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by Theodore Katsanis

SUMMARY

A FORTRAN computer program for flow analysis of a radial inflow gas turbine is given. The program obtains a meridional solution on the mean surface between the blades, followed by solutions on hub, mean, and shroud blade-to-blade surfaces, in a single computer run. Suggestions for modifying the program for use with other types of turbomachines are given. Techniques for overcoming convergence problems are discussed.

INTRODUCTION

A method of flow analysis for any turbomachine is summarized in reference 1, with the details being presented in references 2 and 3. Reference 2 gives the method applied to the meridional plane. Reference 3 gives the method for obtaining a blade-to-blade solution, using information obtained from the meridional plane solution. The FORTRAN program for each solution as applied to a radial inflow gas turbine is given in the appropriate reference.

As stated in reference 3, a FORTRAN program has been written which combines both programs. The combined program obtains first the meridional solution, followed by three blade-to-blade solutions (hub, mean, and shroud), in a single computer run. Either the meridional solution or blade-to-blade solution may be obtained separately.

This report presents this FORTRAN program, with sample output for the example rotor of reference 1. Also suggestions are given for modifying the program for other types of turbomachines, and for overcoming convergence problems which may be encountered.

PROGRAM VARIABLES

The variable names used in the combined program are the same as listed in reference 2 and 3 with the addition of the following variables.

THH(I) θ coordinate of mean blade surface at I^{th} quasi-orthogonal along hub

THM(I) θ coordinate of mean blade surface at I^{th} quasi-orthogonal along mean streamline

THS(I)	θ coordinate of mean blade surface at I^{th} quasi-orthogonal along shroud
PION	π/N
TPION	$2\pi/N$
THHI(I)	θ coordinate of suction surface of complete blade at I^{th} quasi-orthogonal along hub
THMI(I)	θ coordinate of suction surface of complete blade at I^{th} quasi-orthongonal along mean blade-to-blade stream surface
THSI(I)	θ coordinate of suction surface of complete blade at I^{th} quasi-orthogonal along shroud
THHKH(I)	θ coordinate of pressure surface of splitter blade at I^{th} quasi-orthogonal along hub
THMKH(I)	θ coordinate of pressure surface of splitter blade at I^{th} quasi-orthogonal along mean blade-to-blade stream surface
THSKH(I)	θ coordinate of pressure surface of splitter blade at I^{th} quasi-orthogonal along shroud
THHKP(I)	θ coordinate of suction surface of splitter blade at I^{th} quasi-orthogonal along hub
THMKP(I)	θ coordinate of suction surface of splitter blade at I^{th} quasi-orthogonal along mean blade-to-blade stream surface
THSKP(I)	θ coordinate of suction surface of splitter blade at I^{th} quasi-orthogonal along shroud
THHKMX(I)	θ coordinate of pressure surface of complete blade at I^{th} quasi-orthogonal along hub
THMKMX(I)	θ coordinate of pressure surface of complete blade at I^{th} quasi-orthogonal along mean blade-to-blade stream surface
THSKMX(I)	θ coordinate of pressure surface of complete blade at I^{th} quasi-orthogonal along shroud

MODIFICATIONS REQUIRED FOR OTHER APPLICATIONS

The program as written can be used for a radial inflow gas turbine. It should be emphasized that the listing of the combined program is being published as a guide to the technique used in programming the quasi-orthogonal method of flow analysis. If it is desired to obtain a program for analysing any type of turbomachine other than a radial inflow gas turbine, several modifications as indicated below will have to be made to the program. This will require a reasonable understanding of the program and the equations involved. With this understanding, the required modifications can be easily made. Modifications which are necessary for some particular cases are listed below:

(1) Changes required for a compressor are:

(a) Rotation of coordinates for use in calculating spline fit curve for the meridional streamlines. It is assumed that the inlet is to the left with the positive direction to the right, and that the quasi-orthogonals are numbered starting with 1 at the inlet. The coordinates for the streamlines must be rotated 45° in the direction opposite to that in the present program. The modifications needed are to statements for calculating AB(I) and AC(I) near statements 160 and 390, and for calculating AL(I,K) four statements after statement 160.

(b) The sign of CEF as calculated just before statement 150 must be reversed.

(2) Changes required for a pump or liquid turbine.
Statements involving temperature or density must be modified to eliminate temperature, and to allow for constant density.

(3) Changes required for axial flow machines.
Statements for rotating streamline coordinates for use in calculating the spline fit curve for the meridional streamlines should be modified to eliminate this rotation. The statements involved are the same as those mentioned under 1a above.

CONVERGENCE

It may be found that with some geometries there is a convergence problem. This is helped by using as few and as evenly spaced quasi-orthogonals as possible, consistent with a reasonable accuracy. The number of streamlines used does not appreciably affect the number of iterations. Of course, it does affect the computer time required per iteration. Another factor which helps convergence is to reduce the streamline correction factor, CORFAC, (see ref. (2), p. 23 and fig. 5). Of course, this reduces the rate of convergence, but may result in convergence when a solution could not be obtained otherwise.

However, in some cases when the initial streamline estimate is poor it may be necessary to make the streamline correction factor, CORFAC, so small that the convergence rate is too slow. One way of improving the initial streamline estimate is to use a large streamline correction for the first iteration, say CORFAC = 1. This will bring the streamlines fairly close to the correct position, but will result in rather uneven streamlines. If the streamlines are then smoothed sufficiently, the convergence will be generally much better than when working from the original position. It has not been found helpful to make this large streamline correction more than once. There are several mathematical techniques for smoothing (ref. 4).

Another problem that may be encountered with compressible fluids is that calculations may indicate choking weight flow less than the desired weight flow in the early interations. This usually leads to a problem in convergence. However, this may be overcome by obtaining a solution based on a slightly lower weight flow, followed by a solution based on the desired weight flow. Possibly more than one increment of weight flow increase will be required to increase the flow up to the desired weight, or perhaps the desired weight flow will prove to be actually in excess of the choking weight flow.

