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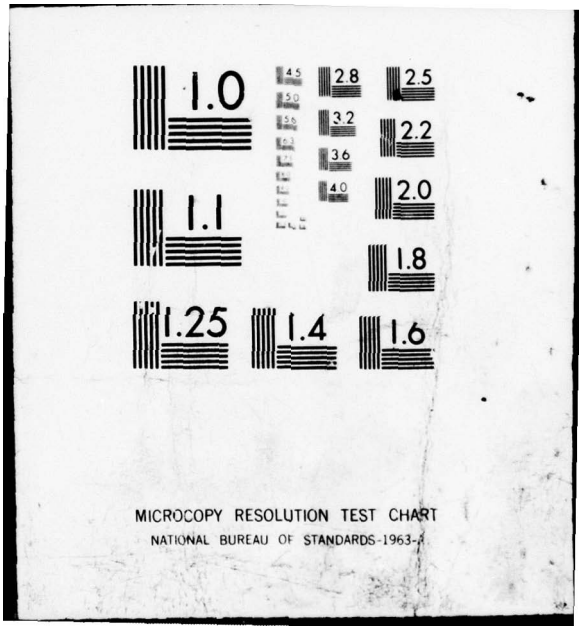
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Technical Report 352

A COMPUTER PROGRAM PACKAGE FOR PROVIDING INPUT TO THE DOUGLAS THREE-DIMENSIONAL POTENTIAL FLOW PROGRAM: A USER'S MANUAL

TS Mautner

30 November 1978

Prepared for:
Naval Sea Systems Command

Final Report

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The work report herein was performed as a portion of research conducted at NOSC within the Torpedo Hydrodynamic and Hydroacoustics Program, funded by the Naval Sea Systems Command (NAVSEA 035), Dr. T. E. Pierce, program manager. The work was performed in the Fluid Mechanics Branch (code 6342), Hydromechanics Division, of the Fleet Engineering Department.

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REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: NOSC TR-352	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): A COMPUTER PROGRAM PACKAGE FOR PROVIDING INPUT TO THE DOUGLAS THREE-DIMENSIONAL POTENTIAL FLOW PROGRAM: A USER'S MANUAL	5. TYPE OF REPORT & PERIOD COVERED: Final Report
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): T.S. Mautner	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Naval Ocean Systems Center, San Diego, CA 92152	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: 61153N, SR02301
11. CONTROLLING OFFICE NAME AND ADDRESS: Naval Sea Systems Command, Washington, DC	12. REPORT DATE: 30 November 1978
	13. NUMBER OF PAGES: 89
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report): UNCLASSIFIED
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

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

This report documents the procedures for using a computer program package designed to calculate and format the coordinates required as input to the Douglas Three-Dimensional Potential Flow Program. The programs calculate the three-dimensional coordinates for axisymmetric bodies, with and without appendages, and the radial and angular distribution of off-body points required to determine velocity profiles for propeller thrust deduction calculations.

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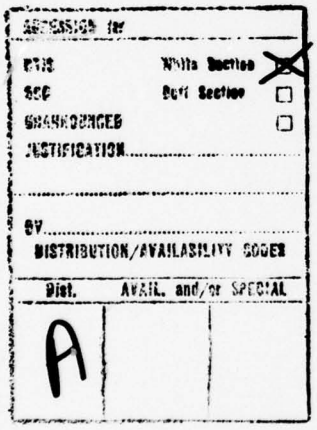
SUMMARY

This report documents the procedures for using a computer program package designed to calculate and format the coordinates required as input to the Douglas Three-Dimensional Potential Flow Program. The programs calculate the three-dimensional coordinates for axisymmetric bodies, with and without appendages, and the radial and angular distribution of off-body points required to determine velocity profiles for propeller thrust deduction calculations.



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CONTENTS

	Page
INTRODUCTION	1
DESCRIPTION OF COMPUTER PROGRAMS	3
Program 1 - AXISYM	3
Program 2 - APNDG1	3
Program 3 - OFFBDY	3
DEFINITION OF TERMS	5
SPECIFICATION OF INPUT QUANTITIES	7
Body Contour	7
Appendage Configuration	7
CALCULATED COORDINATES	11
Appendage Coordinates	11
Body Coordinates	11
DOUGLAS THREE-DIMENSIONAL COORDINATE FORMAT	13
OFF-BODY POINTS	17
INPUT TO COMPUTER PROGRAMS	19
Method of Inputting Tables	19
Definition of Flag Card Variables	20
Input Scheme for Program 1	22
Input Scheme for Program 2	23
Input Scheme for Program 3	25
COMPUTER PRINTOUT	27
Included Items	27
Printout Correspondences	28
Typical Computer Runs	28

CONTENTS

		Page
APPENDIX A	COMPUTER PRINTOUT EXAMPLES	33
APPENDIX B	FORTRAN LISTINGS	55

Figure		Page
1	Typical body contours	8
2	Typical appendage cross section	8
3	Definition of appendage input quantities	9
4	Allowable appendage configurations	10
5	Calculated coordinates - body and appendage	12
6	Organization of input points into rows and columns (Adapted from Douglas Aircraft Company, Report ES40622, "Calculation of Nonlifting Potential Flow About Arbitrary Three-Dimensional Bodies," by J.L. Hess and A.M.O. Smith, March 1962	14
7	Coordinate system for the off-body points	18
8	Body with two planes of symmetry - program 1	29
9	Body with two planes of symmetry - program 2	30
10	Body with three planes of symmetry - program 2	31

INTRODUCTION

Considerable effort is required to prepare the input data required by the Douglas Three-Dimensional Potential Flow Program.[1] Extensive hand calculations are necessary to provide the body coordinates, appendage, body intersection points, and appendage coordinates. These calculations are then organized into the Douglas format and cards are punched and manually checked. Because this procedure is so time consuming, a computer program package was developed to calculate and format the required three-dimensional coordinates.

The development of this package, which consists of three computer programs, is complete. The programs calculate the three-dimensional coordinates for axisymmetric bodies with and without appendages, calculate the radial and angular distribution of off-body points required for propeller thrust deduction calculations, and provide punched card output in the format required by the Douglas program. These programs reduce coordinate data preparation time from 1 week or more to 1 or 2 days, making it possible to provide three-dimensional potential flow analysis in approximately 3 days.

This report documents the procedures for using the computer programs. The text is divided into the following sections: (1) a description of the three programs, (2) a definition of terms, (3) a specification of input quantities, (4) the calculated coordinates, (5) the Douglas program format, (6) off-body points, (7) a description of the schemes used to input the

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1 Douglas Aircraft Company, Report ES40622, "Calculation of Nonlifting Potential Flow about Arbitrary Three-Dimensional Bodies," by J. L. Hess and A.M.O. Smith, March 1962.

data, (8) typical program output including the correspondences between conventional symbols and their computer representation, and (9) a complete FORTRAN listing of the programs and the nonsystem subroutines required by them.

Program development was carried out on a UNIVAC 1110 computer system; however, standard FORTRAN IV was used so that the programs would be easily adaptable to other large computer systems. Although the FORTRAN listings are included for completeness, a copy of the programs may be acquired by contacting the author (a listing, card deck, and check solutions will be provided).

DESCRIPTION OF COMPUTER PROGRAMS

The three computer programs described in this report calculate and format the three-dimensional coordinates for axisymmetric bodies with and without appendages. The programs have been designed to require a minimum of input data and to provide flexibility in the specification of appendage shapes and locations and in the number of output stations along the body. Each program is limited to a maximum of 1000 output points. The three computer programs are as follows.

PROGRAM 1 - AXISYM

This program computes the three-dimensional coordinates for an axisymmetric body without appendages and with one, two, or three planes of symmetry. The final results consist of a maximum of 100 equally spaced body stations.

PROGRAM 2 - APNDG1

The second program computes the three-dimensional coordinates for an axisymmetric body with two or three planes of symmetry and an appendage configuration located in the afterbody region. Some flexibility is provided for the number of output stations along the body and the appendages.

PROGRAM 3 - OFFBDY

The final program calculates the radial and angular distribution of the off-body points required for the construction of the potential flow velocity profiles needed to calculate propeller thrust deduction. The starting points and the radial and angular increments are program inputs.

DEFINITION OF TERMS

C	Appendage chord
h	Appendage half thickness
$\frac{h}{C}$	Appendage nondimensional half thickness
$\frac{h}{C})_{REF}$	Value of $\frac{h}{C}$ for the reference appendage half thickness distribution
m,n	Defines a position in the Douglas formatted coordinate array
t	Maximum thickness of the appendage section
$\frac{t}{C}$	Ratio of appendage section maximum thickness to chord
$\frac{t}{C})_{REF}$	Value of $\frac{t}{C}$ for reference appendage section thickness distribution
X-Y-Z	Cartesian coordinate system
X_B	Appendage nondimensional chordwise coordinate
X_{OB}	X location of the off-body points
X_S	Location of the appendage leading edge
X_O	Appendage leading edge offset
Δ_θ	Angular increment - off-body points
Δ_{yz}	Radial increment - off-body points
θ_S	Starting angle - off-body points

Subscripts

i	Point identifying the beginning of the nonredundant portion of a body having three planes of symmetry
j	Arbitrary point
n	Last point
o	First point
R	Value at the appendage root
T	Value at the appendage tip

SPECIFICATION OF INPUT QUANTITIES

BODY CONTOUR

A rectangular cartesian coordinate system (X,Y,Z) is used to describe both the input and output coordinates. Figure 1 shows a typical axisymmetric body described by the relationship $Z = f(x)$. For bodies with one or two planes of symmetry, the body contour is described by an array of points from (X_o, Z_o) to (X_n, Z_n) (figure 1A). For three planes of symmetry, only the nonredundant portion of the body is input; therefore, the body is described by points from (X_i, Z_i) to (X_n, Z_n) (figure 1B). Regions of large curvature should contain a sufficient number of points so that the contour will be accurately represented.

APPENDAGE CONFIGURATION

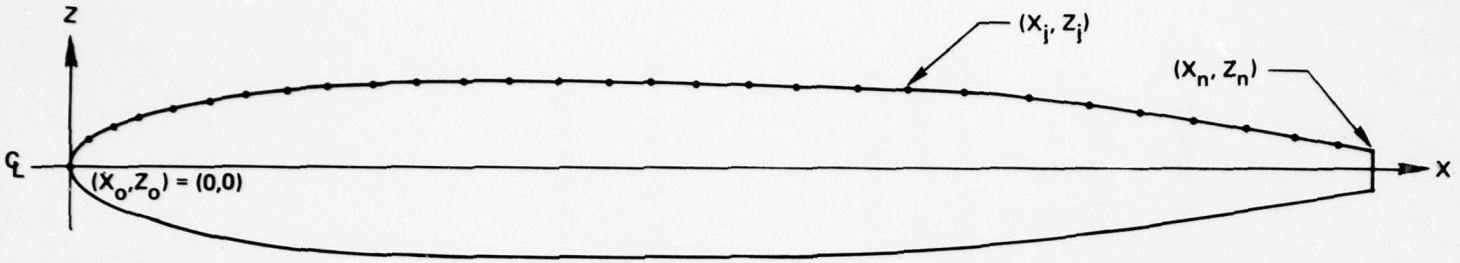
The appendage thickness distribution at all radial stations is derived from the reference nondimensional half-thickness distribution $\left(\frac{h}{C}\right)_{REF} = f(X_B)$ input to program 2. The chordwise variation of the nondimensional half thickness at the appendage root

$$\left(\frac{h}{C}\right)_R \frac{(t/C)_R}{(t/C)_{REF}} f(X_B),$$

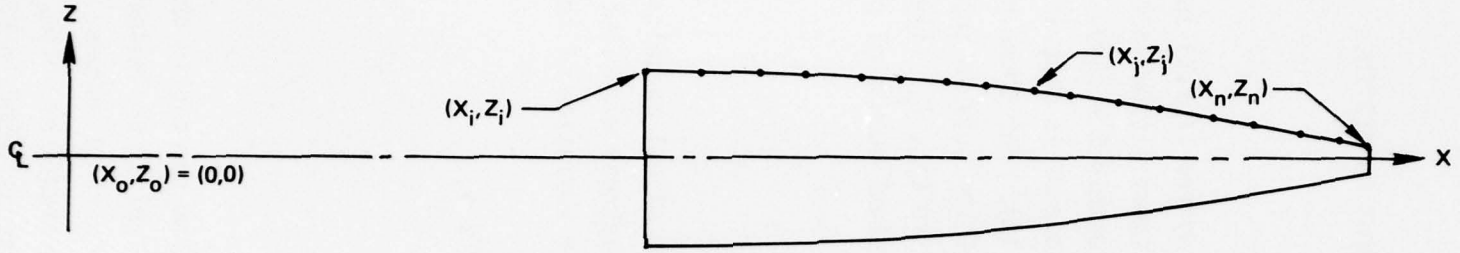
and at the appendage tip

$$\left(\frac{h}{C}\right)_T = \frac{(t/C)_T}{(t/C)_{REF}} f(X_B),$$

is used to calculate a linear variation from the tip to the root of the appendage thickness t. Figure 2 shows a typical appendage cross section; however, appendages are not restricted to airfoil shapes. The additional input appendage quantities are defined in figure 3. Also, to provide flexibility in program 2, any appendage shapes found in figure 4 may be used.



PART A. ONE AND TWO PLANES OF SYMMETRY



PART B. THREE PLANES OF SYMMETRY

Figure 1. Typical body contours.

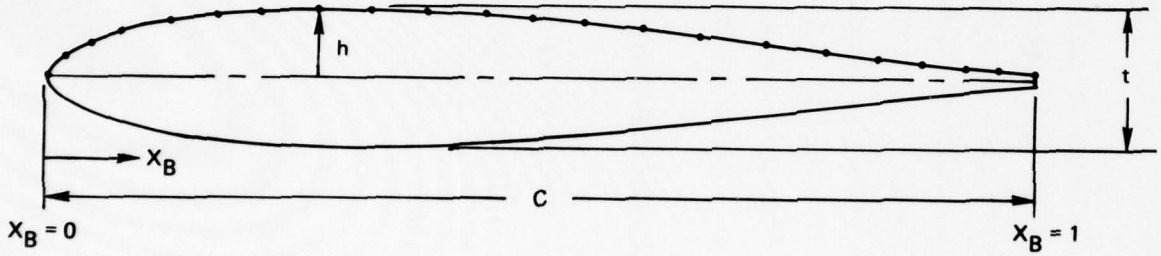


Figure 2. Typical appendage cross section.

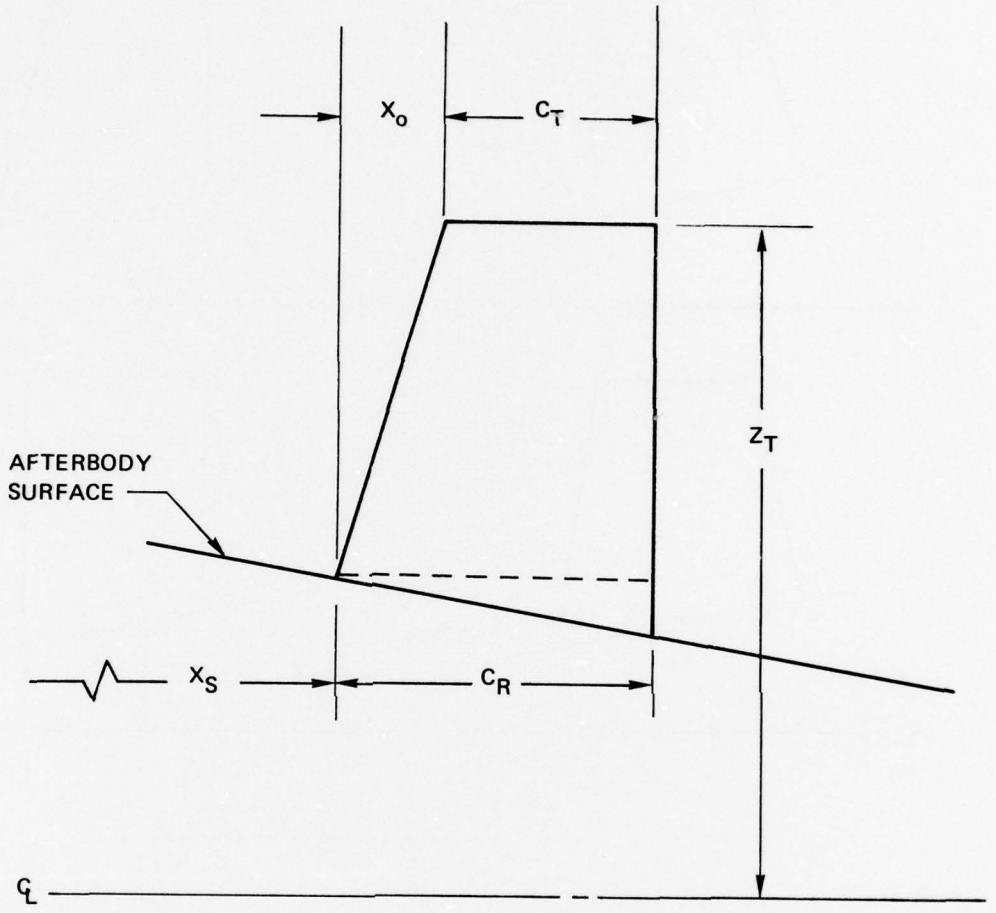


Figure 3. Definition of appendage input quantities.

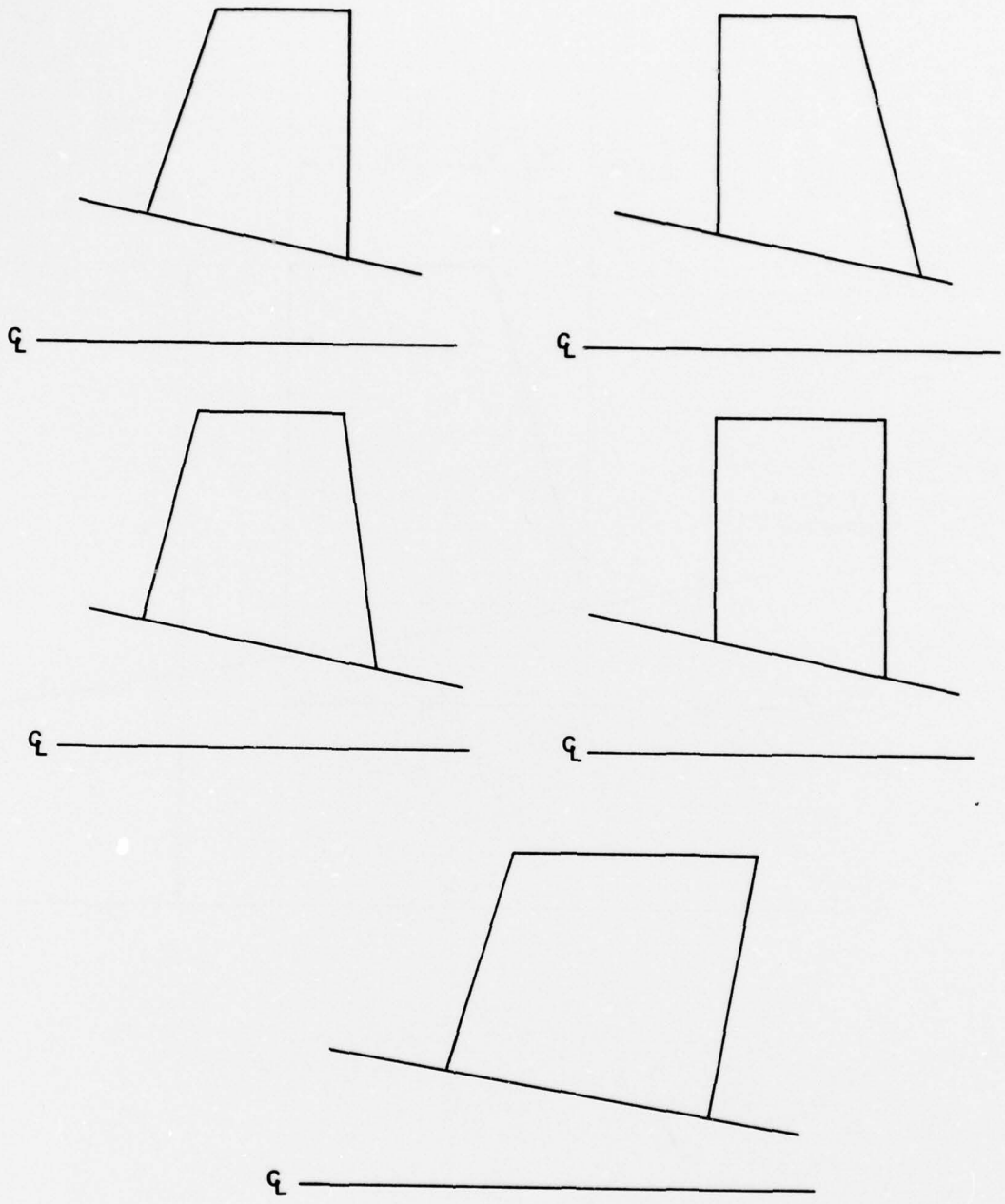


Figure 4. Allowable appendage configurations.

CALCULATED COORDINATES

APPENDAGE COORDINATES

The calculated appendage coordinates are described by section numbers corresponding to various Z locations (figure 5). Each section contains the (X, Y) coordinates describing the appendage cross section. Only that portion of the appendage parallel to the positive Z axis is calculated, while the coordinates parallel to the positive Y axis are obtained from symmetry.

BODY COORDINATES

Any body section not containing an appendage is represented by 10 equally spaced points. For one and two planes of symmetry the body section is divided into 20-degree increments, and for three planes of symmetry the body section is divided into 10-degree increments. For body sections containing an appendage, the 10 body points are distributed equally with the first and tenth points coinciding with the appendage intersection points (figure 5).

