VOLUME 3

Appendices 17 to 29 inclusive

APPENDIX 17

ANALYSIS OF TURBULENCE DATA

After the initial reduction of the turbulence data as detailed in Appendix 11, the data was re-analysed to calculate:

(i) The Reynolds normal stress coefficient

(ii) The dissipation coefficient (Two-dimensional definition)

(iii) The mixing length and eddy viscosity

A17-1 Calculation Procedure

Firstly, at incremental distances (dR) of 0.010 ins. the values of (u/U) were fed to a computer with the object of determining $\frac{d(u/U)}{dR}$. This could have been obtained by using the raw data to calculate $\left(\frac{\left(\frac{u}{U}\right)_{R+dR} - \left(\frac{u}{U}\right)_R}{dR}\right)$, but this approach was abandoned because it calculated a small difference between two relatively large quantities. Instead a subroutine was used to curve-fit the mean velocity profile data, using the method of least squares. The value of $\frac{d(u/U)}{dR}$ was then calculated from an eighth order polynomial velocity profile equation, except in the region of the point of maximum velocity. In this region $\frac{d(u/U)}{dR}$ was calculated by assuming a linear relationship between $\frac{d(u/U)}{dR}$ and dr from the point at which $\frac{d(u/U)}{dR} = 0.3$ to the position of maximum velocity $\frac{d(u/U)}{dR} = 0$. An eighth order polynomial was also used to curve-fit the values of $d(u/U)/dR$, $\overline{u'^2}/U^2$, $\overline{v'^2}/U^2$, & $2\overline{u'v'}/U^2$ against the distance from the wall. The value of the shear stress at the wall was estimated from the equation due to Ludwieg and Tillmann[42].

A17-2 BASIC EQUATIONS

(i) Mixing length

Prandtl defined the mixing length (ℓ) as

$$\rho \ell^2 = \frac{-\rho\overline{u'v'}}{\left|\frac{du}{dR}\right| \frac{du}{dR}}$$

$$\therefore \ell^2 = \frac{-\overline{u'v'}/U^2}{\left|\frac{d(u/U)}{dR}\right| \frac{d(u/U)}{dR}}$$

the mixing length has been non-dimensionalised in the following ways.

$$\frac{\ell}{\delta^*} = \frac{-\overline{u'v'}/U^2}{\left|\frac{d(u/U)}{d(R/\delta^*)}\right| \frac{d(u/U)}{d(R/\delta^*)}}$$

$$\frac{\ell}{R_o - R_i} = \frac{-\overline{u'v'}/U^2}{\left|\frac{d(u/U)}{d(R/(R_o-R_i))}\right| \frac{d(u/U)}{d(R/(R_o-R_i))}}$$

(ii) Eddy Viscosity

J. Boussinesq introduced the concept of a turbulent exchange coefficient ε in order to relate the turbulent shear stress $-\rho\overline{u'v'}$ and the mean velocity gradient, in the form

$$-\rho\overline{u'v'} = \rho \varepsilon \frac{du}{dR}$$

$$\therefore \varepsilon = \frac{-\overline{u'v'}}{\left(\frac{du}{dR}\right)}$$

the eddy viscosity is non-dimensionalised as:-

$$\frac{\varepsilon}{U\delta^*} = \frac{-\overline{u'v'}/U^2}{d(u/U)/d(R/\delta^*)}$$

$$\frac{\varepsilon}{U(R_o-R_i)} = \frac{-\overline{u'v'}/U^2}{d(u/U)/d(R/R_o-R_i)}$$

(iii) Dissipation Coefficient

The two-dimensional version of the dissipation coefficient is defined as;

$$C_D = \frac{2}{\rho U^3}\int_0^{\delta} \tau \frac{du}{dy}\, dy$$

where $\tau = -\rho\overline{u'v'} + \mu\frac{du}{dy}$

The corresponding definition to rotationally symmetrical flow is, $C_D = \frac{2}{\rho U^3}\int u \frac{d}{dR}(R\tau)\, dR$

In view of the large radius ratio and the inaccuracies associated with the turbulence measurements and the calculation of the gradient of the mean velocity profile, the two-dimensional version of the dissipation coefficient has been used without incurring any significant error. A similar assumption has been made by Goldberg[29] in studying the boundary layer growth along a tube of the same diameter on which boundary layers of comparable thickness were developed. For calculation purposes the boundary layer thickness was divided into 60 elemental strips and the local values of τ, and $\frac{d(u/U)}{dR}$, calculated using the polynomial curve-fit equations.

The computer programme is detailed in Appendix 18, and a sample print-out is included.

