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THEORETICAL CONSIDERATIONS AND USER'S MANUAL FOR A
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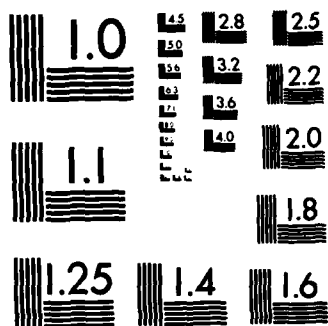
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NAVAL UNDERWATER SYSTEMS CENTER
NEWPORT LABORATORY
NEWPORT, RHODE ISLAND 02840

Technical Memorandum

THEORETICAL CONSIDERATIONS AND USER'S
MANUAL FOR A MODIFIED XYZ POTENTIAL FLOW
PROGRAM FOR CALCULATING FIVE DEGREES-OF-
FREEDOM VELOCITY POTENTIALS

Date: 15 November 1982

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Launcher Systems Department

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The latter sections of this report are intended for use as a user's manual.

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The XYZ Potential Flow Computer Program (XYZPF) has been modified to include the calculation of perturbation and total velocity potentials for on-body and off-body points. The program's capabilities have also been extended from three to five degrees of freedom by incorporating calculations for two rotational degrees of freedom of the body (body rotation about its Y and Z axes). In addition to these modifications which increase the program's capabilities, the program, which was originally written for a CDC 6700 computer, was rewritten to fit on a PDP 11/34 computer.

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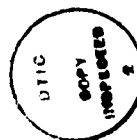
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ADMINISTRATIVE INFORMATION

This memorandum documents work performed under IRIED Project No. A43105, "Torpedo Launch Force Due to Bernoulli Effect," Project Engineer -- Paul Lefebvre (Code 3711). The sponsoring activity is the Naval Underwater Systems Center (Code 10), Dr. W. A. Von Winkle.

The original XYZPF was written by Charles W. Dawson and Janet S. Dean (David Taylor Naval Ship Research and Development Center) and is presently maintained by J. S. Dean.

The author of this memorandum is located at the Newport Laboratory, Naval Underwater Systems Center, Newport, Rhode Island 02840.



ACKNOWLEDGMENT

A significant effort on the part of Robert Thibodeau (Launcher Department Staff, Code 3701) is to be commended. Through his efforts, the original David Taylor Naval Ship Research and Development Center's version of the XYZPF program was installed on a PDP 11/34 minicomputer and was rewritten to be executed interactively.

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1.0 INTRODUCTION

The Naval Underwater Systems Center (NUSC) version of the XYZ Potential Flow Computer Program (XYZPF) described in this report was written under an ongoing NUSC IRIED project titled "Torpedo Launch Force Due to Bernoulli Effect." The main objective of the project is to create a hydrodynamic coefficient computer code to calculate the unsteady forces and moments on a body travelling with five degrees of freedom (D.O.F.) motion (three translational motions, u , v , w , and two rotational, q , r) in close proximity to a wall or other structure.

The hydrodynamic coefficient code is presently being developed and will be described in a future technical memorandum. Input to the code will require the velocity potential distribution on the surface of the body for all five degrees of freedom.

The XYZPF was chosen as the basis for calculating this velocity potential distribution since it utilizes a very general singularity method to conveniently calculate the potential flow about three-dimensional bodies of arbitrary shape. This report describes the velocity potential code.

In particular, the DTNSRDC version of the XYZPF is a computer program, written in FORTRAN, which utilizes a surface source density distribution on the surface of the body to compute the irrotational, incompressible potential flow about three-dimensional arbitrary shaped bodies. The body

surface is approximated by a set of plane quadrilaterals with a corresponding set of Fredholm integral equations of the second kind to solve for the source density on each quadrilateral. The equations are approximated by (1) assuming that the source density is constant in each quadrilateral, and (2) by applying the boundary condition (normal component of velocity is zero for a uniform onset flow) at only one point in the quadrilateral, the centroid. Once the set of equations is solved for the source density distribution, the flow velocity at on-and off-body points is calculated. Velocities are calculated for the three unit translational onflows and any other onflow specified by the user. This code was installed on a CDC 6700 computer.

The DTNSRDC version of XYZPF was supplied to NUSC by the Navy Engineering Software Systems (NESS) and was used as the basis for the NUSC version of the program. The NUSC version described in this report has been written to fit on a PDP 11/34 minicomputer and has the increased capability of calculating the perturbation and total velocity potentials at points on and off the body. In addition, programs were created to perform calculations for body motion with two rotational degrees of freedom, q and r .

Previously, difficulties in using the XYZPF were the tediousness and excessive time requirements involved in the task of generating the surface grid which is used as input to the program to define the surface of the body. This task has been facilitated by the use of a finite element mesh generator. The mesh generator used at NUSC has been SUPERTAB, a product of Structural Dynamics Research Corporation. An additional benefit of using

this interactive graphics mesh generator is the use of its visual display of the grid as an error check.

A post-processor has been written which converts the node point numbering scheme of SUPERTAB to that required by XYZPF. This is described further in the "Grid Generator" section of this report.

2.0 THEORETICAL CONSIDERATIONS

2.1 VELOCITY POTENTIAL AND BOUNDARY CONDITIONS

The total velocity potential (ϕ) was calculated as the sum of the perturbation potential (ϕ_p) due to the presence of the body and the potential (ϕ_∞) due to the onflow:

$$\phi = \phi_p + \phi_\infty$$

$$\text{where } \phi_\infty = -(V_{\infty X} X + V_{\infty Y} Y + V_{\infty Z} Z) \quad \text{For translational D.O.F.}$$

$$\phi_\infty = 0 \quad \text{For rotational D.O.F.}$$

where X, Y, Z are Cartesian coordinates of a point in the flow field.

$V_{\infty X}, V_{\infty Y}, V_{\infty Z}$ are the three components of flow field velocity at infinity.

The surface boundary condition for translational onflow is identical in the DTNSRDC and NUSC versions of XYZPF. The program assumes the body is

stationary and values are computed separately for unit onflow in the negative direction of the X, Y, and Z axes. The surface boundary condition for this case is that the normal component of velocity on the surface is zero, i.e.:

$$\left(\frac{\partial \phi}{\partial n}\right)_s = \vec{n} \cdot \nabla \phi = 0 \quad \text{TRANSLATION B.C.}$$

where \vec{n} is the unit outward normal vector, and ∇ is the gradient.

For the case of rotational motion of the body, the onset flow is zero and the body is rotating with unit angular velocity in the positive direction (right-hand coordinate system). The surface boundary condition therefore, requires the normal velocity of flow on the surface to equal the normal velocity of the surface at that point, i.e.:

$$\left(\frac{\partial \phi}{\partial n}\right)_s = \vec{n} \cdot \nabla \phi = \vec{n} \cdot (\vec{\omega} \times \vec{R}) \quad \text{ROTATIONAL B.C.}$$

where $\vec{\omega}$ is the angular velocity vector of the body and \vec{R} is the directional vector from the center of gravity (C.G.) of the body to the point on the surface.

It should be noted that the translation of a body in the positive direction of a stationary flow field perturbs the fluid in the same manner as a stationary body in a uniform onflow in the negative direction. Therefore, perturbation velocity potentials calculated in XYZPF for uniform onflow in the negative direction are identical to the total velocity potentials of a body moving in the positive direction of a stationary flow field.

The perturbation velocity potential (ϕ_p) is evaluated by one of three methods depending upon the ratio (X/T) of the distance (X) between the point under consideration and the centroid of the quadrilateral to the maximum dimension (T) of the quadrilateral. This approach, utilizing three ranges, is consistent with the remainder of the program where integral equations for the source density were evaluated using the same criteria. As stated in reference 1, the criteria is: "If the ratio (X/T) is greater than 4.0, the quadrilateral is approximated by a monopole (as if it were concentrated at one point). If the ratio is greater than 2.0 and less than or equal to 4.0, the quadrilateral is approximated by a quadrupole. If the ratio is less than or equal to 2.0, the integrals are evaluated exactly. The approximate methods are used because they require much less time than the exact method."

The perturbation velocity potential equations for each range were derived in reference 2. The resulting equations using the terminology of XYZPFP and rearranged to facilitate computations are:

$$\begin{aligned} \text{Exact:} \quad \phi_p = & - (PR12)(CLA1) + (PR23)(CLA2) + (PR34)(CLA3) \\ & + (PR41)(CLA4) + (Z)(TVZ) \end{aligned}$$

$$\text{Quadrupole:} \quad \phi_p = (A)(W) - (C1XX)(WXX) + (C1XY)(WXY) - (C1YY)(WYY)$$

$$\begin{aligned} \text{Monopole:} \quad \phi_p &= (A)(W) \\ W &= 1 / X^2 + Y^2 + Z^2 \quad \frac{1}{2} \end{aligned}$$

where: A = Area of quadrilateral

CIXX, CIXY, CIYY = Moments of inertia about the
origin of the quadrilateral

CLA1, CLA2, CLA3, CLA4 = Coefficients calculated in XYZPPF

PR12, PR23, PR34, PR41 = Signed perpendicular distance of
the point from the extension of a
side of the quadrilateral (in
quadrilateral coordinate system).

$$WXX = \frac{\partial^2 W}{\partial X^2}$$

$$WXY = \frac{\partial^2 W}{\partial X \partial Y}$$

$$WYY = \frac{\partial^2 W}{\partial Y^2}$$

X, Y, Z = location of point in quadrilateral coordinate
system

TVZ = Z component of induced velocity

To validate the applicable range of each formula, comparisons were made between velocity potentials computed by the exact and approximate formulas for a square quadrilateral having unit source density.

Results are shown in figure 1 where velocity potential is plotted versus nondimensionalized normal distance from the plane of the quadrilateral. With the exact formula as a baseline, it is evident that, for a square quadrilateral, the monopole and quadrupole approximations are highly accurate. The two approximate methods converge to the exact at the nondimensionalized (X/T) distance of approximately 1.4, considerably closer

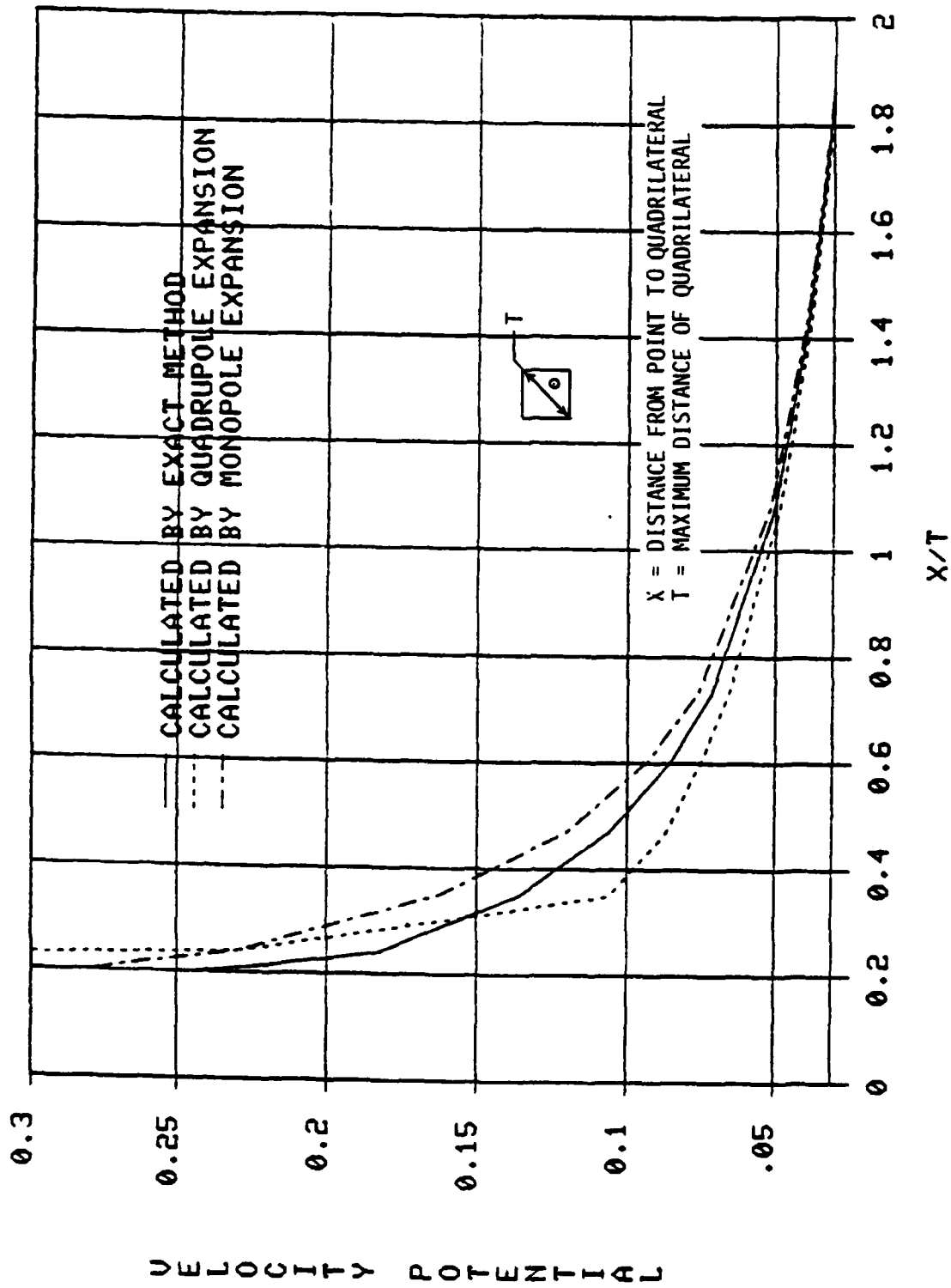


Figure 1. Effect of Quadrupole and Monopole Approximations on Velocity Potential Calculations

than the range in which each approximation is used. Even with these excellent results, the range criteria previously stated was not changed. The reasons were to remain consistent with the ranges used for other calculations and to be conservative since quadrilaterals of other shapes may not give rise to approximate values with the same degree of convergence as the square quadrilateral.