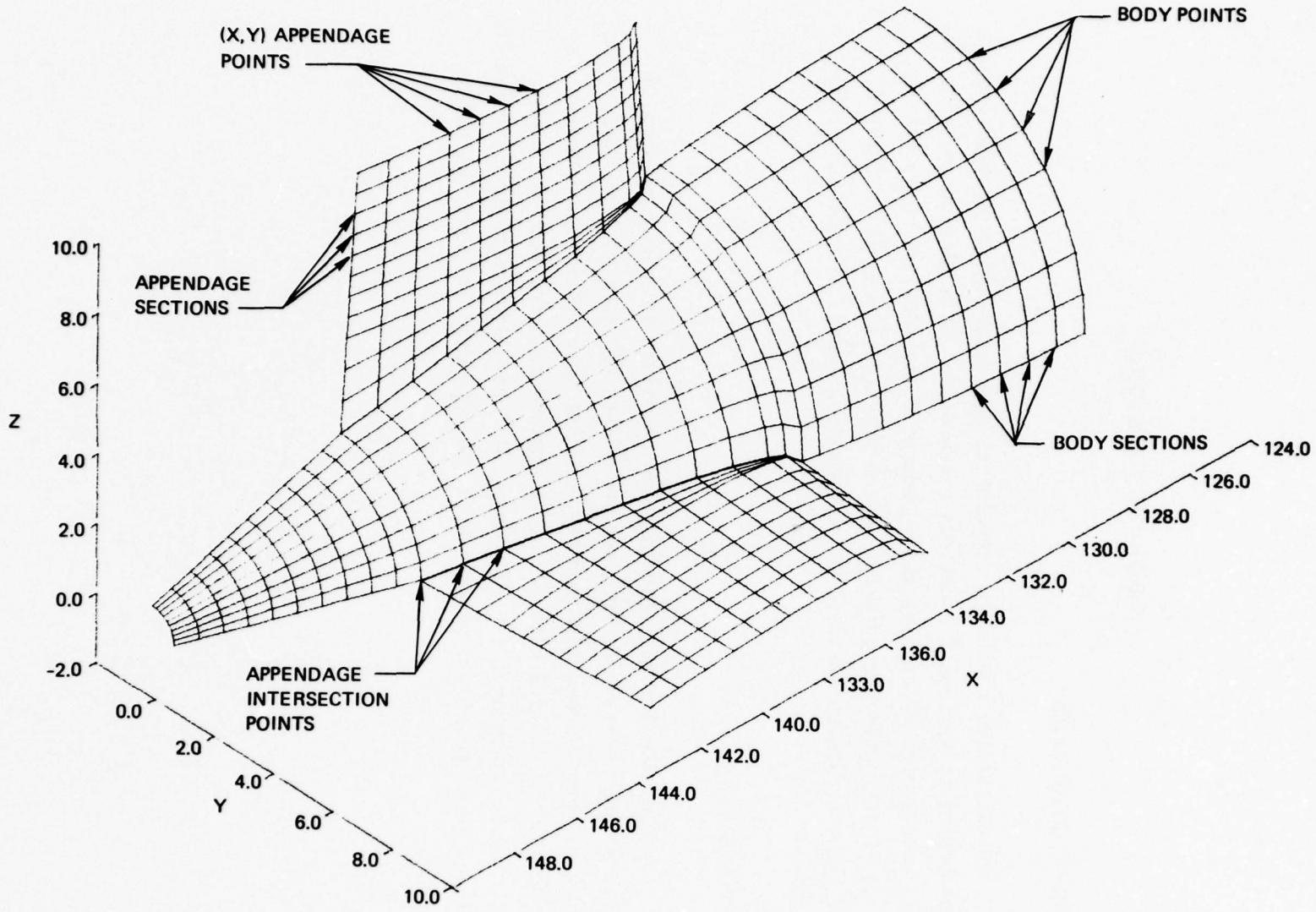


Figure 5. Calculated coordinates - body and appendage.

DOUGLAS THREE-DIMENSIONAL COORDINATE FORMAT

The Douglas Three-Dimensional Potential Flow Program requires the input body and appendage coordinates to be arranged in an array of (n, m) points, where n identifies the column and m identifies the position in the column. The n and m designations follow the convention shown in figure 6. An observer located in the flow, oriented so that the m values increase upward, also sees n values increasing to the right. The Douglas-formatted output is arranged so that the body sections are followed by the appendage sections located in the positive Y-Z quadrant.

The Douglas input scheme also requires the use of a status word to indicate the beginning of new sections and to identify the last data point. The input data cards must also contain sequence numbers arranged in ascending order. The cards punched by programs 1, 2, and 3 have the following format:

CARD COLUMNS	1-10	11-20	21-30	31	32-41	42-51	52-61	62	77-80
VARIABLE	X	Y	Z	STAT	X	Y	Z	STAT	SEQ
FORMAT	F10.5	F10.5	F10.5	I1	F10.5	F10.5	F10.5	I1	I4

SEQ is the sequence number, and STAT (the status word) is defined as follows:

STAT = 1 - data point is the beginning of a new n line
STAT = 2 - data point is the beginning of a new section
STAT = 3 - data point is the last point.

The status word is left blank otherwise.

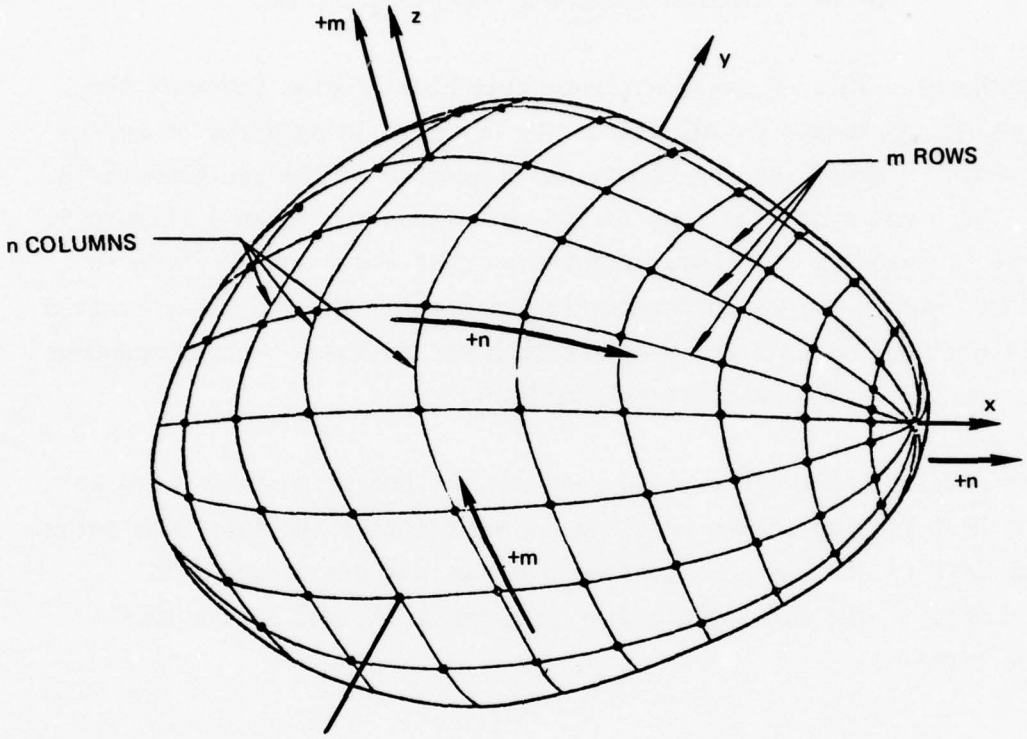


Figure 6. Organization of input points into rows and columns.
(Adapted from Douglas Aircraft Company, Report ES40622,
"Calculation of Nonlifting Potential Flow About
Arbitrary Three-Dimensional Bodies,"
by J. L. Hess and A. M. O. Smith,
March 1962.)

The method of inputting coordinates to the Douglas program also requires a change in the coordinate system origin for bodies with three planes of symmetry. In this case, the coordinate system origin is translated to (X_i, Z_i) (figure 1B) so that the nonredundant portion of the body begins at $X = 0$. The calculated body and appendage coordinates are adjusted by the relationship $X_j)_{NEW} = X_j)_{OLD} - X_i$. The origin change is performed within programs 1 and 2 and is reflected in the Douglas-formatted output. The coordinate system origin remains the same for bodies with one or two planes of symmetry.

OFF-BODY POINTS

Program 3 computes the radial and angular distribution of off-body points required in the construction of potential flow velocity profiles. The starting points X_{OB} and Z_S and the radial Δ_{yz} and angular Δ_Θ increments are defined in figure 7. The punched card output of program 3 has the same format as described in the previous section. It should be noted that the coordinate system change in origin for bodies with three planes of symmetry must also be applied by the user to the starting X_{OB} values of the off-body points.

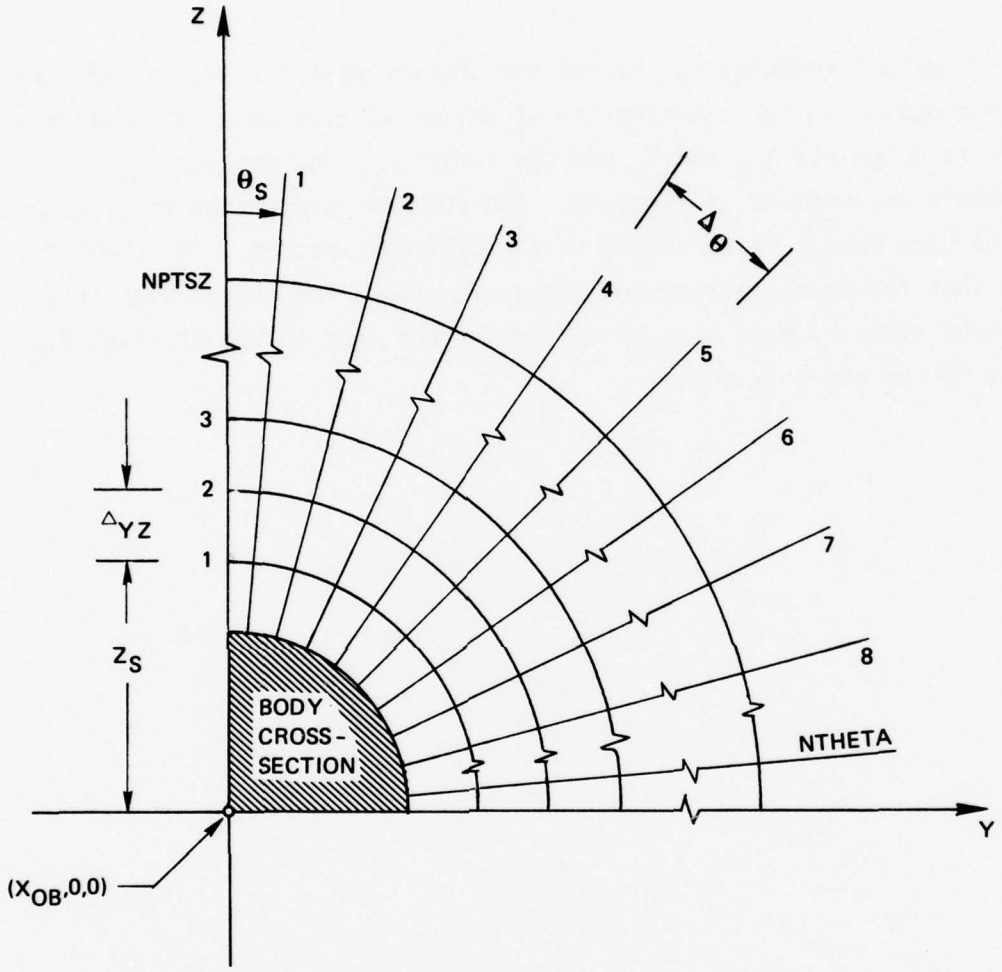


Figure 7. Coordinate system for off-body points.

INPUT TO COMPUTER PROGRAMS

METHOD OF INPUTTING TABLES

The input tables of body and appendage coordinates are described by functional relationships of the type $Y = f(x)$. All tables of this type are input according to either scheme 1 or scheme 2.

SCHEME 1

F Format

CARD COLUMNS	1-10	11-20	21-30	31-40	41-50	51-60
	X_i	Y_i	X_{i+1}	Y_{i+1}	X_{i+2}	Y_{i+2}

SCHEME 2

F Format

CARD COLUMNS	1-10	11-20	21-30	31-40	41-50	51-60
	X_1	X_2	X_3	...	...	...
	...	...	...	X_n		
	Y_1	Y_2	Y_3	...	...	...
	...	...	...	Y_n		

DEFINITION OF FLAG CARD VARIABLES

The flag card variables common to programs 1 and 2 are described below. All variables are of the I format and must be right justified.

Variable	Description
IREAD	If IREAD = 1, all data tables are input according to scheme 1 If IREAD = 2, all data tables are input according to scheme 2
IPRINT	If IPRINT = 0, only the input data and the Douglas formatted output are printed If IPRINT = 1, the input data, intermediate results, and Douglas formatted output are printed
IPLOT	If IPLOT = 0, no plotting is performed If IPLOT = 1, a three dimensional plot of the body is made
IPUNCH	If IPUNCH = 0, no cards are punched If IPUNCH = 1, the Douglas formatted ouput is punched
IDOUG	If IDOUG = 0, the Douglas formatted output will not be calculated If IDOUG = 1, the Douglas formatted output will be calculated
NSYM	The number of planes of symmetry

The following defines the additional flag card variables used in programs 1, 2, and 3.

PROGRAM 1

Variable	Description
NPTS	Number of input (X, Z) body coordinates
NBODY	Number of output stations

PROGRAM 2

Variable	Description
NBODY	Number of input (X, Z) body coordinates
NFIN	Number of input (X_B, $\frac{h}{C}$) appendage coordinates
IFWD	Number of output stations forward of the appendage
IAFT	Number of output stations aft of the appendage
IFIN	Number of longitudinal output stations for the appendage

PROGRAM 3

Variable	Description
NPTSZ	Number of output stations in the radial direction
NTHETA	Number of output stations in the angular direction

INPUT SCHEME FOR PROGRAM 1

LABEL CARD

Card Columns	Format	Input Quantity	
1-80	A	Label	Alphanumeric characters

FLAG CARD

Card Columns	Format	Input Quantity	
1-3	I	IREAD	
4-6	I	IPRINT	
7-9	I	IPLOT	
10-12	I	IPUNCH	
13-15	I	NSYM	NSYM = 1, 2, or 3
16-18	I	IDOUG	
19-21	I	NPTS	$20 \leq$ NPTS ≤ 200
22-24	I	NBODY	NBODY ≤ 100

TABLE 1 - Z = f(X)

Maximum number of entries this table may contain is 200.
Minimum number of entries this table may contain is 20.

INPUT SCHEME FOR PROGRAM 2

LABEL CARD

Card Columns	Format	Input Quantity	
1-80	A	LABEL	Alphanumeric characters

FLAG CARD

Card Columns	Format	Input Quantity	
1-3	I	IREAD	
4-6	I	IPRINT	
7-9	I	IPLOT	
10-12	I	IPUNCH	
13-15	I	NSYM	NSYM = 2 or 3
16-18	I	IDOUG	
19-21	I	NBODY	$20 \leq$ NBODY ≤ 200
22-24	I	NFIN	$5 \leq$ NFIN ≤ 25
25-27	I	IFWD	If IDOUG = 0, IFWD ≤ 60 If IDOUG = 1, and NSYM = 2, IFWD ≤ 40 NSYM = 3, IFWD ≤ 30
28-30	I	IAFT	If IDOUG = 0, IAFT ≤ 25 If IDOUG = 1, and NSYM = 2, IAFT ≤ 10 NSYM = 3, IAFT ≤ 20
31-33	I	IFIN	$5 \leq$ IFIN ≤ 14

TABLE 1 - $Z = f(X)$

Maximum number of entries this table may contain is 200.
Minimum number of entries this table may contain is 20.

CONSTANT CARD 1

Card Columns	Format	Input Quantity
1-10	F	C_T
11-20	F	C_R
21-30	F	X_S
31-40	F	X_o
41-50	F	Z_T
51-60	F	$\left(\frac{t}{C}\right)_{REF}$
61-70	F	$\left(\frac{t}{C}\right)_T$
71-80	F	$\left(\frac{t}{C}\right)_R$

TABLE 2 - $\left(\frac{h}{C}\right)_{REF} = f(X)_B$

Maximum number of entries this table may contain is 25.
Minimum number of entries this table may contain is 5.

INPUT SCHEME FOR PROGRAM 3

LABEL CARD

Card Columns	Format	Input Quantity	
1-80	A	LABEL	Alphanumeric characters

CONSTANT CARD

Card Columns	Format	Input Quantity	
1-3	I	NPTSZ	See note below
5-7	I	NTHETA	
11-20	F	X_{OB}	
21-30	F	Z_S	
31-40	F	Δ_{yz}	
41-50	F	θ_S	
51-60	F	Δ_θ	In degrees

NOTE: Repeat the constant card for each desired value of X_{OB} (the total number of points ≤ 1000). To initiate the output of the complete set of calculated body points, a constant card with NPTSZ=0 must be used.

COMPUTER PRINTOUT

INCLUDED ITEMS

All input quantities to programs 1, 2, and 3 are printed out to allow rapid checking for errors. The results of the computer solutions are tabulated and identified with the computer correspondences to conventional symbols given in this section. The following is a list of the items included in the output of each program.

PROGRAM 1

1. Control parameters
2. Input body coordinates
3. Calculated three-dimensional coordinates
4. Calculated coordinates - *Douglas format*

PROGRAM 2

1. Control parameters
2. Input body coordinates
3. Input appendage data
4. Intersection point summary - appendage and body
5. Calculated appendage coordinates
6. Calculated body coordinates
7. Calculated coordinates - Douglas format

PROGRAM 3

1. Control parameters for each X location
2. Complete set of off-body points in the Douglas format

PRINTOUT CORRESPONDENCES

SYMBOL	COMPUTER REPRESENTATIVE
C_R	CORDR
C_T	CORDT
h	H
$\frac{h}{C}$	HC
$\frac{t}{C})_{REF}$	TCREF
$\frac{t}{C})_R$	TCROOT
$\frac{t}{C})_T$	TCTIP
X	X
X_B	XB
X_o	XOFSET
X_S	XSTART
Y	Y
Z	Z
Z_R	ZROOT
Z_S	ZSTART
Z_T	ZTIP
Δ_{yz}	DELYZ
Δ_Θ	DELT
Θ_S	TSTART

TYPICAL COMPUTER RUNS

Several examples have been included to illustrate the results produced by programs 1, 2, and 3. Figure 8 shows the results of program 1 for an axisymmetric body with two planes of symmetry, while figures 9 and 10 demonstrate the results of program 2 for the cases of two and three planes of symmetry. The computer printouts for the three-dimensional coordinates and off-body points for the example shown in figure 10 are found in appendix A.

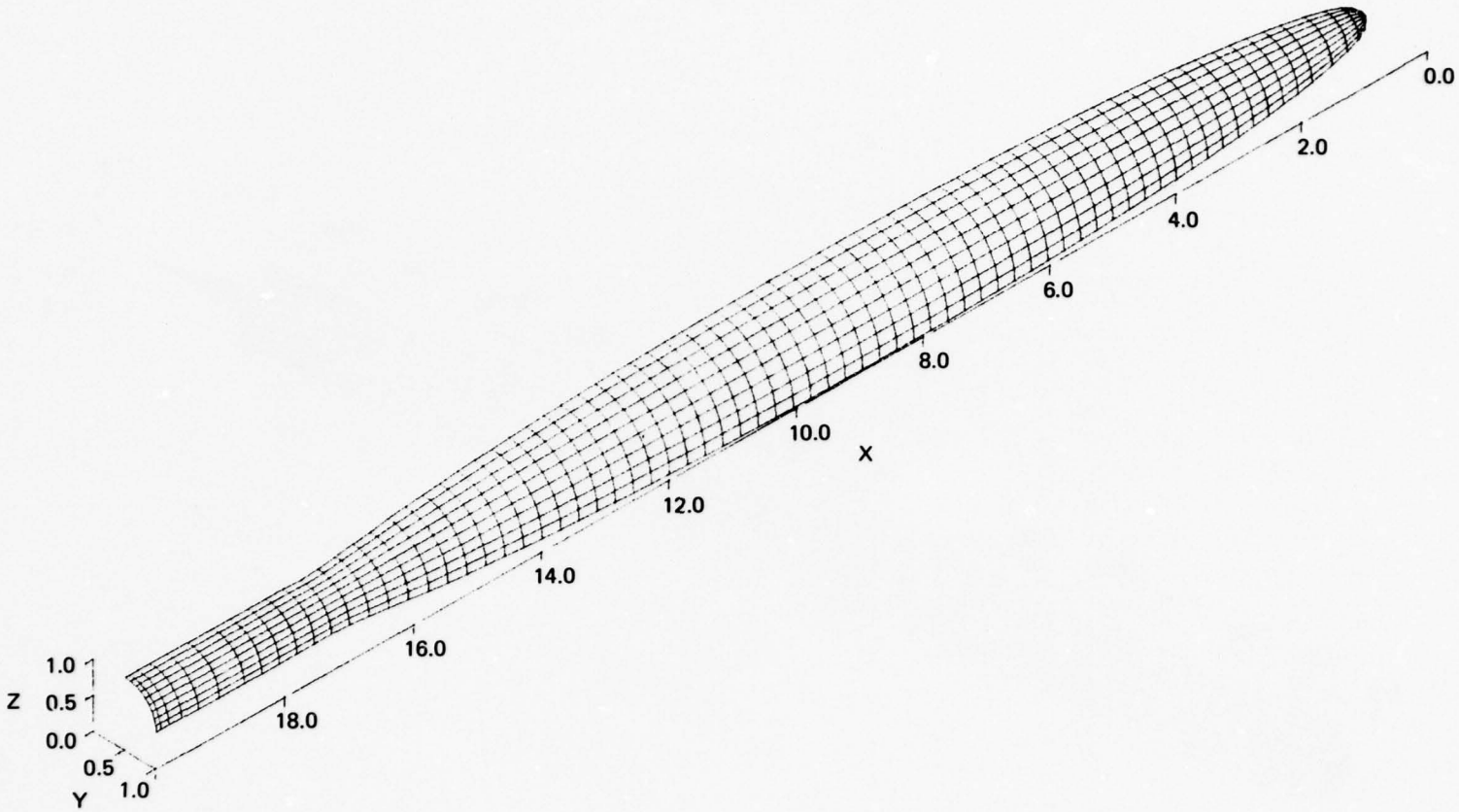


Figure 8. Body with two planes of symmetry - program 1.