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PROGRAM LISTING

```
$IBFTC FIXED    DECK
      SUBROUTINE FIXED(HUB,MEAN,SHROUD)
C  CALCULATION OF VELOCITY AND PRESSURE DISTRIBUTION IN A RADIAL FLOW
C            TURBO MACHINE
C
C
      COMMON SRW,KMX ,MX,WT,XN,GAM,AR,TYPE,BCDP,TEMP,ALM,RHO,TOLER,
     1   PLOSS,NPRT,ITER1,BETIN,WTOLER,THH1,THHKH,THHKP,THHKMX,THM1,
     2   THMKH,THMKP,THMKMX,THS1,THSKH,THSKP,THSKMX,Z ,R ,AB,AC,AD,
     3   RUNO,MXBL,PION,W,BETAI,WTR,CURV
      DIMENSION AL(21,21),BETA(21,21),CAL(21,21),CBETA(21,21),
     1CURV(21,22),DN(21,21),PRS(21,21),R(21,21),Z(21,21),SM(21,21),
     2SA(21,21),SB(21,21),SC(21,21),SD(21,21),SAL(21,21),SBETA(21,21),
     3TN(21,21),TT(21,21),WA(21,21),WTR(21,21)
      DIMENSION AB(22),AC(22),AD(22),BA(21),DELBTA(21),DRDM(21),
     1DTDR(21),DTDZ(21),DWMDM(21),DWTDM(21),RH(21),RS(21),ZH(21),ZS(21),
     2THTA(21),WTHL(21),XR(21),XT(21),XZ(21),BETAI(3),AA(3)
      DIMENSION THH(21),THM(21),THS(21),THH1(21),THHKH(21),THHKP(21),
     1  THHKMX(21),THM1(21),THMKH(21),THMKP(21),THMKMX(21),THS1(21),
     2 THSKH(21),THSKP(21),THSKMX(21)
      INTEGER RUNO,TYPE,BCDP,SRW,HUB,SHROUD
      RUNO=0
   10 READ  (5,1010)MX,KMX,MR,MZ,W,WT,XN,GAM,AR

      ITNO = 1
      RUNO=RUNO+1
      WRITE (6,1020) RUNO
      WRITE (6,1010)MX,KMX,MR,MZ,W,WT,XN,GAM,AR
      READ (5,1010)TYPE,BCDP,SRW,MXBL,TEMP,ALM,RHO,TOLER,PLOSS,WTOLER

      WRITE(6,1010)TYPE,BCDP,SRW,MXBL,TEMP,ALM,RHO,TOLER,PLOSS,WTOLER
      READ (5,1010)MTHTA,NPRT,ITER,NULL,SFACT,ZSPLIT,BETIN,CORFAC

      WRITE(6,1010)MTHTA,NPRT,ITER,NULL,SFACT,ZSPLIT,BETIN,CORFAC
      ITER1 = ITER
      READ(5,1030)(ZS(I),I=1,MX)
      WRITE(6,1030)(ZS(I),I=1,MX)
      READ(5,1030)(ZH(I),I=1,MX)
      WRITE(6,1030)(ZH(I),I=1,MX)
      READ(5,1030)(RS(I),I=1,MX)
      WRITE(6,1030)(RS(I),I=1,MX)
      READ(5,1030)(RH(I),I=1,MX)
      WRITE(6,1030)(RH(I),I=1,MX)
      DO 20 I=1,MX
      ZS(I)=ZS(I)/12.
      ZH(I)=ZH(I)/12.
      RS(I)=RS(I)/12.
   20 RH(I)=RH(I)/12.
      IF(TYPE.NE.0) GO TO 40
      WA(1,1) = WT/RHO/(ZS(1)-ZH(1))/3.14/(RS(1)+RH(1))
      DO 30 I=1,MX
      DN(I,KMX)=SQRT((ZS(I)-ZH(I))**2+(RS(I)-RH(I))**2)
      DO 30 K=1,KMX
      DN(I,K)=FLOAT(K-1)/FLOAT(KMX-1)*DN(I,KMX)
      WA(I,K)=WA(1,1)
      Z(I,K)=DN(I,K)/DN(I,KMX)*(ZS(I)-ZH(I))+ZH(I)
```

```
   30 R(I,K)=DN(I,K)/DN(I,KMX)*(RS(I)-RH(I))+RH(I)
      GO TO 50
   40 IF(TYPE.NE.1) GO TO 145
      CALL BCREAD(DN(1,1),DN(21,21))
      CALL BCREAD (WA(1,1),WA(21,21))
      CALL BCREAD (Z(1,1),Z(21,21))
      CALL BCREAD (R(1,1),R(21,21))
      WRITE (6,1040)
   50 READ  (5,1030)(THTA(I),I=1,MTHTA)
      WRITE (6,1030)(THTA(I),I=1,MTHTA)
      READ (5,1030)(XT(I),I=1,MTHTA)
      WRITE(6,1030)(XT(I),I=1,MTHTA)
      DO 60 K=1,MR
      READ  (5,1030)(TN(I,K),I=1,MZ)
   60 WRITE (6,1030)(TN(I,K),I=1,MZ)

      READ  (5,1030)(XZ(I),I=1,MZ)
      WRITE (6,1030)(XZ(I),I=1,MZ)
      READ  (5,1030)(XR(I),I=1,MR)
      WRITE (6,1030)(XR(I),I=1,MR)
C
C     END OF INPUT STATEMENTS
C
C     SCALING-CHANGE INCHES TO FEET AND PSI TO LB/SQ FT, INITIALIZE, CALCULATE
C        CONSTANTS
C
   70 DO 90 K=1,MR
      DO 80 I=1,MZ
   80 TN(I,K) = TN(I,K)/12.
   90 XR(K) = XR(K)/12.
      DO 100 I=1,MZ
  100 XZ(I) = XZ(I)/12.
      DO 110 K=1,KMX
  110 SM(1,K)=0.
      BA(1)=0.
      DO 120 K=2,KMX
  120 BA(K) = FLOAT(K-1)*WT/FLOAT(KMX -1)
      DO 130 I=1,MX
  130 DN(I,1)=0.
      DO 140 I=1,MTHTA
  140 XT(I)=XT(I)/12.
      ROOT = SQRT(2.0)
  145 CONTINUE
      TOLER =TOLER/12.
      ZSPLIT = ZSPLIT/12.
      PLOSS=PLOSS*144.
      CI = SQRT(GAM*AR*TEMP)
      WRITE (6,1050) CI
      KMXM1 = KMX-1
      CP=AR*GAM/(GAM-1.)
      EXPON = 1./(GAM-1.)
      BETIN =  BETIN/57.29577
      ZINLET = (ZS(1)+ZH(1))/2.
      RINLET = (RS(1)+RH(1))/2.
      CALL LININT (ZINLET,RINLET,XZ,XR,TN,21,21,T)
      RB = RINLET*EXP(-.71*(2.*3.14159/(XN*SFACT)-T/RINLET))
```

```
      WRITE (6,1030) RB
      CEF = -SIN(BETIN)/COS(BETIN)/RINLET/(RINLET-RB)**2
      ERROR=100000.
C
C  BEGINNING OF LOOP FOR ITERATIONS
C
  150 IF(ITER.EQ.0) WRITE (6,1060) ITNO
      IF(ITER.EQ.0) WRITE (6,1070)
      ERROR1=ERROR
      ERROR=0.
C
C  START CALCULATION OF PARAMETERS
C
      DO 230 K=1,KMX
      DO 160 I=1,MX
      AB(I) = (Z(I,K)-R(I,K))/ROOT
  160 AC(I)=(Z(I,K)+R(I,K))/ROOT
      CALL SPLINE (AB,AC,MX,AL(1,K),CURV(1,K))
      DO 170 I=1,MX
      CURV(I,K)=CURV(I,K)/(1.+AL(I,K)**2)**1.5
      AL(I,K) = ATAN(AL(I,K))-.785398
      CAL(I,K) = COS(AL(I,K))
  170 SAL(I,K) = SIN(AL(I,K))
      DO 180 I=2,MX
  180 SM(I,K) = SM(I-1,K)+SQRT((Z(I,K)-Z(I-1,K))**2+(R(I,K)-R(I-1,K))**
     1  2)
  190 CALL SPLDER(XT(1),THTA(1),MTHTA,Z(1,K),MX,DTDZ(1))
      DO 220 I=1,MX
      T = 0.
      IF(I.LE.MXBL) CALL LININT(Z(I,K),R(I,K),XZ,XR,TN,21,21,T)
      IF(R(I,K).LE.RB)GO TO 200
      DTDR(I)=CEF*(R(I,K)-RB)**2
      GO TO 210
  200 DTDR(I)=0.
  210 TQ=R(I,K)*DTDR(I)
      TP = R(I,K)*DTDZ(I)
      TT(I,K)=T*SQRT(1.+TP*TP)
      BETA(I,K)=ATAN(TP*CAL(I,K)+TQ*SAL(I,K))
      SBETA(I,K) = SIN(BETA(I,K))
      CBETA(I,K) = COS(BETA(I,K))
      SA(I,K)=CBETA(I,K)**2*CAL(I,K)*CURV(I,K)-SBETA(I,K)**2/R(I,K)+
     1SAL(I,K)*CBETA(I,K)*SBETA(I,K)*DTDR(I)
      SC(I,K)=-SAL(I,K)*CBETA(I,K)**2*CURV(I,K)+SAL(I,K)*CBETA(I,K)
     1*SBETA(I,K)*DTDZ(I)
      AB(I)=WA(I,K)*CBETA(I,K)
  220 AC(I)=WA(I,K)*SBETA(I,K)
      CALL SPLINE(SM(1,K),AB,MX,DWMDM,AD)
      CALL SPLINE(SM(1,K),AC,MX,DWTDM,AD)
      IF((ITER.LE.0).AND.(MOD(K-1,NPRT).EQ.0)) WRITE (6,1080) K
      DO 230 I=1,MX
      SB(I,K)=SAL(I,K)*CBETA(I,K)*DWMDM(I)-2.*W*SBETA(I,K)+DTDR(I)*
     1R(I,K)*CBETA(I,K)*(DWTDM(I)+2.*W*SAL(I,K))
      SD(I,K)=CAL(I,K)*CBETA(I,K)*DWMDM(I)+DTDZ(I)*
     1R(I,K)*CBETA(I,K)*(DWTDM(I)+2.*W*SAL(I,K))
      IF((ITER.GT.0).OR.(MOD(K-1,NPRT).NE.0))GO TO 230
      A=  AL(I,K)*57.29577
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      B=  SM(I,K)*12.
      E=  TT(I,K)*12.
      G=BETA(I,K)*57.29577
      WRITE (6,1090) A,CURV(I,K),B,G,E,  SA(I,K),SB(I,K),SC(I,K),SD(I,K)
  230 CONTINUE
C
C  END OF LOOP - PARAMETER CALCULATION
C  CALCULATE BLADE SURFACE VELOCITIES (AFTER CONVERGENCE)
C
      IF(ITER.NE.0) GO TO 260
      DO 250 K=1,KMX
      CALL SPLINE (SM(1,K),TT(1,K),MX,DELBTA,AC)
      A=XN
      DO 240 I=1,MX
  240 AB(I)=(R(I,K)*W+WA(I,K)*SBETA(I,K))*(6.283185*R(I,K)/ A-TT(I,K))
      CALL SPLINE (SM(1,K),AB,MX,DRDM,AC)
      IF (SFACT.LE. 1.0) GO TO 245
      A = SFACT*XN
      DO 244 I=1,MX
  244 AB(I)=(R(I,K)*W+WA(I,K)*SBETA(I,K))*(6.283185*R(I,K)/ A-TT(I,K))
      CALL SPLINE (SM(1,K),AB,MX,AD   ,AC)
  245 DO 250       I=1,MX
      BETAD = BETA(I,K)-DELBTA(I)/2.
      BETAT = BETAD+DELBTA(I)
      COSBD = COS(BETAD)
      COSBT = COS(BETAT)
      IF(Z(I,K).LT.ZSPLIT) DRDM(I) = AD(I)
      WTR(I,K)=COSBD*COSBT/(COSBD+COSBT)*(2.*WA(I,K)/COSBD+R(I,K)*W*
     1(BETAD-BETAT)/CBETA(I,K)**2+DRDM(I))
  250 CONTINUE
C
C       END  OF  BLADE  SURFACE  VELOCITY  CALCULATIONS
C  START CALCULATION OF WEIGHT FLOW VS. DISTANCE FROM HUB
C
  260 DO 370 I=1,MX
      IND=1
      DO 270 K=1,KMX
  270 AC(K)=DN(I,K)
      GO TO 290
  280 WA(I,1)=.5*WA(I,1)
  290 DO 300 K=2,KMX
      J=K-1
      HR=R(I,K)-R(I,J)
      HZ=Z(I,K)-Z(I,J)
      WAS=WA(I,J)*(1.+SA(I,J)*HR+SC(I,J)*HZ)+SB(I,J)*HR+SD(I,J)*HZ
      WASS=WA(I,J)+WAS*(SA(I,K)*HR+SC(I,K)*HZ)+SB(I,K)*HR+SD(I,K)*HZ
  300 WA(I,K)=(WAS+WASS)/2.
  310 DO 340 K=1,KMX
      T1P= 1.-(WA(I,K)**2+2.*W*ALM-(W*R(I,K))**2)/2./CP/TEMP
      IF(T1P.LT..0) GO TO 280
      TPP1P= 1.-           (2.*W*ALM-(W*R(I,K))**2)/2./CP/TEMP
      DENSTY=T1P**EXPON*RHO-(T1P/TPP1P)**EXPON*PLOSS/AR/TPP1P/TEMP
     1 *32.17*SM(I,K)/SM(MXBL,K)
      PR(I,K)=DENSTY*AR*T1P*TEMP/32.17/144.
      IF(ZS(I).LE.ZH(I)) GO TO 320
      PSI=ATAN((RS(I)-RH(I))/(ZS(I)-ZH(I)))-1.5708
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      GO TO 330
  320 PSI=ATAN((ZH(I)-ZS(I))/(RS(I)-RH(I)))
  330 WTHRU=WA(I,K)*CBETA(I,K)*COS(PSI-AL(I,K))
      A=XN
      IF(Z(I,K).LT.ZSPLIT) A=SFACT*XN
      C = 6.283186*R(I,K)-A*TT(I,K)
  340 AD(K)=DENSTY*WTHRU*C
      CALL  INTGRL(AC(1),AD(1),KMX,WTFL(1))
      IF (ABS(WT-WTFL(KMX)).LE.WTOLER) GO TO 350
      CALL  CONTIN (WA(I,1),WTFL(KMX),IND,I,WT)
      IF (IND.NE.6) GO TO 290
  350 CALL  SPLINT (WTFL,AC,KMX,BA,KMX,AB)
      DO 360 K=1,KMX
      DELTA=ABS(AB(K)-DN(I,K))
      DN(I,K)=(1.-CORFAC)*DN(I,K)+CORFAC*AB(K)
  360 IF(DELTA.GT.ERROR)ERROR=DELTA
  370 CONTINUE
C
C  END OF LOOP -  WEIGHT FLOW CALCULATION
C  CALCULATE STREAMLINE COORDINATES FOR NEXT ITERATION
C
      DO 380 K=2,KMXM1
      DO 380 I=1,MX
      Z(I,K)=DN(I,K)/DN(I,KMX)*(ZS(I)-ZH(I))+ZH(I)
  380 R(I,K)=DN(I,K)/DN(I,KMX)*(RS(I)-RH(I))+RH(I)
      IF((ERROR.GE.ERROR1).OR.(ERROR.LE.TOLER)) ITER=ITER-1
      IF(ITER.GT.0) GO TO 410
      WRITE (6,1100)
      DO 400 K=1,KMX,NPRT
      WRITE (6,1080) K
      DO 390 I=1,MX
      AB(I)=(Z(I,K)-R(I,K))/ROOT
  390 AC(I)=(Z(I,K)+R(I,K))/ROOT
      CALL  SPLINE (AB,AC,MX,AD,CURV(1,K))
      DO 400 I=1,MX
      CURV(I,K)=CURV(I,K)/(1.+AD(I)   **2)**1.5
      A=DN(I,K)*12.
      B= Z(I,K)*12.
      D= R(I,K)*12.
  400 WRITE (6,1110) A,B,D,WA(I,K),PRS(I,K),WTR(I,K),CURV(I,K)
      WRITE (6,1130)
  410 A=ERROR*12.
      WRITE (6,1120) ITNO,A
      ITNO=ITNO+1
      IF (ITER.GE.0) GO TO 150
      WRITE (6,1140)
      K = (KMX+1)/2
      DO 440 I=1,MX
      IF(ZS(I).LE.ZH(I)) GO TO 420
      PSI = ATAN((RS(I)-RH(I))/(ZS(I)-ZH(I)))-1.5708
      GO TO 430
  420 PSI = ATAN((ZH(I)-ZS(I))/(RS(I)-RH(I)))
  430 AB(I) = (DN(I,2  )-DN(I,1  ))    *COS(PSI-AL(I,2))
      AC(I) = (DN(I,K+1)-DN(I,K-1))/2.*COS(PSI-AL(I,K))
      AD(I) = (DN(I,KMX)-DN(I,KMXM1))    *COS(PSI-AL(I,KMX-1))
      A = AB(I)*12.
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      B = AC(I)*12.
      D = AD(I)*12.
  440 WRITE (6,1110) A,B,D
      CALL SPLINT (XT,THTA,MTHTA,Z(1,1),MX,THH)
      CALL SPLINT (XT,THTA,MTHTA,Z(1,2),MX,THH)
      CALL SPLINT (XT,THTA,MTHTA,Z(1,K),MX,THM)
      CALL SPLINT (XT,THTA,MTHTA,Z(1,KMX  ),MX,THS)
      PION = 3.1415927/XN
      TPION = PION*SFACT
      WRITE (6,1150)
      DO 450 I=1,MX
      THH1(I)  = THH(I)-TPION+TT(I,1)/2./R(I,1)
      THM1(I)  = THM(I)-TPION+TT(I,K)/2./R(I,K)
      THS1(I)  = THS(I)-TPION+TT(I,KMX  )/2./R(I,KMX  )
      THHKH(I) = THH(I)- PION-TT(I,1)/2./R(I,1)
      THMKH(I) = THM(I)- PION-TT(I,K)/2./R(I,K)
      THSKH(I) = THS(I)- PION-TT(I,KMX  )/2./R(I,KMX  )
      THHKP(I) = THH(I)- PION+TT(I,1)/2./R(I,1)
      THMKP(I) = THM(I)- PION+TT(I,K)/2./R(I,K)
      THSKP(I) = THS(I)- PION+TT(I,KMX  )/2./R(I,KMX)
      THHKMX(I)= THH(I)-TT(I,1  )/2./R(I,1  )
      THMKMX(I)= THM(I)-TT(I,K  )/2./R(I,K  )
      THSKMX(I)= THS(I)-TT(I,KMX  )/2./R(I,KMX)
  450 WRITE(6,1160) THH1(I),THHKH(I),THHKP(I),THHKMX(I),THM1(I),THMKH(I)
     1,THMKP(I),THMKMX(I),THS1(I),THSKH(I),THSKP(I),THSKMX(I)
      DO 460 J=1,3
      I=1
      K=1
      IF(J.EQ.2) K=(KMX+1)/2
      IF(J.EQ.3) K=KMX
      T1P= 1.-(WA(I,K)**2+2.*W*ALM-(W*R(I,K))**2)/2./CP/TEMP
      DENSTY = T1P**EXPON*RHO
      C = 6.283186*R(I,K)-XN*TT(I,K)*SFACT
      WIDTH = AB
      IF(J.EQ.2) WIDTH = AC
      IF(J.EQ.3) WIDTH = AD
      WM = BA(2)/DENSTY/C/WIDTH
      WTHETA = ALM/R(I,K)-W*R(I,K)
      BETAI(J) = ATAN(WTHETA/WM)
      AA(J) = BETAI(J)*57.29577
  460 CONTINUE
      WRITE (6,1170) AA
      IF(BCDP.EQ.2) CALL BCDUMP(SRW,BETAI(3))
      IF(BCDP.NE.1) RETURN
      CALL BCDUMP (DN(1,1),DN(21,21))
      CALL BCDUMP (WA(1,1),WA(21,21))
      CALL BCDUMP ( Z(1,1), Z(21,21))
      CALL BCDUMP ( R(1,1), R(21,21))
      RETURN
 1010 FORMAT (4I5,6F10.4)
 1020 FORMAT (8H1RUN NO.I3,10X,25HINPUT DATA CARD LISTING    )
 1030 FORMAT (7F10.4)
 1040 FORMAT (10X24HBCD CARDS FOR DN,WA,Z,R  )
 1050 FORMAT (36HK     STAG. SPEED OF SOUND AT INLET = ,F9.2)
 1060 FORMAT (///5X13HITERATION NO.I3)
 1070 FORMAT (1H 6X5HALPHA9X5HRC    9X5HSM    9X5HBETA 9X5HTT    9X5H[illegible]    9
```

```
   1X5HSB    9X5HSC    9X5HSD    )
1080 FORMAT (2X10HSTREAMLINEI3)
1090 FORMAT (9F14.6)
1100 FORMAT (1HL9X5HDN    15X5HZ     15X5HR     15X5HWA    15X5HPRESS14X3HW
   1TR14X3HRC )
1110 FORMAT (6F19.6,F18.6)
1120 FORMAT (18H      ITERATION NO. I3,10X,24HMAX. STREAMLINE CHANGE = ,
   1F10.6)
1130 FORMAT (1HJ)
1140 FORMAT (34H1  STREAMLINE SPACING ALONG NORMAL//10X5HHUB  14X5HMEAN
   1 14X6HSHROUD)
1150 FORMAT (1H1,56X,17HBLADE COORDINATES/19X,6HHUB   ,38X,6HMEAN  ,
   1  38X,6HSHROUD/3(5X,1H1,10X,4HKHMX, 7X,4HKMPI,7X,3HKMX,3X))
1160 FORMAT (12F11.4)
1170 FORMAT (///1HL,10X,20HINLET ANGLES  -  HUB,F7.2,8H,   MEANF7.2,10H
   1,   SHROUDF7.2)
    END
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```
$IBFTC SPLBLD  DECK
      SUBROUTINE SPLBLD(HUB,MEAN,SHROUD,MOB)
      COMMON SRW,KMXF,MX,WT,XN,GAM,AR,TYPE,BCDP,TEMP,ALM,RHO,TOLER,
     1   PLOSS,NPRT,ITER1,BETIN,WTOLER,THH1,THHKH,THHKP,THHKMX,THM1,
     2   THMKH,THMKP,THMKMX,THS1,THSKH,THSKP,THSKMX,Z1,R1,AB,AD,AE,
     3   RUNO,MXBL,PION,W,BETAI,DTDM,CURV
      DIMENSION Z(21),R(21),DN(21),SM(21),BA(22),AB(22),AC(22),AL(21),
     1RC(21),CAL(21),SAL(21),PRS(22),WTFL(22),WTHETA(21,22),DWDM(21,22),
     2THETA(21,22),WA(21,22),BETA(21,22),SBETA(21,22),CBETA(21,22),
     3SA(21,22),SB(21,22),CURV(21,22),DTDM(21,22)
      DIMENSION Z1(21,21),R1(21,21),     THH1(21),THHKH(21),THHKP(21),