The translation D.O.F. programs automatically calculate and output values of velocities and velocity potentials for the three unit flows in the negative direction. In addition, the user may specify the vector of other flows to be considered.

Similarly, the rotational D.O.F. programs also automatically calculate and output values of velocities and velocity potentials for unit body motion in the positive direction for both rotational degrees of freedom. However, no provision for calculations of additional flows has been included. Additional flows were intentionally not included since it is a simple matter to calculate them from the unit flows.

Since velocity potentials of each unit flow are linearly independent, the total velocity potential for a five degree-of-freedom flow becomes:

$$\phi = u\phi_u + v\phi_v + w\phi_w + q\phi_q + r\phi_r$$

where u, v, w, q, r are the actual velocity components

and $\phi_u, \phi_v, \phi_w, \phi_q, \phi_r$ are the unit velocity potentials for each D.O.F.

2.2 SYMMETRY CONSIDERATIONS

The translational D.O.F. XYZPF has the feature that only nonsymmetrical parts of the surface have to be defined. This feature capitalizes on the fact that for uniform onflows, geometrically symmetric quadrilaterals about a plane have source densities equal in magnitude. However, the sign of a reflected quadrilateral is a function of the plane about which it is reflected and also the direction of motion of the body or onflow.

For rotational motion of the body, the symmetry feature is only applicable when the C.G. and centroid of the body coincide. This constraint is imposed because this is the only condition where source densities of geometrically symmetric quadrilaterals are equal in magnitude. This is a consequence of the boundary condition being a function of the displacement vector \vec{R} between the C.G. and the quadrilateral. If the magnitude of \vec{R} varies between geometrically symmetric quadrilaterals, then the magnitude of the boundary condition will vary, resulting in unequal source densities. In this case, the complete body will have to be defined.

3.0 GRID GENERATOR

As mentioned in the introduction, the tediousness and excessive time requirements of manually generating the surface grid of the body have been overcome by utilizing a finite element mesh generator. Figure 2 is a typical grid generated with the use of SUPERTAB. Since the body is symmetric, only one-quarter of the body has been defined and is represented by those points connected with lines. The remaining points are a reflection

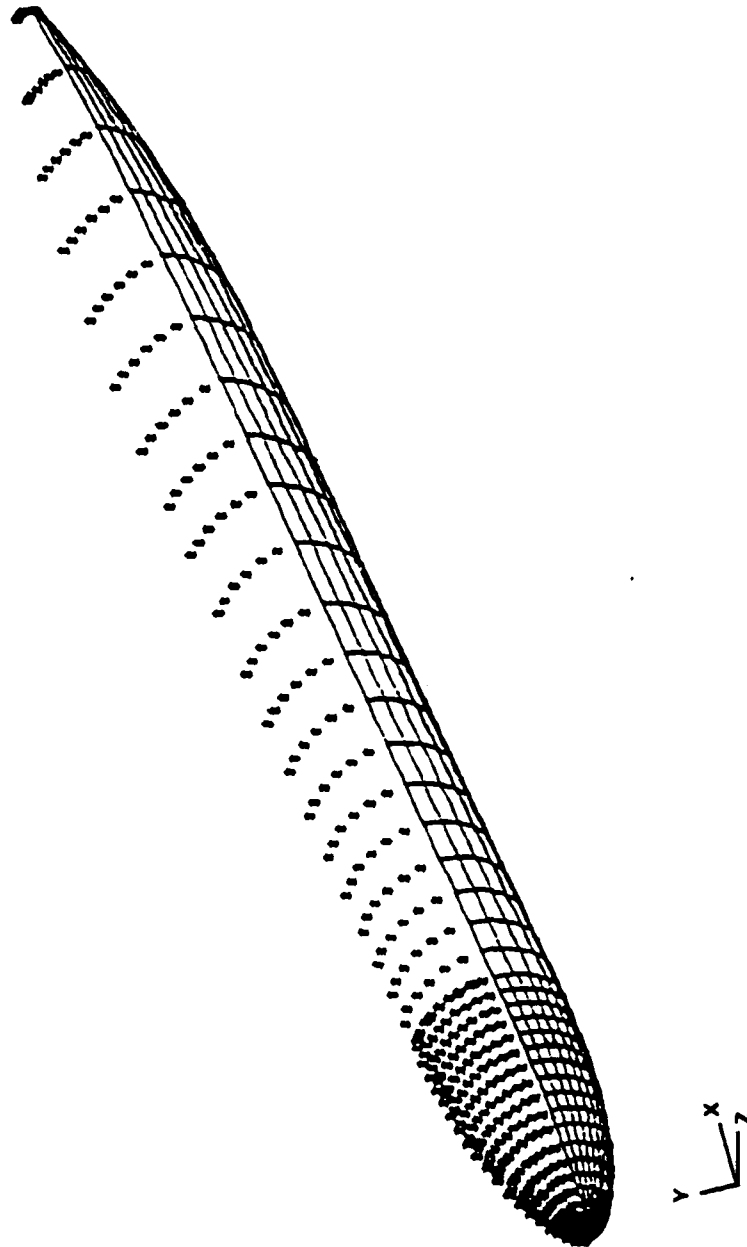


Figure 2. XYZPF Grid Generated with a Finite Element Mesh Generator

of the basic points and are displayed only as an aid to visualize the body shape.

Since SUPERTAB has a consecutive node numbering scheme with only one indice per node and the XYZPFP requires a two-indice per node numbering scheme, a post-processor called XYZIN.FTN was written to accommodate the change. The program is run interactively and requests information as needed.

Appendix A contains the program listing. Instructions on its use are contained in the comment statements of the program and are self explanatory.

4.0 PROGRAM STRUCTURE

The NUSC version of XYZPFP has been rewritten to fit on a PDP 11/34A minicomputer as opposed to a mainframe CDC 6700 computer for which DTNSRDC's version was written.

The distribution of calculations into seven separate programs remains the same in both versions. The first three programs calculate quadrilateral geometric data and source densities. Program 4 calculates values of velocity and velocity potential for on-body points while program 5 performs similar calculations for off-body points. The sixth and seventh programs calculate off-body and on-body streamlines, respectively, for translational motion only.

The seven programs for the translational D.O.F. are named PFP1.FTN through PFP7.FTN. The five programs for the rotational D.O.F. are named RFP1.FTN through RFP5.FTN. Programs for the translational D.O.F. are independent of the rotational D.O.F. programs and must be run separately.

In any case, the first four programs must be executed initially to generate geometric parameters and calculate source densities. These data are then saved in three files which are subsequently used when the remaining programs are executed. The remaining programs can be run in any combination and may be executed in the same run as the first four programs or later during a separate run.

The files created during execution of the first four programs are named UNIT3.DAT, UNIT4.DAT and POTFILE.DAT by the program. These files are necessary to execute programs 5 through 7 and are the default names for the files called by these programs. In order to manage these files, they can be appropriately renamed. As discussed in the next section, these non-default file names can be specified as the files to be called by the programs. Since the translational and rotational D.O.F. programs are separate programs, the contents of the files will be different. To avoid confusion, care should be taken when renaming the files.

5.0 ORGANIZATION OF INPUT DATA

Input data for the NUSC version of XYZPF is via a computer file. The input format is basically the same in both the NUSC and DTNSRDC versions, therefore, the input description in reference 1 is repeated here but with the changes required for the NUSC version.

The format for a new job starting from program 1 is:

1st Line: RESTART - Typed in columns 1 to 7

FLAG 1 - 0 or 1 in column 19

0 - specifies a new job starting from Program 1

1 - specifies a restart job with Programs 1 through
4 previously run

FLAG 2 - 0 or 1 in column 21

0 - specifies default file names are used

1 - specifies non-default file names are used

When Flag 2 on line 1 is 1 (non-default file names) the three renamed file names are listed on the next three lines in the order:

UNIT3.DAT renamed

UNIT4.DAT renamed

POTFILE.DAT renamed.

The next line is for identification. It contains information to identify the problem in columns 2 to 60.

The parameter line is next and contains the following information in the order given. The FORTRAN format for this line is (6I4, F8.4, 3I4).

NQE is the number of quadrilateral elements to be specified by the point lines. NQE must be in columns 2, 3, and 4 and as far to the right as possible. The maximum value permitted for NQE is 650.

NSE is the number of sections used. NSE must be in columns 6, 7, and 8 and as far to the right as possible.

MIX is the maximum number of iterations to be performed for the X or Q flow. MIX must be in columns 10, 11, 12 and must be as far to the right as possible. MIX must be less than 200.

MIY is the maximum number of iterations for the Y or R flow. MIY must be in columns 14, 15, 16 and must be as far to the right as possible. MIY must be less than 200.

MIZ is the maximum number of iterations for the Z flow. MIZ must be in columns 18, 19, 20 and must be as far to the right as possible. MIZ must be less than 200. MIZ is read in during a rotational D.O.F. run but can have any value since it is not used during the run.

ISM is the number of planes of symmetry.
 ISM = 0 indicates there are no planes of symmetry.
 ISM = 1 indicates that $Y=0$ is a plane of symmetry.
 ISM = 2 indicates that $Y=0$ and $Z=0$ are planes of symmetry.
 ISM = 3 indicates that $Y=0$, $Z=0$ and $X=0$ are planes of symmetry.

ISM must be in column 24.

EPS is the convergence criteria used in testing the convergence of the iterations. EPS must be in columns 25 through 32 and should include the decimal point.

The next line contains the X, Y, Z coordinates for the center of gravity.

The format is 3F10.4.

Lines containing information for the grid points follow. Each line has the format (3F12.9, 4I4, F12.9) and contains the following information for one point on the surface. See reference 1 for grid requirements.

- XI is the X-coordinate of the point and must be in columns 1 through 12.
- YI is the Y-coordinate of the point and must be in columns 13 through 24.
- ZI is the Z-coordinate of the point and must be in columns 25 through 36.
- NI is the N index for the point. NI must be less than 71 and must be in columns 39 and 40.
- MI is the M index for the point. MI must be less than 41 and must be in columns 43 and 44.
- NS is the section identification number. NS may be any positive integer from 1 to 9999 and must be in columns 45 through 48. NS must be different for different sections.
- NE is used to change the direction of the normal vector. When NE in the first line of a section is not blank or zero, NI and MI are interchanged for that section. On the other cards, NE is ignored. Column 52 is used for NE.
- VN is the normal component of the velocity at the body surface. Most problems have VN equal to zero. For some problems, such as inlet pipes, it is desirable to have a nonzero VN on some sections of the input. The value of VN from the first card in a section is used for the entire section. Columns 53 through 64 are used for VN.

All point lines for one section must be together, but within the section they may be in any order.

Additional flows are calculated only for the translation D.O.F. programs. Lines for additional flows to be edited follow the last point line for the last section. A maximum of 18 flows may be edited. The format for these lines is (3F12.9). On each line are specified the three components of the free-stream velocity for one flow as shown below.

VXI is the X-component and must be in columns 1 through 12.

VYI is the Y-component and must be in columns 13 through 24.

VZI is the Z-component and must be in columns 25 through 36.

This is all the information which is required to run the first four programs.

The input file format for programs 5 through 7 is identical to the DTNSRDC version except that an additional line which specifies the program to be executed is required. This line immediately precedes the standard input data for that program and consists of the word SEGMENT5, SEGMENT6, or SEGMENT7 (starting in column 1) depending on whether the program to be executed next is for program 5, program 6, or program 7, respectively. This completes the input data file for a new job starting from program 1.

When the job to be run is a restart job where programs 1 through 4 have already been executed, the input data file has the structure of a new job data file except the following lines are excluded:

Identification line

Parameter line

Line with C.G. data

Grid point lines

Additional flow lines

Appendix B lists two input files for the sample case of a sphere (the same sample as presented in reference 1) with a radius equal to 1, a coarse grid of 12 quadrilaterals and using three planes of symmetry (see figure 3). The first file is the case where programs 1 through 5 are run successively, while the second is for the restart case where only program 5 is run.

6.0 EXECUTING THE PROGRAMS

To execute the programs, the task (.TSK) files for each of the PFP and RPFP programs must be accessible. In addition, the following files must also be accessible: XYZ.CMD, XYZ.TSK, CREATE.TSK, and XYZSUB.OLB. These latter programs control execution of the PFP and RPFP programs and contain required subroutines.

The procedure for executing a new job or a restart job is identical. The procedure is simple and straightforward as evidenced in the sample of figure 4. The job is run interactively on the terminal via a command file. To initiate the job, the operator types "@XYZ" into the terminal. The computer responds by asking whether the translational or rotational programs are to be executed, and the operator answers with a "T" or "R" specifying translational or rotational, respectively. The computer next asks for the input data filename and, lastly, the filename to which the output will be written. This is all that is required of the operator.