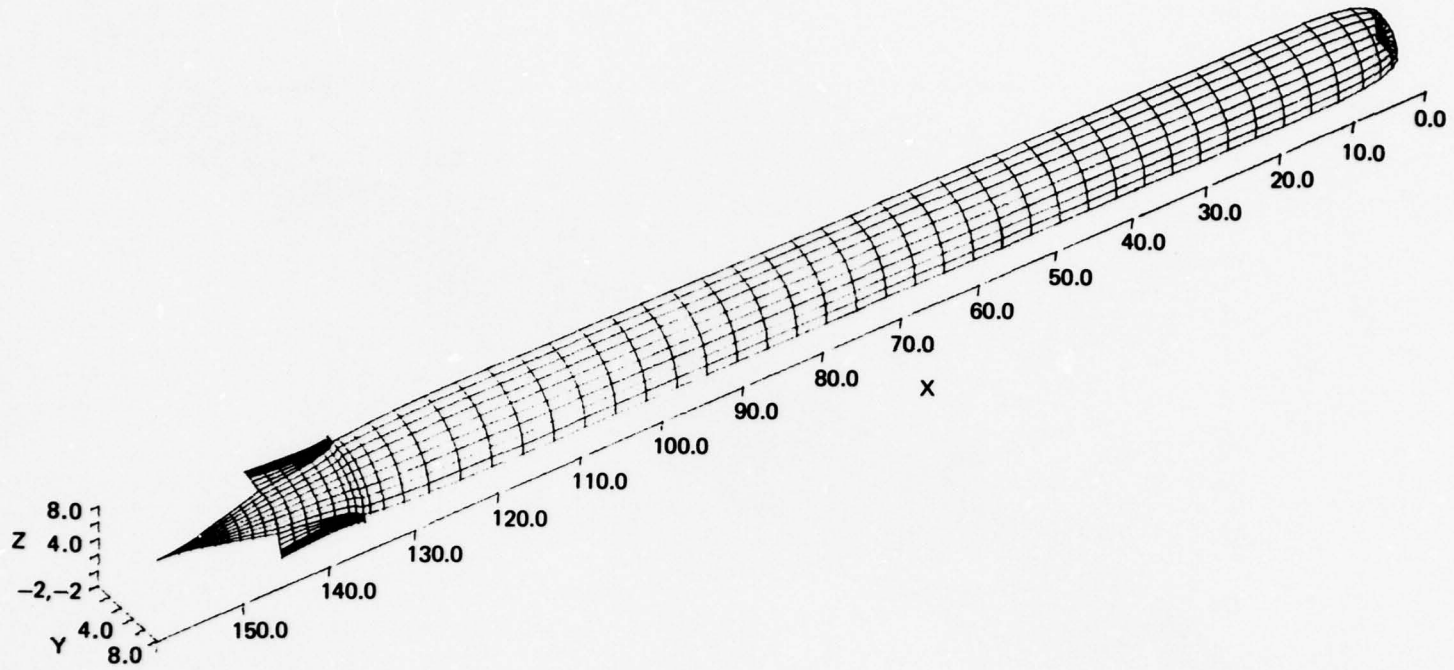


Figure 9. Body with two planes of symmetry - program 2.

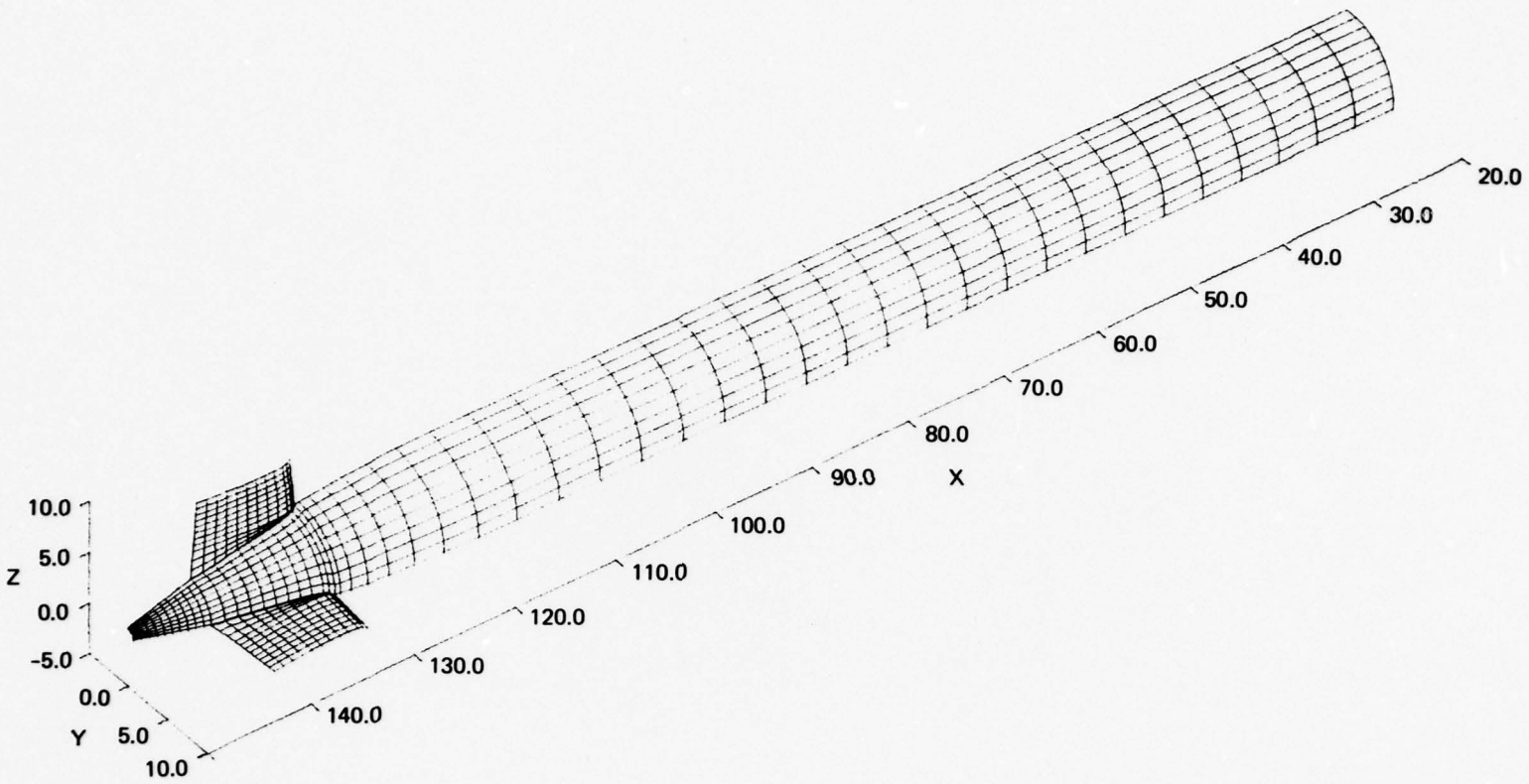


Figure 10. Body with three planes of symmetry - program 2.

APPENDIX A. COMPUTER PRINTOUT EXAMPLES

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CALCULATION OF THE THREE DIMENSIONAL COORDINATES
FOR AN AXISYMMETRIC BODY WITH APPENDAGES
HAVING   3  PLANES OF SYMMETRY


TEST CASE 4


                CONTROL PARAMETERS

IREAD =  2     IPRINT =  1  IPLOT =  1  IPUNCH =  0

NBODY =  54      NFIN =  17  IFWD =  30   IAFT =  10

 NSYM =   3     IDOUG =   1  IFIN =  12
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INPUT BODY COORDINATES

	X	Z
1	.2500000+02	.6375000+01
2	.3000000+02	.6375000+01
3	.3500000+02	.6375000+01
4	.4000000+02	.6375000+01
5	.4500000+02	.6375000+01
6	.5000000+02	.6375000+01
7	.5500000+02	.6375000+01
8	.6000000+02	.6375000+01
9	.6500000+02	.6375000+01
10	.7000000+02	.6375000+01
11	.7500000+02	.6375000+01
12	.8000000+02	.6375000+01
13	.8500000+02	.6375000+01
14	.9000000+02	.6375000+01
15	.9500000+02	.6375000+01
16	.1000000+03	.6375000+01
17	.1050000+03	.6375000+01
18	.1100000+03	.6375000+01
19	.1150000+03	.6375000+01
20	.1190000+03	.6375000+01
21	.1207000+03	.6375000+01
22	.1221790+03	.6370000+01
23	.1233430+03	.6334000+01
24	.1245570+03	.6289000+01
25	.1257710+03	.6230000+01
26	.1269860+03	.6165000+01
27	.1282000+03	.6093000+01
28	.1294190+03	.6004000+01
29	.1306290+03	.5891000+01
30	.1318430+03	.5754000+01
31	.1330570+03	.5597000+01
32	.1342710+03	.5411000+01
33	.1354860+03	.5202000+01
34	.1367000+03	.4958000+01
35	.1379140+03	.4679000+01
36	.1388250+03	.4449000+01
37	.1397360+03	.4196000+01
38	.1409500+03	.3823000+01
39	.1419890+03	.3475500+01
40	.1428890+03	.3171520+01
41	.1436390+03	.2918240+01
42	.1442890+03	.2698730+01
43	.1448390+03	.2513000+01
44	.1453390+03	.2344130+01
45	.1458390+03	.2175300+01
46	.1463390+03	.2006400+01
47	.1468390+03	.1837560+01
48	.1472640+03	.1694040+01
49	.1476640+03	.1559000+01
50	.1480890+03	.1415420+01
51	.1485890+03	.1246600+01
52	.1490890+03	.1080000+01
53	.1495890+03	.9088600+00
54	.1500890+03	.7400000+00

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INPUT APPENDAGE DATA

XSTART= .1342710+03 XOFSET= .4000000+00 ZTIP= .1000000+02

CORDT= .9000000+01 CORDR= .9676000+01

TCREF= .1198840+00 TCTIP= .1000000+00 TCROOT= .1250000+00

	XB	HC
1	.0000000	.0000000
2	.4961000-02	.1570900-01
3	.1250500-01	.1891300-01
4	.2501000-01	.2614700-01
5	.5002100-01	.3555200-01
6	.7492800-01	.4206300-01
7	.9993800-01	.4681700-01
8	.1499590+00	.5343100-01
9	.1998760+00	.5735800-01
10	.2498970+00	.5932200-01
11	.2998140+00	.5994200-01
12	.3998550+00	.5797900-01
13	.4997930+00	.5291400-01
14	.5998350+00	.4557700-01
15	.6997730+00	.3658500-01
16	.7997110+00	.2625100-01
17	.1000000+01	.0000000

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ITERSECTION POINT SUMMARY - APPENDAGE AND BODY

	X	Y	Z
1	.1342710+03	.0000000	.5411153+01
2	.1347476+03	.3604347+00	.5320269+01
3	.1352253+03	.9772740+00	.5227438+01
4	.1361843+03	.5909954+00	.5031600+01
5	.1371483+03	.6247824+00	.4816985+01
6	.1381182+03	.6117277+00	.4588185+01
7	.1390945+03	.5656244+00	.4338751+01
8	.1400782+03	.4941413+00	.4066811+01
9	.1410705+03	.4028007+00	.3762079+01
10	.1420724+03	.2936624+00	.3435219+01
11	.1430843+03	.1612121+00	.3101086+01
12	.1441044+03	.7934229-07	.2760490+01

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APPENDAGE SECTION NUMBER 1 Z= .1000000+02

X	Y
.1346710+03	.0000000
.1351210+03	.2668526+00
.1355710+03	.3515456+00
.1364710+03	.4306541+00
.1373710+03	.4500007+00
.1382710+03	.4352234+00
.1391710+03	.3971410+00
.1400710+03	.3420564+00
.1409710+03	.2744893+00
.1418710+03	.1968313+00
.1427710+03	.1062711+00
.1436710+03	.5143707-07

APPENDAGE SECTION NUMBER 2 Z= .9426375+01

X	Y
.1346210+03	.0000000
.1350752+03	.2783236+00
.1355294+03	.3666572+00
.1364379+03	.4491663+00
.1373463+03	.4693445+00
.1382548+03	.4539320+00
.1391632+03	.4142126+00
.1400717+03	.3567601+00
.1409801+03	.2862885+00
.1418886+03	.2052924+00
.1427970+03	.1108393+00
.1437055+03	.5364815-07

APPENDAGE SECTION NUMBER 3 Z= .8852750+01

X	Y
.1345710+03	.0000000
.1350294+03	.2897945+00
.1354879+03	.3817688+00
.1364048+03	.4676784+00
.1373217+03	.4886883+00
.1382386+03	.4726405+00
.1391555+03	.4312841+00
.1400724+03	.3714638+00
.1409893+03	.2980877+00
.1419062+03	.2137534+00
.1428231+03	.1154075+00
.1437400+03	.5585923-07

APPENDAGE SECTION NUMBER 4 Z= .8279125+01

X	Y
.1345210+03	.0000000
.1349837+03	.3012655+00
.1354464+03	.3968803+00
.1363717+03	.4861906+00
.1372971+03	.5080321+00
.1382224+03	.4913491+00
.1391477+03	.4483557+00
.1400731+03	.3861674+00
.1409984+03	.3098869+00
.1419238+03	.2222144+00
.1428491+03	.1199757+00
.1437745+03	.5807031-07

APPENDAGE SECTION NUMBER 5 Z= .7705500+01

X	Y
.1344710+03	.0000000
.1349379+03	.3127364+00
.1354048+03	.4119919+00
.1363384+03	.5047027+00
.1372724+03	.5273759+00
.1382062+03	.5100577+00
.1391400+03	.4654272+00
.1400738+03	.4008711+00
.1410076+03	.3216862+00
.1419414+03	.2306754+00
.1428752+03	.1245439+00
.1438090+03	.6078139-07

APPENDAGE SECTION NUMBER 6 Z= .7131875+01

X	Y
.1344210+03	.0000000
.1348921+03	.3242074+00
.1353633+03	.4271035+00
.1363055+03	.5232149+00
.1372477+03	.5467196+00
.1381900+03	.5287662+00
.1391322+03	.4824988+00
.1400745+03	.4155748+00
.1410167+03	.3334854+00
.1419590+03	.2391364+00
.1429012+03	.1291121+00
.1438435+03	.6249247-07

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APPENDAGE SECTION NUMBER 7 Z= .6558250+01

X	Y
.1343710+03	.0000000
.1348963+03	.3356784+00
.1353217+03	.4422151+00
.1362724+03	.5417270+00
.1372231+03	.5660634+00
.1381738+03	.5474748+00
.1391245+03	.4995703+00
.1400752+03	.4302785+00
.1410259+03	.3452846+00
.1419766+03	.2475974+00
.1429273+03	.1336802+00
.1438780+03	.6470354-07

APPENDAGE SECTION NUMBER 8 Z= .5984625+0

X	Y
.1343210+03	.0000000
.1348006+03	.3471493+00
.1352802+03	.4573267+00
.1362393+03	.5602392+00
.1371985+03	.5854072+00
.1381576+03	.5661833+00
.1391168+03	.5166419+00
.1400759+03	.4449821+00
.1410350+03	.3570838+00
.1419942+03	.2560584+00
.1429533+03	.1382484+00
.1439125+03	.6691462-07

APPENDAGE SECTION NUMBER 9 Z= .5411000+01

X	Y
.1342710+03	.0000000
.1347548+03	.3586203+00
.1352386+03	.4724382+00
.1362062+03	.5787513+00
.1371738+03	.6047510+00
.1381414+03	.5846919+00
.1391090+03	.5337134+00
.1400766+03	.4596858+00
.1410442+03	.3688831+00
.1420118+03	.2645195+00
.1429794+03	.1428166+00
.1439470+03	.6912571-07

APPENDAGE SECTION NUMBER 10 Z= .5411000+01

X	Y
.1342710+03	.0000000
.1347524+03	.3592251+00
.1352342+03	.4740502+00
.1361989+03	.5828327+00
.1371653+03	.6114281+00
.1381337+03	.5938372+00
.1391042+03	.5443504+00
.1400771+03	.4711710+00
.1410530+03	.3801889+00
.1420320+03	.2742338+00
.1430144+03	.1489484+00
.1440001+03	.7253123-07

APPENDAGE SECTION NUMBER 11 Z= .5411000+01

X	Y
.1342710+03	.0000000
.1347500+03	.3598299+00
.1352297+03	.4756621+00
.1361916+03	.5869140+00
.1371568+03	.6181052+00
.1381259+03	.6027824+00
.1390993+03	.5549874+00
.1400777+03	.4826561+00
.1410617+03	.3914948+00
.1420522+03	.2839481+00
.1430493+03	.1550803+00
.1440533+03	.7593676-07

APPENDAGE SECTION NUMBER 12 Z= .5411153+01

X	Y
.1342710+03	.0000000
.1347476+03	.3604347+00
.1352253+03	.4772740+00
.1361843+03	.5909954+00
.1371483+03	.6247824+00
.1381182+03	.6117277+00
.1390945+03	.5656244+00
.1400782+03	.4941413+00
.1410705+03	.4028007+00
.1420724+03	.2936624+00
.1430843+03	.1612121+00
.1441064+03	.7934229-07

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CALCULATED BODY COORDINATES

BODY SECTION NUMBER 1 X= .2500000+02

Y	Z
.0000000	.6375000+01
.1107006+01	.6278150+01
.2180377+01	.5990541+01
.3187498+01	.5520913+01
.4097768+01	.4883536+01
.4883530+01	.4097775+01
.5520909+01	.3187505+01
.5990538+01	.2180385+01
.6278148+01	.1107015+01
.6375000+01	.8745856-05

BODY SECTION NUMBER 2 X= .2918706+02

Y	Z
.0000000	.6375000+01
.1107006+01	.6278149+01
.2180377+01	.5990541+01
.3187497+01	.5520913+01
.4097768+01	.4883536+01
.4883530+01	.4097775+01
.5520909+01	.3187505+01
.5990538+01	.2180385+01
.6278148+01	.1107015+01
.6375000+01	.8745855-05

BODY SECTION NUMBER 3 X= .3337413+02

Y	Z
.0000000	.6375000+01
.1107006+01	.6278149+01
.2180377+01	.5990541+01
.3187497+01	.5520913+01
.4097768+01	.4883536+01
.4883530+01	.4097775+01
.5520909+01	.3187505+01
.5990538+01	.2180385+01
.6278148+01	.1107015+01
.6375000+01	.8745855-05

BODY SECTION NUMBER 4 X= .3756119+02

Y	Z
.0000000	.6375000+01
.1107006+01	.6278149+01
.2180377+01	.5990541+01
.3187497+01	.5520913+01
.4097768+01	.4883536+01
.4883530+01	.4097775+01
.5520909+01	.3187505+01
.5990538+01	.2180385+01
.6278148+01	.1107015+01
.6375000+01	.8745855-05

BODY SECTION NUMBER 5 X= .4174825+02

Y	Z
.0000000	.6375000+01
.1107006+01	.6278149+01
.2180377+01	.5990541+01
.3187497+01	.5520913+01
.4097768+01	.4883536+01
.4883530+01	.4097775+01
.5520909+01	.3187505+01
.5990538+01	.2180385+01
.6278148+01	.1107015+01
.6375000+01	.8745855-05

BODY SECTION NUMBER 6 X= .4593531+02

Y	Z
.0000000	.6375000+01
.1107006+01	.6278150+01
.2180377+01	.5990541+01
.3187497+01	.5520913+01
.4097768+01	.4883536+01
.4883530+01	.4097775+01
.5520909+01	.3187505+01
.5990538+01	.2180385+01
.6278148+01	.1107015+01
.6375000+01	.8745855-05

BODY SECTION NUMBER 7 X= .5012238+02

Y	Z
.0000000	.6375000+01
.1107006+01	.6278149+01
.2180377+01	.5990541+01
.3187497+01	.5520913+01
.4097768+01	.4883536+01
.4883530+01	.4097775+01
.5520909+01	.3187505+01
.5990538+01	.2180385+01
.6278148+01	.1107015+01
.6375000+01	.8745855-05

BODY SECTION NUMBER 8 X= .5430944+02

Y	Z
.0000000	.6375000+01
.1107006+01	.6278149+01
.2180377+01	.5990541+01
.3187497+01	.5520913+01
.4097768+01	.4883536+01
.4883530+01	.4097775+01
.5520909+01	.3187505+01
.5990538+01	.2180385+01
.6278148+01	.1107015+01
.6375000+01	.8745855-05

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BODY SECTION NUMBER 9 X= .5849650+02

Y	Z
.0000000	.6375000+01
.1107006+01	.6278149+01
.2180377+01	.5990541+01
.3187497+01	.5520913+01
.4097768+01	.4883536+01
.4883530+01	.4097775+01
.5520909+01	.3187505+01
.5990538+01	.2180385+01
.6278148+01	.1107015+01
.6375000+01	.8745855-05

BODY SECTION NUMBER 10 X= .6268356+02

Y	Z
.0000000	.6375001+01
.1107006+01	.6278150+01
.2180377+01	.5990542+01
.3187498+01	.5520914+01
.4097769+01	.4883536+01
.4883531+01	.4097775+01
.5520910+01	.3187505+01
.5990539+01	.2180385+01
.6278149+01	.1107015+01
.6375001+01	.8745857-05

BODY SECTION NUMBER 11 X= .6687063+02

Y	Z
.0000000	.6375000+01
.1107006+01	.6278150+01
.2180377+01	.5990541+01
.3187498+01	.5520913+01
.4097768+01	.4883536+01
.4883530+01	.4097775+01
.5520909+01	.3187505+01
.5990538+01	.2180385+01
.6278148+01	.1107015+01
.6375000+01	.8745856-05

BODY SECTION NUMBER 12 X= .7105769+02

Y	Z
.0000000	.6375000+01
.1107006+01	.6278149+01
.2180377+01	.5990541+01
.3187497+01	.5520913+01
.4097768+01	.4883536+01
.4883530+01	.4097775+01
.5520909+01	.3187505+01
.5990538+01	.2180385+01
.6278148+01	.1107015+01
.6375000+01	.8745855-05

BODY SECTION NUMBER 13 X= .7524475+02

Y	Z
.0000000	.6375000+01
.1107006+01	.6278149+01
.2180377+01	.5990541+01
.3187497+01	.5520913+01
.4097768+01	.4883536+01
.4883530+01	.4097775+01
.5520909+01	.3187505+01
.5990538+01	.2180385+01
.6278148+01	.1107015+01
.6375000+01	.8745855-05

BODY SECTION NUMBER 14 X= .7943181+02

Y	Z
.0000000	.6375000+01
.1107006+01	.6278149+01
.2180377+01	.5990541+01
.3187497+01	.5520913+01
.4097768+01	.4883536+01
.4883530+01	.4097775+01
.5520909+01	.3187505+01
.5990538+01	.2180385+01
.6278148+01	.1107015+01
.6375000+01	.8745855-05

BODY SECTION NUMBER 15 X= .8361888+02

Y	Z
.0000000	.6375000+01
.1107006+01	.6278149+01
.2180377+01	.5990541+01
.3187497+01	.5520913+01
.4097768+01	.4883536+01
.4883530+01	.4097775+01
.5520909+01	.3187505+01
.5990538+01	.2180385+01
.6278148+01	.1107015+01
.6375000+01	.8745855-05

BODY SECTION NUMBER 16 X= .8780594+02

Y	Z
.0000000	.6375000+01
.1107006+01	.6278149+01
.2180377+01	.5990541+01
.3187497+01	.5520913+01
.4097768+01	.4883536+01
.4883530+01	.4097775+01
.5520909+01	.3187505+01
.5990538+01	.2180385+01
.6278148+01	.1107015+01
.6375000+01	.8745855-05

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BODY SECTION NUMBER 17 X= .9199300+02

Y	Z
.0000000	.6375000+01
.1107006+01	.6278149+01
.2180377+01	.5990541+01
.3187497+01	.5520913+01
.4097768+01	.4883536+01
.4883530+01	.4097775+01
.5520909+01	.3187505+01
.5990538+01	.2180385+01
.6278148+01	.1107015+01
.6375000+01	.8745855-05

