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USER'S MANUAL FOR FLAP 3.(U)

JUL 77 R M HACKETT

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Redstone Arsenal, Alabama 35809

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This manual describes a three-dimensional finite element computer code developed for the purpose of predicting the combustion instability of solid propellant rocket motors. The analysis requires the use of three separate codes which are described here. FLESH3 is used to generate a finite element mesh. FLSH3P is used to combine the segments generated in FLESH3 into the continuum for analysis. FLAP3 is used to calculate acoustic frequencies and mode shapes, to calculate the potential flow field, and to evaluate the stability integrals.

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July 1977

USER'S MANUAL FOR FLAP3

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CONTENTS

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The FLAP3 computer code is the result of the efforts of a number of individuals over the past two years. Radwan Juruf and Carl DeVilbiss, graduate students at Vanderbilt University, contributed substantially to the development of the code. Robert Radke made many helpful and vital suggestions relative to implementation of the code. Al Maykut gave invaluable encouragement and advice along the way. These are gratefully acknowledged for their contributions and support.

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Section 1
INTRODUCTION

Fluid Analysis Program, 3-Dimensions (FLAP3) is a three-dimensional finite element code developed for the purpose of predicting the combustion instability of solid propellant rocket motors. The complete code consists of four phases:

a) A pre-processor phase (a three-dimensional finite element mesh generator).

b) The acousto-modal analysis (calculation of the acoustic frequency, mode shape, and corresponding velocities).

c) The potential flow analysis (calculation of gas flow velocities).

d) The determination of mode stability/instability (evaluation of stability integrals).

The second phase of the code provides for the coupling of the acoustic response of the rocket cavity with that of the solid propellant grain for the purpose of obtaining a more accurate value (than would be obtained by considering "acoustically hard" cavity boundaries) of the acoustic frequency, and for calculating the amount of structural damping provided by the propellant grain. The solid propellant can be modeled as a virtually incompressible material having a frequency dependent complex modulus. The frequency dependency of the solid propellant modulus may require, in some cases, the employment of an iterative technique to obtain the coupled frequency and the rate of structural damping.

Because modeling of the solid propellant greatly increases the size of the problem, and therefore the cost of running it, the user has the option of a cavity-solid coupled analysis or of a cavity analysis alone. The principle of dihedral symmetry is fundamental in the development of the code and requires that the user generate a finite element mesh only for the geometry of the smallest repeating cavity-propellant segment, the problem being basically one in cylindrical coordinates.

FLAP3 was developed primarily for the following purposes:

a) To provide generality and accuracy in the modeling of complex combustion chamber geometries.

b) To provide a means of predicting the damping of acoustic oscillations by the solid propellant grain.

c) To provide an integrated program designed solely for the purpose of combustion instability prediction with ease of use.

The main features of FLAP3 are given in the following list and will be explained later:

a) It utilizes a specially adapted three-dimensional finite element input data generation (FLESH3 and FLSH3P) package.

b) It utilizes the principle of dihedral symmetry which enables a consideration of only the smallest repeating geometrical segment.

c) It couples the response of the gas cavity with that of the solid propellant grain to enable the calculation of the frequency of the coupled system and the acoustic wave damping provided by the propellant grain.

d) It provides for modeling the propellant grain as a nearly incompressible material (which differs from the usual minimum potential energy formulation).

e) It utilizes the principle of condensation, in which, in this case, the fluid pressure degrees-of-freedom are designated "master" and the solid propellant displacement and mean pressure parameter degrees-of-freedom are designated "slave." This enables a major reduction in the size of the problem; the number of equations is reduced from the total number of degrees-of-freedom of the coupled system to the number of fluid pressure degrees-of-freedom.

f) It provides the option of considering the response of the gas cavity alone (which models the cavity boundaries as "acoustically hard"). This option might be utilized in certain cases where a savings in computer costs or storage is a dominant consideration. In this case the previously described condensation routine obviously would not be invoked.

g) It calculates the three-dimensional potential flow field.

h) It evaluates the stability integrals for the calculation of the net driving/damping coefficient for each acoustic mode.

Section 2
PRE-PROCESSOR – FINITE ELEMENT MESH GENERATOR

It is necessary to develop a finite element mesh for only one repeating segment (Figure 1) of the total cavity-solid propellant rocket geometry. This is true because of the employment of the principle of dihedral symmetry in FLAP3. Although the three-dimensional element used in FLAP3 for both the cavity region and the solid propellant is a tetrahedron [1], the mesh is that of bricks connected at the corners. Each brick, or quasi-hexahedron, is comprised of five basic tetrahedra (Figure 2). The breakdown of the quasi-hexahedron into tetrahedra is performed internally; therefore, the mesh need be no more complicated than that shown in Figure 3.

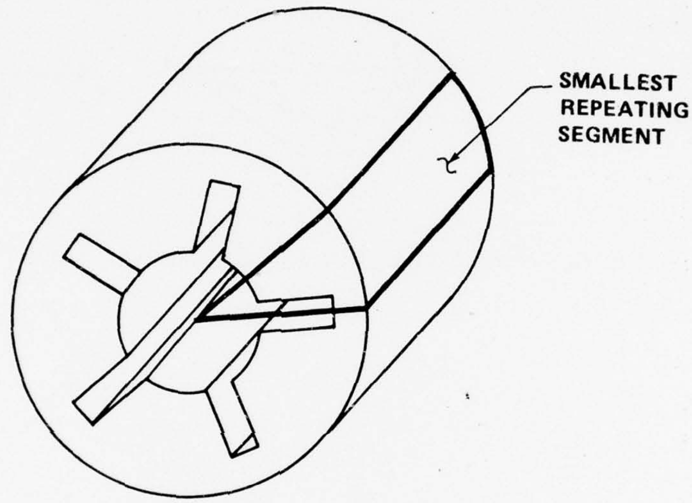


Figure 1. Three-dimensional cavity-solid propellant model.

The pre-processor phase, or finite element mesh generator, FLESH3 (Fluid Mesh Generation, 3-Dimensions), is an efficient routine which automatically creates the complete finite element mesh, consisting of both cavity and solid propellant regions, from a minimal amount of input. Each repeating segment is sectioned in the longitudinal or z-direction, with each section comprised of a number of quadrilateral parts which are identified by a counterclockwise listing of their part boundary curves. Part boundary curves may be ellipses as well as straight lines; their points of intersection are designated by I,J indices as shown in the User's Guide for FLESH3 (Figure 4) which begins on page 14.

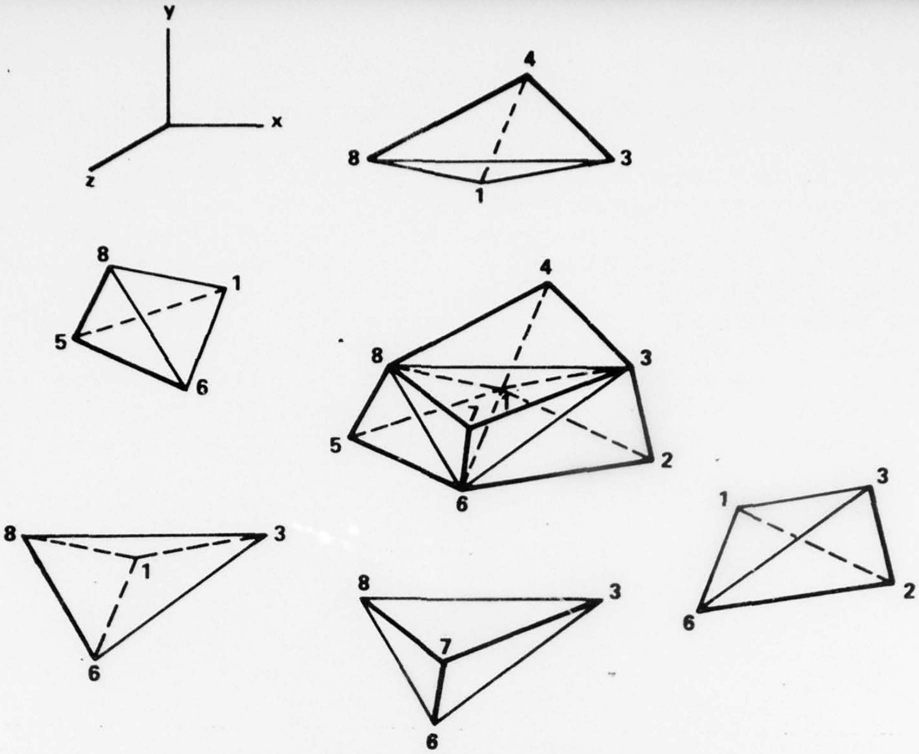


Figure 2. Quasi-hexahedron (brick) composed of five tetrahedra.

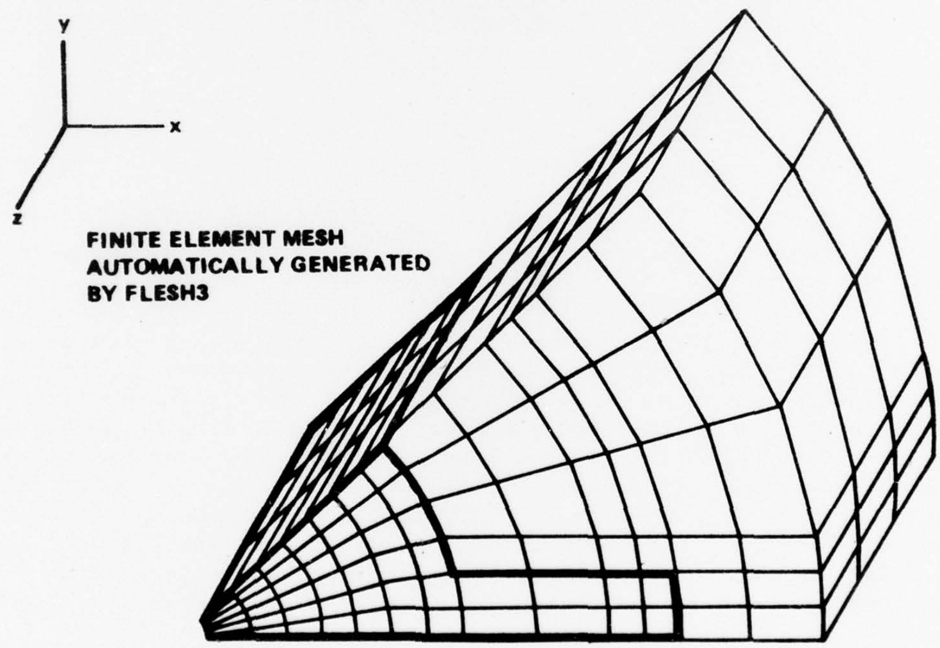


Figure 3. Repeating cavity-solid propellant segment model.

Section 3
DISCUSSION

3.1 Dihedral Symmetry

If a geometrically defined body is comprised of identical segments symmetrically arranged with respect to an axis, the degrees-of-freedom, for a finite element analysis, can be transformed into uncoupled symmetrical components, thereby greatly reducing the number of equations which must be solved simultaneously [2]. A further reduction occurs if each segment has a plane of reflective symmetry. Dihedral symmetry is the term applied to this latter condition. It can be seen from Figure 1 that a typical solid rocket geometry meets this requirement; therefore, the principle of dihedral symmetry can be employed in a three-dimensional (cylindrical coordinate) analysis. The application of the principle to this problem is explained in detail in Reference 3 and will not be repeated here, but the resulting analysis will be discussed.

Employing the principle of dihedral symmetry, FLAP3 computes three distinct types of acoustic harmonics: the zero harmonic, the K harmonics, and the M/2 harmonic. The zero harmonic exists for all cases and is the only harmonic which does exist for the case of a rocket having an annular cavity. The number of possible K harmonics is given by

$$K = 1, \ldots, J \tag{1}$$

where the harmonic index J is given by

$$J = \frac{M - 1}{2} \text{ (if M is an odd number)} \tag{2a}$$

or

$$J = \frac{M - 2}{2} \text{ (if M is an even number)} \tag{2b}$$

where M is the number of radial slots or lobes. For the case of an annular cavity, where radial slots do not exist, an arbitrarily small repeating segment (subtended by a whole number of degrees) may be selected for analysis. The M/2 harmonic exists only when M is an even number. Referring to the geometry of Figure 1, the zero, first, and second harmonics, for example, could be calculated. The latter two are both K harmonics.

The longitudinal modes associated with each harmonic are calculated internally by FLAP3, as requested by the user. The result of this operation (acousto-modal eigensolution) is the natural circular frequency associated with each acoustic mode and the corresponding acoustic pressure distribution (normalized acoustic pressure at each finite element nodal point) for the smallest repeating segment. The pressure distribution in all of the other segments is then simply calculated automatically through the dihedral transformation. The acoustic velocity components (constant for the region occupied by each cavity tetrahedral element) are computed from the acoustic pressure nodal point values for those cavity elements which are adjacent to the solid propellant grain (characterized in FLAP3 as fluid interface tetrahedrons).

The formulation of the complete three-dimensional finite element acousto-modal analysis, in which the natural circular frequency, the acoustic pressure distribution, and the element acoustic velocities are calculated, is given in Reference 4 and will not be repeated here. The theoretical finite element formulation which was used in the development of FLAP3 is also presented in Reference 5.

3.2 Coupled Response

The presence of the solid propellant grain can significantly shift the acoustic system frequency from that of the gas phase alone, a portion of the acoustic energy being dissipated by the deformable solid material. This effect can be one of the more significant sinks for acoustic energy in both large and small rocket motors, the amount of damping depending on the grain geometry and mechanical properties and on the acoustic mode shape and natural frequency.

To evaluate the coupled cavity-solid propellant grain response, it is necessary to model both cavity and grain by the finite element method. This greatly increases the size of the problem to be solved from the standpoint of number of initial degrees-of-freedom. The coupled finite element formulation [5] which is programmed in FLAP3 is expressed in matrix form as:

$$\left(\left[\begin{array}{c|c} F & 0 \\ \hline -U^T & K \end{array} \right] - \lambda^2 \left[\begin{array}{c|cc} T & \multicolumn{2}{c}{U} \\ \hline 0 & M & 0 \\ & 0 & 0 \end{array} \right] \right) \left\{ \begin{array}{c} P \\ \hline \Delta \\ \hline H \end{array} \right\} = 0 \tag{3}$$

where [F] is the fluid inertia matrix, [T] is the fluid compressibility matrix, [K] is the solid stiffness matrix, [M] is the solid consistent mass matrix, [U] is the matrix which couples acoustic pressure degrees-of-freedom to solid displacement degrees-of-freedom, {p} is the acoustic pressure vector, {Δ} is the solid displacement vector, {H} is the mean pressure parameter vector (to be explained later), and λ^2 is the eigenvalue of the coupled system.

The structural damping can be attributed to the out-of-phase response of the solid propellant grain which is measured in terms of the complex shearing modulus of the grain, which, in turn, results in a complex eigenvalue for the coupled system. The imaginary part of the complex eigenvalue obtained from the eigensolution is the natural circular frequency of the coupled system while the real part is the structural damping rate.

Because the complex shearing modulus is frequency dependent, a series of iterations may be necessary before the accurate value of complex modulus for input into the program is determined.

3.3 Propellant Grain Modeling

Because the propellant grain is accurately modeled only as a nearly incompressible material, the well-known standard Navier displacement formulation would lead to inaccuracies in the finite element modeling of the grain. To avoid this situation, the solid finite element formulation utilized in FLAP3 is that of a linear displacement-linear mean pressure tetrahedron [6]. It is similar to the Herrmann variational formulation [7] which employs a linear displacement function and a constant mean pressure function. The finite element modeling of the propellant grain used in FLAP3 is outlined in detail in Reference 5 and will not be repeated here.

3.4 Eigenvalue Economizer — Condensation

The extraction of eigenvalues and eigenvectors is a far more expensive operation than is the solution of simultaneous linear equations. It requires roughly twice as long to extract a single eigenvalue as it does to do a single static analysis. To reduce or condense the number of degrees-of-freedom in the eigensolution, the following technique is utilized in FLAP3. Further details of the method are found in Reference 8.

The original formulation of the coupled system is given by Equation (3), where the number of degrees-of-freedom is equal to the number of cavity nodal point pressures plus the number of solid propellant nodal point displacement components plus the number of solid propellant nodal point mean pressure parameter values (one at each propellant node) for the analyzed repeating segment. The condensed formulation is given by:

$$\left([F_r] - \lambda^2\,[T_r]\right)\{p\} = 0 \qquad (4)$$

where

$$[F_r] = \begin{bmatrix} I \\ \hline K^{-1}U^T \end{bmatrix}^T \begin{bmatrix} F & 0 \\ -U^T & K \end{bmatrix} \begin{bmatrix} I \\ \hline K^{-1}U^T \end{bmatrix} \qquad (5a)$$

and

$$[T_r] = \begin{bmatrix} I \\ \hline K^{-1}U^T \end{bmatrix}^T \begin{bmatrix} T & U \\ 0 & \begin{matrix} M & 0 \\ 0 & 0 \end{matrix} \end{bmatrix} \begin{bmatrix} I \\ \hline K^{-1}U^T \end{bmatrix} \qquad (5b)$$

where I is the identity matrix. The relationship between initial and reduced degrees-of-freedom is given by:

$$\begin{Bmatrix} p \\ \Delta \\ H \end{Bmatrix} = \begin{bmatrix} I \\ \hline K^{-1}U^T \end{bmatrix} \{p\} \qquad (6)$$

3.5 Uncoupled Response

Although one of the most important features of FLAP3 is the coupled cavity-solid propellant response analysis capability, the option of a cavity analysis alone is available to the user. In this case, the cavity-solid propellant interface is modeled as an "acoustically hard" boundary. The cavity only option would greatly reduce the computer storage requirements for FLAP3 and would in certain cases, suffice. The user need make only two simple modifications in the input data; these modifications are described in the FLAP3 User's Guide which begins on page 19.

3.6 Potential Flow Calculation

The fourth phase of the complete three-dimensional code package utilizes the FLAP3 subroutine which carries out a potential flow analysis for the purpose of determining the mean flow field in the rocket cavity. As in the case of the acousto-modal analysis, only the smallest repeating geometrical segment need be considered; for this calculation, only the cavity portion of the segment with the proper boundary conditions is considered. The same general formulation of the finite element model equations of motion is utilized except that, in this case, the fluid is considered to be incompressible. The mass flow into the cavity from the burning propellant surface is modeled as a cavity-solid propellant interface nodal point quantity.

It is calculated by summing the interface surface areas associated with each nodal point lying on the cavity-solid propellant interface. The solution of the resulting set of linear equations for the mean flow velocity components (constant for each cavity tetrahedron) is explained in Reference 4; it is not considered necessary to go into it in detail here.

3.7 Evaluation of Stability Integrals

The final phase of the code consists of the calculation of the stability integrals associated with the various driving/damping coupling mechanisms which occur in the cavity chamber in the presence of combustion and flow. The stability integrals presently incorporated into FLAP3 are those derived [9] for the three-dimensional case, along with the flow-turning formulation. The use of a linear pressure (and therefore constant velocity) tetrahedral element to represent the cavity region enables an exact evaluation of the stability integrals, given the acoustic nodal point pressures and element velocities and the mean flow element velocities from the finite element solutions. At present FLAP3 does not contain a routine for evaluating nozzle damping or particle damping.

The calculation of stability integrals is for the purpose of evaluating the driving/damping coefficient, α, a fact well-known to the combustion community. A positive α indicates an unstable mode of oscillation while a negative α indicates a stable mode. The net value of α computed by FLAP3 is a summation of the computed values of α_{PC} (pressure coupling), α_{VC} (velocity coupling), α_{FT} (flow-turning), and α_{SD} (structural damping). The value of α_{SD} is obtained from the complex eigensolution described in an earlier section; the other three α-values are obtained from the evaluation of the stability integrals. It is known that the pressure coupling mechanism always drives the acoustic oscillations, that the velocity coupling mechanism may either drive or damp the oscillations, and that the flow-turning mechanism always damps the oscillations. The response factors are input into the program as multiples of the stability integrals for the calculation of the α's obtained from the different coupling mechanisms. The propellant grain-dependent response functions are obtained from other analyses and utilized as direct input into FLAP3.

Section 4
FLESH3 USER'S GUIDE

I. TITLE CARD (80A1)

Columns	Variable	Entry
1-80	ITITLE	Title information Key word "END" stops job

II. CONTROL CARD (4I5,F10.0,I5)

Columns	Variable	Entry
1-5[1]	IMAX	
6-10[1]	JMAX	
11-15	NNC	Total number of part boundary curves
16-20[1]	IBC	Number of node code sequences
21-30	SCALE	Scale factor to multiply coordinates (Default set to 1)
31-35	NLAY	Number of sections in z-direction

III. PART BOUNDARY CURVE CARDS (2F10.0,2I5,4F10.0)[2]

Columns	Variable	Entry
1-10	A(1,K)	x coordinate (x_o of ellipse)
11-20	A(2,K)	y coordinate (y_o of ellipse)
21-25	NN	Number label of curve (for tabulated curves, last card only)
26-30	NP	Blank for tabulated curve Angle subtended by generated ellipse (to nearest degree)
31-40	AA	Radius of ellipse along x-axis
41-50	BB	Radius of ellipse along y-axis
51-60[3]	TH1	Beginning and end angles in degrees, counterclockwise positive from x-axis
61-70[3]	TH2	

IV. NODE CODE SEQUENCE CARDS (5I5)

Columns	Variable	Entry
1-5[4]	IC	Node sequence type
6-10	I1	
11-15	J1	
16-20	I1 (or I2)	
21-25	J2 (or J1)	

V. PART DEFINITION CARDS (14I5)[5]

(A value of -1 will end this sequence)

Columns	Variable	Entry
1-5	NP	Part number (do not define degenerate parts)
6-10	I1	Minimum index of part
11-15	J1	Minimum index of part
16-20	I2	Maximum index of part
21-25	J2	Maximum index of part
26-30	L1	Number label of curve from (I1,J1) to (I2,J1)
31-35	L2	Number label of curve from (I2,J1) to (I2,J2)
36-40	L3	Number label of curve from (I2,J2) to (I1,J2)
41-45	L4	Number label of curve from (I1,J2) to (I1,J1)
46-50	MT	Part designator
51-55	NN	Number of additional parts in (I) direction whose constant (I) curves are incremented by 1
56-60	I3	Increment in I (I3) default set to 1
61-65	J3	Increment in J (J3) default set to 1
66-70	IR	Set to 1 to invoke Laplace relaxer for this sequence of parts

VI. SECTION LOCATION CARD (F10.0)
(The axis origin should be placed at the nozzle end of the cavity)

Columns	Variable	Entry
1-10[6]	ZO	Distance along x-axis (cavity longitudinal axis)

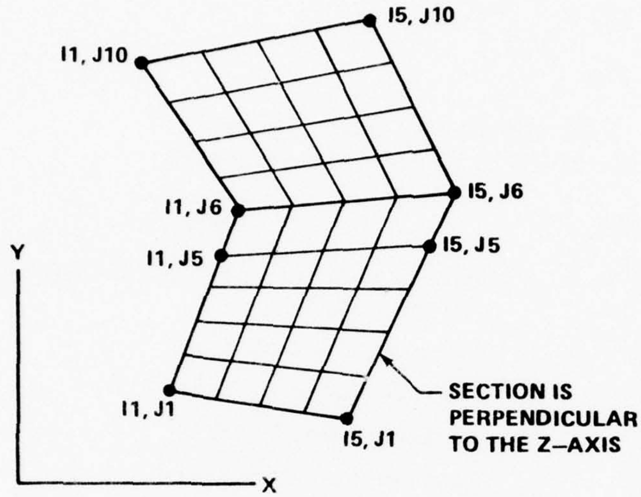


Figure 4. Finite element mesh generation for cavity-solid propellant by FLESH3.