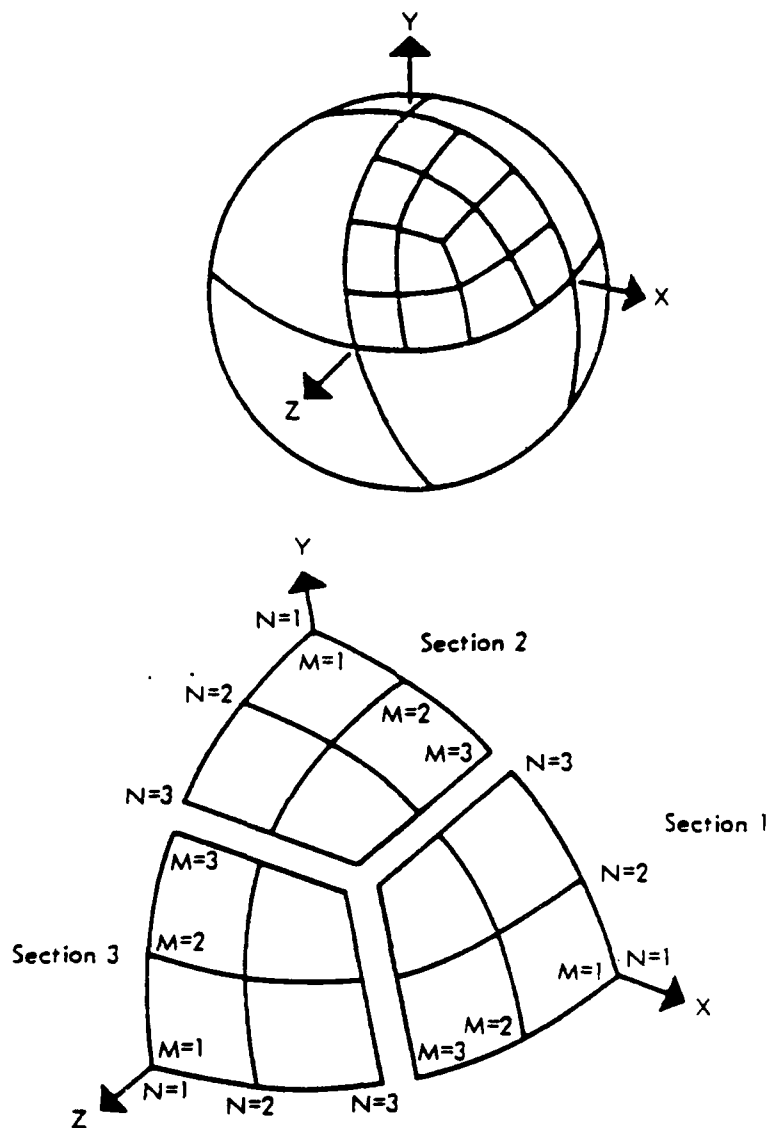


Figure 3. Representation of a Sphere (from Ref. 1)

```

XVYZ
DO YOU WANT TO RUN TRANSLATIONAL OR ROTATIONAL XYZ (T OR R) [ES]: T
*****
TRANSLATIONAL DEGREES OF FREEDOM
XYZ POTENTIAL FLOW PROGRAM - PDP 11/34 VERSION
PROGRAM IS LIMITED TO 650 QUADS AND 120 OFF
BODY POINTS WITH 50 OFF BODY STREAMLINES AND
50 ON-BODY STREAMLINES. PLEASE REPORT ANY
PROBLEMS WHICH OCCUR WITH RESULTS OR DURING
EXECUTION. CAUTION: - THIS PROGRAM USES A
LARGE AMOUNT OF DISK SPACE, IF YOU ARE GOING
TO RUN A LARGE JOB IT MIGHT BE ADVISABLE TO
SEE YOUR SYSTEMS PEOPLE AND HAVE A BLANK DISK
ASSIGNED TO THE JOB.
*****

```

ENTER FILE NAME CONTAINING THE INPUT DATA
 SPHERE.DAT

ENTER FILE NAME TO WHICH YOU WANT THE OUTPUT TO GO
 SPHERE.OUT

```

TT1 -- STOP END OF XYZ CREATION PHASE
TT1 -- STOP END OF PFP1
TT1 -- STOP END OF PFP2
TT1 -- STOP END OF PFP3
TT1 -- STOP END OF PFP4
TT1 -- STOP END OF SEGMENT 5
TT1 -- STOP SEGMENT 6 NOT RUN
TT1 -- STOP NO SCRATCH FILES CREATED FOR SECTION 7
TT1 -- STOP SEGMENT 7 NOT RUN
>0 (EOF)
)

```

NOTE: ITEM IN BLOCKS ARE INPUT BY OPERATOR.

Figure 4. Program Execution Procedure

If a program is not being executed, the computer acknowledges this and notifies the operator via the terminal. If a program is executed, the computer makes acknowledgement upon completion via the terminal.

A file called FILENAMES.DAT, created during the execution of the programs, remains in the user's directory at the end of the job. This file is useful only during the execution of the immediate job and may be deleted upon completion of the job. A new file is automatically created at the beginning of each new and restart job.

7.0 OUTPUT

The sample case of the sphere with a radius equal to 1 was run for both the translational and rotational XYZPF programs. The output listings are presented in appendix C.

Output from the translational programs are similar to the DTNSRDC version except for the addition of total and perturbation velocity potentials for each on- and off-body point. A similar output listing is also generated for the rotational D.O.F. calculations. However, since the total velocity potential equals the perturbation velocity potential, only one value is given. The output table from the rotational programs also differs in that pressure coefficient (CP) is not given for the rotational D.O.F. This is because pressure coefficient, as calculated in the translational D.O.F. programs, is not applicable to the rotational case.

8.0 RESULTS

Results of velocity potential calculations for the sample case of the sphere in a uniform stream is presented in figure 5. It is evident that even though this sample has a coarse grid, excellent results were obtained.

A second sample was run using a 2:1 ellipsoid. Since this body is symmetric about three planes, only one-eighth of the body was modeled. A coarse grid of only 32 quadrilaterals was chosen.

Figures 6 through 8 present results for two translational onflows and one rotational motion of the ellipsoid. Again, as with the sphere example, excellent results were obtained.