BODY SECTION NUMBER 18 X= .9618006+02

Y	Z
.0000000	.6375000+01
.1107006+01	.6278149+01
.2180377+01	.5990541+01
.3187497+01	.5520913+01
.4097768+01	.4883536+01
.4883530+01	.4097775+01
.5520909+01	.3187505+01
.5990538+01	.2180385+01
.6278148+01	.1107015+01
.6375000+01	.8745855-05

BODY SECTION NUMBER 19 X= .1003671+03

Y	Z
.0000000	.6375000+01
.1107006+01	.6278149+01
.2180377+01	.5990541+01
.3187497+01	.5520913+01
.4097768+01	.4883536+01
.4883530+01	.4097775+01
.5520909+01	.3187505+01
.5990538+01	.2180385+01
.6278148+01	.1107015+01
.6375000+01	.8745855-05

BODY SECTION NUMBER 20 X= .1045542+03

Y	Z
.0000000	.6375000+01
.1107006+01	.6278149+01
.2180377+01	.5990541+01
.3187497+01	.5520913+01
.4097768+01	.4883536+01
.4883530+01	.4097775+01
.5520909+01	.3187505+01
.5990538+01	.2180385+01
.6278148+01	.1107015+01
.6375000+01	.8745855-05

BODY SECTION NUMBER 21 X= .1087413+03

Y	Z
.0000000	.6375000+01
.1107006+01	.6278149+01
.2180377+01	.5990541+01
.3187497+01	.5520913+01
.4097768+01	.4883536+01
.4883530+01	.4097775+01
.5520909+01	.3187505+01
.5990538+01	.2180385+01
.6278148+01	.1107015+01
.6375000+01	.8745855-05

BODY SECTION NUMBER 22 X= .1129283+03

Y	Z
.0000000	.6375000+01
.1107006+01	.6278149+01
.2180377+01	.5990541+01
.3187497+01	.5520913+01
.4097768+01	.4883536+01
.4883530+01	.4097775+01
.5520909+01	.3187505+01
.5990538+01	.2180385+01
.6278148+01	.1107015+01
.6375000+01	.8745855-05

BODY SECTION NUMBER 23 X= .1171154+03

Y	Z
.0000000	.6375000+01
.1107006+01	.6278149+01
.2180377+01	.5990541+01
.3187497+01	.5520913+01
.4097768+01	.4883536+01
.4883530+01	.4097775+01
.5520909+01	.3187505+01
.5990538+01	.2180385+01
.6278148+01	.1107015+01
.6375000+01	.8745855-05

BODY SECTION NUMBER 24 X= .1209277+03

Y	Z
.0000000	.6375575+01
.1107106+01	.6278716+01
.2180573+01	.5991081+01
.3187785+01	.5521411+01
.4098138+01	.4883976+01
.4883971+01	.4098144+01
.5521407+01	.3187792+01
.5991078+01	.2180581+01
.6278714+01	.1107115+01
.6375575+01	.8746644-05

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BODY SECTION NUMBER 25 X= .1242636+03

Y	Z
.0000000	.6300970+01
.1094151+01	.6205245+01
.2155057+01	.5920976+01
.3150483+01	.5456802+01
.4050183+01	.4826826+01
.4826820+01	.4050189+01
.5456797+01	.3150490+01
.5920973+01	.2155065+01
.6205243+01	.1094160+01
.6300970+01	.8644294-05

BODY SECTION NUMBER 26 X= .1271228+03

Y	Z
.0000000	.6157422+01
.1069224+01	.6063877+01
.2105961+01	.5786084+01
.3078708+01	.5332485+01
.3957912+01	.4716861+01
.4716856+01	.3957918+01
.5332481+01	.3078716+01
.5786082+01	.2105968+01
.6063875+01	.1069232+01
.6157422+01	.8447360-05

BODY SECTION NUMBER 27 X= .1295056+03

Y	Z
.0000000	.5996321+01
.1041249+01	.5905223+01
.2050861+01	.5634699+01
.2998158+01	.5192967+01
.3854358+01	.4593450+01
.4593445+01	.3854364+01
.5192963+01	.2998165+01
.5634696+01	.2050868+01
.5905222+01	.1041257+01
.5996321+01	.8226346-05

BODY SECTION NUMBER 28 X= .1314117+03

Y	Z
.0000000	.5805169+01
.1008056+01	.5716976+01
.1985483+01	.5455075+01
.2902582+01	.5027425+01
.3731488+01	.4447020+01
.4447015+01	.3731494+01
.5027421+01	.2902589+01
.5455072+01	.1985491+01
.5716974+01	.1008064+01
.5805169+01	.7964105-05

BODY SECTION NUMBER 29 X= .1328414+03

Y	Z
.0000000	.5626745+01
.9770732+00	.5541262+01
.1924459+01	.5287411+01
.2813370+01	.4872905+01
.3616799+01	.4310339+01
.4310334+01	.3616805+01
.4872901+01	.2813377+01
.5287409+01	.1924466+01
.5541261+01	.9770807+00
.5626745+01	.7719325-05

BODY SECTION NUMBER 30 X= .1337945+03

Y	Z
.0000000	.5487073+01
.9528195+00	.5403712+01
.1876688+01	.5156163+01
.2743534+01	.4751946+01
.3527020+01	.4203344+01
.4203339+01	.3527026+01
.4751942+01	.2743541+01
.5156160+01	.1876695+01
.5403711+01	.9528268+00
.5487073+01	.7527710-05

BODY SECTION NUMBER 31 X= .1342710+03

Y	Z
.0000000	.5411153+01
.9396361+00	.5328946+01
.1850722+01	.5084821+01
.2705575+01	.4686197+01
.3478220+01	.4145186+01
.4145181+01	.3478225+01
.4686194+01	.2705581+01
.5084819+01	.1850729+01
.5328945+01	.9396434+00
.5411153+01	.7423555-05

BODY SECTION NUMBER 32 X= .1347476+03

Y	Z
.3604347+00	.5320269+01
.1200853+01	.5195491+01
.2010786+01	.4938817+01
.2769671+01	.4556764+01
.3458245+01	.4059029+01
.4059025+01	.3458250+01
.4556760+01	.2769677+01
.4938814+01	.2010792+01
.5195489+01	.1200860+01
.5320269+01	.3604347+00

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BODY SECTION NUMBER 33 X= .1352253+03

Y	Z
.4772740+00	.5227438+01
.1274999+01	.5091982+01
.2042428+01	.4835534+01
.2761326+01	.4464188+01
.3414612+01	.3986768+01
.3986763+01	.3414618+01
.4464184+01	.2761332+01
.4835531+01	.2042434+01
.5091980+01	.1275005+01
.5227438+01	.4772740+00

BODY SECTION NUMBER 34 X= .1361843+03

Y	Z
.5909954+00	.5031600+01
.1329186+01	.4888715+01
.2038100+01	.4638148+01
.2702121+01	.4285419+01
.3304623+01	.3838296+01
.3838291+01	.3306628+01
.4285415+01	.2702126+01
.4638146+01	.2038106+01
.4888713+01	.1329193+01
.5031600+01	.5909954+00

BODY SECTION NUMBER 35 X= .1371483+03

Y	Z
.6247824+00	.4816985+01
.1318310+01	.4675014+01
.1983836+01	.4433745+01
.2607226+01	.4098301+01
.3175237+01	.3675809+01
.3675805+01	.3175242+01
.4098298+01	.2607231+01
.4433742+01	.1983842+01
.4675013+01	.1318316+01
.4816985+01	.6247824+00

BODY SECTION NUMBER 36 X= .1381182+03

Y	Z
.6117277+00	.4588185+01
.1768615+01	.4451547+01
.1898847+01	.4221378+01
.2489184+01	.3902515+01
.3027220+01	.3501656+01
.3501652+01	.3027225+01
.3902511+01	.2489189+01
.4221376+01	.1898853+01
.4451545+01	.1268621+01
.4588185+01	.6117277+00

BODY SECTION NUMBER 37 X= .1390945+03

Y	Z
.5656244+00	.4338751+01
.1189659+01	.4210630+01
.1788474+01	.3993251+01
.2349378+01	.3691222+01
.2860478+01	.3310945+01
.3310941+01	.2860482+01
.3691218+01	.2349382+01
.3993248+01	.1788480+01
.4210628+01	.1189664+01
.4338751+01	.5656244+00

BODY SECTION NUMBER 38 X= .1400782+03

Y	Z
.4941413+00	.4066811+01
.1087102+01	.3949852+01
.1656402+01	.3746926+01
.2189651+01	.3462449+01
.2675243+01	.3102612+01
.3102608+01	.2675247+01
.3462446+01	.2189656+01
.3746924+01	.1656407+01
.3949851+01	.1087107+01
.4066811+01	.4941413+00

BODY SECTION NUMBER 39 X= .1410705+03

Y	Z
.4028007+00	.3762079+01
.9635130+00	.3658842+01
.1502347+01	.3472526+01
.2007068+01	.3207360+01
.2466215+01	.2869367+01
.2869363+01	.2466219+01
.3207358+01	.2007073+01
.3472524+01	.1502352+01
.3658841+01	.9635180+00
.3762079+01	.4028007+00

BODY SECTION NUMBER 40 X= .1420724+03

Y	Z
.2936624+00	.3435219+01
.8224201+00	.3348222+01
.1331311+01	.3180342+01
.1808041+01	.2935635+01
.2241094+01	.2620012+01
.2620009+01	.2241097+01
.2935633+01	.1808045+01
.3180340+01	.1331315+01
.3348221+01	.8224247+00
.3435219+01	.2936624+00

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BODY SECTION NUMBER 41 X= .1430843+03

Y	Z
.1612121+00	.3101086+01
.6622889+00	.3033826+01
.1145810+01	.2886147+01
.1598959+01	.2661964+01
.2009725+01	.2367220+01
.2367218+01	.2009728+01
.2661962+01	.1598963+01
.2886145+01	.1145814+01
.3033825+01	.6622930+00
.3101086+01	.1612121+00

BODY SECTION NUMBER 42 X= .1441064+03

Y	Z
.7934229-07	.2760490+01
.4793537+00	.2718552+01
.9441424+00	.2594012+01
.1380294+01	.2390655+01
.1774407+01	.2114659+01
.2114657+01	.1774410+01
.2390653+01	.1380247+01
.2594011+01	.9441459+00
.2718551+01	.4793573+00
.2760490+01	.7934229-07

BODY SECTION NUMBER 43 X= .1447047+03

Y	Z
.0000000	.2558363+01
.4442548+00	.2519496+01
.8750111+00	.2404076+01
.1279181+01	.2215608+01
.1644483+01	.1959821+01
.1959819+01	.1644486+01
.2215607+01	.1279184+01
.2404074+01	.8750144+00
.2519496+01	.4442582+00
.2558363+01	.3509816-05

BODY SECTION NUMBER 44 X= .1453029+03

Y	Z
.0000000	.2356312+01
.4091690+00	.2320515+01
.8059056+00	.2214209+01
.1178155+01	.2040627+01
.1514607+01	.1805041+01
.1805039+01	.1514610+01
.2040625+01	.1178158+01
.2214208+01	.8059086+00
.2320514+01	.4091722+00
.2356312+01	.3232622-05

BODY SECTION NUMBER 45 X= .1459012+03

Y	Z
.0000000	.2154294+01
.3740890+00	.2121566+01
.7368114+00	.2024375+01
.1077146+01	.1865674+01
.1384753+01	.1650286+01
.1650284+01	.1384755+01
.1865673+01	.1077149+01
.2024374+01	.7368142+00
.2121565+01	.3740919+00
.2154294+01	.2955474-05

BODY SECTION NUMBER 46 X= .1464994+03

Y	Z
.0000000	.1952217+01
.3389987+00	.1922559+01
.6676971+00	.1834484+01
.9761079+00	.1690670+01
.1254860+01	.1495486+01
.1495484+01	.1254862+01
.1690669+01	.9761102+00
.1834484+01	.6676996+00
.1922558+01	.3390013+00
.1952217+01	.2678245-05

BODY SECTION NUMBER 47 X= .1470977+03

Y	Z
.0000000	.1750194+01
.3039178+00	.1723605+01
.5986011+00	.1644645+01
.8750964+00	.1515713+01
.1125002+01	.1340727+01
.1340726+01	.1125004+01
.1515712+01	.8750984+00
.1644644+01	.5986034+00
.1723604+01	.3039201+00
.1750194+01	.2401089-05

BODY SECTION NUMBER 48 X= .1476960+03

Y	Z
.0000000	.1548203+01
.2688423+00	.1524682+01
.5295160+00	.1454835+01
.7741007+00	.1340783+01
.9951647+00	.1185993+01
.1185991+01	.9951663+00
.1340782+01	.7741025+00
.1454834+01	.5295180+00
.1524682+01	.2688444+00
.1548203+01	.2123977-05

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BODY SECTION NUMBER 49 X= .1482942+03

Y	Z
.0000000	.1346003+01
.2337307+00	.1325554+01
.4603596+00	.1264829+01
.6730008+00	.1165673+01
.8651932+00	.1031098+01
.1031097+01	.8651946+00
.1165672+01	.6730023+00
.1264828+01	.4603613+00
.1325553+01	.2337325+00
.1346003+01	.1846579-05

BODY SECTION NUMBER 50 X= .1488925+03

Y	Z
.0000000	.1145647+01
.1989393+00	.1128242+01
.3918340+00	.1076556+01
.5728230+00	.9921595+00
.7364071+00	.8776169+00
.8776159+00	.7364083+00
.9921588+00	.5728243+00
.1076555+01	.3918354+00
.1128242+01	.1989409+00
.1145647+01	.1571712-05

BODY SECTION NUMBER 51 X= .1494907+03

Y	Z
.0000000	.9425268+00
.1636679+00	.9282077+00
.3223629+00	.8856856+00
.4712630+00	.8162524+00
.6058441+00	.7220178+00
.7220170+00	.6058451+00
.8162517+00	.4712641+00
.8856851+00	.3223641+00
.9282075+00	.1634692+00
.9425268+00	.1293051-05

BODY SECTION NUMBER 52 X= .1500890+03

Y	Z
.0000000	.7400000+00
.1284995+00	.7287578+00
.2530947+00	.6953726+00
.3699997+00	.6408590+00
.4756625+00	.5668732+00
.5668725+00	.4756633+00
.6408585+00	.3700006+00
.6953723+00	.2530956+00
.7287576+00	.1285005+00
.7400000+00	.1015205-05

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COORDINATES FOR INPUT TO THE DOUGLAS THREE DIMENSIONAL POTENTIAL FLOW PROGRAM

TEST CASE 4

FINAL THREE DIMENSIONAL COORDINATE OUTPUT

X	Y	Z	STAT	X	Y	Z	STAT	SEQ
.00000	.00000	6.37500	2	.00000	1.10701	6.27815		1
.00000	2.18038	5.99054		.00000	3.18750	5.52091		2
.00000	4.09777	4.88354		.00000	4.88353	4.09777		3
.00000	5.52091	3.18751		.00000	5.99054	2.18038		4
.00000	6.27815	1.10701		.00000	6.37500	.00001		5
4.18706	.00000	6.37500	1	4.18706	1.10701	6.27815		6
4.18706	2.18038	5.99054		4.18706	3.18750	5.52091		7
4.18706	4.09777	4.88354		4.18706	4.88353	4.09777		8
4.18706	5.52091	3.18750		4.18706	5.99054	2.18038		9
4.18706	6.27815	1.10701		4.18706	6.37500	.00001		10
8.37413	.00000	6.37500	1	8.37413	1.10701	6.27815		11
8.37413	2.18038	5.99054		8.37413	3.18750	5.52091		12
8.37413	4.09777	4.88354		8.37413	4.88353	4.09777		13
8.37413	5.52091	3.18750		8.37413	5.99054	2.18038		14
8.37413	6.27815	1.10701		8.37413	6.37500	.00001		15
12.56119	.00000	6.37500	1	12.56119	1.10701	6.27815		16
12.56119	2.18038	5.99054		12.56119	3.18750	5.52091		17
12.56119	4.09777	4.88354		12.56119	4.88353	4.09777		18
12.56119	5.52091	3.18750		12.56119	5.99054	2.18038		19
12.56119	6.27815	1.10701		12.56119	6.37500	.00001		20
16.74825	.00000	6.37500	1	16.74825	1.10701	6.27815		21
16.74825	2.18038	5.99054		16.74825	3.18750	5.52091		22
16.74825	4.09777	4.88354		16.74825	4.88353	4.09777		23
16.74825	5.52091	3.18750		16.74825	5.99054	2.18038		24
16.74825	6.27815	1.10701		16.74825	6.37500	.00001		25
20.93531	.00000	6.37500	1	20.93531	1.10701	6.27815		26
20.93531	2.18038	5.99054		20.93531	3.18750	5.52091		27
20.93531	4.09777	4.88354		20.93531	4.88353	4.09777		28
20.93531	5.52091	3.18750		20.93531	5.99054	2.18038		29
20.93531	6.27815	1.10701		20.93531	6.37500	.00001		30
25.12238	.00000	6.37500	1	25.12238	1.10701	6.27815		31
25.12238	2.18038	5.99054		25.12238	3.18750	5.52091		32
25.12238	4.09777	4.88354		25.12238	4.88353	4.09777		33
25.12238	5.52091	3.18750		25.12238	5.99054	2.18038		34
25.12238	6.27815	1.10701		25.12238	6.37500	.00001		35
29.30944	.00000	6.37500	1	29.30944	1.10701	6.27815		36
29.30944	2.18038	5.99054		29.30944	3.18750	5.52091		37
29.30944	4.09777	4.88354		29.30944	4.88353	4.09777		38
29.30944	5.52091	3.18750		29.30944	5.99054	2.18038		39
29.30944	6.27815	1.10701		29.30944	6.37500	.00001		40
33.49650	.00000	6.37500	1	33.49650	1.10701	6.27815		41
33.49650	2.18038	5.99054		33.49650	3.18750	5.52091		42
33.49650	4.09777	4.88354		33.49650	4.88353	4.09777		43
33.49650	5.52091	3.18750		33.49650	5.99054	2.18038		44
33.49650	6.27815	1.10701		33.49650	6.37500	.00001		45
37.68356	.00000	6.37500	1	37.68356	1.10701	6.27815		46
37.68356	2.18038	5.99054		37.68356	3.18750	5.52091		47
37.68356	4.09777	4.88354		37.68356	4.88353	4.09778		48
37.68356	5.52091	3.18751		37.68356	5.99054	2.18039		49
37.68356	6.27815	1.10701		37.68356	6.37500	.00001		50
41.87063	.00000	6.37500	1	41.87063	1.10701	6.27815		51
41.87063	2.18038	5.99054		41.87063	3.18750	5.52091		52
41.87063	4.09777	4.88354		41.87063	4.88353	4.09777		53
41.87063	5.52091	3.18751		41.87063	5.99054	2.18038		54
41.87063	6.27815	1.10701		41.87063	6.37500	.00001		55

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46.05769	.00000	6.37500	1	46.05769	1.10701	6.27815	56
46.05769	2.18038	5.99054		46.05769	3.18750	5.52091	57
46.05769	4.09777	4.88354		46.05769	4.88353	4.09777	58
46.05769	5.52091	3.18750		46.05769	5.99054	2.18038	59
46.05769	6.27815	1.10701		46.05769	6.37500	.00001	60
50.24475	.00000	6.37500	1	50.24475	1.10701	6.27815	61
50.24475	2.18038	5.99054		50.24475	3.18750	5.52091	62
50.24475	4.09777	4.88354		50.24475	4.88353	4.09777	63
50.24475	5.52091	3.18750		50.24475	5.99054	2.18038	64
50.24475	6.27815	1.10701		50.24475	6.37500	.00001	65
54.43181	.00000	6.37500	1	54.43181	1.10701	6.27815	66
54.43181	2.18038	5.99054		54.43181	3.18750	5.52091	67
54.43181	4.09777	4.88354		54.43181	4.88353	4.09777	68
54.43181	5.52091	3.18750		54.43181	5.99054	2.18038	69
54.43181	6.27815	1.10701		54.43181	6.37500	.00001	70
58.61888	.00000	6.37500	1	58.61888	1.10701	6.27815	71
58.61888	2.18038	5.99054		58.61888	3.18750	5.52091	72
58.61888	4.09777	4.88354		58.61888	4.88353	4.09777	73
58.61888	5.52091	3.18750		58.61888	5.99054	2.18038	74
58.61888	6.27815	1.10701		58.61888	6.37500	.00001	75
62.80594	.00000	6.37500	1	62.80594	1.10701	6.27815	76
62.80594	2.18038	5.99054		62.80594	3.18750	5.52091	77
62.80594	4.09777	4.88354		62.80594	4.88353	4.09777	78
62.80594	5.52091	3.18750		62.80594	5.99054	2.18038	79
62.80594	6.27815	1.10701		62.80594	6.37500	.00001	80
66.99300	.00000	6.37500	1	66.99300	1.10701	6.27815	81
66.99300	2.18038	5.99054		66.99300	3.18750	5.52091	82
66.99300	4.09777	4.88354		66.99300	4.88353	4.09777	83
66.99300	5.52091	3.18750		66.99300	5.99054	2.18038	84
66.99300	6.27815	1.10701		66.99300	6.37500	.00001	85
71.18006	.00000	6.37500	1	71.18006	1.10701	6.27815	86
71.18006	2.18038	5.99054		71.18006	3.18750	5.52091	87
71.18006	4.09777	4.88354		71.18006	4.88353	4.09777	88
71.18006	5.52091	3.18750		71.18006	5.99054	2.18038	89
71.18006	6.27815	1.10701		71.18006	6.37500	.00001	90
75.36713	.00000	6.37500	1	75.36713	1.10701	6.27815	91
75.36713	2.18038	5.99054		75.36713	3.18750	5.52091	92
75.36713	4.09777	4.88354		75.36713	4.88353	4.09777	93
75.36713	5.52091	3.18750		75.36713	5.99054	2.18038	94
75.36713	6.27815	1.10701		75.36713	6.37500	.00001	95
79.55419	.00000	6.37500	1	79.55419	1.10701	6.27815	96
79.55419	2.18038	5.99054		79.55419	3.18750	5.52091	97
79.55419	4.09777	4.88354		79.55419	4.88353	4.09777	98
79.55419	5.52091	3.18750		79.55419	5.99054	2.18038	99
79.55419	6.27815	1.10701		79.55419	6.37500	.00001	100
83.74125	.00000	6.37500	1	83.74125	1.10701	6.27815	101
83.74125	2.18038	5.99054		83.74125	3.18750	5.52091	102
83.74125	4.09777	4.88354		83.74125	4.88353	4.09777	103
83.74125	5.52091	3.18750		83.74125	5.99054	2.18038	104
83.74125	6.27815	1.10701		83.74125	6.37500	.00001	105
87.92831	.00000	6.37500	1	87.92831	1.10701	6.27815	106
87.92831	2.18038	5.99054		87.92831	3.18750	5.52091	107
87.92831	4.09777	4.88354		87.92831	4.88353	4.09777	108
87.92831	5.52091	3.18750		87.92831	5.99054	2.18038	109
87.92831	6.27815	1.10701		87.92831	6.37500	.00001	110
92.11538	.00000	6.37500	1	92.11538	1.10701	6.27815	111
92.11538	2.18038	5.99054		92.11538	3.18750	5.52091	112
92.11538	4.09777	4.88354		92.11538	4.88353	4.09777	113
92.11538	5.52091	3.18750		92.11538	5.99054	2.18038	114
92.11538	6.27815	1.10701		92.11538	6.37500	.00001	115
95.92774	.00000	6.37557	1	95.92774	1.10711	6.27872	116
95.92774	2.18057	5.99108		95.92774	3.18778	5.52141	117
95.92774	4.09814	4.88398		95.92774	4.88397	4.09814	118
95.92774	5.52141	3.18779		95.92774	5.99108	2.18058	119
95.92774	6.27871	1.10711		95.92774	6.37557	.00001	120
99.26356	.00000	6.30097	1	99.26356	1.09415	6.20524	121
99.26356	2.15506	5.92098		99.26356	3.15048	5.45680	122