FLESH3 Notes

1. Each node will be identified in a sequence as this input labels the node type. No node may be contained in more than one node sequence.

2. Care is necessary in defining part boundary curves to insure that all parts are bound by intersecting curves and that ellipses are cut by other curves passing through them. All part boundary curves, regardless of section location, are labeled and defined in Cards III.

3. For tabulated curves, TH1 = 0.; TH2 is blank.

4. Enter for IC: 1 if fluid node sequence; 2 if interface node sequence; 3 if solid node sequence.

5. Each section of a common z-dimension is comprised of four-sided parts which are identified by CCW listing of their part boundary curves; one card for each part (Figure 4). MT is the part designator and identifies all elements within that part as being of the same material. Enter for MT: 1 if fluid part, 2 if interface part, 3 if solid part. Interface parts are those whose elements all have at least one side on the fluid-solid interface. Elements with only one edge on the interface are not interface elements. Enter -1 for NP to terminate each set of part definition cards which define a section perpendicular to the z-axis (cavity longitudinal axis).

6. Card VI is placed at the end of a series of Part Definition cards which describe a section. There should be as many Cards VI as there are sections.

Section 5
FLSH3P USER'S GUIDE

The use of FLESH3 is limited to continua with consistent part description from section to section. Consequently, when abrupt changes in cross-section configuration occur, it is necessary to run the continua through FLESH3 in segments and to post-process the results to combine the segments. A post-processor, FLSH3P, is provided for such cases. Minimal FLESH3 output manipulation is necessary to enable FLSH3P to renumber all nodes, elements, and interface surfaces, and to redesignate nodes which may fall on the interface surface after consolidation of the segments. FLSH3P will not generate interface surfaces perpendicular to the z-axis (cavity longitudinal axis).

I. CONSOLIDATION CONTROL CARD (3I5)[1]

Columns	Variable	Entry
1-5[2]	ND	Number of segments to be consolidated
6-10	IM	Maximum I index of sections
11-15	JM	Maximum J index of sections

II. SEGMENT CONTROL CARD (5I5)
("ND" number required)

Columns	Variable	Entry
1-5	NC	Number of nodes in segment
6-10	NF	Number of fluid brick elements in segment
11-15	NS	Number of solid brick elements in segment
16-20	NI	Number of quadrilateral interfaces in segment
21-25	NZ	Number of sections in previous segment (NLAY for previous segment)

FLSH3P Notes

1. The consolidation control card is input as the first record with segment control cards and FLESH3 data following. The segment control cards for each segment precede the segment data cards.

2. A value of 0 stops the job.

I. TITLE CARD (80A1)

Columns	Variable	Entry
1-80	ITITLE	Title information Key word "END" stops job

II. CONTROL CARD (3I5,F10.0)

Columns	Variable	Entry
1-5	NOD	Total number of nodes
6-10[1]	NTS	Number of interface surfaces
11-15[2]	NSLOT	Number of radial slots
16-25	ANGLE	Angle (in degrees) subtended by smallest repeating segment; must be whole number of degrees if NSLOT = 0

III. FLUID PROPERTIES CARD (I5,2F10.0)

Columns	Variable	Entry
1-5[3]	NFB	Number of fluid bricks
6-15	BULK	Fluid bulk modulus
16-25	FDEN	Fluid mass density

IV. SOLID PROPERTIES CARD (I5,4F10.0)

Columns	Variable	Entry
1-5[4]	NSB	Number of solid bricks
6-15	SDEN	Solid mass density
16-25	PRT	Poisson's ratio
26-35	GR	Storage modulus
36-45	GI	Loss modulus

V. MODAL ANALYSIS CARD — ZERO HARMONIC (3I5)

Columns	Variable	Entry
1-5[5]	ZHAR	Enter 1 if zero harmonic is desired; enter 0 if not
6-10	IZM	Enter number of lowest zero harmonic mode desired
11-15	LZM	Enter number of highest zero harmonic mode desired

VI. MODAL ANALYSIS CARD — M/2 HARMONIC (3I5)

Columns	Variable	Entry
1-5[5]	MHAR	Enter 1 if M/2 harmonic is desired; enter 0 if not
6-10	IMM	Enter number of lowest M/2 harmonic mode desired
11-15	LMM	Enter number of highest M/2 harmonic mode desired

VII. MODAL ANALYSIS CARD — K HARMONICS (3I5)

Columns	Variable	Entry
1-5[5]	KHAR	Enter number of K harmonics desired; enter 0 if no K harmonics are desired
6-10	IKM	Enter number of lowest K harmonic mode desired
11-15	LKM	Enter number of highest K harmonic mode desired

VIII. K HARMONICS CARD (8I5)

(Omit this card if NSLOT = 0 or if KHAR = 0)

Columns	Variable	Entry
1-5	KHD	Enter 1 if K = 1 is desired; enter 0 if not
6-10		Enter 2 if K = 2 is desired; enter 0 if not
.		(continue through all possible K harmonics)[5]
.		
36-40		

IX. COMBUSTION PARAMETERS CARD (2F10.0)

Columns	Variable	Entry
1-10	GSPEED	Speed of gas leaving the burning surface
11-20	CCM	Mass fraction of particulate material

X. RESPONSE FACTOR CARD (4F10.0)

Columns	Variable	Entry
1-10	RPC	Pressure coupling response factor
11-20	RVC	Velocity coupling response factor
21-30	RFT	Flow turning response factor
31-40	RSD	Structural damping response factor

XI. NODAL POINT DATA CARDS (I5,3F10.0,I5)[6]

(The axis origin should be placed at the nozzle end of the cavity)

Columns	Variable	Entry
1-5	NNUM	Nodal point number
6-15	X	x coordinate
16-25	Y	y coordinate
26-35	Z	z coordinate
36-40[7]	NTYPE	Nodal point identifier

XII. FLUID ELEMENT CARDS (10I5)[8]

Columns	Variable	Entry
1-5	ENUM	Brick element number
6-10	Global node point numbers corresponding to element nodes	1
11-15		2
16-20		3
21-25		4
26-30		5
31-35		6
36-40		7
41-45		8
46-50		Enter 2 for an element on the fluid-solid interface; enter 1 otherwise

SOLID ELEMENT CARDS (10I5)[8]

(Omit these cards if NSB = 0)

Columns	Variable	Entry
1-5	ENUM	Brick element number
6-10	Global node point numbers corresponding to element nodes	1
11-15		2
16-20		3
21-25		4
26-30		5
31-35		6
36-40		7
41-45		8
46-50		Enter 3

XIII. QUADRILATERAL INTERFACE SURFACE CARDS (6I5)[9]

Columns	Variable	Entry
1-5	SNUM	Quadrilateral surface number
6-10	Global node point numbers corresponding to element nodes	1
11-15		2
16-20		3
21-25		4
26-30[10]		Enter 1 for a surface whose outward normal is positive; enter 2 for a surface whose outward normal is negative

FLAP3 Notes

1. An interface surface is the quadrilateral face of a brick (quasi-hexahedral) which lies on the cavity-solid propellant boundary.

2. The program is not limited to the analysis of cavities having narrow radial slots. It is applicable to any similar type geometry such as a star or cloverleaf pattern, or to an annular cavity where NSLOT = 0.

3. This is the number of bricks (quasi-hexahedral) making up the cavity portion of a repeating segment.

4. This is the number of bricks (quasi-hexahedral) making up the solid propellant portion of a repeating segment. When the "cavity only" option is exercised, NSB is input as 0.

5. There are three distinct types of harmonics: zero, K, and M/2. The zero harmonic always exists; the K harmonics are given by

   $K = 1, \ldots, J$

   where

   $J = \frac{M - 1}{2}$ (for odd M)

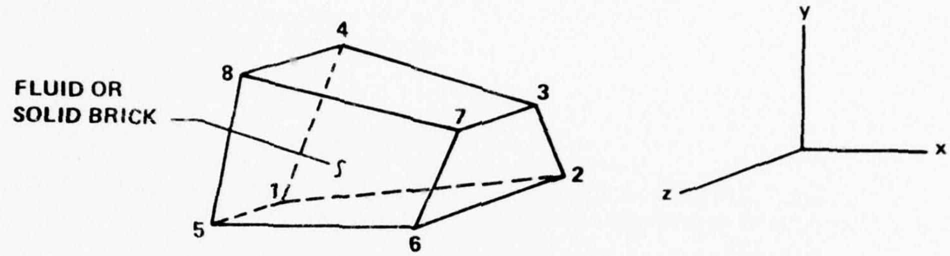
   $J = \frac{M - 2}{2}$ (for even M)

where M is the number of radial slots or lobes; the M/2 harmonic exists only when M is an even number. When NSLOT = 0, only the zero harmonic exists.

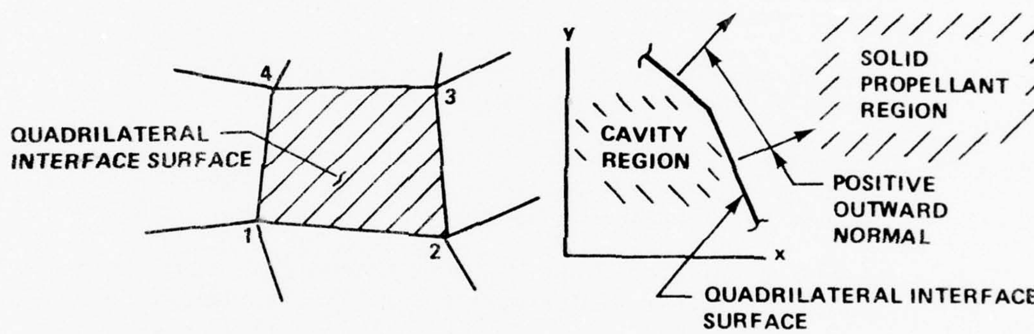
6. All of the remaining data (Cards XI through XIII) can be automatically generated by the program FLESH3 which is specially developed for use with FLAP3.

7. Each nodal point lying inside the cavity region is identified by 1; each nodal point lying on the cavity-solid propellant interface is identified by 2; each nodal point lying in the solid propellant region is identified by 3.

8. Element node numbers:



9. When the outward normal to a quadrilateral interface surface is positive, the surface is designated 1; when the outward normal is negative, the surface is designated 2.



10. If FLESH3 is used to generate the finite element mesh data for FLAP3, all quadrilateral interface surfaces will be automatically designated as 1 (positive outward normal). In cases where the outward normal is actually negative, the designation change to 2 must be made manually.

Section 7
CONCLUSIONS

Simply stated, FLAP3 performs a linear acousto-modal analysis of the irrotational motions of an inviscid, compressible fluid coupled to the irrotational motions of a nearly incompressible, linearly isotropic viscoelastic solid and a linear potential flow analysis of the irrotational motions of an inviscid, incompressible fluid, and then determines the effect of the flow field and combustion on the calculated acoustic oscillations. There are obvious limitations attached to any code which is as basic as the previously listed restrictions dictate, but it is felt that the developed code presented here is probably as sophisticated as the present state-of-the-art warrants. It is viewed by the developer as having much potential as both a design and a research tool. As the state-of-the-art in combustion technology advances, it is felt that the code can be revised relatively easily and updated to include the new technology; at least it was designed with that in mind.

One of the most attractive features of FLAP3 is the ease of use, which, hopefully, is demonstrated in the examples found in the appendices. Other extremely important attributes are the fact that it is three-dimensional, that it performs a coupled cavity-solid propellant analysis (or, alternatively, a cavity only analysis) and that all analyses are contained in a single program. Features of the code which do not enhance its reputation also exist; they too should be pointed out. It is a large program requiring a large amount of storage and it may require long run times, as is the case with any three-dimensional finite element program. Presently, the entire program is in-core computation, but this will probably be modified. In certain instances, a two-dimensional (axisymmetric) uncoupled analysis provides sufficient accuracy; for such cases, use of the three-dimensional code might not have merit.

It is felt that the demonstrated attributes of FLAP3 far outweigh any foreseen disadvantages and that it can provide the means of performing important analyses which were impossible before its implementation.

REFERENCES

1. Zienkiewicz, O. C., The Finite Element Method in Engineering Science, London: McGraw-Hill, 1971.

2. MacNeal, R. H., Harder, R. L., and Mason, J. B., "NASTRAN Cyclic Symmetry Capability," NASTRAN: User's Experiences, NASA, September 1973, TM X-2893, pp. 395-421.

3. Hackett, R. M., Three-Dimensional Acoustic Analysis of Solid Rocket Motor Cavities, US Army Missile Command, Redstone Arsenal, Alabama, November 1975, Technical Report RK-76-7.

4. Hackett, R. M., "Three-Dimensional Finite Element Acoustic Analysis of Solid Rocket Motor Cavities," Journal of Spacecraft and Rockets, Volume 13, No. 10, October 1976, pp. 585-588.

5. Hackett, R. M. and Juruf, R. S., "Three-Dimensional Finite Element Analysis of Acoustic Instability of Solid Propellant Rocket Motors," Proceedings of the 13th Annual Meeting of the Society of Engineering Science, Inc., Hampton, Virginia, November, 1976, pp. 1641-1651.

6. Hughes, T. J. R. and Allik, H., "Finite Elements for Compressible and Incompressible Continua," Proceedings of the Symposium on Application of Finite Element Methods in Civil Engineering, Vanderbilt University, November 1969, pp. 27-62.

7. Herrmann, L. R., "Elasticity Equations for Incompressible and Nearly Incompressible Materials by a Variational Theorem," Journal of the American Institute of Aeronautics and Astronautics, Volume 3, No. 10, October 1965, pp. 1896-1900.

8. Cook, R. D., Concepts and Applications of Finite Element Analysis, New York: John Wiley and Sons, Inc., 1974.

9. Final Report - T-Burner Testing of Metallized Solid Propellants, (F. E. C. Culick, Editor) Air Force Rocket Propulsion Laboratory, Edwards, California, October 1974, Report No. AFRPL-TR-74-28.

Appendix A. DIMENSIONS OF VARIABLES

MAIN PROGRAM - FLAP3

1) The following variables have the fixed dimensions indicated: K(16,16), SUM(16,16), TR(16,16), FF(10,10), SB(10,16), ART(12), N(16), NHARM(16), ITITLE(80).

2) The following variables have dimensions at least equal to NOD, where NOD is the total number of nodes whose coordinates are input: X, Y, Z, NP, NR, NT, NZ, NH, SP, NTYPE, SS, ANR, ANT, ANZ.

3) The following variables have dimensions at least equal to NIS where NIS is the number of quadrilateral interface surfaces: INS, JNS, LNS, MNS, ISCODE, SAREA, XCON, YCON, ZCON.

4) The following variables have dimensions at least equal to 2*NIS: IST, JST, KST, IDT, IDS, SVX, SVY, SVZ, STAR.

5) The variables INT, JNT, LNT, and MNT have dimensions at least equal to 5*NE, where NE = NFB + NSB, where NFB is the number of fluid bricks and NSB is the number of solid bricks.

6) The variables PR and PL have dimensions at least equal to (S,P) where S is one-half of the number cf repeating segments and P is the number of fluid nodal points plus the number of interface nodal points.

7) The variables MASS, STIFF, and STM have dimensions at least equal to (NUDF,NUDF) where NUDF = (Number of Fluid Nodal Points) + 5*(Number of Interface Nodal Points) + 4*(Number of Solid Nodal Points), or NUDF = P, when NSB = 0.

8) The variable T has dimensions of (2*NPD,NPD) where NPD = NUDF - P. If NSB = 0, the dimensions of T can be (2*P,P). If NSB = 0 and KHAR = 0, the dimensions of T can be (1,1).

9) The variable KHD has the dimension of KHAR. The variables AL, BW and EIG have the dimension of LZM, LMM or LKM, whichever is larger.

SUBROUTINES - FLAP3

Table A denotes the correspondence between subroutine variables and variables in the main program. All subroutine variables must have the same dimensions as the corresponding variables of the main program.

TABLE A. CORRESPONDENCE OF VARIABLES - FLAP3

Subroutine Variables	Main Program Variables
Subroutine MULTGF	
BUM	MASS or STIFF
Subroutine MULTGS	
BUM	MASS or STIFF
Subroutine MULT	
DUM	MASS or STIFF
Subroutine DETERM	
S	STM
Subroutine EQSOLV	
S	STM

FLSH3P

1) The variables NP and NM have dimensions at least equal to ISNC where ISNC is the sum of the nodal points in all of the segments which are being combined.

2) The variable C has dimensions at least equal to (3,ISNC).

3) The variable MF has dimensions at least equal to (10,ISNF) where ISNF is the total number of fluid bricks.

4) The variable MS has dimensions at least equal to (10,ISNS) where ISNS is the total number of solid bricks.

5) The variable MI has dimensions at least equal to (6,ISNI) where ISNI is the total number of quadrilateral interface surfaces.

Appendix B. EXAMPLE ANALYSIS OF A TYPICAL BEAM RIDER MOTOR CONFIGURATION

The beam rider motor configuration shown in Figure B has an annular cavity containing a solid propellant core, with solid propellant also at the head end. Because the cavity-propellant geometry undergoes abrupt changes from end to end, the finite element input data to FLAP3 were generated using both FLESH3 and FLSH3P. Because FLESH3 does not automatically generate cavity-propellant interface surfaces which are perpendicular to the longitudinal axis, these surfaces and those interface surfaces having negative outward normals were manually added to those interface surfaces which were automatically generated. It was also necessary to change the designation of some of the nodal points and bricks generated by FLSH3P, for this configuration for the preceding reasons. The changes are systematic and easily made and are noted in the Input to FLAP3.

Because the cavity is annular (no radial slots), the angle subtended by the smallest repeating segment was arbitrarily taken as 9°. The fact that only the zero harmonic exists for the case of an annular cavity was recognized, as reflected in the input data. The pages following Figure B contain reduced computer output for the beam rider analysis.

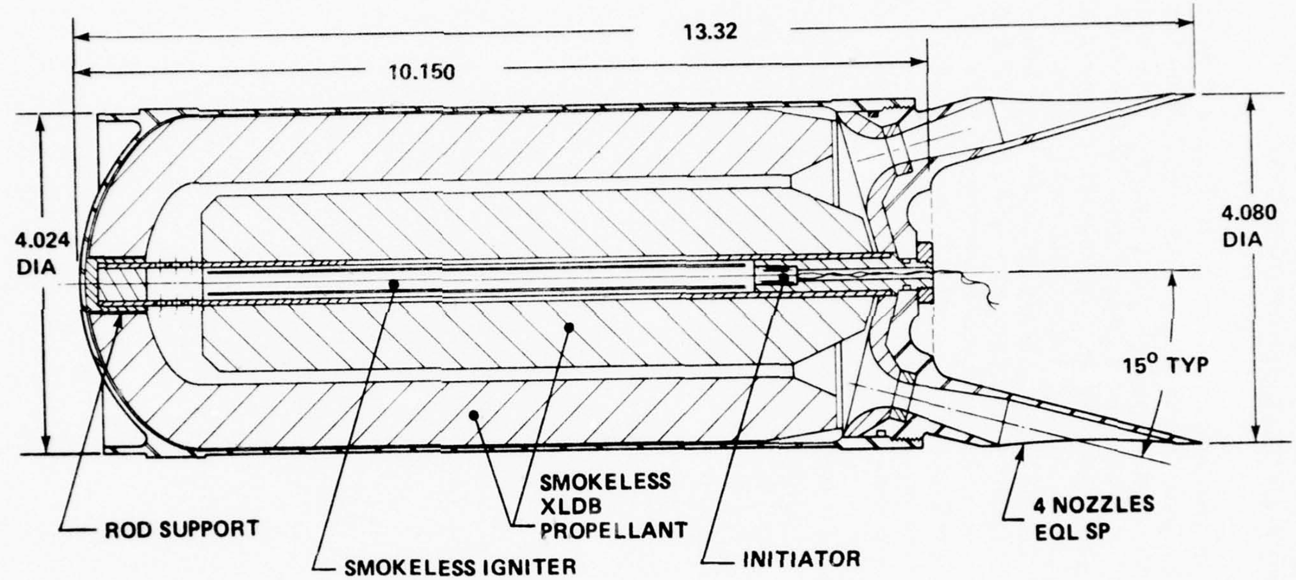


Figure B. Typical beam rider motor configuration.

Input to FLESH3

```
   FLESH3    -    BEAM RIDER (I)
 8    2.   6    5          1.0    4
      0.         0.    0    0           0.         0.         0.         0.
      2.         0.    1    0           0.         0.         0.         0.
      0.         0.    0    0           0.         0.         0.         0.
1.97538     .31287     2    0           0.         0.         0.         0.
      0.         0.    3    9          .25        .25         0.         9.
      0.         0.    4    9         1.03       1.33         0.         9.
      0.         0.    5    9         1.18       1.18         0.         9.
      0.         0.    6    9         1.96       1.35         0.         9.
 3    1    1    3    1
 3    1    2    3    2
 3    4    1    4    2
 2    5    1    5    2
 3    5    1    3    1
 3    5    2    3    2
 1    1    1    4    2    1    4    2    3    3    0    0    0
 2    4    1    5    2    1    5    2    4    2    0    0    0
 3    5    1    8    2    1    6    2    5    3    0    0    0
-1    0    0    0  0 0    0    0    0    0    0    0    0    0
    0.
 1    1    1    4    2    1    4    2    3    3    0    0    0
 2    4    1    5    2    1    5    2    4    2    0    0    0
 3    5    1    8    2    1    6    2    5    3    0    0    0
-1    0    0    0  0 0    0    0    0    0    0    0    0    0
  2.33
 1    1    1    4    2    1    4    2    3    3    0    0    0
 2    4    1    5    2    1    5    2    4    2    0    0    0
 3    5    1    8    2    1    6    2    5    3    0    0    0
-1    0    0    0  0 0    0    0    0    0    0    0    0    0
   4.57
 1    1    1    4    2    1    4    2    3    3    0    0    0
 2    4    1    5    2    1    5    2    4    2    0    0    0
 3    5    1    8    2    1    6    2    5    3    0    0    0
-1    0    0    0  0 0    0    0    0    0    0    0    0    0
   7.00
   FLESH3    -    BEAM RIDER (II)
 8    2    6    6          1.0    2
      0.         0.    0    0           0.         0.         0.         0.
      2.         0.    1    0           0.         0.         0.         0.
      0.         0.    0    0           0.         0.         0.         0.
1.97538     .31287     2    0           0.         0.         0.         0.
      0.         0.    3    9          .25        .25         0.         9.
      0.         0.    4    9         1.03       1.03         0.         9.
      0.         0.    5    9         1.18       1.18         0.         9.
      0.         0.    6    9         1.96       1.35         0.         9.
 1    1    1    3    1
 1    1    2    3    2
 1    4    1    4    2
 2    5    1    5    2
 3    6    1    3    1
 3    6    2    3    2
 1    1    1    4    2    1    4    2    3    1    0    0    0
 2    4    1    5    2    1    5    2    4    2    0    0    0
 3    5    1    3    2    1    6    2    5    3    0    0    0
-1    0    0    0  0 0    0    0    0    0    0    0    0    0
   7.00
 1    1    1    4    2    1    4    2    3    1    0    0    0
 2    4    1    5    2    1    5    2    4    2    0    0    0
 3    5    1    3    2    1    6    2    5    3    0    0    0
-1    0    0    0  0 0    0    0    0    0    0    0    0    0
   7.50
```

```
    FLESH3    -    BEAM RIDER (III)
 8     2     6     5           1.0     2
       0.             0.     0     0          0.          0.          0.          0.
       2.             0.     1     0          0.          0.          0.          0.
       0.             0.     0     4          0.          0.          0.          0.
 1.97538         .31287     2     0          0.          0.          0.          0.
       0.             0.     3     9         .25         .25          0.          9.
       0.             0.     4     9        1.03        1.03          0.          9.
       0.             0.     5     9        1.18        1.18          0.          9.
       0.             0.     6     9        1.96        1.35          0.          9.
 3     1     1     3     1
 3     1     2     3     2
 3     4     1     4     2
 3     5     1     5     2
 3     5     1     8     1
 3     5     2     8     2
 1     1     1     4     2     1     4     2     3     3     0     0     0
 2     4     1     5     2     1     5     2     4     3     0     0     0
 3     5     1     3     2     1     6     2     5     3     0     0     0
-1     0     0     0  0  0     0     0     0     0     0     0     0     0
    7.50
 1     1     1     4     2     1     4     2     3     3     0     0     0
 2     4     1     5     2     1     5     2     4     3     0     0     0
 3     5     1     8     2     1     6     2     5     3     0     0     0
-1     0     0     0  0  0     0     0     0     0     0     0     0     0
    8.20
END
```

Output from FLESH3

****

CARD I. TITLE.

