frac{1 + \cos \theta}{2}\right) * \cos^2 (K * \theta)$$

where

$$K = \frac{\cos^{-1}[0.562 * \sqrt{2/(1 + \cos \theta_o)}]}{\theta_o}$$

and

$$\theta_o = 2 * \tan^{-1} \left(\frac{D}{4F}\right)$$

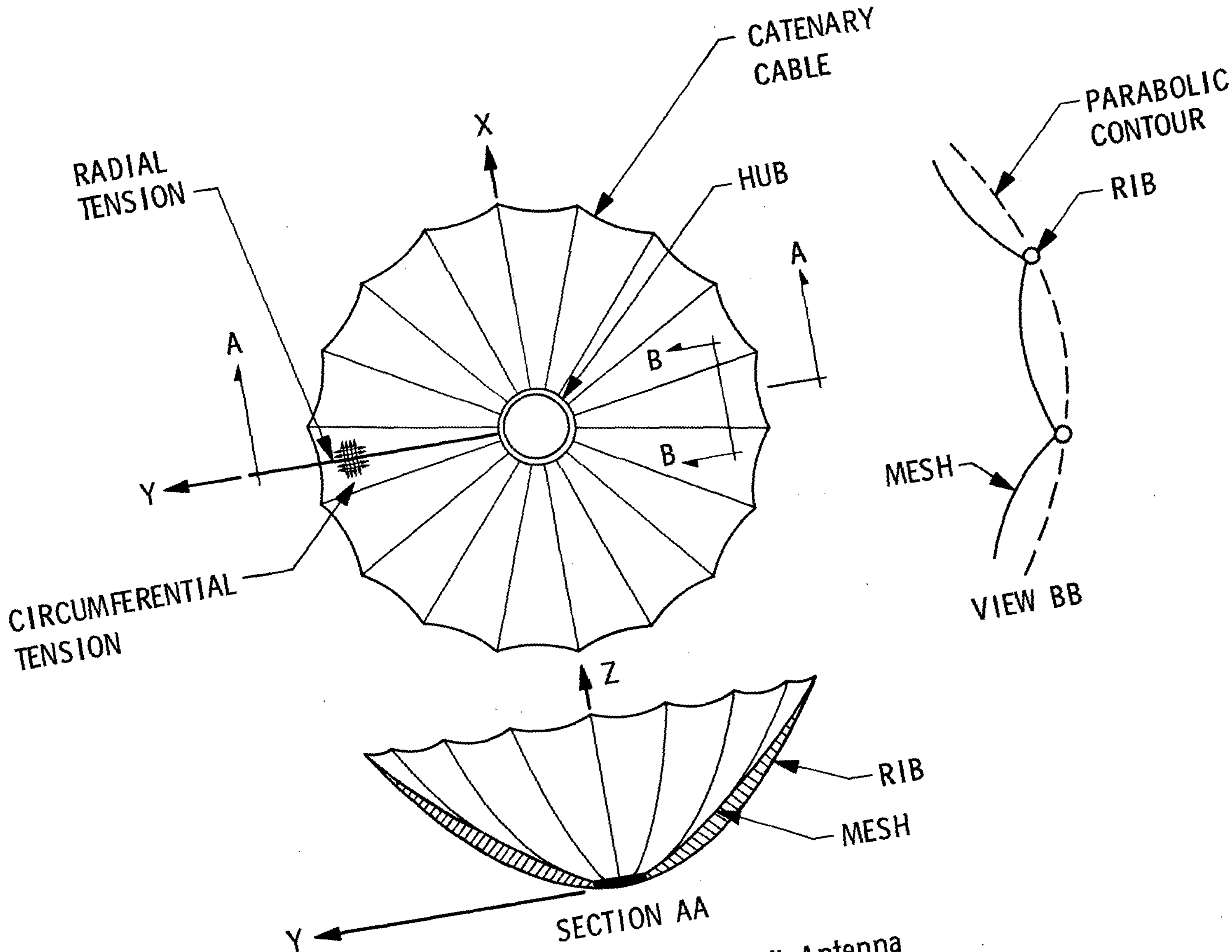


Figure 1 - Radial Rib Antenna

D = antenna diameter
F = antenna focal length
θ_o and θ are in radians

θ is the angle between the ray through the focal point and the node on the antenna being considered, and the ray on the antenna axis of symmetry through the focal point. Additional weighting functions can be substituted simply by programming the equations in the form of a subroutine and replacing the existing weighting function subroutine with the new subroutine. The user may request illumination weighting or no illumination weighting.

Rib Optimization: The computer program will calculate the optimum rib shape which will minimize the electrical performance degradations due to the deviation of the mesh surface from the ideal parabola. The program alters the rib shape and determines the associated mesh contour and RMS surface error. The program continues to do this until it finds the rib shape with the minimum RMS surface error. The final equation of the optimum rib is

$$Z = \frac{(\text{Radius})}{8*\text{FPD}*\text{RO}} + A1*(\rho) + A2*(4*\rho^3 - 3*\rho) + A3*(16*\rho^5 - 20*\rho^3 + 5*\rho)$$

where $\rho = \frac{\text{Radius} - \text{RI}}{\text{RO} - \text{RI}}$ is the normalized radius and A1, A2, A3 are the optimization variables, and Radius = $\sqrt{x^2 + y^2}$

Rib Deflection Due to Mesh Tension and Catenary Cable Tension: The computer program calculates the rib deflection due to (1) the mesh tension, (2) the tension in the catenary cable connecting the rib tips. To obtain the desired optimum rib shape after the cable and mesh are applied, the predeflected rib shape must differ from the desired optimum rib by an amount equal to the predicted rib deflection. Therefore, when the mesh and cable are applied, the rib will be deflected to its optimum shape. The program prints this predeflected rib shape in both tabular form and also in equation form. The equation has the same form as the optimum rib shape equation. The final equation of the predeflected rib shape (machined shape) is

$$Z = \frac{(\text{Radius})}{8*\text{FPD}*\text{RO}} + B1*(\rho) + B2*(4*\rho^3 - 3*\rho) + B3*(16*\rho^5 - 20*\rho^3 + 5*\rho)$$

where $\rho = \frac{\text{Radius} - \text{RI}}{\text{RO} - \text{RI}}$ and B1, B2, B3 are the variables determined during the curve fitting of the equation through the node points on the predeflected rib shape.

Catenary Cable Effect: The computer program will accept either a straight rigid boundary between rib tips or a catenary cable attached between the ribs. The rib deflection analysis can only be run when using the catenary cable as an upper boundary. When using the straight rigid boundary, the program only calculates the optimum rib shape and RMS error and not the predeflected rib shape.

Mesh Cutting Pattern: The program will calculate the required mesh pattern for cutting out the mesh gores for the antenna. This pattern includes the curved boundary which is fastened to the catenary cable.

Mathematical Formulation

In the design of unfurlable antennas with reflectors composed of mesh materials stretched between radial ribs, one of the problems is the determination of the deviations of the mesh surface from an ideal paraboloid. The general nature of the deviation can be seen by examining an umbrella in its open position. The cloth membrane is pulled taut between two curved, relatively rigid ribs. Due to the curvature of the ribs and the mesh tension in the radial direction, the membrane takes a doubly curved contour bowing in toward the concave side of the antenna. The greater the curvature and the greater the tension in the radial direction, the greater the deviation from the ideal surface. To calculate this deviation at points on the antenna mesh, a program was developed to find the equilibrium contour of the mesh for any radial rib antenna (given the orthogonal tensions in the radial and circumferential directions). The mesh surface is assumed to be a membrane with negligible bending stiffness with all forces acting in the plane of the membrane. The solution of the membrane equilibrium equation is approximated by applying an iterative relaxation process to a finite difference approximation to the equations. The scope of the mesh contour calculation program also includes the capability to calculate the radial rib shape which produces the minimum electrical performance degradation due to the deviation of the mesh surface from the parabola. The optimization of the rib shape is accomplished by superimposing three Chebychev polynomials on the generating parabola of the ideal paraboloid and using the simplex method to optimize the polynomial constants.

The mesh contour analysis is formulated by considering the equilibrium of forces acting on an element of a deformed membrane (Figure 2).

The unit tensions N_ξ and N_η in two orthogonal directions are assumed to be uniform throughout the surface. Let $\underset{\sim}{i}_\xi$ and $\underset{\sim}{i}_\eta$ be unit tangent vectors along orthogonal curves β and α respectively. X_ξ is the curvature of a line formed by the intersection of the surface and a plane containing $\underset{\sim}{i}_\xi$ and $\underset{\sim}{i}_h = \underset{\sim}{i}_\xi \times \underset{\sim}{i}_\eta$, while X_η is the curvature of a line formed by the intersection of the surface with a plane containing $\underset{\sim}{i}_\eta$ and $\underset{\sim}{i}_h$. Equating forces along $\underset{\sim}{i}_h$ to zero (Reference 1), and neglecting the cross term,

$$N_\xi X_\xi + N_\eta X_\eta = 0 \tag{1}$$

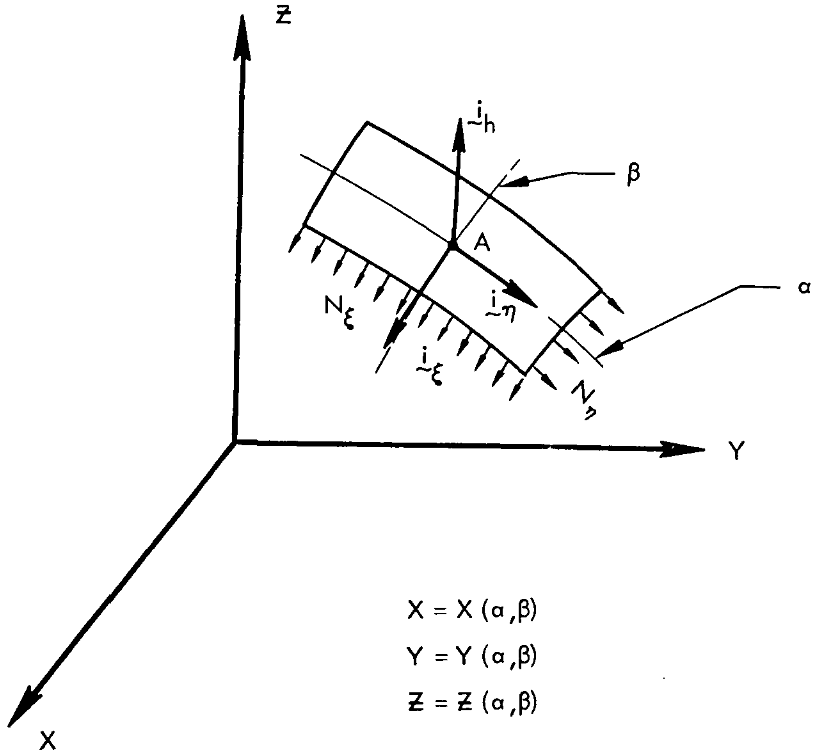


Figure 2. Deformed Membrane Element

To obtain the governing equation of the antenna mesh in terms of (x, y, z) coordinates, one section between two ribs of the antenna is considered. Let F be the rigid frame formed by the parabolic ribs and the top and bottom relatively rigid members (Figure 3).

This frame is filled with a surface formed by straight line generators parallel to the x-axis. If the frame is filled with a membrane, the resulting surface will be displaced from the straight line surface. Letting ξ and η correspond to x and y respectively, and letting U = displacement of the membrane in the z direction,

$$X_\eta = \frac{\partial^2 U/\partial Y^2}{\left[1 + \left(\frac{\partial U}{\partial Y}\right)^2\right]^{3/2}}$$

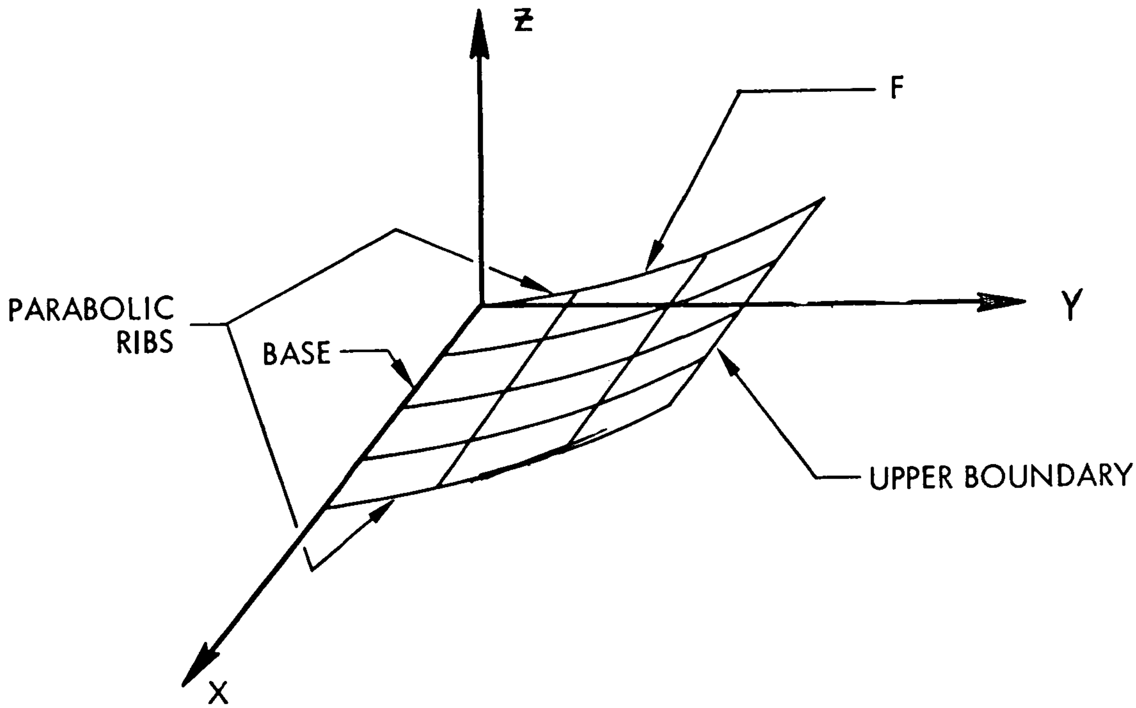


Figure 3. Antenna Section

Let θ be the angle between the normal to the surface and the x-z plane, and let

$$K_x = \frac{\partial^2 U/\partial X^2}{\left[1 + \left(\frac{\partial U}{\partial X}\right)^2\right]^{3/2}} \tag{3}$$

and

$$\cos\theta = \frac{1}{\left[1 + \left(\frac{\partial U}{\partial Y}\right)^2\right]^{1/2}} \tag{4}$$

where

$$X_\xi = K_x \cos\theta$$

Substitution of Equations (2) and (3) and (4) into Equation (1) yields

$$N_\xi \frac{\partial^2 U/\partial X^2}{\left[1 + \left(\frac{\partial U}{\partial X}\right)^2\right]^{3/2}} \left\{\frac{1}{\left[1 + \left(\frac{\partial U}{\partial Y}\right)^2\right]^{1/2}}\right\} + N_\eta \frac{\partial^2 U/\partial Y^2}{\left[1 + \left(\frac{\partial U}{\partial Y}\right)^2\right]^{3/2}} = 0 \tag{5}$$

or

$$\frac{\partial^2 U}{\partial X^2} + \frac{N_\eta}{N_\xi} \left\{ \frac{\left[1 + \left(\frac{\partial U}{\partial X}\right)^2\right]^{3/2}}{\left[1 + \left(\frac{\partial U}{\partial Y}\right)^2\right]} \right\} \frac{\partial^2 U}{\partial Y^2} = 0 \tag{6}$$

The numerical solution of the above equation was obtained by a finite difference method using successive over-relaxation to increase convergence (Reference 2).

To minimize the electrical performance degradation due to the deviation of the mesh surface from the ideal paraboloid, a program to optimize the shape of the radial ribs was added. To define this optimum shape in terms of a few variables, Chebychev polynomials are superimposed on the original parabola to define the new shape. The equation of the rib becomes,

$$Z = (x^2 + y^2)/8{*}FPD{*}RO + A1{*}(\rho) + A2{*}(4{*}\rho^3 - 3{*}\rho) + A3{*}(16{*}\rho^5 - 20{*}\rho^3 + 5{*}\rho) \tag{7}$$

where ρ is the normalized radius and Z is the distance from the plane through the vertex of the parabola and normal to the antenna axis of symmetry to a point on the rib. The variables A1, A2, A3 are varied to obtain a rib shape which produces a membrane deflection with the least RMS surface error. The simplex method of Nelder and Mead is used to iterate toward the minimum from an initial estimate (Reference 3). This method obtains a minimization of a function of N variables by comparison of function values at the (N + 1) vertices of a general simplex. Then the highest value vertex is replaced by another of lower value.

Since the optimum rib shape is the shape desired after assembly of the antenna, the as-manufactured rib shape must deviate for the optimum rib shape by an amount equal to the deflection of the rib when the mesh and catenary cable are applied. This predicted deflection is subtracted for the optimum shape so that when the mesh and cable are applied to the rib, the deflection due to the applied tensions produces the desired optimum rib shape. The rib deflection due to the mesh tension is determined from the equation,

$$\frac{d^2 u}{ds^2} + \frac{u}{R} = - \frac{M(s)}{E{*}I(s)}$$

where

- u = deflection normal to the rib
- s = distance along rib
- R = radius of curvature of rib
- M = moment applied to rib from mesh and cable
- E = modulus of elasticity of rib
- I = moment of inertia of rib section

The equation is solved using trapezoidal integration.

III. PROGRAM USAGE

RRAMRO is a main program designed to be used in batch mode. The input parameters which define the radial rib antenna's configuration and material properties are read in from data cards using namelist names DATA1 and DATA2. Any number of antenna configurations can be generated in a single computer run by including one or more data groups in the run stream. A data group consists of a DATA1 card and, when required, a DATA2 card. All input data must be supplied to the computer program in the same basic units. If these basic units are centimeters, grams, and seconds, then all dimensions or combinations of dimensions must use these units. The user cannot mix centimeters and meters, grams and kilograms, or seconds and minutes, etc. The program then outputs all calculated data in the user's basic units.

NAMELIST/DATA1/ contains 23 parameters which may be assigned values in any data group. Since the parameter assignments of previous data groups are used if not reassigned, data groups following the first need contain only those parameter assignments which are changes from those in the previous data group. The first 13 parameters listed below are all preset to nominal values during compilation, and only those parameters differing from the preassigned values need be inputed. The other 10 parameters must be assigned a value in the first data group. A DATA1 card must be supplied for each data group.

The following parameters belong to NAMELIST/DATA1/ and may be included in any order.

General Parameters

LOOP = An integer to be used in the first data group to indicate the number of data groups to be read. RRAMRO reads LOOP data groups including the first. Parameter preset to a nominal value of 1.

NB = An integer used to define the grid size for the finite difference analysis. 1 specifies a coarse grid, and 2 specifies a fine grid. Since the CPU time increases by a factor of three for the fine grid as compared to the coarse grid, the fine grid should be used only when the configuration being analyzed is a final analysis. For parametric studies looking at relationships between the RMS surface error and antenna parameters such as number of ribs, orthogonal tension ratios, antenna diameters, etc., the coarse grid should be used. Parameter preset to a nominal value of 1.

NOPTIM = An integer used to define whether the antenna rib will be optimized. 0 specifies no rib optimization, and 1 specifies rib optimization. Parameter preset to a nominal value of 0.

NWEIGH = An integer used to define whether the antenna has constant illumination intensity throughout the antenna surface or has varying illumination intensity. 0 specifies varying intensity and 1 specifies constant intensity. Parameter preset to a nominal value of 1.

NAREA = An integer used to define whether the surface errors will be weighted by the actual antenna surface area associated with each node or weighted by the projected surface area associated with each node. 0 specifies projected area, while 1 specifies surface area. Parameter preset to a nominal value of 1.

NTENS = An integer used to define whether the rib deflection due to the mesh and cable tension will be considered. 0 specifies no rib deflection analysis, and 1 specifies the rib deflection will be analyzed. Parameter preset to a nominal value of 0. SAG must be set to 0.0 when NTENS = 0.

NCHECK = An integer used to define whether the expanded output will be printed. The differences between the expanded output and the standard output are described in the sample output section. 0 specifies the standard output, and 1 specifies the expanded output. Parameter preset to a nominal value of 0.