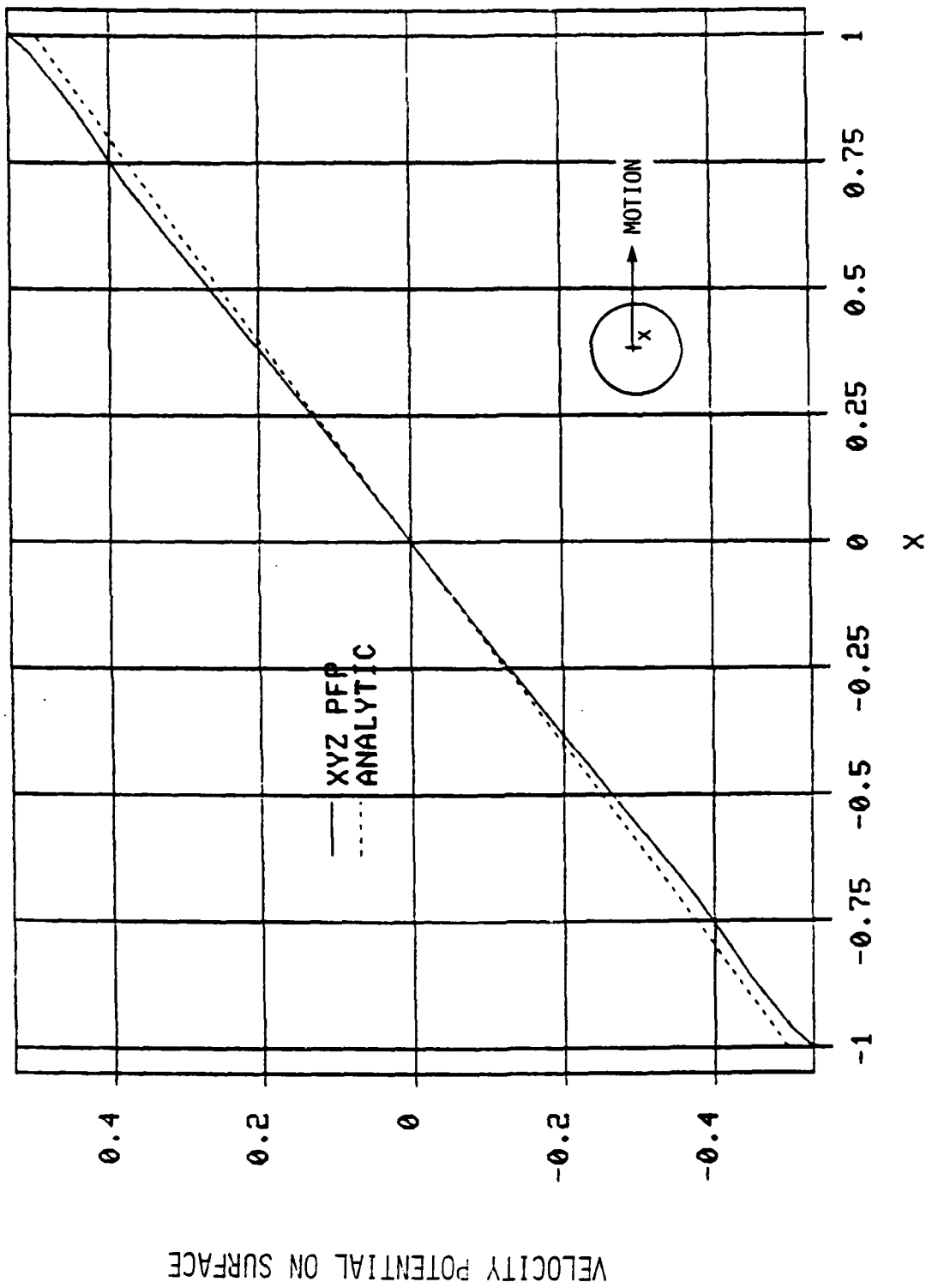


Figure 5. Sphere (Radius = 1) Moving in a Stationary Fluid

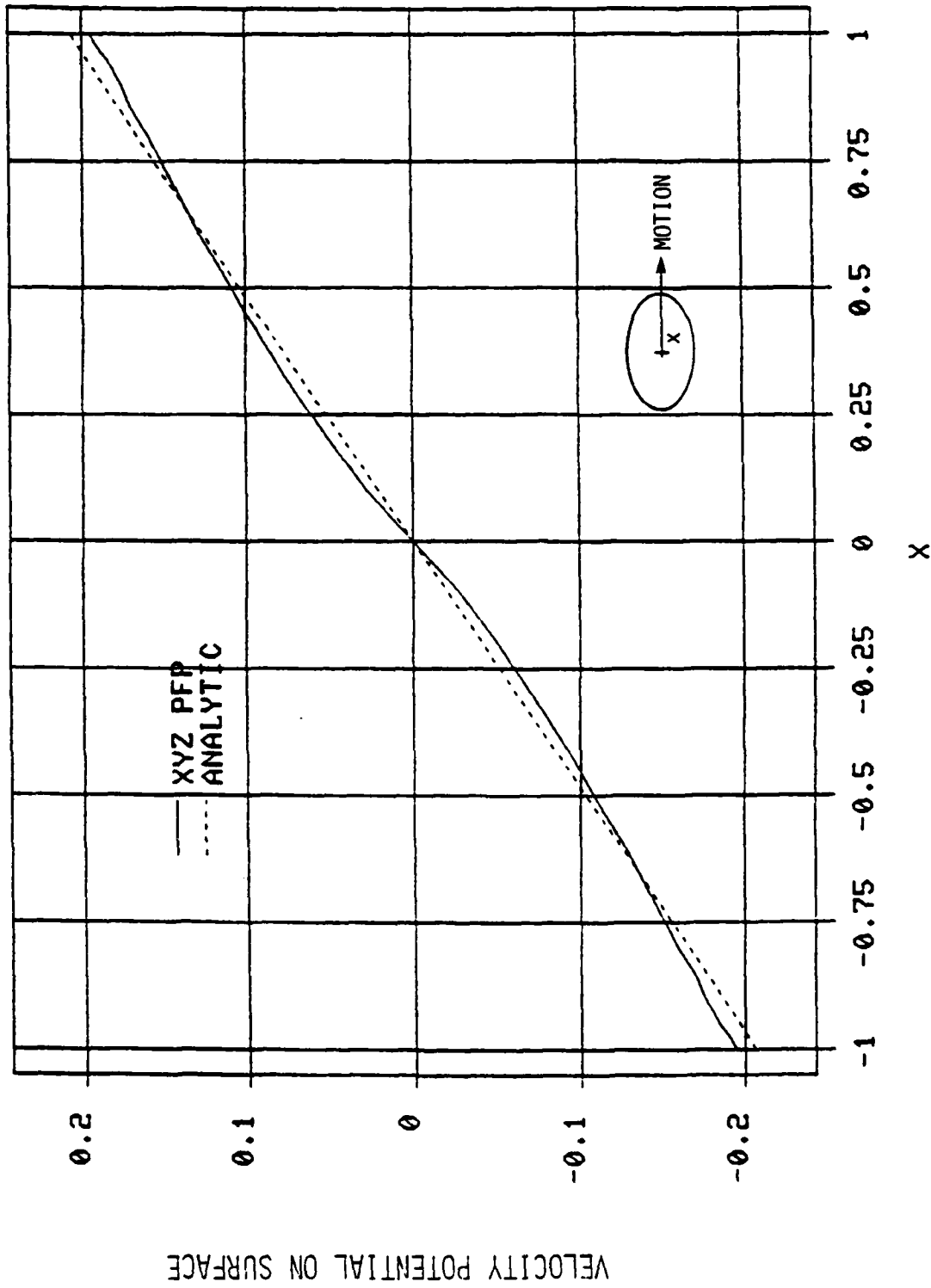


Figure 6. 2:1 Ellipsoid - End-on Motion,

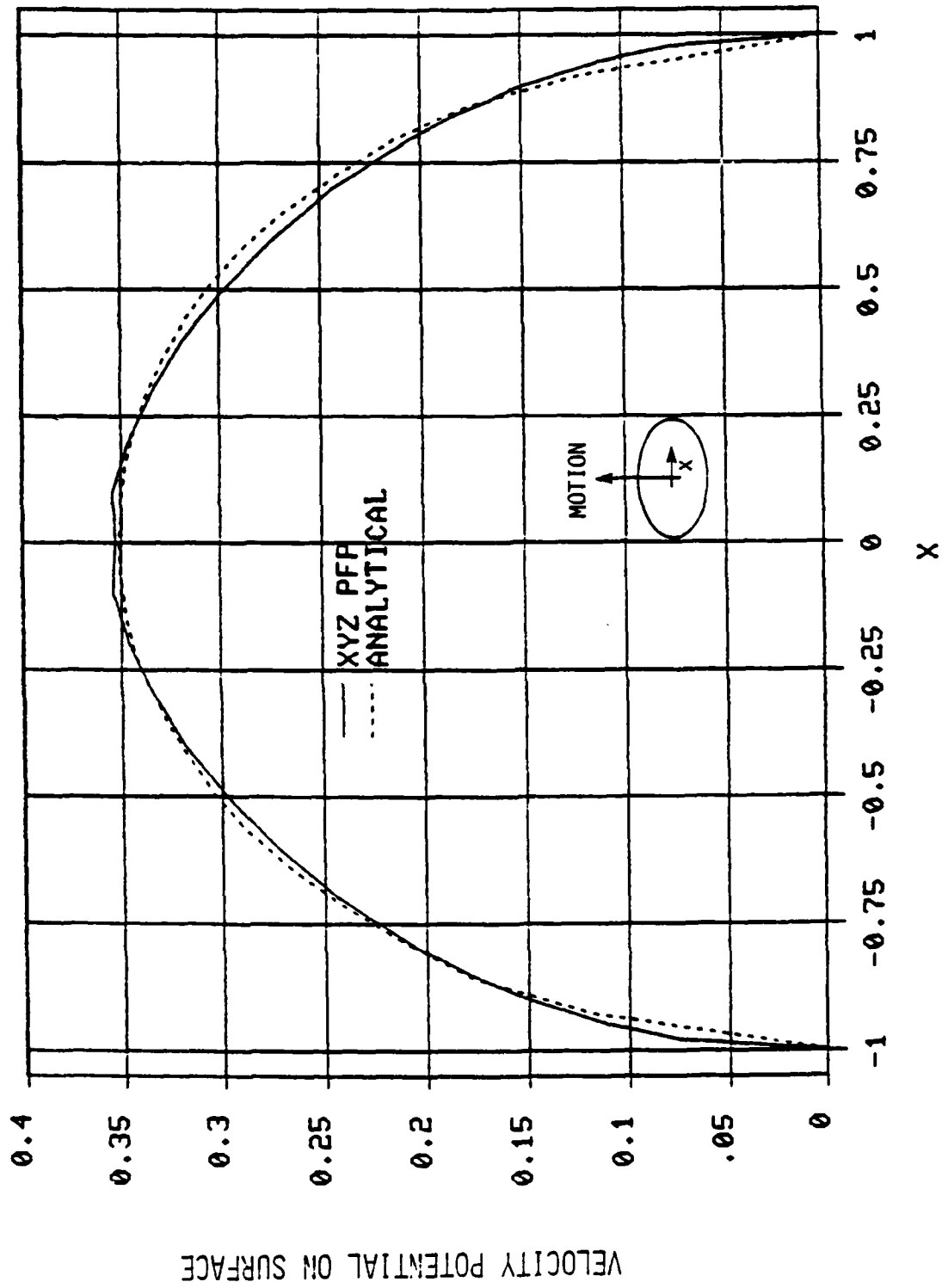


Figure 7. 2:1 Ellipsoid - Broadside Motion

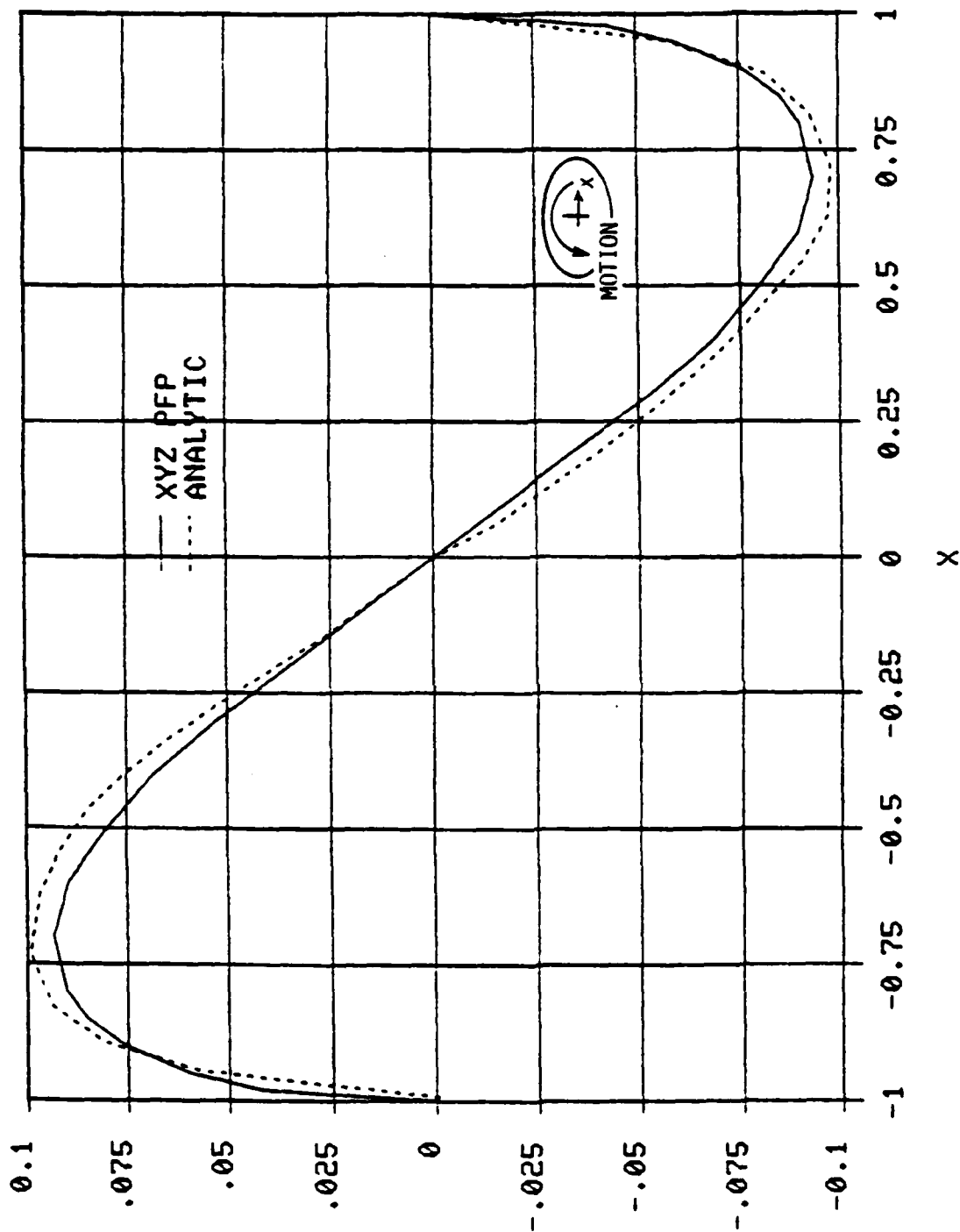


Figure 8. 2:1 Ellipsoid - Rotational Motion

9.0 REFERENCES

1. Dawson, C. W., and Dean, J. S., "The XYZ Potential Flow Program," Naval Ship Research and Development Center, NSRDC Report 3892, June 1972.
2. Hess, J. L., and Smith, A. M. U., "Calculation of Potential Flow About Arbitrary Bodies," Progress in Aeronautical Sciences, Vol. 8, 1966.
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TM No. 82-2076A

APPENDIX A
GRID GENERATOR POST-PROCESSOR
COMPUTER LISTING

A-1/A-2
Reverse Blank

```

1000      *XVZIN.PYM (COMPATIBLE WITH PDP 11/34)
1001
1002      THIS PROGRAM REARRANGES THE OUTPUT(UNIVERSAL) FILE OF
1003      PROGRAM "SUPERTAB" (A FINITE ELEMENT MESH GENERATOR)
1004      INTO A FORMAT ACCEPTABLE FOR
1005      INPUT INTO "XVZPPF" (XYZ POTENTIAL FLOW PROGRAM).
1006      THIS PROGRAM IS RUN INTERACTIVELY ON A TERMINAL.
1007
1008      WHEN GENERATING THE MESH WITH SUPERTAB, THE MODEL MAY BE SEPARATED
1009      INTO SECTIONS AS ALLOWED BY "XYZPPF". THE UNIVERSAL FILE MUST BE
1010      EDITED SO THAT ONLY LINES WITH NODE DATA ARE PRESENT.
1011
1012      FOR EACH SECTION TO BE FORMATTED, THE PROGRAM ASKS FIRST FOR
1013      THE SECTION NUMBER TO BE ASSIGNED. REQUESTED NEXT IS THE RANGE
1014      OF NODE POINTS TO BE INCLUDED IN THE SECTION. LASTLY, THE
1015      COMPUTER ASKS FOR THE MAXIMUM VALUES OF THE "M" AND "N"
1016      INDICES. THE FIRST NODE POINT ENCOUNTERED WITHIN THE
1017      ACCEPTABLE RANGE IS GIVEN THE INDICES M=1 AND N=1.
1018      FOR SUBSEQUENT NODES, M IS INDEXED BY ONE UNTIL "M" MAXIMUM
1019      IS ASSIGNED. THEN "M" IS INDEXED BY ONE AND "N" VALUES ARE
1020      AGAIN REPEATED FROM ONE TO "N" MAXIMUM.
1021
1022      WHEN GENERATING THE MESH WITH SUPERTAB, THE USER SHOULD
1023      BE CAUTIOUS THAT THE NODES ARE INITIALLY NUMBERED IN THE
1024      CORRECT DIRECTION TO GIVE A RIGHT HANDED COORDINATE SYSTEM
1025      UPON REFORMATTING.
1026
1027      DATA IS OUTPUT TO THE FILE ONLY AFTER IT HAS BEEN
1028      DETERMINED THAT THE DATA FOR THAT SECTION HAS BEEN
1029      CORRECTLY READ IN.
1030
1031      ARRAYS ARE DIMENSIONED TO ACCEPT SECTIONS WITH
1032      VALUES OF MAXIMUM NNM WHICH ARE NOT GREATER THAN 1000.
1033      FOR SECTIONS WITH NNM GREATER THAN 1000, THE ARRAYS WILL
1034      HAVE TO BE INCREASED TO THE NNM VALUE.
1035
1036      DIMENSION X(1000),Y(1000),Z(1000),NVAR(1000),FILEIN(14),
1037      1 FILE10(14),NVARP(1000)
1038      BYTE ANS
1039      FORMAT(14A1)
1040      FORMAT(11I3,3F13.5)
1041      FORMAT(21F7)
1042      FORMAT(1I7)
1043      FORMAT(1I7)
1044      FORMAT(3F12.5,3I4)
1045      TYPE *,TYPE INPUT DATA FILENAME= E.P. FILE=NAME.DAT
1046      ACCEPT 10,FILEIN
1047      FILEIN(14)=0
1048      TYPE *,TYPE OUTPUT DATA FILENAME=
1049      ACCEPT 10,FILEOUT
1050      FILEOUT(14)=0
1051      IF (NUNIT=1,NAM=FILEIN,CRM=FORMATTED,TYPE='CLO',
1052      READONLY)
1053      IF (NUNIT=2,NAM=FILEOUT,TYPE='NEW',FORM=FORMATTED,
1054      CARRIAGECONTROL='LIST')
1055      GO TO 300
1056      TYPE *,DO YOU WANT TO SET UP ANOTHER SECTION? Y/N
1057      ACCEPT 50,ANS
1058      IF (ANS.EQ.'N') GO TO 999
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100  TYPE #,TYPE, SECTION NUMBER
    ACCEPT 4,0,INSECT
    TYPE #,TYPE NUMBERS WHICH DESIGNATE THE RANGE OF
    1 LDC POINTS TO BE INCLUDED IN THIS SECTION
    2 I.E. MINIMUM PL, MAXIMUM PL
    ACCEPT 30,1,MIN,LMAX
    TYPE #,TYPE MAXIMUM M AND M VALUES I.E. M,P
    ACCEPT 30,M,M
    MVAR=0
    MVAR=1
    J=0
1000 READ(1,20,END=3000)I,11,22,13,14,15,22
    IF(1,11,LMIN-20,1,61,LMAX) GO TO 1000
    IF(MVAR=1) MGO TO 1500
    MVAR=MVAR+1
    GO TO 1600
1500 MVAR=MVAR+1
1600 J=J+1
    X(J)=X
    Y(J)=Y
    Z(J)=Z
    MVAR(J)=MVAR
    MVAR(J)=MVAR
    GO TO 1000
3000 CONTINUE
    IF(M,NE,MVAR) GO TO 4000
    IF(M,NE,MVAR) GO TO 4000
    WRITE (2,60)(X(K),Y(K),Z(K),MVAR(K),INSECT,K=1,J)
    TYPE #,DATA READ IN CORRECTLY
    GO TO 200
4000 TYPE #,ERROR - DATA NOT READ IN CORRECTLY
    GO TO 200
9999 STOP
END

```

TM No. 82-2076A

APPENDIX B
INPUT FILES FOR SPHERE SAMPLE

B-1/B-2
Reverse Blank

SPHERE INPUT FILE TO EXECUTE PROGRAMS 1 THROUGH 5

RESTART		SAMPLE PROBLEM				SPHERE
12	3	150	150	150	3	
0.0	0.0	0.0				-0.001
1.0						
-92300	-0					-0
-70711	-0					-30260
-92300	-0					-70711
-80000	30260					-0
-67303	32504					-32504
-70711	-0					-67303
-67303	-0					-0
-57735	-67303					-30320
-57735	-57735					-57735
-0	1.0					-0
-30260	-92300					-0
-70711	-70711					-0
-0	32300					-30260
-32504	-98000					-32504
-67303	-67303					-30320
-0	-70711					-70711
-30320	-67303					-67303
-57735	-57735					-57735
-0	-0					1.0
-0	-30260					-92300
-0	-70711					-70711
-0	-0					-92300
-30260	-32504					-80000
-30320	-67303					-67303
-70711	-0					-70711
-67303	-30320					-67303
-57735	-57735					-57735
-57735	-57735					-57735
-70711	-0					-70711
SEGMENTS						
4						
-999						-999
15.0						0.
-2.0						3.0
0.0						0.0
0.0						0.0
-777						-777
-1.0						-1.0
0.0						0.0
0.0						0.0