FLESH3 - BEAM RIDER (I)

CARD II. CONTROL.

IMAX	JMAX	NNC	IBC	SCALE	NLAY
8	2	6	6	1.	4

CARD III. PART BOUNDARY CURVE.

X - COORD	Y - COORD	NN	NP	A X-AXIS	B Y-AXIS	THETAI	THETAF
0.000	0.000	8	6	0.00000	0.00000	0.00000	0.00000
2.000	0.000	1	0	0.00000	0.00000	0.00000	0.00000
0.000	0.000	0	0	0.00000	0.00000	0.00000	0.00000
1.975	.313	2	0	0.00000	0.00000	0.00000	0.00000
0.000	0.000	3	9	.25000	.25000	0.00000	9.00000
0.000	0.000	4	9	1.03000	1.03000	0.00000	9.00000
0.000	0.000	5	9	1.18000	1.18000	0.00000	9.00000
0.000	0.000	6	9	1.96000	1.35000	0.00000	9.00000

CARD IV. NODE CODE SEQUENCE.

IC	I1	J1	I2	J2
3	1	1	3	1
3	1	2	3	2
3	4	1	4	2
2	5	1	5	2
3	5	1	8	1
3	5	2	8	2

CARD V. PART DEFINITION.

NP	I1	J1	I2	J2	L1	L2	L3	L4	MT	NN	I3	J3	IR
1	1	1	4	2	1	4	2	3	3	0	0	0	-1
2	4	1	5	2	1	5	2	4	2	0	0	0	-1
3	5	1	8	2	1	6	2	5	3	0	0	0	-1
-1	0	0	0	0	0	0	0	0	0	0	0	0	-0

CARD VI. SECTION LOCATION.

Z - COORD

0.000

N	X	Y	Z	MT
1	.25000	0.00000	0.00000	3
2	.51000	0.00000	0.00000	3
3	.77000	0.00000	0.00000	3
4	1.03000	0.00000	0.00000	3
5	1.18000	0.00000	0.00000	2
6	1.44000	0.00000	0.00000	3
7	1.70000	0.00000	0.00000	3
8	1.96000	0.00000	0.00000	3
9	.24692	.03911	0.00000	3
10	.50372	.07978	0.00000	3
11	.76052	.12045	0.00000	3
12	1.01732	.16113	0.00000	3
13	1.16547	.18459	0.00000	2
14	1.42227	.22527	0.00000	3
15	1.57907	.26594	0.00000	3
16	1.93587	.30661	0.00000	3

CARD V. PART DEFINITION.

NP	I1	J1	I2	J2	L1	L2	L3	L4	MT	NN	I3	J3	IR
1	1	1	4	2	1	4	2	3	3	0	0	0	-0
2	4	1	5	2	1	5	2	4	2	0	0	0	-0
3	5	1	8	2	1	6	2	5	3	0	0	0	-0
-1	0	0	0	0	0	0	0	0	0	0	0	0	-0

CARD VI. SECTION LOCATION.

Z - COORD

2.330

N	X	Y	Z	MT
17	.25000	0.00000	2.33000	3
18	.51000	0.00000	2.33000	3
19	.77000	0.00000	2.33000	3
20	1.03000	0.00000	2.33000	3
21	1.18000	0.00000	2.33000	2
22	1.44000	0.00000	2.33000	3
23	1.70000	0.00000	2.33000	3
24	1.96000	0.00000	2.33000	3
25	.24692	.03911	2.33000	3
26	.50372	.07978	2.33000	3
27	.76052	.12045	2.33000	3
28	1.01732	.16113	2.33000	3
29	1.16547	.18459	2.33000	2
30	1.42227	.22527	2.33000	3
31	1.67907	.26594	2.33000	3
32	1.93587	.30661	2.33000	3

CARD V.   PART DEFINITION.

NP	I1	J1	I2	J2	L1	L2	L3	L4	MT	NN	I3	J3	I?
1	1	1	4	2	1	4	2	3	3	0	0	0	-[illegible]
2	4	1	5	2	1	5	2	4	2	0	0	0	-[illegible]
3	5	1	8	2	1	5	2	5	3	0	0	[illegible]	-[illegible]
-1	0	0	0	0	0	0	0	0	0	0	0	0	-[illegible]

CARD VI.   SECTION LOCATION.

Z - COORD

4.670

N	X	Y	Z	MT
33	.25000	0.00000	4.67000	3
34	.51000	0.00000	4.67000	3
35	.77000	0.00000	4.67000	3
36	1.03000	0.00000	4.67000	3
37	1.18000	0.00000	4.67000	2
38	1.44000	0.00000	4.67000	3
39	1.70000	0.00000	4.67000	3
40	1.96000	0.00000	4.67000	3
41	.24692	.03911	4.67000	3
42	.50372	.07978	4.67000	3
43	.76052	.12045	4.67000	3
44	1.01732	.16113	4.67000	3
45	1.16547	.18459	4.67000	2
46	1.42227	.22527	4.67000	3
47	1.67907	.26594	4.67000	3
48	1.93587	.30661	4.67000	3

CARD V. PART DEFINITION.

NP	I1	J1	I2	J2	L1	L2	L3	L4	MT	NN	I3	J3	IR
1	1	1	4	2	1	4	2	3	3	0	0	0	-0
2	4	1	5	2	1	5	2	4	2	0	0	0	-0
3	5	1	8	2	1	5	2	5	3	0	0	0	-0
-1	0	0	0	0	0	0	0	0	0	0	0	0	-0

CARD VI. SECTION LOCATION.

Z - COORD

7.000

N	X	Y	Z	MT
49	.25000	0.00000	7.00000	3
50	.51000	0.00000	7.00000	3
51	.77000	0.00000	7.00000	3
52	1.03000	0.00000	7.00000	3
53	1.18000	0.00000	7.00000	2
54	1.44000	0.00000	7.00000	3
55	1.70000	0.00000	7.00000	3
56	1.96000	0.00000	7.00000	3
57	.24692	.03911	7.00000	3
58	.50372	.07978	7.00000	3
59	.76052	.12045	7.00000	3
60	1.01732	.16113	7.00000	3
61	1.16547	.18459	7.00000	2
62	1.42227	.22527	7.00000	3
63	1.67907	.26594	7.00000	3
64	1.93587	.30661	7.00000	3

1	4	5	13	12	20	21	29	28	2
2	20	21	29	28	36	37	45	44	2
3	36	37	45	44	52	53	61	60	2
4	1	2	10	9	17	18	26	25	3
5	2	3	11	10	18	19	27	26	3
6	3	4	12	11	19	20	28	27	3
7	5	6	14	13	21	22	30	29	3
8	6	7	15	14	22	23	31	30	3
9	7	8	16	15	23	24	32	31	3
10	17	18	26	25	33	34	42	41	3
11	18	19	27	26	34	35	43	42	3
12	19	20	28	27	35	36	44	43	3
13	21	22	30	29	37	38	46	45	3
14	22	23	31	30	38	39	47	46	3
15	23	24	32	31	39	40	48	47	3
16	33	34	42	41	49	50	58	57	3
17	34	35	43	42	50	51	59	58	3
18	35	36	44	43	51	52	60	59	3
19	37	38	46	45	53	54	62	61	3
20	38	39	47	46	54	55	63	62	3
21	39	40	48	47	55	56	64	63	3

1	5	13	29	21	1
2	21	29	45	37	1
3	37	45	61	53	1

CARD I. TITLE.

FLESH3 - BEAM RIDER (II)

CARD II. CONTROL.

IMAX	JMAX	NNC	IBC	SCALE	NLAY
8	2	6	6	1.	2

CARD III. PART BOUNDARY CURVE.

X - COORD	Y - COORD	NN	NP	A X-AXIS	B Y-AXIS	THETAI	THETAF
0.010	0.000	0	0	0.00000	0.00000	0.00000	0.00000
2.000	0.000	1	0	0.00000	0.00000	0.00000	0.00000
0.010	0.000	0	0	0.00000	0.00000	0.00000	0.00000
1.975	.313	2	0	0.00000	0.00000	0.00000	0.00000
0.010	0.000	3	9	.25000	.25000	0.00000	9.00000
0.010	0.000	4	9	1.03000	1.03000	0.00000	9.00000
0.010	0.000	5	9	1.18000	1.18000	0.00000	9.00000
0.010	0.000	6	9	1.95000	1.95000	0.00000	9.00000

CARD IV. NODE CODE SEQUENCE.

IC	I1	J1	I2	J2
1	1	1	3	1
1	1	2	3	2
1	4	1	4	2
2	5	1	5	2
3	6	1	8	1
3	6	2	8	2

CARD V. PART DEFINITION.

NP	I1	J1	I2	J2	L1	L2	L3	L4	MT	NN	I3	J3	IR
1	1	1	4	2	1	4	2	3	1	0	0	0	-0
2	4	1	5	2	1	5	2	4	2	0	0	0	-0
3	5	1	8	2	1	6	2	5	3	0	0	0	-0
-1	0	0	0	0	0	0	0	0	0	0	0	0	-0

CARD VI. SECTION LOCATION.

Z - COORD

7.000

N	X	Y	Z	MT
1	.25000	0.00000	7.00000	1
2	.51000	0.00000	7.00000	1
3	.77000	0.00000	7.00000	1
4	1.03000	0.00000	7.00000	1
5	1.18000	0.00000	7.00000	2
6	1.44000	0.00000	7.00000	3
7	1.70000	0.00000	7.00000	3
8	1.96000	0.00000	7.00000	3
9	.24692	.03911	7.00000	1
10	.50372	.07978	7.00000	1
11	.76052	.12045	7.00000	1
12	1.01732	.16113	7.00000	1
13	1.16547	.18459	7.00000	2
14	1.42227	.22527	7.00000	3
15	1.67907	.26594	7.00000	3
16	1.93587	.30661	7.00000	3

CARD V. PART DEFINITION.

NP	I1	J1	I2	J2	L1	L2	L3	L4	MT	NN	I3	J3	I4
1	1	1	4	2	1	4	2	3	1	0	0	0	-0
2	4	1	5	2	1	5	2	4	2	0	0	0	-0
3	5	1	8	2	1	6	2	5	3	0	0	0	-0
-1	0	0	0	0	0	0	0	0	0	0	0	0	-0

CARD VI. SECTION LOCATION.

Z - COORD

7.500

N	X	Y	Z	MT
17	.25000	0.00000	7.50000	1
18	.51000	0.00000	7.50000	1
19	.77000	0.00000	7.50000	1
20	1.03000	0.00000	7.50000	1
21	1.18000	0.00000	7.50000	2
22	1.44000	0.00000	7.50000	3
23	1.70000	0.00000	7.50000	3
24	1.96000	0.00000	7.50000	3
25	.24692	.03911	7.50000	1
26	.50372	.07978	7.50000	1
27	.76052	.12045	7.50000	1
28	1.01732	.16113	7.50000	1
29	1.16547	.18459	7.50000	2
30	1.42227	.22527	7.50000	3
31	1.67907	.26594	7.50000	3
32	1.93587	.30661	7.50000	3

1	1	2	10	9	17	18	26	25	1
2	2	3	11	10	18	19	27	26	1
3	3	4	12	11	19	20	28	27	1
4	4	5	13	12	20	21	29	28	2
5	5	6	14	13	21	22	30	29	3
6	6	7	15	14	22	23	31	30	3
7	7	8	16	15	23	24	32	31	3
1	5	13	29	21	1				

CARD I. TITLE.

FLESH3 - BEAM RIDER (III)

CARD II. CONTROL.

IMAX	JMAX	NNC	IBC	SCALE	NLAY
8	2	5	6	1.	2

CARD III. PART BOUNDARY CURVE.

X - COORD	Y - COORD	NN	NP	A X-AXIS	B Y-AXIS	THETAI	THETAF
0.000	0.000	0	0	0.00000	0.00000	0.00000	0.00000
2.000	0.000	1	0	0.00000	0.00000	0.00000	0.00000
0.000	0.000	0	0	0.00000	0.00000	0.00000	0.00000
1.975	.313	2	0	0.00000	0.00000	0.00000	0.00000
0.000	0.000	3	9	.25000	.25000	0.00000	9.00000
0.000	0.000	4	9	1.03000	1.03000	0.00000	9.00000
0.000	0.000	5	9	1.18000	1.18000	0.00000	9.00000
0.000	0.000	6	9	1.96000	1.95000	0.00000	9.00000

CARD IV. NODE CODE SEQUENCE.

IC	I1	J1	I2	J2
3	1	1	3	1
3	1	2	3	2
3	4	1	4	2
3	5	1	5	2
3	6	1	8	1
3	6	2	8	2

CARD V. PART DEFINITION.

NP	I1	J1	I2	J2	L1	L2	L3	L4	MT	NN	I3	J3	IR
1	1	1	4	2	1	4	2	3	3	0	0	0	-1
2	4	1	5	2	1	5	2	4	3	0	0	0	-1
3	5	1	8	2	1	5	2	5	3	0	0	0	-1
-1	0	0	0	0	0	0	0	0	0	0	0	0	-1

CARD VI. SECTION LOCATION.

Z - COORD

7.500

N	X	Y	Z	MT
1	.25000	0.00000	7.50000	3
2	.51000	0.00000	7.50000	3
3	.77000	0.00000	7.50000	3
4	1.03000	0.00000	7.50000	3
5	1.18000	0.00000	7.50000	3
6	1.44000	0.00000	7.50000	3
7	1.70000	0.00000	7.50000	3
8	1.96000	0.00000	7.50000	3
9	.24692	.03911	7.50000	3
10	.50372	.07978	7.50000	3
11	.76052	.12045	7.50000	3
12	1.01732	.16113	7.50000	3
13	1.16547	.18459	7.50000	3
14	1.42227	.22527	7.50000	3
15	1.67907	.26594	7.50000	3
16	1.93587	.30661	7.50000	3

CARD V. PART DEFINITION.

NP	I1	J1	I2	J2	L1	L2	L3	L4	MT	NN	I3	J3	I[illegible]
1	1	1	4	2	1	4	2	3	3	0	0	0	-0
2	4	1	5	2	1	5	2	4	3	0	0	0	-0
3	5	1	8	2	1	5	2	5	3	0	0	0	-0
-1	0	0	0	0	0	0	0	0	0	0	0	0	-0

CARD VI. SECTION LOCATION.

Z - COORD

8.200

N	X	Y	Z	MT
17	.25000	0.00000	8.20000	3
18	.51000	0.00000	8.20000	3
19	.77000	0.00000	8.20000	3
20	1.03000	0.00000	8.20000	3
21	1.18000	0.00000	8.20000	3
22	1.44000	0.00000	8.20000	3
23	1.70000	0.00000	8.20000	3
24	1.96000	0.00000	8.20000	3
25	.24692	.03911	8.20000	3
26	.50372	.07978	8.20000	3
27	.76052	.12045	8.20000	3
28	1.01732	.16113	8.20000	3
29	1.16547	.18459	8.20000	3
30	1.42227	.22527	8.20000	3
31	1.67907	.26594	8.20000	3
32	1.93587	.30661	8.20000	3

1	1	2	10	9	17	18	26	25	3
2	2	3	11	10	18	19	27	26	3
3	3	4	12	11	19	20	28	27	3
4	4	5	13	12	20	21	29	28	3
5	5	6	14	13	21	22	30	29	3
6	6	7	15	14	22	23	31	30	3
7	7	8	16	15	23	24	32	31	3

3	8	2			
64	3	18	3	0	
1	.25000	0.00000	0.00000	3	
2	.51000	0.00000	0.00000	3	
3	.77000	0.00000	0.00000	3	
4	1.03000	0.00000	0.00000	3	
5	1.18000	0.00000	0.00000	2	
6	1.44000	0.00000	0.00000	3	
7	1.70000	0.00000	0.00000	3	
8	1.96000	0.00000	0.00000	3	
9	.24692	.03911	0.00000	3	
10	.50372	.07978	0.00000	3	
11	.76052	.12045	0.00000	3	
12	1.01732	.16113	0.00000	3	
13	1.16547	.18459	0.00000	2	
14	1.42227	.22527	0.00000	3	
15	1.67907	.26594	0.00000	3	
16	1.93587	.30661	0.00000	3	
17	.25000	0.00000	2.33000	3	
18	.51000	0.00000	2.33000	3	
19	.77000	0.00000	2.33000	3	
20	1.03000	0.00000	2.33000	3	
21	1.18000	0.00000	2.33000	2	
22	1.44000	0.00000	2.33000	3	
23	1.70000	0.00000	2.33000	3	
24	1.96000	0.00000	2.33000	3	
25	.24692	.03911	2.33000	3	
26	.50372	.07978	2.33000	3	
27	.76052	.12045	2.33000	3	
28	1.01732	.16113	2.33000	3	
29	1.16547	.18459	2.33000	2	
30	1.42227	.22527	2.33000	3	
31	1.67907	.26594	2.33000	3	
32	1.93587	.30661	2.33000	3	
33	.25000	0.00000	4.67000	3	
34	.51000	0.00000	4.67000	3	
35	.77000	0.00000	4.67000	3	
36	1.03000	0.00000	4.67000	3	
37	1.18000	0.00000	4.67000	2	
38	1.44000	0.00000	4.67000	3	
39	1.70000	0.00000	4.67000	3	
40	1.96000	0.00000	4.67000	3	
41	.24692	.03911	4.67000	3	
42	.50372	.07978	4.67000	3	
43	.76052	.12045	4.67000	3	
44	1.01732	.16113	4.67000	3	
45	1.16547	.18459	4.67000	2	
46	1.42227	.22527	4.67000	3	
47	1.67907	.26594	4.67000	3	
48	1.93587	.30661	4.67000	3	
49	.25000	0.00000	7.00000	3	
50	.51000	0.00000	7.00000	3	
51	.77000	0.00000	7.00000	3	
52	1.03000	0.00000	7.00000	3	
53	1.18000	0.00000	7.00000	2	
54	1.44000	0.00000	7.00000	3	
55	1.70000	0.00000	7.00000	3	
56	1.96000	0.00000	7.00000	3	
57	.24692	.03911	7.00000	3	
58	.50372	.07978	7.00000	3	
59	.76052	.12045	7.00000	3	
60	1.01732	.16113	7.00000	3	

61	1.16547	.18459	7.00000	2					
62	1.42227	.22527	7.00000	3					
63	1.67907	.26594	7.00000	3					
64	1.93587	.30661	7.00000	3					
1	4	5	13	12	20	21	29	28	2
2	20	21	29	28	36	37	45	44	2
3	36	37	45	44	52	53	61	60	2
4	1	2	10	9	17	18	26	25	3
5	2	3	11	10	18	19	27	26	3
6	3	4	12	11	19	20	28	27	3
7	5	6	14	13	21	22	30	29	3
8	6	7	15	14	22	23	31	30	3
9	7	8	16	15	23	24	32	31	3
10	17	18	26	25	33	34	42	41	3
11	18	19	27	26	34	35	43	42	3
12	19	20	28	27	35	36	44	43	3
13	21	22	30	29	37	38	46	45	3
14	22	23	31	30	38	39	47	46	3
15	23	24	32	31	39	40	48	47	3
16	33	34	42	41	49	50	58	57	3
17	34	35	43	42	50	51	59	58	3
18	35	36	44	43	51	52	60	59	3
19	37	38	46	45	53	54	62	61	3
20	38	39	47	46	54	55	63	62	3
21	39	40	48	47	55	56	64	63	3
1	5	13	29	21	1				
2	21	29	45	37	1				
3	37	45	61	53	1				
32	4	3	1	4					
1	.25000	0.00000	7.00000	1					
2	.51000	0.00000	7.00000	1					
3	.77000	0.00000	7.00000	1					
4	1.03000	0.00000	7.00000	1					
5	1.18000	0.00000	7.00000	2					
6	1.44000	0.00000	7.00000	3					
7	1.70000	0.00000	7.00000	3					
8	1.96000	0.00000	7.00000	3					
9	.24692	.03911	7.00000	1					
10	.50372	.07978	7.00000	1					
11	.76052	.12045	7.00000	1					
12	1.01732	.16113	7.00000	1					
13	1.16547	.18459	7.00000	2					
14	1.42227	.22527	7.00000	3					
15	1.67907	.26594	7.00000	3					
16	1.93587	.30661	7.00000	3					
17	.25000	0.00000	7.50000	1					
18	.51000	0.00000	7.50000	1					
19	.77000	0.00000	7.50000	1					
20	1.03000	0.00000	7.50000	1					
21	1.18000	0.00000	7.50000	2					
22	1.44000	0.00000	7.50000	3					
23	1.70000	0.00000	7.50000	3					
24	1.96000	0.00000	7.50000	3					
25	.24692	.03911	7.50000	1					
26	.50372	.07978	7.50000	1					
27	.76052	.12045	7.50000	1					
28	1.01732	.16113	7.50000	1					
29	1.16547	.18459	7.50000	2					
30	1.42227	.22527	7.50000	3					
31	1.67907	.26594	7.50000	3					
32	1.93587	.30661	7.50000	3					

```
 1     1     2    10     9    17    18    26    25     1
 2     2     3    11    10    18    19    27    26     1
 3     3     4    12    11    19    20    28    27     1
 4     4     5    13    12    20    21    29    28     2
 5     5     6    14    13    21    22    30    29     3
 6     6     7    15    14    22    23    31    30     3
 7     7     8    16    15    23    24    32    31     3
 1     5    13    29    31     1
32     0     7     0     2
 1     .25000     0.00000     7.50000     3
 2     .51000     0.00000     7.50000     3
 3     .77000     0.00000     7.50000     3
 4    1.03000     0.00000     7.50000     3
 5    1.18000     0.00000     7.50000     3
 6    1.44000     0.00000     7.50000     3
 7    1.70000     0.00000     7.50000     3
 8    1.96000     0.00000     7.50000     3
 9     .24692      .03911     7.50000     3
10     .50372      .07978     7.50000     3
11     .76052      .12045     7.50000     3
12    1.01732      .16113     7.50000     3
13    1.16547      .18459     7.50000     3
14    1.42227      .22527     7.50000     3
15    1.67907      .26594     7.50000     3
16    1.93587      .30661     7.50000     3
17     .25000     0.00000     8.20000     3
18     .51000     0.00000     8.20000     3
19     .77000     0.00000     8.20000     3
20    1.03000     0.00000     8.20000     3
21    1.18000     0.00000     8.20000     3
22    1.44000     0.00000     8.20000     3
23    1.70000     0.00000     8.20000     3
24    1.96000     0.00000     8.20000     3
25     .24692      .03911     8.20000     3
26     .50372      .07978     8.20000     3
27     .76052      .12045     8.20000     3
28    1.01732      .16113     8.20000     3
29    1.16547      .18459     8.20000     3
30    1.42227      .22527     8.20000     3
31    1.67907      .26594     8.20000     3
32    1.93587      .30661     8.20000     3
 1     1     2    10     9    17    18    26    25     3
 2     2     3    11    10    18    19    27    26     3
 3     3     4    12    11    19    20    28    27     3
 4     4     5    13    12    20    21    29    28     3
 5     5     6    14    13    21    22    30    29     3
 6     6     7    15    14    22    23    31    30     3
 7     7     8    16    15    23    24    32    31     3
 0
```