NPUNCH = An integer used to define whether punched cards are outputed. These cards describe the antenna's surface contour in (x, y, z) coordinates where z is the distance from a plane normal to the antenna axis of symmetry through the vertex of the parabolic antenna to the node point being considered. 0 specifies no cards outputed, while 1 specifies punched cards outputed. Parameter preset to a nominal value of 0.

NGORE = An integer used to define whether the mesh gore cutting pattern is printed. 0 specifies no gore pattern, while 1 specifies the printing of the gore pattern. Parameter preset to a nominal value of 0.

SAG = The deflection from a straight line of the catenary cable attached at the rib tips. For a straight rigid boundary, this value is 0.0. Parameter preset to a nominal value of 0.0.

A1,A2,A3= The variables multiplying the Chebychev polynomials which perturb the rib shape. If a case has been run and the optimum rib shape determined (A1, A2, A3 known), and if the user wants to rerun that case with the same DATA1 data but with new DATA2 data, he may input the previously calculated values of A1, A2, and A3 and set NOPTIM = 0. This saves CPU time, since the optimum rib is inputed instead of calculated. Parameters preset to nominal values of 0.0.

RO = The radius of the antenna.

RI = The radius of the antenna hub.

FPD = The focal length of the antenna divided by the diameter of the antenna. Unitless quantity.

DIFM = The maximum allowable surface error at any point on the antenna.

DHUBR = The subdish primary blockage radius.

ERRHUB = The RMS surface error of the central rigid dish. The central rigid dish is part of the main reflector surface and lies within the hub of of the main reflector surface. When RI > DHUBR, the central dish is included in the overall RMS error computation.

TYC = The mesh tension per unit length in the radial direction.

TXT = The mesh tension per unit length in the circumferential direction at the inner radius of the mesh.

TXB = The mesh tension per unit length in the circumferential direction at the outer radius of the mesh. Using TXT and TXB, the program is capable of calculating the mesh contour and deflected rib shape for a linearly varying circumferential tension.

NRIBS = An integer defining the number of antenna ribs. Must be greater than 4.

The following 7 parameters belong to NAMELIST/DATA2/ and may be included in any order. All 7 parameters must be assigned values in the first DATA2 card. Since the parameter assignments of previous data groups are used if not reassigned, data groups following the first DATA2 card need contain only those parameter assignments which are changes from those previously assigned. A DATA2 card must be supplied whenever the rib deflection analysis is run; i.e., when NTENS = 1.

General Parameters

WIDTH = The effective width of the fin attached to the rib. If no fin is attached to the rib, this value is set to 0.0.

HEIGHT = The effective height of the fin attached to the rib. If no fin is attached to the rib, this value should be set to 0.0.

TROB = The outside radius of the rib at its base.

TRIB = The inside radius of the rib at its base.

TROT = The outside radius of the rib at the rib tip.

TRIT = The inside radius of the rib at the rib tip.

ERIB = The modulus of elasticity of the rib and fin divided by 10^6. The rib and fin are assumed to be made of the same material.

IV. PROGRAM REQUIREMENTS

Storage: RRAMRO requires approximately 22,000 words of storage.

Timing: RRAMRO requires approximately 15 seconds to run one mesh shape calculation with the coarse grid and approximately 45 seconds with the fine grid. Mesh shape calculation and rib optimization requires approximately 45-60 seconds with the coarse grid and 90-120 seconds with the fine mesh. Compilation time is approximately 15 seconds and should be added to the total estimated computation time.

V. JOB PREPARATION

RRAMRO and related subroutines are available in source deck. The complete run stream is as follows.

```
@RUN....
@FOR, IS RRAMRO,RRAMRO
     .
     .
     .
@XQT
 $DATA1....$
 $DATA2....$
 $DATA1....$
      .
      .
      .
@FIN
```

VI. EXAMPLES AND SAMPLE OUTPUT

In order to demonstrate the program's use, example problems are considered in Table 1. The units are specified by the user (L. = Length, F. = Force)

$DATA1

Parameter	Nominal Values Preset in Program	Case 1	Case 2	Case 3
LOOP	1	3	*	*
NB	1	*	*	*
NOPTIM	0	*	1	0
NWEIGH	1	0	*	1
NAREA	1	*	*	*
NTENS	0	1	*	0
NCHECK	0	*	1	0
NPUNCH	0	*	1	0
NGORE	0	*	1	0
SAG	0.0 L.	1.0	*	0.0
A1	0.0	-0.0807598	0.0	*
A2	0.0	-0.0001072	0.0	*
A3	0.0	0.0011375	0.0	*
RO	- L.	84.0	*	60.0
RI	- L.	27.0	*	20.0
FPD	- L./L.	0.42	*	0.5
DIFM	- L.	0.08	*	0.8
DHUBR	- L.	18.0	*	20.0
ERRHUB	- L.	0.008	*	*
TYC	- F./L.	0.03	*	0.04
TXT	- F./L.	0.09	0.12	0.08
TXB	- F./L.	0.09	0.12	0.08
NRIBS	-	48	*	38

$DATA2

Parameter	Nominal Values Preset in Program	Case 1	Case 2	Case 3
WIDTH	- L.	0.1875	*	x
HEIGHT	- L.	0.045	*	x
TROB	- L.	0.5625	*	x
TRIB	- L.	0.5425	*	x
TROT	- L.	0.5625	*	x
TRIT	- L.	0.5425	*	x
ERIB	- megaforce/L.^{2}	10.0	*	x

The (-) indicates no preset value is supplied for that variable. The (*) indicates preassigned values are used. The (x) indicates that no value need be assigned.

Table 1 - Data defining three example cases.

The following data cards were used to input the three cases.

```
$DATA1 LOOP=3, NWEIGH=0, NTENS=1, SAG=1.0, A1=-.0807598, A2=-.0001072,
A3=.0011375, RO=84., RI=27., FPD=.42, DIFM=.08, DHUBR=18., ERRHUB=.008,
TYC=.03, TXT=.09, TXB=.09, NRIBS=48$
$DATA2 WIDTH=.1875, HEIGHT=.045, TROB=.5625, TRIB=.5425, TROT=.5625,
TRIT=.5425, ERIB=10.$
$DATA1 NOPTIM=1, NCHECK=1, NPUNCH=1, NGORE=1, A1=0.0, A2=0.0, A3=0.0,
TXT=.12, TXB=.12$
$DATA2 WIDTH=.1875$
$DATA1 NOPTIM=0, NWEIGH=1, NTENS=0, NCHECK=0, NPUNCH=0, NGORE=0,
SAG=0.0, RO=60., RI=20., FPD=.5, DIFM=.8, DHUBR=20., TYC=.04, TXT=.08,
TXB=.08, NRIBS=38$
```

For Case 1, only those variables that are not preassigned or are redefined have been inputed. Cases 2 and 3 reflect the fact that preceding cases have redefined some of the variables, and only those variables different from the previous cases are inputed. Note that for Case 1, the variables A1, A2, and A3 are read in, and no rib optimization is performed (NOPTIM = 0). Previously, the same set of DATA1 data had been run and A1, A2, and A3 were determined. For Case 2, new circumferential tensions are assigned; therefore, a new rib optimization is required. Although no changes are made in DATA2 variables from Case 1 to Case 2, a DATA2 card is still required for Case 2 since NTENS = 1. For Case 3, no rib deflection analysis is performed; therefore, no DATA2 card is required. Also, for Case 3, no solid central dish is considered in the RMS error calculation since the hub radius (RI=20) and the subdish primary blockage radius (DHUBR=20) are equal.

Description of the Output for Case 2

Case 2 represents a standard mesh contour calculation, rib optimization, and rib deflection analysis and is printed using the expanded output. Appendix B is the output for case 2 data.

The output of the node coordinates and z-deflections is in the form of an array of numbers, with the left hand column being the centerline of a mesh between two ribs. Only half of the mesh panel is printed, since it is symmetric. The right hand element in each row is the node on the rib. Figure 4 shows a typical array of elements.

Case 2 also has card punch output. The format is described below. The first seven cards list the parameters RO, RI, half angle between ribs, FPD, TYC, TXT, TXB. The next punched card has the variables, focal length, Y_1 and Y_2 (from Figure 5), half angle between ribs, and A_1, A_2, A_3, listed in a (4F10.4, 3E13.8) format. The next group of cards list the (X, Y, Z) coordinates, node numbers (I, J), and node card number. The format is (3F10.4, 3I10). The final card has the total number of node cards printed. This total is added to 1,000,000 and printed in a (50X, I10) format. This card can be used as a check to see if all node cards are in the deck.

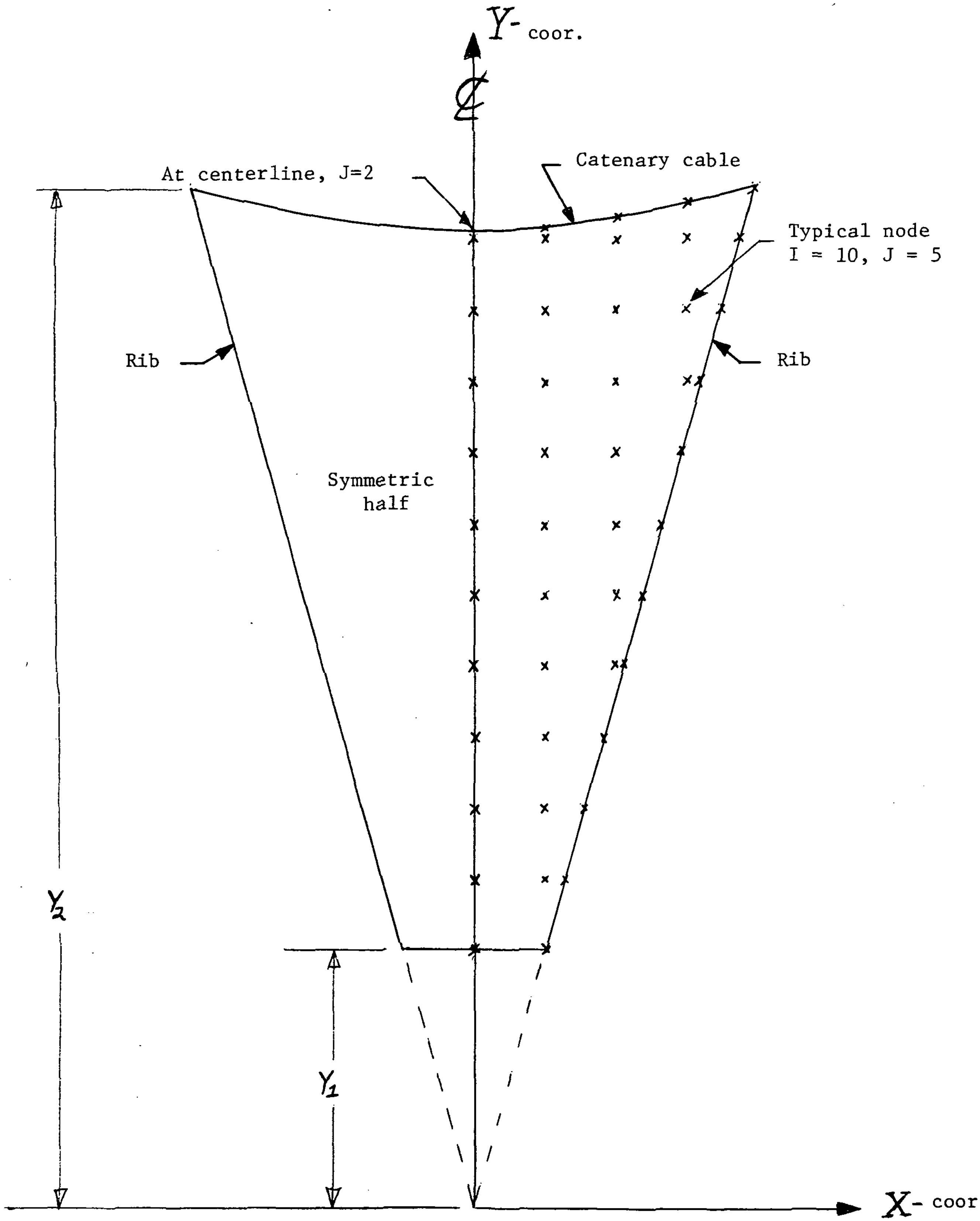


Figure 4 - Typical node locations for mesh shape analysis.

VII. REFERENCES

1. Utku, S., and C. H. Norrs, "Utilization of Digital Computers in the Analysis of Thin Shells," Bulletin Rilem No. 19.

2. Smith, G. D., Numerical Solution of Partial Differential Equations, Oxford University Press, London, England, pp. 150-151, 1965.

3. Nelder, J. A., and R. Mead, "A Simplex Method for Function Minimization," Computer Journal, Vol. 7, pp. 308-13, January 1965.