SPHERE INPUT FILE TO EXECUTE PROGRAM 5 AS A RESTART JOB

RESTART	1	1	
ROUND3.DAT			
ROUND4.DAT			
ROUND5.DAT			
SEGMENTS	4		
		.888	.777
	15.0	0.	-1.0
	-2.0	3.0	0.0
	0.0	0.0	2.0

TM No. 82-2076A

APPENDIX C
OUTPUT LISTING - SPHERE SAMPLE

C-1/C-2
Reverse Blank

C-3

SECTION 1

M	X1	X2	X3	X4	XP	YN	A	CZ4
N	Y1	Y2	Y3	Y4	YP	YN	FL	CZ5
P	Z1	Z2	Z3	Z4	ZP	ZM	CZ1	CZ6
1	0.10000E+01	0.92388E+00	0.48309E+00	0.92388E+00	0.92388E+00	0.92388E+00	0.12402E+00	-0.55519E+00
1	0.00000E+00	0.00000E+00	0.42504E+00	0.38269E+00	0.17163E+00	0.11887E+00	0.27040E+00	-0.55328E+00
1	0.00000E+00	0.39269E+00	0.32504E+00	0.00000E+00	0.17163E+00	0.11887E+00	0.38023E-01	-0.11684E-01
1	0.12388E+00	0.98408E+00	0.67383E+00	0.70711E+00	0.80023E+00	0.42701E+00	0.12715E+00	-0.55114E+00
2	0.00000E+00	0.32504E+00	0.67383E+00	0.00000E+00	0.52041E+00	0.22792E+00	0.26563E+00	-0.55033E+00
2	0.00000E+00	0.32504E+00	0.10320E+00	0.00000E+00	0.15846E+00	0.22792E+00	0.35472E-01	0.53794E-02
2	0.32388E+00	0.70711E+00	0.67383E+00	0.98408E+00	0.90023E+00	0.42701E+00	0.12715E+00	-0.55045E+00
1	0.00000E+00	0.00000E+00	0.10320E+00	0.32504E+00	0.15846E+00	0.22792E+00	0.26563E+00	-0.55207E+00
3	0.38269E+00	0.70711E+00	0.67383E+00	0.32504E+00	0.52041E+00	0.22792E+00	0.35472E-01	0.14949E-02

QUESTIONABLE POINT -POOR FIT

2	0.48309E+00	0.67383E+00	0.57735E+00	0.67383E+00	0.71067E+00	0.74905E+00	0.12400E+00	-0.55114E+00
2	0.32504E+00	0.10320E+00	0.57735E+00	0.67383E+00	0.46210E+00	0.22792E+00	0.26207E+00	-0.55114E+00
4	0.32504E+00	0.47383E+00	0.57735E+00	0.30320E+00	0.46210E+00	0.22792E+00	0.37339E-01	-0.11353E-01

SECTION 2

M	X1	X2	X3	X4	XP	YN	A	CZ4
N	Y1	Y2	Y3	Y4	YP	YN	FL	CZ5
P	Z1	Z2	Z3	Z4	ZP	ZM	CZ1	CZ6
1	0.00000E+00	0.18268E+00	0.32504E+00	0.00000E+00	0.17363E+00	0.17087E+00	0.12402E+00	-0.55519E+00
1	0.10000E+01	0.32388E+00	0.88001E+00	0.32388E+00	0.93409E+00	0.60748E+00	0.27040E+00	-0.55328E+00
5	0.00000E+00	0.00000E+00	0.32504E+00	0.38269E+00	0.17163E+00	0.11887E+00	0.38023E-01	-0.11684E-01
1	0.00000E+00	0.32504E+00	0.67383E+00	0.00000E+00	0.15846E+00	0.22792E+00	0.12715E+00	-0.55114E+00
2	0.32388E+00	0.98408E+00	0.67383E+00	0.70711E+00	0.80023E+00	0.42701E+00	0.26563E+00	-0.55033E+00
6	0.38269E+00	0.32504E+00	0.67383E+00	0.00000E+00	0.52041E+00	0.22792E+00	0.35472E-01	0.53794E-02
2	0.38269E+00	0.70711E+00	0.67383E+00	0.98408E+00	0.90023E+00	0.42701E+00	0.12715E+00	-0.55045E+00
1	0.32388E+00	0.70711E+00	0.67383E+00	0.32504E+00	0.80023E+00	0.42701E+00	0.26563E+00	-0.55207E+00
7	0.00000E+00	0.00000E+00	0.30320E+00	0.32504E+00	0.15846E+00	0.22792E+00	0.35472E-01	0.14949E-02

QUESTIONABLE POINT -POOR FIT

2	0.48309E+00	0.67383E+00	0.57735E+00	0.67383E+00	0.65210E+00	0.74905E+00	0.12400E+00	-0.55114E+00
2	0.32504E+00	0.10320E+00	0.57735E+00	0.67383E+00	0.46210E+00	0.22792E+00	0.26207E+00	-0.55114E+00
8	0.32504E+00	0.30320E+00	0.57735E+00	0.67383E+00	0.46210E+00	0.22792E+00	0.37339E-01	-0.11353E-01

SECTION 3									
M	X1	X2	X3	X4	XP	XM	A	CZ4	
N	Y1	Y2	Y3	Y4	YP	YM	FI	C74	
P	Z1	Z2	Z3	Z4	ZP	ZM	CZ1	C75	
1	0.00000E+00	0.00000E+00	0.12504E+00	0.18268E+00	0.17163E+00	0.17887E+00	0.12802E+00	-0.55513E+00	
1	0.00000E+00	0.18268E+00	0.12504E+00	0.00000E+00	0.17163E+00	0.17887E+00	0.27060E+00	-0.55923E+00	
9	0.10100E+01	0.12504E+00	0.00000E+00	0.12504E+00	0.17163E+00	0.17887E+00	0.38021E-01	-0.11586E-01	
1	0.30268E+00	0.12504E+00	0.67383E+00	0.70711E+00	0.52041E+00	0.52792E+00	0.12715E+00	-0.55114E+00	
2	0.00000E+00	0.12504E+00	0.30320E+00	0.00000E+00	0.15846E+00	0.16333E+00	0.26643E+00	-0.55339E+00	
10	0.12504E+00	0.12504E+00	0.57383E+00	0.70711E+00	0.00023E+00	0.00023E+00	0.35672E-01	0.54793E-02	
2	0.00000E+00	0.00000E+00	0.30320E+00	0.12504E+00	0.15846E+00	0.16333E+00	0.12715E+00	-0.55339E+00	
1	0.18268E+00	0.70711E+00	0.67383E+00	0.12504E+00	0.52041E+00	0.52792E+00	0.26643E+00	-0.55207E+00	
11	0.12504E+00	0.70711E+00	0.67383E+00	0.38021E+00	0.00023E+00	0.00023E+00	0.35672E-01	0.74767E-02	
QUESTIONABLE POINT - PQR FIT 0.749E-03									
2	0.12504E+00	0.30320E+00	0.57383E+00	0.67383E+00	0.46210E+00	0.47954E+00	0.12400E+00	-0.55339E+00	
2	0.12504E+00	0.67383E+00	0.57383E+00	0.30320E+00	0.46210E+00	0.47954E+00	0.26207E+00	-0.55114E+00	
12	0.30320E+00	0.67383E+00	0.57383E+00	0.67383E+00	0.71067E+00	0.71067E+00	0.37339E-01	-0.11372E-01	
EXTRA FLUX 0.57735 0.57735 0.57735									
EXTRA FLUX 0.70711 0.00000 0.70711									
SOLID ANGLE - 12.349									

XYZ POTENTIAL FLOW PROGRAM SECTION 2, VERSION 4

DATE: 22-APR-82 SUBROUTINE START TIME 14:11:00
 SPHERE PROBLEM SPHERE

XYZ POTENTIAL FLOW PROGRAM SECTION 3, VERSION 4

DATE: 22-APR-92 SUBROUTINE START TIME 14:11:17

SAMPLE PROBLEM SPHERE

X VELOCITY=1.0 Y VELOCITY=0.0 Z VELOCITY=0.0
 ITERATION SUM OF CHANGES A B1 B2

1 0.10255E+00
 2 0.17695E-01
 3 0.37817E-02
 4 0.72600E-03
 5 0.11931E-03

X VELOCITY=0.0 Y VELOCITY=1.0 Z VELOCITY=0.0

ITERATION SUM OF CHANGES A B1 B2

1 0.10235E+00
 2 0.17635E-01
 3 0.37817E-02
 4 0.72597E-03
 5 0.11935E-03

X VELOCITY=0.0 Y VELOCITY=0.0 Z VELOCITY=1.0

ITERATION SUM OF CHANGES A B1 B2

1 0.10255E+00
 2 0.17695E-01
 3 0.37817E-02
 4 0.72578E-03
 5 0.11935E-03

X12 POTENTIAL FLOW PROGRAM SECTION 4, VERSION 4

DATE: 22-APR-82 SUBROUTINE START TIME 14:11:23
SAMPLE PROBLEM SPHERE

PAGE - 1

SAMPLE PROBLEM SPHERE

PT.	X FLOW	X	Y	Z	VX	VY	VZ	ABS.V	CP	SOURCE	V INITIAL (PERTURBATION)	POTENTIAL (TOTAL)
1		0.71403	0.17163	0.17163	-0.09689	0.26213	0.26213	0.38312	0.45320	0.12393	0.256-04	0.51241
2		0.30023	0.52041	0.15346	-0.47232	0.56381	0.20542	0.84023	0.29407	0.10396	0.233F-04	0.45375
3		0.10023	0.15845	0.52041	-0.47232	0.20541	0.66382	0.84023	0.29405	0.10396	0.233F-04	0.45375
4		0.71067	0.66210	0.46210	-0.68729	0.52665	0.52666	1.01343	-0.02708	0.09321	0.206F-04	0.40444
5		0.17163	0.93408	0.17163	-1.45656	0.26091	0.04533	1.48046	-1.19163	0.02426	0.466F-05	0.09935
6		0.15346	0.80023	0.52041	-1.47125	0.20490	0.13186	1.49133	-1.22398	0.02159	0.491E-05	0.09054
7		0.52041	0.80023	0.15945	-1.05796	0.66240	0.13032	1.25503	-0.57503	0.07160	0.15E-04	0.29543
8		0.66210	0.71067	0.46210	-1.15476	0.53123	0.34067	1.31593	-0.73173	0.06417	0.11E-04	0.26429
9		0.17163	0.17163	0.93409	-1.45653	0.04530	0.26091	1.48046	-1.19160	0.02425	0.466E-05	0.09936
10		0.72041	0.15945	0.80023	-1.05798	0.13031	0.66242	1.25503	-0.57503	0.07160	0.15E-04	0.29543
11		0.15946	0.52941	0.80023	-1.47125	0.13187	0.20490	1.49124	-1.22396	0.02159	0.47E-05	0.09053
12		0.46210	0.46210	0.71067	-1.15475	0.34067	0.53122	1.31593	-0.73170	0.06417	0.11E-04	0.26429

SAMPLE PROBLEM SPHERE

PAGE - 2

PT.	X	Y	Z	VX	VY	VZ	ABS.V	CP	SOURCE	V NORMAL (PERTURBATION)	POTENTIAL (TOTAL)
1	0.33408	0.17163	0.17163	0.26091	-1.45653	0.04530	1.48044	-1.19160	0.02425	0.43E-05	0.09874
2	0.40023	0.52041	0.15345	0.66242	-1.05799	0.13031	1.25503	-0.57507	0.07160	0.15E-04	0.26737
3	0.40023	0.15345	0.52041	0.20490	-1.47125	0.13187	1.49130	-1.22394	0.02153	0.47E-05	0.09543
4	0.71067	0.46210	0.46210	0.53122	-1.15475	0.34067	1.11599	-0.73170	0.06417	0.13E-04	0.26429
5	0.17163	0.33408	0.17163	0.26211	-0.05689	0.26213	0.38317	0.85320	0.12993	0.25E-04	0.45324
6	0.15345	0.40023	0.52041	0.20562	-0.47232	0.66381	0.84023	0.29407	0.10995	0.21E-04	0.45375
7	0.52041	0.40023	0.15345	0.66382	-0.47232	0.20561	1.01344	-0.29406	0.10995	0.21E-04	0.45376
8	0.46210	0.71067	0.46210	0.52464	-0.40728	0.52665	1.01344	-0.29406	0.10995	0.21E-04	0.45376
9	0.17163	0.17163	0.33408	0.04533	-1.45656	0.26091	1.48044	-1.19160	0.02425	0.43E-05	0.09874
10	0.52041	0.15345	0.80023	0.13186	-1.47126	0.20490	1.49130	-1.22394	0.02153	0.47E-05	0.09543
11	0.15345	0.52041	0.60023	0.13032	-1.05799	0.66240	1.25503	-0.57507	0.07160	0.15E-04	0.26737
12	0.46210	0.46210	0.71067	0.34067	-1.15476	0.53123	1.11599	-0.73173	0.06417	0.13E-04	0.26429