The following notation is used in the results "print-out"

DIST. Ro-RI	DU/UMAX DR	SHEAR STRESS	ED. VIS. U DEL*	ED. VIS. U(Ro-RI)	MIX L DEL*	MIX L (Ro-RI)	REYNOLDS NORMAL STRESS
$\frac{R-R_i}{R_o-R_i}$	$\frac{d(u/U)}{dR}$	$\frac{2\,u'v'}{U^2}$	$\frac{\varepsilon}{U\delta_i^*}$	$\frac{\varepsilon}{U(R_o-R_i)}$	$\frac{\ell}{\delta_i^*}$	$\frac{\ell}{(R_o-R_i)}$	UCOMPNT ~ $\int\sqrt{\overline{u'^2}}/U\,dR$ VCOMPNT ~ $\int\sqrt{\overline{v'^2}}/U\,dR$

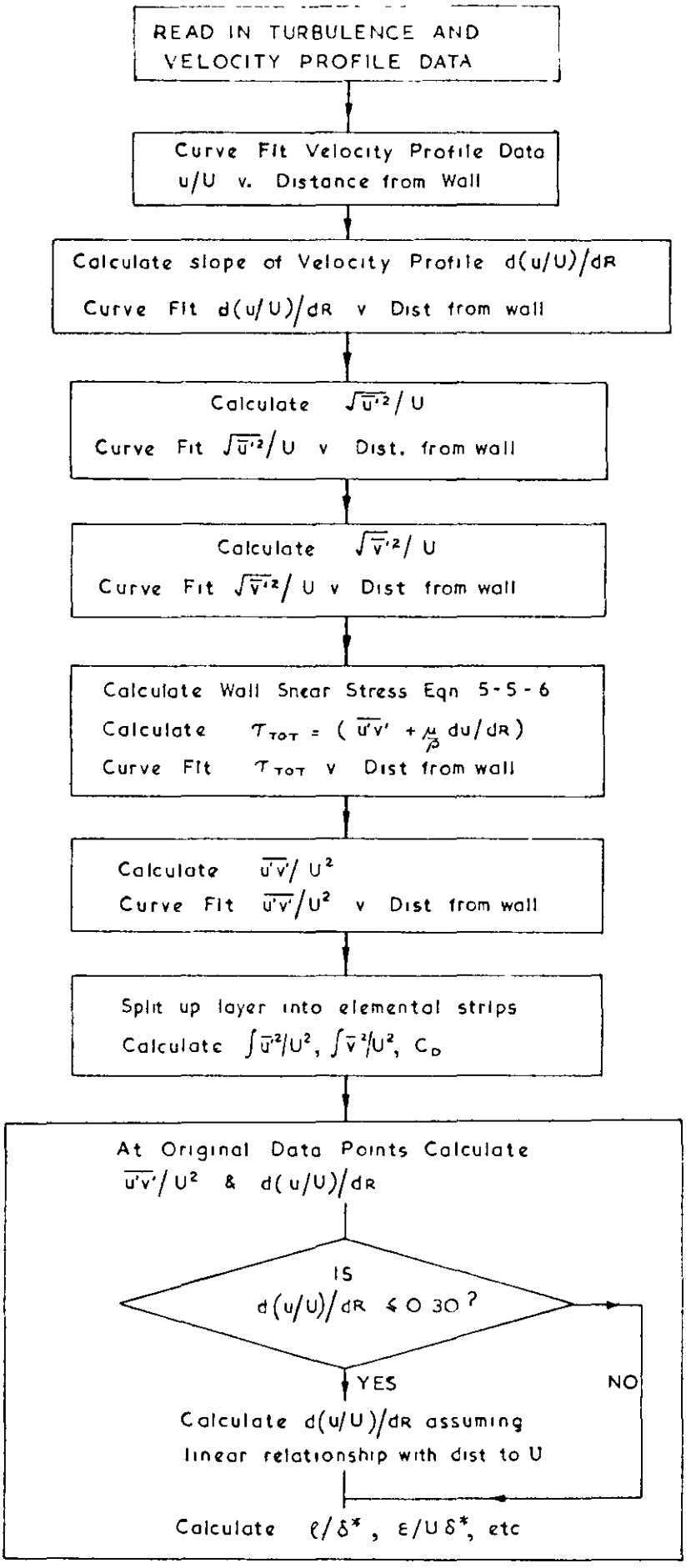

FIG. A17-1 FLOW DIAGRAM OF COMPUTER PROGRAMME FOR ANALYSIS OF TURBULENCE DATA

Appendix 18

Computer Programme

Analysis of Turbulence Data

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C                                   APPENDIX 1A

COMMENT              TURBULENCE DATA ANALYSIS PROGRAM
C*****THIS PROGRAM COMBINES INPUT DATA FROM MEAN VELOCITY PROFILES AND
C     TURBULENCE MEASUREMENTS TO CALCULATE MIXING LENGTH, EDDY VISCOSITY
C     AND DISSIPATION COEFFICIENT
      REAL L
      REAL MIXNDD,MIXNDA
      DIMENSION F(10,10),Q(9),P(9),O(9)
C*****ARRAY FOR STORING INPUT DATA
      DIMENSION EA(60),EB(60),VASQ(60),EC(60),VCSQ(60)
      DIMENSION UNDI(96),UNDO(96)
      DIMENSION ED(60),EE(60),VD(60)
      DIMENSION X(100),Y(100),A(10,10),B(10,10),C(10,10)
      DIMENSION G(10,10),R(10,10),S(9)
      DIMENSION D(10,10),E(10,10),H(9)
      DIMENSION RT(100),UNON(100),W(9),T(9),U(9)
      DIMENSION V(10,10),Z(9)