VIII. APPENDIX A PROGRAM LISTING

```
-FOR,IS   MAIN,MAIN
      DIMENSION Y(321),LIM(321),U(321,25),X(3),UP(321,2)
      COMMON HH,Y,LIM,RI,ILIM,DIS,CAS,RO,ELAM,SAN,TXB,TXT,FPD,U,HVT,JPL
     1,DM,DIFMX,DIFM,RIBN,UP,SAG,NCHECK,NPUNCH,NGORE
      COMMON/NQQ/NOPTIM,TYC,THETA,EROR,NB,DHUBR,ERRHUB
      COMMON/NT/NDELTU,NWEIGH,NMESH,NAREA,NTENS
 1020 FORMAT(1H ,28H***          NUMBER OF RIBS =,I5,28H             ANTEN
     1NA RADIUS =,F7.3,12H         ***)
 1040 FORMAT(1H1,80H*****************************************************
     1***************************)
 1050 FORMAT(1H ,80H*****************************************************
     1***************************)
      NMESH=150
      NAMELIST/DATA1/LOOP,NB,NOPTIM,NWEIGH,NAREA,NTENS,NCHECK,NPUNCH,
     1NGORE,SAG,A1,A2,A3,RO,RI,FPD,DIFM,DHUBR,ERRHUB,TYC,TXB,TXT,NRIBS
      DATA LOOP,NB,NOPTIM,NWEIGH,NAREA,NTENS/1,1,0,1,1,0/
     1NCHECK,NPUNCH,NGORE,SAG,A1,A2,A3/0,0,0,0.0,0.0,0.0,0.0/
      LOP=0
 10   LOP=LOP+1
      READ(5,DATA1)
      X(1)=A1
      X(2)=A2
      X(3)=A3
      RIBN=NRIBS
      WRITE(6,1040)
      WRITE(6,1050)
      WRITE(6,1020)NRIBS,RO
      WRITE(6,1050)
      WRITE(6,1050)
      THETA=180./RIBN
      CALL SMAIN(X)
      IF(SAG.EQ.0.0)GO TO 20
      IF(NTENS.NE.0)CALL RIBDEF(X)
 20   IF(LOP.LT.LOOP)GO TO 10
      STOP
      END
```

```
-FOR,IS   SMAIN,SMAIN
      SUBROUTINE SMAIN(X)
      DIMENSION Y(321),LIM(321),U(321,25),X(3),UP(321,2)
      REAL LENGTH
      COMMON HH,Y,LIM,RI,ILIM,DIS,CAS,RO,ELAM,SAN,TXB,TXT,FPD,U,HVT,JPL
     1,DM,DIFMX,DIFM,RIBN,UP,SAG,NCHECK,NPUNCH,NGORE
      COMMON/NT/NDELTU,NWEIGH,NMESH,NAREA,NTENS
      COMMON/NOQ/NOPTIM,TYC,THETA,EROR,NB,DHUER,ERRHUB,TT
      COMMON/RBB/FMAX,SINTTH,SINTTV,SINTTD
 1010 FORMAT(1H0,38HOUTPUT UNITS EQUIVALENT TO INPUT UNITS)
 1020 FORMAT(1H0,46HRMS ERROR IS WEIGHTED BY ILLUMINATION FUNCTION)
 1030 FORMAT(1H0,50HRMS ERROR IS NOT WEIGHTED BY ILLUMINATION FUNCTION)
 1040 FORMAT(1H0,48HRMS ERROR IS WEIGHTED BY SURFACE AREA OF ANTENNA///)
 1050 FORMAT(1H0,50HRMS ERROR IS WEIGHTED BY PROJECTED AREA OF ANTENNA//
     1/)
 1059 FORMAT(1H0,45H***INPUT PARAMATERS FOR RADIAL RIB ANTENNA***)
 1060 FORMAT(1H0,25HANTENNA RADIUS          =,F10.3)
 1061 FORMAT(1H0,25HHUB RADIUS              =,F10.3)
 1062 FORMAT(1H0,25HHALF ANGLE BETWEEN RIBS =,F10.3)
 1063 FORMAT(1H0,25HFOCAL LENGTH TO DIAMETER=,F10.3)
 1064 FORMAT(1H0,25HFOCAL LENGTH            =,F10.3)
 1065 FORMAT(1H0,25HTENSION RADIAL DIRECTION=,F10.3)
 1067 FORMAT(1H0,25HTENSION CIRCUM. DIR,TOP =,F10.3)
 1068 FORMAT(1H0,25HTENSION CIRCUM. DIR,BASE=,F10.3)
 1072 FORMAT(1H0,25HMAX NORMAL SURFACE ERROR=,F10.3)
 1073 FORMAT(1H0,25HSUBDISH BLOCKAGE RADIUS =,F10.3)
 1074 FORMAT(1H0,25HRIGID DISH RMS ERROR    =,F10.3)
 1075 FORMAT(1H0,25HCABLE SAG               =,F10.3)
 1076 FORMAT(1H0,25HGRID SIZE PARAMETER     =,I10)
 1110 FORMAT(1H0,43HRIB OPTIMIZATION VARIABLES A(1) TO A(3)  = ,3(E12.6)
     1)
 1130 FORMAT(1H0,31HDIMENSION 25 ON MATRIX EXCEEDED,I10)
 1140 FORMAT(1H0,72HUNABLE TO OPTIMIZE DUE TO MAX SURFACE ERROR ALLOWED,
     1SO ERROR INCREASED. /8H DIFMX =,F10.5)
 1150 FORMAT(1H0,10X,43HCALCULATED ANTENNA MESH SHAPE Z-COORDINATES)
 1160 FORMAT(1H1,19HANTENNA RMS ERROR =,E12.6)
 1190 FORMAT(1H0,19HWEIGHTED RMS ERROR=,E12.6)
 1200 FORMAT(///1H0,10X,43HOPTIMIZED ANTENNA MESH SHAPE Z-COORDINATES //
     1)
 1209 FORMAT(1H0,38HFINAL RECALCULATED WEIGHTED RMS ERROR=,E12.6)
 1210 FORMAT(1H0,38HFINAL RECALCULATED ANTENNA RMS ERROR =,E12.6)
 1240 FORMAT(1H1,50H    CATENARY CABLE TENSION   CATENARY CABLE LENGTH)
 1260 FORMAT(1H ,5X,F15.5,10X,F15.5///)
 1280 FORMAT(1H1,10X,13HX-COORDINATES//)
 1288 FORMAT(7F10.4)
 1290 FORMAT(1H1,10X,13HY-COORDINATES//)
 1299 FORMAT(4F10.4,3E13.8)
 1300 FORMAT(3F10.4,3I10)
 1301 FORMAT(50X,I10)
 1310 FORMAT(1H1,18H***GORE PATTERN***)
 1320 FORMAT(1H0,17H  LENGTH   WIDTH )
 1330 FORMAT(1H ,2F8.3)
 1340 FORMAT(1H0,16H  UPPER BOUNDARY)
 1350 FORMAT(1H ,17H    COOR   CURVE )
      NDELTU=0
      DM=.00001
      MAXITR=150
      DIFMX=DIFM
      FLE=2.*FPD*RO
      TT=THETA/57.29578
```

```
      SAN=SIN(TT)
      CAS=COS(TT)
      DIS=RI*CAS
      RIC=RI*SAN
10    ENB=NB
      HH=RIC/ENB
      HVT=(RO-RI)*CAS
      HVTT=HVT+RI*CAS
50    WRITE(6,1010)
      IF(NWEIGH.NE.0)GO TO 60
      WRITE(6,1020)
      GO TO 70
60    WRITE(6,1030)
70    IF(NAREA.EQ.0)GO TO 80
      WRITE(6,1040)
      GO TO 90
80    WRITE(6,1050)
90    WRITE(6,1059)
      WRITE(6,1060)RO
      WRITE(6,1061)RI
      WRITE(6,1062)THETA
      WRITE(6,1063)FPD
      WRITE(6,1064)FLE
      WRITE(6,1065)TYC
      WRITE(6,1067)TXT
      WRITE(6,1068)TXB
      WRITE(6,1072)DIFMX
      WRITE(6,1073)DHUBR
      WRITE(6,1074)ERRHUB
      WRITE(6,1075)SAG
      WRITE(6,1076)NB
      WRITE(6,1110)(X(I),I=1,3)
110   LIM(1)=NB+2
      ILIM=0
      Y(1)=DIS
      DO 150 I=2,321
      IF(ILIM.NE.0)GO TO 160
      XBNDM1=Y(I-1)*TAN(TT)
      SLOPE=SQRT(XBNDM1**2+Y(I-1)**2)/(4.*FPD*RO*COS(TT))
      THETI=ATAN(SLOPE)
      ELMT=HH*COS(THETI)
      Y(I)=Y(I-1)+ELMT
      IF(Y(I).LT.HVTT)GO TO 120
      Y(I)=HVTT
      ILIM=I
      IF(Y(I)-Y(I-1).GT.0.1*(Y(I-1)-Y(I-2)))GO TO 120
      ILIM=I-1
      Y(I-1)=HVTT
      GO TO 160
120   XBND=Y(I)*TAN(TT)
      ELMNUM=XBND/HH
      NUMELM=ELMNUM
      LIM(I)=NUMELM+3
      ELMNU=NUMELM
      IF(ELMNUM-ELMNU.LT.0.01*HH)LIM(I)=LIM(I)-1
150   CONTINUE
160   JLIM=LIM(ILIM)
      IF(JLIM.GT.25)WRITE(6,1130)JLIM
      IF (JLIM.GT.25)GO TO 340
      IF(NOPTIM.EQ.0)GO TO 210
```

```
170   DIF=DIFMAX(X)
      IF(DIF.GT.DIFMX)GO TO 180
      GO TO 200
180   CALL SIMPLX(X,-3,-2,ITER,150,3,ERO,1)
      NDELTU=0
      IF (ERO.LT.DIFMX) GO TO 200
      DIFMX=1.1*ERO
190   WRITE(6,1140)DIFMX
200   CALL SIMPLX(X,-3,-2,ITER,150,3,ERO,0)
      GO TO 230
210   CALL RMS(EROR,WEROR,X,1,0)
      WRITE(6,1160)EROR
      IF(NWEIGH.EQ.0)WRITE(6,1190)WEROR
      WRITE(6,1150)
      GO TO 260
230   CALL RMS(EROR,WEROR,X,0,0)
      EROR1=EROR
      WEROR1=WEROR
      NDELTU=0
      CALL RMS(EROR,WEROR,X,1,0)
      WRITE(6,1160)EROR1
      IF(NWEIGH.EQ.0)WRITE(6,1190)WEROR1
      WRITE(6,1210)EROR
      IF(NWEIGH.EQ.0)WRITE(6,1209)WEROR
      WRITE(6,1110)(X(I),I=1,3)
      WRITE(6,1200)
260   IF(NPUNCH.EQ.0)GO TO 262
      NCARDP=0
      PUNCH 1060,RO
      PUNCH 1061,RI
      PUNCH 1062,THETA
      PUNCH 1063,FPD
      PUNCH 1065,TYC
      PUNCH 1067,TXT
      PUNCH 1068,TXB
      BASE=Y(1)
      TOP=Y(ILIM)
      PUNCH 1299,FLE,BASE,TOP,THETA,X(1),X(2),X(3)
      DO 261 I=1,ILIM
      NXQC=LIM(I)
      DO 261 J=2,NXQC
      NCARDP=NCARDP+1
      B1=XX(I,J)
      B2=Y(I)
      B3=U(I,J)
      PUNCH 1300,B1,B2,B3,I,J,NCARDP
261   CONTINUE
      NCARDP=NCARDP+1000000
      PUNCH 1301,NCARDP
262   IF(SAG.EQ.0.0)GO TO 301
      DO 270 I=1,ILIM
      LIMI=LIM(I)
      SAG1=U(I,2)-U(I,LIMI)
      UP(I,1)=2.0*SAG1/XX(I,LIMI)
      UP(I,2)=SQRT(Y(I)**2+XX(I,LIMI)**2)
270   CONTINUE
      XLL=2.*XX(ILIM,LIM(ILIM))
      XX2=XX(ILIM,LIM(ILIM))
290   FMAX=XX2*TYC*SQRT(1.0+XLL**2/(16.*SAG**2))
      S=XLL*(1.+8.0*(SAG/XLL)**2/3.0-32.*(SAG/XLL)**4/5.)
```

```
      CTAN=2.0*SAG/XX2
      DELTH=Y(ILIM)-Y(ILIM-2)
      DELTV=U(ILIM,2)-U(ILIM-2,2)
  300 HVP=SQRT(DELTH**2+DELTV**2)
      ATHETA=ATAN(CTAN)
      SINTTH=SIN(ATHETA)*(DELTH/HVP)*COS(TT)
      SINTTV=SIN(ATHETA)*(DELTV/HVP)
      SINTTD=COS(ATHETA)*SIN(TT)
      IF(SAG.EQ.0.0)GO TO 301
      CALL CABLE(1)
      GO TO 303
  301 CALL PRINT
  303 IF(NGORE.EQ.0)GO TO 309
      CON=8.*FPD*RO
      WRITE(6,1310)
      WRITE(6,1320)
      LENGTH=0.0
      DO 305 I=1,ILIM
      NXQC=LIM(I)
      YC1=Y(I)
      XC= XX(I,LIM(I))
      RATIO=(YC1-DIS)/HVT
      IF (RATIO.LT.1.E-5)RATIO=0.
      DEFL=(XC*XC+YC1*YC1)/CON+X(1)*RATIO+X(2)*(4.*RATIO**3-3.*RATIO)+X(
     13)*(16.*RATIO**5-20.*RATIO**3+5.*RATIO)
      IF(I.EQ.1)GO TO 304
      LENGTH=LENGTH+SQRT((Y(I)-Y(I-1))**2+(DEFL-DEFLM1)**2)
  304 WIDTH=2.*XX(I,NXQC)
      WRITE(6,1330)LENGTH,WIDTH
      DEFLM1=DEFL
  305 CONTINUE
      WRITE(6,1340)
      WRITE(6,1350)
      NXQC=LIM(ILIM)
      DO 306 J=2,NXQC
      XSPEC=XX(ILIM,J)
      CDEFL=SAG-(4.0*SAG*XSPEC**2)/((2.0*XX(ILIM,NXQC))**2)
      WRITE(6,1330)XSPEC,CDEFL
  306 CONTINUE
  309 DO 310 I=1,ILIM
      NXCQ=LIM(I)
      DO 310 J=1,NXCQ
  310 U(I,J)=XX(I,J)
      WRITE(6,1280)
      IF(SAG.EQ.0.0)GO TO 311
      CALL CABLE(3)
  311 CALL PRINT
      DO 320 I=1,ILIM
      NXCQ=LIM(I)
      DO 320 J=1,NXCQ
  320 U(I,J)=Y(I)
      WRITE(6,1290)
      IF(SAG.EQ.0.0)GO TO 321
      CALL CABLE(4)
  321 CALL PRINT
      IF(SAG.EQ.0.0)GO TO 340
  330 WRITE(6,1240)
      WRITE(6,1260)FMAX,S
  340 RETURN
      END
```

```
-FOR,IS   SIMPLX,SIMPLX
      SUBROUTINE SIMPLX(X,AE,RE,ITER,MAXITR,N,FL,NCHEK)
      INTEGER AE,RE,ITER,MAXITR,WANTEM,N,I,PT,IPT,NPT,NP1,
     1        ITR,L,H,CC,IL,IH,LIM(321)
      REAL X(3),P(420),PS(20),PSS(20),PB(20),F(21),FH,FL,FS,FSS,
     1        AER,RER,ALFA,BETA,GAMA,U(321,25),UP(321,2),Y(321)
      COMMON HH,Y,LIM,RI,ILIM,DIS,CAS,RO,ELAM,SAN,TXB,TXT,FPD,U,HVT,JPL
     1,DM,DIFMX,DIFM,RIBN,UP,SAG,NCHECK,NPUNCH,NGORE
      COMMON/NT/NDELTU,NWEIGH,NMESH,NAREA,NTENS
 1000 FORMAT(1H1,10X,40HINITIAL ANTENNA MESH SHAPE Z-COORDINATES//)
 1001 FORMAT(1H1,10X,32HINITIAL RIB SHAPE(CURVE FITTING))
 1002 FORMAT(1H1,32HRIB SHAPE CURVE FITTING ITERATES//)
 1010 FORMAT(///1H0,5X,43HINITIAL MAXIMUM NORMAL DIFFERENCE FUNCTION=,F1
     14.6)
 1011 FORMAT(1H1,47HMINIMUM NORMAL DIFFERENCE MINIMIZATION ITERATES//)
 1020 FORMAT(1H0,5X,28HINITIAL RMS ERROR FUNCTION =,E12.6//)
 1021 FORMAT(1H1,25HRIB OPTIMIZATION ITERATES//)
 1040 FORMAT(1H ,17H            ERROR    ,38H                  OPTIMIZATION VA
     1RIABLES)
 1050 FORMAT(1H ,17HITER      FUNCTION,47H            (1)               (2)
     1               (3))
 1060 FORMAT(I4,E15.6)
 1070 FORMAT(1H+,18X,3E17.8)
 10   NP1=N+1
      NDELTC=10
      WANTEM=NCHECK
      NPT=NP1*20
      AER=10.**AE
      RER=10.**RE
      ALFA=1.
      BETA=0.5
      GAMA=2.
      ITRP=NMESH
      ITR=IABS(WANTEM)
      ITER=0
      IL=1
      DO 30 I=1,N
        DO 20 IPT=I,NPT,20
 20       P(IPT)=X(I)
      P(IL)=P(IL)+SIGN(.05,P(IL))
 30   IL=IL+21
      JC=0
 40   CC=0
      DO 150 PT=1,NP1
        DO 50 I=1,N
          IPT=CC+I
 50       X(I)=P(IPT)
      IF(NCHEK.EQ.0)GO TO 60
      IF(NCHEK.EQ.2)GO TO 70
      F(PT)=DIFMAX(X)
      GO TO 80
 60   CALL RMS(EROR,WEROR,X,0,1)
      F(PT)=EROR
      IF(NWEIGH.EQ.0)F(PT)=WEROR
      GO TO 80
 70   F(PT)=RIBEQ(X)
 80   IF(CC-N*20) 150,90,90
 90   IF (JC) 150,100,150
 100  IF(NCHEK.EQ.1)GO TO 130
      IF(NCHEK.EQ.2)GO TO 140
```

```
      WRITE(6,1000)
      CALL PRINT
      WRITE(6,1020)F(PT)
      IF(WANTEM.GT.0)WRITE(6,1021)
      GO TO 150
130   WRITE(6,1010)F(PT)
      IF(WANTEM.GT.0)WRITE(6,1011)
      GO TO 150
140   IF(WANTEM.EQ.0)GO TO 150
      WRITE(6,1001)
      CALL RPRINT
      WRITE(6,1020)F(PT)
      WRITE(6,1002)
150   CC=CC+20
      IF (JC.NE.0) GO TO 160
      IF(WANTEM.EQ.0)GO TO 160
      WRITE(6,1040)
      IF(WANTEM.GT.0) WRITE(6,1050)
160   ITER=ITER+1
        FH=F(NP1)
        FL=F(NP1)
        H=NP1
        L=NP1
        DO 190 I=1,N
          IF(F(I).GT.FH)GO TO 170
          IF(F(I).LT.FL)GO TO 180
      GO TO 190
170       FH=F(I)
          H=I
      GO TO 190
180       FL=F(I)
          L=I
190       PB(I)=0.
        IL=20*L-19
        DO 200 I=1,N
          X(I)=P(IL)
200       IL=IL+1
      IF(NCHEK.NE.0)GO TO 201
      IF(ITER.NE.NDELTC)GO TO 201
      NDELTC=NDELTC+10
      NDELTU=0
      CALL CALC(X)
201     IF(ITER.NE.ITR)GO TO 210
        ITR=ITR+IABS(WANTEM)
        WRITE(6,1060) ITER,FL
        IF(WANTEM.GT.0) WRITE(6,1070)(X(I),I=1,N)
210   IH=20*H-19
      IF (NCHEK.NE.1)GO TO 260
      IF(FL.LT.DIFMX)GO TO 280
260     DO 270 I=1,N
          IF(ABS(X(I)-P(IH)).GT.ABS(X(I)*RER)+AER)GO TO 320
270       IH=IH+1
280   IF(ITER.EQ.ITR)GO TO 290
      IF(WANTEM.EQ.0)GO TO 290
      WRITE(6,1060) ITER,FL
      IF(WANTEM.GT.0)WRITE(6,1070)(X(I),I=1,N)
290   RETURN
320     IF(ITER.LT.MAXITR)GO TO 330
        ITER=-MAXITR
        RETURN
```

```
330    CC=0
       DO 350 PT=1,NP1
         IF(PT.EQ.H)GO TO 350
         DO 340 I=1,N
           IPT=CC+I
340        PB(I)=PB(I)+P(IPT)
350      CC=CC+20
       IH=H*20-19
       DO 360 I=1,N
         PB(I)=PB(I)/FLOAT(N)
         PS(I)=(1.+ALFA)*PB(I)-ALFA*P(IH)
360      IH=IH+1
     IF(NCHEK.EQ.0)GO TO 370
     IF(NCHEK.EQ.2)GO TO 380
     FS=DIFMAX(PS)
     GO TO 390
370  CALL RMS(EROR,WEROR,PS,0,1)
     FS=EROR
     IF(NWEIGH.EQ.0)FS=WEROR
     GO TO 390
380  FS=RIBEQ(PS)
390    IF(FS.GE.FL)GO TO 480
       DO 400 I=1,N
400      PSS(I)=(1.+GAMA)*PS(I)-GAMA*PB(I)
     IF(NCHEK.EQ.0)GO TO 410
     IF(NCHEK.EQ.2)GO TO 420
     FSS=DIFMAX(PSS)
     GO TO 430
410  CALL RMS(EROR,WEROR,PSS,0,1)
     FSS=EROR
     IF(NWEIGH.EQ.0)FSS=WEROR
     GO TO 430
420  FSS=RIBEQ(PSS)
430    IF(FSS.GE.FL)GO TO 460
440    IH=20*H-19
       DO 450 I=1,N
         P(IH)=PSS(I)
450      IH=IH+1
       F(H)=FSS
     GO TO 160
460    F(H)=FS
       IH=20*H-19
       DO 470 I=1,N
         P(IH)=PS(I)
470      IH=IH+1
     GO TO 160
480    DO 490 I=1,NP1
490      IF(FS.LT.F(I).AND.I.NE.H)GO TO 460
       IF(FS.LT.FH)GO TO 510
       IH=20*H-19
       DO 500 I=1,N
         PS(I)=P(IH)
500      IH=IH+1
510    DO 520 I=1,N
520      PSS(I)=BETA*PS(I)+(1.-BETA)*PB(I)
     IF(NCHEK.EQ.0)GO TO 530
     IF(NCHEK.EQ.2)GO TO 540
     FSS=DIFMAX(PSS)
     GO TO 550
530  CALL RMS(EROR,WEROR,PSS,0,1)
```

```
      FSS=EROR
      IF(NWEIGH.EQ.0)FSS=WEROR
      GO TO 550
540   FSS=RIBEQ(PSS)
550     IF(FSS.LT.FH)GO TO 440
        IL=20*L-19
        DO 570 I=1,N
          FL=P(IL)
          DO 560 PT=I,NPT,20
560         P(PT)=(P(PT)+FL)/2.
570     IL=IL+1
      JC=1
      GO TO 40
      END
```

```
-FOR,IS   SCALC,SCALC
      SUBROUTINE CALC(X)
      DIMENSION Y(321),LIM(321),U(321,25),X(3),UP(321,2)
      COMMON HH,Y,LIM,RI,ILIM,DIS,CAS,RO,ELAM,SAN,TXB,TXT,FPD,U,HVT,JPL
     1,DM,DIFMX,DIFM,RIBN,UP,SAG,NCHECK,NPUNCH,NGORE,RILTH,RIBLTH
      COMMON/NOG/NOPTIM,TYC,THETA,EROR,NB,DHUBR,ERRHUB,TT
      COMMON/NT/NDELTU,NWEIGH,NMESH,NAREA,NTENS
 1000 FORMAT(//1H ,32HLAST SUM LESS THAN PRESENT SUM  ,2F15.10,I5//)
      CON=8.*FPD*RO
      IDM=0
      XPYRO=1.0/(8.0*FPD)
      XPYRI=RI/(8.0*FPD*RO)
      ROLTH=RO*(1.0+2.0*XPYRO**2/3.0-2.0*XPYRO**4/5.0)
      RILTH=RI*(1.0+2.0*XPYRI**2/3.0-2.0*XPYRI**4/5.0)
      RIBLTH=ROLTH-RILTH
      IF(NDELTU.NE.0)GO TO 20
      NDELTU=1
      DO 10 I=1,ILIM
      YC1=Y(I)
      XC= XX(I,LIM(I))
      RATIO=(YC1-DIS)/HVT
      IF (RATIO.LT.1.E-5)RATIO=0.
      DEFL=(XC*XC+YC1*YC1)/CON+X(1)*RATIO+X(2)*(4.*RATIO**3-3.*RATIO)+X(
     13)*(16.*RATIO**5-20.*RATIO**3+5.*RATIO)
      NXQC=LIM(I)
      DO 10 J=1,NXQC
 10   U(I,J)=DEFL
      GO TO 40
 20   DO 30 I=1,ILIM
      XC= XX(I,LIM(I))
      YC1=Y(I)
      RATIO=(YC1-DIS)/HVT
      IF (RATIO.LT.1.E-5)RATIO=0.
      DEFL=(XC*XC+YC1*YC1)/CON+X(1)*RATIO+X(2)*(4.*RATIO**3-3.*RATIO)+X(
     13)*(16.*RATIO**5-20.*RATIO**3+5.*RATIO)
      NXQC=LIM(I)
      DO 30 J=1,NXQC
 30   U(I,J)=U(I,J)-U(I,NXQC)+DEFL
      GO TO 150
 40   WM1=0.0
      W=1.0
      DMM1=0.0
      ISTEP=0
      NT=10
 50   DSUM=0.0
      NILT=ILIM-1
      DO 70 I=2,NILT
      NXQC=LIM(I)-1
      DO 70 J=2,NXQC
      II=I-1
      UIM1J=U(II,J)
      YIM1J=Y(II)
      IF(J.NE.NXQC)GO TO 51
      IF(LIM(I).EQ.LIM(II))GO TO 51
      XC=XX(I,J)
      YC1=XC/TAN(TT)
      RATIO=(YC1-DIS)/HVT
      IF (RATIO.LT.1.E-5)RATIO=0.
      UIM1J=(XC*XC+YC1*YC1)/CON+X(1)*RATIO+X(2)*(4.*RATIO**3-3.*RATIO)+X
     1(3)*(16.*RATIO**5-20.*RATIO**3+5.*RATIO)
```

```
      YIM1J=YC1
51    CALL CONT(I,J,C1,C2,C3,C4,UIM1J,YIM1J)
      UNEXT=W*(C1*U(I,J+1)+C3*U(I,J-1)+C2*U(I+1,J)+C4*UIM1J)+WM1*U(I,J)
      DSUM=DSUM+(UNEXT-U(I,J))*(UNEXT-U(I,J))
      U(I,J)=UNEXT
      IF(J-3) 70,60,70
60    U(I,1)=U(I,3)
70    CONTINUE
      DSUM=SQRT(DSUM)
      ISTEP=ISTEP+1
80    IF(ISTEP.EQ.1)GO TO 130
      IF(DSUM-DM) 150,150,90
90    IF(ISTEP.NE.(ISTEP/2)*2)GO TO 91
      IF (DMM1.GT.DSUM)GO TO 91
      WRITE(6,1000)DSUM,DMM1,ISTEP
      IDM=IDM+1
      IF(IDM.GT.4)GO TO 150
      GO TO 130
91    IF(NT-ISTEP) 100,100,130
100   NT=NT+10
110   W=2./(1.+SQRT(1.-DSUM/DMM1))
120   WM1=1.-W
130   DMM1=DSUM
      GO TO 50
150   RETURN
      END
```

```
-FOR,IS    SRMS,SRMS
      SUBROUTINE RMS(ERO,WERO,X,NPRT,NDIF)
      DIMENSION Y(321),LIM(321),U(321,25),X(3),UP(321,2)
      COMMON HH,Y,LIM,RI,ILIM,DIS,CAS,RO,ELAM,SAN,TXB,TXT,FPD,U,HVT,JPL
     1,DM,DIFMX,DIFM,RIBN,UP,SAG,NCHECK,NPUNCH,NGORE
      COMMON/NOO/NOPTIM,TYC,THETA,EROR,NR,DHUBR,ERRHUB,TT
      COMMON/NT/NDELTU,NWEIGH,NMESH,NAREA,NTENS
      COMMON/XY/XA,YA,XC,YC1,Z
 1000 FORMAT(1H ,18H   HUB RMS ERROR =,F6.4,13H   HUB AREA =,F10.5)
 1009 FORMAT(1H1,51HCALCULATION OF THE RMS ERROR OF THE ANTENNA SURFACE)
 1011 FORMAT(1H0,54H  NODE  ILLUMINATION  ELEMENT    SURFACE      ELEMEN
     1T )
 1010 FORMAT(1H ,51H   I  J       WEIGHT      AREA        ERROR          SUM)
 1020 FORMAT(1H ,2I3,3F11.4,F14.8)
 1030 FORMAT(1H ,3X,22HHUB WEIGHTING FUNCTION,F10.5)
      DIF=DIFMAX(X)
      IF(NDIF.EQ.0)GO TO 1
      IF(DIF.GT.DIFMX)GO TO 70
 1    CON=8.*FPD*RO
      BB=0.
      WCC=0.
      WBB=0.
      CC=0.
      FP=2.*FPD*RO
      CALL AHUB(BBP,CCP)
      IF(NPRT.EQ.0)GO TO 10
      IF(NCHECK.NE.0)WRITE(6,1009)
      IF(NCHECK.NE.0)WRITE(6,1011)
      IF(NCHECK.NE.0)WRITE(6,1010)
 10   DO 30 I=1,ILIM
      NXQC=LIM(I)
      DO 30 J=2,NXQC
      XA=XX(I,J)
      YA=Y(I)
      XC=XA**2
      YC1=YA**2
      Z=(XC+YC1)/CON
      SLOPE=SQRT(XC+YC1)/(4.0*FPD*RO*COS(TT))
      THET=ATAN(SLOPE)
      DELTER=(U(I,J)-Z)*COS(THET)
      AREA=SAREA(I,J)
      IF(NWEIGH.NE.0)GO TO 20
      A=WEIGH(I,J)
      ABCD=DELTER**2*AREA*A
      WBB=WBB+ABCD
      WCC=WCC+AREA*A
      IF(NPRT.EQ.0)GO TO 20
      IF(NCHECK.NE.0)WRITE(6,1020)I,J,A,AREA,DELTER,ABCD
 20   A=1.
      ABCD=DELTER**2*AREA*A
      BB=BB+ABCD
      CC=CC+AREA*A
      IF(NPRT.EQ.0)GO TO 30
      IF(NCHECK.NE.0)WRITE(6,1020)I,J,A,AREA,DELTER,ABCD
 30   CONTINUE
      CC=CC+CCP
      BB=BB+BBP*BBP*CCP
      I=0
      J=0
      IF(NWEIGH.NE.0)GO TO 40
```

```
      A=WEIGH(I,J)
      GO TO 50
40    A=1.
50    WCC=WCC+CCP*A
      WBB=WBB+BBP*BBP*CCP*A
      IF(NPRT.EQ.0)GO TO 60
      IF(NCHECK.NE.0)WRITE(6,1000)BBP,CCP
      IF(NCHECK.NE.0)WRITE(6,1030)A
60    ERO=SQRT(BB/CC)
      IF(NWEIGH.EQ.0)WERO=SQRT(WBB/WCC)
      GO TO 80
70    ERO=1.+DIF*100.
      WERO=1.+DIF*100.
80    RETURN
      END
```

```
-FOR,IS   SAREA,SAREA
      FUNCTION SAREA(I,J)
      DIMENSION Y(321),LIM(321),U(321,25)
      COMMON HH,Y,LIM,RI,ILIM,DIS,CAS,RO,ELAM,SAN,TXB,TXT,FPD,U,HVT,JPL
     1,DM,DIFMX
      COMMON/NT/NDELTU,NWEIGH,NMESH,NAREA,NTENS
      COMMON/NQQ/NOPTIM,TYC,THETA,EROR,NB,DHUBR,ERRHUB,TT
      COMMON/XY/XA,YA,XC,YC1,Z
      LIMI=LIM(I)
      LIMIM1=LIM(I-1)
      HEIGHT=0.0
      IF(NAREA.EQ.0)GO TO 50
      IF(I.GT.1)GO TO 10
      GO TO 30
   10 IF(I.LT.ILIM)GO TO 20
      GO TO 40
   20 HEIGHT=(U(I+1,2)-U(I-1,2))/2.
      GO TO 50
   30 HEIGHT=(U(I+1,2)-U(I,2))
      GO TO 50
   40 HEIGHT=(U(I,2)-U(I-1,2))
   50 YIM1J=Y(I-1)
      IF(J.LT.LIMIM1)GO TO 51
      IF(LIMI.EQ.LIMIM1)GO TO 51
      YIM1J=XX(I,J)/TAN(TT)
   51 H1=HH/2.
      H3=HH/2.
      IF(J-LIMI+1) 80,70,60
   60 H1=0.
      H3=(XA-XX(I,J-1))/2.
      GO TO 82
   70 H1=(XX(I,J+1)-XA)/2.
      GO TO 82
   80 IF(J-2)81,81,82
   81 H3=0.
   82 IF(I-ILIM+1) 110,100,90
   90 H2=0.
      H4=(YA-YIM1J)/2.
      GO TO 140
  100 H2=(Y(I+1)-YA)/2.
      H4=(YA-YIM1J)/2.
      GO TO 140
  110 IF(I-2)120,130,130
  120 H4=0.
      H2=(Y(I+1)-YA)/2.
      GO TO 140
  130 H2=(Y(I+1)-YA)/2.
      H4=(YA-YIM1J)/2.
  140 H2PH4=((H2+H4)**2+HEIGHT**2)**.5
      SAREA=H2PH4*(H1+H3)
      RETURN
      END
```

```
-FOR,IS    SCONT,SCONT
      SUBROUTINE CONT(I,J,C1,C2,C3,C4,UIM1J,YIM1J)
      DIMENSION Y(321),LIM(321),U(321,25),UP(321,2)
      COMMON HH,Y,LIM,RI,ILIM,DIS,CAS,RO,ELAM,SAN,TXB,TXT,FPD,U,HVT,JPL
     1,DM,DIFMX,DIFM,RIBN,UP,SAG,NCHECK,NPUNCH,NGORE,RILTH,RIBLTH
      COMMON/NOG/NOPTIM,TYC,THETA,EROR,NB,DHUBR,ERRHUB,TT
      H1=HH
      H2=Y(I+1)-Y(I)
      H3=HH
      H4=Y(I)-YIM1J
      A=(1.+((U(I,J-1)-U(I,J+1))/(XX(I,J-1)-XX(I,J+1)))**2)**(3./2.)
      B=1.+((U(I,J)-UIM1J)/(Y(I)-YIM1J))**2
      RADUS=SQRT(Y(I)**2+XX(I,LIM(I))**2)
      XPY=RADUS/(8.0*FPD*RO)
 100  IF(J-LIM(I)+1) 120,110,110
 110  H1=XX(I,LIM(I))-XX(I,LIM(I)-1)
 120  RLTH=RADUS*(1.+2.*XPY**2/3.-2.*XPY**4/5.)-RILTH
      ELAM=TYC*A/((TXB+(TXT-TXB)*(RLTH/RIBLTH))*B)
 140  H2H4=H2*H4
      H1H3=H1*H3
      H1PH3=H1+H3
      H2PH4=H2+H4
      CC=H2H4+ELAM*H1H3
      C1=H2H4*H3/(H1PH3*CC)
      C2=(H1H3*H4/(H2PH4*CC))*ELAM
      C3=H2H4*H1/(H1PH3*CC)
      C4=(H1H3*H2/(H2PH4*CC))*ELAM
      RETURN
      END
```

```
-FOR,IS    SAHUB,SAHUB
      SUBROUTINE AHUB(BBP,CCP)
      DIMENSION Y(321),LIM(321),U(321,25)
      COMMON HH,Y,LIM,RI,ILIM,DIS,CAS,RO,ELAM,SAN,TXB,TXT,FPD,U,HVT,JPL
     1,DM,DIFMX,DIFM,RIBN
      COMMON/NOG/NOPTIM,TYC,THETA,EROR,NB,DHUBR,ERRHUB
      COMMON/NT/NDELTU,NWEIGH,NMESH,NAREA,NTENS
      IF(NAREA.EQ.0)GO TO 10
      CON=8.*FPD*RO
      H=RI**2/CON
      DIA2=(2.*RI)**2
      P=DIA2/(8.*H)
      BBP=ERRHUB
      CCP=(6.2832*((DIA2/4.+P**2)**(3./2.)-P**3)/(3.*P))/(RIBN*2.)
      H=DHUBR**2/CON
      DIA2=(2.*DHUBR)**2
      P=DIA2/(8.*H)
      CCP=CCP-(6.2832*((DIA2/4.+P**2)**(3./2.)-P**3)/(3.*P))/(RIBN*2.)
      GO TO 20
 10   BBP=ERRHUB
      CCP=(3.14159*RI**2-3.14159*DHUBR**2)/(RIBN*2.)
 20   RETURN
      END
```

```
-FOR,IS    SDIFMX,SDIFMX
      FUNCTION DIFMAX(X)
      DIMENSION Y(321),LIM(321),U(321,25),X(3)
      COMMON HH,Y,LIM,RI,ILIM,DIS,CAS,RO,ELAM,SAN,TXB,TXT,FPD,U,HVT,JPL
     1,DM,DIFMX
      COMMON/NQQ/NOPTIM,TYC,THETA,EROR,NB,DHUBR,ERRHUB,TT
      COMMON/NT/NDELTU,NWEIGH,NMESH,NAREA,NTENS
      CON=8.*FPD*RO
      CALL CALC(X)
      DIFMAX=0.0
      DO 10 I=1,ILIM
      NXQC=LIM(I)
      DO 10 J=1,NXQC
      XA=XX(I,J)
      YA=Y(I)
      XC=XA**2
      YC1=YA**2
      PARA=(XC+YC1)/CON
      SLOPE=SQRT(XC+YC1)/(4.0*FPD*RO*COS(TT))
      THET=ATAN(SLOPE)
      DIF=ABS(PARA-U(I,J))*COS(THET)
      IF (DIF.GT.DIFMAX)DIFMAX=DIF
 10   CONTINUE
      RETURN
      END
```

```
-FOR,IS    SWEIGH,SWEIGH
      FUNCTION WEIGH(I,J)
      DIMENSION Y(321),LIM(321),U(321,25)
      COMMON HH,Y,LIM,RI,ILIM,DIS,CAS,RO,ELAM,SAN,TXB,TXT,FPD,U,HVT,JPL
     1,DM,DIFMX,DIFM,RIBN
      COMMON/NQQ/NOPTIM,TYC,THETA,EROR,NB,DHUBR,ERRHUB,TT
      COMMON/NT/NDELTU,NWEIGH,NMESH,NAREA,NTENS
      COMMON/XY/XA,YA,XC,YC1,Z
      FP=2.*FPD*RO
      CON=8.*FPD*RO
      IF(I.EQ.0)GO TO 10
      C=(FP-U(I,J))/SQRT(XC+YC1+(FP-U(I,J))**2)
      GO TO 20
 10   RRR=38.197*(RI**3-DHUBR**3)*SIN(TT)/((RI**2-DHUBR**2)*THETA)
      ZZZ=RRR**2/CON
      C=(FP-ZZZ)/SQRT(RRR**2+(FP-ZZZ)**2)
 20   THETS=ACOS(C)
      THETO=2.*ATAN(1./(4.*FPD))
      CONST=ACOS(.562*(2./(1.+COS(THETO)))**.5)/THETO
      WEIGH=((1.+C)/2.)*(COS(CONST*THETS))**2.
      RETURN
      END
```

```
-FOR,IS    SXX,SXX
      FUNCTION XX(I,J)
      DIMENSION Y(321),LIM(321)
      COMMON HH,Y,LIM,RI,ILIM,DIS,CAS,RO,ELAM,SAN
      COMMON/NQQ/NOPTIM,TYC,THETA,EROR,NB,DHUBR,ERPHUB,TT
      EJ=J-2
      IF(J-LIM(I)) 10,20,20
 10   XX=EJ*HH
      RETURN
 20   IF(I-ILIM) 40,30,30
 30   XX=RO*SAN
      RETURN
 40   XX=Y(I)*TAN(TT)
      RETURN
      END
```

```
-FOR,IS    CABLE,CABLE
      SUBROUTINE CABLE(N)
      DIMENSION Y(321),LIM(321),U(321,25),UP(321,2)
      REAL LENGTH(10,25)
      COMMON HH,Y,LIM,RI,ILIM,DIS,CAS,RO,ELAM,SAN,TXB,TXT,FPD,U,HVT,JPL
     1,DM,DIFMX,DIFM,RIBN,UP,SAG,NCHECK,NPUNCH,NGORE
      NXQC=LIM(ILIM)
      DO 40 J=2,NXQC
      NN=1
      I=ILIM
      CDEFL=SAG-4.0*SAG*(XX(ILIM,J))**2/(2.0*XX(ILIM,NXQC))**2
      JJ=J
      IF(J.LT.NXQC-1)GO TO 19
      IF(LIM(ILIM).GT.LIM(ILIM-1))JJ=J-1
      IF(J.EQ.NXQC)JJ=JJ-1
 19   IF(N.NE.1)GO TO 20
      LENGTH(NN,J)=SQRT((Y(I)-Y(I-1))**2+(U(I,JJ)-U(I-1,JJ))**2)
 20   IF(CDEFL.LT.LENGTH(NN,J))GO TO 30
      CDEFL=CDEFL-LENGTH(NN,J)
      U(I,J)=10000000.
      NN=NN+1
      I=I-1
      GO TO 19
 30   IF(N.EQ.1)U(I,J)=U(I,J)-(U(I,JJ)-U(I-1,JJ))*CDEFL/LENGTH(NN,J)
      IF(N.EQ.4)U(I,J)=U(I,J)-(Y(I)-Y(I-1))*CDEFL/LENGTH(NN,J)
 40   CONTINUE
      IF(N.NE.1)RETURN
      CALL PRINT
      RETURN
      END
```

```
-FOR,IS    SPRINT,SPRINT
      SUBROUTINE PRINT
      DIMENSION Y(321),LIM(321),U(321,25)
      COMMON HH,Y,LIM,RI,ILIM,DIS,CAS,RO,ELAM,SAN,TXB,TXT,FPD,U,HVT,JPL
      COMMON/NT/NDELTU,NWEIGH,NMESH,NAREA,NTENS
 1000 FORMAT(1H ,9H  I    J   ,I2,7(7X,I2))
 1001 FORMAT(1H ,12HNODE NUMBERS)
 1010 FORMAT(1H ,I3,3X,8(1X,F8.4))
      NNN=0
      J1=2
      J2=9
      WRITE(6,1001)
 10   NN=0
      WRITE(6,1000)(J,J=J1,J2)
      DO 90 II=1,ILIM
      I=ILIM-II+1
      LIMIT=LIM(I)-NNN*8-1
      IF(LIMIT) 100,100,20
 20   IF(LIMIT-8)30,30,40
 30   LHIGH=LIM(I)
      LOW=2+NNN*8
      GO TO 50
 40   NN=1
      NQ=NNN+1
      LHIGH=NQ*8+1
      LOW=LHIGH-7
 50   WRITE(6,1010)I,(U(I,J),J=LOW,LHIGH)
 90   CONTINUE
      J1=J1+8
      J2=J2+8
      NNN=NNN+1
 100  IF(NN-1)110,10,10
 110  RETURN
      END
```

```
-FOR,IS    RIBDEF,RIBDEF
      SUBROUTINE RIBDEF(X)
      DIMENSION Y(321),LIM(321),U(321,25),X(3),UP(321,2)
      COMMON HH,Y,LIM,RI,ILIM,DIS,CAS,RO,ELAM,SAN,TXB,TXT,FPD,U,HVT,JPL
     1,DM,DIFMX,DIFM,RIBN,UP,SAG,NCHECK,NPUNCH,NCORE
      COMMON/NT/NDELTU,NWEIGH,NMESH,NAREA,NTENS
      COMMON/NOQ/NOPTIM,TYC,THETA
      COMMON/RBB/FMAX,SINTTH,SINTTV,SINTTD,NODES
      COMMON/RIB/NUM,NUMP1,NBLKS
 1000 FORMAT(1HO,50H***INPUT PARAMETERS FOR RIB DEFLECTION ANALYSIS***)
 1011 FORMAT(1HO,22HANTENNA RADIUS        =,F10.4)
 1012 FORMAT(1HO,22HHUB RADIUS            =,F10.4)
 1013 FORMAT(1HO,22HA1                    =,F10.6)
 1014 FORMAT(1HO,22HA2                    =,F10.6)
 1015 FORMAT(1HO,22HA3                    =,F10.6)
 1016 FORMAT(1HO,22HMESH TENSION BASE     =,F10.4)
 1017 FORMAT(1HO,22HFOCAL LENGTH TO DIA   =,F10.4)
 1018 FORMAT(1HO,22HHALF ANGLE            =,F10.4)
 1019 FORMAT(1HO,22HFIN WIDTH             =,F10.4)
 1020 FORMAT(1HO,22HFIN HEIGHT            =,F10.4)
 1021 FORMAT(1HO,22HRIB BASE OUTER RADIUS=,F10.4)
 1022 FORMAT(1HO,22HRIB BASE INNER RADIUS=,F10.4)
 1023 FORMAT(1HO,22HRIB TIP OUTER RADIUS =,F10.4)
 1024 FORMAT(1HO,22HRIB TIP INNER RADIUS =,F10.4)
 1025 FORMAT(1HO,22HALLOWABLE DEFL ERROR =,F10.4)
 1026 FORMAT(1HO,22HRIB MODULUS E*10**-6 =,F10.4)
 1027 FORMAT(1HO,22HCABLE SAG             =,F10.4)
 1028 FORMAT(1HO,22HMESH TENSION TIP      =,F10.4)
 1080 FORMAT(1H ,I3,2X,E10.5,5(2X,E11.6))
 1120 FORMAT(1H1,80HNODE LENGTH FROM  RIB MOMENT    MOMENT           RIB
     1        RADIUS          Z      )
 1130 FORMAT(1H ,80H        RIB TIP    OF INERTIA    ON RIB       DEFLECTI
     1ON    COORDINATE   COORDINATE/)
 1140 FORMAT(1HO,29HRIB CURVE FITTING RMS ERROR =,E12.6)
 1150 FORMAT(1HO,40H        B(1)            B(2)            B(3) )
 1160 FORMAT(1HO,3E15.9)
 1170 FORMAT(1H1,10X,30HFINAL RIB SHAPE(CURVE FITTING))
      NBLKS=80
      ERR=.001
      NAMELIST/DATA2/WIDTH,HEIGHT,TROB,TRIB,TROT,TRIT,ERIB
      READ(5,DATA2)
      WRITE(6,1000)
      WRITE(6,1011)RO
      WRITE(6,1012)RI
      WRITE(6,1013)X(1)
      WRITE(6,1014)X(2)
      WRITE(6,1015)X(3)
      WRITE(6,1016)TXB
      WRITE(6,1028)TXT
      WRITE(6,1017)FPD
      WRITE(6,1018)THETA
      WRITE(6,1019)WIDTH
      WRITE(6,1020)HEIGHT
      WRITE(6,1021)TROB
      WRITE(6,1022)TRIB
      WRITE(6,1023)TROT
      WRITE(6,1024)TRIT
      WRITE(6,1025)ERR
      WRITE(6,1026)ERIB
      WRITE(6,1027)SAG
```

```
      INDEX=0
      CON=8.*FPD*RO
      TT=THETA/57.29578
40    IF(NBLKS.GT.160)GO TO 220
      NBLKS=NBLKS*2
      BLKS=NBLKS
      RIB=0.0
      NODES=NBLKS+1
      H=(RO-RI)/BLKS
      RATIO=1.0
      Z2=RO**2/CON+X(1)*RATIO+X(2)*(4.*RATIO**3-3.*RATIO)+X(3)*(16.*RATI
     1O**5-20.*RATIO**3+5.*RATIO)
60    DO 90 I=1,NODES
      AI=I
      Z1=Z2
      U(I,1)=Z1
      U(I,2)=RIB
      U(I,8)=RO-(AI-1.0)*H
      IF (I.GT.NBLKS)GO TO 90
      RHO=RO-AI*H
      RATIO=(RHO-RI)/(RO-RI)
      Z2=RHO**2/CON+X(1)*RATIO+X(2)*(4.*RATIO**3-3.*RATIO)+X(3)*(16.*RAT
     1IO**5-20.*RATIO**3+5.*RATIO)
80    U(I,3)=SQRT(H**2+(Z2-Z1)**2)
      RIB=RIB+U(I,3)
90    CONTINUE
101   RHO=RO
      NUM=NBLKS/2
      NUMP1=NUM+1
      I=ILIM
      DO 130 N=1,NUMP1
      NNN=2*(N-1)+1
      DO 110 II=1,10
      IF(U(NNN,8)+.0001.GT.UP(I,2))GO TO 120
      I=I-1
      IF(I.NE.0)GO TO 110
      I=1
      GO TO 120
110   CONTINUE
120   IF(N.EQ.1)NNN=NNN+1
      IF(N.EQ.NUMP1)NNN=NNN-1
      SQ=SQRT((U(NNN+1,1)-U(NNN-1,1))**2+4.*H**2)
      U(N,6)=2.0*H/SQ
      U(N,11)=(U(NNN-1,1)-U(NNN+1,1))/SQ
      HTH=UP(I,1)*U(N,6)*U(N,11)
      HTV=UP(I,1)*U(N,6)**2
      TTM=ATAN(HTH)
      TTT=TT+TTM
      U(N,24)=SIN(TTT)
      VTTT=ATAN(HTV)
      U(N,25)=SIN(VTTT)
130   CONTINUE
141   NNN=2
      CONST=0.0
      DO 170 N=1,NUMP1
      SUM=0.0
      NN=N-1
      IF(N.EQ.1)GO TO 160
      NNN=2*N-1
      DY=U(NNN,1)
```

```
      DX=U(NNN,8)
      F1=RMOM(1,DY,DX)
      DO 150 I=1,NN
      II=2*I-1
      F3=RMOM(II+2,DY,DX)
      DS=0.5*(U(II,3)+U(II+1,3))
      SUM=SUM+(DS/3.0)*(F1+4.0*RMOM(II+1,DY,DX)+F3)
150   F1=F3
      CABMOM=2.*FMAX*((SINTTH+SINTTD)*(U(1,1)-DY)-SINTTV*(U(1,8)-DX))
      SUM=SUM+CABMOM
      CONST=U(NNN,2)/RIB
160   U(N,4)=SUM
      TRO=TROT+CONST*(TROB-TROT)
      TRI=TRIT+CONST*(TRIB-TRIT)
      AC=3.145193*(TRO**2-TRI**2)
      ASQ=WIDTH*HEIGHT
      YPSQ=TRO+HEIGHT/2.0
      YPT=ASQ*YPSQ/(AC+ASQ)
      SIC=3.141593*(TRO**4-TRI**4)/4.0
      SISQ=WIDTH*HEIGHT**3/12.0
      U(N,5)=SIC+SISQ+AC*YPT**2+ASQ*(TRO+HEIGHT/2.0-YPT)**2
      U(N,7)=SUM/(ERIB*1000000*U(N,5))
170   CONTINUE
181   U(NUMP1,9)=0.0
      YP=0.0
      DO 190 I=NUM,1,-1
      II=2*I-1
      YP1=U(II,3)*(U(I,7)+U(I+1,7))
      U(I,9)=U(I+1,9)+U(II,3)*(2*YP+YP1)
      YP=YP+YP1
190   CONTINUE
      DO 200 I=1,NUMP1
      II=2*I-1
      U(I,12)=U(II,8)+U(I,9)*U(I,11)
      U(I,13)=U(II,1)-U(I,9)*U(I,6)
200   CONTINUE
      WRITE(6,1120)
      WRITE(6,1130)
      DO 210 I=1,NUMP1
      III=2*I-1
      WRITE(6,1080)III,U(III,2),U(I,5),U(I,4),U(I,9),U(I,12),U(I,13)
210   CONTINUE
      INDEX=INDEX+1
      U(INDEX,10)=U(1,9)
      IF(INDEX.EQ.1)GO TO 40
      DIF=ABS(U(INDEX,10)-U(INDEX-1,10))
      IF(ERR.LT.DIF)GO TO 40
220   X(1)=0.0
      X(2)=0.0
      X(3)=0.0
      CALL SIMPLX(X,-5,-4,ITER,150,3,RIBERO,2)
      CALL RCALC(X)
      WRITE(6,1170)
      CALL RPRINT
      WRITE(6,1140)RIBERO
      WRITE(6,1150)
      WRITE(6,1160)X(1),X(2),X(3)
      RETURN
      END
```

```
-FOR,IS    RMOM,RMOM
      FUNCTION RMOM(N,DY,DX)
      DIMENSION Y(321),LIM(321),U(321,25)
      COMMON HH,Y,LIM,RI,ILIM,DIS,CAS,RO,ELAM,SAN,TXB,TXT,FPD,U
      COMMON/RBB/FMAX,SINTTH,SINTTV,SINTTD,NODES
      TMAX=TXT-(TXT-TXB)*(U(N,2)/U(NODES,2))
      NN=(N-1)/2+1
      RMOM=2.*TMAX*(U(NN,24)*(U(N,1)-DY)+U(NN,25)*(U(N,8)-DX))
 10   RETURN
      END
```

```
-FOR,IS    RIBEQ,RIBEQ
      FUNCTION RIBEQ(X)
      DIMENSION Y(321),LIM(321),U(321,25),X(3)
      COMMON HH,Y,LIM,RI,ILIM,DIS,CAS,RO,ELAM,SAN,TXB,TXT,FPD,U,HVT,JPL
     1,DM,DIFMX,DIFM,RIBN
      COMMON/RIB/NUM,NUMP1,NBLKS
      CALL RCALC(X)
      BB=0.0
      CC=0.0
      DO 30 I=1,NUM
      II=2*I-1
      IF(I.EQ.1)GO TO 10
      RTH=U(II,3)+U(II-1,3)
      GO TO 20
 10   RTH=U(II,3)
 20   BB=BB+(U(I,13)-U(I,14))**2*RTH
 30   CC=CC+U(NBLKS,3)
      RIBEQ=SQRT(BB/CC)
      RETURN
      END
```

```
-FOR,IS   RCALC,RCALC
      SUBROUTINE RCALC(X)
      DIMENSION Y(321),LIM(321),U(321,25),X(3)
      COMMON HH,Y,LIM,RI,ILIM,DIS,CAS,RO,ELAM,SAN,TXB,TXT,FPD,U,HVT,JPL
     1,DM,DIFMX,DIFM,RIBN
      COMMON/NT/NDELTU,NWEIGH,NMESH,NARFA,NTENS
      COMMON/RIB/NUM,NUMP1
      RLENTH=U(1,12)-U(NUMP1,12)
      CON=8.*FPD*RO
      DO 20 I=1,NUMP1
      RATIO=(U(I,12)-U(NUMP1,12))/RLENTH
      U(I,14)=U(I,12)**2/CON+X(1)*RATIO+X(2)*(4.*RATIO**3-3.*RATIO)+X(3)
     1*(16.*RATIO**5-20.*RATIO**3+5.*RATIO)
 20   CONTINUE
      RETURN
      END
```

```
-FOR,IS   RPRINT,RPRINT
      SUBROUTINE RPRINT
      DIMENSION Y(321),LIM(321),U(321,25)
      COMMON HH,Y,LIM,RI,ILIM,DIS,CAS,RO,ELAM,SAN,TXB,TXT,FPD,U.HVT,JPL
     1,DM,DIFMX,DIFM,RIBN
      COMMON/RIB/NUM,NUMP1
 1000 FORMAT(1H ,I3,3F15.5)
 1001 FORMAT(1H0,51H                           CURVE FIT      CURVE FITTING)
 1010 FORMAT(1H ,50HNODE       RADIUS       Z-COORDINATE        ERROR    )
      WRITE(6,1001)
      WRITE(6,1010)
      DO 10 I=1,NUMP1
      II=2*I-1
      U(I,15)=U(I,13)-U(I,14)
      WRITE(6,1000)II,U(I,12),U(I,14),U(I,15)
 10   CONTINUE
      RETURN
      END
```