     1  THHKMX(21),THM1(21),THMKH(21),THMKP(21),THMKMX(21),THS1(21),
     2 THSKH(21),THSKP(21),THSKMX(21)
      DIMENSION THAL(23,4),SMAL(23),AD(22),AE(22),DENSTY(22),BETAI(3)
      INTEGER RUNO,TYPE,BCDP,SRW,RR,HUB,SHROUD
      LOGICAL PRINT
      IF(MOB.EQ.2) GO TO 10
      RUNO=0
      IF(MOB.EQ.4) GO TO 10
    5 READ  (5,1010)MX,KMX,MXSP,RR,W,WT,XN,GAM,AR

      ITNO = 1
      RUNO=RUNO+1
      WRITE (6,1020) RUNO
      WRITE (6,1010)MX,KMX,MXSP,RR,W,WT,XN,GAM,AR
      READ (5,1010)TYPE,BCDP,SRW,MXBL,TEMP,ALM,RHO,TOLER,PLOSS,DWDM1

      WRITE(6,1010)TYPE,BCDP,SRW,MXBL,TEMP,ALM,RHO,TOLER,PLOSS,DWDM1
      PLOSS=PLOSS*144.
      READ (5,1010) NULL,NPRT,ITER,NULL,BETIN,WTOLER,CORFAC

      WRITE(6,1010) NULL,NPRT,ITER,NULL,BETIN,WTOLER,CORFAC
      BETIN =  BETIN/57.29577
      KHMX = KMX/2
      KHP1 = KHMX+1
      KHP2 = KHMX+2
      READ (5,1030) (THETA(I,1),I=1,MX)
      WRITE(6,1030) (THETA(I,1),I=1,MX)
      READ (5,1030)(THETA(I,KMX),I=1,MX)
      WRITE(6,1030)(THETA(I,KMX),I=1,MX)
      READ (5,1030) (THETA(I,KHMX),I=1,MXSP)
      WRITE(6,1030) (THETA(I,KHMX),I=1,MXSP)
      READ (5,1030) (THETA(I,KHP1),I=1,MXSP)
      WRITE(6,1030) (THETA(I,KHP1),I=1,MXSP)
      IF(RR.EQ.1) GO TO 90
      READ (5,1030)(Z(I),I=1,MX)
      WRITE(6,1030)(Z(I),I=1,MX)
      READ (5,1030)(R(I),I=1,MX)
      WRITE(6,1030)(R(I),I=1,MX)
      READ (5,1030)(DN(I),I=1,MX)
      WRITE(6,1030)(DN(I),I=1,MX)
      DO 9   I=1,MX
      Z(I)=Z(I)/12.
      R(I)=R(I)/12.
    9 DN(I)=DN(I)/12.
      GO TO 21
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```
10 IF(MOB.EQ.4) CALL BCREAD(SRW,BETAI(3))
   MX = MX+1
   MOB = 2
   WT = WT/FLOAT(KMXF-1)
   WTOLER = WTOLER/FLOAT(KMXF-1)
   MXBL = MXBL+1
11 READ (5,1010)KMX,MXSP,RR   ,TYPE,CORFAC,TOLER,THIKMX

   RUNO = RUNO+1
   IF((HUB.EQ.0).AND.(MEAN.EQ.0).AND.(SHROUD.EQ.0)) RETURN
   WRITE (6,1020) RUNO
   WRITE(6,1010)KMX,MXSP,RR   ,TYPE,CORFAC,TOLER,THIKMX
   ITNO = 1
   ITER = ITER1
   KHMX = KMX/2
   KHP1 = KHMX+1
   KHP2 = KHMX+2
   READ (5,1030) Z(1),R(1),DN(1)
   WRITE(6,1030) Z(1),R(1),DN(1)
   Z(1) = Z(1)/12.
   R(1) = R(1)/12.
   DN(1) = DN(1)/12.
   DWDM1 = W+ALM/R(1)**2
   IF(HUB.EQ.0) GO TO 14
   HUB = 0
   DO 12 I=2,MX
   J = I-1
   THETA(I,1) = THH1(J)
   THETA(I,KMX) = THHKMX(J)
   Z(I) = Z1(J,1)
   R(I) = R1(J,1)
12 DN(I) = AB(J)
   DO 13 I=2,MXSP
   J = I-1
   THETA(I,KHMX) = THHKH(J)
13 THETA(I,KHP1) = THHKP(J)
   BETIN = BETAI(1)
   GO TO 20
14 IF(MEAN.EQ.0) GO TO 17
   MEAN = 0
   K = (KMXF+1)/2
   DO 15 I=2,MX
   J = I-1
   THETA(I,1) = THM1(J)
   THETA(I,KMX) = THMKMX(J)
   Z(I) = Z1(J,K)
   R(I) = R1(J,K)
15 DN(I) = AD(J)
   DO 16 I=2,MXSP
   J = I-1
   THETA(I,KHMX) = THMKH(J)
16 THETA(I,KHP1) = THMKP(J)
   BETIN = BETAI(2)
   GO TO 20
17 IF(SHROUD.EQ.0) RETURN
   SHROUD = 0
```

```
      DO 18 I=2,MX
      J = I-1
      THETA(I,1) = THS1(J)
      THETA(I,KMX) = THSKMX(J)
      Z(I) = Z1(J,KMXF)
      R(I) = R1(J,KMXF)
   18 DN(I) = AE(J)
      DO 19 I=2,MXSP
      J = I-1
      THETA(I,KHMX) = THSKH(J)
   19 THETA(I,KHP1) = THSKP(J)
      BETIN = BETAI(3)
   20 TANBTO = SIN(BETIN)/COS(BETIN)
      TANBT = TANBTO*(ALM-W*R(1)**2)/(ALM-W*R(2)**2)*DN(1)/DN(2)
      DTDM1 = TANBT/R(1)
      DELTHT = TANBTO/(W*R(2)**2-ALM)*(ALM*ALOG(R(1)/R(2))+W/2.*(R(2)**2
     1   -R(1)**2))*(DN(1)+DN(2))/2./DN(2)
      THETA(1,KMX) = THIKMX*DELTHT
      THETA(1,KHP1) = THETA(1,KMX)-PION
      THETA(1,KHMX) = THETA(1,KHP1)
      THETA(1,1) = THETA(1,KHMX)-PION
      NULL = 0
      WRITE (6,1010)MX,KMX,MXSP,RR,W,WT,XN,GAM,AR
      PLOSS1 = PLOSS/144.
      WRITE(6,1010)TYPE,BCDP,SRW,MXBL,TEMP,ALM,RHO,TOLER,PLOSS1,DWDM1
      BETIN1 = BETIN*57.29577
      WRITE(6,1010) NULL,NPRT,ITER,NULL,BETIN1,WTOLER,CORFAC
      WRITE(6,1030) (THETA(I,1),I=1,MX)
      WRITE(6,1030)(THETA(I,KMX),I=1,MX)
      WRITE(6,1030) (THETA(I,KHMX),I=1,MXSP)
      WRITE(6,1030) (THETA(I,KHP1),I=1,MXSP)
      WRITE(6,1030)(Z(I),I=1,MX)
      WRITE(6,1030)(R(I),I=1,MX)
      WRITE(6,1030)(DN(I),I=1,MX)
   21 IF(TYPE.EQ.1 ) GO TO 30
      WA(1,1)=WT/RHO/DN(1)/R(1)/XN/(THETA(1,KMX)-THETA(1,1))
      DO 23 I=1,MX
      IF((I.EQ.1).OR.(I.GT.MXSP)) THETA(I,KHMX) = (THETA(I,KMX)+THETA
     1 (I,1))/2.
      IF((I.EQ.1).OR.(I.GT.MXSP)) THETA(I,KHP1) = THETA(I,KHMX)
      DO 22 K=1,KHMX
      THETA(I,K) = FLOAT(K-1)/FLOAT(KHMX-1)*(THETA(I,KHMX)-THETA(I,1))
     1  + THETA(I,1)
   22 WA(I,K)=WA(1,1)
      DO 23 K=KHP1,KMX
      THETA(I,K) = FLOAT(K-KHP1)/FLOAT(KMX-KHP1)*(THETA(I,KMX)-
     1   THETA(I,KHP1))+THETA(I,KHP1)
   23 WA(I,K) = WA(1,1)
      READ (5,1010) NEXT
      WRITE(6,1010) NEXT
   24 IF(NEXT.EQ.0) GO TO 25
      READ (5,1021)I1,K1,THETA(I1,K1),I2,K2,THETA(I2,K2),I3,K3,THETA(I3,
     1   K3),I4,K4,THETA(I4,K4),I5,K5,THETA(I5,K5),NEXT


      WRITE(6,1021)I1,K1,THETA(I1,K1),I2,K2,THETA(I2,K2),I3,K3,THETA(I3,
     1   K3),I4,K4,THETA(I4,K4),I5,K5,THETA(I5,K5),NEXT
```

```
      GO TO 24
C
C       END OF INPUT STATEMENTS
C
   25 WRITE (6,1023)
      DO 26 K=1,KMX
   26 WRITE (6,1030) (THETA(I,K),I=1,MX)

      GO TO 45
   30 CALL BCREAD (THETA(1,1),THETA(21,21))
      CALL BCREAD (WA    (1,1),    WA(21,21))
      WRITE (6,1040)
   45 CONTINUE
      CP=AR*GAM/(GAM-1.)
      CI = SQRT(GAM*AR*TEMP)
      WRITE (6,1050) CI
      KMXM1 = KMX-1
      MXP2 = MX+2
      MXSP1 = MXSP+1
      WTH = WT/2.
      EXPON = 1./(GAM-1.)
      DTDM1=SIN(BETIN)/COS(BETIN)/R(1)
      IF(MJB.EQ.2) DTDM1 = TANBT/R(1)
      ROOT=SQRT(2.)
      SM(1) = -SQRT((Z(2)-Z(1))**2+(R(2)-R(1))**2)
      DO 60 K=1,KMXM1
   60 BA(K)=FLOAT(K-1)*WT/FLOAT(KMXM1-1)
C
C       CALCULATE ALPHA AND SM
C
      DO 70 I=1,MX
      AB(I)=(Z(I)-R(I))/ROOT
   70 AC(I)=(Z(I)+R(I))/ROOT
      CALL SPLINE(AB,AC,MX,AL,RC)
      DO 80 I=1,MX
      AL(I)=ATAN(AL(I))-.785398
      CAL(I)=COS(AL(I))
   80 SAL(I)=SIN(AL(I))
      DO 85 I=2,MX
      J=I-1
   85 SM(I)=SM(J)+SQRT((Z(I)-Z(J))**2+(R(I)-R(J))**2)
      SMAL(3) = SM(2)+.1*(SM(3)-SM(2))
      SMAL(4) = SM(2)+.5*(SM(3)-SM(2))
   90 ERROR = 1000.
C
C       CALCULATE BETA ON BLADE SURFACES
C    BEGINNING OF LOOP FOR ITERATIONS
C
   91 DO 97 J=1,4
      K = 1
      IF(J.EQ.2) K=KHMX
      IF(J.EQ.3) K=KHP1
      IF(J.EQ.4) K=KMX
      DO 93 I=1,2
      THAL(I,J) = THETA(I,K)
   93 SMAL(I) = SM(I)
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      DO 94 I=3,4
   94 THAL(I,J) = THETA(2,K)+(SMAL(I)-SM(2))/(SM(3)-SM(2))*(THETA(3,K)
     1   -THETA(2,K))
      DO 95 I=5,MXP2
      IM2 = I-2
      THAL(I,J) = THETA(IM2,K)
   95 SMAL(I) = SM(IM2)
      CALL SPLIN2(SMAL,THAL(1,J),DTDM1,MXP2,DTDM(1,K),AB)
      DO 96 I=1,2
      CURV(I,K) = AB(I)/12./(1.+(DTDM(I,K)/12.)**2)**1.5
      BETA(I,K) = ATAN(R(I)*DTDM(I,K))
      SBETA(I,K) = SIN(BETA(I,K))
      CBETA(I,K) = COS(BETA(I,K))
   96 CONTINUE
      DO 97 I=3,MX
      IP2 = I+2
      CURV(I,K) = AB(IP2)/12./(1.+(DTDM(IP2,K)/12.)**2)**1.5
      BETA(I,K) = ATAN(R(I)*DTDM(IP2,K))
      SBETA(I,K) = SIN(BETA(I,K))
      CBETA(I.K) = COS(BETA(I,K))
   97 CONTINUE
      PRINT = (ITER.LE.0).OR.(ITNO.LE.NC)
      IF (PRINT) WRITE(6,1060)ITNO
      ERROR1=ERROR
      ERROR=0.
C
C     START CALCULATION OF PARAMETERS
C
      LAST = KHMX-1
      DO 100 K=2,LAST
      CALL SPLIN2(SM,THETA(1,K),DTDM1,MX,DTDM(1,K),AB)
      DO 100 I=1,MX
      CURV(I,K) = AB(I)/12./(1.+(DTDM(I,K)/12.)**2)**1.5
      BETA(I,K)=ATAN(R(I)*DTDM(I,K))
      SBETA(I,K)=SIN(BETA(I,K))
      CBETA(I,K)=COS(BETA(I,K))
  100 CONTINUE
      DO 101 K=KHP2,KMXM1
      CALL SPLIN2(SM,THETA(1,K),DTDM1,MX,DTDM(1,K),AB)
      DO 101 I=1,MX
      CURV(I,K) = AB(I)/12./(1.+(DTDM(I,K)/12.)**2)**1.5
      BETA(I,K)=ATAN(R(I)*DTDM(I,K))
      SBETA(I,K)=SIN(BETA(I,K))
      CBETA(I,K)=COS(BETA(I,K))
  101 CONTINUE
      DO 110 K=1,KMX
      DO 105 I=1,MX
      WTHETA(I,K)=WA(I,K)*SBETA(I,K)
  105 CONTINUE
      CALL SPLIN2(SM,WTHETA(1,K),DWDM1,MX,DWDM(1,K),AC)
      DO 110 I=1,MX
      SA(I,K) = SAL(I)*SBETA(I,K)*CBETA(I,K)
      SB(I,K) = CBETA(I,K)*R(I)*(2.*W*SAL(I)+DWDM(I,K))
  110 CONTINUE
C
C     END OF PARAMETER CALCULATION
```

```
C      CALCULATE VELOCITY DISTRIBUTION,CHECK CONTINUITY
C
       DO 200 I=1,MX
       IND=1
       IND2 = 1
       GO TO 130
  120 WA(I,1)=.5*WA(I,1)
       GO TO 130
  125 WA(I,1)=2.*WA(I,1)
       GO TO 130
  126 WA(I,KHP1) = .5*WA(I,KHP1)
       GO TO 130
  127 WA(I,KHP1) = 2.*WA(I,KHP1)
  130 IF((I.GT.1).AND.(I.LE.MXSP)) GO TO 142
       DO 140 K=2,KMX
       J = K-1
       IF(K.EQ.KHP1) WA(I,K) = WA(I,J)
       IF(K.EQ.KHP1)  GO TO 140
       HT=THETA(I,K)-THETA(I,J)
       WAS = WA(I,J)+(WA(I,J)*SA(I,J)+SB(I,J))*HT
       WASS = WA(I,J)+(WAS*SA(I,K)+SB(I,K))*HT
       WA(I,K) = (WAS+WASS)/2.
  140 CONTINUE
       GO TO 148
  142 DO 144 K=2,KHMX
       J=K-1
       HT=THETA(I,K)-THETA(I,J)
       WAS = WA(I,J)+(WA(I,J)*SA(I,J)+SB(I,J))*HT
       WASS = WA(I,J)+(WAS*SA(I,K)+SB(I,K))*HT
       WA(I,K) = (WAS+WASS)/2.
  144 CONTINUE
       DO 146 K=KHP2,KMX
       J = K-1
       HT=THETA(I,K)-THETA(I,J)
       WAS = WA(I,J)+(WA(I,J)*SA(I,J)+SB(I,J))*HT
       WASS = WA(I,J)+(WAS*SA(I,K)+SB(I,K))*HT
       WA(I,K) = (WAS+WASS)/2.
  146 CONTINUE
  148 CONTINUE
       DO 150 K=1,KMX
       T1P= 1.-(WA(I,K)**2+2.*W*ALM-(W*R(I)   )**2)/2./CP/TEMP
       IF((T1P.LT..0).AND.(I.GT.1).AND.(I.LE.MXSP).AND.(K.GE.KHP1))
      1  GO TO 126
       IF(T1P.LT..0) GO TO 120
       TPP1P= 1.-          (2.*W*ALM-(W*R(I)   )**2)/2./CP/TEMP
       DENSTY(K) = T1P**EXPON*RHO-(T1P/TPP1P)**EXPON*PLOSS/AR/TPP1P/TEMP
      1 *32.17*SM(I)  /SM(MXBL)
       PRS(K) = DENSTY(K)*AR*T1P*TEMP/32.17/144.
       WM=WA(I,K)*CBETA(I,K)
       AB(K) = DENSTY(K)*WM*DN(I)*R(I)*XN
  150 AC(K)=THETA(I,K)
       CALL  INTGRL(AC,AB,KHMX,WTFL)
       IF(WTFL(KHMX).LE..0) GO TO 125
       CALL  INTGRL(AC(KHP1),AB(KHP1),KHMX,WTFL(KHP1))
       IF((WTFL(KMX).LE..0).AND.(I.GT.1).AND.(I.LE.MXSP)) GO TO 127
       IF(WTFL( KMX).LE..0) GO TO 125
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      IF((I.GT.1).AND.(I.LE.MXSP)) GO TO 155
      DO 152 K=KHP1,KMXM1
      AC(K) = AC(K+1)
  152 WTFL(K) = WTFL(KHMX)+WTFL(K+1)
      IF(ABS(WT-WTFL(KMXM1)).LE.WTOLER) GO TO 160
      CALL CONTIN(WA(I,1),WTFL(KMXM1),IND,I,WT)
      IF(IND.NE.6)GO TO 130
      GO TO 160
  155 IF (ABS(WTH-WTFL(KHMX)).LE.WTOLER) IND=6
      IF (ABS(WTH-WTFL(KMX )).LE.WTOLER) IND2=6
      IF(IND.NE.6) CALL CONTIN(WA(I,1),WTFL(KHMX),IND,I,WTH)
      IF(IND2.NE.6) CALL CONTAL(WA(I,KHP1),WTFL(KMX),IND2,I,WTH)
      IF((IND.NE.6).OR.(IND2.NE.6)) GO TO 130
  160 IF((I.GT.1).AND.(I.LE.MXSP)) GO TO 165
      CALL SPLINT (WTFL,AC,KMXM1,BA,KMXM1,AB)
      GO TO 166
  165 CALL SPLINT(WTFL,AC,KHMX,BA,KHMX,AB)
      CALL SPLINT(WTFL(KHP1),AC(KHP1),KHMX,BA(1)    ,KHMX,AB(KHP1))
  166 CONTINUE
      IF((I.GT.1).AND.(I.LE.MXSP)) GO TO 168
      DO 167 K=1,KHMX
      KA = KMX-K+1
      J = KA-1
  167 AB(KA) = AB(J)
  168 DO 170 K=1,KMX
      DELTA=ABS(AB(K)-THETA(I,K))
  170 IF(DELTA.GT.ERROR)ERROR=DELTA
      IF(.NOT.PRINT) GO TO 178
      A=SM(I)*12.
      C=AL(I   )*57.29577
      D = R(I)*12.
      E = Z(I)*12.
      F = DN(I)*12.
      WRITE (6,1080) I,A,C,D,E,F
      WRITE (6,1070)
      DO 175 K=1,KHMX,NPRT
      B=BETA(I,K)*57.29577
      C = WTHETA(I,K)+W*R(I)
      WM = WA(I,K)*CBETA(I,K)
      V = SQRT(C**2+WM**2)
      DWDT = WA(I,K)*SA(I,K)+SB(I,K)
      WRITE (6,1090) THETA(I,K),CURV(I,K),B,WA(I,K),WTHETA(I,K),C,WM,V,
     1   PRS(K),DENSTY(K),DTDM(I,K),DWDM(I,K),SA(I,K),SB(I,K),DWDT
  175 CONTINUE
      WRITE  (6,1095)
      DO 176 K=KHP1,KMX,NPRT
      B=BETA(I,K)*57.29577
      C = WTHETA(I,K)+W*R(I)
      WM = WA(I,K)*CBETA(I,K)
      V = SQRT(C**2+WM**2)
      DWDT = WA(I,K)*SA(I,K)+SB(I,K)
      WRITE (6,1090) THETA(I,K),CURV(I,K),B,WA(I,K),WTHETA(I,K),C,WM,V,
     1   PRS(K),DENSTY(K),DTDM(I,K),DWDM(I,K),SA(I,K),SB(I,K),DWDT
  176 CONTINUE
      WRITE (6,1095)
  178 DO 180 K=2,KMXM1
```

```
  180 THETA(I,K)=(1.-CORFAC)*THETA(I,K)+CORFAC*AB(K)
  200 CONTINUE
C
C     END OF VELOCITY CALCULATIONS.
C
      WRITE (6,1120) ITNO,ERROR
      IF(ITER.LE.0) GO TO 230
      IF((ERROR.GE.ERROR1).OR.(ERROR.LE.TOLER)) ITER=ITER-1
      ITNO=ITNO+1
      GO TO 91
  230 IF(BCDP.NE.1) GO TO 240
      CALL BCDUMP (THETA(1,1),THETA(21,21))
     .CALL BCDUMP (   WA(1,1),    WA(21,21))
  240 IF(MOB.EQ.2) GO TO 11
      GO TO 5
 1010 FORMAT (4I5,6F10.4)
 1020 FORMAT (8H1RUN NO.I3,10X,25HINPUT DATA CARD LISTING     )
 1021 FORMAT (5(2I2,F8.5),I1)
 1023 FORMAT (32H  THETA-CALCULATED AND/OR INPUT  )
 1030 FORMAT (7F10.4)
 1040 FORMAT (10X24HBCD CARDS FOR THETA,WA    )
 1050 FORMAT (36HK     STAG. SPEED OF SOUND AT INLET = ,F9.2,//)
 1060 FORMAT (///5X13HITERATION NO.I3)
 1070 FORMAT (132HK    THETA    T-CURV    BETA      WA     WTHETA  VTHETA
     1WM       V       PRS     DENSTY   DTDM    DWDM      SA        SB       DW
     2DT            )
 1080 FORMAT (2X16HQUASI-ORTHOGONALI3,6X,4HSM =,F7.4,9H  ALPHA =,F7.2,
     1    5H  R =,F7.4,5H  Z =,F7.4,6H  DN =,F7.4)
 1090 FORMAT (1X,F9.4,2F8.2,5F8.1,F7.2,F9.5,F7.2,F8.0,F8.4,2F9.1)
 1095 FORMAT (1H )
 1120 FORMAT (18HJ     ITERATION NO. I3,10X,24HMAX. STREAMLINE CHANGE = ,
     1F10.6)
 1200 FORMAT(//10X7HNORMAL I4)
 1210 FORMAT(7F18.6)
      END
```