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99.26356	4.05018	4.82683		99.26356	4.82682	4.05019	123
99.26356	5.45680	3.15049		99.26356	5.92097	2.15507	124
99.26356	6.20524	1.09416		99.26356	6.30097	.00001	125
102.12283	.00000	6.15742	1	102.12283	1.06922	6.06388	126
102.12283	2.10596	5.78608		102.12283	3.07871	5.33249	127
102.12283	3.95791	4.71686		102.12283	4.71686	3.95792	128
102.12283	5.33248	3.07872		102.12283	5.78608	2.10597	129
102.12283	6.06388	1.06923		102.12283	6.15742	.00001	130
104.50556	.00000	5.99632	1	104.50556	1.04125	5.90522	131
104.50556	2.05086	5.63470		104.50556	2.99816	5.19297	132
104.50556	3.85436	4.59345		104.50556	4.59345	3.85436	133
104.50556	5.19296	2.99817		104.50556	5.63470	2.05087	134
104.50556	5.90522	1.04126		104.50556	5.99632	.00001	135
106.41174	.00000	5.80517	1	106.41174	1.00806	5.71698	136
106.41174	1.98548	5.45508		106.41174	2.90258	5.02743	137
106.41174	3.73149	4.44702		106.41174	4.44701	3.73149	138
106.41174	5.02742	2.90259		106.41174	5.45507	1.98549	139
106.41174	5.71697	1.00806		106.41174	5.80517	.00001	140
107.84138	.00000	5.62674	1	107.84138	.97707	5.54126	141
107.84138	1.92446	5.28741		107.84138	2.81337	4.87291	142
107.84138	3.61680	4.31034		107.84138	4.31033	3.61681	143
107.84138	4.87290	2.81338		107.84138	5.28741	1.92447	144
107.84138	5.54126	.97708		107.84138	5.62674	.00001	145
108.79447	.00000	5.48707	1	108.79447	.95282	5.40371	146
108.79447	1.87669	5.15616		108.79447	2.74353	4.75195	147
108.79447	3.52702	4.20334		108.79447	4.20334	3.52703	148
108.79447	4.75194	2.74354		108.79447	5.15616	1.87670	149
108.79447	5.40371	.95283		108.79447	5.48707	.00001	150
109.27101	.00000	5.41115	1	109.27101	.93964	5.32895	151
109.27101	1.85072	5.08482		109.27101	2.70557	4.68620	152
109.27101	3.47822	4.14519		109.27101	4.14518	3.47823	153
109.27101	4.68619	2.70558		109.27101	5.08482	1.85073	154
109.27101	5.32894	.93964		109.27101	5.41115	.00001	155
109.74756	.36043	5.32027	1	109.74756	1.20085	5.19549	156
109.74756	2.01079	4.93882		109.74756	2.76967	4.55676	157
109.74756	3.45824	4.05903		109.74756	4.05902	3.45825	158
109.74756	4.55676	2.76968		109.74756	4.93881	2.01079	159
109.74756	5.19549	1.20086		109.74756	5.32027	.36043	160
110.22530	.47727	5.22744	1	110.22530	1.27500	5.09198	161
110.22530	2.04243	4.83553		110.22530	2.76133	4.46419	162
110.22530	3.41961	3.98677		110.22530	3.98676	3.41962	163
110.22530	4.46418	2.76133		110.22530	4.83553	2.04243	164
110.22530	5.09198	1.27501		110.22530	5.22744	.47727	165
111.18431	.59100	5.03160	1	111.18431	1.32919	4.88871	166
111.18431	2.03810	4.63815		111.18431	2.70212	4.28542	167
111.18431	3.30662	3.83830		111.18431	3.83829	3.30663	168
111.18431	4.28542	2.70213		111.18431	4.63815	2.03811	169
111.18431	4.88871	1.32919		111.18431	5.03160	.59100	170
112.14827	.62478	4.81699	1	112.14827	1.31831	4.67501	171
112.14827	1.98384	4.43374		112.14827	2.60723	4.09830	172
112.14827	3.17524	3.67581		112.14827	3.67580	3.17524	173
112.14827	4.09830	2.60723		112.14827	4.43374	1.98384	174
112.14827	4.67501	1.31832		112.14827	4.81699	.62478	175
113.11816	.61173	4.58819	1	113.11816	1.26861	4.45155	176
113.11816	1.89885	4.22138		113.11816	2.48918	3.90251	177
113.11816	3.02722	3.50166		113.11816	3.50165	3.02722	178
113.11816	3.90251	2.48919		113.11816	4.22138	1.89885	179
113.11816	4.45155	1.26862		113.11816	4.58819	.61173	180
114.09451	.56562	4.33875	1	114.09451	1.18966	4.21063	181
114.09451	1.78847	3.99325		114.09451	2.34938	3.69122	182
114.09451	2.86048	3.31095		114.09451	3.31094	2.86048	183
114.09451	3.69122	2.34938		114.09451	3.99325	1.78848	184
114.09451	4.21063	1.18966		114.09451	4.33875	.56562	185
115.07824	.99414	4.06681	1	115.07824	1.08710	3.99985	186
115.07824	1.65640	3.74693		115.07824	2.18965	3.46245	187
115.07824	2.67524	3.10261		115.07824	3.10261	2.67525	188
115.07824	3.46245	2.18966		115.07824	3.74692	1.65641	189

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115.07824	3.94985	1.08711		115.07824	4.06681	.49414	190
116.07050	.40280	3.76208	1	116.07050	.96351	3.65884	191
116.07050	1.50235	3.47253		116.07050	2.00707	3.20736	192
116.07050	2.46622	2.86937		116.07050	2.86936	2.46622	193
116.07050	3.20736	2.00707		116.07050	3.47252	1.50235	194
116.07050	3.65884	.96352		116.07050	3.76208	.40280	195
117.07242	.29366	3.43522	1	117.07242	.82242	3.34822	196
117.07242	1.33131	3.18034		117.07242	1.80804	2.93564	197
117.07242	2.24109	2.62001		117.07242	2.62001	2.24110	198
117.07242	2.93563	1.80804		117.07242	3.18034	1.33131	199
117.07242	3.34822	.82242		117.07242	3.43522	.29366	200
118.08430	.16121	3.10109	1	118.08430	.66229	3.03383	201
118.08430	1.14581	2.88615		118.08430	1.59896	2.66196	202
118.08430	2.00972	2.36722		118.08430	2.36722	2.00973	203
118.08430	2.66196	1.59896		118.08430	2.88615	1.14581	204
118.08430	3.03382	.66229		118.08430	3.10109	.16121	205
119.10641	.00000	2.76049	1	119.10641	.47935	2.71855	206
119.10641	.94414	2.59401		119.10641	1.38024	2.39065	207
119.10641	1.77441	2.11466		119.10641	2.11466	1.77441	208
119.10641	2.39065	1.38025		119.10641	2.59401	.94415	209
119.10641	2.71855	.47936		119.10641	2.76049	.00000	210
119.70467	.00000	2.55836	1	119.70467	.44425	2.51950	211
119.70467	.87501	2.40408		119.70467	1.27918	2.21561	212
119.70467	1.64448	1.95982		119.70467	1.95982	1.64449	213
119.70467	2.21561	1.27918		119.70467	2.40407	.87501	214
119.70467	2.51950	.44424		119.70467	2.55836	.00000	215
120.30293	.00000	2.35631	1	120.30293	.40917	2.32051	216
120.30293	.80591	2.21421		120.30293	1.17816	2.04063	217
120.30293	1.51461	1.80504		120.30293	1.80504	1.51461	218
120.30293	2.04063	1.17816		120.30293	2.21421	.80591	219
120.30293	2.32051	.40917		120.30293	2.35631	.00000	220
120.90119	.00000	2.15429	1	120.90119	.37409	2.12157	221
120.90119	.73681	2.02437		120.90119	1.07715	1.86567	222
120.90119	1.38475	1.65029		120.90119	1.65028	1.38475	223
120.90119	1.86567	1.07715		120.90119	2.02437	.73681	224
120.90119	2.12157	.37409		120.90119	2.15429	.00000	225
121.49945	.00000	1.95222	1	121.49945	.33900	1.92256	226
121.49945	.66770	1.83948		121.49945	.97611	1.69067	227
121.49945	1.25486	1.49549		121.49945	1.49548	1.25486	228
121.49945	1.69067	.97611		121.49945	1.83948	.66770	229
121.49945	1.92256	.33900		121.49945	1.95222	.00000	230
122.09771	.00000	1.75019	1	122.09771	.30392	1.72360	231
122.09771	.59860	1.64464		122.09771	.87510	1.51571	232
122.09771	1.12500	1.34073		122.09771	1.34073	1.12500	233
122.09771	1.51571	.87510		122.09771	1.64464	.59860	234
122.09771	1.72360	.30392		122.09771	1.75019	.00000	235
122.69596	.00000	1.54820	1	122.69596	.26884	1.52468	236
122.69596	.52952	1.45483		122.69596	.77410	1.34078	237
122.69596	.99516	1.18599		122.69596	1.18599	.99517	238
122.69596	1.34078	.77410		122.69596	1.45483	.52952	239
122.69596	1.52468	.26884		122.69596	1.54820	.00000	240
123.29422	.00000	1.34600	1	123.29422	.23373	1.32555	241
123.29422	.46036	1.26483		123.29422	.67300	1.16567	242
123.29422	.86519	1.03110		123.29422	1.03110	.86519	243
123.29422	1.16567	.67300		123.29422	1.26483	.46036	244
123.29422	1.32555	.23373		123.29422	1.34600	.00000	245
123.89248	.00000	1.14565	1	123.89248	.19894	1.12824	246
123.89248	.39183	1.07656		123.89248	.57282	.99216	247
123.89248	.73641	.87762		123.89248	.87762	.73641	248
123.89248	.99216	.57282		123.89248	1.07656	.39184	249
123.89248	1.12824	.19894		123.89248	1.14565	.00000	250
124.49074	.00000	.94253	1	124.49074	.16367	.92821	251
124.49074	.32236	.88569		124.49074	.47126	.81625	252
124.49074	.60584	.72202		124.49074	.72202	.60585	253
124.49074	.81625	.47126		124.49074	.88569	.32236	254
124.49074	.92821	.16367		124.49074	.94253	.00000	255
125.08900	.00000	.74000	1	125.08900	.12850	.72876	256

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125.08900	.25309	.69537		125.08900	.37000	.64086	257
125.08900	.47564	.56687		125.08900	.56687	.47566	258
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125.08900	.72876	.12850		125.08900	.74000	.00000	260
109.27101	5.41115	.00000	2	109.27100	5.41100	.00000	261
109.27100	5.41100	.00000		109.27100	5.41100	.00000	262
109.32100	5.98463	.00000		109.37100	6.55825	.00000	263
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109.52100	8.27913	.00000		109.57100	8.85275	.00000	265
109.62100	9.42638	.00000		109.67100	10.00000	.00000	266
109.74756	5.32027	.36043	1	109.74997	5.35051	.35983	267
109.75239	5.38076	.35923		109.75480	5.41100	.35862	268
109.80058	5.98463	.34715		109.84635	6.55825	.33568	269
109.89212	7.13188	.32421		109.93790	7.70550	.31274	270
109.98368	8.27913	.30127		110.02945	8.85275	.28979	271
110.07522	9.42638	.27837		110.12100	10.00000	.26685	272
110.22530	5.22744	.47727	1	110.22974	5.28863	.47566	273
110.23417	5.34981	.47405		110.23860	5.41100	.47244	274
110.28015	5.98463	.45733		110.32170	6.55825	.44722	275
110.36325	7.13188	.42710		110.40480	7.70550	.41199	276
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110.52945	9.42638	.36666		110.57100	10.00000	.35155	278
111.18431	5.03160	.59100	1	111.19161	5.15807	.58691	279
111.19890	5.28453	.58283		111.20620	5.41100	.57875	280
111.23930	5.98463	.56024		111.27240	6.55825	.54173	281
111.30550	7.13188	.52321		111.33860	7.70550	.50470	282
111.37170	8.27913	.48619		111.40480	8.85275	.46768	283
111.43790	9.42638	.44917		111.47100	10.00000	.43065	284
112.14827	4.81699	.62478	1	112.15678	5.01499	.61811	285
112.16529	5.21300	.61143		112.17380	5.41100	.60475	286
112.19845	5.98463	.58541		112.22310	6.55825	.56606	287
112.24775	7.13188	.54672		112.27240	7.70550	.52738	288
112.29705	8.27913	.50803		112.32170	8.85275	.48869	289
112.34635	9.42638	.46934		112.37100	10.00000	.45000	290
113.11816	4.58819	.61173	1	113.12591	4.86246	.60278	291
113.13366	5.13673	.59384		113.14140	5.41100	.58489	292
113.15760	5.98463	.56618		113.17380	6.55825	.54747	293
113.19000	7.13188	.52877		113.20620	7.70550	.51006	294
113.22240	8.27913	.49135		113.23860	8.85275	.47264	295
113.25480	9.42638	.45393		113.27100	10.00000	.43522	296
114.09451	4.33875	.56562	1	114.09939	4.69617	.55499	297
114.10417	5.05358	.54435		114.10900	5.41100	.53371	298
114.11675	5.98463	.51669		114.12950	6.55825	.49957	299
114.13225	7.13188	.48250		114.14000	7.70550	.46543	300
114.14775	8.27913	.44836		114.15550	8.85275	.43128	301
114.16325	9.42638	.41421		114.17100	10.00000	.39714	302
115.07824	4.06681	.49414	1	115.07769	4.51487	.48266	303
115.07714	4.96294	.47117		115.07660	5.41100	.45969	304
115.07590	5.98463	.44498		115.07520	6.55825	.43028	305
115.07450	7.13188	.41557		115.07380	7.70550	.40087	306
115.07310	8.27913	.38617		115.07240	8.85275	.37146	307
115.07170	9.42638	.35676		115.07100	10.00000	.34206	308
116.07050	3.76208	.40280	1	116.06173	4.31172	.39149	309
116.05297	4.86136	.38019		116.04420	5.41100	.36888	310
116.03505	5.98463	.35709		116.02590	6.55825	.34528	311
116.01675	7.13188	.33349		116.00760	7.70550	.32169	312
115.99845	8.27913	.30989		115.98930	8.85275	.29809	313
115.98015	9.42638	.28629		115.97100	10.00000	.27449	314
117.07242	3.43522	.29366	1	117.05221	4.09381	.28395	315
117.03201	4.75241	.27423		117.01180	5.41100	.26452	316
116.99420	5.98463	.25606		116.97640	6.55825	.24760	317
116.95900	7.13188	.23914		116.94140	7.70550	.23068	318
116.92380	8.27913	.22221		116.90620	8.85275	.21375	319
116.88860	9.42638	.20529		116.87100	10.00000	.19683	320
118.08430	3.10109	.16121	1	118.04933	3.87106	.15508	321
118.01436	4.64103	.14895		117.97940	5.41100	.14282	322
117.95335	5.98463	.13825		117.92730	6.55825	.13368	323

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117.90125	7.13188	.12911		117.87520	7.70550	.12454	324
117.84915	8.27913	.11998		117.82310	8.85275	.11541	325
117.79705	9.42638	.11084		117.77100	10.00000	.10627	326
119.10641	2.76049	.00000	1	119.05327	3.64399	.00000	327
119.00014	4.52750	.00000		118.94700	5.41100	.00000	328
118.91250	5.98463	.00000		118.87800	6.55825	.00000	329
118.84350	7.13188	.00000		118.80900	7.70550	.00000	330
118.77450	8.27913	.00000		118.74000	8.85275	.00000	331
118.70550	9.42638	.00000		118.67100	10.00000	.00000	332
109.67100	.00000	10.00000	2	109.62100	.00000	9.42638	333
109.57100	.00000	8.85275		109.52100	.00000	8.27913	334
109.47100	.00000	7.70550		109.42100	.00000	7.13188	335
109.37100	.00000	6.55825		109.32100	.00000	5.98463	336
109.27100	.00000	5.41100		109.27100	.00000	5.41100	337
109.27100	.00000	5.41100		109.27101	.00000	5.41115	338
110.12100	.26685	10.00000	1	110.07522	.27832	9.42638	339
110.02945	.28979	8.85275		109.98368	.30127	8.27913	340
109.93790	.31274	7.70550		109.89212	.32421	7.13188	341
109.84635	.33568	6.55825		109.80058	.34715	5.98463	342
109.75480	.35862	5.41100		109.75239	.35923	5.38076	343
109.74997	.35983	5.35051		109.74756	.36043	5.32027	344
110.57100	.35155	10.00000	1	110.52945	.36666	9.42638	345
110.48790	.38177	8.85275		110.44635	.39688	8.27913	346
110.40480	.41199	7.70550		110.36325	.42710	7.13188	347
110.32170	.44222	6.55825		110.28015	.45733	5.98463	348
110.23860	.47244	5.41100		110.23417	.47405	5.34981	349
110.22974	.47566	5.28863		110.22530	.47727	5.22744	350
111.47100	.43065	10.00000	1	111.43790	.44917	9.42638	351
111.40480	.46768	8.85275		111.37170	.48619	8.27913	352
111.33860	.50470	7.70550		111.30550	.52321	7.13188	353
111.27240	.54173	6.55825		111.23930	.56024	5.98463	354
111.20620	.57875	5.41100		111.19890	.58283	5.28453	355
111.19161	.58691	5.15807		111.18431	.59100	5.03160	356
112.37100	.45000	10.00000	1	112.34635	.46934	9.42638	357
112.32170	.48869	8.85275		112.29705	.50803	8.27913	358
112.27240	.52738	7.70550		112.24775	.54672	7.13188	359
112.22310	.56606	6.55825		112.19845	.58541	5.98463	360
112.17380	.60475	5.41100		112.16529	.61143	5.21300	361
112.15678	.61811	5.01499		112.14827	.62478	4.81699	362
113.27100	.43522	10.00000	1	113.25480	.45393	9.42638	363
113.23860	.47264	8.85275		113.22240	.49135	8.27913	364
113.20620	.51006	7.70550		113.19000	.52877	7.13188	365
113.17380	.54747	6.55825		113.15760	.56618	5.98463	366
113.14140	.58489	5.41100		113.13366	.59384	5.13673	367
113.12591	.60278	4.86246		113.11816	.61173	4.58819	368
114.17100	.39714	10.00000	1	114.16325	.41421	9.42638	369
114.15550	.43128	8.85275		114.14775	.44836	8.27913	370
114.14000	.46543	7.70550		114.13225	.48250	7.13188	371
114.12450	.49957	6.55825		114.11675	.51664	5.98463	372
114.10900	.53371	5.41100		114.10417	.54435	5.05358	373
114.09934	.55499	4.69617		114.09451	.56562	4.33875	374
115.07100	.34206	10.00000	1	115.07170	.35676	9.42638	375
115.07240	.37146	8.85275		115.07310	.38617	8.27913	376
115.07380	.40087	7.70550		115.07450	.41557	7.13188	377
115.07520	.43028	6.55825		115.07590	.44498	5.98463	378
115.07660	.45969	5.41100		115.07714	.47117	4.96294	379
115.07769	.48266	4.51487		115.07824	.49414	4.06681	380
115.97100	.27449	10.00000	1	115.98015	.28629	9.42638	381
115.98930	.29809	8.85275		115.99845	.30989	8.27913	382
116.00760	.32169	7.70550		116.01675	.33349	7.13188	383
116.02590	.34528	6.55825		116.03505	.35708	5.98463	384
116.04420	.36888	5.41100		116.05297	.38019	4.86136	385
116.04173	.39149	4.31172		116.07050	.40280	3.76208	386

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116.87100	.19683	10.00000	1	116.88860	.20529	9.42638		387
116.90620	.21375	8.85275		116.92380	.22221	8.27913		388
116.94140	.23068	7.70550		116.95900	.23914	7.13188		389
116.97660	.24760	6.55825		116.99420	.25606	5.98463		390
117.01180	.26452	5.41100		117.03701	.27423	4.75241		391
117.05221	.28395	4.09381		117.07242	.29366	3.43522		392
117.77100	.10627	10.00000	1	117.79705	.11084	9.42638		393
117.82310	.11541	8.85275		117.84915	.11998	8.27913		394
117.87520	.12454	7.70550		117.90125	.12911	7.13188		395
117.92730	.13368	6.55825		117.95335	.13825	5.98463		396
117.97940	.14282	5.41100		118.01436	.14895	4.64103		397
118.04933	.15508	3.87106		118.08430	.16121	3.10109		398
118.67100	.00000	10.00000	1	118.70550	.00000	9.42638		399
118.74000	.00000	8.85275		118.77450	.00000	8.27913		400
118.80900	.00000	7.70550		118.84350	.00000	7.13188		401
118.87800	.00000	6.55825		118.91250	.00000	5.98463		402
118.94700	.00000	5.41100		119.00014	.00000	4.52750		403
119.05327	.00000	3.64399		119.10641	.00000	2.76049	3	404

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CALCULATION OF THE OFF BODY POINTS FOR THE DOUGLAS THREE DIMENSIONAL
POTENTIAL FLOW PROGRAM