IX. APPENDIX B TYPICAL COMPUTER PRINTOUT

```
**********************************************************************************
**********************************************************************************
***        NUMBER OF RIBS =   48            ANTENNA RADIUS = 84.000           ***
**********************************************************************************
**********************************************************************************

OUTPUT UNITS EQUIVALENT TO INPUT UNITS

RMS ERROR IS WEIGHTED BY ILLUMINATION FUNCTION

RMS ERROR IS WEIGHTED BY SURFACE AREA OF ANTENNA


***INPUT PARAMATERS FOR RADIAL RIB ANTENNA***

ANTENNA RADIUS           =    84.000

HUB RADIUS               =    27.000

HALF ANGLE BETWEEN RIBS =      3.750

FOCAL LENGTH TO DIAMETER=       .420

FOCAL LENGTH             =    70.560

TENSION RADIAL DIRECTION=       .030

TENSION CIRCUM. DIR,TOP =       .120

TENSION CIRCUM. DIR,BASE=       .120

MAX NORMAL SURFACE ERROR=       .080

SUBDISH BLOCKAGE RADIUS =     18.000

RIGID DISH RMS ERROR     =      .008

CABLE SAG                =     1.000

GRID SIZE PARAMETER      =         1

RIB OPTIMIZATION VARIABLES A(1) TO A(3)  =   .000000     .000000     .000000


     INITIAL MAXIMUM NORMAL DIFFERENCE FUNCTION=    .100178+00
```