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```
$IBFTC SPLINT  DECK
      SUBROUTINE SPLINT (X,Y,N,Z,MAX,YINT)
      DIMENSION X(50),Y(50),S(50),A(50),B(50),C(50),F(50),W(50),SB(50),
     1G(50),EM(50),Z(50),YINT(50)
      COMMON Q
      INTEGER Q
      DO 10 I=2,N
   10 S(I)=X(I)-X(I-1)
      NO=N-1
      DO 20 I=2,NO
      A(I)=S(I)/6.0
      B(I)=(S(I)+S(I+1))/3.0
      C(I)=S(I+1)/6.0
   20 F(I)=(Y(I+1)-Y(I))/S(I+1)-(Y(I)-Y(I-1))/S(I)
      A(N)=-.5
      B(1)=1.0
      B(N)=1.0
      C(1)=-.5
      F(1)=0.0
      F(N)=0.0
      W(1)=B(1)
      SB(1)=C(1)/W(1)
      G(1)=0.0
      DO 30 I=2,N
      W(I)=B(I)-A(I)*SB(I-1)
      SB(I)=C(I)/W(I)
   30 G(I)=(F(I)-A(I)*G(I-1))/W(I)
      EM(N)=G(N)
      DO 40 I=2,N
      K=N+1-I
   40 EM(K)=G(K)-SB(K)*EM(K+1)
      DO 90 I=1,MAX
      K=2
      IF(Z(I)-X(1)) 60,50,70
   50 YINT(I)=Y(1)
      GO TO 90
   60 IF(Z(I).LT.(1.1*X(1)-.1*X(2)))WRITE (6,1000)Z(I)
      GO TO 85
 1000 FORMAT (17H OUT OF RANGE Z =F10.6)
   65 IF(Z(I).GT.(1.1*X(N)-.1*X(N-1))) WRITE (6,1000)Z(I)
      K=N
      GO TO 85
   70 IF(Z(I)-X(K)) 85,75,80
   75 YINT(I)=Y(K)
      GO TO 90
   80 K=K+1
      IF(K-N) 70,70,65
   85 YINT(I) = EM(K-1)*(X(K)-Z(I))**3/6./S(K)+EM(K)*(Z(I)-X(K-1))**3/6.
     1/S(K)+(Y(K)/S(K)-EM(K)*S(K)/6.)*(Z(I)-X(K-1))+(Y(K-1)/S(K)-EM(K-1)
     2*S(K)/6.)*(X(K)-Z(I))
   90 CONTINUE
      MXA = MAX0(N,MAX)
      IF(Q.EQ.16) WRITE(6,1010) N,MAX,(X(I),Y(I),Z(I),YINT(I),I=1,MXA)