SAMPLE PROBLEM SPHERE

PAGE - 3

PT.	X	Y	Z	VX	VY	VZ	ABS.V	CP	SOURCE	V NORMAL (PERTURBATION)	POTENTIAL (TOTAL)
1	0.33408	0.17163	0.17163	0.26091	0.04533	-1.45656	1.48044	-1.19160	0.02425	0.43E-05	0.09874
2	0.40023	0.52041	0.15345	0.66240	0.13186	-1.47126	1.49130	-1.22394	0.02153	0.47E-05	0.09543
3	0.40023	0.15345	0.52041	0.20490	0.13032	-1.05799	1.25503	-0.57507	0.07160	0.15E-04	0.26737
4	0.71067	0.46210	0.46210	0.53123	0.34067	-1.15476	1.11599	-0.73173	0.06417	0.13E-04	0.26429
5	0.17163	0.33408	0.17163	0.04530	0.26091	-1.45653	1.48044	-1.19160	0.02425	0.43E-05	0.09874
6	0.15345	0.40023	0.52041	0.20490	0.66242	-1.05798	1.25503	-0.57507	0.07160	0.15E-04	0.26737
7	0.52041	0.40023	0.15345	0.66242	0.20490	-1.47125	1.49130	-1.22394	0.02153	0.47E-05	0.09543
8	0.46210	0.71067	0.46210	0.52467	0.53122	-1.15475	1.11599	-0.73170	0.06417	0.13E-04	0.26429
9	0.17163	0.17163	0.33408	0.26213	0.26211	-0.05689	0.38317	0.85320	0.12993	0.25E-04	0.45375
10	0.52041	0.15345	0.80023	0.66381	0.20542	-0.47232	0.84023	0.29407	0.10995	0.21E-04	0.45375
11	0.15345	0.52041	0.60023	0.20561	0.66382	-0.47232	0.84023	0.29407	0.10995	0.21E-04	0.45375
12	0.46210	0.46210	0.71067	0.34067	0.52665	-0.40728	1.01344	-0.29406	0.10995	0.21E-04	0.45376

SAMPLE PROBLEM SPHERE

PAGE = 4

PT.	ONSET FLOW, X	VXI= 0.577	V	V I= 0.577	VZ= 0.577	VX	VY	VZ	MS-V	CP	POTENTIAL (PERTURBATION)	POTENTIAL (TOTAL)
1	0.33409	0.17163	0.17163	0.17163	-0.24533	0.66342	0.66342	0.66346	0.76979	0.05751	-0.62034	-1.15342
2	0.00023	0.52041	0.15946	0.15946	-0.22905	0.15144	0.65560	0.65560	0.71046	0.47524	-0.48481	-1.31977
3	0.00023	0.15946	0.52041	0.52041	-0.22804	0.65560	0.15142	0.65560	0.71045	0.49524	-0.48481	-1.31974
4	0.11067	0.46210	0.46210	0.46210	-0.21661	0.16595	0.16595	0.16595	0.76979	0.89100	-0.53867	-1.48255
5	0.17163	0.33408	0.17163	0.17163	0.66346	-0.24533	0.66342	0.66342	0.76979	0.05951	-0.62034	-1.15342
6	0.15946	0.90023	0.52041	0.52041	0.65560	-0.22805	0.15142	0.65560	0.71046	0.49524	-0.48481	-1.31977
7	0.52041	0.90023	0.15946	0.15946	0.15142	-0.22804	0.65560	0.65560	0.71045	0.49524	-0.48481	-1.31974
8	0.46210	0.71067	0.46210	0.46210	0.16595	-0.21661	0.16595	0.16595	0.76979	0.89100	-0.53867	-1.48256
9	0.17163	0.17163	0.17163	0.17163	0.66342	0.66342	0.66342	0.66342	0.76979	0.05951	-0.62034	-1.15342
10	0.52041	0.15946	0.90023	0.90023	0.15144	0.65560	-0.22805	0.65560	0.71046	0.49524	-0.48481	-1.31977
11	0.15946	0.52041	0.90023	0.90023	0.65560	0.15142	-0.22805	0.65560	0.71045	0.49524	-0.48481	-1.31974
12	0.46210	0.46210	0.71067	0.71067	0.16595	0.16595	-0.21661	0.16595	0.76979	0.89100	-0.53867	-1.48255

SAMPLE PROBLEM SPHERE

PAGE = 5

PT.	ONSET FLOW, X	VXI= 0.707	V	V I= 0.707	VZ= 0.707	VX	VY	VZ	MS-V	CP	POTENTIAL (PERTURBATION)	POTENTIAL (TOTAL)
1	0.33409	0.17163	0.17163	0.17163	-0.11599	0.66342	0.66342	0.66346	0.76979	0.22593	-0.44602	-1.22787
2	0.00023	0.52041	0.15946	0.15946	0.18909	0.65560	0.65560	0.65560	0.76979	0.15349	-0.33498	-1.36277
3	0.00023	0.15946	0.52041	0.52041	-0.13441	0.65560	0.65560	0.65560	0.76979	0.84790	-0.52975	-1.46353
4	0.11067	0.46210	0.46210	0.46210	0.11034	0.16595	0.16595	0.16595	0.76979	0.41445	-0.47234	-1.10213
5	0.17163	0.33408	0.17163	0.17163	0.39791	0.66342	0.66342	0.66342	0.76979	-1.12772	-0.13904	-0.30100
6	0.15946	0.90023	0.52041	0.52041	0.65560	-0.61329	0.65560	0.65560	0.76979	-0.70399	-0.27272	-0.75296
7	0.52041	0.90023	0.15946	0.15946	0.65560	-0.61329	0.65560	0.65560	0.76979	-0.70399	-0.27272	-0.75296
8	0.46210	0.71067	0.46210	0.46210	0.57565	-0.75127	0.57564	0.57564	0.76979	-0.22714	-0.37371	-1.02724
9	0.17163	0.17163	0.17163	0.17163	0.66342	0.66342	0.66342	0.66342	0.76979	0.22400	-0.44601	-1.22784
10	0.52041	0.15946	0.90023	0.90023	0.27872	-0.27872	0.27872	0.27872	0.76979	0.47809	-0.52975	-1.46353
11	0.15946	0.52041	0.90023	0.90023	0.65560	-0.56264	0.65560	0.65560	0.76979	-0.15349	-0.38487	-1.04277
12	0.46210	0.46210	0.71067	0.71067	0.16595	0.16595	-0.61329	0.16595	0.76979	0.41444	-0.47236	-1.10213

XVZ POTENTIAL FLOW PROGRAM SECTION 5. VERSION 4

DATE: 22-APR-82 SUBROUTINE START TIME 14:11:32

SAMPLE PROBLEM SPHERE

NDSP = 4
LEOIS = 0
IREAD = 0

OFF BODY POINTS

PT.	X	Y	Z
1	0.99900	0.00000	0.77700
2	15.00000	0.00000	-1.00000
3	-2.00000	3.00000	0.00000
4	0.00000	0.00000	2.00000

SAMPLE PROBLEM SPHERE				OFF BODY POINTS			PAGE	1
X FLOW PT.	X	Y	Z	VX	VY	VZ	CP	POTENTIAL (TOTAL)
1	0.99900	0.00000	0.77700	-0.76442	0.13744	0.13703	0.02511	0.14131
2	15.00000	0.00000	-1.00000	-0.99749	0.00000	-0.00003	0.00001	1.14031
3	-2.00000	3.00000	0.00000	-1.00085	-0.01544	0.00000	-0.00278	15.00231
4	0.00000	0.00000	2.00000	-1.06552	0.00000	0.00000	-0.00194	-2.02231
							-0.13533	0.00000

SAMPLE PROBLEM SPHERE				OFF BODY POINTS			PAGE	2
Y FLOW PT.	X	Y	Z	VX	VY	VZ	CP	POTENTIAL (TOTAL)
1	0.99900	0.00000	0.77700	0.13754	-1.00140	0.12256	-0.04201	0.12543
2	15.00000	0.00000	-1.00000	0.00000	-1.00015	0.00000	-0.00031	1.01361
3	-2.00000	3.00000	0.00000	-0.01543	-0.98799	0.00000	0.00000	0.00000
4	0.00000	0.00000	2.00000	0.00000	-1.06552	0.00000	0.02364	1.01165
							-0.13533	0.00000

Z FLJW		SAMPLE PROBLEM		SPHERE		OFF 300V POINTS				PAGE 3	
PT.	X	Y	Z	VX	VY	VZ	CP	POTENTIAL (PERTURBATION)	POTENTIAL (TOTAL)		
1	0.9900	0.48100	0.77700	0.13006	0.12271	-1.03631	-0.10192	0.10939	0.98499		
2	15.00000	0.00000	-1.00000	-0.00003	0.00000	-1.00015	-0.00030	-0.00015	-1.00015		
3	-4.00000	3.00000	0.00000	0.00000	0.00000	-1.01116	-0.02245	0.00000	0.00000		
4	0.00000	0.00000	2.00000	0.00000	0.00000	-3.86216	0.26459	0.13074	2.13074		

SAMPLE PROBLEM				SPHERE				OFF 900V POINTS				PAGE 4	
UNSET FLOW				VX = 0.577 VY = 0.577 VZ = 0.577									
PT.				X Y Z				VX VY VZ				CP	
1				0.99000 0.00400 0.77700				0.30415 0.41646 0.44682				0.47800	
2				15.00000 0.00000 -1.00000				0.57719 0.57764 0.57746				-0.00004	
3				-2.00000 3.00000 0.00000				0.58475 0.57933 0.58379				-0.02072	
4				0.00000 0.00000 2.00000				0.61510 0.61510 0.50100				-0.00469	
												POTENTIAL (PERTURBATION)	
												POTENTIAL (TOTAL)	
												-1.75569	
												-4.08414	
												-0.58379	
												-1.23019	

SAMPLE PROBLEM				SPHERE				OFF 800V POINTS				PAGE 5	
UNSET FLOW				VX = 0.707 VY = 0.000 VZ = 0.707									
PT.				X Y Z				VX VY VZ				CP POTENTIAL (PERTURBATION) POTENTIAL (TOTAL)	
1				0.99000 0.48300 0.77700				0.58433 -0.19809 0.63391				0.21745 -0.17770 -1.42353	
2				15.00000 0.00000 -1.00000				0.70622 0.00000 0.70724				0.00000 -0.00152 -3.90106	
3				-2.00000 3.00000 0.00000				0.70771 0.01092 0.71500				-0.31213 0.01577 1.42993	
4				0.00000 0.00000 2.00000				0.75344 0.00000 0.61458				0.05463 -0.07245 -1.50567	

XYZ POTENTIAL FLOW PROGRAM SECTION 6, VERSION 4

DATE: 22-APR-92 SUPRUTIME START TIME 14:11:40

SAMPLE PROBLEM SPHERE

3 STREAMLINES TO BE COMPUTED AT 4 STEPS OF 0.1500 T FOR AN ONSET VELOCITY OF 0.7071 0.0000 0.7071

STARTING POINTS

PT	X	Y	Z
1	0.0000	1.0000	1.0000
2	1.0000	1.0000	0.0000
3	1.0000	0.0000	1.0000

STEP 0

LINE	X	Y	Z	VX	VY	VZ	CP
1	0.0000	1.0000	1.0000	0.4386	-0.1962	0.6417	-0.1540
2	1.0000	1.0000	0.0000	0.4417	-0.1962	0.6386	-0.1540
3	1.0000	0.0000	1.0000	0.4452	0.0000	0.6452	0.4030

STEP 1

LINE	X	Y	Z	VX	VY	VZ	CP
1	0.1224	0.9762	1.0934	0.4052	-0.1927	0.6070	-0.0450
2	1.0345	0.9762	0.1224	0.4070	-0.1927	0.6052	-0.0451
3	1.0707	0.0000	1.0707	0.4946	0.0000	0.4945	0.5116

STEP 2

LINE	X	Y	Z	VX	VY	VZ	CP
1	0.2403	0.9428	1.1829	0.7651	-0.1767	0.5032	0.0346
2	1.1822	0.9428	0.2403	0.5832	-0.1751	0.7652	0.0346
3	1.1478	0.0000	1.1479	0.5343	0.0000	0.5342	0.4207

STEP 3

LINE	X	Y	Z	VX	VY	VZ	CP
1	0.3529	0.9179	1.2109	0.7325	-0.1544	0.5824	0.0332
2	1.2109	0.9179	0.3529	0.5824	-0.1544	0.7325	0.0332
3	1.2304	0.0000	1.2304	0.5667	0.0000	0.5667	0.3575

STEP 4

LINE	X	Y	Z	VX	VY	VZ	CP
1	0.4618	0.8962	1.3581	0.7163	-0.1307	0.5848	0.1260
2	1.3581	0.8962	0.4618	0.5848	-0.1307	0.7163	0.1260
3	1.3175	0.0000	1.3175	0.5925	0.0000	0.5926	0.2976

3 STREAMLINES TO BE COMPUTED AT 3 STEPS OF -0.1500 T FOR AN ONSET VELOCITY OF 0.7071 0.0000 0.7071

STARTING POINTS

LINE	X	Y	Z
1	0.0000	1.0000	1.0000
2	1.0000	1.0000	0.0000
3	1.0000	0.0000	1.0000

STEP 0

LINE	X	Y	Z	VX	VY	VZ	CP
1	0.0000	1.0000	1.0000	0.0000	-0.1962	0.6417	-0.1540
2	1.0000	1.0000	0.0000	0.6417	-0.1962	0.0000	-0.1540
3	1.0000	0.0000	1.0000	0.4452	0.0000	0.4452	0.6030

STEP 1

LINE	X	Y	Z	VX	VY	VZ	CP
1	-0.1245	1.0245	0.9001	0.8170	-0.1802	0.6925	-0.2755
2	0.9001	1.0245	-0.1245	0.6925	-0.1802	0.0000	-0.2755
3	0.9172	0.0000	0.9332	0.3889	0.0000	0.3889	0.5974

STEP 2

LINE	X	Y	Z	VX	VY	VZ	CP
1	-0.2614	1.0524	0.7317	0.8956	-0.1407	0.7516	-0.3900
2	0.7317	1.0524	-0.2614	0.7516	-0.1407	0.0000	-0.3900
3	0.6833	0.0000	0.8333	0.3261	0.0000	0.3261	0.7872