C*****INPUT DATA

C     L-DIFFUSER NON DIMENSIONAL LENGTH,ENU-KINEMATIC VISCOSITY-FTSQ/SEC
      READ(1,40)ENU
   40 FORMAT(F0.0)
 1059 READ(1,303)DIFNDL,DESGN1,DESGN2
  303 FORMAT(3F0.0)
C*****TURBULENCE DATA
C     RINNER-INNER WALL RADIUS(INS),ANNHT-ANNULUS HEIGHT(INS)
C     ROM-APPROX. DIST. FROM OUTER WALL TO UMAX,XACT-DIST. FROM INLET
C     (INS)
C     XND-NON DIMENSIONAL DIST. FROM INLET,VOC-WIND OFF VOLTS PROBE IN
   59 READ(1,60)RINNER,ANNHT,ROM,XACT,XND,VOC,VOA,VOD,M
   60 FORMAT(8F0.0,I2)
C     RT-RADIAL DIST. FROM WALL(INS),EC-RMS VOLTAGE PROBE IN*U*PLANE
C     VCSQ-BRIDGE VOLTS SQUARED*U*PLANE,UNON-NON.DIM. VELOCITY(U/UMAX)
   63 READ(1,64) (RT(I),I=1,M)
   64 FORMAT(60F0.0)
      READ(1,70) (EC(I),I=1,M)
   70 FORMAT(60F0.0)
      READ(1,70) (VCSQ(I),I=1,M)
   61 READ(1,62) (UNON(I),I=1,M)
   62 FORMAT(60F0.0)
   16 READ(1,17) (EA(I),I=1,M)
   17 FORMAT(60F0.0)
   18 READ(1,19) (EB(I),I=1,M)
   19 FORMAT(60F0.0)
   20 READ(1,21) (VASQ(I),I=1,M)
   21 FORMAT(60F0.0)
      READ(1,21) (ED(I),I=1,M)
      READ(1,21) (EE(I),I=1,M)
      READ(1,21) (VD(I),I=1,M)
C*****MEAN VELOCITY PROFILE DATA
C     UNDO-NON-DIMENSIONAL MEAN AXIAL VELOCITY (OUTER WALL LAYER)
C     ROUTER-OUTER WALL RADIUS(INS),DISP-DIST FROM WALL(INS) OF FIRST
C     VALUE OF NON-DIMENSIONAL VELOCITY,DRVELP-RADIAL SPACING OF MEAN
C     VELOCITY PROFILE DATA POINTS,RINNER-INNER WALL RADIUS(INS)
C     UMAX-MAXIMUM VELOCITY(FT/SEC)
C     UNDI-NON-DIMENSIONAL MEAN AXIAL VELOCITY (INNER WALL LAYER)
```

```
      READ(1,121) (UNDO(I),I=1,96)
  121 FORMAT(12F6.3)
      READ(1,125)ROUTER,DISP,DRVELP,RINNER
  125 FORMAT(4F7.3)
      READ(1,41)UMAX,XACTP
C*****BOUNDARY LAYER PROFILE DATA  (INNER OR OUTER WALL AS APPROPRIATE
C*****RTAWO-APPROX. RAD.DIST. FROM WALL TO POSITION OF ZERO SHEAR STRESS
C     RN-NO. OF RADIAL POSITIONS AT WHICH THE NON-DIMENSIONAL SLOPE OF
C     THE VELOCITY PROFILE IS CALCULATED
C     RINT-BOUNDARY THICKNESS(INS) OVER WHICH REYNOLDS STRESSES ARE
C     CALCULATED
C     TINT-NO. OF ELEMENTAL STRIPS INTO WHICH THE BOUNDARY LAYER IS
C     SUBDIVIDED FOR INTEGRATION
C     RNN-NO. OF RADIAL POSITIONS AT WHICH MIXING LENGTH,EDDY VISCOSITY,
C     ETC. IS CALCULATED
C     MM-INTEGER VALUE OF RN
C     J- INTEGER VALUE OF TINT
C     MN-INTEGER VALUE OF RNN
      READ(1,124)RTAWO,RN,RINT,TINT,RNN,MM,J,MN
  124 FORMAT(5F0.0,3I2)
C     DELST-DISPLACEMENT THICKNESS (INS)
C     THETA-MOMENTUM THICKNESS (INS)
C     HB-SHAPE PARAMETER
  122 READ(1,123)DELST,THETA,HB
  123 FORMAT(3F0.0)

C     CURVE FITTING OF MEAN VELOCITY PROFILE

C     RR-DIST. FROM WALL OF POSITION OF MAXIMUM VELOCITY
C     N-NO. OF CASES TO BE CONSIDERED IN CURVE FITTING PROGRAM
      RR=DISP
      N=0.
      DO 33 I=1,96
      N=N+1.
      UNDIFF=UNDO(I)-1.
      IF (UNDIFF) 23,24,24
   23 CONTINUE
C     X AND Y ARE DATA VALUES FOR CURVE FITTING
      Y(I)=UNDO(I)
      X(I)=RR
   33 RR=RR+DRVELP
   24 CONTINUE
      N=N-1.
C*****LIBRARY PROGRAM  NO.Z201 POLYNOMIAL CURVE FITTING BY METHOD OF
C     LEAST SQUARES
C     W(1) TO W(9) COEFFICIENTS OF POLYNOMIAL VELOCITY PROFILE EQN.
      WRITE(2,850)
  850 FORMAT(10X,5HCURVE,1X,7HFITTING,1X,2HOF,1X,4HMEAN,1X,8HVELOCIT',)
      CALL CURVEFIT(N,X,Y,A,SA,W)