 1010 FORMAT (2X21HNO. OF POINTS GIVEN =,I3,30H, NO. OF INTERPOLATED POI
     1NTS =,I3,/10X5HX     15X5HY     12X11HX-INTERPOL.9X11HY-INTERPOL./(4

       2E20.8))
  100 RETURN
      END
```

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```
$IBFTC SPLDER   DECK
      SUBROUTINE SPLDER(X,Y,N,Z,MAX,DYDX)
      DIMENSION X(50),Y(50),S(50),A(50),B(50),C(50),F(50),W(50),SB(50),
     1G(50),EM(50),Z(50),DYDX(50)
      DO 10 I=2,N
   10 S(I)=X(I)-X(I-1)
      NO=N-1
      DO 20 I=2,NO
      A(I)=S(I)/6.0
      B(I)=(S(I)+S(I+1))/3.0
      C(I)=S(I+1)/6.0
   20 F(I)=(Y(I+1)-Y(I))/S(I+1)-(Y(I)-Y(I-1))/S(I)
      A(N)=-.5
      B(1)=1.0
      B(N)=1.0
      C(1)=-.5
      F(1)=0.0
      F(N)=0.0
      W(1)=B(1)
      SB(1)=C(1)/W(1)
      G(1)=0.0
      DO 30 I=2,N
      W(I)=B(I)-A(I)*SB(I-1)
      SB(I)=C(I)/W(I)
   30 G(I)=(F(I)-A(I)*G(I-1))/W(I)
      EM(N)=G(N)
      DO 40 I=2,N
      K=N+1-I
   40 EM(K)=G(K)-SB(K)*EM(K+1)
      DO 90 I=1,MAX
      K=2
      IF(Z(I)-X(1)) 60,70,70
   60 WRITE (6,1000)Z(I)
 1000 FORMAT (17H OUT OF BLADE Z =F10.6)
      GO TO 85
   65 WRITE (6,1000)Z(I)
      K=N
      GO TO 85
   70 IF(Z(I)-X(K)) 85,85,80
   80 K=K+1
      IF(K-N) 70,70,65
   85 DYDX(I)=-EM(K-1)*(X(K)-Z(I))**2/2.0/S(K)+EM(K)*(X(K-1)-Z(I))**2/2.
     10/S(K)+(Y(K)-Y(K-1))/S(K)-(EM(K)-EM(K-1))*S(K)/6.0
   90 CONTINUE
  100 RETURN
      END
```

```
$IBFTC CONTIN  DECK
      SUBROUTINE CONTIN (WA,WTFL,IND,I,WT)
      DIMENSION SPEED(3),WEIGHT(3)
  135 GO TO (140,150,210,270,370),IND
  140 SPEED(1) = WA
      WEIGHT(1) = WTFL
      DELTA = WT/WTFL*WA-WA
      IF(ABS(DELTA).GT.100.) DELTA = SIGN(100.,DELTA)
      WA = DELTA+WA
      IND = 2
      RETURN
  150 IF ((WTFL-WEIGHT(1))/(WA-SPEED(1))) 180,180,160
  160 SPEED(2) = WA
      DELTA = (WT-WTFL)/(WTFL-WEIGHT(1))*(WA-SPEED(1))
      IF(ABS(DELTA).GT.100.) DELTA = SIGN(100.,DELTA)
      WA = DELTA+WA
  166 SPEED(1) = SPEED(2)
      WEIGHT(1) = WTFL
      RETURN
  170 WRITE (6,1000) I,WTFL
      IND = 6
      RETURN
  180 IND = 3
      IF (WTFL.GE.WT) GO TO 140
      IF (SPEED(1)-WA) 190,200,200
  190 SPEED(2) = SPEED(1)
      SPEED(1) = 2.0*SPEED(1)-WA
      SPEED(3) = WA
      WEIGHT(2) = WEIGHT(1)
      WEIGHT(3) = WTFL
      WA = SPEED(1)
      RETURN
  200 SPEED(2) = WA
      SPEED(3) = SPEED(1)
      SPEED(1) = 2.0*WA-SPEED(1)
      WEIGHT(2) = WTFL
      WEIGHT(3) = WEIGHT(1)
      WA = SPEED(1)
      RETURN
  210 WEIGHT(1) = WTFL
      IF (WTFL.GE.WT) GO TO 140
      IF (WEIGHT(1)-WEIGHT(2)) 230,380,220
  220 WEIGHT(3) = WEIGHT(2)
      WEIGHT(2) = WEIGHT(1)
      SPEED(3) = SPEED(2)
      SPEED(2) = SPEED(1)
      SPEED(1) = 2.0*SPEED(2)-SPEED(3)
      WA = SPEED(1)
      RETURN
  230 IF (SPEED(3)-SPEED(1)-10.0) 170,170,240
  240 IND = 4
  245 IF (WEIGHT(3)-WEIGHT(1)) 260,260,250
  250 WA = (SPEED(1)+SPEED(2))/2.0
      RETURN
  260 WA = (SPEED(3)+SPEED(2))/2.0
      RETURN
```

```
270 IF (SPEED(3)-SPEED(1)-10.0) 170,170,280
280 IF (WTFL-WEIGHT(2)) 320,350,290
290 IF (WA-SPEED(2)) 310,300,300
300 SPEED(1) = SPEED(2)
    SPEED(2) = WA
    WEIGHT(1) = WEIGHT(2)
    WEIGHT(2) = WTFL
    GO TO 245
310 SPEED(3) = SPEED(2)
    SPEED(2) = WA
    WEIGHT(3) = WEIGHT(2)
    WEIGHT(2) = WTFL
    GO TO 245
320 IF (WA-SPEED(2)) 340,330,330
330 WEIGHT(3) = WTFL
    SPEED(3) = WA
    GO TO 245
340 WEIGHT(1) = WTFL
    SPEED(1) = WA
    GO TO 245
350 IND = 5
    IF (WA-SPEED(2)) 380,360,360
360 SPEED(1) = SPEED(2)
    WEIGHT(1) = WEIGHT(2)
    SPEED(2) = (SPEED(1)+SPEED(3))/2.0
    WA = SPEED(2)
    RETURN
370 IND = 4
    WEIGHT(2) = WTFL
    WA = (SPEED(1)+SPEED(2))/2.0
    RETURN
380 IND = 5
390 WEIGHT(3) = WEIGHT(2)
    SPEED(3) = SPEED(2)
    SPEED(2) = (SPEED(1)+SPEED(3))/2.
    WA = SPEED(2)
    RETURN
1000 FORMAT (/12H FIXED LINE I2,12H,  MAX WT = F10.6)
    END
```

```
$IBFTC SPLIN2  DECK
      SUBROUTINE SPLIN2(X,Y,Y1P,N,SLOPE,EM)
      DIMENSION X(50),Y(50),S(50),A(50),B(50),C(50),F(50),W(50),SB(50),
     1G(50),EM(50),SLOPE(50)
      COMMON Q
      INTEGER Q
      DO 10 I=2,N
   10 S(I)=X(I)-X(I-1)
      NO=N-1
      DO 20 I=2,NO
      A(I)=S(I)/6.
      B(I)=(S(I)+S(I+1))/3.
      C(I)=S(I+1)/6.
   20 F(I)=(Y(I+1)-Y(I))/S(I+1)-(Y(I)-Y(I-1))/S(I)
      A(N)=-.5
      B(1)=S(2)/3.
      B(N)=1.
      C(1)=S(2)/6.
      F(1)=(Y(2)-Y(1))/S(2)-Y1P
      F(N)=0.
      W(1)=B(1)
      SB(1)=C(1)/W(1)
      G(1)=F(1)/W(1)
      DO 30 I=2,N
      W(I)=B(I)-A(I)*SB(I-1)
      SB(I)=C(I)/W(I)
   30 G(I)=(F(I)-A(I)*G(I-1))/W(I)
      EM(N)=G(N)
      DO 40 I=2,N
      K=N+1-I
   40 EM(K)=G(K)-SB(K)*EM(K+1)
      SLOPE(1)=-S(2)/6.*(2.*EM(1)+EM(2))+(Y(2)-Y(1))/S(2)
      DO50 I=2,N
   50 SLOPE(I)=S(I)/6.*(2.*EM(I)+EM(I-1))+(Y(I)-Y(I-1))/S(I)
      IF (Q.EQ.14) WRITE (6,100) N,(X(I),Y(I),SLOPE(I),EM(I),I=1,N)

  100 FORMAT (2X15HNO. OF POINTS =I3/10X5HX     15X5HY     15X5HSLOPE15X5H
     1EM    /(4F20.8))
      RETURN
      END
```

```
$IBFTC SPLINE  DECK
      SUBROUTINE SPLINE (X,Y,N,SLOPE,EM)
      DIMENSION X(50),Y(50),S(50),A(50),B(50),C(50),F(50),W(50),SB(50),
     1G(50),EM(50),SLOPE(50)
      COMMON Q
      INTEGER Q
      DO 10 I=2,N
   10 S(I)=X(I)-X(I-1)
      NO=N-1
      DO 20 I=2,NO
      A(I)=S(I)/6.
      B(I)=(S(I)+S(I+1))/3.
      C(I)=S(I+1)/6.
   20 F(I)=(Y(I+1)-Y(I))/S(I+1)-(Y(I)-Y(I-1))/S(I)
      A(N)=-.5
      B(1)=1.
      B(N)=1.
      C(1)=-.5
      F(1)=0.
      F(N)=0.
      W(1)=B(1)
      SB(1)=C(1)/W(1)
      G(1)=0.
      DO 30 I=2,N
      W(I)=B(I)-A(I)*SB(I-1)
      SB(I)=C(I)/W(I)
   30 G(I)=(F(I)-A(I)*G(I-1))/W(I)
      EM(N)=G(N)
      DO 40 I=2,N
      K=N+1-I
   40 EM(K)=G(K)-SB(K)*EM(K+1)
      SLOPE(1)=-S(2)/6.*(2.*EM(1)+EM(2))+(Y(2)-Y(1))/S(2)
      DO50 I=2,N
   50 SLOPE(I)=S(I)/6.*(2.*EM(I)+EM(I-1))+(Y(I)-Y(I-1))/S(I)
      IF (Q.EQ.13) WRITE (6,100) N,(X(I),Y(I),SLOPE(I),EM(I),I=1,N)

  100 FORMAT (2X15HNO. OF POINTS =I3/10X5HX     15X5HY     15X5HSLOPE15X5H
     1EM   /(4F20.8))
      RETURN
      END
```

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```
$IBFTC INTGRL  DECK
      SUBROUTINE INTGRL (X,Y,N,SUM)
      DIMENSION X(50),Y(50),S(50),A(50),B(50),C(50),F(50),W(50),SB(50),
     1G(50),EM(50),SUM(50)
      COMMON SRW
      INTEGER SRW
      DO 10 I=2,N
   10 S(I)=X(I)-X(I-1)
      NO=N-1
      DO 20 I=2,NO
      A(I)=S(I)/6.0
      B(I)=(S(I)+S(I+1))/3.0
      C(I)=S(I+1)/6.0
   20 F(I)=(Y(I+1)-Y(I))/S(I+1)-(Y(I)-Y(I-1))/S(I)
      A(N)=-.5
      B(1)=1.0
      B(N)=1.0
      C(1)=-.5
      F(1)=0.0
      F(N)=0.0
      W(1)=B(1)
      SB(1)=C(1)/W(1)
      G(1)=0.0
      DO 30 I=2,N
      W(I)=B(I)-A(I)*SB(I-1)
      SB(I)=C(I)/W(I)
   30 G(I)=(F(I)-A(I)*G(I-1))/W(I)
      EM(N)=G(N)
      DO 40 I=2,N
      K=N+1-I
   40 EM(K)=G(K)-SB(K)*EM(K+1)
      SUM(1) =0.0
      DO 50 K=2,N
   50 SUM(K) = SUM(K-1)+S(K)*(Y(K)+Y(K-1))/2.0-S(K)**3*(EM(K)+EM(K-1))/2
     14.0
      IF(SRW.EQ.17) WRITE(6,1000) N,(X(I),Y(I),SUM(I),EM(I),I=1,N)

      RETURN
 1000 FORMAT (17HK NO. OF POINTS =I3/10X5HX     15X5HY     15X5HSUM
     1    13X10H2ND DERIV./(4F20.8))
      END
```

```
$IBFTC LININT   DECK
      SUBROUTINE LININT(X1,Y1,X,Y,TN,MX,MY,F)
      COMMON K
      DIMENSION X(MX),Y(MY),TN(MX,MY)
      DO 10 J3=1,MX
   10 IF(X1.LE.X(J3))GO TO 20
      J3=MX
   20 DO 30 J4=1,MY
   30 IF(Y1.LE.Y(J4))GO TO 40
      J4=MY
   40 J1=J3-1
      J2=J4-1
      EPS1=(X1-X(J1))/(X(J3)-X(J1))
      EPS2=(Y1-Y(J2))/(Y(J4)-Y(J2))
      EPS3=1.-EPS1
      EPS4=1.-EPS2
      F=TN(J1,J2)*EPS3*EPS4+TN(J3,J2)*EPS1*EPS4+TN(J1,J4)*EPS2*EPS3+
     1TN(J3,J4)*EPS1*EPS2
      IF(K.EQ.14) WRITE(6,1)X1,Y1,F,J1,J2,EPS1,EPS2
    1 FORMAT (8H  LININT3F10.5,2I3,2F10.5)
      K=0
      RETURN
      END
```

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```
$IBFTC CONTAL   DECK
      SUBROUTINE CONTAL (WA,WTFL,IND,I,WT)
      DIMENSION SPEED(3),WEIGHT(3)
  135 GO TO (140,150,210,270,370),IND
  140 SPEED(1) = WA
      WEIGHT(1) = WTFL
      WA = WT/WTFL*WA
      IND = 2
      RETURN
  150 IF ((WTFL-WEIGHT(1))/(WA-SPEED(1))) 180,180,160
  160 SPEED(2) = WA
      WA = (WT-WTFL)/(WTFL-WEIGHT(1))
     1   *(WA-SPEED(1))+WA
      IF (ABS(WA-SPEED(2))-100.0) 166,165,161
  161 IF(WA-SPEED(2))163,163,162
  162 WA = SPEED(2)+100.0
      GO TO 166
  163 WA = SPEED(2)-100.0
  166 SPEED(1) = SPEED(2)
      WEIGHT(1) = WTFL
      RETURN
  170 WRITE (6,1000) I,WTFL
      IND = 6
      RETURN
  180 IND = 3
      IF (WTFL.GE.WT) GO TO 140
      IF (SPEED(1)-WA) 190,200,200
  190 SPEED(2) = SPEED(1)
      SPEED(1) = 2.0*SPEED(1)-WA
      SPEED(3) = WA
      WEIGHT(2) = WEIGHT(1)
      WEIGHT(3) = WTFL
      WA = SPEED(1)
      RETURN
  200 SPEED(2) = WA
      SPEED(3) = SPEED(1)
      SPEED(1) = 2.0*WA-SPEED(1)
      WEIGHT(2) = WTFL
      WEIGHT(3) = WEIGHT(1)
      WA = SPEED(1)
      RETURN
  210 WEIGHT(1) = WTFL
      IF (WTFL.GE.WT) GO TO 140
      IF (WEIGHT(1)-WEIGHT(2)) 230,380,220
  220 WEIGHT(3) = WEIGHT(2)
      WEIGHT(2) = WEIGHT(1)
      SPEED(3) = SPEED(2)
      SPEED(2) = SPEED(1)
      SPEED(1) = 2.0*SPEED(2)-SPEED(3)
      WA = SPEED(1)
      RETURN
  230 IF (SPEED(3)-SPEED(1)-10.0) 170,170,240
  240 IND = 4
  245 IF (WEIGHT(3)-WEIGHT(1)) 260,260,250
  250 WA = (SPEED(1)+SPEED(2))/2.0
      RETURN
```

```
260 WA = (SPEED(3)+SPEED(2))/2.0
    RETURN
270 IF (SPEED(3)-SPEED(1)-10.0) 170,170,280
280 IF (WTFL-WEIGHT(2)) 320,350,290
290 IF (WA-SPEED(2)) 310,300,300
300 SPEED(1) = SPEED(2)
    SPEED(2) = WA
    WEIGHT(1) = WEIGHT(2)
    WEIGHT(2) = WTFL
    GO TO 245
310 SPEED(3) = SPEED(2)
    SPEED(2) = WA
    WEIGHT(3) = WEIGHT(2)
    WEIGHT(2) = WTFL
    GO TO 245
320 IF (WA-SPEED(2)) 340,330,330
330 WEIGHT(3) = WTFL
    SPEED(3) = WA
    GO TO 245
340 WEIGHT(1) = WTFL
    SPEED(1) = WA
    GO TO 245
350 IND = 5
    IF (WA-SPEED(2)) 380,360,360
360 SPEED(1) = SPEED(2)
    WEIGHT(1) = WEIGHT(2)
    SPEED(2) = (SPEED(1)+SPEED(3))/2.0
    WA = SPEED(2)
    RETURN
370 IND = 4
    WEIGHT(2) = WTFL
    WA = (SPEED(1)+SPEED(2))/2.0
    RETURN
380 IND = 5
390 WEIGHT(3) = WEIGHT(2)
    SPEED(3) = SPEED(2)
    SPEED(2) = (SPEED(1)+SPEED(3))/2.
    WA = SPEED(2)
    RETURN
1000 FORMAT (/12H FIXED LINE I2,12H,  MAX WT = F10.6)
    END
```