STEP 3

LINE	X	Y	Z	VX	VY	VZ	CP
1	-0.3916	1.0696	0.6140	0.8963	-0.0798	0.8150	-0.4740
2	0.6140	1.0696	-0.3916	0.8150	-0.0798	0.0000	-0.4740
3	0.3352	0.0000	0.8352	0.2604	0.0000	0.2604	0.8443

STEP 4

LINE	X	Y	Z	VX	VY	VZ	CP
1	-0.5290	1.0761	0.5474	0.8712	-0.0051	0.8656	-0.5033
2	0.5474	1.0761	-0.5290	0.8656	-0.0051	0.0000	-0.5033
3	0.2054	0.0000	0.8054	0.1960	0.0000	0.1960	0.9211

XYZZ POTENTIAL FLOW PROGRAM SECTION 7, VERSION 4

DATE: 22-APR-82 SUBROUTINE START TIME 14:12:13

SAMPLE PROBLEM SPHERE

UNBODY STREAMLINES - INPUT DATA

VX1 = 1.0000
VY1 = 0.0000
VZ1 = 0.0000
NLIN = 2
JMAX = 0
IWRITE = 0
MACH NU = 0.0000

STREAMLINE STARTING POINTS

LINE	X	Y	Z	MSP
1	0.71000	0.45000	0.45000	4
2	0.17000	0.17000	0.95000	9

SAMPLE PROBLEM SPHERE

UNSET FLOW, VX1= 1.000 VY1= 0.000 VZ1= 1.000

LINE NU. 1 PASSING THROUGH QUADRILATERAL 4 WITH STARTING POINT, X= 0.71000 Y= 0.45000 Z= 0.45000

I	N	V	Z	VX	VY	VZ	CP	K1	K2	M2	SL	V	P
1	0.47341	0.64001	-0.00015	0.35433	-0.92740	1.53240	-1.09243	0.52774	-0.12186	1.85495	0.00000	1.44459	7
2	0.66704	0.64982	0.31916	0.52450	-1.00099	1.00010	-0.15184	0.92376	-0.04283	1.38149	0.41790	1.97413	7
3	0.71307	0.65500	0.45500	0.14079	-0.83389	0.63013	0.42192	1.48875	0.05707	1.00000	0.41784	0.76032	4
4	0.73971	0.31054	0.56916	0.01140	-0.60425	0.34414	0.75100	2.45090	0.03945	0.61755	0.96327	0.49992	3
5	0.69345	0.00039	0.69705	0.00951	-0.18067	0.04025	0.78282	10.45003	-0.06216	0.18052	1.17059	0.11105	3

SAMPLE PROBLEM SPHERE

UNSET PLU-4, VAI- 1.000 VTI- 0.000 VTI- 1.000

LINE NO. 2 PASSING THROUGH QUADRILATERAL 9 WITH STARTING POINT, K= 0.17000 Y= 0.17000 Z= 0.95000

I	K	V	Z	VX	VY	VZ	CP	K1	K2	HZ	SL	V	P
1	0.00000	0.20153	0.75950	1.51892	-0.36672	-0.21672	-0.27586	1.01806	0.02995	1.21771	0.00000	1.12310	9
2	0.16735	0.16735	0.13565	1.20295	-0.30067	-0.16681	0.21734	1.30038	0.04027	1.00300	0.11294	0.48668	9
3	0.36203	0.11425	0.90349	0.75751	-0.22649	-0.26069	0.65391	1.13880	0.04213	0.71762	0.37534	0.59929	10
4	0.62095	0.30020	0.76610	0.17293	-0.02235	-0.12107	0.97381	1.72850	0.10690	0.19751	0.69352	0.16184	10

S ECTION

	K1	K2	K3	K4	K5	K6	K7	K8	K9	K10	K11	K12	K13	K14	K15	K16	K17	K18	K19	K20	K21	K22	K23	K24	K25	K26	K27	K28	K29	K30	K31	K32	K33	K34	K35	K36	K37	K38	K39	K40	K41	K42	K43	K44	K45	K46	K47	K48	K49	K50	K51	K52	K53	K54	K55	K56	K57	K58	K59	K60	K61	K62	K63	K64	K65	K66	K67	K68	K69	K70	K71	K72	K73	K74	K75	K76	K77	K78	K79	K80	K81	K82	K83	K84	K85	K86	K87	K88	K89	K90	K91	K92	K93	K94	K95	K96	K97	K98	K99	K100	K101	K102	K103	K104	K105	K106	K107	K108	K109	K110	K111	K112	K113	K114	K115	K116	K117	K118	K119	K120	K121	K122	K123	K124	K125	K126	K127	K128	K129	K130	K131	K132	K133	K134	K135	K136	K137	K138	K139	K140	K141	K142	K143	K144	K145	K146	K147	K148	K149	K150	K151	K152	K153	K154	K155	K156	K157	K158	K159	K160	K161	K162	K163	K164	K165	K166	K167	K168	K169	K170	K171	K172	K173	K174	K175	K176	K177	K178	K179	K180	K181	K182	K183	K184	K185	K186	K187	K188	K189	K190	K191	K192	K193	K194	K195	K196	K197	K198	K199	K200	K201	K202	K203	K204	K205	K206	K207	K208	K209	K210	K211	K212	K213	K214	K215	K216	K217	K218	K219	K220	K221	K222	K223	K224	K225	K226	K227	K228	K229	K230	K231	K232	K233	K234	K235	K236	K237	K238	K239	K240	K241	K242	K243	K244	K245	K246	K247	K248	K249	K250	K251	K252	K253	K254	K255	K256	K257	K258	K259	K260	K261	K262	K263	K264	K265	K266	K267	K268	K269	K270	K271	K272	K273	K274	K275	K276	K277	K278	K279	K280	K281	K282	K283	K284	K285	K286	K287	K288	K289	K290	K291	K292	K293	K294	K295	K296	K297	K298	K299	K300	K301	K302	K303	K304	K305	K306	K307	K308	K309	K310	K311	K312	K313	K314	K315	K316	K317	K318	K319	K320	K321	K322	K323	K324	K325	K326	K327	K328	K329	K330	K331	K332	K333	K334	K335	K336	K337	K338	K339	K340	K341	K342	K343	K344	K345	K346	K347	K348	K349	K350	K351	K352	K353	K354	K355	K356	K357	K358	K359	K360	K361	K362	K363	K364	K365	K366	K367	K368	K369	K370	K371	K372	K373	K374	K375	K376	K377	K378	K379	K380	K381	K382	K383	K384	K385	K386	K387	K388	K389	K390	K391	K392	K393	K394	K395	K396	K397	K398	K399	K400	K401	K402	K403	K404	K405	K406	K407	K408	K409	K410	K411	K412	K413	K414	K415	K416	K417	K418	K419	K420	K421	K422	K423	K424	K425	K426	K427	K428	K429	K430	K431	K432	K433	K434	K435	K436	K437	K438	K439	K440	K441	K442	K443	K444	K445	K446	K447	K448	K449	K450	K451	K452	K453	K454	K455	K456	K457	K458	K459	K460	K461	K462	K463	K464	K465	K466	K467	K468	K469	K470	K471	K472	K473	K474	K475	K476	K477	K478	K479	K480	K481	K482	K483	K484	K485	K486	K487	K488	K489	K490	K491	K492	K493	K494	K495	K496	K497	K498	K499	K500	K501	K502	K503	K504	K505	K506	K507	K508	K509	K510	K511	K512	K513	K514	K515	K516	K517	K518	K519	K520	K521	K522	K523	K524	K525	K526	K527	K528	K529	K530	K531	K532	K533	K534	K535	K536	K537	K538	K539	K540	K541	K542	K543	K544	K545	K546	K547	K548	K549	K550	K551	K552	K553	K554	K555	K556	K557	K558	K559	K560	K561	K562	K563	K564	K565	K566	K567	K568	K569	K570	K571	K572	K573	K574	K575	K576	K577	K578	K579	K580	K581	K582	K583	K584	K585	K586	K587	K588	K589	K590	K591	K592	K593	K594	K595	K596	K597	K598	K599	K600	K601	K602	K603	K604	K605	K606	K607	K608	K609	K610	K611	K612	K613	K614	K615	K616	K617	K618	K619	K620	K621	K622	K623	K624	K625	K626	K627	K628	K629	K630	K631	K632	K633	K634	K635	K636	K637	K638	K639	K640	K641	K642	K643	K644	K645	K646	K647	K648	K649	K650	K651	K652	K653	K654	K655	K656	K657	K658	K659	K660	K661	K662	K663	K664	K665	K666	K667	K668	K669	K670	K671	K672	K673	K674	K675	K676	K677	K678	K679	K680	K681	K682	K683	K684	K685	K686	K687	K688	K689	K690	K691	K692	K693	K694	K695	K696	K697	K698	K699	K700	K701	K702	K703	K704	K705	K706	K707	K708	K709	K710	K711	K712	K713	K714	K715	K716	K717	K718	K719	K720	K721	K722	K723	K724	K725	K726	K727	K728	K729	K730	K731	K732	K733	K734	K735	K736	K737	K738	K739	K740	K741	K742	K743	K744	K745	K746	K747	K748	K749	K750	K751	K752	K753	K754	K755	K756	K757	K758	K759	K760	K761	K762	K763	K764	K765	K766	K767	K768	K769	K770	K771	K772	K773	K774	K775	K776	K777	K778	K779	K780	K781	K782	K783	K784	K785	K786	K787	K788	K789	K790	K791	K792	K793	K794	K795	K796	K797	K798	K799	K800	K801	K802	K803	K804	K805	K806	K807	K808	K809	K810	K811	K812	K813	K814	K815	K816	K817	K818	K819	K820	K821	K822	K823	K824	K825	K826	K827	K828	K829	K830	K831	K832	K833	K834	K835	K836	K837	K838	K839	K840	K841	K842	K843	K844	K845	K846	K847	K848	K849	K850	K851	K852	K853	K854	K855	K856	K857	K858	K859	K860	K861	K862	K863	K864	K865	K866	K867	K868	K869	K870	K871	K872	K873	K874	K875	K876	K877	K878	K879	K880	K881	K882	K883	K884	K885	K886	K887	K888	K889	K890	K891	K892	K893	K894	K895	K896	K897	K898	K899	K900	K901	K902	K903	K904	K905	K906	K907	K908	K909	K910	K911	K912	K913	K914	K915	K916	K917	K918	K919	K920	K921	K922	K923	K924	K925	K926	K927	K928	K929	K930	K931	K932	K933	K934	K935	K936	K937	K938	K939	K940	K941	K942	K943	K944	K945	K946	K947	K948	K949	K950	K951	K952	K953	K954	K955	K956	K957	K958	K959	K960	K961	K962	K963	K964	K965	K966	K967	K968	K969	K970	K971	K972	K973	K974	K975	K976	K977	K978	K979	K980	K981	K982	K983	K984	K985	K986	K987	K988	K989	K990	K991	K992	K993	K994	K995	K996	K997	K998	K999	K1000	K1001	K1002	K1003	K1004	K1005	K1006	K1007	K1008	K1009	K1010	K1011	K1012	K1013	K1014	K1015	K1016	K1017	K1018	K1019	K1020	K1021	K1022	K1023	K1024	K1025	K1026	K1027	K1028	K1029	K1030	K1031	K1032	K1033	K1034	K1035	K1036	K1037	K1038	K1039	K1040	K1041	K1042	K1043	K1044	K1045	K1046	K1047	K1048	K1049	K1050	K1051	K1052	K1053	K1054	K1055	K1056	K1057	K1058	K1059	K1060	K1061	K1062	K1063	K1064	K1065	K1066	K1067	K1068	K1069	K1070	K1071	K1072	K1073	K1074	K1075	K1076	K1077	K1078	K1079	K1080	K1081	K1082	K1083	K1084	K1085	K1086	K1087	K1088	K1089	K1090	K1091	K1092	K1093	K1094	K1095	K1096	K1097	K1098	K1099	K1100	K1101	K1102	K1103	K1104	K1105	K1106	K1107	K1108	K1109	K1110	K1111	K1112	K1113	K1114	K1115	K1116	K1117	K1118	K1119	K1120	K1121	K1122	K1123	K1124	K1125	K1126	K1127	K1128	K1129	K1130	K1131	K1132	K1133	K1134	K1135	K1136	K1137	K1138	K1139	K1140	K1141	K1142	K1143	K1144	K1145	K1146	K1147	K1148	K1149	K1150	K1151	K1152	K1153	K1154	K1155	K1156	K1157	K1158	K1159	K1160	K1161	K1162	K1163	K1164	K1165	K1166	K1167	K1168	K1169	K1170	K1171	K1172	K1173	K1174	K1175	K1176	K1177	K1178	K1179	K1180	K1181	K1182	K1183	K1184	K1185	K1186	K1187	K1188	K1189	K1190	K1191	K1192	K1193	K1194	K1195	K1196	K1197	K1198	K1199	K1200	K1201	K1202	K1203	K1204	K1205	K1206	K1207	K1208	K1209	K1210	K1211	K1212	K1213	K1214	K1215	K1216	K1217	K1218	K1219	K1220	K1221	K1222	K1223	K1224	K1225	K1226	K1227	K1228	K1229	K1230	K1231	K1232	K1233	K1234	K1235	K1236	K1237	K1238	K1239	K1240	K1241	K1242	K1243	K1244	K1245	K1246	K1247	K1248	K1249	K1250	K1251	K1252	K1253	K1254	K1255	K1256	K1257	K1258	K1259	K1260	K1261	K1262	K1263	K1264	K1265	K1266	K1267	K1268	K1269	K1270	K1271	K1272	K1273	K1274	K1275	K1276	K1277	K1278	K1279	K1280	K1281	K1282	K1283	K1284	K1285	K1286	K1287	K1288	K1289	K1290	K1291	K1292	K1293	K1294	K1295	K1296	K1297	K1298	K1299	K1300	K1301	K1302	K1303	K1304	K1305	K1306	K1307	K1308	K1309	K1310	K1311	K1312	K1313	K1314	K1315	K1316	K1317	K1318	K1319	K1320	K1321	K1322	K1323	K1324	K1325	K1326	K1327	K1328	K1329	K1330	K1331	K1332	K1333	K1334	K1335	K1336	K1337	K1338	K1339	K1340	K1341	K1342	K1343	K1344	K1345	K1346	K1347	K1348	K1349	K1350	K1351	K1352	K1353	K1354	K1355	K1356	K1357	K1358	K1359	K1360	K1361	K1362	K1363	K1364	K1365	K1366	K1367	K1368	K1369	K1370	K1371	K1372	K1373	K1374	K1375	K1376	K1377	K1378	K1379	K1380	K1381	K1382	K1383	K1384	K1385	K1386	K1387	K1388	K1389	K1390	K1391	K1392	K1393	K1394	K1395	K1396	K1397	K1398	K1399	K1400	K1401	K1402	K1403	K1404	K1405	K1406	K1407	K1408	K1409	K1410	K1411	K1412	K1413	K1414	K1415	K1416	K1417	K1418	K1419	K1420	K1421	K1422	K1423	K1424	K1425	K1426	K1427	K1428	K1429	K1430	K1431	K1432	K1433	K1434	K1435	K1436	K1437	K1438	K1439	K1440	K1441	K1442	K1443	K1444	K1445	K1446	K1447	K1448	K1449	K1450	K1451	K1452	K1453	K1454	K1455	K1456	K1457	K1458	K1459	K1460	K1461	K1462	K1463	K1464	K1465	K1466	K1467	K1468	K1469	K1470	K1471	K1472	K1473	K1474	K1475	K1476	K1477	K1478	K1479	K1480	K1481	K1482	K1483	K1484	K1485	K1486	K1487	K1488	K1489	K1490	K1491	K1492	K1493	K1494	K1495	K1496	K1497	K1498
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ROTATIONAL D.O.F. SAMPLE