C     CURVE FIT OF SLOPE OF VELOCITY PROFILE

      DR=RR/RN
      V=DR/2.
      N=0.
      DO 34 I=1,MM
      N=N+1.
      UCURV1=W(1)+W(2)*V+W(3)*(V**2)+W(4)*(V**3)+W(5)*(V**4)+W(6)*(V**5)
     1+W(7)*(V**6)+W(8)*(V**7)+W(9)*(V**8)
      V=V+DR
```

```
      UCURV2=W(1)+W(2)*V+W(3)*(V**2)+W(4)*(V**3)+W(5)*(V**4)+W(6)*(V**5)
     1+W(7)*(V**6)+W(8)*(V**7)+W(9)*(V**8)
C     DUDRND=SLOPE OF VELOCITY PROFILE
      DUDRND=(UCURV2-UCURV1)/DR
      V=V-(DR/2.)
      Y(I)=DUDRND
      X(I)=V
   34 V=V+(DR/2.)
      WRITE(2,851)
  851 FORMAT(10X,5HCURVE,1X,3HFIT,1X,2HOF,1X,5HSLOPE,1X,2HOF,1X,8HVELOCI
     1TY,1X,7HPROFILE/)
      CALL CURVEFIT(N,X,Y,C,SC,U)


C     CURVE FIT OF AXIAL TURBULENCE INTENSITIES

      N=0
      DO 75 I=1,M
      N=N+1
      VC=VCSQ(I)**0.5
      SENSC=(VCSQ(I)-(VOC*VOC))/(4.*VC*UNON(I))
      UTURSQ=(EC(I)*EC(I))/(SENSC*SENSC)
      Y(I)=UTURSQ
      X(I)=RT(I)
   75 WRITE(2,76)RT(I),UTURSQ
   76 FORMAT(2X,F6.3,2X,F8.5)
      WRITE(2,852)
  852 FORMAT(10X,5HCURVE,1X,3HFIT,1X,2HOF,1X,5HAXIAL,1X,10HTURBULENCE,1X
     1,11HINTENSITIES/)
      CALL CURVEFIT(N,X,Y,D,SD,Q)


C     CURVE FIT OF RADIAL TURBULENCE INTENSITIES

      N=0
      DO 77 I=1,M
      N=N+1
      VC=VCSQ(I)**0.5
      SENSC=(VCSQ(I)-(VOC*VOC))/(4.*VC*UNON(I))
      UTURSQ=(EC(I)*EC(I))/(SENSC*SENSC)
      VA=VASQ(I)**0.5
      SENSA=(VASQ(I)-(VOA*VOA))/(4.*VA*UNON(I))
      VTURSQ=(((EA(I)*EA(I))+(EB(I)*EB(I)))/(2.*SENSA*SENSA))-UTURSQ
      IF (VTURSQ) 800,800,801
  800 VTURSQ=0.
  801 CONTINUE
      Y(I)=VTURSQ
      X(I)=RT(I)
   77 WRITE(2,803)RT(I),VTURSQ
  803 FORMAT(2X,F6.3,2X,F8.5)
      WRITE(2,853)
  853 FORMAT(10X,5HCURVE,1X,3HFIT,1X,2HOF,1X,6HRADIAL,1X,10HTURBULENCE,1
     1X,11HINTENSITIES/)
      CALL CURVEFIT(N,X,Y,E,SE,H)


C     CURVE FIT OF TURBULENT SHEAR STRESS

      N=0
      DO 37 I=1,M
      N=N+1
      VA=VASQ(I)**0.5
```

```
      SENSA=(VASQ(I)-(VOA*VOA))/(4.*VA*UNON(I))
      UVREY=((EA(I)*EA(I))-(EB(I)*EB(I)))/(4.*SENSA*SENSA)
      IF (UVREY) 940,941,941
  940 CONTINUE
      UVREY=ABS(UVREY)
      Y(I)=UVREY
      X(I)=RT(I)
      WRITE(2,942)RT(I),UVREY
  942 FORMAT(2X,F6.3,2X,F7.4)
      GO TO 943
  941 CONTINUE
      N=N-1
  943 CALL CURVEFIT(N,X,Y,V,SV,Z)