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SAMPLE OUTPUT

For aid in checking the operation of the program and as an illustration of the results obtained by the program, sample output is included below. The case used here is the same radial gas turbine rotor with splitter blades that was used for the numerical example in reference (2). The first output is from the calling program (Q3D) and consists of the values of variables MOB, H, M, and S. The value of MOB determines whether the meridional solution (FIXED) or the blade-to-blade solution (SPLBLD) or both is desired. In the example below MOB = 2 which gives both solutions. The value of H, M, or S is used to indicate whether the hub, meridional or shroud blade-to-blade solution is desired; the value 1 indicates that particular solution is desired, the value 0 not. In the example H = 1, and M and S = 0.

The data given immediately following "RUN NO. 1 INPUT DATA CARD LISTING", up to the line before "STAG. SPEED OF SOUND AT INLET", are a listing of the data on the input data cards for the meridional solution. This is followed by a list of the maximum computed streamline change at each iteration for the meridional solution. Convergence to the specified accuracy of .001" was obtained after 105 iterations. Then the calculated information is printed out for every 5th streamline. Data at more streamlines will be printed out if the value of NPRT is reduced from 5.

The output for the meridional solution is given in two parts. The first part gives values of DN, Z, R, WA, PRESS, WTR, and RC and the maximum streamline change for iteration No. 106. The second part for iteration No. 107 gives values for ALPHA, RC, SM, BETA, TT, SA, SB, SC, and SD, followed by a repetition of the values of DN, Z, R, WA, PRESS, WTR, and RC. The next output is the "STREAMLINE SPACING ALONG NORMAL", "BLADE COORDINATES", and "INLET ANGLES", which is computed by the meridional program (FIXED) and is used for input to the blade-to-blade program (SPLBLD).

Next is the output from the blade-to-blade program at the hub. The first line is "RUN NO. 2 INPUT DATA CARD LISTING". The next two lines are data from input cards. The following lines up to the 3rd line before "THETA-CALCULATED AND/OR INPUT", are computed by the program, and are the data which would have to be supplied if not furnished by the meridional program. The second line before "THETA-CALCULATED AND/OR INPUT" is data from an input card with a 1 in card column 5, indicating further data is given. A blank card here would indicate no more input for this blade-to-blade solution. The line just before "THETA-CALCULATED AND/OR INPUT" is data from an input card giving information of splitter blade coordinates near the trailing edge that were altered from those computed by the meridional program. The next data are the θ coordinates of the initial equally spaced streamlines at every quasi-orthongonal. This is followed by the stagnation speed of sound, and then a list of the maximum predicted streamline change at each iteration for the blade-to-blade solution. Convergence to the desired accuracy of .001" was obtained in 27 iterations. The desired output is printed out for every 5th streamline at each quasi-orthogonal. Again, data at more streamlines can be obtained with a different value of NPRT.

The mean and shroud blade-to-blade solutions would have also been obtained on the same computer run if we had set M and S equal to 1, and supplied the appropriate input cards.

```
RUN NO.  1            INPUT DATA CARD LISTING
  14   21    7    7 4030.0000    0.6110   11.0000     1.6667 1245.0000
   0    2    0   11 1950.0000  221.5000    0.0247     0.0010    0.2500    0.000
  19    5    2    0    2.0000    1.0000  -25.1000     0.0500
   0.7590    0.8100    0.6900    1.0150    1.1200    1.2300    1.3520
   1.5500    1.8030    2.1000    2.3500    2.5500    2.8500    3.1500
   0.       -0.0030    0.0300    0.1400    0.3170    0.5900    0.9430
   1.3550    1.7650    2.1000    2.3500    2.5500    2.8500    3.1500
   3.0100    2.7360    2.5130    2.3230    2.2420    2.1880    2.1600
   2.1470    2.1470    2.1470    2.1470    2.1470    2.1470    2.1470
   3.0100    2.6000    2.2300    1.8220    1.4700    1.1580    0.9230
   0.7970    0.7520    0.7500    0.7500    0.7500    0.7500    0.7500
  -0.       -0.       -0.       -0.       -0.       -0.       -0.
  -0.0012   -0.0044   -0.0201   -0.0567   -0.1246   -0.2339   -0.3966
  -0.6231   -0.8604   -1.0978   -1.3352   -1.5725
  -0.2000    0.        0.2000    0.4000    0.6000    0.8000    1.0000
   1.1000    1.2000    1.4000    1.6000    1.8000    2.0000    2.2000
   2.4000    2.6000    2.8000    3.0000    3.2000
   0.1860    0.1710    0.1560    0.1410    0.1270    0.1160    0.0330
   0.1660    0.1510    0.1360    0.1210    0.1065    0.0960    0.0300
   0.1460    0.1310    0.1160    0.1010    0.0870    0.0760    0.0270
   0.1260    0.1110    0.0960    0.0820    0.0670    0.0560    0.0240
   0.1050    0.0910    0.0760    0.0620    0.0480    0.0360    0.0220
   0.0855    0.0710    0.0560    0.0420    0.0280    0.0160    0.0190
   0.0670    0.0510    0.0360    0.0220    0.0080   -0.0050    0.0160
  -0.0040    0.4000    0.8000    1.2000    1.6000    2.0000    2.4000
   0.6000    1.0000    1.4000    1.8000    2.2000    2.6000    3.0200

 STAG. SPEED OF SOUND AT INLET =  2011.55
0.2073
 ITERATION NO.  1        MAX. STREAMLINE CHANGE =  0.397387
 ITERATION NO.  2        MAX. STREAMLINE CHANGE =  0.364558
 ITERATION NO.  3        MAX. STREAMLINE CHANGE =  0.338418
 ITERATION NO.  4        MAX. STREAMLINE CHANGE =  0.317072
 ITERATION NO.  5        MAX. STREAMLINE CHANGE =  0.294279
 ITERATION NO.  6        MAX. STREAMLINE CHANGE =  0.277526
 ITERATION NO.  7        MAX. STREAMLINE CHANGE =  0.261206
 ITERATION NO.  8        MAX. STREAMLINE CHANGE =  0.245780
 ITERATION NO.  9        MAX. STREAMLINE CHANGE =  0.231244
 ITERATION NO. 10        MAX. STREAMLINE CHANGE =  0.217489
 ITERATION NO. 11        MAX. STREAMLINE CHANGE =  0.204468
 ITERATION NO. 12        MAX. STREAMLINE CHANGE =  0.192163
 ITERATION NO. 13        MAX. STREAMLINE CHANGE =  0.180295
 ITERATION NO. 14        MAX. STREAMLINE CHANGE =  0.169344
 ITERATION NO. 15        MAX. STREAMLINE CHANGE =  0.159114
 ITERATION NO. 16        MAX. STREAMLINE CHANGE =  0.149380
 ITERATION NO. 17        MAX. STREAMLINE CHANGE =  0.140383
 ITERATION NO. 18        MAX. STREAMLINE CHANGE =  0.132053
 ITERATION NO. 19        MAX. STREAMLINE CHANGE =  0.124201
 ITERATION NO. 20        MAX. STREAMLINE CHANGE =  0.116800
 ITERATION NO. 21        MAX. STREAMLINE CHANGE =  0.109090
 ITERATION NO. 22        MAX. STREAMLINE CHANGE =  0.099879
 ITERATION NO. 23        MAX. STREAMLINE CHANGE =  0.093197
 ITERATION NO. 24        MAX. STREAMLINE CHANGE =  0.087511
 ITERATION NO. 25        MAX. STREAMLINE CHANGE =  0.032277
 ITERATION NO. 26        MAX. STREAMLINE CHANGE =  0.077409
 ITERATION NO. 27        MAX. STREAMLINE CHANGE =  0.072972
 ITERATION NO. 28        MAX. STREAMLINE CHANGE =  0.068739
 ITERATION NO. 29        MAX. STREAMLINE CHANGE =  0.064801
 ITERATION NO. 30        MAX. STREAMLINE CHANGE =  0.061076
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ITERATION NO. 31          MAX. STREAMLINE CHANGE =  0.057551
ITERATION NO. 32          MAX. STREAMLINE CHANGE =  0.054177
ITERATION NO. 33          MAX. STREAMLINE CHANGE =  0.051032
ITERATION NO. 34          MAX. STREAMLINE CHANGE =  0.049114
ITERATION NO. 35          MAX. STREAMLINE CHANGE =  0.045275
ITERATION NO. 36          MAX. STREAMLINE CHANGE =  0.042680
ITERATION NO. 37          MAX. STREAMLINE CHANGE =  0.040203
ITERATION NO. 38          MAX. STREAMLINE CHANGE =  0.037993
ITERATION NO. 39          MAX. STREAMLINE CHANGE =  0.035860
ITERATION NO. 40          MAX. STREAMLINE CHANGE =  0.033894
ITERATION NO. 41          MAX. STREAMLINE CHANGE =  0.031966
ITERATION NO. 42          MAX. STREAMLINE CHANGE =  0.030159
ITERATION NO. 43          MAX. STREAMLINE CHANGE =  0.028456
ITERATION NO. 44          MAX. STREAMLINE CHANGE =  0.026837
ITERATION NO. 45          MAX. STREAMLINE CHANGE =  0.025363
ITERATION NO. 46          MAX. STREAMLINE CHANGE =  0.023967
ITERATION NO. 47          MAX. STREAMLINE CHANGE =  0.022629
ITERATION NO. 48          MAX. STREAMLINE CHANGE =  0.021369
ITERATION NO. 49          MAX. STREAMLINE CHANGE =  0.020179
ITERATION NO. 50          MAX. STREAMLINE CHANGE =  0.019052
ITERATION NO. 51          MAX. STREAMLINE CHANGE =  0.017998
ITERATION NO. 52          MAX. STREAMLINE CHANGE =  0.017001
ITERATION NO. 53          MAX. STREAMLINE CHANGE =  0.016058
ITERATION NO. 54          MAX. STREAMLINE CHANGE =  0.015168
ITERATION NO. 55          MAX. STREAMLINE CHANGE =  0.014330
ITERATION NO. 56          MAX. STREAMLINE CHANGE =  0.013539
ITERATION NO. 57          MAX. STREAMLINE CHANGE =  0.012791
ITERATION NO. 58          MAX. STREAMLINE CHANGE =  0.012087
ITERATION NO. 59          MAX. STREAMLINE CHANGE =  0.011487
ITERATION NO. 60          MAX. STREAMLINE CHANGE =  0.010813
ITERATION NO. 61          MAX. STREAMLINE CHANGE =  0.010206
ITERATION NO. 62          MAX. STREAMLINE CHANGE =  0.009696
ITERATION NO. 63          MAX. STREAMLINE CHANGE =  0.009128
ITERATION NO. 64          MAX. STREAMLINE CHANGE =  0.008669
ITERATION NO. 65          MAX. STREAMLINE CHANGE =  0.008158
ITERATION NO. 66          MAX. STREAMLINE CHANGE =  0.007750
ITERATION NO. 67          MAX. STREAMLINE CHANGE =  0.007291
ITERATION NO. 68          MAX. STREAMLINE CHANGE =  0.006937
ITERATION NO. 69          MAX. STREAMLINE CHANGE =  0.006519
ITERATION NO. 70          MAX. STREAMLINE CHANGE =  0.006204
ITERATION NO. 71          MAX. STREAMLINE CHANGE =  0.005890
ITERATION NO. 72          MAX. STREAMLINE CHANGE =  0.005517
ITERATION NO. 73          MAX. STREAMLINE CHANGE =  0.005248
ITERATION NO. 74          MAX. STREAMLINE CHANGE =  0.004985
ITERATION NO. 75          MAX. STREAMLINE CHANGE =  0.004665
ITERATION NO. 76          MAX. STREAMLINE CHANGE =  0.004424
ITERATION NO. 77          MAX. STREAMLINE CHANGE =  0.004201
ITERATION NO. 78          MAX. STREAMLINE CHANGE =  0.003997
ITERATION NO. 79          MAX. STREAMLINE CHANGE =  0.003801
ITERATION NO. 80          MAX. STREAMLINE CHANGE =  0.003538
ITERATION NO. 81          MAX. STREAMLINE CHANGE =  0.003360
ITERATION NO. 82          MAX. STREAMLINE CHANGE =  0.003189
ITERATION NO. 83          MAX. STREAMLINE CHANGE =  0.003028
ITERATION NO. 84          MAX. STREAMLINE CHANGE =  0.002872
ITERATION NO. 85          MAX. STREAMLINE CHANGE =  0.002728
ITERATION NO. 86          MAX. STREAMLINE CHANGE =  0.002603
ITERATION NO. 87          MAX. STREAMLINE CHANGE =  0.002406
ITERATION NO. 88          MAX. STREAMLINE CHANGE =  0.002284
ITERATION NO. 89          MAX. STREAMLINE CHANGE =  0.002178
ITERATION NO. 90          MAX. STREAMLINE CHANGE =  0.002058
```