OFF BODY POINTS FOR EXAMPLE

INPUT DATA - LOCATION 1

NPTSZ= 5 NTHETA= 6
X=103.089000 ZSTART= 2.340845 DELYZ= .500000 TSTART= .000000 DELT= 15.000000

INPUT DATA - LOCATION 2

NPTSZ= 5 NTHETA= 6
X=105.839000 ZSTART= 1.412140 DELYZ= .500000 TSTART= .000000 DELT= 15.000000

CALCULATION OF THE OFF BODY POINTS FOR THE DOUGLAS THREE DIMENSIONAL
POTENTIAL FLOW PROGRAM

OFF BODY POINTS FOR EXAMPLE

X	Y	Z	X	Y	Z		SEQ
103.089000	.000000	2.340845	103.089000	.605855	2.261083		1
103.089000	1.170422	2.027232	103.089000	1.655226	1.655228		2
103.089000	2.027230	1.170424	103.089000	2.261082	.605858		3
103.089000	.000000	2.840845	103.089000	.735264	2.744046		4
103.089000	1.420421	2.460245	103.089000	2.008779	2.008782		5
103.089000	2.460243	1.420425	103.089000	2.744045	.735268		6
103.089000	.000000	3.340845	103.089000	.844674	3.227009		7
103.089000	1.670421	2.893257	103.089000	2.362333	2.362336		8
103.089000	2.893255	1.670425	103.089000	3.227007	.844678		9
103.089000	.000000	3.840845	103.089000	.954083	3.709972		10
103.089000	1.920421	3.326270	103.089000	2.715886	2.715889		11
103.089000	3.326268	1.920425	103.089000	3.709970	.954088		12
103.089000	.000000	4.340845	103.089000	1.123492	4.192935		13
103.089000	2.170421	3.759283	103.089000	3.069439	3.069443		14
103.089000	3.759280	2.170424	103.089000	4.192933	1.123498		15
105.839000	.000000	1.412140	105.839000	.365488	1.364023		16
105.839000	.706069	1.222949	105.839000	.998533	.998534		17
105.839000	1.222948	.706071	105.839000	1.364022	.365490		18
105.839000	.000000	1.912140	105.839000	.494898	1.846986		19
105.839000	.956069	1.655962	105.839000	1.352086	1.352088		20
105.839000	1.655961	.956071	105.839000	1.846985	.494900		21
105.839000	.000000	2.412140	105.839000	.624307	2.329948		22
105.839000	1.206069	2.088975	105.839000	1.705639	1.705642		23
105.839000	2.088973	1.206072	105.839000	2.329948	.624310		24
105.839000	.000000	2.912140	105.839000	.753717	2.812911		25
105.839000	1.456069	2.521988	105.839000	2.059193	2.059195		26
105.839000	2.521986	1.456072	105.839000	2.812910	.753720		27
105.839000	.000000	3.412140	105.839000	.883126	3.295874		28
105.839000	1.706069	2.955001	105.839000	2.412746	2.412749		29
105.839000	2.954998	1.706073	105.839000	3.295873	.883131	3	30

APPENDIX B. FORTRAN LISTINGS

The FORTRAN listings are preceded by a list of the nonsystem subroutines required by each of the three main programs

Program 1:

Main Program	AXISYM	
Subroutines	AXI3D	
	BDYAX	
	LAGINT	
	PLOTA	

Program 2:

Main Program	APNDG1	
Subroutines	APPINT	INTSEC
	APPNDG	LAGINT
	BODY	LINE
	DELBDY	PLANE
	DOUGC	PLOTC
	FINCRD	
	FINEND	

Program 3:

Main Program	OFFBDY
Subroutines	Nonrequired

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```
C
C       PROGRAM 1 - AXISYM
C
C       MAIN PROGRAM - AXISYMMETRIC BODY WITHOUT APPENDAGES
C
        DIMENSION LABEL(40)
        DIMENSION XBODY(100,10),YBODY(100,10),ZBODY(100,10)
        DIMENSION X(200),Y(200)
        NI=5
        NO=6
        NP=1
        IZ=10
        READ(NI,501)LABEL
        READ(NI,502)IREAD,IPRINT,IPLOT,IPUNCH,NSYM,IDOUG,NPTS,NBODY
        WRITE(NO,530)NSYM
        WRITE(NO,503)LABEL
        WRITE(NO,504)
        WRITE(NO,505)IREAD,IPRINT,IPUNCH,NPTS,NBODY,IPLOT,IDOUG
        IF(NSYM.GT.3.OR.NSYM.LT.1)WRITE(NO,531)
        IF(NPTS.GT.200)WRITE(NO,506)
        IF(NPTS.LT.20)WRITE(NO,533)
        IF(NBODY.GT.100)WRITE(NO,507)
        IF(NSYM.GT.3.OR.NSYM.LT.1)STOP
        IF(NPTS.GT.200.OR.NBODY.GT.100)STOP
        IF(NPTS.LT.20)STOP
        GO TO (1,2),IREAD
1       DO 3 I=1,NPTS,3
3       READ(NI,508)X(I),Y(I),X(I+1),Y(I+1),X(I+2),Y(I+2)
        GO TO 5
2       READ(NI,508)(X(I),I=1,NPTS)
        READ(NI,508)(Y(I),I=1,NPTS)
5       CONTINUE
        WRITE(NO,509)
        WRITE(NO,510)
        DO 6 I=1,NPTS
6       WRITE(NO,511)I,X(I),Y(I)
        CALL BDYAX(X,Y,NPTS,XBODY,YBODY,ZBODY,NBODY,IZ,NSYM)
        IF(IPRINT.EQ.0)GO TO 11
        WRITE(NO,515)
        DO 16 I=1,NBODY,2
        II=I+1
        IF(II.GT.NBODY)GO TO 15
        WRITE(NO,516)I,XBODY(I,1),II,XBODY(I+1,1)
        WRITE(NO,517)
        DO 13 J=1,IZ
13      WRITE(NO,518)ZBODY(I,J),YBODY(I,J),ZBODY(I+1,J),YBODY(I+1,J)
        GO TO 16
15      WRITE(NO,519)I,XBODY(I,1)
        WRITE(NO,520)
        DO 17 J=1,IZ
17      WRITE(NO,521)YBODY(I,J),ZBODY(I,J)
16      CONTINUE
11      CONTINUE
        IF(IDOUG.EQ.0)GO TO 40
        WRITE(NO,500)NSYM
        WRITE(NO,503)LABEL
```

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```
      CALL AXI3D(XBODY,YBODY,ZBODY,NBODY,IZ,IPUNCH,NO,NP)
40    IF(IPLOT.EQ.0)GO TO 50
      WRITE(NO,532)
      CALL PLOTA(XBODY,YBODY,ZBODY,NBODY,IZ)
50    CONTINUE
      STOP
500   FORMAT(1H1,5X,'  COORDINATES FOR INPUT TO THE DOUGLAS  THREE DIMEN
     1SIONAL POTENTIAL FLOW PROGRAM',/,5X,'   HAVING ',I4,2X,'PLANES OF
     1SYMMETRY',///)
501   FORMAT(40A2)
502   FORMAT(8I3)
503   FORMAT(2X,40A2,///)
504   FORMAT(14X,' CONTROL PARAMETERS',///)
505   FORMAT(2X,'IREAD = ',I4,2X,'IPRINT = ',I4,2X,'IPUNCH = ',I4,//,
     13X,'NPTS = ',I4,3X,'NBODY = ',I4,3X,'IPLOT = ',I4,3X,'IDOUG = ',
     1 I4,///)
506   FORMAT(2X,'  NUMBER OF INPUT POINTS EXCEEDS 200 - PROGRAM TERMINATE
     1ED',//)
507   FORMAT(2X,' NUMBER OF OUTPUT POINTS EXCEEDS 100 - PROGRAM TERMINAT
     1ED',//)
508   FORMAT(6F10.6)
509   FORMAT(1H1,9X,'INPUT BODY COORDINATES',//)
510   FORMAT(14X,'X',16X,'Z',//)
511   FORMAT(2X,I3,2(2X,E14.7))
515   FORMAT(1H1,5X,'CALCULATED THREE DIMENSIONAL COORDINATES',//)
516   FORMAT(///,2X,'BODY SECTION NUMBER',I4,2X,'X=',E14.7,4X,'BODY SECT
     1ION NUMBER',I4,2X,'X=',E14.7,/)
517   FORMAT(10X,'Y',17X,'Z',28X,'Y',17X,'Z',/)
518   FORMAT(2(4X,E14.7),12X,2(4X,E14.7))
519   FORMAT(///,2X,'BODY SECTION NUMBER',I4,2X,'X=',E14.7,/)
520   FORMAT(10X,'Z',17X,'Y',/)
521    FORMAT(2(4X,E14.7))
530   FORMAT(1H1,4X,'CALCULATION OF THE THREE DIMENSIONAL COORDINATES',/
     1,5X,'FOR AN AXISYMMETRIC BODY WITHOUT APPENDAGES',/,5X,'HAVING',
     2 I4,2X,'PLANES OF SYMMETRY',///)
531   FORMAT(5X,'NUMBER OF PLANES OF SYMMETRY INCORRECT',//)
532   FORMAT(1H1,5X,'PLOT INFORMATION',//)
533   FORMAT(2X,'  NUMBER OF INPUT POINTS IS LESS THAN 20 - PROGRAM TERM
     1INATED',//)
      END
```

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```
C
C       PROGRAM 2 - APNDG1
C
C       MAIN PROGRAM - AXISYMMETRIC BODY WITH APPENDAGES
C
C       TWO OR THREE PLANES OF SYMMETRY ALLOWED
C
        DIMENSION LABEL(40)
        DIMENSION COEF(4)
        DIMENSION XB(25),HC(25)
        DIMENSION X(200),Y(200)
        DIMENSION XAPP(14,14),YAPP(14,14),ZAPP(14,14)
        DIMENSION XINC(14),YINC(14),ZINC(14)
        DIMENSION XBODY(100,10),YBODY(100,10),ZBODY(100,10)
        NI=5
        NO=6
        NP=1
        IZ=10
        READ(NI,201)LABEL
        READ(NI,202)IREAD,IPRINT,IPLOT,IPUNCH,NSYM,IDOUG,NBODY,NFIN,IFWD,
       1 IAFT,IFIN
        WRITE(NO,221)NSYM
        WRITE(NO,217)LABEL
        WRITE(NO,218)
        WRITE(NO,216)IREAD,IPRINT,IPLOT,IPUNCH,NBODY,NFIN,IFWD,IAFT,NSYM
       1 ,IDOUG,IFIN
        IF(NSYM.GT.3.OR.NSYM.LT.2)WRITE(NO,219)
        IF(NBODY.GT.200)WRITE(NO,300)
        IF(NBODY.LT.20)WRITE(NO,352)
        IF(NFIN.GT.25)WRITE(NO,301)
        IF(IFIN.GT.14)WRITE(NO,350)
        IF(NFIN.LT.5)WRITE(NO,353)
        IF(IFIN.LT.5)WRITE(NO,351)
        IF(NSYM.GT.3.OR.NSYM.LT.2)STOP
        IF(IDOUG.EQ.0)GO TO 40
        GO TO(36,36,37),NSYM
36      IF(IFWD.GT.40)WRITE(NO,305)
        IF(IAFT.GT.10) WRITE(NO,307)
        IF(IFWD.GT.40.OR.IAFT.GT.10)STOP
        GO TO 38
37      IF(IFWD.GT.30)WRITE(NO,302)
        IF(IAFT.GT.20)WRITE(NO,303)
        IF(IFWD.GT.30.OR.IAFT.GT.20)STOP
40      IF(IFWD.GT.60)WRITE(NO,308)
        IF(IAFT.GT.25)WRITE(NO,309)
        IF(IFWD.GT.60.OR.IAFT.GT.25)STOP
38      CONTINUE
        IF(NBODY.GT.200.OR.NFIN.GT.25)STOP
        IF(NBODY.LT.20.OR.NFIN.LT.5)STOP
        IF(IFIN.GT.14.OR.IFIN.LT.5)STOP
        LPTS=IFIN
        LSECT=IFIN-3
        GO TO(205,206),IREAD
205     DO 1 I=1,NBODY,3
1       READ(NI,2)X(I),Y(I),X(I+1),Y(I+1),X(I+2),Y(I+2)
        GO TO 207
```

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```
206   READ(NI,2)(X(I),I=1,NBODY)
      READ(NI,2)(Y(I),I=1,NBODY)
207   CONTINUE
      WRITE(NO,3)
      WRITE(NO,22)
      DO 19 I=1,NBODY
19    WRITE(NO,4)I,X(I),Y(I)
      WRITE(NO,14)
      READ(NI,6)CORDT,CORDR,XSTART,XOFSET,YTIP,TCREF,TCTIP,TCROOT
      LOOK=0
      DO 220 I=1,NBODY
      IF(LOOK.NE.0)GO TO 220
220   IF(X(I).GE.XSTART)LOOK=I-1
      CALL LAGINT(X,NBODY,Y,4,XSTART,YROOT,LOOK,IS,COEF)
      WRITE(NO,11)XSTART,XOFSET,YTIP,CORDT,CORDR
      WRITE(NO,12)TCREF,TCTIP,TCROOT
      GO TO(211,212),IREAD
211   DO 213 I=1,NFIN,3
213   READ(NI,2)XB(I),HC(I),XB(I+1),HC(I+1),XB(I+2),HC(I+2)
      GO TO 214
212   READ(NI,2)(XB(I),I=1,NFIN)
      READ(NI,2)(HC(I),I=1,NFIN)
214    CONTINUE
      WRITE(NO,24)
      DO 21 I=1,NFIN
21    WRITE(NO,13)I,XB(I),HC(I)
      CALL APPNDG(X,Y,NBODY,XB,HC,NFIN,XSTART,XEND,XOFSET,YTIP,YROOT,
     1CORDT,CORDR,LSECT,LPTS,XINC,YINC,ZINC,XAPP,YAPP,ZAPP,MSECT,
     2TCREF,TCTIP,TCROOT)
43    CALL BODY(X,Y,NBODY,XAPP,YAPP,ZAPP,K,IZ,MSECT,LPTS,XBODY,YBODY,
     1ZBODY,XSTART,IFWD,IAFT,NSYM)
44    CONTINUE
      IF(IPRINT.EQ.0)GO TO 110
      WRITE(NO,82)
      WRITE(NO,88)
      DO 83 L=1,LPTS
83    WRITE(NO,35)L,XINC(L),ZINC(L),YINC(L)
      WRITE(NO,15)
      DO 400 I=1,MSECT,2
      II=I+1
      IF(II.GT.MSECT)GO TO 401
      WRITE(NO,18)I,YAPP(I,1),II ,YAPP(I+1,1)
       WRITE(NO,25)
      DO 29 J=1,LPTS
29    WRITE(NO,16) XAPP(I,J),ZAPP(I,J),XAPP(I+1,J),ZAPP(I+1,J)
      GO TO 400
401   WRITE(NO,402)I,YAPP(I,1)
      WRITE(NO,403)
      DO 404 J=1,LPTS
404   WRITE(NO,405)XAPP(I,J),ZAPP(I,J)
400   CONTINUE
      WRITE(NO,5)
      DO 100 I=1,K,2
      II=I+1
      IF(II.GT.K)GO TO 101
      WRITE(NO,20)I,XBODY(I,1),II ,XBODY(I+1,1)
      WRITE(NO,23)
```

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```
      DO 100 J=1,IZ
100   WRITE(NO,8) ZBODY(I,J),YBODY(I,J),ZBODY(I+1,J),YBODY(I+1,J)
      GO TO 102
101   WRITE(NO,30)I,XBODY(I,1)
      WRITE(NO,31)
      DO 32 J=1,IZ
32    WRITE(NO,33)ZBODY(I,J),YBODY(I,J)
102   CONTINUE
110   IF(IPLOT.EQ.0)GO TO 130
      WRITE(NO,41)
      CALL PLOTC(XBODY,YBODY,ZBODY,K,IZ,XAPP,YAPP,ZAPP,MSECT,LPTS)
130   CONTINUE
      IF(IDOUG.EQ.0)GO TO 140
      WRITE(NO,215)
      WRITE(NO,217)LABEL
      CALL DOUGC (XBODY,YBODY,ZBODY,K,IZ,XAPP,YAPP,ZAPP,MSECT,LPTS,
     1 IPUNCH,NO,NP)
140   CONTINUE
2     FORMAT(6F10.6)
3     FORMAT(1H1,9X,'INPUT BODY COORDINATES',//)
4     FORMAT(2X,I3,2(2X,E14.7))
5     FORMAT(1H1,5X,'CALCULATED BODY COORDINATES',//)
6     FORMAT(8F10.6)
8     FORMAT(2(4X,E14.7),12X,2(4X,E14.7))
9     FORMAT(//)
11    FORMAT(2X,'XSTART=',E14.7,2X,'XOFSET=',E14.7,2X,'ZTIP=',E14.7,//,3
     1X,'CORDT=',E14.7,3X,'CORDR=',E14.7,/)
12    FORMAT(3X,'TCREF=',E14.7,3X,'TCTIP=',E14.7,3X,'TCROOT=',E14.7,//)
13    FORMAT(2X,I3,2(4X,E14.7))
14    FORMAT(1H1,12X,'INPUT APPENDAGE DATA',///)
15    FORMAT(1H1,2X,'CALCULATED APPENDAGE COORDINATES',//)
16    FORMAT(2(2X,E14.7),20X,2(2X,E14.7))
18    FORMAT(///,2X,'APPENDAGE SECTION NUMBER',I4,2X,'Z=',E14.7,4X,
     1  'APPENDAGE SECTION NUMBER',I4,2X,'Z=',E14.7,/)
20    FORMAT(///,2X,'BODY SECTION NUMBER',I4,2X,'X=',E14.7,4X,'BODY SECT
     1ION NUMBER',I4,2X,'X=',E14.7,/)
22    FORMAT(14X,'X',16X,'Z',//)
23    FORMAT(10X,'Y',17X,'Z',28X,'Y',17X,'Z',/)
24     FORMAT(15X,'XB',16X,'HC',//)
25    FORMAT(8X,'X ',14X,'Y ',34X,'X ',14X,'Y ',/)
30    FORMAT(///,2X,'BODY SECTION NUMBER',I4,2X,'X=',E14.7,/)
31    FORMAT(10X,'Y',17X,'Z',/)
33    FORMAT(2(4X,E14.7))
35    FORMAT(5X,I3,3(3X,E14.7),/)
41    FORMAT(1H1,5X,'PLOT INFORMATION',//)
82    FORMAT(1H1,9X,'ITERSECTION POINT SUMMARY - APPENDAGE AND BODY',//)
88    FORMAT(18X,'X',16X,'Y',16X,'Z',//)
201    FORMAT(40A2)
202   FORMAT(1I13)
215   FORMAT(1H1,5X,'COORDINATES FOR INPUT TO THE DOUGLAS THREE DIMENSIO
     1NAL POTENTIAL FLOW PROGRAM',///)
216    FORMAT(2X,'IREAD = ',I2,4X,'IPRINT = ',I2,2X,'IPLOT = ',I2,2X,
     1 'IPUNCH = ',I2,///,2X,'NBODY = ',I3,5X,'NFIN = ',I3,2X,'IFWD = ',
     2 I3,3X,'IAFT = ',I3,///,3X,'NSYM = ',I3,4X,'IDOUG = ',I3,2X,
     3 'IFIN = ',I3,///)
217   FORMAT(2X,40A2,//)
218   FORMAT(//,15X,'CONTROL PARAMETERS',//)
```

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```
219   FORMAT(5X,'NUMBER OF PLANES OF SYMMETRY INCORRECT',//)
221   FORMAT(1H1,5X,'CALCULATION OF THE THREE DIMENSIONAL COORDINATES',/
     1,5X,' FOR AN AXISYMMETRIC BODY WITH APPENDAGES',/,6X,'HAVING',
     2 I4,2X,'PLANES OF SYMMETRY',///)
300   FORMAT(//,2X,'NBODY EXCEEDES 200 POINTS - PROGRAM TERMINATED')
301   FORMAT(//,2X,'NFIN EXCEEDES 25 POINTS - PROGRAM TERMINATED')
302   FORMAT(//,2X,'IFWD EXCEEDES 30 POINTS - PROGRAM TERMINATED')
303   FORMAT(//,2X,'IAFT EXCEEDES 20 POINTS - PROGRAM TERMINATED')
305   FORMAT(//,2X,'IFWD EXCEEDES 40 POINTS - PROGRAM TERMINATED')
307   FORMAT(//,2X,'IAFT EXCEEDES 10 POINTS - PROGRAM TERMINATED')
308   FORMAT(//,2X,'IFWD EXCEEDES 60 POINTS - PROGRAM TERMINATED')
309   FORMAT(//,2X,'IAFT EXCEEDES 25 POINTS - PROGRAM TERMINATED')
350   FORMAT(//,2X,'IFIN EXCEEDES 14 POINTS - PROGRAM TERMINATED')
351   FORMAT(//,2X,'IFIN IS LESS THAN 5 - PROGRAM TERMINATED')
352   FORMAT(//,2X,'NBODY IS LESS THAN 20 - PROGRAM TERMINATED')
353   FORMAT(//,2X,'NFIN IS LESS THAN 5 - PROGRAM TERMINATED')
402   FORMAT(///,2X,'APPENDAGE SECTION NUMBER',I4,2X,'Z=',E14.7,/)
403   FORMAT(8X,'X ',14X,'Y ',/)
405   FORMAT(2(2X,E14.7))
310   STOP
      END
```