Output from FLSH3P

1	.25000	0.00000	0.00000	3
2	.51000	0.00000	0.00000	3
3	.77000	0.00000	0.00000	3
4	1.03000	0.00000	0.00000	3
5	1.18000	0.00000	0.00000	2
6	1.44000	0.00000	0.00000	3
7	1.70000	0.00000	0.00000	3
8	1.96000	0.00000	0.00000	3
9	.24692	.03911	0.00000	3
10	.50372	.07978	0.00000	3
11	.76052	.12045	0.00000	3
12	1.01732	.16113	0.00000	3
13	1.16547	.18459	0.00000	2
14	1.42227	.22527	0.00000	3
15	1.67907	.26594	0.00000	3
16	1.93587	.30661	0.00000	3
17	.25000	0.00000	2.33000	3
18	.51000	0.00000	2.33000	3
19	.77000	0.00000	2.33000	3
20	1.03000	0.00000	2.33000	3
21	1.18000	0.00000	2.33000	2
22	1.44000	0.00000	2.33000	3
23	1.70000	0.00000	2.33000	3
24	1.96000	0.00000	2.33000	3
25	.24692	.03911	2.33000	3
26	.50372	.07978	2.33000	3
27	.76052	.12045	2.33000	3
28	1.01732	.16113	2.33000	3
29	1.16547	.18459	2.33000	2
30	1.42227	.22527	2.33000	3
31	1.67907	.26594	2.33000	3
32	1.93587	.30661	2.33000	3
33	.25000	0.00000	4.67000	3
34	.51000	0.00000	4.67000	3
35	.77000	0.00000	4.67000	3
36	1.03000	0.00000	4.67000	3
37	1.18000	0.00000	4.67000	2
38	1.44000	0.00000	4.67000	3
39	1.70000	0.00000	4.67000	3
40	1.96000	0.00000	4.67000	3
41	.24692	.03911	4.67000	3
42	.50372	.07978	4.67000	3
43	.76052	.12045	4.67000	3
44	1.01732	.16113	4.67000	3
45	1.16547	.18459	4.67000	2
46	1.42227	.22527	4.67000	3
47	1.67907	.26594	4.67000	3
48	1.93587	.30661	4.67000	3
49	.25000	0.00000	7.00000	1
50	.51000	0.00000	7.00000	1
51	.77000	0.00000	7.00000	1
52	1.03000	0.00000	7.00000	1
53	1.18000	0.00000	7.00000	2
54	1.44000	0.00000	7.00000	3
55	1.70000	0.00000	7.00000	3
56	1.96000	0.00000	7.00000	3
57	.24692	.03911	7.00000	1
58	.50372	.07978	7.00000	1
59	.76052	.12045	7.00000	1
60	1.01732	.16113	7.00000	1

61	1.16547	.18459	7.00000	2
62	1.42227	.22527	7.00000	3
63	1.67907	.26594	7.00000	3
64	1.93587	.30661	7.00000	3
65	.25000	0.00000	7.50000	3
66	.51000	0.00000	7.50000	3
67	.77000	0.00000	7.50000	3
68	1.03000	0.00000	7.50000	3
69	1.18000	0.00000	7.50000	2
70	1.44000	0.00000	7.50000	3
71	1.70000	0.00000	7.50000	3
72	1.96000	0.00000	7.50000	3
73	.24692	.03911	7.50000	3
74	.50372	.07978	7.50000	3
75	.76052	.12045	7.50000	3
76	1.01732	.16113	7.50000	3
77	1.16547	.18459	7.50000	2
78	1.42227	.22527	7.50000	3
79	1.67907	.26594	7.50000	3
80	1.93587	.30661	7.50000	3
81	.25000	0.00000	8.20000	3
82	.51000	0.00000	8.20000	3
83	.77000	0.00000	8.20000	3
84	1.03000	0.00000	8.20000	3
85	1.18000	0.00000	8.20000	3
86	1.44000	0.00000	8.20000	3
87	1.70000	0.00000	8.20000	3
88	1.96000	0.00000	8.20000	3
89	.24692	.03911	8.20000	3
90	.50372	.07978	8.20000	3
91	.76052	.12045	8.20000	3
92	1.01732	.16113	8.20000	3
93	1.16547	.18459	8.20000	3
94	1.42227	.22527	8.20000	3
95	1.67907	.26594	8.20000	3
96	1.93587	.30661	8.20000	3

1	4	5	13	12	20	21	29	28	2
2	20	21	29	28	36	37	45	44	2
3	36	37	45	44	52	53	61	60	2
4	49	50	58	57	65	66	74	73	1
5	50	51	59	58	66	67	75	74	1
6	51	52	60	59	67	68	76	75	1
7	52	53	61	60	68	69	77	76	2
8	1	2	10	9	17	18	26	25	3
9	2	3	11	10	18	19	27	26	3
10	3	4	12	11	19	20	28	27	3
11	5	6	14	13	21	22	30	29	3
12	6	7	15	14	22	23	31	30	3
13	7	8	16	15	23	24	32	31	3
14	17	18	26	25	33	34	42	41	3
15	18	19	27	26	34	35	43	42	3
16	19	20	28	27	35	36	44	43	3
17	21	22	30	29	37	38	46	45	3
18	22	23	31	30	38	39	47	46	3
19	23	24	32	31	39	40	48	47	3
20	33	34	42	41	49	50	58	57	3
21	34	35	43	42	50	51	59	58	3
22	35	36	44	43	51	52	60	59	3
23	37	38	46	45	53	54	62	61	3
24	38	39	47	46	54	55	63	62	3
25	39	40	48	47	55	56	64	63	3

26	53	54	62	61	69	70	78	77	3
27	54	55	63	62	70	71	79	78	3
28	55	56	64	63	71	72	80	79	3
29	65	66	74	73	81	82	90	89	3
30	66	67	75	74	82	83	91	90	3
31	67	68	76	75	83	84	92	91	3
32	68	69	77	76	84	85	93	92	3
33	69	70	78	77	85	86	94	93	3
34	70	71	79	78	86	87	95	94	3
35	71	72	80	79	87	88	96	95	3
1	5	13	29	21	1				
2	21	29	45	37	1				
3	37	45	61	53	1				
4	53	61	77	69	1				

Input to FLAP3

```
        FLAP3    -     BEAM RIDER
  96    14      0      9.
   7    20.59    .000000115
   0    .0001656     0.50    1180.0        625.0
   1    0       3
   0    0       0
   0    0       0
      10.0           0.0
1.0          1.0          1.0          1.0
   1       .25000    0.00000    0.00000     3
   2       .51000    0.00000    0.00000     3
   3       .77000    0.00000    0.00000     3
   4      1.03000    0.00000    0.00000     2  <---- Manually changed to identify
   5      1.18000    0.00000    0.00000     2        as an interface nodal point
   6      1.44000    0.00000    0.00000     3
   7      1.70000    0.00000    0.00000     3
   8      1.96000    0.00000    0.00000     3
   9       .24692     .03911    0.00000     3
  10       .50372     .07978    0.00000     3
  11       .76052     .12045    0.00000     3
  12      1.01732     .16113    0.00000     2  <----
  13      1.16547     .18459    0.00000     2
  14      1.42227     .22527    0.00000     3
  15      1.67907     .26594    0.00000     3
  16      1.93587     .30661    0.00000     3
  17       .25000    0.00000    2.33000     3
  18       .51000    0.00000    2.33000     3
  19       .77000    0.00000    2.33000     3
  20      1.03000    0.00000    2.33000     2  <----
  21      1.18000    0.00000    2.33000     2
  22      1.44000    0.00000    2.33000     3
  23      1.70000    0.00000    2.33000     3
  24      1.96000    0.00000    2.33000     3
  25       .24692     .03911    2.33000     3
  26       .50372     .07978    2.33000     3
  27       .76052     .12045    2.33000     3
  28      1.01732     .16113    2.33000     2  <----
  29      1.16547     .18459    2.33000     2
  30      1.42227     .22527    2.33000     3
  31      1.67907     .26594    2.33000     3
  32      1.93587     .30661    2.33000     3
  33       .25000    0.00000    4.67000     3
  34       .51000    0.00000    4.67000     3
  35       .77000    0.00000    4.67000     3
  36      1.03000    0.00000    4.67000     2  <----
  37      1.18000    0.00000    4.67000     2
  38      1.44000    0.00000    4.67000     3
  39      1.70000    0.00000    4.67000     3
  40      1.96000    0.00000    4.67000     3
  41       .24692     .03911    4.67000     3
  42       .50372     .07978    4.67000     3
  43       .76052     .12045    4.67000     3
  44      1.01732     .16113    4.67000     2  <----
  45      1.16547     .18459    4.67000     2
  46      1.42227     .22527    4.67000     3
```

47	1.67907	.26594	4.67000	3	
48	1.93587	.30661	4.67000	3	
49	.25000	0.00000	7.00000	2	←
50	.51000	0.00000	7.00000	2	←
51	.77000	0.00000	7.00000	2	←
52	1.03000	0.00000	7.00000	2	←
53	1.18000	0.00000	7.00000	2	
54	1.44000	0.00000	7.00000	3	
55	1.70000	0.00000	7.00000	3	
56	1.96000	0.00000	7.00000	3	
57	.24692	.03911	7.00000	2	←
58	.50372	.07978	7.00000	2	←
59	.76052	.12045	7.00000	2	←
60	1.01732	.16113	7.00000	2	←
61	1.16547	.18459	7.00000	2	
62	1.42227	.22527	7.00000	3	
63	1.67907	.26594	7.00000	3	
64	1.93587	.30661	7.00000	3	
65	.25000	0.00000	7.50000	2	←
66	.51000	0.00000	7.50000	2	←
67	.77000	0.00000	7.50000	2	←
68	1.03000	0.00000	7.50000	2	←
69	1.18000	0.00000	7.50000	2	
70	1.44000	0.00000	7.50000	3	
71	1.70000	0.00000	7.50000	3	
72	1.96000	0.00000	7.50000	3	
73	.24692	.03911	7.50000	2	←
74	.50372	.07978	7.50000	2	←
75	.76052	.12045	7.50000	2	←
76	1.01732	.16113	7.50000	2	←
77	1.16547	.18459	7.50000	2	
78	1.42227	.22527	7.50000	3	
79	1.67907	.26594	7.50000	3	
80	1.93587	.30661	7.50000	3	
81	.25000	0.00000	8.20000	3	
82	.51000	0.00000	8.20000	3	
83	.77000	0.00000	8.20000	3	
84	1.03000	0.00000	8.20000	3	
85	1.18000	0.00000	8.20000	3	
86	1.44000	0.00000	8.20000	3	
87	1.70000	0.00000	8.20000	3	
88	1.96000	0.00000	8.20000	3	
89	.24692	.03911	8.20000	3	
90	.50372	.07978	8.20000	3	
91	.76052	.12045	8.20000	3	
92	1.01732	.16113	8.20000	3	
93	1.16547	.18459	8.20000	3	
94	1.42227	.22527	8.20000	3	
95	1.67907	.26594	8.20000	3	
96	1.93587	.30661	8.20000	3	

1	4	5	13	12	20	21	29	28	2	
2	20	21	29	28	36	37	45	44	2	
3	36	37	45	44	52	53	61	60	2	
4	49	50	58	57	65	66	74	73	2	← Manually changed
5	50	51	59	58	66	67	75	74	2	← to identify as an interface brick

6	51	52	60	59	67	68	76	75	2	←
7	52	53	61	60	68	69	77	76	2	
1	5	13	29	21	1					
2	21	29	45	37	1					
3	37	45	61	53	1					
4	53	61	77	69	1					
5	65	66	74	73	1					
6	66	67	75	74	1					
7	67	68	76	75	1					
8	68	69	77	76	1					
9	4	12	28	20	2					
10	20	28	44	36	2	Manually added to generated interface surfaces (rows 5–14)				
11	36	44	60	52	2					
12	49	50	58	57	2					
13	50	51	59	58	2					
14	51	52	60	59	2					

[redacted]

52

Output from FLAP3

```
CARD I.    TITLE.

                FLAP3   -   BEAM RIDER

CARD II.   SECTION GEOMETRY IDENTIFIERS.

           TOTAL NUMBER OF NODES ( NOD )                              =    96
           NUMBER OF INTERFACE SURFACES ( NIS)                        =    14
           NUMBER OF SLOTS ( NSLOT )                                  =     0
           ANGLE OF SMALLEST REPEATING SEGMENT ( ANGLE )              =   9.00

CARD III.  FLUID PROPERTIES.

           NUMBER OF FLUID BRICKS ( NFB )                             =     7
           BULK MODULUS ( BULK )                                      =    20.590
           FLUID MASS DENSITY ( FDEN )                                =  1.15000000E-07

CARD IV.   SOLID PROPERTIES.

           NUMBER OF SOLID BRICKS ( NSB )                             =     0
           SOLID MASS DENSITY ( SDEN )                                =  1.65600000E-04
           POISSON RATIO ( PRT )                                      =   .50
           STORAGE MODULUS ( GR)                                      =      1180.00
           LOSS MODULUS ( GI )                                        =       625.00

           HARMONICS    ( ZERO FOR UNREQUESTED HARMONIC )
                        (  ONE FOR   REQUESTED HARMONIC )

CARD V.    ZERO HARMONIC ( ZHAR)                                      =   1
           INITIAL ZERO HARMONIC MODE ( IZM )                         =   0
           LAST    ZERO HARMONIC MODE ( LZM )                         =   3

CARD VI.   M/2  HARMONIC ( MHAR)                                      =   0
           INITIAL M/2  HARMONIC MODE ( IMM )                         =   0
           LAST    M/2  HARMONIC MODE ( LMM )                         =   0

CARD VII.  K    HARMONIC ( KHAR)                                      =   0
           INITIAL K    HARMONIC MODE ( IKM )                         =   0
           LAST    K    HARMONIC MODE ( LKM )                         =   0
           NUMBER OF K   HARMONICS EXISTING ( NKM )                   =   0
```

CARD IX. COMBUSTION PARAMETERS.

SPEED OF GAS LEAVING THE BURNING SURFACE (GSPEED) = 10.00
MASS FRACTION OF PARTICULATE MATERIAL (CCM) = 0.00

CARD X. RESPONSE FACTORS.

PRESSURE COUPLING (RPC) = 1.000
VELOCITY COUPLING (RVC) = 1.000
FLOW TURNING (RFT) = 1.000
STRUCTURAL DAMPING (RSD) = 1.000

CARD XI. NODES AND THEIR COORDINATES.

NODAL POINT	X - COORDINATE	Y - COORDINATE	Z - COORDINATE	NODE DESCRIPTION
1	.25000	0.00000	0.00000	3
2	.51000	0.00000	0.00000	3
3	.77000	0.00000	0.00000	3
4	1.03000	0.00000	0.00000	2
5	1.18000	0.00000	0.00000	2
6	1.44000	0.00000	0.00000	3
7	1.70000	0.00000	0.00000	3
8	1.96000	0.00000	0.00000	3
9	.24692	.03911	0.00000	3
10	.50372	.07978	0.00000	3
11	.76052	.12045	0.00000	3
12	1.01732	.15113	0.00000	2
13	1.16547	.18459	0.00000	2
14	1.42227	.22527	0.00000	3
15	1.67907	.26594	0.00000	3
16	1.93587	.30661	0.00000	3
17	.25000	0.00000	2.33000	3
18	.51000	0.00000	2.33000	3
19	.77000	0.00000	2.33000	3
20	1.03000	0.00000	2.33000	2
21	1.18000	0.00000	2.33000	2
22	1.44000	0.00000	2.33000	3
23	1.70000	0.00000	2.33000	3
24	1.96000	0.00000	2.33000	3
25	.24692	.03911	2.33000	3
26	.50372	.07978	2.33000	3
27	.76052	.12045	2.33000	3
28	1.01732	.15113	2.33000	2
29	1.16547	.18459	2.33000	2
30	1.42227	.22527	2.33000	3

31	1.67907	.26594	2.33000	3
32	1.93587	.30661	2.33000	3
33	.25000	0.00000	4.67000	3
34	.51000	0.00000	4.67000	3
35	.77000	0.00000	4.67000	3
36	1.03000	0.00000	4.67000	2
37	1.18000	0.00000	4.67000	2
38	1.44000	0.00000	4.67000	3
39	1.70000	0.00000	4.67000	3
40	1.96000	0.00000	4.67000	3
41	.24692	.03911	4.67000	3
42	.50372	.07978	4.67000	3
43	.76052	.12045	4.67000	3
44	1.01732	.16113	4.67000	2
45	1.16547	.18459	4.67000	2
46	1.42227	.22527	4.67000	3
47	1.67907	.26594	4.67000	3
48	1.93587	.30661	4.67000	3
49	.25000	0.00000	7.00000	2
50	.51000	0.00000	7.00000	2
51	.77000	0.00000	7.00000	2
52	1.03000	0.00000	7.00000	2
53	1.18000	0.00000	7.00000	2
54	1.44000	0.00000	7.00000	3
55	1.70000	0.00000	7.00000	3
56	1.96000	0.00000	7.00000	3
57	.24692	.03911	7.00000	2
58	.50372	.07978	7.00000	2
59	.76052	.12045	7.00000	2
60	1.01732	.16113	7.00000	2
61	1.16547	.18459	7.00000	2
62	1.42227	.22527	7.00000	3
63	1.67907	.26594	7.00000	3
64	1.93587	.30661	7.00000	3
65	.25000	0.00000	7.50000	2
66	.51000	0.00000	7.50000	2
67	.77000	0.00000	7.50000	2
68	1.03000	0.00000	7.50000	2
69	1.18000	0.00000	7.50000	2
70	1.44000	0.00000	7.50000	3
71	1.70000	0.00000	7.50000	3
72	1.96000	0.00000	7.50000	3
73	.24692	.03911	7.50000	2
74	.50372	.07978	7.50000	2
75	.76052	.12045	7.50000	2
76	1.01732	.16113	7.50000	2
77	1.16547	.18459	7.50000	2
78	1.42227	.22527	7.50000	3
79	1.67907	.26594	7.50000	3

80	1.93587	.30661	7.50000	3
81	.25000	0.00000	8.20000	3
82	.51000	0.00000	8.20000	3
83	.77000	0.00000	8.20000	3
84	1.03000	0.00000	8.20000	3
85	1.18000	0.00000	8.20000	3
86	1.44000	0.00000	8.20000	3
87	1.70000	0.00000	8.20000	3
88	1.96000	0.00000	8.20000	3
89	.24692	.03911	8.20000	3
90	.50372	.07978	8.20000	3
91	.75652	.12045	8.20000	3
92	1.01732	.16113	8.20000	3
93	1.16547	.18459	8.20000	3
94	1.42227	.22527	8.20000	3
95	1.67907	.26594	8.20000	3
96	1.93587	.30661	8.20000	3

CARD XII. ELEMENT - NODE RELATIONSHIP.

BRICK	NODES								BRICK DESCRIPT
1	4	5	13	12	20	21	29	28	2
2	20	21	29	28	36	37	45	44	2
3	36	37	45	44	52	53	61	60	2
4	49	50	58	57	65	66	74	73	2
5	50	51	59	58	66	67	75	74	2
6	51	52	60	59	67	68	76	75	2
7	52	53	61	60	68	69	77	76	2

CARD XIII. QUADRILATERAL INTERFACE SURFACES AND THEIR NODES AND SURFACE DESCRIPTION.