MINIMUM NORMAL DIFFERENCE MINIMIZATION ITERATES (1)

ITER	ERROR FUNCTION	OPTIMIZATION VARIABLES (1)	(2)	(3)
1	.100178+00	.00000000	.00000000	.00000000
2	.100178+00	.00000000	.00000000	.00000000
3	.100178+00	.00000000	.00000000	.00000000
4	.583116-01	-.55555555-01	.37037035-02	.92592589-02
4	.583116-01	-.55555555-01	.37037035-02	.92592589-02

(1) This section lists the minimization iterates of the maximum surface error at any point on the antenna and reduces this error to the maximum allowable.

INITIAL ANTENNA MESH SHAPE Z-COORDINATES (2)

NODE NUMBERS

I \ J	2	3	4	5	6	7	8	9
36	24.9574	24.9574	24.9574	24.9574	24.9574			
35	24.3050	24.3040	24.3009	24.2950	24.2945			
34	23.4151	23.4134	23.4081	23.3988				
33	22.5349	22.5328	22.5266	22.5168				
32	21.6669	21.6647	21.6582	21.6485				
31	20.8123	20.8100	20.8034	20.7943				
30	19.9715	19.9692	19.9625	19.9541				
29	19.1449	19.1426	19.1358	19.1281				
28	18.3326	18.3304	18.3235	18.3165				
27	17.5349	17.5326	17.5258	17.5194				
26	16.7519	16.7496	16.7427	16.7370				
25	15.9838	15.9815	15.9746	15.9695				
24	15.2307	15.2284	15.2215	15.2170				
23	14.4929	14.4906	14.4836	14.4799				
22	13.7706	13.7683	13.7613	13.7581				
21	13.0640	13.0616	13.0546	13.0521				
20	12.3732	12.3709	12.3638	12.3619				
19	11.6986	11.6962	11.6891	11.6878				
18	11.0403	11.0379	11.0307	11.0300				
17	10.3986	10.3962	10.3888					
16	9.7736	9.7712	9.7644					
15	9.1657	9.1633	9.1571					
14	8.5752	8.5727	8.5670					
13	8.0021	7.9996	7.9944					
12	7.4468	7.4443	7.4396					
11	6.9096	6.9071	6.9029					
10	6.3907	6.3882	6.3844					
9	5.8903	5.8878	5.8845					
8	5.4088	5.4062	5.4034					
7	4.9463	4.9437	4.9414					
6	4.5031	4.5005	4.4986					
5	4.0795	4.0769	4.0754					
4	3.6757	3.6731	3.6720					
3	3.2920	3.2893	3.2886					
2	2.9283	2.9259	2.9255					
1	2.5829	2.5829						

INITIAL RMS ERROR FUNCTION = .22640D-01

(2) This section lists the array of z-coordinates of the initial shape and also lists the initial RMS error before optimization. The z-coordinate is the distance from a plane normal to the paraboloid through the vertex of the antenna to the node.

RIB OPTIMIZATION ITERATES

ITER	ERROR FUNCTION	OPTIMIZATION VARIABLES (1)	(2)	(3)
1	.226400-01	-.55555555-01	.37037035-02	.92592589-02
2	.226400-01	-.55555555-01	.37037035-02	.92592589-02
3	.226400-01	-.55555555-01	.37037035-02	.92592589-02
4	.226400-01	-.55555555-01	.37037035-02	.92592589-02
5	.226400-01	-.55555555-01	.37037035-02	.92592589-02
6	.226400-01	-.55555555-01	.37037035-02	.92592589-02
7	.216335-01	-.76861495-01	.11313657-01	.70312495-02
8	.215813-01	-.71847670-01	.13276427-01	.45765812-02
9	.208130-01	-.67715833-01	-.29256730-03	.23951899-02
10	.208130-01	-.67715833-01	-.29256730-03	.23951899-02
11	.208130-01	-.67715833-01	-.29256730-03	.23951899-02
12	.208093-01	-.69906702-01	.90404213-02	.48210940-02
13	.206475-01	-.76121591-01	.58000500-02	.17394993-02
14	.204734-01	-.70163317-01	.89422485-03	.13235788-03
15	.204574-01	-.69889851-01	.24761657-02	.23130868-02
16	.204099-01	-.74209804-01	-.29267943-02	-.20311314-02
17	.203717-01	-.73771290-01	.29739577-02	.93880186-03
18	.202963-01	-.75083978-01	.78799449-03	.68148033-03
19	.202963-01	-.75083978-01	.78799449-03	.68148033-03
20	.202963-01	-.75083978-01	.78799449-03	.68148033-03
21	.202963-01	-.75083978-01	.78799449-03	.68148033-03
22	.202906-01	-.74453220-01	-.53987316-03	.40644121-04
23	.202682-01	-.76368552-01	-.43216869-03	.31776907-03
24	.202682-01	-.76368552-01	-.43216869-03	.31776907-03
25	.202682-01	-.76368552-01	-.43216869-03	.31776907-03
26	.202682-01	-.76368552-01	-.43216869-03	.31776907-03
27	.202682-01	-.76368552-01	-.43216869-03	.31776907-03
28	.202682-01	-.76368552-01	-.43216869-03	.31776907-03
29	.202682-01	-.76368552-01	-.43216869-03	.31776907-03
29	.202682-01	-.76368552-01	-.43216869-03	.31776907-03

CALCULATION OF THE RMS ERROR OF THE ANTENNA SURFACE

NODE I	NODE J	ILLUMINATION WEIGHT (3)	ELEMENT AREA	SURFACE ERROR	ELEMENT SUM
1	2	.8793	1.6472	.0109	.00017065
1	2	1.0000	1.6472	.0109	.00019397
1	3	.8793	.8236	.0000	.00000000
1	3	1.0000	.8236	.0000	.00000000
2	2	.8651	1.5609	.0128	.00021970
2	2	1.0000	1.5609	.0128	.00025397
2	3	.8647	1.6614	-.0004	.00000026
2	3	1.0000	1.6614	-.0004	.00000030
2	4	.8646	.0531	-.0022	.00000022
2	4	1.0000	.0531	-.0022	.00000026
3	2	.8498	1.5608	.0127	.00021254
3	2	1.0000	1.5608	.0127	.00025009
3	3	.8494	1.7615	-.0007	.00000076
3	3	1.0000	1.7615	-.0007	.00000090
3	4	.8493	.2007	-.0044	.00000326
3	4	1.0000	.2007	-.0044	.00000384
4	2	.8341	1.5608	.0124	.00020159
4	2	1.0000	1.5608	.0124	.00024168
4	3	.8337	1.8615	-.0009	.00000127
4	3	1.0000	1.8615	-.0009	.00000152
4	4	.8335	.3007	-.0065	.00001073
4	4	1.0000	.3007	-.0065	.00001287
5	2	.8179	1.5609	.0123	.00019328
5	2	1.0000	1.5609	.0123	.00023632
5	3	.8175	1.9614	-.0010	.00000159
5	3	1.0000	1.9614	-.0010	.00000195
5	4	.8173	.4004	-.0087	.00002475
5	4	1.0000	.4004	-.0087	.00003028
6	2	.8013	1.5610	.0123	.00018798
6	2	1.0000	1.5610	.0123	.00023460
6	3	.8009	2.0609	-.0010	.00000162
6	3	1.0000	2.0609	-.0010	.00000202
6	4	.8006	.4999	-.0108	.00004698
6	4	1.0000	.4999	-.0108	.00005868
7	2	.7843	1.5611	.0123	.00018546
7	2	1.0000	1.5611	.0123	.00023646
7	3	.7840	2.1602	-.0009	.00000133
7	3	1.0000	2.1602	-.0009	.00000170
7	4	.7836	.5991	-.0130	.00007884
7	4	1.0000	.5991	-.0130	.00010061
8	2	.7670	1.5611	.0124	.00018549
8	2	1.0000	1.5611	.0124	.00024182
8	3	.7667	2.2592	-.0007	.00000083
8	3	1.0000	2.2592	-.0007	.00000109
8	4	.7663	.6981	-.0151	.00012149
8	4	1.0000	.6981	-.0151	.00015853
9	2	.7495	1.5612	.0127	.00018790
9	2	1.0000	1.5612	.0127	.00025069
9	3	.7492	2.3579	-.0004	.00000030
9	3	1.0000	2.3579	-.0004	.00000040
9	4	.7488	.7967	-.0172	.00017583
9	4	1.0000	.7967	-.0172	.00023481
10	2	.7318	1.5613	.0130	.00019254

(3) Since both the illumination weighted RMS error and the constant illumination RMS error are calculated, each node has two entries, weighted and nonweighted.