C     CURVE FIT OF SHEAR STRESS,WALL VALUE FROM LUDWIEG AND TILLMAN EQN

      N=0
      WW=0.
      DO 14 I=1,M
      N=N+1
      VA=VASQ(I)**0.5
      SENSA=(VASQ(I)-(VOA*VOA))/(4.*VA*UNON(I))
      UVREY=((EA(I)*EA(I))-(EB(I)*EB(I)))/(4.*SENSA*SENSA)
      IF (UVREY) 910,909,909
  910 CONTINUE
      UVREY=2*UVREY
      UVREY=ABS(UVREY)
      IF (WW) 900,900,901
C*****CALCULATION OF WALL SHEAR STRESS FROM LUDWIEG AND TILLMAN EQN
  900 RENOLN=(UMAX*THETA)/(ENU*12.)
      UVREL=0.246/((10.**(0.678*HB))*(RENOLN**0.268))
      Y(I)=UVREL
      X(I)=0.
      WW=1.
      N=N+1
      WRITE(2,15)X(I),Y(I)
   15 FORMAT(2X,F6.3,2X,F7.4)
C*****IF RT IS TAKEN TO BE GREATER THAN RR THEN SLOPEU IS SET AT ZERO
  901 IF (RT(I)-RR) 902,903,903
  902 CONTINUE
C     SLOPEU-SLOPE OF VELOCITY PROFILE CALCULATED FROM CURVE FIT EQN.
C     U(1) TO U(9) COEFFICIENTS OF POLYNOMIAL EQN. FOR SLOPE OF VELOCITY
C     PROFILE
      SLOPEU=U(1)+U(2)*RT(I)+U(3)*(RT(I)**2)+U(4)*(RT(I)**3)+U(5)*(RT(I)
     1**4)+U(6)*(RT(I)**5)+U(7)*(RT(I)**6)+U(8)*(RT(I)**7)+U(9)*(RT(I)**
     28)
C*****IF SLOPE OF VELOCITY PROFILE IS LESS THAN 0.3 THE SLOPE IS
C     CALCULATED ASSUMING A LINEAR RELATIONSHIP BETWEEN SLOPEU AND RT
C     SLOPEU BEING ZERO AT POSITION OF MAX. VELOCITY
      IF (0.3-SLOPEU) 905,906,906
  905 CONTINUE
C     STORES VALUE OF SLOPEU
      SLOPES=SLOPEU
C     SLOPE IS THE GRADIENT OF SLOPEU AGAINST DIST. ASSUMING LINEAR
C     RELATIONSHIP TO POSITION OF MAXIMUM VELOCITY
      SLOPE=SLOPES/(RR-RT(I))
      GO TO 907
  903 SLOPEU=0.
      GO TO 907
```

```
C       CALCULATION OF SLOPEU ASSUMING LINEAR RELATIONSHIP
  906 SLOPEU=SLOPE*(RR-RT(I))
C       VISDIS-NON DIMENSIONAL VISCOUS SHEAR
  907 VISDIS=(ENU*SLOPEU*24.)/UMAX
C       SHSTOT-TOTAL NON DIMENSIONAL SHEAR STRESS (SUM OF VISCOUS AND
C       TURBULENT SHEAR STRESSES)
      SHSTOT=VISDIS+UVREY
      Y(I+1)=SHSTOT
      X(I+1)=RT(I)
   14 WRITE(2,39)RT(I),UVREY,VISDIS,SHSTOT
   39 FORMAT(2X,F6.3,2X,F7.4,2X,F11.8,2X,F8.5)
      GO TO 911
  909 CONTINUE
      N=N-1
C*****CURVE FIT OF TOTAL NON DIMENSIONAL SHEAR STRESS
      WRITE(2,854)
  854 FORMAT(10X,5HCURVE,1X,3HFIT,1X,2HOF,1X,5HSHEAR,1X,7HSTRESS,4HWALL,
     11X,5HVALUE,1X,4HFROM,1X,7HLUDWIEG,1X,3HAND,7HTILLMAN,1X,3HEQN)
  911 CALL CURVEFIT(N,X,Y,F,SF,P)
      WRITE(2,1)
    1 FORMAT(1H1)


C*****CALCULATION OF DISSIPATION COEFFICIENT AND REYNOLDS NORMAL STRESS

      SUMDIS=0.
      SUMUTB=0.
      SUMVTB=0.
      SUMVIS=0.
      DRINT=RINT/TINT
      V=DRINT/2.
      DO 602 J=1,J
      IF (V-RR) 600,601,601
  600 SHSTOT=P(1)+P(2)*V+P(3)*(V**2)+P(4)*(V**3)+P(5)*(V**4)+P(6)*(V**5)
     1+P(7)*(V**6)+P(8)*(V**7)+P(9)*(V**8)
      IF (SHSTOT) 601,601,603
  603 SLOPEU=U(1)+U(2)*V+U(3)*(V**2)+U(4)*(V**3)+U(5)*(V**4)+U(6)*(V**5)
     1+U(7)*(V**6)+U(8)*(V**7)+U(9)*(V**8)
      IF (0.3-SLOPEU) 930,931,931
  930 CONTINUE
      SLOPES=SLOPEU
      SLOPE=SLOPES/(RR-V)
      GO TO 932
  931 SLOPEU=SLOPE*(RR-V)
  932 CONTINUE
C       Q(1) TO Q(9) COEFFICIENTS OF POLYNOMIAL EQN. FOR AXIAL TURBULENCE
C       INTENSITIES
      UTURB=Q(1)+Q(2)*V+Q(3)*(V**2)+Q(4)*(V**3)+Q(5)*(V**4)+Q(6)*(V**5)+
     1Q(7)*(V**6)+Q(8)*(V**7)+Q(9)*(V**8)
C       H(1) TO H(9) COEFFICIENTS OF POLYNOMIAL EQN. FOR RADIAL TURBULENCE
C       INTENSITIES
      VTURB=H(1)+H(2)*V+H(3)*(V**2)+H(4)*(V**3)+H(5)*(V**4)+H(6)*(V**5)+
     1H(7)*(V**6)+H(8)*(V**7)+H(9)*(V**8)
      UTURBL=UTURB*DRINT
      VTURBL=VTURB*DRINT
C       DISPAT-RATE OF NON-DIMENSIONAL ENERGY LOSS IN ELEMENTAL STRIP
      DISPAT=SHSTOT*SLOPEU*DRINT
      VISDIP=(ENU*SLOPEU*SLOPEU*DRINT*24.)/UMAX
C       SUMUTB-REYNOLDS NORMAL STRESSES
C       SUMVTB-REYNOLDS NORMAL STRESSES
C       SUMDIS-DISSIPATION COEFFICIENT
```