1	5	13	29	21	1
2	21	29	45	37	1
3	37	45	61	53	1
4	53	61	77	69	1
5	65	66	74	73	1
6	66	67	75	74	1
7	67	68	76	75	1
8	68	69	77	76	1
9	4	12	28	20	2
10	20	28	44	36	2
11	36	44	60	52	2
12	49	50	58	57	2
13	50	51	59	58	2
14	51	52	60	59	2

POTENTIAL FLOW ANALYSIS

INTERFACE	TETRAHEDRA AND THEIR NODES I	J	L	M	NODES ON INTERFACE II	JJ	KK	SURFACE AREAS	VX	VELOCITIES VY	VZ
1	20	4	23	21	20	4	23	.1883	-8.[illegible]6	1.05[illegible]	-98.4[illegible]
2	29	21	23	13	29	21	13	.2157	-11.[illegible]8[illegible]	-1.973	-99.043
3	28	12	13	4	28	12	4	.1883	0.[illegible]	0.00[illegible]	-98.28[illegible]
4	5	13	4	21	5	13	21	.2157	0.00[illegible]	0.00[illegible]	-98.35[illegible]
5	36	20	44	37	36	20	44	.1891	-8.81[illegible]	[illegible]344	-77.482
6	45	37	44	29	45	37	29	.2165	-11.[illegible]93	-1.359	-77.495
7	44	28	29	20	44	28	20	.1891	-12.[illegible]2[illegible]	.747	-77.53[illegible]
8	21	29	20	37	21	29	37	.2166	-8.[illegible]8[illegible]	-1.737	-77.497
9	52	36	60	53	52	36	60	.1883	-7.921	-2.204	-56.24[illegible]
10	61	53	60	45	61	53	45	.2157	-9.[illegible]	-3.946	-56.35[illegible]
11	60	44	45	36	60	44	36	.1883	-11.42[illegible]	.135	-56.42[illegible]
12	37	45	36	53	37	45	53	.2157	-8.812	-1.779	-56.18[illegible]
13	65	49	73	65	65	73	66	.0051	.0[illegible]	.804	-12.29[illegible]
14	74	66	73	58	74	66	73	.0104	-.[illegible]73	-.051	-12.315
15	73	57	58	49	57	58	49	.0051	-.17[illegible]	.737	-12.29[illegible]
16	50	58	49	65	50	58	49	.0104	.[illegible]8[illegible]	-.047	-12.315
17	65	50	74	57	66	74	67	.0104	-.73[illegible]	-.113	-12.315
18	75	67	74	59	75	67	74	.0157	-1.[illegible]1[illegible]	-1.04[illegible]	-13.304
19	74	58	59	50	58	59	50	.0104	[illegible]752	[illegible]036	-12.315
20	51	59	50	67	51	59	50	.0157	1.14[illegible]	-.814	-13.294
21	67	51	75	58	67	75	68	.0157	-2.[illegible]8[illegible]	-1.159	-13.294
22	76	68	75	50	76	68	75	.0209	-3.[illegible]2	-3.172	-16.832
23	75	59	60	51	59	60	51	.0157	2.982	-.659	-13.30[illegible]
24	52	60	51	53	52	60	51	.0209	3.4[illegible]	-1.313	-16.43[illegible]
25	68	52	76	69	68	76	69	.0121	-8.33[illegible]	-3.554	-16.43[illegible]
26	77	69	76	61	77	69	61	.0463	-10.43[illegible]	-5.679	-17.143
27	53	61	52	59	53	61	69	.0463	-7.921	-3.81[illegible]	-16.53[illegible]

HARMONIC 0 MODE 0

FREQUENCY 0.000 RAD/SEC 0.000 HZ

SEGMENT 1 R

NODE NUMBER	ACOUSTIC PRESSURE
4	1.00000
5	1.00000
12	1.00000
13	1.00000
20	1.00000
21	1.00000
28	1.00000
29	1.00000
36	1.00000
37	1.00000
44	1.00000
45	1.00000
49	1.00000
50	1.00000
51	1.00000
52	1.00000
53	1.00000
57	1.00000
58	1.00000
59	1.00000
60	1.00000
61	1.00000
65	1.00000
66	1.00000
67	1.00000
68	1.00000
69	1.00000
73	1.00000
74	1.00000
75	1.00000
76	1.00000
77	1.00000

SEGMENT 1 L

NODE NUMBER	ACOUSTIC PRESSURE
4	1.00000
5	1.00000
12	1.00000
13	1.00000
20	1.00000
21	1.00000
28	1.00000
29	1.00000
36	1.00000
37	1.00000
44	1.00000
45	1.00000
49	1.00000
50	1.00000
51	1.00000
52	1.00000
53	1.00000
57	1.00000
58	1.00000
59	1.00000
60	1.00000
61	1.00000
65	1.00000
66	1.00000
67	1.00000
68	1.00000
69	1.00000
73	1.00000
74	1.00000
75	1.00000
76	1.00000
77	1.00000

HARMONIC 0 MODE 1

FREQUENCY 4851.528 RAD/SEC 775.919 HZ

SEGMENT 1 R

NODE NUMBER	ACOUSTIC PRESSURE
4	-1.23444
5	-1.23395
12	-1.23408
13	-1.23450
20	-.83563
21	-.83663
28	-.83661
29	-.83559
36	.10650
37	.10516
44	.10521
45	.10663
49	1.01388
50	1.00910
51	.99626
52	.97677
53	.97513
57	1.01383
58	1.00967
59	.99843
60	.97699
61	.97565
65	1.02128
66	1.01767
67	1.01604
68	1.00130
69	1.00065
73	1.02140
74	1.01775
75	1.01021
76	1.00112
77	1.00000

SEGMENT 1 L

NODE NUMBER	ACOUSTIC PRESSURE
4	-1.23444
5	-1.23395
12	-1.23408
13	-1.23450
20	-.83563
21	-.83663
28	-.83661
29	-.83559
36	.10650
37	.10516
44	.10521
45	.10653
49	1.01388
50	1.00910
51	.99626
52	.97677
53	.97513
57	1.01383
58	1.00967
59	.99843
60	.97699
61	.97565
65	1.02128
66	1.01767
67	1.01004
68	1.00130
69	1.00066
73	1.02140
74	1.01775
75	1.01021
76	1.00112
77	1.00000

ZERO HARMONIC MODE 1

ALPHPC = 16.32
ALPHVC = 1.14
ALPHFT = -154.14
ALPHSO = 0.0
ALPHA = -136.17

HARMONIC 0   MODE 2

FREQUENCY 10984.151 RAD/SEC   1748.182 HZ

SEGMENT 1 R

NODE NUMBER	ACOUSTIC PRESSURE
4	2.15202
5	2.15963
12	2.15026
13	2.16228
20	-.29932
21	-.29315
28	-.29360
29	-.29976
36	-2.08017
37	-2.08165
44	-2.08152
45	-2.07952
49	1.07603
50	1.05028
51	.98222
52	.88187
53	.87181
57	1.07577
58	1.05328
59	.99356
60	.88180
61	.87678
65	1.11444
66	1.09480
67	1.05353
68	1.00693
69	1.00318
73	1.11507
74	1.09511
75	1.05414
76	1.00582
77	1.00000

SEGMENT 1 L

NODE NUMBER	ACOUSTIC PRESSURE
4	2.16202
5	2.15963
12	2.16026
13	2.16228
20	-.29932
21	-.29315
28	-.29360
29	-.29976
36	-2.08017
37	-2.08165
44	-2.08152
45	-2.07952
49	1.07603
50	1.05028
51	.98222
52	.88187
53	.87181
57	1.07577
58	1.05328
59	.99356
60	.88180
61	.87678
65	1.11444
66	1.09480
67	1.05353
68	1.00693
69	1.00318
73	1.11507
74	1.09511
75	1.05414
76	1.00582
77	1.00080

ZERO HARMONIC MODE 2

```
ALPHPC =     16.28
ALPHVC =      8.27
ALPHFT =   -236.78
ALPHSD =      0.10
ALPHA  =   -162.23
```

HARMONIC 0 MODE 3

FREQUENCY 18209.701 RAD/SEC 2898.164 HZ

SEGMENT 1 R

NODE NUMBER	ACOUSTIC PRESSURE
4	-7.00367
5	-6.99784
12	-6.99922
13	-7.00366
20	6.16170
21	6.15188
28	6.15318
29	6.16218
36	-3.87148
37	-3.85433
44	-3.85601
45	-3.87143
49	1.25332
50	1.17087
51	.96011
52	.66613
53	.63371
57	1.25243
58	1.18004
59	.99412
60	.66326
61	.65296
65	1.36570
66	1.30141
67	1.16803
68	1.02218
69	1.00812
73	1.36764
74	1.30168
75	1.16788
76	1.01766
77	1.00000

SEGMENT 1 L

NODE NUMBER	ACOUSTIC PRESSURE
4	-7.00367
5	-6.99784
12	-6.99922
13	-7.00366
20	6.16170
21	6.15188
28	6.15318
29	6.16218
36	-3.87148
37	-3.85433
44	-3.85601
45	-3.87143
49	1.25332
50	1.17087
51	.96011
52	.66613
53	.63371
57	1.25243
58	1.18004
59	.99412
60	.66326
61	.65296
65	1.36570
66	1.30141
67	1.16803
68	1.02218
69	1.00812
73	1.36764
74	1.30168
75	1.16788
76	1.01766
77	1.00000

ZERO HARMONIC MODE 3

ALPHPC = 15.35
ALPHVC = 34.51
ALPHFT = -292.31
ALPHSD = 0.10
ALPHA = -242.34

Appendix C. EXAMPLE ANALYSIS OF A TYPICAL FOUR-SLOT FINOCYL MOTOR CONFIGURATION

A typical four-slot finocyl rocket is shown in Figure C. Because the cavity-propellant geometry undergoes rather abrupt changes from end to end, the finite element input data to FLAP3 were generated using both FLESH3 and FLSH3P. The pages following Figure C contain the reduced computer output sheets for the finocyl analysis.

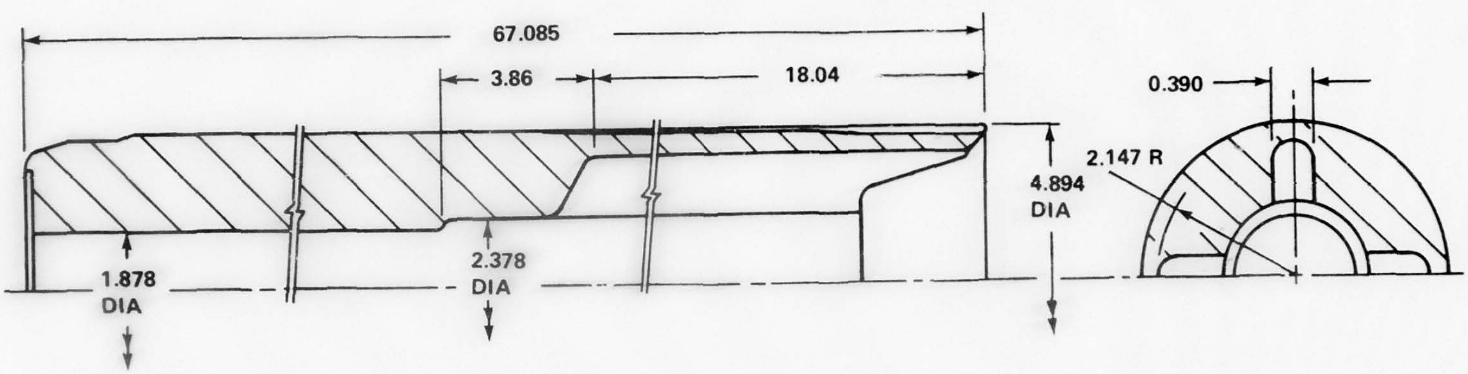


Figure C. Typical four-slot finocyl motor configuration.

```
     FLESH3     -     FINOCYL (I)
5    3   10     7     1.0         3
     0.0        0.0   0     0      0.0        0.0        0.0        0.0
     3.0        0.0   1     0      0.0        0.0        0.0        0.0
     0.0        0.0   0     0      0.0        0.0        0.0        0.0
     3.0        3.0   2     0      0.0        0.0        0.0        0.0
     0.0        0.0   3    90      0.1        0.1        0.0       90.0
     0.0        0.0   4    90      0.939      0.939      0.0       90.0
     0.0        0.0   5    90      1.189      1.189      0.0       90.0
     0.0        0.0   7    90      2.147      2.147      0.0       90.0
     0.0        0.0   8    90      2.347      2.347      0.0       90.0
     0.0        0.0   9    90      2.433      2.433      0.0       90.0
     0.0        0.0   0     0      0.0        0.0        0.0        0.0
1.17285       0.195  11     0      0.0        0.0        0.0        0.0
     0.0      0.195   0     0      0.0        0.0        0.0        0.0
     3.0      0.195  12     0      0.0        0.0        0.0        0.0
 1   1    1    1    3
 1   2    2    2    3
 1   2    1    3    1
 2   3    2    3    3
 2   4    1    4    2
 3   4    3    5    3
 3   5    1    5    2
 1   1    1    2    2    1    4   11    3    1
 2   1    2    2    3   11    4    2    3    1
 3   2    1    3    2    1    5   11    4    1
 4   2    2    3    3   11    5    2    4    2
 5   3    1    4    2    1    7   12    5    2
 6   3    2    4    3   12    7    2    5    3
 7   4    1    5    2    1    8   12    7    3
 8   4    2    5    3   12    8    2    7    3
-1
    0.0
 1   1    1    2    2    1    4   11    3    1
 2   1    2    2    3   11    4    2    3    1
 3   2    1    3    2    1    5   11    4    1
 4   2    2    3    3   11    5    2    4    2
 5   3    1    4    2    1    7   12    5    2
 6   3    2    4    3   12    7    2    5    3
 7   4    1    5    2    1    9   12    7    3
 8   4    2    5    3   12    9    2    7    3
-1
   8.13
 1   1    1    2    2    1    4   11    3    1
 2   1    2    2    3   11    4    2    3    1
 3   2    1    3    2    1    5   11    4    1
 4   2    2    3    3   11    5    2    4    2
 5   3    1    4    2    1    7   12    5    2
 6   3    2    4    3   12    7    2    5    3
 7   4    1    5    2    1    9   12    7    3
 8   4    2    5    3   12    9    2    7    3
-1
  16.26
```

```
     FLESH3    -    FINOCYL (II)
 5     3   10     5      1.0          2
     0.0         0.0    0     0        0.0        0.0        0.0        0.0
     3.0         0.0    1     0        0.0        0.0        0.0        0.0
     0.0         0.0    0     0        0.0        0.0        0.0        0.0
     3.0         3.0    2     0        0.0        0.0        0.0        0.0
     0.0         0.0    3    90        0.1        0.1        0.0       90.0
     0.0         0.0    4    90      0.939      0.939        0.0       90.0
     0.0         0.0    5    90      1.189      1.189        0.0       90.0
     0.0         0.0    7    90      2.147      2.147        0.0       90.0
     0.0         0.0    9    90      2.433      2.433        0.0       90.0
     0.0         0.0   10    90      2.447      2.447        0.0       90.0
     0.0         0.0    0     0        0.0        0.0        0.0        0.0
 1.17285       0.195   11     0        0.0        0.0        0.0        0.0
     0.0       0.195    0     0        0.0        0.0        0.0        0.0
     3.0       0.195   12     0        0.0        0.0        0.0        0.0
 1     1     1     1     3
 1     2     1     2     3
 2     3     1     3     3
 3     4     1     4     3
 3     5     1     5     3
 1     1     1     2     2     1     4    11     3     1
 2     1     2     2     3    11     4     2     3     1
 3     2     1     3     2     1     5    11     4     2
 4     2     2     3     3    11     5     2     4     2
 5     3     1     4     2     1     7    12     5     3
 6     3     2     4     3    12     7     2     5     3
 7     4     1     5     2     1     9    12     7     3
 8     4     2     5     3    12     9     2     7     3
-1
   16.26
 1     1     1     2     2     1     4    11     3     1
 2     1     2     2     3    11     4     2     3     1
 3     2     1     3     2     1     5    11     4     2
 4     2     2     3     3    11     5     2     4     2
 5     3     1     4     2     1     7    12     5     3
 6     3     2     4     3    12     7     2     5     3
 7     4     1     5     2     1    10    12     7     3
 8     4     2     5     3    12    10     2     7     3
-1
   19.91
```

```
    FLESH3    -    FINOCYL (III)
 5    3   10    5     1.0         5
      0.0        0.0    0    0        0.0        0.0        0.0        0.0
      3.0        0.0    1    0        0.0        0.0        0.0        0.0
      0.0        0.0    0    0        0.0        0.0        0.0        0.0
      3.0        3.0    2    0        0.0        0.0        0.0        0.0
      0.0        0.0    3   90        0.1        0.1        0.0       90.0
      0.0        0.0    4   90      0.939      0.939        0.0       90.0
      0.0        0.0    5   90      1.189      1.139        0.0       90.0
      0.0        0.0    7   90      2.147      2.147        0.0       90.0
      0.0        0.0    8   90      2.347      2.347        0.0       90.0
      0.0        0.0   10   90      2.447      2.447        0.0       90.0
      0.0        0.0    0    0        0.0        0.0        0.0        0.0
  1.17285      0.195   11    0        0.0        0.0        0.0        0.0
      0.0      0.195    0    0        0.0        0.0        0.0        0.0
      3.0      0.195   12    0        0.0        0.0        0.0        0.0
 1    1    1    1    3
 2    2    1    2    3
 3    3    1    3    3
 3    4    1    4    3
 3    5    1    5    3
 1    1    1    2    2    1    4   11    3    2
 2    1    2    2    3   11    4    2    3    2
 3    2    1    3    2    1    5   11    4    3
 4    2    2    3    3   11    5    2    4    3
 5    3    1    4    2    1    7   12    5    3
 6    3    2    4    3   12    7    2    5    3
 7    4    1    5    2    1   10   12    7    3
 8    4    2    5    3   12   10    2    7    3
-1
  19.91
 1    1    1    2    2    1    4   11    3    2
 2    1    2    2    3   11    4    2    3    2
 3    2    1    3    2    1    5   11    4    3
 4    2    2    3    3   11    5    2    4    3
 5    3    1    4    2    1    7   12    5    3
 6    3    2    4    3   12    7    2    5    3
 7    4    1    5    2    1   10   12    7    3
 8    4    2    5    3   12   10    2    7    3
-1
 31.095
```

```
1    1    1    2    2    1    4    11    3    2
2    1    2    2    3   11    4     2    3    2
3    2    1    3    2    1    5    11    4    3
4    2    2    3    3   11    5     2    4    3
5    3    1    4    2    1    7    12    5    3
6    3    2    4    3   12    7     2    5    3
7    4    1    5    2    1   10    12    7    3
8    4    2    5    3   12   10     2    7    3
-1
42.335
1    1    1    2    2    1    4    11    3    2
2    1    2    2    3   11    4     2    3    2
3    2    1    3    2    1    5    11    4    3
4    2    2    3    3   11    5     2    4    3
5    3    1    4    2    1    7    12    5    3
6    3    2    4    3   12    7     2    5    3
7    4    1    5    2    1   10    12    7    3
8    4    2    5    3   12   10     2    7    3
-1
53.585
1    1    1    2    2    1    4    11    3    2
2    1    2    2    3   11    4     2    3    2
3    2    1    3    2    1    5    11    4    3
4    2    2    3    3   11    5     2    4    3
5    3    1    4    2    1    7    12    5    3
6    3    2    4    3   12    7     2    5    3
7    4    1    5    2    1    8    12    7    3
8    4    2    5    3   12    8     2    7    3
-1
64.835
END
```

CARD I. TITLE.

FLESH3 - FINOCYL (I)

CARD II. CONTROL.

IMAX	JMAX	NNC	IBC	SCALE	NLAY
5	3	10	7	1.	3

CARD III. PART BOUNDARY CURVE.

X - COORD	Y - COORD	NN	NP	A X-AXIS	B Y-AXIS	THETAI	THETAF
0.000	0.000	0	0	0.00000	0.00000	0.00000	0.00000
3.000	0.000	1	0	0.00000	0.00000	0.00000	0.00000
0.000	0.000	0	0	0.00000	0.00000	0.00000	0.00000
3.000	3.000	2	0	0.00000	0.00000	0.00000	0.00000
0.000	0.000	3	90	.10000	.10000	0.00000	90.00000
0.000	0.000	4	90	.93900	.93900	0.00000	90.00000
0.000	0.000	5	90	1.18900	1.19900	0.00000	90.00000
0.000	0.000	7	90	2.14700	2.14700	0.00000	90.00000
0.000	0.000	8	90	2.34700	2.34700	0.00000	90.00000
0.000	0.000	9	90	2.43300	2.43300	0.00000	90.00000
0.000	0.000	0	0	0.00000	0.00000	0.00000	0.00000
1.173	.195	11	0	0.00000	0.00000	0.00000	0.00000
0.000	.195	0	0	0.00000	0.00000	0.00000	0.00000
3.000	.195	12	0	0.00000	0.00000	0.00000	0.00000

CARD IV. NODE CODE SEQUENCE.

IC	I1	J1	I2	J2
1	1	1	1	3
1	2	2	2	3
1	2	1	3	1
2	3	2	3	3
2	4	1	4	2
3	4	3	5	3
3	5	1	5	2

CARD V. PART DEFINITION.

NP	I1	J1	I2	J2	L1	L2	L3	L4	MT	NN	I3	J3	IR
1	1	1	2	2	1	4	11	3	1	-0	-0	-0	-0
2	1	2	2	3	11	4	2	3	1	-0	-0	-0	-0
3	2	1	3	2	1	5	11	4	1	-0	-0	-0	-0
4	2	2	3	3	11	5	2	4	2	-0	-0	-0	-0
5	3	1	4	2	1	7	12	5	2	-0	-0	-0	-0
6	3	2	4	3	12	7	2	5	3	-0	-0	-0	-0
7	4	1	5	2	1	3	12	7	3	-0	-0	-0	-0
8	4	2	5	3	12	3	2	7	3	-0	-0	-0	-0
-1	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0

CARD VI. SECTION LOCATION.

Z - COORD

0.000

N	X	Y	Z	MT
1	.10000	0.00000	0.00000	1
2	.93900	0.00000	0.00000	1
3	1.18900	0.00000	0.00000	1
4	2.14700	0.00000	0.00000	2
5	2.34700	0.00000	0.00000	3
6	.09864	.31646	0.00000	1
7	.92625	.15400	0.00000	1
8	1.17286	.19500	0.00000	2
9	2.13807	.19500	0.00000	2
10	2.33882	.19500	0.00000	3
11	.07071	.07071	0.00000	1
12	.66397	.66397	0.00000	1
13	.84075	.84075	0.00000	2
14	1.51816	1.51816	0.00000	3
15	1.65958	1.65958	0.00000	3

CARD V. PART DEFINITION.

NP	I1	J1	I2	J2	L1	L2	L3	L4	MT	NN	I3	J3	IR
1	1	1	2	2	1	4	11	3	1	-0	-0	-0	-0
2	1	2	2	3	11	4	2	3	1	-0	-0	-0	-0
3	2	1	3	2	1	5	11	4	1	-0	-0	-0	-0
4	2	2	3	3	11	5	2	4	2	-0	-0	-0	-0
5	3	1	4	2	1	7	12	5	2	-0	-0	-0	-0
6	3	2	4	3	12	7	2	5	3	-0	-0	-0	-0
7	4	1	5	2	1	9	12	7	3	-0	-0	-0	-0
8	4	2	5	3	12	9	2	7	3	-0	-0	-0	-0
-1	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0

CARD VI. SECTION LOCATION.

Z - COORD

8.130

N	X	Y	Z	MT
16	.10000	0.00000	8.13000	1
17	.93900	0.00000	8.13000	1
18	1.18900	0.00000	8.13000	1
19	2.14700	0.00000	8.13000	2
20	2.43300	0.00000	8.13000	3
21	.09864	.01640	8.13000	1
22	.92625	.15400	8.13000	1
23	1.17286	.19500	8.13000	2
24	2.13807	.19500	8.13000	2
25	2.42508	.19500	8.13000	3
26	.07071	.07071	8.13000	1
27	.66397	.66397	8.13000	1
28	.84075	.84075	8.13000	2
29	1.51816	1.51816	8.13000	3
30	1.72039	1.72039	8.13000	3

CARD V. PART DEFINITION.

NP	I1	J1	I2	J2	L1	L2	L3	L4	MT	NN	I3	J3	IR
1	1	1	2	2	1	4	11	3	1	-0	-0	-0	-0
2	1	2	2	3	11	4	2	3	1	-0	-0	-0	-0
3	2	1	3	2	1	5	11	4	1	-0	-0	-0	-0
4	2	2	3	3	11	5	2	4	2	-0	-0	-0	-0
5	3	1	4	2	1	7	12	5	2	-0	-0	-0	-0
6	3	2	4	3	12	7	2	5	3	-0	-0	-0	-0
7	4	1	5	2	1	9	12	7	3	-0	-0	-0	-0
8	4	2	5	3	12	9	2	7	3	-0	-0	-0	-0
-1	-0	-0	-0	-0	-0	-1	-0	-0	-0	-0	-0	-0	-0

CARD VI. SECTION LOCATION.

Z - COORD

16.260

N	X	Y	Z	MT
31	.10000	0.00000	16.26000	1
32	.93900	0.00000	16.26000	1
33	1.18900	0.00000	16.26000	1
34	2.14700	0.00000	16.26000	2
35	2.43300	0.00000	16.26000	3
36	.09864	.01640	16.26000	1
37	.92625	.15400	16.26000	1
38	1.17286	.19500	16.26000	2
39	2.13807	.19500	16.26000	2
40	2.42503	.19500	16.26000	3
41	.07071	.07071	16.26000	1
42	.66397	.66397	16.26000	1
43	.94075	.94075	16.26000	2
44	1.51816	1.51816	16.26000	3
45	1.72039	1.72039	16.26000	3

1	1	2	7	6	16	17	22	21	1
2	2	3	8	7	17	18	23	22	1
3	3	4	9	8	18	19	24	23	2
4	6	7	12	11	21	22	27	26	1
5	7	8	13	12	22	23	28	27	2
6	16	17	22	21	31	32	37	36	1
7	17	18	23	22	32	33	38	37	1
8	18	19	24	23	33	34	39	38	2
9	21	22	27	26	36	37	42	41	1
10	22	23	28	27	37	38	43	42	2
11	4	5	10	9	19	20	25	24	3
12	8	9	14	13	23	24	29	28	3
13	9	10	15	14	24	25	30	29	3
14	19	20	25	24	34	35	40	39	3
15	23	24	29	28	38	39	44	43	3
16	24	25	30	29	39	40	45	44	3

1	9	8	23	24	1
2	8	13	28	23	1
3	24	23	38	39	1
4	23	28	43	38	1
5	4	9	24	19	1
6	19	24	39	34	1

CARD I.I TITLE.