XYZ POTENTIAL FLOW PROGRAM SECTION 1, VERSION 4

DATE: 24-MAY-82 SUBROUTINE START TIME 10:11:11

SAMPLE PROBLEM SPHERE

NO. OF QUADS. = 12
 NO. OF SECTIONS = 3
 MAX. NO. OF ITERATIONS Q FLOW 150 R FLOW 150
 3 PLANES OF SYMMETRY

CONVERGENCE CRITERIA = 0.00010

ISP = 0

IEDI1 = 0

IEDI3 = 0

IEDI4 = 0

ETAPE = 0

ACENTER = 0.00

VCENTER = 0.00

ZCENTER = 0.00

CMX = 0.000

CMY = 0.000

CMZ = 0.000

SECTION 1

M	N	V1	V2	V3	V4	XP	YN	A	C24
P		V1	V2	V3	V4	YP	YN	FL	C25
		V1	V2	V3	V4	ZP	ZN	C21	C26
1	0.10303E+01	0.22383E+00	0.58308E+00	0.12384E+00	0.33093E+00	0.73093E+00	0.73093E+00	0.12302E+00	-0.55513E+00
1	0.00000E+00	0.00000E+00	0.12504E+00	0.18264E+00	0.17163E+00	0.17163E+00	0.17163E+00	0.27063E+00	-0.55928E+00
1	0.00000E+00	0.38368E+00	0.32504E+00	0.00000E+00	0.17163E+00	0.17163E+00	0.17163E+00	0.38023E+01	-0.11684E+01
1	0.32384E+00	0.48303E+00	0.57303E+00	1.70711E+00	0.30023E+00	0.30023E+00	0.30023E+00	0.12715E+00	-0.55116E+00
2	0.38264E+00	0.32504E+00	0.57303E+00	0.70711E+00	0.52041E+00	0.52041E+00	0.52041E+00	0.26563E+00	-0.55934E+00
2	0.20303E+00	0.32504E+00	0.30023E+00	0.00000E+00	0.15366E+00	0.15366E+00	0.15366E+00	0.35472E+01	0.52794E+02
2	0.38264E+00	0.70711E+00	0.57303E+00	0.38264E+00	0.30023E+00	0.30023E+00	0.30023E+00	0.12715E+00	-0.55116E+00
3	0.38264E+00	0.30023E+00	0.30023E+00	1.32504E+00	1.15366E+00	1.15366E+00	1.15366E+00	0.25663E+00	-0.55207E+00
3	0.38264E+00	0.70711E+00	0.57303E+00	0.32504E+00	0.52041E+00	0.52041E+00	0.52041E+00	0.35472E+01	0.74345E+02
3	0.38264E+00	0.70711E+00	0.57303E+00	0.32504E+00	0.52041E+00	0.52041E+00	0.52041E+00	0.12400E+00	-0.55333E+00
3	0.38264E+00	0.30023E+00	0.30023E+00	0.32504E+00	0.46210E+00	0.46210E+00	0.46210E+00	0.26207E+00	-0.55116E+00
3	0.38264E+00	0.30023E+00	0.30023E+00	0.32504E+00	0.46210E+00	0.46210E+00	0.46210E+00	0.37333E+01	-0.11352E+01

UNSTABLE POINT

SECTION

M	N	V1	V2	V3	V4	XP	YN	A	C24
P		V1	V2	V3	V4	YP	YN	FL	C25
		V1	V2	V3	V4	ZP	ZN	C21	C26
1	0.10303E+01	0.10003E+00	0.32504E+00	0.32504E+00	0.32504E+00	0.17163E+00	0.17163E+00	0.12400E+00	-0.55333E+00
1	0.00000E+00	0.32504E+00	0.32504E+00	0.00000E+00	0.17163E+00	0.17163E+00	0.17163E+00	0.27063E+00	-0.55928E+00
1	0.38264E+00	0.32504E+00	0.32504E+00	0.00000E+00	0.17163E+00	0.17163E+00	0.17163E+00	0.38023E+01	-0.11684E+01
1	0.38264E+00	0.32504E+00	0.32504E+00	0.70711E+00	0.30023E+00	0.30023E+00	0.30023E+00	0.12715E+00	-0.55116E+00
2	0.38264E+00	0.32504E+00	0.32504E+00	0.70711E+00	0.52041E+00	0.52041E+00	0.52041E+00	0.26563E+00	-0.55934E+00
2	0.20303E+00	0.32504E+00	0.30023E+00	0.00000E+00	0.15366E+00	0.15366E+00	0.15366E+00	0.35472E+01	0.52794E+02
2	0.38264E+00	0.70711E+00	0.57303E+00	0.38264E+00	0.30023E+00	0.30023E+00	0.30023E+00	0.12715E+00	-0.55116E+00
3	0.38264E+00	0.30023E+00	0.30023E+00	1.32504E+00	1.15366E+00	1.15366E+00	1.15366E+00	0.25663E+00	-0.55207E+00
3	0.38264E+00	0.70711E+00	0.57303E+00	0.32504E+00	0.52041E+00	0.52041E+00	0.52041E+00	0.35472E+01	0.74345E+02
3	0.38264E+00	0.70711E+00	0.57303E+00	0.32504E+00	0.52041E+00	0.52041E+00	0.52041E+00	0.12400E+00	-0.55333E+00
3	0.38264E+00	0.30023E+00	0.30023E+00	0.32504E+00	0.46210E+00	0.46210E+00	0.46210E+00	0.26207E+00	-0.55116E+00
3	0.38264E+00	0.30023E+00	0.30023E+00	0.32504E+00	0.46210E+00	0.46210E+00	0.46210E+00	0.37333E+01	-0.11352E+01

UNSTABLE POINT

UNSTABLE POINT

UNSTABLE POINT

ATZ POTENTIAL FLOW PROGRAM SECTION 2, VERSION 4

DATE: 24-MAY-82 SUBROUTINE START TIME 10:11:37

SAMPLE PROBLEM SPHERE

ATZ POTENTIAL FLOW PROGRAM SECTION 1, VERSION 4

DATE: 24-MAY-82 SUBROUTINE START TIME 10:11:58

SAMPLE PROBLEM SPHERE
Q= 1.0E+05/C

ELEVATION SUM OF CHARGES A 21 82

1 0.2156E-03

Q= 0.0PAL/SEC W= 1.0E+02/SEC

IF QATION SUM OF CHARGES A 91 82

1 0.2156E-03

XVZ POTENTIAL FLOW PROGRAM SECTION 4, V. 4.10.10.4
 DATE: 24-MAY-82 RUNOUTTIME START TIME 10:12:09
 SAMPLE ORIGIN SP422

SAMPLE PROGRAM SPHERE PAGE 2 1									
W FLOW	Y	CALC VALUES ARE BASED ON THE DEFORMATION DUE TO THE ROTATION OF THE BODY ALONE		VX	VY	VZ	CS-V	V NORMAL (CLEARANCE)	POTENTIAL
PT.		1	2						
1	2.13403	0.17163	0.17163	-0.10102	-0.00031	0.00014	0.00108	-0.00017	-0.00017
2	2.10323	0.15341	0.15341	0.00323	0.00003	0.00023	0.00060	0.00015	0.00060
3	2.10323	0.15345	0.15345	0.00003	0.00003	-0.00027	0.00029	-0.00001	-0.00001
4	2.17163	0.17163	0.17163	-0.00073	-0.00065	-0.00072	0.00121	-0.00019	-0.00019
5	2.17163	0.17163	0.17163	-0.00063	0.00000	0.00001	0.00002	0.00000	0.00000
6	2.13403	0.13403	0.13403	-0.10303	-0.00015	-0.00012	0.00021	-0.00002	-0.00002
7	2.13403	0.13403	0.13403	0.00013	0.00015	0.00004	0.00021	0.00003	0.00003
8	2.13403	0.13403	0.13403	0.00010	0.00000	-0.00013	0.00014	-0.00000	-0.00000
9	2.17163	0.17163	0.17163	-0.00314	0.00031	0.00102	0.00108	0.00017	0.00017
10	2.13403	0.13403	0.13403	-0.10303	-0.00015	-0.00012	0.00021	-0.00002	-0.00002
11	2.13403	0.13403	0.13403	-0.00014	0.00003	-0.00023	0.00040	-0.00005	-0.00005
12	2.13403	0.13403	0.13403	0.00037	0.00025	0.00017	0.00011	0.00014	0.00014

SAMPLE PROGRAM SPHERE PAGE 2 1									
W FLOW	Y	CALC VALUES ARE BASED ON THE DEFORMATION DUE TO THE ROTATION OF THE BODY ALONE		VX	VY	VZ	CS-V	V NORMAL (CLEARANCE)	POTENTIAL
PT.		1	2						
1	2.13403	0.17163	0.17163	-0.10102	-0.00031	0.00014	0.00108	-0.00017	-0.00017
2	2.10323	0.15341	0.15341	0.00323	0.00003	0.00023	0.00060	0.00015	0.00060
3	2.10323	0.15345	0.15345	0.00003	0.00003	-0.00027	0.00029	-0.00001	-0.00001
4	2.17163	0.17163	0.17163	-0.00073	-0.00065	-0.00072	0.00121	-0.00019	-0.00019
5	2.17163	0.17163	0.17163	-0.00063	0.00000	0.00001	0.00002	0.00000	0.00000
6	2.13403	0.13403	0.13403	-0.10303	-0.00015	-0.00012	0.00021	-0.00002	-0.00002
7	2.13403	0.13403	0.13403	0.00013	0.00015	0.00004	0.00021	0.00003	0.00003
8	2.13403	0.13403	0.13403	0.00010	0.00000	-0.00013	0.00014	-0.00000	-0.00000
9	2.17163	0.17163	0.17163	-0.00314	0.00031	0.00102	0.00108	0.00017	0.00017
10	2.13403	0.13403	0.13403	-0.00014	0.00003	-0.00023	0.00040	-0.00005	-0.00005
11	2.13403	0.13403	0.13403	0.00037	0.00025	0.00017	0.00011	0.00014	0.00014

RTI P1101-1 FLUID PROBLEM SECTION 00. V. 0.5110 4

CALC 20 NOV 67 SUBMITTING START TIME 10:11:22.1

SAMPLE PROBLEM SPHER

GROUP
TABLED 0

DEFECT POINTS

PT.	X	Y	Z
1	0.00000	0.00000	0.00000
2	1.00000	0.00000	-1.00000
3	2.00000	0.00000	0.00000
4	0.00000	0.00000	2.00000

SAMPLE PROBLEM SPHER

PT.	CALL VALUES ARE BASED ON THE PERTURBATION DUE TO THE ROTATION AT THE POINT ALONE			DEFECT POINTS			POTENTIAL
	X	Y	Z	VX	VY	VZ	
1	0.00000	0.00000	0.00000	0.00001	-0.00002	-0.00002	0.00000
2	1.00000	0.00000	-1.00000	0.00000	0.00000	0.00000	0.00000
3	2.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
4	0.00000	0.00000	2.00000	-0.00001	0.00000	0.00000	0.00000

SAMPLE PROBLEM SPHER

PT.	CALL VALUES ARE BASED ON THE PERTURBATION DUE TO THE ROTATION AT THE POINT ALONE			DEFECT POINTS			POTENTIAL
	X	Y	Z	VX	VY	VZ	
1	0.00000	0.00000	0.00000	-0.00002	0.00003	0.00001	0.00000
2	1.00000	0.00000	-1.00000	0.00000	0.00000	0.00000	0.00000
3	2.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
4	0.00000	0.00000	2.00000	0.00003	0.00000	0.00002	0.00000

TM No. 82-2076A

THEORETICAL CONSIDERATIONS AND USER'S MANUAL FOR A MODIFIED XYZ POTENTIAL
FLOW PROGRAM FOR CALCULATING FIVE DEGREES OF FREEDOM VELOCITY POTENTIALS

Paul J. Lefebvre

Launch and Handling Development Branch

Launcher Systems Department

TM No. 82-2076A

15 November 1982

IR/IED Project No. A43105

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