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ITERATION NO. 91      MAX. STREAMLINE CHANGE =  0.001955
ITERATION NO. 92      MAX. STREAMLINE CHANGE =  0.001857
ITERATION NO. 93      MAX. STREAMLINE CHANGE =  0.001761
ITERATION NO. 94      MAX. STREAMLINE CHANGE =  0.001675
ITERATION NO. 95      MAX. STREAMLINE CHANGE =  0.001593
ITERATION NO. 96      MAX. STREAMLINE CHANGE =  0.001515
ITERATION NO. 97      MAX. STREAMLINE CHANGE =  0.001440
ITERATION NO. 98      MAX. STREAMLINE CHANGE =  0.001368
ITERATION NO. 99      MAX. STREAMLINE CHANGE =  0.001301
ITERATION NO.100      MAX. STREAMLINE CHANGE =  0.001238
ITERATION NO.101      MAX. STREAMLINE CHANGE =  0.001176
ITERATION NO.102      MAX. STREAMLINE CHANGE =  0.001119
ITERATION NO.103      MAX. STREAMLINE CHANGE =  0.001064
ITERATION NO.104      MAX. STREAMLINE CHANGE =  0.001012
ITERATION NO.105      MAX. STREAMLINE CHANGE =  0.000962
```

DV	Z	R	4A	PRESS	WTR	RC
STREAMLINE 1						
0.	0.	3.010000	307.965088	10.798088	-0.000000	1.137495
0.	-0.003000	2.600000	269.501698	10.213267	-0.000000	2.938300
0.	0.030000	2.230000	255.311989	9.745524	-0.000000	5.758939
0.	0.140000	1.822000	249.271402	9.309812	-0.000000	5.339704
0.	0.317000	1.470000	242.361450	9.007061	-0.000000	9.142985
0.	0.590000	1.158000	257.816582	8.765873	-0.000000	6.507833
0.	0.943000	0.923000	229.855871	8.650198	-0.000000	9.238318
0.	1.355000	0.797000	249.725634	8.551350	-0.000000	6.941405
0.	1.765000	0.752000	326.493009	8.417940	-0.000000	3.892939
0.	2.100000	0.750000	518.566565	8.069547	-0.000000	-0.674995
0.	2.350000	0.750000	686.538170	7.658735	-0.000000	0.199942
0.	2.550000	0.750000	645.716766	7.752184	-0.000000	-0.042567
0.	2.850000	0.750000	679.323357	7.648843	-0.000000	0.009495
0.	3.150000	0.750000	687.157875	7.611016	-0.000000	0.004745
STREAMLINE 6						
0.200993	0.201049	3.010000	315.162716	10.787358	-0.000000	2.065952
0.248913	0.242537	2.641074	294.622234	10.233665	-0.000000	5.269357
0.310360	0.324810	2.327013	305.187008	9.790317	-0.000000	7.964409
0.395765	0.482564	2.020100	324.027397	9.400115	-0.000000	9.590285
0.487924	0.668691	1.808114	345.814606	9.145297	-0.000000	9.370177
0.571772	0.891735	1.543605	369.580849	8.948527	-0.000000	7.555375
0.631010	1.142077	1.522074	340.953114	8.876734	-0.000000	7.205359
0.639154	1.440359	1.429487	364.588326	8.750883	-0.000000	2.777719
0.602008	1.731390	1.353671	440.289177	8.547409	-0.000000	-1.559528
0.525771	2.100000	1.275650	616.855354	8.096530	-0.000000	0.274153
0.472052	2.350000	1.222080	792.763168	7.564175	-0.000000	8.123643
0.452647	2.550000	1.202778	717.302895	7.759147	-0.000000	2.908270
0.442783	2.850000	1.192958	727.215691	7.705014	-0.000000	0.902779
0.440845	3.150000	1.191012	730.766541	7.672916	-0.000000	0.354100
STREAMLINE 11						
0.395417	0.395528	3.010000	325.856609	10.770970	-0.000000	2.497980
0.466925	0.457593	2.577049	328.781162	10.232789	-0.000000	6.355512
0.552803	0.555106	2.402795	365.779358	9.787646	-0.000000	9.455982
0.663441	0.714258	2.154085	411.974716	9.395245	-0.000000	11.392927
0.770004	0.872012	2.003585	448.593491	9.152268	-0.000000	11.555781
0.865507	1.046745	1.893074	440.446377	9.043899	-0.000000	9.863362
0.936435	1.236952	1.812042	437.556976	8.957722	-0.000000	8.772571
0.958981	1.492075	1.745977	444.555134	8.864200	-0.000000	3.153930
0.939317	1.790573	1.690791	513.557175	8.653472	-0.000000	-1.804981
0.876364	2.100000	1.626100	694.439308	8.136862	-0.000000	-1.064492
0.826696	2.350000	1.576744	930.868149	7.434427	-0.000000	9.595790

0.810334	2.550000	1.560569	798.011703	7.742152	-0.000000	2.224055
0.802349	2.850000	1.552666	793.153475	7.727714	-0.000000	0.536912
0.800654	3.150000	1.550957	793.904686	7.700324	-0.000000	0.337582
STREAMLINE 16						
0.581970	0.582132	3.010000	340.181992	10.748186	-0.000000	2.833375
0.657561	0.645643	2.708506	369.315697	10.210643	-0.000000	7.075245
0.747258	0.739818	2.463580	436.510109	9.733882	-0.000000	10.753308
0.860844	0.885125	2.252895	519.938873	9.282377	-0.000000	15.539882
0.968276	1.014925	2.140981	543.744606	9.089550	-0.000000	12.117790
1.064116	1.151556	2.051753	543.449341	8.993367	-0.000000	15.987104
1.144435	1.302244	2.009515	534.171577	8.947193	-0.000000	10.649172
1.185000	1.524391	1.969639	522.184326	8.913226	-0.000000	3.755375
1.190466	1.797410	1.941799	581.572403	8.722108	-0.000000	-1.254417
1.157251	2.100000	1.906984	762.738274	8.163368	-0.000000	-1.480209
1.127390	2.350000	1.877456	987.544664	7.352173	-0.000000	5.332365
1.119212	2.550000	1.869535	870.431419	7.743914	-0.000000	0.731579
1.115434	2.850000	1.865875	861.875244	7.743157	-0.000000	0.334510
1.114568	3.150000	1.864989	861.700546	7.716558	-0.000000	0.164197
STREAMLINE 21						
0.758788	0.759000	3.010000	357.868290	10.718747	0.	3.056959
0.824178	0.810000	2.735000	414.276752	10.168045	0.	7.827293
0.905361	0.890000	2.513000	519.959923	9.617226	0.	12.614864
1.010889	1.015000	2.328000	651.520416	9.033949	0.	21.273702
1.114054	1.120000	2.242000	670.325665	8.872091	0.	19.584972
1.212764	1.230000	2.188000	692.510811	8.737076	0.	25.159187
1.302942	1.352000	2.160000	639.562263	8.842950	0.	13.080172
1.364230	1.550000	2.147000	590.028603	8.936932	0.	3.076135
1.395782	1.803000	2.147000	643.591988	8.770262	0.	-0.716596
1.397322	2.100000	2.147000	828.493217	8.181007	0.	0.212459
1.396918	2.350000	2.147000	1051.483170	7.342592	0.	-0.061705
1.396596	2.550000	2.147000	937.061249	7.758596	0.	0.013247
1.396448	2.850000	2.147000	929.850731	7.755997	0.	-0.002039
1.396473	3.150000	2.147000	929.614441	7.728097	0.	-0.001470

ITERATION NO.106 MAX. STREAMLINE CHANGE = 0.000915

ITERATION NO.107

ALPHA	RC	SM	BETA	TT	SA	SB	SC	SD
STREAMLINE 1								
-92.079852	1.197485	0.	-25.085542	0.067282	-0.035649	2409.414703	0.981628	4.623333
-88.196739	2.938300	0.410011	-1.355874	0.085464	0.092429	473.735358	2.935831	-14.135957
-80.784849	5.758839	0.781480	0.000217	0.102356	0.922232	294.673634	5.684514	-47.998513
-69.173480	5.339704	1.204048	-0.000190	0.119518	1.898475	272.632027	4.990815	-103.632155
-56.547535	8.142886	1.598044	-0.000280	0.130582	4.488724	-245.542917	6.793964	152.314234
-41.600297	6.607853	2.012620	-0.015887	0.135975	4.941300	150.630854	4.387139	-165.170145
-24.788874	9.238318	2.436688	-0.049154	0.134488	4.387074	173.644947	3.873397	-357.595392
-10.733212	4.841406	2.867525	-4.452844	0.126025	4.636741	438.544933	0.878905	1201.911514
-2.107958	3.892939	3.279987	-16.745259	0.119840	2.242521	2199.423676	0.082541	4457.076011
0.231244	-0.674886	3.614993	-31.152805	0.104399	-4.776276	4187.341248	0.019777	9620.833252
-0.056674	0.199842	3.864993	-41.573327	0.055497	-6.961608	5359.006897	-0.006885	1935.435272
0.018123	-0.042660	4.064993	-41.599141	0.	-7.076388	5350.850281	0.002238	-2403.280823
-0.005654	0.009496	4.364993	-41.593157	0.	-7.070536	5359.884094	-0.000698	2129.153574
0.004545	0.004746	4.664993	-41.563993	0.	-7.067869	5357.933105	0.000561	-1139.172180
STREAMLINE 6								
-86.192426	2.045052	0.	-25.051566	0.059338	0.111445	2189.869476	1.674544	15.214757
-80.034306	5.269367	0.371252	-1.993864	0.074753	0.910801	-247.588562	5.183563	55.308590
-69.908507	7.964409	0.695910	0.000045	0.087284	2.735934	-497.570621	7.479737	181.991804
-55.227444	9.593286	1.040993	0.007030	0.096899	5.471243	-583.926216	7.880142	403.315490

-42.256077	9.370177	1.323094	-0.036073	0.100518	6.935300	-919.105957	6.400927	1021.785309
-39.969021	7.566375	1.600244	0.100227	0.100520	6.487713	154.597387	3.893439	-289.918599
-21.081983	7.205368	1.877626	-2.419274	0.097406	6.697061	602.144417	2.581762	-493.758505
-13.777638	2.777719	2.196640	-11.559214	0.092929	2.251640	1369.543198	0.552127	2124.587189
-12.924515	-1.669528	2.540141	-28.807953	0.096789	-3.307820	3610.050267	-0.759082	5002.913635
-14.103229	0.204163	2.868165	-44.919237	0.098458	-4.590942	5348.411671	-1.153440	11543.01953
-8.443632	8.123643	3.123841	-55.123064	0.062374	-3.981251	6735.892517	-0.590998	1788.649792
-3.405184	2.908270	3.324770	-54.870090	0.	-5.712037	6651.391052	-0.339076	-4014.155281
-0.843168	0.802779	3.624930	-54.773328	0.	-6.445198	6576.933167	-0.094855	1895.449292
0.000064	0.384300	3.924937	-54.713967	0.	-6.585154	6579.204529	0.000007	-1183.845399
STREAMLINE 11								
-82.339563	2.497980	0.	-24.901461	0.051653	0.274004	1633.758865	2.037204	117.804335
-75.512821	6.356512	0.338687	-3.022355	0.065171	1.585766	-1225.097336	6.137372	344.745410
-64.616480	9.465882	0.629759	-0.007564	0.075044	4.057788	-1463.916473	8.552033	697.358917
-49.688907	11.392922	0.925033	-0.009337	0.081511	7.370506	-1821.467529	8.687594	1547.961227
-37.586169	11.555781	1.143061	0.154729	0.083301	9.157116	-446.663994	7.048410	534.917145
-27.483977	8.863362	1.349809	-1.059155	0.082728	7.858189	462.410961	4.087922	-501.564235
-18.681746	8.772571	1.556557	-5.336945	0.080403	8.181177	823.455223	2.766271	309.339219
-11.522017	3.153880	1.820095	-16.719365	0.077098	2.265741	2410.478882	0.461877	1515.153895
-10.608468	-1.804881	2.123651	-35.307061	0.082852	-3.552184	4660.972473	-0.665317	5150.785011
-12.799867	-1.064492	2.439756	-51.350363	0.090418	-4.971482	6245.222778	-1.129481	13115.751982
-7.556935	8.595780	2.694593	-61.572864	0.065479	-3.978477	7216.994141	-0.527799	1481.013015
-2.692810	2.224066	2.895246	-61.545811	0.	-5.439581	7133.839355	-0.255840	-5822.402527
-0.701719	0.636912	3.195350	-61.519542	0.	-5.826373	7081.067505	-0.071361	1837.822197
-0.029677	0.307582	3.495355	-61.478693	0.	-5.903021	7081.939575	-0.003058	-1342.632874
STREAMLINE 16								
-81.057615	2.803305	0.	-24.837906	0.044646	0.358669	671.305443	2.279386	299.248615
-74.113600	7.076246	0.308111	-4.158922	0.056621	1.926673	-2279.930084	6.769744	713.324814
-63.050170	10.753308	0.570519	0.014372	0.065078	4.873506	-3487.054230	9.585538	1758.090231
-46.741236	15.639882	0.826452	0.125683	0.070376	10.717844	-2121.083954	11.389910	1959.977005
-35.281972	12.117790	0.997837	-0.588606	0.071436	9.889747	-242.787464	6.997662	555.145591
-24.454083	15.887104	1.155777	-3.456959	0.070763	14.388179	735.852089	6.543151	-147.793548
-14.452373	10.649172	1.315263	-8.538727	0.068634	9.953196	1605.810364	2.565247	-507.157570
-7.123102	3.756306	1.540951	-21.074204	0.066187	2.457659	3154.618988	0.307124	901.4 6708
-5.599013	-1.254417	1.815396	-39.933691	0.071426	-3.280351	5288.414368	-0.321584	4727.049530
-7.582535	-1.480208	2.119982	-55.721359	0.080416	-4.839810	6761.921814	-0.644267	13418.921875
-4.289842	6.332346	2.371720	-65.770160	0.066376	-4.251562	7414.753967	-0.318919	1063.455583
-1.125251	0.731679	2.571876	-65.679476	0.	-5.205934	7361.601929	-0.102254	-6905.020538
-0.367505	0.334510	2.871899	-65.704525	0.	-5.285952	7344.824158	-0.033905	1025.654053
-0.011572	0.154187	3.171900	-65.680281	0.	-5.315227	7344.801453	-0.001073	-1514.503333
STREAMLINE 21								
-82.387672	3.066959	0.	-24.895410	0.038014	0.334615	-544.800774	2.503716	413.509232
-75.479961	7.827293	0.278705	-5.249868	0.049174	1.946470	-3723.462433	7.515603	1025.048599
-64.180804	12.414864	0.515622	0.034850	0.057200	5.407071	-6800.428711	11.175512	3263.534050
-46.117389	21.203702	0.738893	-0.536589	0.062083	14.695595	-2319.579987	15.780266	2431.725464
-32.699182	19.584972	0.874617	-2.599059	0.062798	16.432699	-850.037590	10.549276	2339.477356
-19.041815	25.169187	0.997156	-6.177768	0.061950	23.452905	1445.935242	8.094635	-813.252251
-8.009016	13.080172	1.122328	-11.873043	0.059949	12.169130	2661.694275	1.712213	-5652.797913
-1.045930	3.076135	1.320755	-24.803829	0.057599	1.550693	3448.332916	0.023311	-165.993744
0.292417	-0.716506	1.573755	-43.302332	0.061141	-3.008553	5518.082153	0.015355	4490.252441
-0.072003	0.212459	1.870755	-59.977537	0.069061	-4.136812	6979.509644	-0.005199	12528.465187
0.017547	-0.061705	2.120755	-68.572921	0.066554	-4.851517	7502.671143	0.001486	579.984350
-0.005614	0.013247	2.320755	-68.522058	0.	-4.838128	7500.364258	-0.000474	-6901.589514
0.001766	-0.002939	2.620755	-68.579642	0.	-4.844119	7503.269592	0.000149	1883.128005
-0.001392	-0.001470	2.920755	-68.566519	0.	-4.843053	7502.593506	-0.000118	-1523.460083

DN	Z	R	4A	PRESS	WTR	RC
STREAMLINE 1						
0.	0.	3.010000	307.965088	10.798088	183.159516	1.197485

0.	-0.003000	2.600000	269.501698	10.213267	44.381239	2.938300
0.	0.030000	2.730000	255.311989	9.745524	17.649894	5.758539
0.	0.140000	1.822000	249.271402	9.309812	85.447875	5.339704
0.	0.317000	1.470000	242.361450	9.007061	131.817118	8.142886
0.	0.590000	1.158000	257.816582	8.765873	197.366289	4.507833
0.	0.943000	0.923000	229.855871	8.650198	205.535545	9.230318
0.	1.355000	0.797000	249.725034	8.551350	215.551575	4.841405
0.	1.765000	0.752000	326.490009	8.417940	284.071049	3.892939
0.	2.100000	0.750000	518.568565	8.069547	393.212330	-0.574885
0.	2.350000	0.750000	686.538170	7.658735	597.579430	0.199942
0.	2.550000	0.750000	645.716766	7.752184	636.029503	-0.042550
0.	2.850000	0.750000	679.323357	7.648843	670.534271	0.009495
0.	3.150000	0.750000	687.157875	7.611016	689.221565	0.004745
STREAMLINE 6						
0.200996	0.201052	3.010000	315.162880	10.787358	204.097569	2.045057
0.248925	0.242549	2.641075	294.623375	10.233666	79.501489	5.259305
0.310379	0.324828	2.327019	305.190823	9.790318	74.960696	7.954472
0.395792	0.482586	2.020113	324.033592	9.400119	165.568123	9.593239
0.487955	0.668713	1.808135	345.822739	9.145304	237.262314	9.370250
0.571804	0.891753	1.643633	369.588024	8.948539	297.768276	7.556360
0.631045	1.141088	1.522107	340.962872	8.876746	211.972967	7.205534
0.639193	1.446364	1.429523	364.593916	8.750896	207.946825	2.777501
0.602046	1.781391	1.353707	440.297020	8.547420	253.863977	-1.669562
0.525808	2.100000	1.275685	616.861465	8.096542	373.503254	0.203925
0.472086	2.350000	1.222112	792.771034	7.564170	680.776035	9.123551
0.452676	2.550000	1.202808	717.308304	7.759149	730.896538	2.908151
0.442807	2.850000	1.192983	727.220551	7.705014	716.165359	0.802078
0.440866	3.150000	1.191034	730.770477	7.672917	73[illegible].246048	0.394392
STREAMLINE 11						
0.395423	0.395533	3.013000	325.857048	10.770970	224.906893	2.697965
0.466942	0.457608	2.577051	328.782814	10.232790	127.450715	5.855345
0.552826	0.555128	2.402804	365.786694	9.787643	142.700813	9.455879
0.663473	0.714284	2.154100	411.984879	9.395243	256.589874	11.393339
0.770040	0.872037	2.003609	448.606117	9.152268	335.957592	11.556189
0.865545	1.046765	1.893107	440.459671	9.043905	238.306179	8.852208
0.936476	1.236964	1.812079	437.571918	8.957729	235.808084	8.773085
0.959023	1.492080	1.746016	444.565285	8.864217	191.623953	3.153740
0.939359	1.790574	1.599839	513.566574	8.653436	251.132151	-1.835088
0.876405	2.100000	1.626199	694.445938	8.130874	376.590378	-1.064787
0.826733	2.350000	1.576779	900.876277	7.434424	770.723373	8.595582
0.810364	2.550000	1.560600	798.018745	7.742153	830.394569	2.224011
0.802372	2.850000	1.552693	793.158302	7.727709	781.337524	0.537241
0.800676	3.150000	1.550981	793.910995	7.700321	802.454147	0.307736
STREAMLINE 16						
0.581975	0.582138	3.010000	340.182526	10.748185	247.099993	2.803298
0.657574	0.645654	2.708508	369.316677	10.210644	183.061054	7.075131
0.747275	0.739834	2.463585	436.518093	9.733873	220.004879	10.753232
0.860868	0.885143	2.252905	519.947258	9.282370	357.520557	15.541154
0.968302	1.014942	2.140998	543.757790	9.089538	256.899998	12.115574
1.064143	1.151568	2.061774	543.4590[illegible]1	8.993366	268.854904	15.888821
1.144462	1.302252	2.009539	534.182228	8.947193	261.808247	10.549207
1.185031	1.524385	1.959665	522.189201	8.913236	191.402967	3.755902
1.[illegible]20495	1.797411	1.941825	581.577255	8.722123	276.503910	-1.254530
1.157279	2.100000	1.907008	762.741524	8.163381	404.695511	-1.480363
1.127415	2.350000	1.877478	987.548767	7.352176	849.245132	6.332313
1.119229	2.550000	1.869555	870.436935	7.743912	908.501259	0.731835
1.115446	2.850000	1.855892	861.882187	7.743148	847.635330	0.334714
1.114580	3.150000	1.865004	861.705940	7.716552	873.430992	0.164295
STREAMLINE 21						
0.758788	0.759000	3.010000	357.868176	10.718747	268.014072	3.056959

0.824179	0.810000	2.736000	414.274696	10.168049	245.513897	7.827293
0.905361	0.890000	2.513000	519.960502	9.617225	302.936909	12.414864
1.010892	1.015000	2.328000	651.511513	9.033974	256.796684	21.203702
1.114056	1.120000	2.242000	670.013733	8.872125	286.295414	19.594972
1.212764	1.230000	2.188000	692.500496	8.737106	329.763535	25.159187
1.302944	1.352000	2.160000	639.5[illegible]5328	8.842977	313.160950	13.080172
1.364235	1.550000	2.147000	590.021835	8.936949	222.181339	3.076135
1.395786	1.803000	2.147000	643.588181	8.770273	306.830257	-0.715506
1.397328	2.100000	2.147000	828.489792	8.181018	461.813942	0.212459
1.396922	2.350000	2.147000	1051.482574	7.342595	917.599991	-0.061705
1.396[illegible]94	2.550000	2.147000	937.062500	7.758592	960.334343	0.013267
1.396442	2.850000	2.147000	929.853561	7.755987	915.630478	-0.002939
1.396468	3.150000	2.147000	929.616028	7.728092	941.769290	-0.001470

ITERATION NO.107 MAX. STREAMLINE CHANGE = 0.000871

STREAMLINE SPACING ALONG NORMAL

HUB	MEAN	SHROUD
0.040693	0.037813	0.034168
0.052181	0.040605	0.031432
0.068673	0.042892	0.028822
0.094510	0.044754	0.025841
0.130443	0.045669	0.025764
0.170835	0.045781	0.026083
0.206420	0.048879	0.028606
0.200044	0.052244	0.033175
0.175676	0.055190	0.038419
0.134393	0.060227	0.045457
0.110665	0.063937	0.052036
0.102950	0.065784	0.052418
0.099283	0.066623	0.054067
0.098594	0.066764	0.054241

BLADE COORDINATES

HUB				MEAN				SHROUD			
1	KHMX	KHP1	KMX	1	KHMX	KHP1	KMX	1	KHMX	KHP1	KMX
-0.5600	-0.2968	-0.2744	-0.0112	-0.5626	-0.2942	-0.2770	-0.0086	-0.5649	-0.2920	-0.2793	-0.0064
-0.5548	-0.3020	-0.2692	-0.0164	-0.5599	-0.2978	-0.2734	-0.0122	-0.5622	-0.2946	-0.2765	-0.0099
-0.5482	-0.3085	-0.2626	-0.0229	-0.5595	-0.3012	-0.2700	-0.0156	-0.5597	-0.2968	-0.2741	-0.0112
-0.5384	-0.3184	-0.2528	-0.0328	-0.5523	-0.3045	-0.2667	-0.0190	-0.5580	-0.2990	-0.2724	-0.0134
-0.5268	-0.3300	-0.2412	-0.0444	-0.5503	-0.3063	-0.2647	-0.0207	-0.5588	-0.3013	-0.2733	-0.0157
-0.5125	-0.3443	-0.2269	-0.0587	-0.5497	-0.3078	-0.2641	-0.0222	[illegible]	-0.3056	-0.2773	-0.0200
-0.4984	-0.3585	-0.2128	-0.0729	-0.5552	-0.3140	-0.2596	-0.0284	[illegible]	-0.3143	-0.2866	-0.0287
-0.5103	-0.3828	-0.2247	-0.0972	-0.5828	-0.3414	-0.2972	-0.0558	[illegible]	[illegible]	-0.3172	-0.0564