FLESH3 - FINOCYL (II)

CARD II. CONTROL.

IMAX	JMAX	NNC	IBC	SCALE	NLAY
5	3	16	5	1.	2

CARD III. PART BOUNDARY CURVE.

X - COORD	Y - COORD	NN	NP	A X-AXIS	B Y-AXIS	THETAI	THETA
0.000	0.000	0	0	0.00000	0.00000	0.00000	0.00000
3.000	0.000	1	0	0.00000	0.00000	0.00000	0.00000
0.000	0.000	0	0	0.00000	0.00000	0.00000	0.00000
3.000	3.000	2	0	0.00000	0.00000	0.00000	0.00000
0.000	0.000	3	90	.10000	.10000	0.00000	90.00000
0.000	0.000	4	90	.93900	.93900	0.00000	90.00000
0.000	0.000	5	90	1.18360	1.19900	0.00000	90.00000
0.000	0.000	7	90	2.14700	2.14700	0.00000	90.00000
0.000	0.000	9	90	2.43300	2.43300	0.00000	90.00000
0.000	0.000	10	90	2.44700	2.44700	0.00000	90.00000
0.000	0.000	0	0	0.00000	0.00000	0.00000	0.00000
1.173	.195	11	0	0.00000	0.00000	0.00000	0.00000
0.000	.195	0	0	0.00000	0.00000	0.00000	0.00000
3.000	.195	12	0	0.00000	0.00000	0.00000	0.00000

CARD IV. NODE CODE SEQUENCE.

IC	I1	J1	I2	J2
1	1	1	1	3
1	2	1	2	3
2	3	1	3	3
3	4	1	4	3
3	5	1	5	3

CARD V. PART DEFINITION.

NP	I1	J1	I2	J2	L1	L2	L3	L4	MT	NN	I3	J3	IR
1	1	1	2	2	1	[illegible]	11	3	1	-0	-0	-0	-0
2	1	2	2	3	11	[illegible]	2	3	1	-0	-0	-0	-0
3	2	1	3	2	1	5	11	4	2	-0	-0	-0	-0
4	2	2	3	3	11	5	2	4	2	-0	-0	-0	-0
5	3	1	4	2	1	7	12	5	3	-0	-0	-0	-0
6	3	2	4	3	12	7	2	5	3	-0	-0	-0	-0
7	4	1	5	2	1	9	12	7	3	-0	-0	-0	-0
8	4	2	5	3	12	9	2	7	3	-0	-0	-0	-0
-1	-0	-0	-0	-0	-0	-1	-0	-0	-0	-0	-0	-0	-0

CARD VI. SECTION LOCATION.

Z - COORD

16.260

N	X	Y	Z	MT
1	.10000	0.00000	16.26000	1
2	.93900	0.00000	16.26000	1
3	1.18900	0.00000	16.26000	2
4	2.14700	0.00000	16.26000	3
5	2.43300	0.00000	16.26000	3
6	.09864	.01640	16.26000	1
7	.92625	.15400	16.26000	1
8	1.17286	.19500	16.26000	2
9	2.13807	.19500	16.26000	3
10	2.42508	.19500	16.26000	3
11	.07071	.07071	16.26000	1
12	.66397	.66397	16.26000	1
13	.84075	.84075	16.26000	2
14	1.51816	1.51816	16.26000	3
15	1.72039	1.72039	16.26000	3

CARD V. PART DEFINITION.

NP	I1	J1	I2	J2	L1	L2	L3	L4	MT	NN	I3	J3	IR
1	1	1	2	2	1	4	11	3	1	-0	-0	-0	-0
2	1	2	2	3	11	4	2	3	1	-0	-0	-0	-0
3	2	1	3	2	1	5	11	4	2	-0	-0	-0	-0
4	2	2	3	3	11	5	2	4	2	-0	-0	-0	-0
5	3	1	4	2	1	7	12	5	3	-0	-0	-0	-0
6	3	2	4	3	12	7	2	5	3	-0	-0	-0	-0
7	4	1	5	2	1	10	12	7	3	-0	-0	-0	-0
8	4	2	5	3	12	10	2	7	3	-0	-0	-0	-0
-1	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0

CARD VI. SECTION LOCATION.

Z - COORD

19.910

N	X	Y	Z	MT
16	.10000	0.00000	19.91000	1
17	.93900	0.00000	19.91000	1
18	1.18900	0.00000	19.91000	2
19	2.14700	0.00000	19.91000	3
20	2.44700	0.00000	19.91000	3
21	.09864	.01640	19.91000	1
22	.92625	.15400	19.91000	1
23	1.17286	.19500	19.91000	2
24	2.13807	.19500	19.91000	3
25	2.43913	.19500	19.91000	3
26	.07071	.07071	19.91000	1
27	.66397	.66397	19.91000	1
28	.84075	.84075	19.91000	2
29	1.51816	1.51816	19.91000	3
30	1.73029	1.73029	19.91000	3

1	1	2	7	6	16	17	22	21	1
2	2	3	8	7	17	18	23	22	2
3	6	7	12	11	21	22	27	26	1
4	7	8	13	12	22	23	28	27	2
5	3	4	9	8	18	19	24	23	3
6	4	5	10	9	19	20	25	24	3
7	8	9	14	13	23	24	29	28	3
8	9	10	15	14	24	25	30	29	3
1	3	8	23	18	1				
2	8	13	28	23	1				

CARD I. TITLE.

FLESH3 - FINOCYL (III)

CARD II. CONTROL.

IMAX	JMAX	NNC	IBC	SCALE	NLAY
5	3	10	5	1.	5

CARD III. PART BOUNDARY CURVE.

X - COORD	Y - COORD	NN	NP	A X-AXIS	B Y-AXIS	THETAI	THETAF
0.000	0.000	0	0	0.00000	0.00000	0.00000	0.00000
3.000	0.000	1	0	0.00000	0.00000	0.00000	0.00000
0.000	0.000	0	0	0.00000	0.00000	0.00000	0.00000
3.000	3.000	2	0	0.00000	0.00000	0.00000	0.00000
0.000	0.000	3	90	.10000	.10000	0.00000	90.00000
0.000	0.000	4	90	.93900	.93900	0.00000	90.00000
0.000	0.000	5	90	1.18900	1.18900	0.00000	90.00000
0.000	0.000	7	90	2.14700	2.14700	0.00000	90.00000
0.000	0.000	8	90	2.34700	2.34700	0.00000	90.00000
0.000	0.000	10	90	2.44700	2.44700	0.00000	90.00000
0.000	0.000	0	0	0.00000	0.00000	0.00000	0.00000
1.173	.195	11	0	0.00000	0.00000	0.00000	0.00000
0.000	.195	0	0	0.00000	0.00000	0.00000	0.00000
3.000	.195	12	0	0.00000	0.00000	0.00000	0.00000

CARD IV. NODE CODE SEQUENCE.

IC	I1	J1	I2	J2
1	1	1	1	3
2	2	1	2	3
3	3	1	3	3
3	4	1	4	3
3	5	1	5	3

CARD V. PART DEFINITION.

NP	I1	J1	I2	J2	L1	L2	L3	L4	MT	NN	I3	J3	IR
1	1	1	2	2	1	[illegible]	11	3	2	-0	-0	-0	-0
2	1	2	2	3	11	[illegible]	2	3	2	-0	-0	-0	-0
3	2	1	3	2	1	5	11	4	3	-0	-0	-0	-0
4	2	2	3	3	11	5	2	4	3	-0	-0	-0	-0
5	3	1	4	2	1	7	12	5	3	-0	-0	-0	-0
6	3	2	4	3	12	7	2	5	3	-0	-0	-0	-0
7	4	1	5	2	1	10	12	7	3	-0	-0	-0	-0
8	4	2	5	3	12	10	2	7	3	-0	-0	-0	-0
-1	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0

CARD VI. SECTION LOCATION.

Z - COORD

19.910

N	X	Y	Z	MT
1	.10000	0.00000	19.91000	1
2	.93900	0.00000	19.91000	2
3	1.18900	0.00000	19.91000	3
4	2.14700	0.00000	19.91000	3
5	2.44700	0.00000	19.91000	3
6	.09864	.01540	19.91000	1
7	.92625	.15400	19.91000	2
8	1.17286	.19500	19.91000	3
9	2.13807	.19500	19.91000	3
10	2.43913	.19500	19.91000	3
11	.07071	.07071	19.91000	1
12	.66397	.66397	19.91000	2
13	.84075	.84075	19.91000	3
14	1.51816	1.51816	19.91000	3
15	1.73029	1.73029	19.91000	3

CARD V.   PART DEFINITION.

NP	I1	J1	I2	J2	L1	L2	L3	L4	MT	NN	I3	J3	I[illegible]
1	1	1	2	2	1	[illegible]	11	3	2	-0	-0	-0	-0
2	1	2	2	3	11	[illegible]	2	3	2	-0	-0	-0	-0
3	2	1	3	2	1	5	11	4	3	-0	-0	-0	-0
4	2	2	3	3	11	5	2	4	3	-0	-0	-0	-0
5	3	1	4	2	1	7	12	5	3	-0	-0	-0	-0
6	3	2	4	3	12	7	2	5	3	-0	-0	-0	-0
7	4	1	5	2	1	10	12	7	3	-0	-0	-0	-0
8	4	2	5	3	12	10	2	7	3	-0	-0	-0	-0
-1	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0

CARD VI.   SECTION LOCATION.

Z - COORD

31.085

N	X	Y	Z	MT
16	.10000	0.00000	31.08500	1
17	.93900	0.00000	31.08500	2
18	1.18900	0.00000	31.08500	3
19	2.14700	0.00000	31.08500	3
20	2.44700	0.00000	31.08500	3
21	.09864	.01640	31.08500	1
22	.92625	.15400	31.08500	2
23	1.17286	.19500	31.08500	3
24	2.13807	.19500	31.08500	3
25	2.43913	.19500	31.08500	3
26	.07071	.07071	31.08500	1
27	.66397	.66397	31.08500	2
28	.84075	.84075	31.08500	3
29	1.51816	1.51816	31.08500	3
30	1.73029	1.73029	31.08500	3

CARD V. PART DEFINITION.

NP	I1	J1	I2	J2	L1	L2	L3	L4	MT	NN	I3	J3	IR
1	1	1	2	2	1	4	11	3	2	-0	-0	-0	-0
2	1	2	2	3	11	4	2	3	2	-0	-0	-0	-0
3	2	1	3	2	1	5	11	4	3	-0	-0	-0	-0
4	2	2	3	3	11	5	2	4	3	-0	-0	-0	-0
5	3	1	4	2	1	7	12	5	3	-0	-0	-0	-0
6	3	2	4	3	12	7	2	5	3	-0	-0	-0	-0
7	4	1	5	2	1	11	12	7	3	-0	-0	-0	-0
8	4	2	5	3	12	13	2	7	3	-0	-0	-0	-0
-1	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0

CARD VI. SECTION LOCATION.

Z - COORD

42.335

N	X	Y	Z	MT
31	.10000	0.00000	42.33500	1
32	.93900	0.00000	42.33500	2
33	1.18900	0.00000	42.33500	3
34	2.14700	0.00000	42.33500	3
35	2.44700	0.00000	42.33500	3
36	.09864	.01640	42.33500	1
37	.92625	.15400	42.33500	2
38	1.17286	.19500	42.33500	3
39	2.13807	.19500	42.33500	3
40	2.43913	.19500	42.33500	3
41	.07071	.07071	42.33500	1
42	.66397	.66397	42.33500	2
43	.84075	.84075	42.33500	3
44	1.51816	1.51816	42.33500	3
45	1.73029	1.73029	42.33500	3

CARD V. PART DEFINITION.

NP	I1	J1	I2	J2	L1	L2	L3	L4	MT	NN	I3	J3	IR
1	1	1	2	2	1	4	11	3	2	-0	-0	-0	-0
2	1	2	2	3	11	4	2	3	2	-0	-0	-0	-0
3	2	1	3	2	1	5	11	4	3	-0	-0	-0	-0
4	2	2	3	3	11	5	2	4	3	-0	-0	-0	-0
5	3	1	4	2	1	7	12	5	3	-0	-0	-0	-0
6	3	2	4	3	12	7	2	5	3	-0	-0	-0	-0
7	4	1	5	2	1	10	12	7	3	-0	-0	-0	-0
8	4	2	5	3	12	10	2	7	3	-0	-0	-0	-0
-1	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0

CARD VI. SECTION LOCATION.

Z - COORD

53.585

N	X	Y	Z	MT
46	.10000	0.00000	53.58500	1
47	.33900	0.00000	53.58500	2
48	1.18900	0.00000	53.58500	3
49	2.14700	0.00000	53.58500	3
50	2.44700	0.00000	53.58500	3
51	.09864	.01640	53.58500	1
52	.32625	.15406	53.58500	2
53	1.17286	.19500	53.58500	3
54	2.13807	.19500	53.58500	3
55	2.43913	.19500	53.58500	3
56	.07071	.07071	53.58500	1
57	.66397	.66397	53.58500	2
58	.84075	.84075	53.58500	3
59	1.51816	1.51816	53.58500	3
60	1.73029	1.73029	53.58500	3

CARD V. PART DEFINITION.

NP	I1	J1	I2	J2	L1	L2	L3	L4	MT	NN	I3	J3	IR
1	1	1	2	2	1	4	11	3	2	-0	-0	-0	-0
2	1	2	2	3	11	4	2	3	2	-0	-0	-0	-0
3	2	1	3	2	1	5	11	4	3	-0	-0	-0	-0
4	2	2	3	3	11	5	2	4	3	-0	-0	-0	-0
5	3	1	4	2	1	7	12	5	3	-0	-0	-0	-0
6	3	2	4	3	12	7	2	5	3	-0	-0	-0	-0
7	4	1	5	2	1	8	12	7	3	-0	-0	-0	-0
8	4	2	5	3	12	8	2	7	3	-0	-0	-0	-0
-1	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0	-0

CARD VI. SECTION LOCATION.

Z - COORD

64.835

N	X	Y	Z	MT
61	.10000	0.00000	64.83500	1
62	.93900	0.00000	64.83500	2
63	1.18900	0.00000	64.83500	3
64	2.14700	0.00000	64.83500	3
65	2.34700	0.00000	64.83500	3
66	.09864	.01640	64.83500	1
67	.92625	.15400	64.83500	2
68	1.17286	.19500	64.83500	3
69	2.13807	.19500	64.83500	3
70	2.33882	.19500	64.83500	3
71	.07071	.07071	64.83500	1
72	.66397	.66397	64.83500	2
73	.84075	.84075	64.83500	3
74	1.51816	1.51816	64.83500	3
75	1.65958	1.65958	64.83500	3

1	1	2	7	6	16	17	22	21	2
2	6	7	12	11	21	22	27	26	2
3	16	17	22	21	31	32	37	36	2
4	21	22	27	26	36	37	42	41	2
5	31	32	37	36	46	47	52	51	2
6	36	37	42	41	51	52	57	56	2
7	46	47	52	51	61	62	67	66	2
8	51	52	57	56	66	67	72	71	2
9	2	3	8	7	17	18	23	22	3
10	3	4	9	8	18	19	24	23	3
11	4	5	10	9	19	20	25	24	3
12	7	8	13	12	22	23	28	27	3
13	8	9	14	13	23	24	29	28	3
14	9	10	15	14	24	25	30	29	3
15	17	18	23	22	32	33	38	37	3
16	18	19	24	23	33	34	39	38	3
17	19	20	25	24	34	35	40	39	3
18	22	23	28	27	37	38	43	42	3
19	23	24	29	28	38	39	44	43	3
20	24	25	30	29	39	40	45	44	3
21	32	33	38	37	47	48	53	52	3
22	33	34	39	38	48	49	54	53	3
23	34	35	40	39	49	50	55	54	3
24	37	38	43	42	52	53	58	57	3
25	38	39	44	43	53	54	59	58	3

26	39	40	45	44	54	55	60	59	3
27	47	48	53	52	62	63	68	67	3
28	48	49	54	53	63	64	69	68	3
29	49	50	55	54	64	65	70	69	3
30	52	53	58	57	67	68	73	72	3
31	53	54	59	58	68	69	74	73	3
32	54	55	60	59	69	70	75	74	3
1	2	7	22	17	1				
2	7	12	27	22	1				
3	17	22	37	32	1				
4	22	27	42	37	1				
5	32	37	52	47	1				
6	37	42	57	52	1				
7	47	52	67	62	1				
8	52	57	72	67	1				

Input to FLSH3P

3	5	3							
45	10	6	6	0					
1	.10000	0.00000	0.00000	1					
2	.93900	0.00000	0.00000	1					
3	1.18900	0.00000	0.00000	1					
4	2.14700	0.00000	0.00000	2					
5	2.34700	0.00000	0.00000	3					
6	.09864	.01640	0.00000	1					
7	.92625	.15400	0.00000	1					
8	1.17286	.19500	0.00000	2					
9	2.13807	.19500	0.00000	2					
10	2.33882	.19500	0.00000	3					
11	.07071	.07071	0.00000	1					
12	.66397	.66397	0.00000	1					
13	.84075	.84075	0.00000	2					
14	1.51816	1.51816	0.00000	3					
15	1.65958	1.65958	0.00000	3					
16	.10000	0.00000	8.13000	1					
17	.93900	0.00000	8.13000	1					
18	1.18900	0.00000	8.13000	1					
19	2.14700	0.00000	8.13000	2					
20	2.43300	0.00000	8.13000	3					
21	.09864	.01640	8.13000	1					
22	.92625	.15400	8.13000	1					
23	1.17286	.19500	8.13000	2					
24	2.13807	.19500	8.13000	2					
25	2.42500	.19500	8.13000	3					
26	.07071	.07071	8.13000	1					
27	.66397	.66397	8.13000	1					
28	.84075	.84075	8.13000	2					
29	1.51816	1.51816	8.13000	3					
30	1.72039	1.72039	8.13000	3					
31	.10000	0.00000	16.26000	1					
32	.93900	0.00000	16.26000	1					
33	1.18900	0.00000	16.26000	1					
34	2.14700	0.00000	16.26000	2					
35	2.43300	0.00000	16.26000	3					
36	.09864	.01640	16.26000	1					
37	.92625	.15400	16.26000	1					
38	1.17286	.19500	16.26000	2					
39	2.13807	.19500	16.26000	2					
40	2.42500	.19500	16.26000	3					
41	.07071	.07071	16.26000	1					
42	.66397	.66397	16.26000	1					
43	.84075	.84075	16.26000	2					
44	1.51816	1.51816	16.26000	3					
45	1.72039	1.72039	16.26000	3					
1	1	2	7	6	16	17	22	21	1
2	2	3	8	7	17	18	23	22	1
3	3	4	9	8	18	19	24	23	2
4	6	7	12	11	21	22	27	26	1
5	7	8	13	12	22	23	28	27	2
6	16	17	22	21	31	32	37	36	1
7	17	18	23	22	32	33	38	37	1
8	18	19	24	23	33	34	39	38	2
9	21	22	27	26	36	37	42	41	1
10	22	23	28	27	37	38	43	42	2
11	4	5	10	9	19	20	25	24	3
12	8	9	14	13	23	24	29	28	3
13	9	10	15	14	24	25	30	29	3
14	19	20	25	24	34	35	40	39	3
15	23	24	29	28	38	39	44	43	3
16	24	25	30	29	39	40	45	44	3

1	9	8	23	24	1				
2	8	13	28	23	1				
3	24	23	38	39	1				
4	23	28	43	38	1				
5	4	9	24	19	1				
6	19	24	39	34	1				
30	4	4	2	3					
1	.10000	0.00000	16.26000	1					
2	.93900	0.00000	16.26000	1					
3	1.18900	0.00000	16.26000	2					
4	2.14700	0.00000	16.26000	3					
5	2.43300	0.00000	16.26000	3					
6	.09864	.01640	16.26000	1					
7	.92625	.15400	16.26000	1					
8	1.17286	.19500	16.26000	2					
9	2.13807	.19500	16.26000	3					
10	2.42508	.19500	16.26000	3					
11	.07071	.07071	16.26000	1					
12	.66397	.66397	16.26000	1					
13	.84075	.84075	16.26000	2					
14	1.51816	1.51816	16.26000	3					
15	1.72039	1.72039	16.26000	3					
16	.10000	0.00000	19.91000	1					
17	.93900	0.00000	19.91000	1					
18	1.18900	0.00000	19.91000	2					
19	2.14700	0.00000	19.91000	3					
20	2.44700	0.00000	19.91000	3					
21	.09864	.01640	19.91000	1					
22	.92625	.15400	19.91000	1					
23	1.17286	.19500	19.91000	2					
24	2.13807	.19500	19.91000	3					
25	2.43913	.19500	19.91000	3					
26	.07071	.07071	19.91000	1					
27	.66397	.66397	19.91000	1					
28	.84075	.84075	19.91000	2					
29	1.51816	1.51816	19.91000	3					
30	1.73029	1.73029	19.91000	3					
1	1	2	7	6	16	17	22	21	1
2	2	3	8	7	17	18	23	22	2
3	6	7	12	11	21	22	27	26	1
4	7	8	13	12	22	23	28	27	2
5	3	4	9	8	18	19	24	23	3
6	4	5	10	9	19	20	25	24	3
7	8	9	14	13	23	24	29	29	3
8	9	10	15	14	24	25	30	29	3
1	3	8	23	18	1				
2	8	13	28	23	1				
75	8	24	8	2					
1	.10000	0.00000	19.91000	1					
2	.93900	0.00000	19.91000	2					
3	1.18900	0.00000	19.91000	3					
4	2.14700	0.00000	19.91000	3					
5	2.44700	0.00000	19.91000	3					
6	.09864	.01640	19.91000	1					
7	.92625	.15400	19.91000	2					
8	1.17286	.19500	19.91000	3					
9	2.13807	.19500	19.91000	3					
10	2.43913	.19500	19.91000	3					
11	.07071	.07071	19.91000	1					
12	.66397	.66397	19.91000	2					
13	.84075	.84075	19.91000	3					
14	1.51816	1.51816	19.91000	3					
15	1.73029	1.73029	19.91000	3					
16	.10000	0.00000	31.08500	1					
17	.93900	0.00000	31.08500	2					
18	1.18900	0.00000	31.08500	3					

19	2.14700	0.00000	31.08500	3
20	2.44700	0.00000	31.08500	3
21	.09864	.01640	31.08500	1
22	.92625	.15400	31.08500	2
23	1.17286	.19500	31.08500	3
24	2.13807	.19500	31.08500	3
25	2.43913	.19500	31.08500	3
26	.07071	.07071	31.08500	1
27	.66397	.66397	31.08500	2
28	.84075	.84075	31.08500	3
29	1.51816	1.51816	31.08500	3
30	1.73029	1.73029	31.08500	3
31	.10000	0.00000	42.33500	1
32	.93900	0.00000	42.33500	2
33	1.18900	0.00000	42.33500	3
34	2.14700	0.00000	42.33500	3
35	2.44700	0.00000	42.33500	3
36	.09864	.01640	42.33500	1
37	.92625	.15400	42.33500	2
38	1.17286	.19500	42.33500	3
39	2.13807	.19500	42.33500	3
40	2.43913	.19500	42.33500	3
41	.07071	.07071	42.33500	1
42	.66397	.66397	42.33500	2
43	.84075	.84075	42.33500	3
44	1.51816	1.51816	42.33500	3
45	1.73029	1.73029	42.33500	3
46	.10000	0.00000	53.58500	1
47	.93900	0.00000	53.58500	2
48	1.18900	0.00000	53.58500	3
49	2.14700	0.00000	53.58500	3
50	2.44700	0.00000	53.58500	3
51	.09864	.01640	53.58500	1
52	.92625	.15400	53.58500	2
53	1.17286	.19500	53.58500	3
54	2.13807	.19500	53.58500	3
55	2.43913	.19500	53.58500	3
56	.07071	.07071	53.58500	1
57	.66397	.66397	53.58500	2
58	.84075	.84075	53.58500	3
59	1.51816	1.51816	53.58500	3
60	1.73029	1.73029	53.58500	3
61	.10000	0.00000	64.83500	1
62	.93900	0.00000	64.83500	2
63	1.18900	0.00000	64.83500	3
64	2.14700	0.00000	64.83500	3
65	2.34700	0.00000	64.83500	3
66	.09864	.01640	64.83500	1
67	.92625	.15400	64.83500	2
68	1.17286	.19500	64.83500	3
69	2.13807	.19500	64.83500	3
70	2.33882	.19500	64.83500	3
71	.07071	.07071	64.83500	1
72	.66397	.66397	64.83500	2
73	.84075	.84075	64.83500	3
74	1.51816	1.51816	64.83500	3
75	1.65958	1.65958	64.83500	3