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```
C
C       PROGRAM    - CFFBDY
C
C       CALCULATION OF THE CFF BODY POINTS FOR THE DOUGLAS THREE
C       DIMENSIONAL POTENTIAL FLOW PROGRAM
C
        DIMENSION LABEL(40)
        DIMENSION YY(1001),ZZ(1001),XX(1001),YR(1001),THETA(1001)
        IPOS=0
        NI=5
        NO=6
        NP=1
        K=0
        ISEQ=0
        ILAST=3
        READ(NI,205)LABEL
        WRITE(NO,203)
        WRITE(NO,204)LABEL
900     READ(NI,500)NPTSZ,NTHETA,X,ZSTART,DELYZ,TSTART,DELT
        IF(NPTSZ.EQ.0)GO TO 901
        IPOS=IPOS+1
        WRITE(NO,206)IPOS
        WRITE(NO,207)NPTSZ,NTHETA,X,ZSTART,DELYZ,TSTART,DELT
        YR(1)=ZSTART
        THETA(1)=TSTART*3.14159/180.
        THETA(1)=0
        DO 2 I=2,NPTSZ
2       YR(I)=YR(I-1)+DELYZ
        DO 1 I=2,NTHETA
1       THETA(I)=THETA(I-1)+DELT*3.14159/180.
        DO 3 I=1,NPTSZ
        DO 3 J=1,NTHETA
        K=K+1
        XX(K)=X
        YY(K)=YR(I)*SIN(THETA(J))
        ZZ(K)=YR(I)*COS(THETA(J))
        IF(K.EQ.1001)WRITE(NO,150)
        IF(K.EQ.1001)STOP
3       CONTINUE
        GO TO 900
901     CONTINUE
        WRITE(NO,203)
        WRITE(NO,204)LABEL
        WRITE(NO,100)
        DO 20 I=1,K,2
        ISEQ=ISEQ+1
        IF(I+1.GT.K)GO TO 21
        IF(I+1.EQ.K)GO TO 22
        WRITE(NO,300)XX(I),YY(I),ZZ(I),XX(I+1),YY(I+1),ZZ(I+1),ISEQ
        WRITE(NP,200)XX(I),YY(I),ZZ(I),XX(I+1),YY(I+1),ZZ(I+1),ISEQ
        GO TO 20
21      WRITE(NO,301)XX(I),YY(I),ZZ(I),ILAST,ISEQ
        WRITE(NP,201)XX(I),YY(I),ZZ(I),ILAST,ISEQ
        GO TO 20
22      WRITE(NO,302)XX(I),YY(I),ZZ(I),XX(I+1),YY(I+1),ZZ(I+1),ILAST,ISEQ
        WRITE(NP,202)XX(I),YY(I),ZZ(I),XX(I+1),YY(I+1),ZZ(I+1),ILAST,ISEQ
```

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```
C     CONTINUE
100   FORMAT(7X,'X',11X,'Y',11X,'Z',13X,'X',11X,'Y',11X,'Z',21X,'SEQ',
     1  //)
150   FORMAT(//,5X,'NUMBER OF OFF BODY POINTS EXCEEDS 1000',/,5X,
     1 'PROGRAM TERMINATED',//)
 200    FORMAT(3(F10.6),1X,3(F10.6),15X,I4)
201   FORMAT(3F10.6,I1,45X,I4)
202   FORMAT(3F10.6,1X,3F10.6,I1,14X,I4)
203   FORMAT(1H1,5X,'CALCULATION OF THE OFF BODY POINTS FOR THE DOUGLAS
     1THREE DIMENSIONAL',/,6X,'POTENTIAL FLOW PROGRAM',//)
204   FORMAT(5X,40A2,//)
205   FORMAT(40A2)
206   FORMAT(//,6X,'INPUT DATA - LOCATION',I4,//)
207   FORMAT(5X,'NPTSZ=',I4,2X,'NTHETA=',I4,/,6X,'X=',F10.6,2X,'ZSTART='
     1 ,F10.6,2X,'DELYZ=',F10.6,2X,'TSTART=',F10.6,2X,'DELT=',F10.6,//)
300   FORMAT(2X,3(F10.6,2X),2X,3(F10.6,2X),14X,I4)
301   FORMAT(2X,3(F10.6,2X),1X,I1,50X,I4)
302   FORMAT(2X,3(F10.6,2X),2X,3(F10.6,2X),1X,I1,12X,I4)
500   FORMAT(I3,1X,I3,3X,5F10.6)
      STOP
      END
```

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```
C
C       CALCULATES THE INTERSECTION POINTS OF AN APPENDAGE WITH THE
C       BODY SURFACE  - APNDG3
C
        SUBROUTINE APPINT(X,Y,NPTS,   XSTART,XEND,LSECT,LPTS,XAPP,YAPP,
       1 ZAPP,XINC,YINC,ZINC)
        DIMENSION X(200),Y(200)
        DIMENSION COEF(4),A(4)
        DIMENSION XINC(14),YINC(14),ZINC(14)
        DIMENSION XAPP(14,14),YAPP(14,14),ZAPP(14,14)
        DIMENSION XWORK(50,50),YWORK(50,50),ZWORK(50,50),THETA(50)
        LTEST=0
        LT=0
        NX=50
        IT=50
        DELT=(FLOAT(IT)/FLOAT(IT-1))*3.14159/180.
        THETA(1)=0.
        DO 4 I=2,IT
4       THETA(I)=THETA(I-1)+DELT
        DO 50 L=1,LPTS
        TEST=0.0
        X1=XAPP(1,L)
        X2=XAPP(LSECT,L)
        Y1=YAPP(1,L)
        Y2=YAPP(LSECT,L)
        Z1=ZAPP(1,L)
        Z2=ZAPP(LSECT,L)
        ITEST=1
        XSTART=XINC(L-1)
        CALL FINEND(X,Y,NPTS,X1,Y1,Z1,X2,Y2,Z2,XSTART,XEND,YEND,ZEND)
        DO 102 I=1,NPTS
102     IF(X(I).GE.XEND)GO TO 101
101     XBEG=X(I-1)
        XSTOP=X(I+1)
        LTEST=I-5
        LT=I+5
        DELX=(XSTOP-XBEG) /FLOAT(NX-1)
        XWORK(1,1)=XBEG
        DO 3 I=2,NX
3       XWORK(I,1)=XWORK(I-1,1)+DELX
        DO 5 I=1,NX
        DO 15 NT=LTEST,LT
15      IF(XWORK(I,1).GE.X(NT))GO TO 16
16      ITER=NT-1
5       CALL LAGINT(X,NPTS,Y,4,XWORK(I,1),YWORK(I,1),ITER ,IS,COEF)
        DO 6 I=1,NX
        DO 6 J=1,IT
        XWORK(I,J)=XWORK(I,1)
        YWORK(I,J)=YWORK(I,1)*COS(THETA(J))
6       ZWORK(I,J)=YWORK(I,1)*SIN(THETA(J))
90      CONTINUE
        DO 100 IJ=1,2
        IF(IJ.EQ.1)IT1=2
        IF(IJ.EQ.1)IT2=20
        IF(IJ.EQ.2)IT1=20
        IF(IJ.EQ.2)IT2=IT
```

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```
      DO 10 I=2,NX
      DO 10 J=IT1,IT2
      M1=I-1
      M2=I
      M3=I
      N1=J-1
      N2=J-1
      N3=J
      XX1=XWORK(M1,N1)
      XX2=XWORK(M2,N2)
      XX3=XWORK(M3,N3)
      YY1=YWORK(M1,N1)
      YY2=YWORK(M2,N2)
      YY3=YWORK(M3,N3)
      ZZ1=ZWORK(M1,N1)
      ZZ2=ZWORK(M2,N2)
      ZZ3=ZWORK(M3,N3)
      CALL PLANE(XX1,YY1,ZZ1,XX2,YY2,ZZ2,XX3,YY3,ZZ3,A)
      CALL INTSEC(X1,Y1,Z1,X2,Y2,Z2,A,XT,YT,ZT)
      X1TEST=XX1-TEST
      X2TEST=XX2+TEST
      Y1TEST=YY1+TEST
      Y2TEST=YY2-TEST
      Z1TEST=ZZ1-TEST
      Z2TEST=ZZ2+TEST
      IF(XT.GT.X2TEST.OR.XT.LT.X1TEST)GO TO 20
      IF(Z1TEST.LT.0)Z1TEST=0.
      IF(YT.GT.Y1TEST.OR.YT.LT.Y2TEST)GO TO 20
      IF(ZT.GT.Z2TEST.OR.ZT.LT.Z1TEST)GO TO 20
      ITEST=0
      XINC(L)=XT
      YINC(L)=YT
      ZINC(L)=ZT
20    CONTINUE
      IF(ITEST.EQ.0)GO TO 55
10    CONTINUE
100   CONTINUE
      IF(ITEST.EQ.1)TEST=TEST+.05
      IF(ITEST.EQ.1)GO TO 90
55    CONTINUE
50    CONTINUE
      RETURN
      END
```

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```
C
C      CONTROLS THE CALCULATION OF THE APPENDAGE COORDINATES
C
       SUBROUTINE APPNDG(X,Y,NBODY,XB,HC,NFIN,XSTART,XEND,XOFSET,YTIP,
      1YROOT,CORDT,CORDR,LSECT,LPTS,XINC,YINC,ZINC,XAPP,YAPP,ZAPP,MSECT,
      2TCREF,TCTIP,TCROOT)
       DIMENSION XB(25),HC(25)
       DIMENSION X(200),Y(200)
       DIMENSION XINC(14),YINC(14),ZINC(14)
       DIMENSION XAPP(14,14),YAPP(14,14),ZAPP(14,14)
       CALL        FINCRD(XB,HC,NFIN,XSTART,XOFSET,YTIP,YROOT,CORDT,CORDR,
      1LSECT,LPTS,XAPP,YAPP,ZAPP,TCREF,TCTIP,TCROOT)
       CALL APPINT(X,Y,NBODY,    XSTART,XEND,LSECT,LPTS,XAPP,YAPP,ZAPP,
      1XINC,YINC,ZINC)
       MSECT=LSECT+3
       DO 27 J=1,LPTS
       XAPP(MSECT,J)=XINC(J)
       YAPP(MSECT,J)=YINC(J)
27     ZAPP(MSECT,J)=ZINC(J)
       DO 30 L=1,LPTS
       IF(L.EQ.1)GO TO 50
       DELY=ABS(YINC(L)-YAPP(LSECT,L))/3.
       X1=XAPP(1,L)
       X2=XAPP(LSECT,L)
       Y1=YAPP(1,L)
       Y2=YAPP(LSECT,L)
       Z1=ZAPP(1,L)
       Z2=ZAPP(LSECT,L)
       DO 120 IY=1,2
       GO TO(111,112),IY
111     YM=YAPP(LSECT,L)-DELY
       GO TO 113
112    YM=YAPP(LSECT,L)-2.*DELY
113     CONTINUE
       CALL LINE(X1,Y1,Z1,X2,Y2,Z2,XM,YM,ZM)
       GO TO(114,115),IY
114    XAPP(MSECT-2,L)=XM
       YAPP(MSECT-2,L)=YM
       ZAPP(MSECT-2,L)=ZM
       GO TO 120
115    XAPP(MSECT-1,L)=XM
       YAPP(MSECT-1,L)=YM
       ZAPP(MSECT-1,L)=ZM
120    CONTINUE
       GO TO 30
50     XAPP(MSECT-1,L)= XAPP(LSECT,1)
       YAPP(MSECT-1,L)=YAPP(LSECT,1)
       ZAPP(MSECT-1,L)= ZAPP(LSECT,1)
       XAPP(MSECT-2,L)= XAPP(LSECT,1)
       YAPP(MSECT-2,L)=YAPP(LSECT,1)
       ZAPP(MSECT-2,L)= ZAPP(LSECT,1)
30     CONTINUE
       RETURN
       END
```

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```
C
C       ESTABLISHES THE INPUT FORMAT OF THE CALCULATED BODY COORDINATES
C       FOR USE IN THE DOUGLAS  THREE DIMENSIONAL POTENTAIL FLOW PROGRAM
C
        SUBROUTINE AXISD(XBODY,YBODY,ZBODY,K,IZ,IPUNCH,NO,NP)
        DIMENSION XBODY(100,10),YBODY(100,10),ZBODY(100,10)
        DIMENSION XC(1000),YC(1000),ZC(1000),ISTAT(1000)
        KOUNT=1
        DO 1 N=1,K
        IF(N.EQ.1)ISTAT(KOUNT+1)=2
         IF(N.GT.1)ISTAT(KOUNT+1)=1
        DO 1 M=1,IZ
        KOUNT=KOUNT+1
        XC(KOUNT)=XBODY(N,M)-XBODY(1,1)
        ZC(KOUNT)=YBODY(N,M)
        YC(KOUNT)=ZBODY(N,M)
1       CONTINUE
        ISTAT(KOUNT)=3
        WRITE(NO,350)
        WRITE(NO,351)
        ISEG=0
        DO 355 IK=1,KOUNT,2
        ISEG=ISEG+1
        IF(ISTAT(IK).EQ.0.AND.ISTAT(IK+1).EQ.0)GO TO 356
        IF(ISTAT(IK).NE.0.AND.ISTAT(IK+1).EQ.0)GO TO 357
        IF(ISTAT(IK).EQ.0.AND.ISTAT(IK+1).NE.0)GO TO 358
        IF(ISTAT(IK).NE.0.AND.ISTAT(IK+1).NE.0)GO TO 359
356     WRITE(NO,306)XC(IK),YC(IK),ZC(IK),XC(IK+1),YC(IK+1),ZC(IK+1),ISEG
        GO TO 355
357     WRITE(NO,307)XC(IK),YC(IK),ZC(IK),ISTAT(IK),XC(IK+1),YC(IK+1),
       1 ZC(IK+1),ISEG
        GO TO 355
358     WRITE(NO,308)XC(IK),YC(IK),ZC(IK),XC(IK+1),YC(IK+1),ZC(IK+1),
       1 ISTAT(IK+1),ISEG
        GO TO 355
359     WRITE(NO,352)XC(IK),YC(IK),ZC(IK),ISTAT(IK),XC(IK+1),YC(IK+1),
       1  ZC(IK+1),ISTAT(IK+1),ISEG
355     CONTINUE
        IF(IPUNCH.EQ.0)GO TO 376
        ISEG=0
        DO 375 IK=1,KOUNT,2
        ISEG=ISEG+1
        IF(ISTAT(IK).EQ.0.AND.ISTAT(IK+1).EQ.0)GO TO 376
        IF(ISTAT(IK).NE.0.AND.ISTAT(IK+1).EQ.0)GO TO 377
        IF(ISTAT(IK).EQ.0.AND.ISTAT(IK+1).NE.0)GO TO 378
        IF(ISTAT(IK).NE.0.AND.ISTAT(IK+1).NE.0)GO TO 379
376     WRITE(NP,306)XC(IK),YC(IK),ZC(IK),XC(IK+1),YC(IK+1),ZC(IK+1),ISEG
        GO TO 375
377     WRITE(NP,307)XC(IK),YC(IK),ZC(IK),ISTAT(IK),XC(IK+1),YC(IK+1),
       1 ZC(IK+1),ISEG
        GO TO 375
378     WRITE(NP,308)XC(IK),YC(IK),ZC(IK),XC(IK+1),YC(IK+1),ZC(IK+1),
       1 ISTAT(IK+1),ISEG
        GO TO 375
379     WRITE(NP,309)XC(IK),YC(IK),ZC(IK),ISTAT(IK),XC(IK+1),YC(IK+1),
       1 ZC(IK+1),ISTAT(IK+1),ISEG
```

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```
375    CONTINUE
350    FORMAT(     2X,'FINAL THREE DIMENSIONAL COORDINATE OUTPUT',//)
351    FORMAT(6X,'X',11X,'Y',11X,'Z',6X,'STAT',5X,'X',11X,'Y',11X,'Z',
      1 6X,'STAT',12X,'SEQ',//)
352    FORMAT(2X,3(F10.5,2X),I2,2X,3(F10.5,2X),I2,13X,I4)
366    FORMAT(2X,3(F10.5,2X),4X,3(F10.5,2X),15X,I4)
367    FORMAT(2X,3(F10.5,2X),I2,2X,3(F10.5,2X),15X,I4)
368    FORMAT(2X,3(F10.5,2X),4X,3(F10.5,2X),I2,13X,I4)
386    FORMAT(3(F10.5),1X,3(F10.5),15X,I4)
387    FORMAT(3(F10.5),I1,3(F10.5),15X,I4)
388    FORMAT(3(F10.5),1X,3(F10.5),I1,14X,I4)
389    FORMAT(3(F10.5),I1,3(F10.5),I1,14X,I4)
370    RETURN
       END
```

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```
C
C       CALCULATES THE BODY COORDINATES
C
        SUBROUTINE BODYAX(X,Y,NPTS,XBODY,YBODY,ZBODY,NBODY,IZ,NSYM)
        DIMENSION X(200),Y(200)
        DIMENSION XBODY(100,10),YBODY(100,10),ZBODY(100,10)
        DIMENSION THETA(10),COEF(10),XTEMP(100),YTEMP(100)
        DEL=(X(NPTS)-X(1))/FLOAT(NBODY-1)
        IF(NSYM.EQ.1)DELT=3.14159/FLOAT(IZ-1)
        IF(NSYM.GT.1)DELT=(90./FLOAT(IZ-1))*3.14159/180.
        THETA(1)=0.
        DO 1 I=2,IZ
1       THETA(I)=THETA(I-1)+DELT
        DELF=DEL/5.
        GO TO(11,11,13),NSYM
11      XTEMP(1)=X(1)
        DO 21 I=2,NBODY
        II=I-1
        DELADD=DELF*FLOAT(II)
        XTEMP(I)=XTEMP(I-1)+DELADD
21      IF(DELADD.GE.DEL)GO TO 22
22      LFWD=I
13      XTEMP(NBODY)=X(NPTS)
        DO 24 I=2,NBODY
        JJ=NBODY-I+1
        II=I-1
        DELSUB=DELF*FLOAT(II)
        XTEMP(JJ)=XTEMP(JJ+1)-DELSUB
24      IF(DELSUB.GE.DEL)GO TO 25
25      JFWD=JJ
        JFWDI=1
        IF(NSYM.EQ.3)GO TO 30
        KFWD=NBODY-LFWD-JFWDI
        DELMID=(XTEMP(JFWD)-XTEMP(LFWD))/FLOAT(KFWD+1)
        DO 26 I=1,KFWD
        J=LFWD+I
26      XTEMP(J)=XTEMP(J-1)+DELMID
        GO TO 40
30      KFWD=NBODY-JFWDI
        DELMID=(XTEMP(JFWD)-X(1))/FLOAT(KFWD)
        XTEMP(1)=X(1)
        DO 32 I=2,KFWD
32      XTEMP(I)=XTEMP(I-1)+DELMID
40      CONTINUE
        YTEMP(1)=Y(1)
        DO 2 I=2,NBODY
        DO 3 J=1,NPTS
3       IF(XTEMP(I).GT.X(J))GO TO 4
4       ISTART=J-1
        IF(ISTART.LE.0)ISTART=1
2       CALL LAGINT(X,NPTS,Y,4,XTEMP(I),YTEMP(I),ISTART,IS,COEF)
        DO 5 I=1,NBODY
        DO 5 J=1,IZ
        XBODY(I,J)=XTEMP(I)
        YBODY(I,J)=YTEMP(I)*COS(THETA(J))
5       ZBODY(I,J)=YTEMP(I)*SIN(THETA(J))
        RETURN
        END
```

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```
C
C       CALCULATES THE THREE DIMENSIONAL COORDINATES ALONG THE BODY
C
        SUBROUTINE BCDY(X,Y,NPTS,XAPP,YAPP,ZAPP,K,IZ,MSECT,LPTS,XBODY,
       1YBODY,ZBODY,XSTART,IFWD,IAFT,NSYM)
        DIMENSION COEF(4)
        DIMENSION XAPP(14,14),YAPP(14,14),ZAPP(14,14)
        DIMENSION XBODY(100,10),YBODY(100,10),ZBODY(100,10)
        DIMENSION XTEMP(100),YTEMP(100),THETA(10)
        DIMENSION X(200),Y(200)
        K=IFWD+LPTS+IAFT
        DEL2=(X(NPTS)-XAPP(MSECT,LPTS))/FLOAT(IAFT)
        YTEMP(1)=Y(1)
        CALL DELBDY(X(1),XAPP(MSECT,1),XAPP(MSECT,2),XTEMP,IFWD,NSYM)
        DO 200 I=2,IFWD
        DO 10 IT=1,NPTS
10       IF(XTEMP(I).GE.X(IT))GO TO 11
11      ITER=IT-1
200     CALL LAGINT(X,NPTS,Y,4,XTEMP(I),YTEMP(I),ITER,IS,COEF)
        DO 203 L=1,LPTS
        XTEMP(IFWD+L)=XAPP(MSECT,L)
203     YTEMP(IFWD+L)=YAPP(MSECT,L)
        LAFT=IFWD+LPTS+1
        XTEMP(LAFT)=XAPP(MSECT,LPTS)+DEL2
        DO 12 IT=1,NPTS
12      IF(XTEMP(LAFT).GE.X(IT))GO TO 13
13      ITER=IT-1
         CALL LAGINT(X,NPTS,Y,4,XTEMP(LAFT),YTEMP(LAFT),ITER,IS,COEF)
        DO 201 I=2,IAFT
        J=IFWD+LPTS+1
        XTEMP(J)=XTEMP(J-1)+DEL2
        DO 14 IT=1,NPTS
14      IF(XTEMP(J).GE.X(IT))GO TO 15
15      ITER=IT-1
201     CALL LAGINT(X,NPTS,Y,4,XTEMP(J),YTEMP(J),ITER,IS,COEF)
        DELT=(90./FLOAT(IZ-1))*3.14159/180.
        THETA(1)=0.
        DO 1 I=2,IZ
1       THETA(I)=THETA(I-1)+DELT
        DO 2 I=1,IFWD
        DO 3 J=1,IZ
        XBODY(I,J)=XTEMP(I)
        YBODY(I,J)=YTEMP(I)*COS(THETA(J))
3       ZBODY(I,J)=YTEMP(I)*SIN(THETA(J))
2       CONTINUE
        K2=IFWD+LPTS+1
        DO 4 I=K2,K
        DO 5 J=1,IZ
        XBODY(I,J)=XTEMP(I)
        YBODY(I,J)=YTEMP(I)*COS(THETA(J))
5       ZBODY(I,J)=YTEMP(I)*SIN(THETA(J))
4       CONTINUE
        DO 6 L=1,LPTS
        I=IFWD+L
        IF(L.NE.1)GO TO 8
        DO 7 J=1,IZ
```

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```
      XBODY(I,J)=XTEMP(I)
      YBODY(I,J)=YTEMP(I)*COS(THETA(J))
7     ZBODY(I,J)=YTEMP(I)*SIN(THETA(J))
      GO TO 6
8     CONTINUE
      YR=YAPP(MSECT,L)
      ZR=ZAPP(MSECT,L)
      R=SQRT(YR**2+ZR**2)
      ANGLE=ATAN(ZR/YR)
      DEG=(90.*3.14159/180.)-ANGLE*2
      DEL=DEG/FLOAT(IZ-1)
       XBODY(I,1)=XAPP(MSECT,L)
      YBODY(I,1)=YAPP(MSECT,L)
      ZBODY(I,1)=ZAPP(MSECT,L)
      XBODY(I,IZ)=XAPP(MSECT,L)
      YBODY(I,IZ)=ZAPP(MSECT,L)
      ZBODY(I,IZ)=YAPP(MSECT,L)
      LZ=IZ-1
      THETA(1)=ANGLE
      DO 9 J=2,LZ
      THETA(J)=THETA(J-1)+DEL
      XBODY(I,J)=XTEMP(I)
      YBODY(I,J)=R*COS(THETA(J))
      ZBODY(I,J)=R*SIN(THETA(J))
9     CONTINUE
6     CONTINUE
      RETURN
      END
```