```
C       SUMUTB=REYNOLDS NORMAL STRESSES
C       SUMVTB=REYNOLDS NORMAL STRESSES
C       SUMDIS=DISSIPATION COEFFICIENT
        SUMUTB=SUMUTB+UTURBL
        SUMVTB=SUMVTB+VTURBL
        SUMVIS=SUMVIS+VISDIP
        SUMDIS=SUMDIS+DISPAT
        RATDIS=SUMVIS/SUMDIS
        WRITE(2,604)V,SHSTOT,SLOPEU,SUMDIS,SUMUTB,SUMVTB
  604   FORMAT(2X,F6.3,2X,F7.4,2X,F7.4,2X,F11.8,2X,F11.8,2X,F11.8)
        VTOTAL=V
  602   V=V+DRINT
  601   CONTINUE
        WRITE(2,1)


C*****CALCULATION OF MIXING LENGTH AND EDDY VISCOSITY
C*****CURVE FIT OF TURBULENT SHEAR STRESS
        N=0
        DO 412 I=1,M
        N=N+1
        VA=VASQ(I)**0.5
        SENSA=(VASQ(I)-(VOA*VOA))/(4.*VA*UNON(I))
        UVREY=((EA(I)*FA(I))-(EB(I)*FB(I)))/(4.*SENSA*SENSA)




        IF (UVREY) 410,409,409
  410   CONTINUE
        UVREY=2.*UVREY
        UVREY=ABS(UVREY)
        Y(I)=UVREY
        X(I)=RT(I)
  412   WRITE(2,414)RT(I),UVREY
  414   FORMAT(2X,F6.3,2X,F8.5)
        GO TO 415
  409   CONTINUE
        N=N-1
  415   CALL CURVEFIT(N,X,Y,FF,SFF,PP)


        WRITE(2,328)DIFNDL
  328   FORMAT(/8X,33HDIFFUSER NON DIMENSIONAL LENGTH =,F5.1)
        XND=XACTP/DIFNDL
        WRITE(2,329)XACTP,XND
  329   FORMAT(/8X,27HAXIAL DIST. FROM INLET(X) =,F7.3,5H INS.,4X,15HN.D.D
     1IST.(X/L)=,F6.3,/)
        IF(DESGN1-1.)304,304,305
C       TRANSFER TO 304 INDICATES OUTER WALL VALUES
  304   IF(DESGN2-1.)306,306,307
  306   WRITE(2,317)
  317   FORMAT(08X,5HOUTER,1X,4HWALL,2X,4HBLUE,1X,8HPOSITION)
        GO TO 316
  307   IF(DESGN2-2.)308,308,309
  308   WRITE(2,318)
  318   FORMAT(08X,5HOUTER,1X,4HWALL,2X,5HGREEN,1X,8HPOSITION)
        GO TO 316
  309   WRITE(2,319)
  319   FORMAT(08X,5HOUTER,1X,4HWALL,2X,3HRED,1X,8HPOSITION)
        GO TO 316
```

```
C       TRANSFER TO 305 INDICATES INNER WALL VALUES
  305   IF(DFSGN2-1.)310,310,311
  310   WRITE(2,320)
  320   FORMAT(08X,5HINNER,1X,4HWALL,2X,4HBLUE,1X,8HPOSITION)
        GO TO 316
  311   IF(DFSGN2-2.)312,312,314
  312   WRITE(2,321)
  321   FORMAT(08X,5HINNER,1X,4HWALL,2X,5HGREEN,1X,8HPOSITION)
        GO TO 316
  314   WRITE(2,322)
  322   FORMAT(08X,5HINNER,1X,4HWALL,2X,3HRED,1X,8HPOSITION)
        GO TO 316
  316   CONTINUE
        WRITE(2,327)DELST,HB,RENOLD
  327   FORMAT(1H0,7X,7HDELTA*=,F6.3,1X,4HINS.,1X,2HH=,F5.2,1X,8HREYNOLDS,
       11X,3HNO.,17H(BASED ON THETA)=,F8.1)
        WRITE(2,300)
  300   FORMAT(1H0,3X,4HDIST,4X,4HDIST,3X,7HDU/DMAX,2X,5HSHEAR,3X,7HED.VIS
       1.,1X,7HED.VIS.,2X,5HMIX L,4X,5HMIX L)
        WRITE(2,301)
  301   FORMAT(9X,4HR-RI,4X,5HRO-RI,4X,2HDR,5X,6HSTRESS,2X,6HU.DEL*,2X,8HU
       1(RO-RI),2X,4HDEL*,3X,7H(RO-RI))
        DRTAW=RTAUO/RHN
        V=DRTAW/2.
C       SLOPE IS ASSIGNED AN INITIAL VALUE GREATER THAN 0.3 TO START
C       CALCULATION PROCEDURE
        SLOPEU=10.
        DO 230 I=1,1