1	1	2	7	6	16	17	22	21	2
2	6	7	12	11	21	22	27	26	2
3	16	17	22	21	31	32	37	36	2
4	21	22	27	26	36	37	42	41	2
5	31	32	37	36	46	47	52	51	2
6	36	37	42	41	51	52	57	56	2
7	46	47	52	51	61	62	67	66	2
8	51	52	57	56	66	67	72	71	2
9	2	3	8	7	17	18	23	22	3

10	3	4	9	8	18	19	24	23	3
11	4	5	10	9	19	20	25	24	3
12	7	8	13	12	22	23	28	27	3
13	8	9	14	13	23	24	29	28	3
14	9	10	15	14	24	25	30	29	3
15	17	18	23	22	32	33	38	37	3
16	18	19	24	23	33	34	39	38	3
17	19	20	25	24	34	35	40	39	3
18	22	23	28	27	37	38	43	42	3
19	23	24	29	28	38	39	44	43	3
20	24	25	30	29	39	40	45	44	3
21	32	33	38	37	47	48	53	52	3
22	33	34	39	38	48	49	54	53	3
23	34	35	40	39	49	50	55	54	3
24	37	38	43	42	52	53	58	57	3
25	38	39	44	43	53	54	59	58	3
26	39	40	45	44	54	55	60	59	3
27	47	48	53	52	62	63	68	67	3
28	48	49	54	53	63	64	69	68	3
29	49	50	55	54	64	65	70	69	3
30	52	53	58	57	67	68	73	72	3
31	53	54	59	58	68	69	74	73	3
32	54	55	60	59	69	70	75	74	3
1	2	7	22	17	1				
2	7	12	27	22	1				
3	17	22	37	32	1				
4	22	27	42	37	1				
5	32	37	52	47	1				
6	37	42	57	52	1				
7	47	52	67	62	1				
8	52	57	72	67	1				
0									

Output from FLSH3P

1	.10000	0.00000	0.00000	1
2	.93900	0.00000	0.00000	1
3	1.18900	0.00000	0.00000	1
4	2.14700	0.00000	0.00000	2
5	2.34700	0.00000	0.00000	3
6	.09854	.01640	0.00000	1
7	.92625	.15400	0.00000	1
8	1.17286	.19500	0.00000	2
9	2.13807	.19500	0.00000	2
10	2.33882	.19500	0.00000	3
11	.07071	.07071	0.00000	1
12	.66397	.66397	0.00000	1
13	.84075	.84075	0.00000	2
14	1.51816	1.51816	0.00000	3
15	1.65958	1.65958	0.00000	3
16	.10000	0.00000	8.13000	1
17	.93900	0.00000	8.13000	1
18	1.18900	0.00000	8.13000	1
19	2.14700	0.00000	8.13000	2
20	2.43300	0.00000	8.13000	3
21	.09854	.01640	8.13000	1
22	.92625	.15400	8.13000	1
23	1.17286	.19500	8.13000	2
24	2.13807	.19500	8.13000	2
25	2.42508	.19500	8.13000	3
26	.07071	.07071	8.13000	1
27	.66397	.66397	8.13000	1
28	.84075	.84075	8.13000	2
29	1.51816	1.51816	8.13000	3
30	1.72039	1.72039	8.13000	3
31	.10000	0.00000	16.26000	1
32	.93900	0.00000	16.26000	1
33	1.18900	0.00000	16.26000	2
34	2.14700	0.00000	16.26000	2
35	2.43300	0.00000	16.26000	3
36	.09854	.01640	16.26000	1
37	.92625	.15400	16.26000	1
38	1.17286	.19500	16.26000	2
39	2.13807	.19500	16.26000	2
40	2.42508	.19500	16.26000	3
41	.07071	.07071	16.26000	1
42	.66397	.66397	16.26000	1
43	.84075	.84075	16.26000	2
44	1.51816	1.51816	16.26000	3
45	1.72039	1.72039	16.26000	3
46	.10000	0.00000	19.91000	1
47	.93900	0.00000	19.91000	2
48	1.18900	0.00000	19.91000	2
49	2.14700	0.00000	19.91000	3
50	2.44700	0.00000	19.91000	3
51	.09854	.01640	19.91000	1
52	.92625	.15400	19.91000	2
53	1.17286	.19500	19.91000	2
54	2.13807	.19500	19.91000	3
55	2.43913	.19500	19.91000	3
56	.07071	.07071	19.91000	1
57	.66397	.66397	19.91000	2
58	.84075	.84075	19.91000	2
59	1.51816	1.51816	19.91000	3
60	1.73029	1.73029	19.91000	3
61	.10000	0.00000	31.08500	1
62	.93900	0.00000	31.08500	2

63	1.18900	0.00000	31.08500	3
64	2.14700	0.00000	31.08500	3
65	2.44700	0.00000	31.08500	3
66	.09854	.01640	31.08500	1
67	.92625	.15400	31.08500	2
68	1.17286	.19500	31.08500	3
69	2.13807	.19500	31.08500	3
70	2.43913	.19500	31.08500	3
71	.07071	.07071	31.08500	1
72	.66397	.66397	31.08500	2
73	.84075	.84075	31.08500	3
74	1.51816	1.51816	31.08500	3
75	1.73029	1.73029	31.08500	3
76	.10000	0.00000	42.33500	1
77	.93900	0.00000	42.33500	2
78	1.18900	0.00000	42.33500	3
79	2.14700	0.00000	42.33500	3
80	2.44700	0.00000	42.33500	3
81	.09854	.01640	42.33500	1
82	.92625	.15400	42.33500	2
83	1.17286	.19500	42.33500	3
84	2.13807	.19500	42.33500	3
85	2.43913	.19500	42.33500	3
86	.07071	.07071	42.33500	1
87	.66397	.66397	42.33500	2
88	.84075	.84075	42.33500	3
89	1.51816	1.51816	42.33500	3
90	1.73029	1.73029	42.33500	3
91	.10000	0.00000	53.58500	1
92	.93900	0.00000	53.58500	2
93	1.18900	0.00000	53.58500	3
94	2.14700	0.00000	53.58500	3
95	2.44700	0.00000	53.58500	3
96	.09854	.01640	53.58500	1
97	.92625	.15400	53.58500	2
98	1.17286	.19500	53.58500	3
99	2.13807	.19500	53.58500	3
100	2.43913	.19500	53.58500	3
101	.07071	.07071	53.58500	1
102	.66397	.66397	53.58500	2
103	.84075	.84075	53.58500	3
104	1.51816	1.51816	53.58500	3
105	1.73029	1.73029	53.58500	3
106	.10000	0.00000	64.83500	1
107	.93900	0.00000	64.83500	2
108	1.18900	0.00000	64.83500	3
109	2.14700	0.00000	64.83500	3
110	2.34700	0.00000	64.83500	3
111	.09854	.01640	64.83500	1
112	.92625	.15400	64.83500	2
113	1.17286	.19500	64.83500	3
114	2.13807	.19500	64.83500	3
115	2.33892	.19500	64.83500	3
116	.07071	.07071	64.83500	1
117	.66397	.66397	64.83500	2
118	.84075	.84075	64.83500	3
119	1.51816	1.51816	64.83500	3
120	1.65958	1.65958	64.83500	3

1	1	2	7	6	16	17	22	21	1
2	2	3	8	7	17	18	23	22	1
3	3	4	9	8	18	19	24	23	2
4	6	7	12	11	21	22	27	26	1
5	7	8	13	12	22	23	28	27	2
6	16	17	22	21	31	32	37	36	1
7	17	18	23	22	32	33	39	37	1
8	18	19	24	23	33	34	39	38	2

9	21	22	27	26	36	37	42	41	1
10	22	23	28	27	37	38	43	42	2
11	31	32	37	36	46	47	52	51	1
12	32	33	38	37	47	48	53	52	2
13	36	37	42	41	51	52	57	56	1
14	37	38	43	42	52	53	58	57	2
15	46	47	52	51	61	62	67	66	2
16	51	52	57	56	66	67	72	71	2
17	61	62	67	66	76	77	82	81	2
18	66	67	72	71	81	82	87	86	2
19	76	77	82	81	91	92	97	96	2
20	81	82	87	86	96	97	102	101	2
21	91	92	97	96	106	107	112	111	2
22	96	97	102	101	111	112	117	116	2
23	4	5	10	9	19	20	25	24	3
24	8	9	14	13	23	24	29	28	3
25	9	10	15	14	24	25	30	29	3
26	19	20	25	24	34	35	40	39	3
27	23	24	29	28	38	39	44	43	3
28	24	25	30	29	39	40	45	44	3
29	33	34	39	38	48	49	54	53	3
30	34	35	40	39	49	50	55	54	3
31	38	39	44	43	53	54	59	58	3
32	39	40	45	44	54	55	60	59	3
33	47	48	53	52	62	63	68	67	3
34	48	49	54	53	63	64	69	68	3
35	49	50	55	54	64	65	70	69	3
36	52	53	58	57	67	68	73	72	3
37	53	54	59	58	68	69	74	73	3
38	54	55	60	59	69	70	75	74	3
39	62	63	68	67	77	78	83	82	3
40	63	64	69	68	78	79	84	83	3
41	64	65	70	69	79	80	85	84	3
42	67	68	73	72	82	83	88	87	3
43	68	69	74	73	83	84	89	88	3
44	69	70	75	74	84	85	90	89	3
45	77	78	83	82	92	93	98	97	3
46	78	79	84	83	93	94	99	98	3
47	79	80	85	84	94	95	100	99	3
48	82	83	88	87	97	98	103	102	3
49	83	84	89	88	98	99	104	103	3
50	84	85	90	89	99	100	105	104	3
51	92	93	98	97	107	108	113	112	3
52	93	94	99	98	108	109	114	113	3
53	94	95	100	99	109	110	115	114	3
54	97	98	103	102	112	113	118	117	3
55	98	99	104	103	113	114	119	118	3
56	99	100	105	104	114	115	120	119	3

1	9	8	23	24	1
2	8	13	28	23	1
3	24	23	38	39	1
4	23	28	43	38	1
5	4	9	24	19	1
6	19	24	39	34	1
7	33	38	53	48	1
8	38	43	58	53	1
9	47	52	67	62	1
10	52	57	72	67	1
11	62	67	82	77	1
12	67	72	87	82	1
13	77	82	97	92	1
14	82	87	102	97	1
15	92	97	112	107	1
16	97	102	117	112	1

Input to FLAP3

```
FLAP3    -    FINOCYL
   120   16     4   45.0
    22   20.59    .000000115
     0 0.0001656   0.5       1180.0       625.0
     1     0    5
     0     1    5
     0     1    5
        10.0          0.0
         1.0          1.0        1.0          1.0
     1      .10000   0.00000   0.00000   1
     2      .93900   0.00000   0.00000   1
     3     1.18900   0.00000   0.00000   1
     4     2.14700   0.00000   0.00000   2
     5     2.34700   0.00000   0.00000   3
     6      .09864    .01640   0.00000   1
     7      .92625    .15400   0.00000   1
     8     1.17286    .19500   0.00000   2
     9     2.13807    .19500   0.00000   2
    10     2.33882    .19500   0.00000   3
    11      .07071    .07071   0.00000   1
    12      .66397    .66397   0.00000   1
    13      .84075    .84075   0.00000   2
    14     1.51816   1.51816   0.00000   3
    15     1.65958   1.65958   0.00000   3
    16      .10000   0.00000   8.13000   1
    17      .93900   0.00000   8.13000   1
    18     1.18900   0.00000   8.13000   1
    19     2.14700   0.00000   8.13000   2
    20     2.43300   0.00000   8.13000   3
    21      .09864    .01640   8.13000   1
    22      .92625    .15400   8.13000   1
    23     1.17286    .19500   8.13000   2
    24     2.13807    .19500   8.13000   2
    25     2.42508    .19500   8.13000   3
    26      .07071    .07071   8.13000   1
    27      .66397    .66397   8.13000   1
    28      .84075    .84075   8.13000   2
    29     1.51816   1.51816   8.13000   3
    30     1.72039   1.72039   8.13000   3
    31      .10000   0.00000  16.26000   1
    32      .93900   0.00000  16.26000   1
    33     1.18900   0.00000  16.26000   2
    34     2.14700   0.00000  16.26000   2
    35     2.43300   0.00000  16.26000   3
    36      .09864    .01640  16.26000   1
    37      .92625    .15400  16.26000   1
    38     1.17286    .19500  16.26000   2
    39     2.13807    .19500  16.26000   2
    40     2.42508    .19500  16.26000   3
    41      .07071    .07071  16.26000   1
    42      .66397    .66397  16.26000   1
    43      .84075    .84075  16.26000   2
    44     1.51816   1.51816  16.26000   3
    45     1.72039   1.72039  16.26000   3
    46      .10000   0.00000  19.91000   1
```

AD-A044 583 VANDERBILT UNIV NASHVILLE TENN DEPT OF CIVIL ENGINEERING F/G 21/8.2
USER'S MANUAL FOR FLAP 3.(U)
JUL 77 R M HACKETT

UNCLASSIFIED DRDMI-TK-77-4 NL

Cur. 2
AD
A044583

END
DATE
FILMED
10-77
DDC

47	.93900	0.00000	19.91000	2
48	1.18900	0.00000	19.91000	2
49	2.14700	0.00000	19.91000	3
50	2.44700	0.00000	19.91000	3
51	.09864	.01640	19.91000	1
52	.92625	.15400	19.91000	2
53	1.17286	.19500	19.91000	2
54	2.13807	.19500	19.91000	3
55	2.43913	.19500	19.91000	3
56	.07071	.07071	19.91000	1
57	.66397	.66397	19.91000	2
58	.84075	.84075	19.91000	2
59	1.51816	1.51816	19.91000	3
60	1.73029	1.73029	19.91000	3
61	.10000	0.00000	31.08500	1
62	.93900	0.00000	31.08500	2
63	1.18900	0.00000	31.08500	3
64	2.14700	0.00000	31.08500	3
65	2.44700	0.00000	31.08500	3
66	.09864	.01640	31.08500	1
67	.92625	.15400	31.08500	2
68	1.17286	.19500	31.08500	3
69	2.13807	.19500	31.08500	3
70	2.43913	.19500	31.08500	3
71	.07071	.07071	31.08500	1
72	.66397	.66397	31.08500	2
73	.84075	.84075	31.08500	3
74	1.51816	1.51816	31.08500	3
75	1.73029	1.73029	31.08500	3
76	.10000	0.00000	42.33500	1
77	.93900	0.00000	42.33500	2
78	1.18900	0.00000	42.33500	3
79	2.14700	0.00000	42.33500	3
80	2.44700	0.00000	42.33500	3
81	.09864	.01640	42.33500	1
82	.92625	.15400	42.33500	2
83	1.17286	.19500	42.33500	3
84	2.13807	.19500	42.33500	3
85	2.43913	.19500	42.33500	3
86	.07071	.07071	42.33500	1
87	.66397	.66397	42.33500	2
88	.84075	.84075	42.33500	3
89	1.51816	1.51816	42.33500	3
90	1.73029	1.73029	42.33500	3
91	.10000	0.00000	53.58500	1
92	.93900	0.00000	53.58500	2
93	1.18900	0.00000	53.58500	3
94	2.14700	0.00000	53.58500	3
95	2.44700	0.00000	53.58500	3
96	.09864	.01640	53.58500	1
97	.92625	.15400	53.58500	2
98	1.17286	.19500	53.58500	3
99	2.13807	.19500	53.58500	3
100	2.43913	.19500	53.58500	3
101	.07071	.07071	53.58500	1

102	.66397	.66397	53.58500	2
103	.84075	.84075	53.58500	3
104	1.51816	1.51816	53.58500	3
105	1.73029	1.73029	53.58500	3
106	.10000	0.00000	64.83500	1
107	.93900	0.00000	64.83500	2
108	1.18900	0.00000	64.83500	3
109	2.14700	0.00000	64.83500	3
110	2.34700	0.00000	64.83500	3
111	.09864	.01640	64.83500	1
112	.92625	.15400	64.83500	2
113	1.17286	.19500	64.83500	3
114	2.13807	.19500	64.83500	3
115	2.33882	.19500	64.83500	3
116	.07071	.07071	64.83500	1
117	.66397	.66397	64.83500	2
118	.84075	.84075	64.83500	3
119	1.51816	1.51816	64.83500	3
120	1.65958	1.65958	64.83500	3

1	1	2	7	6	16	17	22	21	1
2	2	3	8	7	17	18	23	22	1
3	3	4	9	8	18	19	24	23	2
4	6	7	12	11	21	22	27	26	1
5	7	8	13	12	22	23	28	27	2
6	16	17	22	21	31	32	37	36	1
7	17	18	23	22	32	33	38	37	1
8	18	19	24	23	33	34	39	38	2
9	21	22	27	26	36	37	42	41	1
10	22	23	28	27	37	38	43	42	2
11	31	32	37	36	46	47	52	51	1
12	32	33	38	37	47	48	53	52	2
13	36	37	42	41	51	52	57	56	1
14	37	38	43	42	52	53	58	57	2
15	46	47	52	51	61	62	67	66	2
16	51	52	57	56	66	67	72	71	2
17	61	62	67	66	76	77	82	81	2
18	66	67	72	71	81	82	87	86	2
19	76	77	82	81	91	92	97	96	2
20	81	82	87	86	96	97	102	101	2
21	91	92	97	96	106	107	112	111	2
22	96	97	102	101	111	112	117	116	2

1	9	8	23	24	1
2	8	13	28	23	1
3	24	23	38	39	1
4	23	28	43	38	1
5	4	9	24	19	1
6	19	24	39	34	1
7	33	38	53	48	1
8	38	43	58	53	1
9	52	57	72	67	1
10	47	52	67	62	1
11	62	67	82	77	1
12	67	72	87	82	1
13	77	82	97	92	1
14	82	87	102	97	1
15	92	97	112	107	1
16	97	102	117	112	1

Output from FLAP3

```
CARD I      TITLE.

            FLAP3   -   FINOCYL

CARD II.    SECTION GEOMETRY IDENTIFIERS.

            TOTAL NUMBER OF NODES ( NOD )                           =   120
            NUMBER OF INTERFACE SURFACES ( NIS)                     =    16
            NUMBER OF SLOTS ( NSLOT )                               =     4
            ANGLE OF SMALLEST REPEATING SEGMENT ( ANGLE )           =  45.00

CARD III.   FLUID PROPERTIES.

            NUMBER OF FLUID BRICKS ( NFB )                          =    22
            BULK MODULUS ( BULK )                                   =  20.5930
            FLUID MASS DENSITY ( FDEN )                             =  1.15000000E-07

CARD IV.    SOLID PROPERTIES.

            NUMBER OF SOLID BRI[illegible]SB )                      =     0
            SOLID MASS DENSITY [illegible] )                        =  1.65600000E-04
            POISSON RATIO ( PRT )                                   =   .50
            STORAGE MODULUS ( GR)                                   =      1180.00
            LOSS MODULUS ( GI )                                     =       625.00

            HARMONICS   ( ZERO FOR UNREQUESTED HARMONIC )
                        (  ONE FOR   REQUESTED HARMONIC )

CARD V.     ZERO HARMONIC ( ZHAR)                                   =   1
            INITIAL ZERO HARMONIC MODE ( IZM )                      =   0
            LAST    ZERO HARMONIC MODE ( LZM )                      =   5

CARD VI.    M/2  HARMONIC ( MHAR)                                   =   0
            INITIAL M/2  HARMONIC MODE ( IMM )                      =   1
            LAST    M/2  HARMONIC MODE ( LMM )                      =   5

CARD VII.   K    HARMONIC ( KHAR)                                   =   0
            INITIAL K    HARMONIC MODE ( IKM )                      =   1
            LAST    K    HARMONIC MODE ( LKM )                      =   5
            NUMBER OF K  HARMONICS EXISTING ( NKM )                 =   1
```

CARD IX.   COMBUSTION PARAMETERS.

SPEED OF GAS LEAVING THE BURNING SURFACE (GSPEED) = 10.00
MASS FRACTION OF PARTICULATE MATERIAL (CCM) = 0.00

CARD X.   RESPONSE FACTORS.

PRESSURE COUPLING (RPC) = 1.000
VELOCITY COUPLING (RVC) = 1.000
FLOW TURNING (RFT) = 1.000
STRUCTURAL DAMPING (RSD) = 1.000

CARD XI.   NODES AND THEIR COORDINATES.