-0.6036	-0.4774	-0.3180	-0.1918	-0.6575	-0.4308	-0.3816	-0.1452	-0.6831	-0.4260	-0.3975	-0.1404
-0.8085	-0.6621	-0.5229	-0.3765	-0.8503	-0.6203	-0.6047	-0.3347	-0.8620	-0.6076	-0.5754	-0.3230
-1.0977	-0.8861	-0.8121	-0.6005	-1.1129	-0.8698	-0.8283	-0.5842	-1.1197	-0.8646	-0.8336	-0.5790
-1.3724	-1.0868	-1.0868	-0.8012	-1.3724	-1.0868	-1.0868	-0.8012	-1.3724	-1.0868	-1.0869	-0.8012
-1.7284	-1.4428	-1.4428	-1.1572	-1.7284	-1.4428	-1.4428	-1.1572	-1.7284	-1.4428	-1.4428	-1.1572
-2.0844	-1.7988	-1.7988	-1.5132	-2.0844	-1.7988	-1.7988	-1.5132	-2.0844	-1.7988	-1.7988	-1.5132

INLET ANGLES - HUB -24.56, MEAN -23.38, SHROUD -21.61

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RUN NO.  2              INPUT DATA CARD LISTING
  22     8     0     2    0.1500    0.0010    0.2000
   0.          3.3100     0.0380
  15    22     8     0 4030.0000    0.0305   11.0000     1.6567 1245.0000
   2     2     0    12 1950.0000  221.5000    0.0247     0.0010    0.2500 6941.2549
   0     5     2     0  -24.5566    0.0000    0.1500
  -0.5561   -0.5600   -0.5548   -0.5482   -0.5384   -0.5268   -0.5125
  -0.4984   -0.5103   -0.6036   -0.8085   -1.0977   -1.3724   -1.7284
  -2.0844
   0.0151   -0.0112   -0.0164   -0.0229   -0.0328   -0.0444   -0.0587
  -0.0729   -0.0972   -0.1918   -0.3765   -0.6005   -0.8012   -1.1572
  -1.5132
  -0.2705   -0.2968   -0.3020   -0.3085   -0.3184   -0.3300   -0.3443
  -0.3585
  -0.2705   -0.2744   -0.2692   -0.2626   -0.2528   -0.2412   -0.2269
  -0.2128
   0.        0.       -0.0002    0.0025    0.0117    0.0264    0.0492
   0.0786    0.1129    0.1471    0.1750    0.1958    0.2125    0.2375
   0.2625
   0.2758    0.2508    0.2167    0.1858    0.1518    0.1225    0.0965
   0.0769    0.0664    0.0627    0.0625    0.0625    0.0625    0.0625
   0.0625
   0.0032    0.0034    0.0043    0.0057    0.0079    0.0109    0.0142
   0.0172    0.0167    0.0146    0.0112    0.0092    0.0085    0.0083
   0.0082
   1
711-0.33890 811-0.31900 712-0.23630 812-0.28660 812-0.286600
 THETA-CALCULATED AND/OR INPUT
  -0.5561   -0.5600   -0.5548   -0.5482   -0.5384   -0.5268   -0.5125
  -0.4984   -0.5103   -0.6036   -0.8085   -1.0977   -1.3724   -1.7294
  -2.0844
  -0.5275   -0.5337   -0.5295   -0.5243   -0.5164   -0.5071   -0.4957
  -0.4844   -0.4897   -0.5830   -0.7869   -1.0728   -1.3438   -1.6998
  -2.0558
  -0.4990   -0.5074   -0.5042   -0.5003   -0.4944   -0.4874   -0.4789
  -0.4704   -0.4690   -0.5624   -0.7653   -1.0479   -1.3153   -1.6713
  -2.0273
  -0.4704   -0.4810   -0.4789   -0.4763   -0.4724   -0.4678   -0.4621
  -0.4564   -0.4484   -0.5419   -0.7437   -1.0231   -1.2867   -1.6427
  -1.9987
  -0.4418   -0.4547   -0.4537   -0.4524   -0.4504   -0.4481   -0.4453
  -0.4424   -0.4277   -0.5213   -0.7221   -0.9982   -1.2582   -1.6141
  -1.9701
  -0.4133   -0.4284   -0.4284   -0.4284   -0.4284   -0.4284   -0.4284
  -0.4284   -0.4071   -0.5007   -0.7005   -0.9733   -1.2296   -1.5856
  -1.9416
  -0.3847   -0.4021   -0.4031   -0.4044   -0.4064   -0.4087   -0.4116
  -0.4145   -0.3864   -0.4801   -0.6789   -0.9485   -1.2010   -1.5570
  -1.9130
  -0.3562   -0.3757   -0.3779   -0.3805   -0.3844   -0.3890   -0.3948
  -0.4005   -0.3657    0.4595   -0.6573   -0.9236   -1.1725   -1.5285
  -1.8845
  -0.3276   -0.3494   -0.3526   -0.3565   -0.3624   -0.3694   -0.3780
  -0.3865   -0.3451   -0.4389   -0.6357   -0.8988   -1.1439   -1.4999
  -1.8559
  -0.2990   -0.3231   -0.3273   -0.3325   -0.3404   -0.3497   -0.3612
  -0.3725   -0.3244   -0.4183   -0.6141   -0.8739   -1.1154   -1.4713
  -1.8273
  -0.2705   -0.2968   -0.3020   -0.3085   -0.3184   -0.3300   -0.3389
  -0.3190   -0.3038   -0.3977   -0.5925   -0.8491   -1.0868   -1.4428
  -1.7988
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E-3298

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-0.2705  -0.2744  -0.2692  -0.2626  -0.2528  -0.2412  -0.2363
-0.2866  -0.3038  -0.3977  -0.5925  -0.8491  -1.0868  -1.4428
-1.7988
-0.2419  -0.2481  -0.2439  -0.2387  -0.2308  -0.2215  -0.2101
-0.1988  -0.2831  -0.3771  -0.5709  -0.8242  -1.0582  -1.4142
-1.7702
-0.2134  -0.2218  -0.2186  -0.2147  -0.2088  -0.2018  -0.1933
-0.1848  -0.2625  -0.3565  -0.5493  -0.7993  -1.0297  -1.3857
-1.7417
-0.1848  -0.1954  -0.1935  -0.1907  -0.1858  -0.1822  -0.1765
-0.1708  -0.2418  -0.3359  -0.5277  -0.7745  -1.0011  -1.3571
-1.7131
-0.1562  -0.1691  -0.1681  -0.1668  -0.1648  -0.1625  -0.1597
-0.1568  -0.2212  -0.3153  -0.5061  -0.7496  -0.9726  -1.3285
-1.6845
-0.1277  -0.1428  -0.1428  -0.1428  -0.1428  -0.1428  -0.1428
-0.1428  -0.2005  -0.2947  -0.4845  -0.7248  -0.9440  -1.3000
-1.6560
-0.0991  -0.1165  -0.1175  -0.1188  -0.1208  -0.1231  -0.1260
-0.1289  -0.1799  -0.2742  -0.4629  -0.6999  -0.9154  -1.2714
-1.6274
-0.0706  -0.0901  -0.0923  -0.0949  -0.0988  -0.1034  -0.1092
-0.1149  -0.1592  -0.2536  -0.4413  -0.6750  -0.8869  -1.2429
-1.5989
-0.0420  -0.0638  -0.0670  -0.0709  -0.0768  -0.0838  -0.0924
-0.1009  -0.1386  -0.2330  -0.4197  -0.6502  -0.8533  -1.2143
-1.5703
-0.0134  -0.0375  -0.0417  -0.0469  -0.0548  -0.0641  -0.0756
-0.0869  -0.1179  -0.2124  -0.3981  -0.6253  -0.8298  -1.1857
-1.5417
 0.0151  -0.0112  -0.0164  -0.0229  -0.0328  -0.0444  -0.0587
-0.0729  -0.0972  -0.1918  -0.3765  -0.6005  -0.8012  -1.1572
-1.5132

  STAG. SPEED OF SOUND AT INLET =  2011.55

  ITERATION NO.  1        MAX. STREAMLINE CHANGE =  0.068444
  ITERATION NO.  2        MAX. STREAMLINE CHANGE =  0.058218
  ITERATION NO.  3        MAX. STREAMLINE CHANGE =  0.049416
  ITERATION NO.  4        MAX. STREAMLINE CHANGE =  0.041949
  ITERATION NO.  5        MAX. STREAMLINE CHANGE =  0.035614
  ITERATION NO.  6        MAX. STREAMLINE CHANGE =  0.030236
  ITERATION NO.  7        MAX. STREAMLINE CHANGE =  0.025670
  ITERATION NO.  8        MAX. STREAMLINE CHANGE =  0.021794
  ITERATION NO.  9        MAX. STREAMLINE CHANGE =  0.018503
  ITERATION NO. 10        MAX. STREAMLINE CHANGE =  0.015709
  ITERATION NO. 11        MAX. STREAMLINE CHANGE =  0.013338
  ITERATION NO. 12        MAX. STREAMLINE CHANGE =  0.011324
  ITERATION NO. 13        MAX. STREAMLINE CHANGE =  0.009614
  ITERATION NO. 14        MAX. STREAMLINE CHANGE =  0.008163
  ITERATION NO. 15        MAX. STREAMLINE CHANGE =  0.006931
  ITERATION NO. 16        MAX. STREAMLINE CHANGE =  0.005885
  ITERATION NO. 17        MAX. STREAMLINE CHANGE =  0.004996
  ITERATION NO. 18        MAX. STREAMLINE CHANGE =  0.004248
  ITERATION NO. 19        MAX. STREAMLINE CHANGE =  0.003601
  ITERATION NO. 20        MAX. STREAMLINE CHANGE =  0.003061
  ITERATION NO. 21        MAX. STREAMLINE CHANGE =  0.002595
  ITERATION NO. 22        MAX. STREAMLINE CHANGE =  0.002207
  ITERATION NO. 23        MAX. STREAMLINE CHANGE =  0.001876
  ITERATION NO. 24        MAX. STREAMLINE CHANGE =  0.001588
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ITERATION NO. 25 MAX. STREAMLINE CHANGE = 0.001350
ITERATION NO. 26 MAX. STREAMLINE CHANGE = 0.001148
ITERATION NO. 27 MAX. STREAMLINE CHANGE = 0.000976
ITERATION NO. 28 MAX. STREAMLINE CHANGE = 0.000829

ITERATION NO. 29

QUASI-ORTHOGONAL 1 SM =-0.3000 ALPHA = -89.41 R = 3.3100 Z = 0. DN = 0.0380

THETA	T-CURV	BETA	WA	WTHETA	VTHETA	WM	V	PRS	DENSTY	DTDM	DWDM	SA	S3	DWDT
-0.5561	41.46	-48.57	375.8	-281.8	829.8	248.7	866.3	11.22	0.02271	-4.11	6941.	0.4961	-204.1	-17.7
-0.4148	34.12	-48.57	373.2	-279.8	831.8	247.0	867.7	11.23	0.02271	-4.11	6941.	0.4961	-204.1	-19.0
-0.2726	30.29	-48.57	370.4	-277.7	833.9	245.1	869.2	11.23	0.02272	-4.11	6941.	0.4961	-204.1	-20.4
-0.2726	42.80	-48.57	370.4	-277.7	833.9	245.1	869.2	11.23	0.02272	-4.11	6941.	0.4961	-204.1	-20.4
-0.1293	33.7	-48.57	367.4	-275.5	836.1	243.1	870.8	11.24	0.02272	-4.11	6941.	0.4961	-204.1	-21.9
0.0151	28.91	-48.57	364.1	-273.0	838.6	241.0	872.5	11.24	0.02273	-4.11	6941.	0.4961	-204.1	-23.5

QUASI-ORTHOGONAL 2 SM = 0. ALPHA = -90.72 R = 3.0100 Z = 0. DN = 0.0407

THETA	T-CURV	BETA	WA	WTHETA	VTHETA	WM	V	PRS	DENSTY	DTDM	DWDM	SA	S3	DWDT
-0.5600	-18.89	5.70	290.8	28.9	1059.7	289.3	1079.2	10.82	0.02220	0.40	9107.	-0.0988	251.6	232.8
-0.4339	-13.71	-1.75	288.3	-8.8	1002.1	288.2	1042.7	10.83	0.02221	-0.12	6941.	0.0305	-280.5	-271.7
-0.2967	-8.67	-0.62	252.0	-2.7	1008.1	252.0	1039.2	10.87	0.02226	-0.04	7999.	0.0108	-15.2	-12.5
-0.2744	-20.3	5.97	295.8	30.8	1041.6	294.2	1082.4	10.82	0.02219	0.42	8984.	-0.1034	230.7	290.1
-0.1495	-13.0	-1.94	289.5	-9.8	1001.1	289.4	1042.0	10.82	0.02220	-0.14	6784.	0.0336	-319.8	-310.0
-0.0112	-7.16	-0.88	246.5	-3.8	1007.1	246.5	1036.8	10.89	0.02227	-0.06	7798.	0.0154	-65.4	-51.5

QUASI-ORTHOGONAL 3 SM = 0.4100 ALPHA = -88.60 R = 2.6000 Z =-0.0030 DN = 0.0522

THETA	T-CURV	BETA	WA	WTHETA	VTHETA	WM	V	PRS	DENSTY	DTDM	DWDM	SA	S3	DWDT
-0.5548	0.36	1.97	531.8	18.3	891.5	531.5	1037.9	9.73	0.02081	0.05	-2579.	-0.0344	-2303.2	-2321.5
-0.4751	11.56	-6.86	359.8	-43.0	830.2	357.3	903.8	10.08	0.02126	-0.56	-892.	0.1185	-1925.1	-1882.4
-0.3020	-0.20	-2.16	28.8	-1.1	872.1	28.8	872.6	10.38	0.02163	-0.20	-2101.	0.0376	-2199.4	-2193.3
-0.2692	0.34	1.94	530.2	18.0	891.1	529.9	1036.8	9.74	0.02082	0.05	-2541.	-0.0330	-2295.0	-2312.9
-0.1892	11.04	-6.66	358.0	-41.5	831.7	355.5	904.5	10.09	0.02126	-0.54	-808.	0.1151	-1908.0	-1866.8
-0.0164	-0.22	-2.14	31.4	-1.2	872.0	31.4	872.6	10.38	0.02163	-0.19	-2017.	0.0374	-2181.3	-2180.1

QUASI-ORTHOGONAL 4 SM = 0.7818 ALPHA = -80.63 R = 2.2300 Z = 0.0300 DN = 0.0687

THETA	T-CURV	BETA	WA	WTHETA	VTHETA	WM	V	PRS	DENSTY	DTDM	DWDM	SA	S3	DWDT
-0.5482	0.12	2.63	404.9	18.6	757.5	404.4	867.5	9.53	0.02052	0.18	767.	-0.0453	-1333.9	-1352.2
-0.4580	-5.28	6.51	302.4	34.3	783.2	300.5	838.8	9.69	0.02073	0.61	1878.	-0.1111	-1121.5	-1155.1
-0.3085	-0.19	-2.51	112.5	-5.1	743.8	112.3	752.2	9.86	0.02096	-0.14	500.	0.0449	-1383.5	-1378.4
-0.2626	0.19	2.72	407.1	19.3	768.2	406.6	869.2	9.52	0.02052	0.18	655.	-0.0467	-1354.6	-1373.6
-0.1727	-4.86	6.49	303.5	34.3	783.2	301.5	839.3	9.69	0.02073	0.61	1761.	-0.1109	-1143.3	-1176.9
-0.0229	-0.16	-2.60	110.6	-5.0	743.9	110.5	752.1	9.86	0.02096	-0.14	460.	0.0447	-1391.0	-1386.1

QUASI-ORTHOGONAL 5 SM = 1.2040 ALPHA = -69.23 R = 1.8220 Z = 0.1400 DN = 0.0945

THETA	T-CURV	BETA	WA	WTHETA	VTHETA	WM	V	PRS	DENSTY	DTDM	DWDM	SA	S3	DWDT
-0.5384	0.22	2.77	402.8	19.5	631.4	402.3	748.7	9.09	0.01993	0.16	-238.	-0.0451	-1178.9	-1197.1
-0.4553	2.97	1.05	296.0	5.4	617.3	296.0	684.6	9.25	0.02015	0.12	-956.	-0.0172	-1289.1	-1294.2
-0.3184	-0.13	-2.71	124.4	-5.9	606.0	124.3	618.6	9.41	0.02035	-0.17	-258.	0.0442	-1182.1	-1175.6
-0.2528	-0.04	2.50	399.4	17.4	629.3	399.0	745.2	9.10	0.01994	0.16	77.	-0.0408	-1131.5	-1147.8

-0.1693	2.46	0.88	295.0	4.5	616.4	294.9	683.3	9.26	0.02015	0.10	-788.	-0.0144	-1263.6	-1267.9
-0.0328	-0.18	2.75	126.4	-6.4	605.8	126.3	618.8	9.41	0.02035	-0.17	-184.	0.0449	-1170.7	-1155.1

QUASI-ORTHOGONAL 6 SM = 1.5980 ALPHA = -55.53 R = 1.4700 Z = 0.3170 DN = 0.1304

THETA	T-CURV	BETA	WA	WTHETA	VTHETA	WM	V	PRS	DENSTY	DTDM	DWDM	SA	S3	DWDT
-0.5268	0.19	2.68	347.1	16.2	509.9	346.7	616.6	8.88	0.01962	0.25	-26.	-0.0389	-825.9	-839.4
-0.4419	-1.56	2.79	279.1	13.6	507.3	278.8	578.8	8.97	0.01974	0.40	396.	-0.0405	-774.2	-785.5
-0.3301	-0.40	-2.92	191.3	-9.7	483.9	191.1	520.3	9.05	0.01986	-0.25	120.	0.0424	-807.9	-799.8
-0.2412	1.08	3.46	353.0	21.3	515.0	352.3	624.3	8.87	0.01961	0.26	-701.	-0.0502	-907.8	-925.6
-0.1570	-0.76	3.05	280.0	14.9	508.5	279.5	583.4	8.97	0.01974	0.43	-17.	-0.0443	-824.6	-837.0
-0.0444	-0.19	-2.74	187.5	-9.0	484.7	187.3	519.6	9.06	0.01986	-0.24	-67.	0.0398	-830.9	-823.4

QUASI-ORTHOGONAL 7 SM = 2.0126 ALPHA = -41.50 R = 1.1580 Z = 0.5900 DN = 0.1708

THETA	T-CURV	BETA	WA	WTHETA	VTHETA	WM	V	PRS	DENSTY	DTDM	DWDM	SA	S3	DWDT
-0.5125	0.24	2.51	346.2	15.[illegible]	404.0	345.9	531.9	8.65	0.01930	0.32	-51.	-0.0290	-520.9	-531.0
-0.4320	1.53	2.16	303.3	11.4	400.3	303.1	502.1	8.71	0.01938	0.39	-26.	-0.0250	-518.6	-526.2
-0.3388	3.14	0.84	256.5	3.8	392.5	256.5	469.0	8.77	0.01945	-0.31	581.	-0.0097	-460.4	-462.8
-0.2363	-7.21	-4.34	345.2	-26.1	362.8	344.2	505.1	8.66	0.01930	0.29	-951.	0.0501	-606.5	-589.2
-0.1547	-3.79	-2.83	297.5	-14.7	374.2	297.1	477.8	8.72	0.01939	-0.51	-674.	0.0327	-580.8	-571.0
-0.0587	0.03	-2.34	245.5	-10.0	378.9	245.3	451.3	8.78	0.01947	-0.37	98.	0.0271	-506.6	-499.9

QUASI-ORTHOGONAL 8 SM = 2.4367 ALPHA = -25.79 R = 0.9230 Z = 0.9430 DN = 0.2064

THETA	T-CURV	BETA	WA	WTHETA	VTHETA	WM	V	PRS	DENSTY	DTDM	DWDM	SA	S3	DWDT
-0.4984	-1.24	1.06	332.3	6.2	315.1	332.2	458.6	8.53	0.01911	0.38	-622.	-0.0078	-307.7	-310.3
-0.4126	-0.83	2.37	306.4	12.7	322.7	305.1	444.8	8.57	0.01916	0.54	-384.	-0.0173	-289.2	-294.5
-0.3189	-0.43	3.19	279.3	15.5	325.5	278.9	428.7	8.60	0.01920	-0.47	-273.	-0.0233	-280.5	-287.0
-0.2866	5.43	-5.09	280.0	-24.9	285.1	279.5	399.2	8.60	0.01920	0.49	457.	0.0371	-223.9	-211.5
-0.1845	2.91	-3.08	257.4	-13.8	296.1	257.0	392.1	8.62	0.01923	-0.70	190.	0.0225	-245.0	-239.2
-0.0729	0.27	-1.58	229.4	-6.3	303.5	229.3	380.5	8.65	0.01927	-0.39	-109.	0.0116	-268.2	-255.5

QUASI-ORTHOGONAL 9 SM = 2.8675 ALPHA = -10.73 R = 0.7970 Z = 1.3550 DN = 0.2000

THETA	T-CURV	BETA	WA	WTHETA	VTHETA	WM	V	PRS	DENSTY	DTDM	DWDM	SA	S3	DWDT
-0.5103	-5.42	-4.60	358.2	-28.7	238.9	357.0	429.6	8.42	0.01893	0.45	-1129.	0.0149	-174.1	-168.8
-0.4153	-6.80	-4.27	340.9	-25.4	242.3	339.9	417.4	8.44	0.01897	-1.12	-1495.	0.0138	-198.4	-193.7
-0.3152	-7.70	-3.97	320.3	-22.2	245.4	320.0	403.3	8.47	0.01900	0.15	-1628.	0.0129	-207.3	-203.2
-0.3152	-5.87	-4.78	320.8	-26.1	240.9	319.7	400.3	8.47	0.01900	-0.79	-923.	0.0155	-160.6	-155.5
-0.2093	-5.60	-4.93	303.9	-26.1	241.5	302.8	387.3	8.49	0.01903	-1.30	-1033.	0.0159	-167.7	-157.8
-0.0972	-4.89	-5.21	285.7	-26.0	241.7	284.5	373.3	8.51	0.01906	-0.42	-980.	0.0169	-164.1	-159.3

QUASI-ORTHOGONAL 10 SM = 3.2800 ALPHA = -2.11 R = 0.7520 Z = 1.7650 DN = 0.1757

THETA	T-CURV	BETA	WA	WTHETA	VTHETA	WM	V	PRS	DENSTY	DTDM	DWDM	SA	S3	DWDT
-0.6036	-8.86	-16.04	477.3	-131.9	120.7	458.8	474.4	8.17	0.01858	0.24	-6770.	0.0098	-426.1	-421.4
-0.5113	-8.47	-16.45	442.2	-125.2	127.4	424.1	442.8	8.24	0.01867	-4.71	-5534.	0.0100	-350.4	-346.0
-0.4122	-8.24	-16.63	410.5	-117.5	135.0	393.4	415.9	8.29	0.01874	0.72	-4705.	0.0101	-300.3	-295.2
-0.4122	-8.71	-16.47	410.5	-116.4	136.2	393.7	416.6	8.29	0.01874	-1.16	-4794.	0.0100	-305.9	-301.6
-0.3059	-8.59	-16.28	380.6	-106.7	145.8	365.3	393.4	8.34	0.01881	-4.66	-4158.	0.0099	-268.0	-254.2
-0.1918	-8.27	-15.67	352.2	-95.1	157.4	339.1	373.8	8.38	0.01886	-0.36	-3663.	0.0096	-238.9	-235.5

QUASI-ORTHOGONAL 11 SM = 3.6150 ALPHA = 0.23 R = 0.7500 Z = 2.1000 DN = 0.1344

THETA	T-CURV	BETA	WA	WTHETA	VTHETA	WM	V	PRS	DENSTY	DTDM	DWDM	SA	SB	DWDT
-0.8085	-11.20	-34.56	695.2	-394.4	-142.5	572.5	590.0	7.65	0.01784	-1.21	-10037.	-0.0019	-515.0	-515.3
-0.7095	-9.74	-32.31	644.9	-344.7	-92.9	545.0	552.9	7.78	0.01802	-10.12	-9395.	-0.0018	-494.6	-495.8
-0.6058	-8.76	-30.84	595.4	-305.2	-53.3	511.2	514.0	7.90	0.01819	-1.05	-8551.	-0.0018	-457.1	-459.2
-0.6058	-8.67	-30.87	595.4	-305.5	-53.6	511.0	513.8	7.90	0.01819	-1.26	-8554.	-0.0018	-457.1	-458.2
-0.4955	-8.38	-30.09	546.9	-274.2	-22.4	473.2	473.7	8.01	0.01834	-9.27	-7807.	-0.0018	-420.4	-421.4
-0.3765	-9.09	-29.93	498.4	-248.8	3.1	432.0	432.0	8.11	0.01847	-1.37	-7341.	-0.0017	-395.9	-396.7

QUASI-ORTHOGONAL 12 SM = 3.8650 ALPHA = -0.06 R = 0.7500 Z = 2.3500 DN = 0.1107

THETA	T-CURV	BETA	WA	WTHETA	VTHETA	WM	V	PRS	DENSTY	DTDM	DWDM	SA	SB	DWDT
-1.0977	-2.88	-45.28	742.2	-527.4	-275.5	522.2	590.4	7.51	0.01762	-4.59	-89.	0.0005	-4.3	-3.9
-0.9698	-3.48	-42.23	735.3	-494.2	-242.3	544.4	595.9	7.53	0.01765	-14.52	-2181.	0.0005	-101.3	-100.9
-0.8460	-3.30	-39.51	718.2	-456.9	-205.1	554.1	590.8	7.57	0.01772	-4.77	-3523.	0.0005	-170.3	-169.9
-0.8460	-3.32	-39.50	718.2	-456.9	-205.0	554.2	590.9	7.57	0.01772	-4.72	-3514.	0.0005	-169.8	-169.5
-0.7236	-2.22	-37.30	694.8	421.0	-169.2	552.7	578.0	7.64	0.01781	-12.19	-4202.	0.0005	-209.3	-209.0
-0.6005	-0.17	-35.82	667.9	-390.9	-139.0	541.5	559.2	7.71	0.01790	-4.48	-4414.	0.0005	-224.1	-223.8

QUASI-ORTHOGONAL 13 SM = 4.0650 ALPHA = 0.02 R = 0.7500 Z = 2.5500 DN = 0.1030

THETA	T-CURV	BETA	WA	WTHETA	VTHETA	WM	V	PRS	DENSTY	DTDM	DWDM	SA	SB	DWDT
-1.3724	3.85	-44.60	669.9	-470.3	-218.4	475.9	524.6	7.69	0.01787	-11.02	3300.	-0.0002	147.0	145.9
-1.2234	1.44	-42.64	687.0	-474.0	-222.1	497.2	544.5	7.65	0.01781	-15.26	1784.	-0.0002	80.8	80.7
-1.0794	-0.71	-42.29	693.7	-466.7	-214.9	513.1	556.3	7.63	0.01778	-9.55	284.	-0.0002	13.2	13.1
-1.0794	-0.71	-42.29	693.7	-466.7	-214.9	513.1	556.2	7.63	0.01778	-9.56	277.	-0.0002	12.9	12.8
-0.9391	-2.68	-40.73	691.3	-451.0	-199.2	523.8	560.4	7.63	0.01779	-13.78	-938.	-0.0002	-44.3	-44.4
-0.8012	-4.37	-39.08	682.4	-430.1	-178.2	529.7	558.9	7.66	0.01783	-9.21	-1671.	-0.0002	-80.9	-81.0

QUASI-ORTHOGONAL 14 SM = 4.3650 ALPHA = -0.01 R = 0.7500 Z = 2.8500 DN = 0.0993

THETA	T-CURV	BETA	WA	WTHETA	VTHETA	WM	V	PRS	DENSTY	DTDM	DWDM	SA	SB	DWDT
-1.7284	-1.10	-40.69	721.1	-470.2	-218.3	546.8	588.8	7.54	0.01764	-16.16	-944.	0.0000	-44.8	-44.7
-1.5870	0.36	-41.47	717.2	-475.0	-223.1	537.4	581.9	7.55	0.01765	-14.14	-323.	0.0000	-15.7	-15.1
-1.4456	0.98	-42.01	715.6	-478.9	-227.1	531.7	578.2	7.55	0.01766	-13.19	-245.	0.0000	-11.4	-11.4
-1.4456	0.98	-42.01	715.6	-478.9	-227.1	531.7	578.2	7.55	0.01766	-13.19	-242.	0.0000	-11.3	-11.2
-1.3020	1.07	-42.73	713.0	-480.1	-228.2	527.1	574.4	7.56	0.01767	-14.57	-599.	0.0000	-27.7	-27.7
-1.1572	0.79	-42.44	707.0	-477.0	-225.2	521.8	568.3	7.58	0.01769	-11.55	-1250.	0.0000	-57.7	-57.5

QUASI-ORTHOGONAL 15 SM = 4.6650 ALPHA = 0.00 R = 0.7500 Z = 3.1500 DN = 0.0986

THETA	T-CURV	BETA	WA	WTHETA	VTHETA	WM	V	PRS	DENSTY	DTDM	DWDM	SA	SB	DWDT
-2.0844	-0.49	-42.43	688.8	-464.3	-212.9	508.4	551.2	7.61	0.01772	-15.78	1145.	-0.0000	52.8	52.8
-1.9373	0.19	-40.87	698.3	-456.9	-205.0	528.1	566.5	7.58	0.01769	-13.84	1562.	-0.0000	73.9	73.8
-1.7942	0.54	-40.31	709.4	-458.8	-207.0	541.0	579.2	7.55	0.01764	-14.56	1642.	-0.0000	78.3	78.3
-1.7942	0.54	-40.31	709.4	-458.9	-207.0	541.0	579.2	7.55	0.01764	-14.56	1639.	-0.0000	78.2	78.1
-1.6533	0.60	-40.44	719.8	-466.9	-215.0	547.8	586.5	7.52	0.01760	-13.64	1431.	-0.0000	68.1	68.1
-1.5132	0.43	-41.04	727.9	-477.9	-226.0	549.0	593.7	7.50	0.01777	-12.99	939.	-0.0000	44.3	44.3

ITERATION NO. 29 MAX. STREAMLINE CHANGE = 0.000705

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