10	2	1.0000	1.5613	.0130	.00026310
10	3	.7315	2.4563	-.0000	.00000000
10	3	1.0000	2.4563	-.0000	.00000000
10	4	.7311	.8950	-.0193	.00024251
10	4	1.0000	.8950	-.0193	.00033173
11	2	.7139	1.5613	.0134	.00019933
11	2	1.0000	1.5613	.0134	.00027919
11	3	.7137	2.5544	.0004	.00000030
11	3	1.0000	2.5544	.0004	.00000043
11	4	.7132	.9930	-.0213	.00032198
11	4	1.0000	.9930	-.0213	.00045149
12	2	.6960	1.5614	.0138	.00020818
12	2	1.0000	1.5614	.0138	.00029912
12	3	.6957	2.6521	.0009	.00000162
12	3	1.0000	2.6521	.0009	.00000233
12	4	.6952	1.0907	-.0234	.00041445
12	4	1.0000	1.0907	-.0234	.00059620
13	2	.6779	1.5615	.0144	.00021904
13	2	1.0000	1.5615	.0144	.00032310
13	3	.6777	2.7495	.0015	.00000445
13	3	1.0000	2.7495	.0015	.00000656
13	4	.6771	1.1881	-.0254	.00051992
13	4	1.0000	1.1881	-.0254	.00076785
14	2	.6599	1.5615	.0150	.00023187
14	2	1.0000	1.5615	.0150	.00035138
14	3	.6596	2.8466	.0022	.00000929
14	3	1.0000	2.8466	.0022	.00001409
14	4	.6590	1.2851	-.0275	.00063820
14	4	1.0000	1.2851	-.0275	.00096838
15	2	.6418	1.5616	.0157	.00024665
15	2	1.0000	1.5616	.0157	.00038429
15	3	.6416	2.9433	.0030	.00001672
15	3	1.0000	2.9433	.0030	.00002607
15	4	.6410	1.3818	-.0295	.00076890
15	4	1.0000	1.3818	-.0295	.00119956
16	2	.6238	1.5616	.0164	.00026334
16	2	1.0000	1.5616	.0164	.00042212
16	3	.6236	3.0397	.0038	.00002731
16	3	1.0000	3.0397	.0038	.00004379
16	4	.6230	1.4781	-.0315	.00091149
16	4	1.0000	1.4781	-.0315	.00146309
17	2	.6060	1.5617	.0173	.00028194
17	2	1.0000	1.5617	.0173	.00046529
17	3	.6057	3.1357	.0047	.00004163
17	3	1.0000	3.1357	.0047	.00006872
17	4	.6051	1.5740	-.0334	.00106526
17	4	1.0000	1.5740	-.0334	.00176049
18	2	.5882	1.5617	.0181	.00030238
18	2	1.0000	1.5617	.0181	.00051408
18	3	.5880	3.1234	.0056	.00005825
18	3	1.0000	3.1234	.0056	.00009906
18	4	.5874	1.7634	-.0319	.00105360
18	4	1.0000	1.7634	-.0319	.00179372
18	5	.5873	.0639	-.0354	.00004703
18	5	1.0000	.0639	-.0354	.00008008
19	2	.5706	1.5617	.0191	.00032468
19	2	1.0000	1.5617	.0191	.00056905

19	3	.5704	3.1235	.0066	.00007866
19	3	1.0000	3.1235	.0066	.00013790
19	4	.5698	1.7648	-.0307	.00094634
19	4	1.0000	1.7648	-.0307	.00166078
19	5	.5697	.2030	-.0374	.00016138
19	5	1.0000	.2030	-.0374	.00028327
20	2	.5531	1.5618	.0201	.00034879
20	2	1.0000	1.5618	.0201	.00063055
20	3	.5530	3.1236	.0077	.00010289
20	3	1.0000	3.1236	.0077	.00018606
20	4	.5524	1.8596	-.0294	.00088780
20	4	1.0000	1.8596	-.0294	.00160707
20	5	.5523	.2978	-.0393	.00025376
20	5	1.0000	.2978	-.0393	.00045947
21	2	.5359	1.5618	.0212	.00037466
21	2	1.0000	1.5618	.0212	.00069910
21	3	.5358	3.1236	.0089	.00013110
21	3	1.0000	3.1236	.0089	.00024469
21	4	.5353	1.9540	-.0281	.00082334
21	4	1.0000	1.9540	-.0281	.00153822
21	5	.5351	.3922	-.0412	.00035596
21	5	1.0000	.3922	-.0412	.00066525
22	2	.5189	1.5619	.0223	.00040227
22	2	1.0000	1.5619	.0223	.00077518
22	3	.5188	3.1237	.0100	.00016340
22	3	1.0000	3.1237	.0100	.00031498
22	4	.5183	2.0480	-.0267	.00075435
22	4	1.0000	2.0480	-.0267	.00145542
22	5	.5181	.4862	-.0431	.00046725
22	5	1.0000	.4862	-.0431	.00090186
23	2	.5022	1.5619	.0235	.00043153
23	2	1.0000	1.5619	.0235	.00085929
23	3	.5021	3.1238	.0113	.00019986
23	3	1.0000	3.1238	.0113	.00039809
23	4	.5016	2.1417	-.0252	.00068224
23	4	1.0000	2.1417	-.0252	.00136011
23	5	.5014	.5798	-.0449	.00058681
23	5	1.0000	.5798	-.0449	.00117041
24	2	.4857	1.5619	.0247	.00046242
24	2	1.0000	1.5619	.0247	.00095200
24	3	.4856	3.1238	.0126	.00024055
24	3	1.0000	3.1238	.0126	.00049536
24	4	.4852	2.2349	-.0237	.00060833
24	4	1.0000	2.2349	-.0237	.00125383
24	5	.4849	.6730	-.0468	.00071370
24	5	1.0000	.6730	-.0468	.00147179
25	2	.4696	1.5620	.0260	.00049491
25	2	1.0000	1.5620	.0260	.00105399
25	3	.4694	3.1239	.0140	.00028544
25	3	1.0000	3.1239	.0140	.00060806
25	4	.4690	2.3277	-.0221	.00053400
25	4	1.0000	2.3277	-.0221	.00113849
25	5	.4688	.7658	-.0486	.00084693
25	5	1.0000	.7658	-.0486	.00180674
26	2	.4537	1.5620	.0273	.00052891
26	2	1.0000	1.5620	.0273	.00116580
26	3	.4536	3.1240	.0154	.00033453

26	3	1.0000	3.1240	.0154	.00073756
26	4	.4532	2.4202	-.0205	.00046044
26	4	1.0000	2.4202	-.0205	.00101597
26	5	.4529	.8582	-.0504	.00098541
26	5	1.0000	.8582	-.0504	.00217575
27	2	.4381	1.5620	.0287	.00056435
27	2	1.0000	1.5620	.0287	.00128808
27	3	.4380	3.1240	.0168	.00038775
27	3	1.0000	3.1240	.0168	.00088524
27	4	.4377	2.5122	-.0188	.00038894
27	4	1.0000	2.5122	-.0188	.00088864
27	5	.4374	.9502	-.0521	.00112801
27	5	1.0000	.9502	-.0521	.00257910
28	2	.4229	1.5620	.0302	.00060108
28	2	1.0000	1.5620	.0302	.00142132
28	3	.4228	3.1241	.0184	.00044494
28	3	1.0000	3.1241	.0184	.00105238
28	4	.4225	2.6038	-.0171	.00032063
28	4	1.0000	2.6038	-.0171	.00075892
28	5	.4222	1.0418	-.0538	.00127360
28	5	1.0000	1.0418	-.0538	.00301687
29	2	.4080	1.5621	.0317	.00063888
29	2	1.0000	1.5621	.0317	.00156584
29	3	.4079	3.1241	.0199	.00050582
29	3	1.0000	3.1241	.0199	.00124001
29	4	.4076	2.6950	-.0153	.00025666
29	4	1.0000	2.6950	-.0153	.00062964
29	5	.4073	1.1329	-.0555	.00142096
29	5	1.0000	1.1329	-.0555	.00348863
30	2	.3935	1.5621	.0332	.00067711
30	2	1.0000	1.5621	.0332	.00172091
30	3	.3934	3.1241	.0215	.00056962
30	3	1.0000	3.1241	.0215	.00144804
30	4	.3931	2.7857	-.0135	.00019818
30	4	1.0000	2.7857	-.0135	.00050414
30	5	.3928	1.2237	-.0571	.00156889
30	5	1.0000	1.2237	-.0571	.00399449
31	2	.3793	1.5620	.0347	.00071387
31	2	1.0000	1.5620	.0347	.00188225
31	3	.3792	3.1241	.0231	.00063406
31	3	1.0000	3.1241	.0231	.00167217
31	4	.3789	2.8760	-.0116	.00014652
31	4	1.0000	2.8760	-.0116	.00038667
31	5	.3786	1.3140	-.0587	.00171614
31	5	1.0000	1.3140	-.0587	.00453297
32	2	.3654	1.5619	.0361	.00074452
32	2	1.0000	1.5619	.0361	.00203742
32	3	.3653	3.1238	.0246	.00069334
32	3	1.0000	3.1238	.0246	.00189776
32	4	.3651	2.9657	-.0098	.00010330
32	4	1.0000	2.9657	-.0098	.00028294
32	5	.3648	1.4038	-.0603	.00186146
32	5	1.0000	1.4038	-.0603	.00510310
33	2	.3519	1.5615	.0371	.00075669
33	2	1.0000	1.5615	.0371	.00215003
33	3	.3519	3.1230	.0258	.00073185
33	3	1.0000	3.1230	.0258	.00207988

33	4	.3517	3.0543	-.0081	.00007092
33	4	1.0000	3.0543	-.0081	.00020168
33	5	.3513	1.4928	-.0618	.00200342
33	5	1.0000	1.4928	-.0618	.00570274
34	2	.3388	1.5604	.0369	.00072016
34	2	1.0000	1.5604	.0369	.00212541
34	3	.3388	3.1207	.0259	.00071057
34	3	1.0000	3.1207	.0259	.00209754
34	4	.3386	3.1411	-.0071	.00005359
34	4	1.0000	3.1411	-.0071	.00015829
34	5	.3382	1.5807	-.0633	.00214023
34	5	1.0000	1.5807	-.0633	.00632815
35	2	.3261	1.3481	.0336	.00049504
35	2	1.0000	1.3481	.0336	.00151801
35	3	.3260	2.6962	.0232	.00047460
35	3	1.0000	2.6962	.0232	.00145564
35	4	.3258	2.6962	-.0079	.00005429
35	4	1.0000	2.6962	-.0079	.00016662
35	5	.3255	1.5383	-.0602	.00187336
35	5	1.0000	1.5383	-.0602	.00575543
35	6	.3255	.0584	-.0647	.00007948
35	6	1.0000	.0584	-.0647	.00024419
36	2	.3171	.7540	.0262	.00016374
36	2	1.0000	.7540	.0262	.00051641
36	3	.3170	1.5079	.0167	.00013294
36	3	1.0000	1.5079	.0167	.00041934
36	4	.3168	1.5079	-.0118	.00006654
36	4	1.0000	1.5079	-.0118	.00021004
36	5	.3164	.8377	-.0592	.00093043
36	5	1.0000	.8377	-.0592	.00294033
36	6	.3164	.0838	-.0657	.00011435
36	6	1.0000	.0838	-.0657	.00036144

HUB RMS ERROR = .0080   HUB AREA = 13.42759 (4)
HUB WEIGHTING FUNCTION   .91222

(4) Listed here is the area of the rigid dish in the RMS error computation. It is the area that lies between the hub radius (RI) and the primary blockage radius (DHUBR).

ANTENNA RMS ERROR = .227336-01

WEIGHTED RMS ERROR= .202682-01

FINAL RECALCULATED ANTENNA RMS ERROR = .227768-01 (5)

FINAL RECALCULATED WEIGHTED RMS ERROR= .202629-01

RIB OPTIMIZATION VARIABLES A(1) TO A(3) = -.763686-01 -.432169-03 .317769-03

OPTIMIZED ANTENNA MESH SHAPE Z-COORDINATES

NODE NUMBERS

I \ J	2	3	4	5	6	7	8	9
36	24.4202	24.4718	24.6269	24.8878	24.9235			
35	24.2756	24.2747	24.2718	24.2663	24.2657			
34	23.3914	23.3898	23.3848	23.3760				
33	22.5161	22.5141	22.5083	22.4989				
32	21.6521	21.6500	21.6438	21.6346				
31	20.8006	20.7985	20.7921	20.7834				
30	19.9623	19.9601	19.9536	19.9455				
29	19.1374	19.1352	19.1286	19.1211				
28	18.3262	18.3240	18.3174	18.3105				
27	17.5291	17.5269	17.5202	17.5139				
26	16.7463	16.7441	16.7373	16.7317				
25	15.9781	15.9758	15.9690	15.9640				
24	15.2246	15.2223	15.2155	15.2111				
23	14.4863	14.4840	14.4770	14.4733				
22	13.7632	13.7609	13.7539	13.7508				
21	13.0558	13.0535	13.0464	13.0439				
20	12.3642	12.3619	12.3548	12.3529				
19	11.6888	11.6864	11.6793	11.6780				
18	11.0298	11.0274	11.0201	11.0195				
17	10.3874	10.3849	10.3776					
16	9.7619	9.7595	9.7527					
15	9.1537	9.1512	9.1449					
14	8.5628	8.5604	8.5546					
13	7.9898	7.9873	7.9820					
12	7.4346	7.4321	7.4274					
11	6.8978	6.8952	6.8910					
10	6.3794	6.3768	6.3731					
9	5.8797	5.8772	5.8739					
8	5.3991	5.3965	5.3936					
7	4.9376	4.9350	4.9326					
6	4.4957	4.4930	4.4911					
5	4.0734	4.0709	4.0692					
4	3.6710	3.6684	3.6673					
3	3.2888	3.2861	3.2854					
2	2.9266	2.9242	2.9239					
1	2.5829	2.5829						

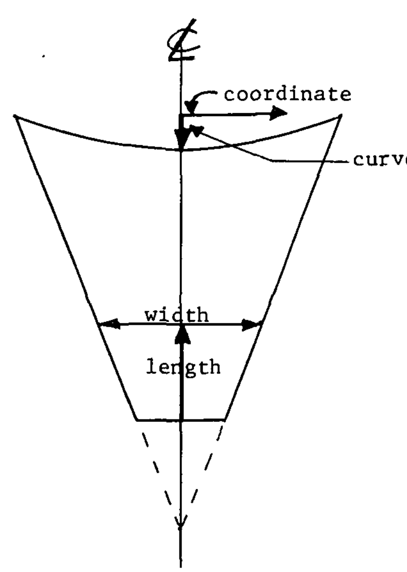
(5) The final recalculated RMS error is determined using the final rib shape and making a final mesh shape calculation which is then used for the RMS error calculation.

CORE PATTERN

LENGTH	WIDTH
.000	3.532
1.767	3.759
3.535	3.986
5.303	4.212
7.071	4.438
8.838	4.663
10.606	4.887
12.374	5.111
14.142	5.334
15.910	5.556
17.679	5.778
19.447	5.999
21.215	6.219
22.984	6.438
24.752	6.657
26.520	6.875
28.289	7.091
30.058	7.307
31.826	7.523
33.595	7.737
35.363	7.950
37.132	8.163
38.901	8.375
40.670	8.585
42.438	8.795
44.207	9.004
45.976	9.212
47.745	9.419
49.514	9.625
51.283	9.830
53.052	10.034
54.821	10.238
56.590	10.440
58.359	10.641
60.128	10.842
61.420	10.988

UPPER BOUNDARY

COOR	CURVE
.000	1.000
1.766	.897
3.532	.587
5.298	.070
5.494	.000



X-COORDINATES

NODE NUMBERS

I	J 2	3	4	5	6	7	8	9
36	.0000	1.7659	3.5318	5.2977	5.4939			
35	.0000	1.7659	3.5318	5.2977	5.4209			
34	.0000	1.7659	3.5318	5.3207				
33	.0000	1.7659	3.5318	5.2200				
32	.0000	1.7659	3.5318	5.1189				
31	.0000	1.7659	3.5318	5.0172				
30	.0000	1.7659	3.5318	4.9151				
29	.0000	1.7659	3.5318	4.8125				
28	.0000	1.7659	3.5318	4.7095				
27	.0000	1.7659	3.5318	4.6060				
26	.0000	1.7659	3.5318	4.5020				
25	.0000	1.7659	3.5318	4.3975				
24	.0000	1.7659	3.5318	4.2926				
23	.0000	1.7659	3.5318	4.1873				
22	.0000	1.7659	3.5318	4.0814				
21	.0000	1.7659	3.5318	3.9752				
20	.0000	1.7659	3.5318	3.8685				
19	.0000	1.7659	3.5318	3.7613				
18	.0000	1.7659	3.5318	3.6537				
17	.0000	1.7659	3.5457					
16	.0000	1.7659	3.4373					
15	.0000	1.7659	3.3284					
14	.0000	1.7659	3.2192					
13	.0000	1.7659	3.1095					
12	.0000	1.7659	2.9995					
11	.0000	1.7659	2.8890					
10	.0000	1.7659	2.7782					
9	.0000	1.7659	2.6670					
8	.0000	1.7659	2.5555					
7	.0000	1.7659	2.4436					
6	.0000	1.7659	2.3314					
5	.0000	1.7659	2.2189					
4	.0000	1.7659	2.1061					
3	.0000	1.7659	1.9930					
2	.0000	1.7659	1.8796					
1	.0000	1.7659						

Y-COORDINATES

NODE NUMBERS

I	J 2	3	4	5	6	7	8	9
36	82.9560	83.0456	83.3139	83.7597	83.8201			
35	82.7077	82.7077	82.7077	82.7077	82.7077			
34	81.1786	81.1786	81.1786	81.1786				
33	79.6423	79.6423	79.6423	79.6423				
32	78.0988	78.0988	78.0988	78.0988				
31	76.5481	76.5481	76.5481	76.5481				
30	74.9902	74.9902	74.9902	74.9902				
29	73.4251	73.4251	73.4251	73.4251				
28	71.8529	71.8529	71.8529	71.8529				
27	70.2735	70.2735	70.2735	70.2735				
26	68.6870	68.6870	68.6870	68.6870				
25	67.0934	67.0934	67.0934	67.0934				
24	65.4929	65.4929	65.4929	65.4929				
23	63.8853	63.8853	63.8853	63.8853				
22	62.2709	62.2709	62.2709	62.2709				
21	60.6496	60.6496	60.6496	60.6496				
20	59.0215	59.0215	59.0215	59.0215				
19	57.3867	57.3867	57.3867	57.3867				
18	55.7452	55.7452	55.7452	55.7452				
17	54.0973	54.0973	54.0973					
16	52.4428	52.4428	52.4428					
15	50.7821	50.7821	50.7821					
14	49.1151	49.1151	49.1151					
13	47.4420	47.4420	47.4420					
12	45.7629	45.7629	45.7629					
11	44.0780	44.0780	44.0780					
10	42.3874	42.3874	42.3874					
9	40.6912	40.6912	40.6912					
8	38.9896	38.9896	38.9896					
7	37.2827	37.2827	37.2827					
6	35.5709	35.5709	35.5709					
5	33.8541	33.8541	33.8541					
4	32.1326	32.1326	32.1326					
3	30.4067	30.4067	30.4067					
2	28.6765	28.6765	28.6765					
1	26.9422	26.9422						

(6) CATENARY CABLE TENSION   CATENARY CABLE LENGTH
.48180   11.22560

INPUT PARAMETERS FOR RIB DEFLECTION ANALYSIS (7)

ANTENNA RADIUS	=	84.0000
HUB RADIUS	=	27.0000
A1	=	-.076369
A2	=	-.000432
A3	=	.000318
MESH TENSION BASE	=	.1200
MESH TENSION TIP	=	.1200
FOCAL LENGTH TO DIA	=	.4200
HALF ANGLE	=	3.7500
FIN WIDTH	=	.1875
FIN HEIGHT	=	.0450
RIB BASE OUTER RADIUS	=	.5625
RIB BASE INNER RADIUS	=	.5425
RIB TIP OUTER RADIUS	=	.5625
RIB TIP INNER RADIUS	=	.5425
ALLOWABLE DEFL ERROR	=	.0010
RIB MODULUS E*10**-6	=	10.0000
CABLE SAG	=	1.0000

(6) All the following sections are listed only when NTEN = 1 and SAG $\neq$ 0.0

(7) There are two iterations of the rib deflection analysis, one with 160 elements along the rib and the second with 320 elements. The deflections obtained from both should be within 5%.