NODAL POINT	X - COORDINATE	Y - COORDINATE	Z - COORDINATE	NODE DESCRIPTION
1	.10000	0.00000	0.00000	1
2	.93900	0.00000	0.00000	1
3	1.18900	0.00000	0.00000	1
4	2.14700	0.00000	0.00000	2
5	2.34700	0.00000	0.00000	3
6	.09864	.01540	0.00000	1
7	.92625	.15400	0.00000	1
8	1.17286	.19500	0.00000	2
9	2.13807	.19500	0.00000	2
10	2.33582	.19500	0.00000	3
11	.07071	.07071	0.00000	1
12	.66397	.66397	0.00000	1
13	.84075	.84075	0.00000	2
14	1.51816	1.51816	0.00000	3
15	1.65958	1.65958	0.00000	3
16	.10000	0.00000	8.13000	1
17	.93900	0.00000	8.13000	1
18	1.18900	0.00000	8.13000	1
19	2.14700	0.00000	8.13000	2
20	2.43300	0.00000	8.13000	3
21	.09864	.01540	8.13000	1
22	.92625	.15400	8.13000	1
23	1.17286	.19500	8.13000	2
24	2.13807	.19500	8.13000	2
25	2.42508	.19500	8.13000	3
26	.07071	.07071	8.13000	1
27	.66397	.66397	8.13000	1
28	.84075	.84075	8.13000	2
29	1.51816	1.51816	8.13000	3
30	1.72039	1.72039	8.13000	3
31	.10000	0.00000	16.26000	1
32	.93900	0.00000	16.26000	1
33	1.18900	0.00000	16.26000	2
34	2.14700	0.00000	16.26000	2

35	2.43300	0.00000	16.26000	3
36	.09864	.01540	16.26000	1
37	.92625	.15400	16.26000	1
38	1.17286	.19500	16.26000	2
39	2.13807	.19500	16.26000	2
40	2.42508	.19500	16.26000	3
41	.07071	.07071	16.26000	1
42	.66397	.66397	16.26000	1
43	.84075	.84075	16.26000	2
44	1.51816	1.51816	16.26000	3
45	1.72039	1.72039	16.26000	3
46	.10000	0.00000	19.91000	1
47	.93900	0.00000	19.91000	2
48	1.18900	0.00000	19.91000	2
49	2.14700	0.00000	19.91000	3
50	2.44700	0.00000	19.91000	3
51	.09864	.01540	19.91000	1
52	.92625	.15400	19.91000	2
53	1.17286	.19500	19.91000	2
54	2.13807	.19500	19.91000	3
55	2.43913	.19500	19.91000	3
56	.07071	.07071	19.91000	1
57	.66397	.66397	19.91000	2
58	.84075	.84075	19.91000	2
59	1.51816	1.51816	19.91000	3
60	1.73029	1.73029	19.91000	3
61	.10000	0.00000	31.08500	1
62	.93900	0.00000	31.08500	2
63	1.18900	0.00000	31.08500	3
64	2.14700	0.00000	31.08500	3
65	2.44700	0.00000	31.08500	3
66	.09864	.01540	31.08500	1
67	.92625	.15400	31.08500	2
68	1.17286	.19500	31.08500	3
69	2.13807	.19500	31.08500	3
70	2.43913	.19500	31.08500	3
71	.07071	.07071	31.08500	1
72	.66397	.66397	31.08500	2
73	.84075	.84075	31.08500	3
74	1.51816	1.51816	31.08500	3
75	1.73029	1.73029	31.08500	3
76	.10000	0.00000	42.33500	1
77	.93900	0.00000	42.33500	2

78	1.18900	0.00000	42.33500	3
79	2.14700	0.00000	42.33500	3
80	2.44700	0.00000	42.33500	3
81	.09864	.01640	42.33500	1
82	.92625	.15400	42.33500	2
83	1.17286	.19500	42.33500	3
84	2.13807	.19500	42.33500	3
85	2.43913	.19500	42.33500	3
86	.07071	.07071	42.33500	1
87	.66397	.66397	42.33500	2
88	.84075	.84075	42.33500	3
89	1.51816	1.51816	42.33500	3
90	1.73029	1.73029	42.33500	3
91	.10000	0.00000	53.58500	1
92	.93900	0.00000	53.58500	2
93	1.18900	0.00000	53.58500	3
94	2.14700	0.00000	53.58500	3
95	2.44700	0.00000	53.58500	3
96	.09864	.01640	53.58500	1
97	.92625	.15400	53.58500	2
98	1.17286	.19500	53.58500	3
99	2.13807	.19500	53.58500	3
100	2.43913	.19500	53.58500	3
101	.07071	.07071	53.58500	1
102	.66397	.66397	53.58500	2
103	.84075	.84075	53.58500	3
104	1.51816	1.51816	53.58500	3
105	1.73029	1.73029	53.58500	3
106	.10000	0.00000	64.83500	1
107	.93900	0.00000	64.83500	2
108	1.18900	0.00000	64.83500	3
109	2.14700	0.00000	64.83500	3
110	2.34700	0.00000	64.83500	3
111	.09864	.01640	64.83500	1
112	.92625	.15400	64.83500	2
113	1.17286	.19500	64.83500	3
114	2.13807	.19500	64.83500	3
115	2.33882	.19500	64.83500	3
116	.07071	.07071	64.83500	1
117	.66397	.66397	64.83500	2
118	.84075	.84075	64.83500	3
119	1.51816	1.51816	64.83500	3
120	1.65958	1.65958	64.83500	3

CARD XII. ELEMENT - NODE RELATIONSHIP.

BRICK	NODES								BRICK DESCRIPTION
1	1	2	7	6	16	17	22	21	1
2	2	3	8	7	17	18	23	22	1
3	3	4	9	8	18	19	24	23	2
4	6	7	12	11	21	22	27	26	1
5	7	8	13	12	22	23	28	27	2
6	16	17	22	21	31	32	37	36	1
7	17	18	23	22	32	33	38	37	1
8	18	19	24	23	33	34	39	38	2
9	21	22	27	26	36	37	42	41	1
10	22	23	28	27	37	38	43	42	2
11	31	32	37	36	46	47	52	51	1
12	32	33	38	37	47	48	53	52	2
13	36	37	42	41	51	52	57	56	1
14	37	38	43	42	52	53	58	57	2
15	46	47	52	51	61	62	67	66	2
16	51	52	57	56	66	67	72	71	2
17	61	62	67	66	76	77	82	81	2
18	66	67	72	71	81	82	87	86	2
19	76	77	82	81	91	92	97	96	2
20	81	82	87	86	96	97	102	101	2
21	91	92	97	96	106	107	112	111	2
22	96	97	102	101	111	112	117	116	2

CARD XIII. QUADRILATERAL INTERFACE SURFACES AND THEIR NODES AND SURFACE DESCRIPTION.

1	9	8	23	24	1
2	8	13	28	23	1
3	24	23	38	39	1
4	23	28	43	38	1
5	4	9	24	19	1
6	19	24	39	34	1
7	33	38	53	48	1
8	38	43	58	53	1
9	52	57	72	67	1
10	47	52	67	62	1
11	62	67	82	77	1
12	67	72	87	82	1
13	77	82	97	92	1
14	82	87	102	97	1
15	92	97	112	107	1
16	97	102	117	112	1

POTENTIAL FLOW ANALYSIS

INTERFACE	TETRAHEDRA AND THEIR NODES				NODES ON INTERFACE			SURFACE AREAS	VELOCITIES		
	I	J	L	M	II	JJ	KK		VX	VY	VZ
1	24	19	23	9	24	23	9	3.9236	-3.84[illegible]	-11.624	-831.795
2	23	8	9	3	23	8	9	3.9236	[illegible]	0.000	-831.339
3	4	9	3	19	4	9	19	.7935	0.00[illegible]	0.000	-831.52[illegible]
4	28	23	27	13	28	23	13	2.9518	-17.021	-12.387	-831.623
5	8	13	7	23	8	13	23	2.9518	0.00[illegible]	0.000	-831.339
6	39	34	33	24	39	38	24	3.9236	5.[illegible]31	-4.238	-513.792
7	38	23	24	18	38	23	24	3.9236	-3.84[illegible]	5.811	-514.845
8	19	24	18	34	19	24	34	.7935	-.291	-11.451	-513.353
9	43	38	42	28	43	38	28	2.9518	-9.68[illegible]	-27.280	-515.323
10	23	28	22	38	23	28	38	2.9518	-10.447	-9.006	-514.845
11	53	48	52	38	53	48	38	.3571	46.32[illegible]	15.556	-555.353
12	33	38	32	48	33	38	48	.3571	21.65[illegible]	-2.045	-555.885
13	58	53	57	43	58	53	43	1.3252	32.[illegible]51	9.859	-553.291
14	38	43	37	53	38	43	53	1.3252	19.435	-12.240	-556.353
15	67	62	66	52	67	62	52	.8634	-1.442	-5.231	-881.341
16	47	52	46	62	47	52	62	.8634	.943	-.454	-881.277
17	72	67	71	57	72	67	57	3.2042	-2.84[illegible]	-5.274	-881.549
18	62	57	51	67	62	57	67	3.2042	.[illegible]	1.074	-881.341
19	82	77	81	67	82	77	67	.8692	-3.735	-3.652	-630.175
20	62	67	61	77	62	67	77	.8692	-1.321	-5.271	-630.231
21	87	82	86	72	87	82	72	3.2257	-4.551	-4.413	-630.397
22	67	72	66	82	67	72	82	3.2257	-1.55[illegible]	-4.613	-630.175
23	97	92	96	82	97	92	82	.8692	-4.89[illegible]	-1.954	-378.395
24	77	82	76	92	77	82	92	.8692	-3.612	-3.645	-378.12[illegible]
25	102	97	101	87	102	97	87	3.2257	-5.10[illegible]	-3.674	-378.349
26	82	87	81	97	82	87	97	3.2257	-3.63[illegible]	-3.952	-378.095
27	112	107	111	97	112	107	97	.8692	-5.333	-1.557	-126.021
28	92	97	91	107	92	97	107	.8692	-4.84[illegible]	-1.950	-126.027
29	117	112	116	102	117	112	102	3.2257	-5.03[illegible]	-4.55[illegible]	-126.661
30	97	102	96	112	97	102	112	3.2257	-4.[illegible]43	-3.439	-126.021

HARMONIC 0 MODE 0

FREQUENCY 0.000 RAD/SEC 0.000 HZ

SEGMENT 1 R

NODE NUMBER	ACOUSTIC PRESSURE
1	1.00000
2	1.00000
3	1.00000
4	1.00000
6	1.00000
7	1.00000
8	1.00000
9	1.00000
11	1.00000
12	1.00000
13	1.00000
16	1.00000
17	1.00000
18	1.00000
19	1.00000
21	1.00000
22	1.00000
23	1.00000
24	1.00000
26	1.00000
27	1.00000
28	1.00000
31	1.00000
32	1.00000
33	1.00000
34	1.00000
36	1.00000
37	1.00000
38	1.00000
39	1.00000
41	1.00000
42	1.00000
43	1.00000
46	1.00000
47	1.00000
48	1.00000
51	1.00000
52	1.00000
53	1.00000
56	1.00000
57	1.00000
58	1.00000
61	1.00000
62	1.00000
66	1.00000
67	1.00000
71	1.00000
72	1.00000
76	1.00000

77	1.00000
81	1.00000
82	1.00000
86	1.00000
87	1.00000
91	1.00000
92	1.00000
96	1.00000
97	1.00000
101	1.00000
102	1.00000
106	1.00000
107	1.00000
111	1.00000
112	1.00000
116	1.00000
117	1.00000

SEGMENT 1 L

NODE NUMBER	ACOUSTIC PRESSURE
1	1.00000
2	1.00000
3	1.00000
4	1.00000
6	1.00000
7	1.00000
8	1.00000
9	1.00000
11	1.00000
12	1.00000
13	1.00000
16	1.00000
17	1.00000
18	1.00000
19	1.00000
21	1.00000
22	1.00000
23	1.00000
24	1.00000
26	1.00000
27	1.00000
28	1.00000
31	1.00000
32	1.00000
33	1.00000
34	1.00000
36	1.00000
37	1.00000
38	1.00000
39	1.00000
41	1.00000
42	1.00000
43	1.00000
46	1.00000
47	1.00000
48	1.00000
51	1.00000
52	1.00000

53	1.00000
56	1.00000
57	1.00000
58	1.00000
61	1.00000
62	1.00000
66	1.00000
67	1.00000
71	1.00000
72	1.00000
76	1.00000
77	1.00000
81	1.00000
82	1.00000
86	1.00000
87	1.00000
91	1.00000
92	1.00000
96	1.00000
97	1.00000
101	1.00000
102	1.00000
106	1.00000
107	1.00000
111	1.00000
112	1.00000
116	1.00000
117	1.00000

HARMONIC 0 MODE 1

FREQUENCY 582.488 RAD/SEC 92.706 HZ

SEGMENT 1 R

NODE NUMBER	ACOUSTIC PRESSURE
1	-.58327
2	-.58333
3	-.58333
4	-.58361
6	-.58327
7	-.58334
8	-.58333
9	-.58363
11	-.58327
12	-.58334
13	-.58334
16	-.54743
17	-.54753
18	-.54753
19	-.54795
21	-.54744
22	-.54755
23	-.54757
24	-.54797
26	-.54746
27	-.54750
28	-.54743
31	-.44427
32	-.44444
33	-.44472
34	-.44546
36	-.44427
37	-.44446
38	-.44472
39	-.44549
41	-.44432
42	-.44434
43	-.44419
46	-.35777
47	-.35799
48	-.35845
51	-.35777
52	-.35799
53	-.35854
56	-.35783
57	-.35802
58	-.35844
61	.11556
62	.11538
65	.11556
67	.11541
71	.11550
72	.11553
76	.56532

77	.56522
81	.56532
82	.56524
86	.56527
87	.56532
91	.88473
92	.88468
96	.88473
97	.88469
101	.88471
102	.88473
106	1.00014
107	1.00012
111	1.00014
112	1.00012
116	1.00014
117	1.00000

SEGMENT 1 L

NODE NUMBER	ACOUSTIC PRESSURE
1	-.58327
2	-.58333
3	-.58333
4	-.58361
6	-.58327
7	-.58334
8	-.58333
9	-.58363
11	-.58327
12	-.58334
13	-.58334
16	-.54743
17	-.54753
18	-.54753
19	-.54795
21	-.54744
22	-.54755
23	-.54757
24	-.54797
26	-.54746
27	-.54750
28	-.54743
31	-.44427
32	-.44444
33	-.44472
34	-.44546
36	-.44427
37	-.44446
38	-.44472
39	-.44549
41	-.44432
42	-.44434
43	-.44419
46	-.35777
47	-.35799
48	-.35845
51	-.35777
52	-.35799

53	-.35854
56	-.35783
57	-.35802
58	-.35844
61	.11556
62	.11538
66	.11556
67	.11541
71	.11550
72	.11553
76	.56532
77	.56522
81	.56532
82	.56524
86	.56527
87	.56532
91	.88473
92	.88468
96	.88473
97	.88459
101	.88471
102	.88473
106	1.00014
107	1.00012
111	1.00014
112	1.00012
116	1.00014
117	1.00009

ZERO HARMONIC   MODE 1

ALPHPC = 2.03
ALPHVC = -1.40
ALPHFT = -3.55
ALPHSD = 0.00
ALPHA = -3.03

HARMONIC 0 MODE 2

FREQUENCY 1392.654 RAD/SEC 221.648 HZ

SEGMENT 1 R

NODE NUMBER	ACOUSTIC PRESSURE
1	.47280
2	.47298
3	.47296
4	.47378
6	.47280
7	.47300
8	.47295
9	.47385
11	.47281
12	.47303
13	.47300
16	.32136
17	.32164
18	.32162
19	.32290
21	.32137
22	.32168
23	.32176
24	.32292
26	.32145
27	.32153
28	.32128
31	-.03631
32	-.03582
33	-.03501
34	-.03286
36	-.03630
37	-.03578
38	-.03504
39	-.03277
41	-.03616
42	-.03615
43	-.03656
46	-.26458
47	-.26403
48	-.26298
51	-.26458
52	-.26405
53	-.26280
56	-.26445
57	-.26417
58	-.26312
61	-.98112
62	-.98080
66	-.98113
67	-.98089
71	-.98110
72	-.98103
76	-.60965

77	-.60961
81	-.60966
82	-.60965
86	-.60976
87	-.60939
91	.44211
92	.44207
96	.44210
97	.44208
101	.44199
102	.44238
106	1.00053
107	1.00057
111	1.00053
112	1.00058
116	1.00052
117	1.00000

SEGMENT 1 L

NODE NUMBER	ACOUSTIC PRESSURE
1	.47280
2	.47298
3	.47296
4	.47378
6	.47280
7	.47300
8	.47295
9	.47385
11	.47281
12	.47303
13	.47300
16	.32136
17	.32164
18	.32162
19	.32290
21	.32137
22	.32168
23	.32176
24	.32292
26	.32145
27	.32153
28	.32128
31	-.03631
32	-.03582
33	-.03501
34	-.03286
36	-.03630
37	-.03578
38	-.03504
39	-.03277
41	-.03616
42	-.03615
43	-.03656
46	-.26458
47	-.26403
48	-.26298
51	-.26458
52	-.26405

53	-.26280
56	-.26445
57	-.26417
58	-.26312
61	-.98112
62	-.98080
66	-.98113
67	-.98089
71	-.98110
72	-.98103
76	-.60965
77	-.60961
81	-.60966
82	-.60965
86	-.60976
87	-.60939
91	.44211
92	.44207
96	.44210
97	.44208
101	.44199
102	.44238
106	1.00053
107	1.00057
111	1.00053
112	1.00058
116	1.00052
117	1.00000

ZERO HARMONIC MODE 2

ALPHPC = 1.37
ALPHVC = -1.58
ALPHFT = -4.27
ALPHSD = 0.10
ALPHA = -3.38

HARMONIC 0 MODE 3

FREQUENCY 2188.131 RAD/SEC 348.252 HZ

SEGMENT 1 R

NODE NUMBER	ACOUSTIC PRESSURE
1	-.86844
2	-.86860
3	-.86857
4	-.86989
6	-.86845
7	-.86867
8	-.86850
9	-.87009
11	-.86845
12	-.86885
13	-.86875
16	-.27503
17	-.27545
18	-.27544
19	-.27774
21	-.27506
22	-.27552
23	-.27580
24	-.27756
26	-.27529
27	-.27512
28	-.27449
31	.69532
32	.69463
33	.69325
34	.68976
36	.69530
37	.69462
38	.69335
39	.68952
41	.69508
42	.69519
43	.69572
46	.94781
47	.94741
48	.94697
51	.94782
52	.94751
53	.94694
56	.94776
57	.94777
58	.94696
61	.24426
62	.24425
66	.24427
67	.24429
71	.24443
72	.24352
76	-.98723

77	-.98727
81	-.98723
82	-.98732
86	-.98719
87	-.98736
91	-.08221
92	-.08244
95	-.08222
97	-.08241
101	-.08238
102	-.08155
106	1.00094
107	1.00089
111	1.00094
112	1.00095
116	1.00090
117	1.00000

SEGMENT 1 L

NODE NUMBER	ACOUSTIC PRESSURE
1	-.86644
2	-.86660
3	-.86857
4	-.86989
6	-.86845
7	-.86867
8	-.86650
9	-.87009
11	-.86845
12	-.86885
13	-.86875
16	-.27503
17	-.27545
18	-.27544
19	-.27774
21	-.27506
22	-.27552
23	-.27580
24	-.27756
26	-.27529
27	-.27512
28	-.27449
31	.69532
32	.69463
33	.69325
34	.68976
36	.69536
37	.69452
38	.69335
39	.68952
41	.69508
42	.69519
43	.69572
46	.94781
47	.94741
48	.94697
51	.94782
52	.94751

53	.94694
56	.94776
57	.94777
58	.94696
61	.24426
62	.24425
66	.24427
67	.24429
71	.24443
72	.24352
76	-.98723
77	-.98727
81	-.98723
82	-.98732
86	-.98719
87	-.98736
91	-.08221
92	-.08244
96	-.08222
97	-.08241
101	-.08238
102	-.08155
106	1.00094
107	1.00089
111	1.00094
112	1.00695
116	1.00090
117	1.00000

ZERO HARMONIC MODE 3

ALPHPC = .39
ALPHVC = -.33
ALPHFT = -3.10
ALPHSD = 0.00
ALPHA = -3.14

HARMONIC 0 MODE 4

FREQUENCY 2875.811 RAD/SEC 457.700 HZ

SEGMENT 1 R

NODE NUMBER	ACOUSTIC PRESSURE
1	.58778
2	.58756
3	.58756
4	.58743
6	.58778
7	.58752
8	.58747
9	.58757
11	.58777
12	.58783
13	.58776
16	-.00690
17	-.00695
18	-.00693
19	-.00670
21	-.00689
22	-.00695
23	-.00671
24	-.00706
26	-.00671
27	-.00718
28	-.00752
31	-.58732
32	-.58749
33	-.58748
34	-.58772
36	-.58733
37	-.58758
38	-.58755
39	-.58759
41	-.58735
42	-.58742
43	-.58714
46	-.41116
47	-.41182
48	-.41335
51	-.41116
52	-.41183
53	-.41360
56	-.41135
57	-.41140
58	-.41257
61	.99881
62	.99844
66	.99883
67	.99855
71	.99884
72	.99847
76	-.53817

77	-.53816
81	-.53817
82	-.53816
86	-.53801
87	-.53906
91	-.48121
92	-.48146
96	-.48122
97	-.48147
101	-.48136
102	-.48033
106	1.00104
107	1.00094
111	1.00104
112	1.00102
116	1.00100
117	1.00000

SEGMENT 1 L

NODE NUMBER	ACOUSTIC PRESSURE
1	.58778
2	.58756
3	.58756
4	.58743
6	.58778
7	.58762
8	.58747
9	.58757
11	.58777
12	.58783
13	.58776
16	-.00690
17	-.00695
18	-.00693
19	-.00670
21	-.00689
22	-.00695
23	-.00671
24	-.00706
26	-.00671
27	-.00718
28	-.00752
31	-.58732
32	-.58749
33	-.58748
34	-.58772
36	-.58733
37	-.58758
38	-.58755
39	-.58759
41	-.58735
42	-.58742
43	-.58714
46	-.41116
47	-.41182
48	-.41335
51	-.41116
52	-.41183

53	-.41360
56	-.41135
57	-.41140
58	-.41257
61	.99881
62	.99844
66	.99883
67	.99655
71	.99884
72	.99847
76	-.53817
77	-.53816
81	-.53817
82	-.53816
86	-.53801
87	-.53906
91	-.48121
92	-.48146
96	-.48122
97	-.48147
101	-.48136
102	-.48033
106	1.00104
107	1.00094
111	1.00104
112	1.00102
116	1.00100
117	1.00000

ZERO HARMONIC MODE 4

ALPHPC = 1.05
ALPHVC = -.07
ALPHFT = -3.43
ALPHSD = 0.00
ALPHA = -2.45

HARMONIC 0 MODE 5

FREQUENCY 3871.957 RAD/SEC 616.238 HZ

SEGMENT 1 R

NODE NUMBER	ACOUSTIC PRESSURE
1	-.23375
2	-.23350
3	-.23350
4	-.23275
6	-.23376
7	-.23352
8	-.23346
9	-.23279
11	-.23375
12	-.23363
13	-.23362
16	.10233
17	.10253
18	.10251
19	.10338
21	.10233
22	.10256
23	.10246
24	.10364
26	.10227
27	.10258
28	.10260
31	.14249
32	.14291
33	.14353
34	.14540
36	.14251
37	.14297
38	.14355
39	.14539
41	.14262
42	.14254
43	.14209
46	-.08866
47	-.08609
48	-.08704
51	-.08866
52	-.08814
53	-.08688
56	-.08853
57	-.08856
58	-.08751
61	-.32376
62	-.32358
66	-.32377
67	-.32362
71	-.32388
72	-.32275
76	.67705

77	.67725
81	.67705
82	.67722
86	.67713
87	.67635
91	-.91628
92	-.91619
96	-.91628
97	-.91619
101	-.91633
102	-.91568
106	1.00067
107	1.00068
111	1.00067
112	1.00061
116	1.00068
117	1.00000

SEGMENT 1 L

NODE NUMBER	ACOUSTIC PRESSURE
1	-.23375
2	-.23350
3	-.23350
4	-.23275
6	-.23376
7	-.23352
8	-.23346
9	-.23279
11	-.23375
12	-.23363
13	-.23362
16	.10233
17	.10253
18	.10251
19	.10338
21	.10233
22	.10256
23	.10246
24	.10364
26	.10227
27	.10258
28	.10266
31	.14249
32	.14291
33	.14353
34	.14540
36	.14251
37	.14297
38	.14355
39	.14539
41	.14262
42	.14254
43	.14209
46	-.08866
47	-.08809
48	-.08704
51	-.08866
52	-.08814

53	-.08688
56	-.08853
57	-.08856
58	-.08751
61	-.32376
62	-.32358
66	-.32377
67	-.32362
71	-.32388
72	-.32275
76	.67705
77	.67725
81	.67705
82	.67722
86	.67713
87	.67635
91	-.91628
92	-.91619
96	-.91628
97	-.91619
101	-.91633
102	-.91568
106	1.00067
107	1.00068
111	1.00067
112	1.00061
116	1.00068
117	1.00000

ZERO HARMONIC MODE 5

ALPHPC	=	2.31
ALPHVC	=	-.25
ALPHFT	=	-4.27
ALPHSO	=	0.00
ALPHA	=	-2.21

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