        V=RT(I)
        IF (V-RR) 500,510,510
  500   CONTINUE
C*****IF SLOPE OF VELOCITY PROFILE IS LESS THAN 0.3 THE SLOPE IS
C       CALCULATED ASSUMING A LINEAR RELATIONSHIP BETWEEN SLOPEU AND V AS
C       IN EARLIER PART OF PROGRAM
        IF (0.3-SLOPEU) 511,501,501
  511   CONTINUE
        SLOPEU=U(1)+U(2)*V+U(3)*(V**2)+U(4)*(V**3)+U(5)*(V**4)+U(6)*(V**5)
       1+U(7)*(V**6)+U(8)*(V**7)+U(9)*(V**8)
        SLOPES=SLOPEU
        SLOPE=SLOPES/(RR-V)
        GO TO 502
  501   SLOPEU=SLOPE*(RR-V)
  502   SHST=PP(1)+PP(2)*V+PP(3)*(V**2)+PP(4)*(V**3)+PP(5)*(V**4)+PP(6)*(V
       1**5)+PP(7)*(V**6)+PP(8)*(V**7)+PP(9)*(V**8)
        IF (SHST) 510,510,799
  799   CONTINUE
C       SHST=SHEAR STRESS
C       VANNL=RADIAL DIST. FROM WALL RELATIVE TO ANNULUS HEIGHT
C       EDVNDD=EDDY VISCOSITY NON DIMENSIONALISED REL. TO DISPLACEMENT
C       THICKNESS
C       EDVNDA=EDDY VISCOSITY NON DIMENSIONALISED REL. TO ANNULUS HEIGHT
C       MIXNDD=-MIXING LENGTH NON DIMENSIONALISED REL. TO DISPLACEMENT
C       THICKNESS
C       MIXNDA=-MIXING LENGTH NON DIMENSIONALISED REL. TO ANNULUS HEIGHT
        SHST=SHST/2.
        SLOPEU=ABS(SLOPEU)
        VANNL=V/ANNHT
        DUDRDD=SLOPEU*DELST
```