NODE	LENGTH FROM RIB TIP	RIB MOMENT OF INERTIA	MOMENT ON RIB	RIB DEFLECTION	RADIUS COORDINATE	Z COORDINATE
1	.00000	.131767-01	.000000	.862676-01	.840439+02	.248493+02
3	.82779+00	.131767-01	.297551-01	.846311-01	.833304+02	.244292+02
5	.16537+01	.131767-01	.640117-01	.829984-01	.826168+02	.240126+02
7	.24779+01	.131767-01	.103035+00	.813696-01	.819033+02	.235997+02
9	.33002+01	.131767-01	.146817+00	.797449-01	.811897+02	.231904+02
11	.41208+01	.131767-01	.195323+00	.781246-01	.804761+02	.227847+02
13	.49395+01	.131767-01	.248482+00	.765088-01	.797626+02	.223825+02
15	.57565+01	.131767-01	.306210+00	.748977-01	.790490+02	.219840+02
17	.65718+01	.131767-01	.368411+00	.732916-01	.783355+02	.215891+02
19	.73853+01	.131767-01	.434978+00	.716909-01	.776220+02	.211978+02
21	.81970+01	.131767-01	.505809+00	.700957-01	.769085+02	.208101+02
23	.90071+01	.131767-01	.580799+00	.685065-01	.761950+02	.204260+02
25	.98154+01	.131767-01	.659840+00	.669235-01	.754815+02	.200455+02
27	.10622+02	.131767-01	.742825+00	.653471-01	.747630+02	.196686+02
29	.11427+02	.131767-01	.829642+00	.637777-01	.740546+02	.192953+02
31	.12230+02	.131767-01	.920184+00	.622155-01	.733411+02	.189256+02
33	.13032+02	.131767-01	.101434+01	.606611-01	.726277+02	.185595+02
35	.13832+02	.131767-01	.111200+01	.591149-01	.719143+02	.181970+02
37	.14630+02	.131767-01	.121306+01	.575772-01	.712009+02	.178381+02
39	.15427+02	.131767-01	.131740+01	.560485-01	.704875+02	.174828+02
41	.16222+02	.131767-01	.142493+01	.545292-01	.697741+02	.171311+02
43	.17016+02	.131767-01	.153554+01	.530197-01	.690607+02	.167830+02
45	.17808+02	.131767-01	.164911+01	.515206-01	.683474+02	.164385+02
47	.18598+02	.131767-01	.176555+01	.500323-01	.676341+02	.160975+02
49	.19387+02	.131767-01	.188474+01	.485553-01	.669207+02	.157602+02
51	.20174+02	.131767-01	.200657+01	.470900-01	.662074+02	.154265+02
53	.20960+02	.131767-01	.213095+01	.456371-01	.654942+02	.150963+02
55	.21744+02	.131767-01	.225775+01	.441968-01	.647809+02	.147698+02
57	.22527+02	.131767-01	.238689+01	.427699-01	.640676+02	.144468+02
59	.23308+02	.131767-01	.251825+01	.413567-01	.633544+02	.141274+02
61	.24088+02	.131767-01	.265173+01	.399579-01	.626412+02	.138116+02
63	.24867+02	.131767-01	.278724+01	.385739-01	.619280+02	.134994+02
65	.25644+02	.131767-01	.292465+01	.372052-01	.612148+02	.131908+02
67	.26419+02	.131767-01	.306387+01	.358525-01	.605016+02	.128858+02
69	.27193+02	.131767-01	.320479+01	.345161-01	.597884+02	.125843+02
71	.27966+02	.131767-01	.334731+01	.331968-01	.590753+02	.122865+02
73	.28737+02	.131767-01	.349132+01	.318949-01	.583622+02	.119922+02
75	.29507+02	.131767-01	.363672+01	.306111-01	.576490+02	.117015+02
77	.30276+02	.131767-01	.378342+01	.293460-01	.569359+02	.114144+02
79	.31043+02	.131767-01	.393131+01	.280999-01	.562229+02	.111309+02
81	.31809+02	.131767-01	.408029+01	.268735-01	.555098+02	.108510+02
83	.32574+02	.131767-01	.423025+01	.256674-01	.547968+02	.105746+02
85	.33337+02	.131767-01	.438109+01	.244821-01	.540837+02	.103018+02
87	.34099+02	.131767-01	.453272+01	.233181-01	.533707+02	.100326+02
89	.34860+02	.131767-01	.468502+01	.221760-01	.526577+02	.976701+01
91	.35619+02	.131767-01	.483791+01	.210563-01	.519447+02	.950497+01
93	.36377+02	.131767-01	.499128+01	.199596-01	.512318+02	.924650+01
95	.37134+02	.131767-01	.514503+01	.188865-01	.505188+02	.899162+01
97	.37890+02	.131767-01	.529906+01	.178373-01	.498059+02	.874030+01
99	.38645+02	.131767-01	.545328+01	.168128-01	.490930+02	.849257+01
101	.39398+02	.131767-01	.560757+01	.158134-01	.483801+02	.824840+01
103	.40151+02	.131767-01	.576184+01	.148397-01	.476672+02	.800782+01
105	.40902+02	.131767-01	.591599+01	.138922-01	.469544+02	.777080+01
107	.41652+02	.131767-01	.606994+01	.129714-01	.462415+02	.753736+01

109	.42401+02	.131767-01	.622357+01	.120778-01	.455287+02	.730749+01
111	.43149+02	.131767-01	.637679+01	.112120-01	.448159+02	.708119+01
113	.43895+02	.131767-01	.652950+01	.103745-01	.441031+02	.685847+01
115	.44641+02	.131767-01	.668159+01	.956584-02	.433903+02	.663931+01
117	.45386+02	.131767-01	.683298+01	.878644-02	.426775+02	.642373+01
119	.46129+02	.131767-01	.698357+01	.803683-02	.419648+02	.621171+01
121	.46872+02	.131767-01	.713325+01	.731752-02	.412520+02	.600326+01
123	.47613+02	.131767-01	.728194+01	.662899-02	.405393+02	.579838+01
125	.48354+02	.131767-01	.742954+01	.597174-02	.398266+02	.559707+01
127	.49094+02	.131767-01	.757594+01	.534623-02	.391139+02	.539932+01
129	.49832+02	.131767-01	.772106+01	.475293-02	.384012+02	.520514+01
131	.50570+02	.131767-01	.786480+01	.419233-02	.376886+02	.501453+01
133	.51307+02	.131767-01	.800707+01	.366487-02	.369759+02	.482748+01
135	.52042+02	.131767-01	.814776+01	.317100-02	.362633+02	.464400+01
137	.52777+02	.131767-01	.828677+01	.271117-02	.355507+02	.446408+01
139	.53512+02	.131767-01	.842402+01	.228583-02	.348380+02	.428772+01
141	.54245+02	.131767-01	.855940+01	.189539-02	.341254+02	.411493+01
143	.54977+02	.131767-01	.869293+01	.154028-02	.334129+02	.394570+01
145	.55709+02	.131767-01	.882421+01	.122093-02	.327003+02	.378004+01
147	.56440+02	.131767-01	.895345+01	.937723-03	.319877+02	.361793+01
149	.57170+02	.131767-01	.908044+01	.691072-03	.312751+02	.345939+01
151	.57899+02	.131767-01	.920508+01	.481364-03	.305626+02	.330441+01
153	.58627+02	.131767-01	.932730+01	.308960-03	.298501+02	.315299+01
155	.59355+02	.131767-01	.944697+01	.174293-03	.291375+02	.300513+01
157	.60082+02	.131767-01	.956399+01	.776666-04	.284250+02	.286083+01
159	.60808+02	.131767-01	.967804+01	.194544-04	.277125+02	.272009+01
161	.61534+02	.131767-01	.978890+01	.000000	.270000+02	.258291+01

NODE	LENGTH FROM RIB TIP	RIB MOMENT OF INERTIA	MOMENT ON RIB	RIB DEFLECTION	RADIUS COORDINATE	Z COORDINATE
1	.00000	.131767-01	.000000	.863528-01	.840440+02	.248492+02
3	.41412+00	.131767-01	.143513-01	.855333-01	.836873+02	.246387+02
5	.82779+00	.131767-01	.298415-01	.847147-01	.833305+02	.244291+02
7	.12410+01	.131767-01	.464997-01	.838970-01	.829737+02	.242204+02
9	.16537+01	.131767-01	.643127-01	.830804-01	.826169+02	.240126+02
11	.20660+01	.131767-01	.833173-01	.822647-01	.822601+02	.238057+02
13	.24779+01	.131767-01	.103525+00	.814500-01	.819033+02	.235996+02
15	.28893+01	.131767-01	.124923+00	.806363-01	.815465+02	.233945+02
17	.33002+01	.131767-01	.147496+00	.798237-01	.811897+02	.231903+02
19	.37107+01	.131767-01	.171251+00	.790121-01	.808329+02	.229870+02
21	.41208+01	.131767-01	.196182+00	.782017-01	.804762+02	.227846+02
23	.45304+01	.131767-01	.222277+00	.773924-01	.801194+02	.225831+02
25	.49395+01	.131767-01	.249521+00	.765842-01	.797626+02	.223825+02
27	.53483+01	.131767-01	.277908+00	.757773-01	.794058+02	.221828+02
29	.57565+01	.131767-01	.307426+00	.749715-01	.790491+02	.219840+02
31	.61644+01	.131767-01	.338062+00	.741671-01	.786923+02	.217860+02
33	.65718+01	.131767-01	.369803+00	.733639-01	.783355+02	.215890+02
35	.69787+01	.131767-01	.402636+00	.725620-01	.779788+02	.213929+02
37	.73853+01	.131767-01	.436548+00	.717615-01	.776220+02	.211977+02
39	.77914+01	.131767-01	.471527+00	.709624-01	.772653+02	.210034+02
41	.81970+01	.131767-01	.507558+00	.701648-01	.769085+02	.208100+02
43	.86023+01	.131767-01	.544630+00	.693686-01	.765518+02	.206175+02
45	.90071+01	.131767-01	.582727+00	.685739-01	.761950+02	.204259+02
47	.94114+01	.131767-01	.621836+00	.677808-01	.758383+02	.202352+02
49	.98154+01	.131767-01	.661945+00	.669893-01	.754815+02	.200454+02
51	.10219+02	.131767-01	.703039+00	.661995-01	.751248+02	.198565+02
53	.10622+02	.131767-01	.745105+00	.654113-01	.747681+02	.196685+02
55	.11025+02	.131767-01	.788128+00	.646249-01	.744113+02	.194815+02
57	.11427+02	.131767-01	.832095+00	.638403-01	.740546+02	.192953+02
59	.11829+02	.131767-01	.876993+00	.630575-01	.736979+02	.191100+02
61	.12230+02	.131767-01	.922810+00	.622766-01	.733412+02	.189256+02
63	.12631+02	.131767-01	.969530+00	.614977-01	.729844+02	.187421+02
65	.13032+02	.131767-01	.101714+01	.607207-01	.726277+02	.185595+02
67	.13432+02	.131767-01	.106562+01	.599457-01	.722710+02	.183778+02
69	.13832+02	.131767-01	.111497+01	.591729-01	.719143+02	.181970+02
71	.14231+02	.131767-01	.116517+01	.584022-01	.715576+02	.180171+02
73	.14630+02	.131767-01	.121621+01	.576336-01	.712009+02	.178381+02
75	.15029+02	.131767-01	.126806+01	.568674-01	.708442+02	.176600+02
77	.15427+02	.131767-01	.132072+01	.561034-01	.704875+02	.174828+02
79	.15825+02	.131767-01	.137419+01	.553418-01	.701308+02	.173065+02
81	.16222+02	.131767-01	.142843+01	.545826-01	.697741+02	.171310+02
83	.16619+02	.131767-01	.148344+01	.538258-01	.694174+02	.169565+02
85	.17016+02	.131767-01	.153920+01	.530716-01	.690608+02	.167829+02
87	.17412+02	.131767-01	.159571+01	.523200-01	.687041+02	.166102+02
89	.17808+02	.131767-01	.165294+01	.515710-01	.683474+02	.164384+02
91	.18203+02	.131767-01	.171089+01	.508247-01	.679908+02	.162675+02
93	.18598+02	.131767-01	.176954+01	.500812-01	.676341+02	.160975+02
95	.18993+02	.131767-01	.182888+01	.493406-01	.672774+02	.159284+02
97	.19387+02	.131767-01	.188890+01	.486028-01	.669208+02	.157602+02
99	.19781+02	.131767-01	.194957+01	.478679-01	.665641+02	.155928+02
101	.20174+02	.131767-01	.201090+01	.471361-01	.662075+02	.154264+02
103	.20567+02	.131767-01	.207285+01	.464073-01	.658508+02	.152609+02
105	.20960+02	.131767-01	.213544+01	.456816-01	.654942+02	.150963+02
107	.21352+02	.131767-01	.219862+01	.449592-01	.651375+02	.149326+02

109	.21744+02	.131767-01	.226241+01	.442400-01	.647809+02	.147697+02
111	.22136+02	.131767-01	.232677+01	.435241-01	.644243+02	.146078+02
113	.22527+02	.131767-01	.239171+01	.428116-01	.640676+02	.144468+02
115	.22918+02	.131767-01	.245720+01	.421026-01	.637110+02	.142866+02
117	.23308+02	.131767-01	.252323+01	.413971-01	.633544+02	.141274+02
119	.23699+02	.131767-01	.258980+01	.406952-01	.629978+02	.139690+02
121	.24088+02	.131767-01	.265688+01	.399969-01	.626412+02	.138116+02
123	.24476+02	.131767-01	.272446+01	.393023-01	.622846+02	.136550+02
125	.24867+02	.131767-01	.279254+01	.386115-01	.619280+02	.134994+02
127	.25255+02	.131767-01	.286109+01	.379246-01	.615714+02	.133446+02
129	.25644+02	.131767-01	.293010+01	.372415-01	.612148+02	.131908+02
131	.26031+02	.131767-01	.299957+01	.365625-01	.608582+02	.130378+02
133	.26419+02	.131767-01	.306948+01	.358874-01	.605016+02	.128858+02
135	.26806+02	.131767-01	.313981+01	.352165-01	.601450+02	.127346+02
137	.27193+02	.131767-01	.321055+01	.345498-01	.597884+02	.125843+02
139	.27580+02	.131767-01	.328169+01	.338873-01	.594319+02	.124349+02
141	.27966+02	.131767-01	.335323+01	.332292-01	.590753+02	.122865+02
143	.28352+02	.131767-01	.342513+01	.325754-01	.587187+02	.121389+02
145	.28737+02	.131767-01	.349739+01	.319261-01	.583622+02	.119922+02
147	.29122+02	.131767-01	.357001+01	.312812-01	.580056+02	.118464+02
149	.29507+02	.131767-01	.364295+01	.306410-01	.576491+02	.117015+02
151	.29892+02	.131767-01	.371622+01	.300054-01	.572925+02	.115575+02
153	.30276+02	.131767-01	.378980+01	.293746-01	.569360+02	.114144+02
155	.30660+02	.131767-01	.386368+01	.287485-01	.565794+02	.112722+02
157	.31043+02	.131767-01	.393784+01	.281273-01	.562229+02	.111309+02
159	.31426+02	.131767-01	.401227+01	.275111-01	.558663+02	.109905+02
161	.31809+02	.131767-01	.408696+01	.268998-01	.555098+02	.108509+02
163	.32191+02	.131767-01	.416190+01	.262936-01	.551533+02	.107123+02
165	.32574+02	.131767-01	.423707+01	.256925-01	.547968+02	.105746+02
167	.32955+02	.131767-01	.431246+01	.250966-01	.544403+02	.104378+02
169	.33337+02	.131767-01	.438805+01	.245060-01	.540837+02	.103018+02
171	.33718+02	.131767-01	.446385+01	.239208-01	.537272+02	.101668+02
173	.34099+02	.131767-01	.453982+01	.233409-01	.533707+02	.100326+02
175	.34479+02	.131767-01	.461597+01	.227666-01	.530142+02	.989935+01
177	.34860+02	.131767-01	.469227+01	.221977-01	.526577+02	.976699+01
179	.35240+02	.131767-01	.476872+01	.216345-01	.523012+02	.963552+01
181	.35619+02	.131767-01	.484530+01	.210770-01	.519448+02	.950495+01
183	.35998+02	.131767-01	.492200+01	.205252-01	.515883+02	.937527+01
185	.36377+02	.131767-01	.499880+01	.199792-01	.512318+02	.924649+01
187	.36756+02	.131767-01	.507571+01	.194391-01	.508753+02	.911859+01
189	.37134+02	.131767-01	.515269+01	.189050-01	.505189+02	.899160+01
191	.37513+02	.131767-01	.522974+01	.183769-01	.501624+02	.886550+01
193	.37890+02	.131767-01	.530685+01	.178549-01	.498059+02	.874029+01
195	.38268+02	.131767-01	.538400+01	.173390-01	.494495+02	.861597+01
197	.38645+02	.131767-01	.546119+01	.168294-01	.490930+02	.849255+01
199	.39022+02	.131767-01	.553840+01	.163260-01	.487366+02	.837002+01
201	.39398+02	.131767-01	.561561+01	.158290-01	.483801+02	.824839+01
203	.39775+02	.131767-01	.569282+01	.153384-01	.480237+02	.812765+01
205	.40151+02	.131767-01	.577001+01	.148544-01	.476672+02	.800780+01
207	.40526+02	.131767-01	.584718+01	.143768-01	.473108+02	.788885+01
209	.40902+02	.131767-01	.592430+01	.139059-01	.469544+02	.777079+01
211	.41277+02	.131767-01	.600136+01	.134417-01	.465979+02	.765362+01
213	.41652+02	.131767-01	.607836+01	.129842-01	.462415+02	.753735+01
215	.42027+02	.131767-01	.615529+01	.125336-01	.458851+02	.742197+01
217	.42401+02	.131767-01	.623212+01	.120898-01	.455287+02	.730748+01
219	.42775+02	.131767-01	.630885+01	.116530-01	.451723+02	.719389+01
221	.43149+02	.131767-01	.638546+01	.112232-01	.448159+02	.708118+01

223	.43522+02	.131767-01	.646195+01	.108005-01	.444595+02	.696937+01
225	.43895+02	.131767-01	.653829+01	.103849-01	.441031+02	.685846+01
227	.44268+02	.131767-01	.661449+01	.997654-02	.437467+02	.674843+01
229	.44641+02	.131767-01	.669051+01	.957543-02	.433903+02	.663930+01
231	.45014+02	.131767-01	.676636+01	.918165-02	.430339+02	.653106+01
233	.45386+02	.131767-01	.684202+01	.879527-02	.426775+02	.642372+01
235	.45758+02	.131767-01	.691749+01	.841635-02	.423212+02	.631726+01
237	.46129+02	.131767-01	.699273+01	.804494-02	.419648+02	.621170+01
239	.46501+02	.131767-01	.706775+01	.768111-02	.416084+02	.610703+01
241	.46872+02	.131767-01	.714254+01	.732493-02	.412520+02	.600325+01
243	.47243+02	.131767-01	.721707+01	.697645-02	.408957+02	.590037+01
245	.47613+02	.131767-01	.729135+01	.663574-02	.405393+02	.579837+01
247	.47984+02	.131767-01	.736535+01	.630284-02	.401830+02	.569727+01
249	.48354+02	.131767-01	.743906+01	.597784-02	.398266+02	.559706+01
251	.48724+02	.131767-01	.751247+01	.566077-02	.394703+02	.549774+01
253	.49094+02	.131767-01	.758558+01	.535172-02	.391139+02	.539932+01
255	.49463+02	.131767-01	.765836+01	.505072-02	.387576+02	.530178+01
257	.49832+02	.131767-01	.773081+01	.475784-02	.384012+02	.520514+01
259	.50201+02	.131767-01	.780292+01	.447315-02	.380449+02	.510939+01
261	.50570+02	.131767-01	.787466+01	.419668-02	.376886+02	.501453+01
263	.50938+02	.131767-01	.794604+01	.392852-02	.373323+02	.492056+01
265	.51307+02	.131767-01	.801704+01	.366870-02	.369759+02	.482748+01
267	.51675+02	.131767-01	.808763+01	.341729-02	.366196+02	.473529+01
269	.52042+02	.131767-01	.815783+01	.317434-02	.362633+02	.464399+01
271	.52410+02	.131767-01	.822760+01	.293992-02	.359070+02	.455359+01
273	.52777+02	.131767-01	.829694+01	.271406-02	.355507+02	.446408+01
275	.53145+02	.131767-01	.836585+01	.249663-02	.351944+02	.437545+01
277	.53512+02	.131767-01	.843429+01	.228829-02	.348380+02	.428772+01
279	.53878+02	.131767-01	.850227+01	.208848-02	.344817+02	.420088+01
281	.54245+02	.131767-01	.856978+01	.189746-02	.341254+02	.411493+01
283	.54611+02	.131767-01	.863680+01	.171528-02	.337691+02	.402987+01
285	.54977+02	.131767-01	.870331+01	.154199-02	.334129+02	.394570+01
287	.55343+02	.131767-01	.876931+01	.137765-02	.330566+02	.386242+01
289	.55709+02	.131767-01	.883478+01	.122230-02	.327003+02	.378004+01
291	.56074+02	.131767-01	.889972+01	.107601-02	.323440+02	.369854+01
293	.56440+02	.131767-01	.896411+01	.938805-03	.319877+02	.361793+01
295	.56805+02	.131767-01	.902794+01	.810752-03	.316314+02	.353822+01
297	.57170+02	.131767-01	.909119+01	.691894-03	.312751+02	.345939+01
299	.57534+02	.131767-01	.915386+01	.582280-03	.309189+02	.338146+01
301	.57899+02	.131767-01	.921594+01	.481959-03	.305626+02	.330441+01
303	.58263+02	.131767-01	.927740+01	.390978-03	.302063+02	.322825+01
305	.58627+02	.131767-01	.933824+01	.309384-03	.298501+02	.315299+01
307	.58991+02	.131767-01	.939844+01	.237224-03	.294938+02	.307861+01
309	.59355+02	.131767-01	.945798+01	.174542-03	.291375+02	.300513+01
311	.59718+02	.131767-01	.951687+01	.121384-03	.287813+02	.293253+01
313	.60082+02	.131767-01	.957508+01	.777957-04	.284250+02	.286083+01
315	.60445+02	.131767-01	.963254+01	.438199-04	.280688+02	.279001+01
317	.60808+02	.131767-01	.968922+01	.195004-04	.277125+02	.272009+01
319	.61171+02	.131767-01	.974510+01	.487973-05	.273563+02	.265105+01
321	.61534+02	.131767-01	.980018+01	.000000	.270000+02	.258291+01