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```
C
C       CALCULATES THE SPACING OF THE POINTS ALONG THE BODY SURFACE IN THE
C       X DIRECTION
C
        SUBROUTINE DELBDY(X,XAPP1,XAPP2,XTEMP,IFWD,NSYM)
        DIMENSION XTEMP(100)
        IF(IFWD.LE.6)GO TO 40
        DEL=(XAPP1-X)/FLOAT(IFWD)
        DELFIN=XAPP2-XAPP1
        GO TO (21,21,23),NSYM
21      XTEMP(1)=X
        DO 1 I=2,IFWD
        II=I-1
        DELADD=DELFIN*FLOAT(II)
        XTEMP(I)=XTEMP(I-1)+DELADD
1       IF(DELADD.GE.DEL)GO TO 2
2       LFWD=I
23      XTEMP(IFWD)=XAPP1-DELFIN
        DO 4 I=2,IFWD
        JJ=IFWD-I+1
        DELSUB=DELFIN*FLOAT(I)
        XTEMP(JJ)=XTEMP(JJ+1)-DELSUB
4       IF(DELSUB.GE.DEL)GO TO 5
5       JFWD=JJ
        JFWDI=I
        IF(NSYM.EQ.3)GO TO 10
        KFWD=IFWD-LFWD-JFWDI
        DELMID=(XTEMP(JFWD)-XTEMP(LFWD))/FLOAT(KFWD+1)
        DO 6 I=1,KFWD
        J=LFWD+I
6       XTEMP(J)=XTEMP(J-1)+DELMID
        RETURN
10      KFWD=IFWD-JFWDI
        DELMID=(XTEMP(JFWD)-X)/FLOAT(KFWD)
        XTEMP(1)=X
        DO 12 I=2,KFWD
12      XTEMP(I)=XTEMP(I-1)+DELMID
        RETURN
40      DEL=(XAPP1-X)/FLOAT(IFWD-1)
        XTEMP(1)=X
        DO 41 I=2,IFWD
41      XTEMP(I)=XTEMP(I-1)+DEL
        RETURN
        END
```

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```
      WRITE(NO,352)XC(IK),YC(IK),ZC(IK),ISTAT(IK),XC(IK+1),YC(IK+1),
     1  ZC(IK+1),ISTAT(IK+1),ISEQ
  355 CONTINUE
      IF(IPUNCH.EQ.0)GO TO 370
      ISEQ=0
      DO 375 IK=1,KOUNT,2
      ISEQ=ISEQ+1
      IF(ISTAT(IK).EQ.0.AND.ISTAT(IK+1).EQ.0)GO TO 376
      IF(ISTAT(IK).NE.0.AND.ISTAT(IK+1).EQ.0)GO TO 377
      IF(ISTAT(IK).EQ.0.AND.ISTAT(IK+1).NE.0)GO TO 378
      IF(ISTAT(IK).NE.0.AND.ISTAT(IK+1).NE.0)GO TO 379
  376 WRITE(NP,386)XC(IK),YC(IK),ZC(IK),XC(IK+1),YC(IK+1),ZC(IK+1),ISEQ
      GO TO 375
  377 WRITE(NP,387)XC(IK),YC(IK),ZC(IK),ISTAT(IK),XC(IK+1),YC(IK+1),
     1 ZC(IK+1),ISEQ
      GO TO 375
  378 WRITE(NP,388)XC(IK),YC(IK),ZC(IK),XC(IK+1),YC(IK+1),ZC(IK+1),
     1 ISTAT(IK+1),ISEQ
      GO TO 375
  379 WRITE(NP,389)XC(IK),YC(IK),ZC(IK),ISTAT(IK),XC(IK+1),YC(IK+1),
     1 ZC(IK+1),ISTAT(IK+1),ISEQ
  375 CONTINUE
  350 FORMAT(    2X,'FINAL THREE DIMENSIONAL COORDINATE OUTPUT',//)
  351 FORMAT(6X,'X',11X,'Y',11X,'Z',6X,'STAT',5X,'X',11X,'Y',11X,'Z',
     1 6X,'STAT',12X,'SEQ',//)
  352 FORMAT(2X,3(F10.5,2X),I2,2X,3(F10.5,2X),I2,13X,I4)
  366 FORMAT(2X,3(F10.5,2X),4X,3(F10.5,2X),15X,I4)
  367 FORMAT(2X,3(F10.5,2X),I2,2X,3(F10.5,2X),15X,I4)
  368 FORMAT(2X,3(F10.5,2X),4X,3(F10.5,2X),I2,13X,I4)
  386 FORMAT(3(F10.5),1X,3(F10.5),15X,I4)
  387 FORMAT(3(F10.5),I1,3(F10.5),15X,I4)
  388 FORMAT(3(F10.5),1X,3(F10.5),I1,14X,I4)
  389 FORMAT(3(F10.5),I1,3(F10.5),I1,14X,I4)
  370 RETURN
      END
```

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```
C
C     ESTABLISHES THE INPUT FORMAT OF THE BODY AND APPENDAGE COORDINATES
C     FOR USE IN THE DOUGLASS THREE DIMENSIONAL POTENTIAL PROGRAM
C
      SUBROUTINE DCUGC (XBODY,YBODY,ZBODY,K,IZ,XAPP,YAPP,ZAPP,MSECT,
     1LPTS,IPUNCH,NO,NP)
      DIMENSION XAPP(14,14),YAPP(14,14),ZAPP(14,14)
      DIMENSION XBODY(100,10),YBODY(100,10),ZBODY(100,10)
      DIMENSION XC(1500),YC(1500),ZC(1500),ISTAT(1500)
      KOUNT=0
      DO 1 N=1,K
      IF(N.EQ.1)ISTAT(KOUNT+1)=2
       IF(N.GT.1)ISTAT(KOUNT+1)=1
      DO 1 M=1,IZ
      KOUNT=KOUNT+1
      XC(KOUNT)=XBODY(N,M)-XBODY(1,1)
      ZC(KOUNT)=YBODY(N,M)
      YC(KOUNT)=ZBODY(N,M)
1     CONTINUE
      DO 2 N=1,LPTS
      IF(N.EQ.1)ISTAT(KOUNT+1)=2
      IF(N.GT.1)ISTAT(KOUNT+1)=1
      DO 2 M=1,MSECT
      MM=MSECT-M+1
      KOUNT=KOUNT+1
      XC(KOUNT)=XAPP(MM,N)-XBODY(1,1)
      ZC(KOUNT)=ZAPP(MM,N)
      YC(KOUNT)=YAPP(MM,N)
2     CONTINUE
      DO 3 N=1,LPTS
       IF(N.EQ.1)ISTAT(KOUNT+1)=2
      IF(N.GT.1)ISTAT(KOUNT+1)=1
      DO 3 M=1,MSECT
      KOUNT=KOUNT+1
      XC(KOUNT)=XAPP(M,N)-XBODY(1,1)
      ZC(KOUNT)=YAPP(M,N)
      YC(KOUNT)=ZAPP(M,N)
3     CONTINUE
      ISTAT(KOUNT)=3
      WRITE(NO,350)
      WRITE(NO,351)
      ISEQ=0
      DO 355 IK=1,KOUNT,2
      ISEQ=ISEQ+1
      IF(ISTAT(IK).EQ.0.AND.ISTAT(IK+1).EQ.0)GO TO 356
      IF(ISTAT(IK).NE.0.AND.ISTAT(IK+1).EQ.0)GO TO 357
      IF(ISTAT(IK).EQ.0.AND.ISTAT(IK+1).NE.0)GO TO 358
      IF(ISTAT(IK).NE.0.AND.ISTAT(IK+1).NE.0)GO TO 359
356   WRITE(NO,366)XC(IK),YC(IK),ZC(IK),XC(IK+1),YC(IK+1),ZC(IK+1),ISEQ
      GO TO 355
357   WRITE(NO,367)XC(IK),YC(IK),ZC(IK),ISTAT(IK),XC(IK+1),YC(IK+1),
     1 ZC(IK+1),ISEQ
      GO TO 355
358   WRITE(NO,368)XC(IK),YC(IK),ZC(IK),XC(IK+1),YC(IK+1),ZC(IK+1),
     1 ISTAT(IK+1),ISEQ
      GO TO 355
```

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```
C
C       CALCULATES THE FIN COORDINATES FROM THE GIVEN INPUT COORDINATES
C       AND THE STARTING POINT, CORD VALUES, AND OFFSET
C
        SUBROUTINE FINCRD(XB,HC,IPTS,XSTART,XOFSET,YTIP,YROOT,CORDT,CORDR,
       1LSECT,LPTS,XAPP,YAPP,ZAPP,TCREF,TCTIP,TCROOT)
        DIMENSION COEF(4)
        DIMENSION XAPP(14,14),YAPP(14,14),ZAPP(14,14)
        DIMENSION XB(25),HC(25)
        DEL=1.0/FLOAT(LPTS-2)
        DO 1 I=1,LSECT
        XAPP(I,1)=0.
        XAPP(I,2)=DEL/2.
        XAPP(I,3)=DEL
        DO 1 J=4,LPTS
1       XAPP(I,J)=XAPP(I,J-1)+DEL
        DO 2 I=1,2
        GO TO (3,4),I
3       L=1
        DO 5 J=1,LPTS
        CALL LAGINT(XB,IPTS,HC,4,XAPP(L,J),ZAPP(L,J),1,IS,COEF)
        XAPP(L,J)=XOFSET+XSTART+XAPP(L,J)*CORDT
        YAPP(L,J)=YTIP
5       ZAPP(L,J)=ZAPP(L,J)*CORDT*(TCTIP/TCREF)
        GO TO 2
4       L=LSECT
        DO 6 J=1,LPTS
        CALL LAGINT(XB,IPTS,HC,4,XAPP(L,J),ZAPP(L,J),1,IS,COEF)
        XAPP(L,J)=XSTART+XAPP(L,J)*CORDR
        YAPP(L,J)=YROOT
6       ZAPP(L,J)=ZAPP(L,J)*CORDR*(TCROOT/TCREF)
2       CONTINUE
        DELFIN=(YTIP-YROOT)/FLOAT(LSECT-1)
        MSECT=LSECT-1
        DO 10 I=2,MSECT
        DO 10 J=1,LPTS
10      YAPP(I,J)=YAPP(I-1,J)-DELFIN
        DO 11 I=2,MSECT
        DO 11 J=1,LPTS
        X1=XAPP(1,J)
        X2=XAPP(LSECT,J)
        Y1=YAPP(1,J)
        Y2=YAPP(LSECT,J)
        Z1=ZAPP(1,J)
        Z2=ZAPP(LSECT,J)
11      CALL LINE(X1,Y1,Z1,X2,Y2,Z2,XAPP(I,J),YAPP(I,J),ZAPP(I,J))
        RETURN
        END
```

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```
C
C       CALCULATES THE APPROXIMATE INTERSECTION POINT OF THE APPENDAGE
C       TRAILING EDGE
C
      SUBROUTINE FINEND(X,Y,NBODY,X1,Y1,Z1,X2,Y2,Z2,XSTART,XEND,YEND,
     1 ZEND)
      DIMENSION COEF(4)
      DIMENSION X(200),Y(200)
      ISTART=0
      DO 1 I=1,NBODY
      IF(ISTART.GT.0)GO TO 1
      IF(X(I).GE.XSTART)ISTART=I-1
1     CONTINUE
      DEL=.005
      TEST=.05
      ITER=0
      YM=Y2
2     ITER=ITER+1
      YM=YM-DEL
      CALL LINE(X1,Y1,Z1,X2,Y2,Z2,XM,YM,ZM)
      CALL LAGINT(X,NBODY,Y,4,XM,YM1,ISTART,IS,COEF)
      XTEST=ABS(YM-YM1)
      IF(XTEST.LE.TEST)GO TO 5
      IF(ITER.GT.500)GO TO 5
      GO TO 2
5     XEND=XM
      YEND=YM
      ZEND=ZM
      RETURN
      END
```

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```
C
C     CALCULATES THE INTERSECTION POINT OF A THREE DIMENSIONAL LINE
C     AND A THREE DIMENSIONAL PLANE
C
C
C     EQUATION OF LINE  (X-X1)/L=(Y-Y1)/M=(Z-Z1)/N
C     L=COSL     M=COSM     N=COSN
C
C     EQUATION OF PLANE  A*X+B*Y+C*Z+D=0
C
      SUBROUTINE INTSEC(X1,Y1,Z1,X2,Y2,Z2,COEF,XT,YT,ZT)
      DIMENSION COEF(4)
      DD=SQRT((X2-X1)**2+(Y2-Y1)**2+(Z2-Z1)**2)
      COSL=(X2-X1)/DD
      COSM=(Y2-Y1)/DD
      COSN=(Z2-Z1)/DD
      A=COEF(1)
      B=COEF(2)
      C=COEF(3)
      D=COEF(4)
      IF(X2.EQ.X1)GO TO 1
      XT=((B*(COSM/COSL)+C*(COSN/COSL))*X1-D-B*Y1-C*Z1)/(A+B*(COSM/COSL)
     1+C*(COSN/COSL))
      YT=Y1+(COSM/COSL)*(XT-X1)
      ZT=Z1+(COSN/COSL)*(XT-X1)
      RETURN
1     CONTINUE
      YT=((A*(COSL/COSM)+C*(COSN/COSM))*Y1-A*X1-C*Z1-D)/(A*(COSL/COSM)+B
     1+C*(COSN/COSM))
      XT=X1+(COSL/COSM)*(YT-Y1)
      ZT=Z1+(COSN/COSM)*(YT-Y1)
      RETURN
      END
```

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```
      SUBROUTINE LAGINT (VINT,NI,VDEP,NPTS,VIN,PS,J,IS,COEF)
C
C
C     OBTAINED FROM D.M. NELSON   NOSC
C
C  THIS SUBROUTINE PERFORMS LAGRANGE INTERPOLATION FOR ANY DEGREE
C  LESS THAN 4
C     VINT = TABLE OF VALUES OF INDEPENDENT VARIABLE
C     NI   = NUMBER OF ENTRIES IN VINT AND VDEP TABLES
C     VDEP = TABLE OF VALUES OF DEPENDENT VARIABLE
C     NPTS = NUMBER OF POINTS FIT BY POLYNOMIAL (DEGREE PLUS ONE)
C     VIN  = VALUE OF INDEPENDENT VARIABLE TO BE MATCHED
C     PS   = MATCH VALUE OF DEPENDENT VARIABLE
C     J    = INDEX AT WHICH TO START SEARCH
C     IS   = SUBSCRIPT OF FIRST POINT OF THOSE FIT BY POLYNOMIAL
C     COEF = ARRAY OF LAGRANGE COEFFICIENTS USED IN EVALUATION OF
C            DEPENDENT VARIABLE ; PS(VIN) = COEF(1)*VDEP(IS) + ***
C            + COEF(NPTS)*VDEF(IS+NPTS-1)
C
    6 FORMAT (/2X,58HLAGINT EXTRAPOLATED MATCH VALUE FOR INDEPENDENT VAR
     1IABLE =,E12.6/)
    7 FORMAT (/2X,105HLAGRANGE INTERPOLATION (SUBROUTINE LAGINT) ATTEMPT
     1ED FOR TOO LARGE A DEGREE - PROGRAM TERMINATED , NPTS =,I3)
      DIMENSION XT(4),YT(4),VINT(NI),VDEP(NI),COEF(NPTS)
      IF (NPTS.GT.4) GO TO 60
      IF (J.LE.1) J = 2
      IF (J.GT.NI) J = NI
      IF (VINT(1)- VIN) 25,51,97
   25 IF (VINT (NI)- VIN) 96,51,51
   51 IF (VINT(J)-VIN) 52,56,56
   52 J = J+1
      GO TO 51
   56 IF (VINT(J-1)-VIN) 28,28,57
   57 J = J-1
      GO TO 51
   28 IF (J - NPTS/2 ) 96,96,29
   29 IF (J + NPTS/2 - NI ) 30,30,95
   30 IS = J - NPTS/2
   33 IE = IS+NPTS-1
      L = 0
      DO 31 K=IS,IE
      L = L+1
      XT(L) = VINT(K)
      YT(L) = VDEP(K)
   31 CONTINUE
      PS = 0.0
      DO 40 M=1,NPTS
      PF = 1.0
      DO 39 N=1,NPTS
      IF (N-M) 32,39,32
   32 PF = ((VIN -XT(N))/(XT(M)- XT(N)))* PF
   39 CONTINUE
      COEF(M) = PF
      PS = PS + YT(M)* PF
   40 CONTINUE
      GO TO 94
```

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```
      WRITE (6,6) NIN
   95 IS = NI - NPTS + 1
      GO TO 33
   97 WRITE (6,6) NIN
   96 IS = 1
      GO TO 33
   94 RETURN
   60 WRITE (6,7) NPTS
      RETURN
      END
```

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```
C
C       CALCULATES THE PARAMETERS OF A THREEE DIMENSIONAL LINE
C
        SUBROUTINE LINE(X1,Y1,Z1,X2,Y2,Z2,XM,YM,ZM)
        D=SQRT((X2-X1)**2+(Y2-Y1)**2+(Z2-Z1)**2)
        COSL=(X2-X1)/D
        COSM=(Y2-Y1)/D
        COSN=(Z2-Z1)/D
        XM=X1+(COSL/COSM)*(YM-Y1)
        ZM=Z1+(COSN/COSM)*(YM-Y1)
        RETURN
        END
```

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```
C
C       COMPUTES THE COEFFICIENTS FOR THE EQUATION OF A THREE
C       DIMENSIONAL PLANE GIVEN THREE POINTS ON THE PLANE
C
C
C       EQUATION OF PLANE  COEF(1)*X+COEF(2)*Y+COEF(3)*Z+COEF(4)=0
C
      SUBROUTINE PLANE(X1,Y1,Z1,X2,Y2,Z2,X3,Y3,Z3,COEF)
      DIMENSION COEF(4)
      DET=X1*(Y2*Z3-Y3*Z2)-X2*(Y1*Z3-Y3*Z1)+X3*(Y1*Z2-Y2*Z1)
      A1=-((Y2*Z3-Y3*Z2)-(Y1*Z3-Y3*Z1)+(Y1*Z2-Y2*Z1))
      A2=(X2*Z3-X3*Z2)-(X1*Z3-X3*Z1)+(X1*Z2-X2*Z1)
      A3=-((X2*Y3-X3*Y2)-(X1*Y3-X3*Y1)+(X1*Y2-X2*Y1))
      COEF(1)=A1/DET
      COEF(2)=A2/DET
      COEF(3)=A3/DET
      COEF(4)=1.
      RETURN
      END
```

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```
C
C       PLOTS THE CALCULATED THREE DIMENSIONAL COORDINATES FOR AN
C       AXISYMMETRIC BODY WITHOUT APPENDAGES
C
        SUBROUTINE PLOTA(XBODY,YBODY,ZBODY,NPTS,IZ)
        DIMENSION XBODY(100,10),YBODY(100,10),ZBODY(100,10)
        DIMENSION XPLOT(100),YPLOT(100),ZPLOT(100)
        ISTART=0
        YO=-ABS(YBODY(1,1)-YBODY(2,1))
        ZO=YO
        XMAX=XBODY(NPTS,1)
        YMAX=0.
        DO 70 I=1,NPTS
70      IF(YBODY(I,1).GT.YMAX)YMAX=YBODY(I,1)
        ZMAX=YMAX
        IPLOT=1
        A=500.
        B=500.
        C=500.
        XO=XBODY(1,1)-ABS(XBODY(2,1)-XBODY(1,1))
        CALL BGNPL(IPLOT)
        CALL PAGE(15.,11.)
        CALL TITL3D(' ',100,10.,10.)
        CALL FRAME
        CALL AXES3D('XS',100,'YS',100,'ZS',100,0.,0.,0.)
        CALL VUABS(A,B,C)
        CALL GRAF3D(XO,'SCALE',XMAX,YO,'SCALE',YMAX,ZO,'SCALE',ZMAX)
        DO 60 I=1,NPTS
        DO 61 J=1,IZ
        XPLOT(J)=XBODY(I,J)
        YPLOT(J)=YBODY(I,J)
61      ZPLOT(J)=ZBODY(I,J)
60      CALL CURV3D(XPLOT,ZPLOT,YPLOT,IZ,0)
        DO 65 J=1,IZ
        DO 66 I=1,NPTS
        XPLOT(I)=XBODY(I,J)
        YPLOT(I)=YBODY(I,J)
66      ZPLOT(I)=ZBODY(I,J)
65      CALL CURV3D(XPLOT,ZPLOT,YPLOT,NPTS,0)
        CALL ENDPL(IPLOT)
100      CONTINUE
        RETURN
        END
```

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```
C
C     PLOTS THE CALCULATED THREE DIMENSIONAL COORDINATES FOR A BODY
C     WITH APPENDAGES
C
      SUBROUTINE PLOTC(XBODY,YBODY,ZBODY,NPTS,IZ,XAPP,YAPP,ZAPP,MSECT,
     1LPTS)
      DIMENSION XAPP(14,14),YAPP(14,14),ZAPP(14,14)
      DIMENSION XBODY(100,10),YBODY(100,10),ZBODY(100,10)
      DIMENSION XPLOT(100),YPLOT(100),ZPLOT(100)
      ISTART=0
      YO=-ABS(YAPP(1,1)-YAPP(2,1))
      ZO=YO
      XMAX=XBODY(NPTS,1)
      YMAX=YAPP(1,1)
      ZMAX=YMAX
      A=500.
      B=500.
      C=500.
      IPLOT=1
      XO=XBODY(1,1)-ABS(XBODY(2,1)-XBODY(1,1))
      CALL BGNPL(IPLOT)
      CALL PAGE(15.,11.)
      CALL TITL3D(' 1',100,10.,10.)
      CALL FRAME
      CALL AXES3D('X$',100,'Y$',100,'Z$',100,0.,0.,0.)
      CALL VUABS(A,B,C)
      CALL GRAF3D(XO,'SCALE',XMAX,YO,'SCALE',YMAX,ZO,'SCALE',ZMAX)
      DO 30 I=1,MSECT
      DO 31 J=1,LPTS
      XPLOT(J)=XAPP(I,J)
      YPLOT(J)=YAPP(I,J)
31    ZPLOT(J)=ZAPP(I,J)
      CALL CURV3D(XPLOT,YPLOT,ZPLOT,LPTS,0)
30     CALL CURV3D(XPLOT,ZPLOT,YPLOT,LPTS,0)
      DO 50 J=1,LPTS
      DO 51 I=1,MSECT
      XPLOT(I)=XAPP(I,J)
      YPLOT(I)=YAPP(I,J)
51    ZPLOT(I)=ZAPP(I,J)
      CALL CURV3D(XPLOT,YPLOT,ZPLOT,MSECT,0)
50    CALL CURV3D(YPLOT,ZPLOT,YPLOT,MSECT,0)
      DO 60 I=1,NPTS
      DO 61 J=1,IZ
      XPLOT(J)=XBODY(I,J)
      YPLOT(J)=YBODY(I,J)
61    ZPLOT(J)=ZBODY(I,J)
60    CALL CURV3D(XPLOT,ZPLOT,YPLOT,IZ,0)
      DO 65 J=1,IZ
      DO 66 I=1,NPTS
      XPLOT(I)=XBODY(I,J)
      YPLOT(I)=YBODY(I,J)
66    ZPLOT(I)=ZBODY(I,J)
65    CALL CURV3D(XPLOT,ZPLOT,YPLOT,NPTS,0)
      CALL ENDPL(IPLOT)
      CALL DONEPL
      RETURN
      END
```