INITIAL RIB SHAPE(CURVE FITTING) 8

NODE	RADIUS	CURVE FIT Z-COORDINATE	CURVE FITTING ERROR
1	84.04403	25.02621	-.17698
3	83.68729	24.81421	-.17547
5	83.33049	24.60307	-.17395
7	82.97369	24.39283	-.17244
9	82.61689	24.18350	-.17092
11	82.26009	23.97507	-.16941
13	81.90330	23.76754	-.16790
15	81.54651	23.56092	-.16640
17	81.18972	23.35520	-.16489
19	80.83294	23.15038	-.16339
21	80.47616	22.94647	-.16189
23	80.11938	22.74346	-.16039
25	79.76260	22.54136	-.15889
27	79.40583	22.34016	-.15740
29	79.04906	22.13986	-.15591
31	78.69229	21.94047	-.15442
33	78.33553	21.74197	-.15293
35	77.97877	21.54439	-.15145
37	77.62201	21.34770	-.14996
39	77.26525	21.15193	-.14848
41	76.90850	20.95705	-.14701
43	76.55175	20.76308	-.14554
45	76.19501	20.57001	-.14407
47	75.83826	20.37784	-.14260
49	75.48152	20.18658	-.14113
51	75.12479	19.99622	-.13967
53	74.76805	19.80677	-.13822
55	74.41132	19.61821	-.13676
57	74.05459	19.43057	-.13531
59	73.69787	19.24382	-.13387
61	73.34115	19.05798	-.13242
63	72.98443	18.87304	-.13098
65	72.62772	18.68901	-.12955
67	72.27101	18.50588	-.12811
69	71.91430	18.32365	-.12669
71	71.55760	18.14232	-.12526
73	71.20090	17.96190	-.12384
75	70.84420	17.78239	-.12243
77	70.48751	17.60377	-.12101
79	70.13082	17.42606	-.11961
81	69.77413	17.24925	-.11820
83	69.41745	17.07335	-.11680
85	69.06077	16.89835	-.11541
87	68.70409	16.72425	-.11402
89	68.34742	16.55106	-.11264
91	67.99075	16.37876	-.11126
93	67.63409	16.20738	-.10988
95	67.27743	16.03689	-.10851
97	66.92077	15.86731	-.10715
99	66.56412	15.69863	-.10578
101	66.20747	15.53086	-.10443
103	65.85082	15.36398	-.10308
105	65.49418	15.19801	-.10173

8 This section is the curve fitting section where a curve is fit through the node locations calculated in the last section. This allows the rib to be presented in both equation form and as a discrete set of points.

107	65.13754	15.03295	-.10040
109	64.78091	14.86879	-.09906
111	64.42428	14.70553	-.09773
113	64.06765	14.54317	-.09641
115	63.71103	14.38171	-.09509
117	63.35441	14.22116	-.09378
119	62.99779	14.06151	-.09247
121	62.64118	13.90277	-.09117
123	62.28457	13.74493	-.08988
125	61.92797	13.58799	-.08859
127	61.57137	13.43195	-.08731
129	61.21478	13.27682	-.08603
131	60.85819	13.12259	-.08476
133	60.50160	12.96926	-.08350
135	60.14502	12.81683	-.08224
137	59.78844	12.66531	-.08099
139	59.43186	12.51469	-.07975
141	59.07529	12.36497	-.07851
143	58.71873	12.21616	-.07728
145	58.36216	12.06825	-.07605
147	58.00561	11.92124	-.07483
149	57.64905	11.77513	-.07362
151	57.29250	11.62993	-.07242
153	56.93596	11.48563	-.07122
155	56.57942	11.34223	-.07003
157	56.22288	11.19973	-.06885
159	55.86634	11.05814	-.06767
161	55.50982	10.91745	-.06650
163	55.15329	10.77766	-.06534
165	54.79677	10.63877	-.06418
167	54.44025	10.50078	-.06303
169	54.08374	10.36370	-.06189
171	53.72723	10.22752	-.06076
173	53.37073	10.09224	-.05963
175	53.01423	9.95787	-.05851
177	52.65773	9.82439	-.05740
179	52.30124	9.69182	-.05630
181	51.94476	9.56015	-.05520
183	51.58827	9.42939	-.05412
185	51.23179	9.29952	-.05304
187	50.87532	9.17056	-.05196
189	50.51885	9.04250	-.05090
191	50.16238	8.91534	-.04984
193	49.80592	8.78908	-.04879
195	49.44946	8.66372	-.04775
197	49.09301	8.53927	-.04672
199	48.73656	8.41572	-.04569
201	48.38012	8.29307	-.04468
203	48.02367	8.17132	-.04367
205	47.66724	8.05047	-.04267
207	47.31080	7.93053	-.04168
209	46.95437	7.81148	-.04069
211	46.59795	7.69334	-.03972
213	46.24153	7.57610	-.03875
215	45.88511	7.45976	-.03779
217	45.52870	7.34433	-.03684
219	45.17229	7.22979	-.03590

221	44.81588	7.11615	-.03497
223	44.45948	7.00342	-.03405
225	44.10309	6.89159	-.03313
227	43.74669	6.78066	-.03222
229	43.39030	6.67063	-.03133
231	43.03392	6.56150	-.03044
233	42.67754	6.45327	-.02956
235	42.32116	6.34595	-.02869
237	41.96478	6.23952	-.02782
239	41.60841	6.13400	-.02697
241	41.25205	6.02938	-.02612
243	40.89568	5.92566	-.02529
245	40.53932	5.82283	-.02446
247	40.18297	5.72091	-.02364
249	39.82662	5.61990	-.02283
251	39.47027	5.51978	-.02203
253	39.11392	5.42056	-.02124
255	38.75758	5.32224	-.02046
257	38.40124	5.22483	-.01969
259	38.04491	5.12831	-.01893
261	37.68858	5.03270	-.01817
263	37.33225	4.93799	-.01743
265	36.97593	4.84417	-.01669
267	36.61960	4.75126	-.01597
269	36.26329	4.65925	-.01525
271	35.90697	4.56814	-.01455
273	35.55066	4.47792	-.01385
275	35.19435	4.38861	-.01316
277	34.83805	4.30020	-.01248
279	34.48174	4.21269	-.01181
281	34.12544	4.12608	-.01115
283	33.76915	4.04037	-.01050
285	33.41285	3.95557	-.00986
287	33.05656	3.87166	-.00923
289	32.70027	3.78865	-.00861
291	32.34399	3.70654	-.00800
293	31.98771	3.62533	-.00740
295	31.63143	3.54502	-.00681
297	31.27515	3.46561	-.00622
299	30.91887	3.38711	-.00565
301	30.56260	3.30950	-.00509
303	30.20633	3.23279	-.00453
305	29.85006	3.15698	-.00399
307	29.49380	3.08207	-.00346
309	29.13754	3.00806	-.00293
311	28.78128	2.93496	-.00242
313	28.42502	2.86275	-.00192
315	28.06876	2.79144	-.00142
317	27.71250	2.72103	-.00094
319	27.35625	2.65152	-.00046
321	27.00000	2.58291	.00000

INITIAL RMS ERROR FUNCTION = .134870+00

RIB SHAPE CURVE FITTING ITERATES

ITER	ERROR FUNCTION	OPTIMIZATION VARIABLES (1)	(2)	(3)
1	.124753+00	.00000000	.50000000-01	.00000000
2	.796426-01	-.15000000+00	.66666666-01	.66666666-01
3	.796426-01	-.15000000+00	.66666666-01	.66666666-01
4	.796426-01	-.15000000+00	.66666666-01	.66666666-01
5	.796426-01	-.15000000+00	.66666666-01	.66666666-01
6	.702292-01	-.70601850-01	.49356995-01	.53936625-01
7	.684256-01	-.77739195-01	.59537893-01	.49138387-01
8	.551981-01	-.97788058-01	.74874237-03	-.68644235-02
9	.551981-01	-.97788058-01	.74874237-03	-.68644285-02
10	.537890-01	-.17692614+00	.11203896-02	-.39665579-01
11	.490719-01	-.18275128+00	-.23886624-01	-.47293883-01
12	.315658-01	-.13425500+00	.22134137-01	.90560669-02
13	.315658-01	-.13425500+00	.22134137-01	.90560669-02
14	.315658-01	-.13425500+00	.22134137-01	.90560669-02
15	.315658-01	-.13425500+00	.22134137-01	.90560669-02
16	.310096-01	-.15579091+00	.14477022-01	.33182137-01
17	.217281-01	-.14662359+00	.14696878-02	-.45897011-02
18	.217281-01	-.14662359+00	.14696878-02	-.45897011-02
19	.104095-01	-.15650309+00	-.79750626-02	.15265265-01
20	.104095-01	-.15650309+00	-.79750626-02	.15265265-01
21	.104095-01	-.15650309+00	-.79750626-02	.15265265-01
22	.104095-01	-.15650309+00	-.79750626-02	.15265265-01
23	.301882-02	-.16795328+00	-.15808036-01	.24513989-02
24	.301882-02	-.16795328+00	-.15808036-01	.24513989-02
25	.301882-02	-.16795328+00	-.15808036-01	.24513989-02
26	.301882-02	-.16795328+00	-.15808036-01	.24513989-02
27	.301882-02	-.16795328+00	-.15808036-01	.24513989-02
28	.301882-02	-.16795328+00	-.15808036-01	.24513989-02
29	.301882-02	-.16795328+00	-.15808036-01	.24513989-02
30	.301882-02	-.16795328+00	-.15808036-01	.24513989-02
31	.301882-02	-.16795328+00	-.15808036-01	.24513989-02
32	.232917-02	-.16171688+00	-.12840887-01	.49118665-02
33	.232917-02	-.16171688+00	-.12840887-01	.49118665-02
34	.232917-02	-.16171688+00	-.12840887-01	.49118665-02
35	.184601-02	-.16603670+00	-.14949116-01	.36719329-02
36	.169314-02	-.16556641+00	-.15149104-01	.43248081-02
37	.169314-02	-.16556641+00	-.15149104-01	.43248081-02
38	.141970-02	-.16374848+00	-.14109119-01	.42237169-02
39	.141970-02	-.16374848+00	-.14109119-01	.42237169-02
40	.141970-02	-.16374848+00	-.14109119-01	.42237169-02
41	.141970-02	-.16374848+00	-.14109119-01	.42237169-02
42	.138015-02	-.16479428+00	-.15005910-01	.37847374-02
43	.136910-02	-.16414353+00	-.14752126-01	.41596779-02
44	.135246-02	-.16458656+00	-.14790704-01	.40979792-02
45	.134614-02	-.16412830+00	-.14479349-01	.41214242-02
46	.134608-02	-.16454021+00	-.14839985-01	.39555489-02
47	.134314-02	-.16455577+00	-.14678955-01	.40076372-02
48	.134314-02	-.16455577+00	-.14678955-01	.40076372-02
49	.133685-02	-.16428508+00	-.14583079-01	.40476477-02
50	.133685-02	-.16428508+00	-.14583079-01	.40476477-02
51	.133685-02	-.16428508+00	-.14583079-01	.40476477-02
52	.133685-02	-.16428508+00	-.14583079-01	.40476477-02

53	.133621-02	-.16440257+00	-.14667158-01	.39964809-02
54	.133621-02	-.16440257+00	-.14667158-01	.39964809-02
55	.133621-02	-.16440257+00	-.14667158-01	.39964809-02
56	.133579-02	-.16433023+00	-.14618345-01	.40405603-02
57	.133575-02	-.16433986+00	-.14637660-01	.40420479-02
58	.133575-02	-.16433986+00	-.14637660-01	.40420479-02
59	.133571-02	-.16437877+00	-.14652191-01	.40182290-02
60	.133560-02	-.16435069+00	-.14633425-01	.40365469-02
61	.133560-02	-.16435069+00	-.14633425-01	.40365469-02
61	.133560-02	-.16435069+00	-.14633425-01	.40365469-02

FINAL RIB SHAPE(CURVE FITTING)

NODE	RADIUS	CURVE FIT Z-COORDINATE	CURVE FITTING ERROR
1	84.04403	24.85127	-.00203
3	83.68729	24.64049	-.00175
5	83.33049	24.43060	-.00148
7	82.97369	24.22162	-.00123
9	82.61689	24.01357	-.00099
11	82.26009	23.80643	-.00078
13	81.90330	23.60021	-.00057
15	81.54651	23.39491	-.00039
17	81.18972	23.19053	-.00022
19	80.83294	22.98706	-.00006
21	80.47616	22.78450	.00008
23	80.11938	22.58286	.00021
25	79.76260	22.38214	.00033
27	79.40583	22.18233	.00043
29	79.04906	21.98343	.00053
31	78.69229	21.78544	.00061
33	78.33553	21.58836	.00068
35	77.97877	21.39220	.00074
37	77.62201	21.19694	.00080
39	77.26525	21.00260	.00084
41	76.90850	20.80916	.00088
43	76.55175	20.61664	.00090
45	76.19501	20.42502	.00092
47	75.83826	20.23431	.00093
49	75.48152	20.04451	.00094
51	75.12479	19.85561	.00094
53	74.76805	19.66762	.00093
55	74.41132	19.48054	.00091
57	74.05459	19.29436	.00090
59	73.69787	19.10908	.00087
61	73.34115	18.92471	.00085
63	72.98443	18.74125	.00081
65	72.62772	18.55868	.00078
67	72.27101	18.37702	.00074
69	71.91430	18.19627	.00069
71	71.55760	18.01641	.00065
73	71.20090	17.83746	.00060
75	70.84420	17.65941	.00055
77	70.48751	17.48226	.00050
79	70.13082	17.30601	.00044
81	69.77413	17.13066	.00039
83	69.41745	16.95621	.00033
85	69.06077	16.78267	.00027
87	68.70409	16.61002	.00021
89	68.34742	16.43827	.00015
91	67.99075	16.26741	.00009
93	67.63409	16.09746	.00003
95	67.27743	15.92841	-.00003
97	66.92077	15.76025	-.00009
99	66.56412	15.59299	-.00014
101	66.20747	15.42663	-.00020
103	65.85082	15.26116	-.00026
105	65.49418	15.09659	-.00032

107	65.13754	14.93292	-.00037
109	64.78091	14.77015	-.00042
111	64.42428	14.60827	-.00048
113	64.06765	14.44728	-.00053
115	63.71103	14.28720	-.00057
117	63.35441	14.12800	-.00062
119	62.99779	13.96971	-.00067
121	62.64118	13.81230	-.00071
123	62.28457	13.65580	-.00075
125	61.92797	13.50018	-.00079
127	61.57137	13.34546	-.00082
129	61.21478	13.19164	-.00086
131	60.85819	13.03871	-.00089
133	60.50160	12.88667	-.00092
135	60.14502	12.73553	-.00094
137	59.78844	12.58528	-.00096
139	59.43186	12.43593	-.00098
141	59.07529	12.28747	-.00100
143	58.71873	12.13990	-.00102
145	58.36216	11.99322	-.00103
147	58.00561	11.84744	-.00104
149	57.64905	11.70255	-.00104
151	57.29250	11.55855	-.00104
153	56.93596	11.41545	-.00104
155	56.57942	11.27324	-.00104
157	56.22288	11.13192	-.00104
159	55.86634	10.99149	-.00103
161	55.50982	10.85196	-.00101
163	55.15329	10.71332	-.00100
165	54.79677	10.57557	-.00098
167	54.44025	10.43871	-.00096
169	54.08374	10.30275	-.00094
171	53.72723	10.16768	-.00091
173	53.37073	10.03350	-.00088
175	53.01423	9.90021	-.00085
177	52.65773	9.76781	-.00082
179	52.30124	9.63631	-.00078
181	51.94476	9.50569	-.00074
183	51.58827	9.37597	-.00070
185	51.23179	9.24715	-.00066
187	50.87532	9.11921	-.00062
189	50.51885	8.99217	-.00057
191	50.16238	8.86601	-.00052
193	49.80592	8.74075	-.00047
195	49.44946	8.61639	-.00041
197	49.09301	8.49291	-.00036
199	48.73656	8.37033	-.00030
201	48.38012	8.24863	-.00024
203	48.02367	8.12783	-.00018
205	47.66724	8.00793	-.00012
207	47.31080	7.88891	-.00006
209	46.95437	7.77079	.00000
211	46.59795	7.65356	.00007
213	46.24153	7.53722	.00013
215	45.88511	7.42177	.00020
217	45.52870	7.30722	.00026
219	45.17229	7.19356	.00033

221	44.81588	7.08079	.00040
223	44.45948	6.96891	.00046
225	44.10309	6.85793	.00053
227	43.74669	6.74784	.00059
229	43.39030	6.63864	.00066
231	43.03392	6.53034	.00073
233	42.67754	6.42293	.00079
235	42.32116	6.31641	.00085
237	41.96478	6.21079	.00092
239	41.60841	6.10605	.00098
241	41.25205	6.00222	.00104
243	40.89568	5.89927	.00109
245	40.53932	5.79722	.00115
247	40.18297	5.69607	.00121
249	39.82662	5.59580	.00126
251	39.47027	5.49644	.00131
253	39.11392	5.39796	.00135
255	38.75758	5.30038	.00140
257	38.40124	5.20370	.00144
259	38.04491	5.10791	.00148
261	37.68858	5.01301	.00151
263	37.33225	4.91901	.00155
265	36.97593	4.82590	.00157
267	36.61960	4.73369	.00160
269	36.26329	4.64238	.00162
271	35.90697	4.55196	.00163
273	35.55066	4.46243	.00165
275	35.19435	4.37380	.00165
277	34.83805	4.28607	.00165
279	34.48174	4.19923	.00165
281	34.12544	4.11329	.00164
283	33.76915	4.02824	.00163
285	33.41285	3.94410	.00161
287	33.05656	3.86084	.00158
289	32.70027	3.77849	.00155
291	32.34399	3.69703	.00151
293	31.98771	3.61647	.00146
295	31.63143	3.53681	.00141
297	31.27515	3.45804	.00135
299	30.91887	3.38017	.00128
301	30.56260	3.30320	.00121
303	30.20633	3.22713	.00113
305	29.85006	3.15195	.00104
307	29.49380	3.07768	.00094
309	29.13754	3.00430	.00083
311	28.78128	2.93182	.00071
313	28.42502	2.86024	.00059
315	28.06876	2.78956	.00046
317	27.71250	2.71978	.00031
319	27.35625	2.65089	.00016
321	27.00000	2.58291	.00000

RIB CURVE FITTING RMS ERROR = .133560-02

B(1)	B(2)	B(3) 9
-.164350692+00	-.146334250-01	.403654686-02

9 These parameters refer to the rib shape and define the as-machined rib shape that will produce the optimum rib when the mesh and cable are applied.

NASA — JPL — Coml., L.A., Calif.