```
      DUDRDA=SLOPEU*ANNHT
      EDVNDD=SHST/DUDRDD
      EDVNDA=SHST/DUDRDA
      MIXNDD=(SHST/(DUDRDD*DUDRDD))**0.5
      MIXNDA=(SHST/(DUDRDA*DUDRDA))**0.5
      SHSTOT=P(1)+P(2)*V+P(3)*(V**2)+P(4)*(V**3)+P(5)*(V**4)+P(6)*(V**5)
     1+P(7)*(V**6)+P(8)*(V**7)+P(9)*(V**8)
  230 WRITE(2,231)V,VANNL,SLOPEU,SHSTOT,EDVNDD,EDVNDA,MIXNDD,MIXNDA
  231 FORMAT(3X,F6.3,2X,F6.3,2X,F6.3,2X,F7.4,2X,F6.3,2X,F7.4,3X,F4.2,4X,
     1F5.3)
  510 CONTINUE
      WRITE(2,323)SUMDIS
  323 FORMAT(1H0,7X,11HDISSIPATION,1X,12HCOEFFICIENT=,F9.6)
      WRITE(2,324)SUMUTB,SUMVTB
  324 FORMAT(/8X,8HREYNOLDS,1X,6HNORMAL,1X,7HSTRESS,,1X,8HUCOMPNT=,F8.5,
     14X,8HVCOMPNT=,F8.5)
      GO TO 1059
      STOP
      END
```

END OF SEGMENT, LENGTH 2609, NAME B141

A18-1 SAMPLE CALCULATION AT X = 9.85 ins. $L/\Delta R_1$ = 10 DIFFUSER, INNER WALL LAYER

CURVE FITTING OF MEAN VELOCITY

ORDER = 8 MEAN SQUARE ERROR = 0.513620E-03

NO.	COEFFICIENT
0	0.22760241
1	6.28509393
2	-48.83724043
3	436.20377901
4	-1549.46673094
5	3216.42364052
6	-3869.26707688
7	2496.62644556
8	-668.29239462

X (R-R_i) ins	Y u/U EXP^T	YCALC u/U CALC$^{TD.}$	ERROR
0.00500000	0.25000000	0.25736054	-0.00736054
0.02000000	0.34000000	0.32902126	0.01097874
0.03500000	0.38500000	0.37979430	0.00520570
0.05000000	0.41500000	0.41555216	-0.00055216
0.06500000	0.43600000	0.44088221	-0.00488221
0.08000000	0.45300000	0.45929867	-0.00629867
0.09500000	0.47000000	0.47342962	-0.00342962
0.11000000	0.48300000	0.48518087	-0.00218087
0.12500000	0.49500000	0.49587865	-0.00087865
0.14000000	0.50800000	0.50639273	0.00160727
0.15500000	0.52000000	0.51724168	0.00275832
0.17000000	0.53200000	0.52868194	0.00331806
0.18500000	0.54500000	0.54078220	0.00421780

(R-R0)/RS	C/U EXP	C/U CALC	ERROR
0.20000000	0.55600000	0.55348450	0.00251550
0.21500000	0.57000000	0.56665362	0.00334638
0.23000000	0.58100000	0.58011583	0.00088417
0.24500000	0.59400000	0.59368856	0.00031144
0.26000000	0.60500000	0.60720198	-0.00220198
0.27500000	0.62000000	0.62051365	-0.00051365
0.29000000	0.63000000	0.63351740	-0.00351740
0.30500000	0.64400000	0.64614727	-0.00214727
0.32000000	0.65500000	0.65837754	-0.00337754
0.33500000	0.66800000	0.67021972	-0.00221972
0.35000000	0.68000000	0.68171713	-0.00171713
0.36500000	0.69100000	0.69293798	-0.00193798
0.38000000	0.70300000	0.70396741	-0.00096741
0.39500000	0.71500000	0.71489920	0.00010080
0.41000000	0.72600000	0.72582757	0.00017243
0.42500000	0.74000000	0.73683956	0.00316044
0.44000000	0.75000000	0.74800832	0.00199168
0.45500000	0.76300000	0.75938758	0.00361242
0.47000000	0.77400000	0.77100764	0.00299236
0.48500000	0.78500000	0.78287289	0.00212711
0.50000000	0.79700000	0.79496107	0.00203893
0.51500000	0.80800000	0.80722425	0.00077575
0.53000000	0.82000000	0.81959141	0.00040859
0.54500000	0.83100000	0.83197265	-0.00097265
0.56000000	0.84300000	0.84426470	-0.00126470
0.57500000	0.85400000	0.85635760	-0.00235760
0.59000000	0.86500000	0.86814208	-0.00314208
0.60500000	0.87700000	0.87951740	-0.00251740
0.62000000	0.88800000	0.89039906	-0.00239906
0.63500000	0.90000000	0.90072596	-0.00072596
0.65000000	0.91000000	0.91046628	-0.00046628
0.66500000	0.92000000	0.91962158	0.00037842
0.68000000	0.92900000	0.92822813	0.00077187
0.69500000	0.93800000	0.93635504	0.00164496
0.71000000	0.94500000	0.94409784	0.00090216
0.72500000	0.95300000	0.95156700	0.00143300
0.74000000	0.96000000	0.95887009	0.00112991
0.75500000	0.96800000	0.96608663	0.00191337
0.77000000	0.97300000	0.97323438	-0.00023438
0.78500000	0.98300000	0.98022605	0.00277395
0.80000000	0.98500000	0.98681486	-0.00181486
0.81500000	0.99000000	0.99252760	-0.00252760
0.83000000	0.99400000	0.99658439	-0.00258439
0.84500000	0.99600000	0.99780242	-0.00180242
0.86000000	0.99800000	0.99448348	0.00351652

CURVE FIT OF SLOPE OF VELOCITY PROFILE

ORDER = 8 MEAN SQUARE ERROR = 0.240087E-02

NO.	COEFFICIENT
0	6.38982015
1	-142.22979189
2	1379.78269765
3	-6720.36149621
4	18136.11273336
5	-27798.52140044
6	23288.42020463
7	-9247.01724434
8	1075.03045483

X (R-R$_1$) ins	Y $d(u/U)/dR$ ins^{-1}	YCALC $d(u/U)/dR$	ERROR
0.01750000	4.27064404	4.28899631	-0.01835227
0.03500000	2.84632861	2.83967343	0.00665518
0.05250000	1.89494991	1.88049374	0.01445617
0.07000000	1.29371885	1.28097736	0.01274149
0.08750000	0.94396102	0.93717429	0.00678672
0.10500000	0.76772285	0.76772964	-0.00000680
0.12250000	0.70468500	0.71033982	-0.00565482
0.14000000	0.70936944	0.71857813	-0.00920868
0.15750000	0.74862675	0.75906839	-0.01044164
0.17500000	0.79938989	0.80898560	-0.00959570
0.19250000	0.84668122	0.85386309	-0.00718188
0.21000000	0.88185886	0.88568607	-0.00382721
0.22750000	0.90108920	0.90125157	-0.00016237
0.24500000	0.90403167	0.90077561	0.00325606
0.26250000	0.89272259	0.88672831	0.00599429
0.28000000	0.87064418	0.86287845	0.00776574

(R−Ri) ins.	d(u/U)/dR	d(u/U)/dR CALCTD.	ERROR
0.29750000	0.84196550	0.83352913	0.00843637
0.31500000	0.81094157	0.80292664	0.00801493
0.33250000	0.78145728	0.77482505	0.00663223
0.35000000	0.75670239	0.75218929	0.00451310
0.36750000	0.73896422	0.73702017	0.00194405
0.38500000	0.72952435	0.73028472	-0.00076036
0.40250000	0.72864597	0.73193600	-0.00329004
0.42000000	0.73563803	0.74100685	-0.00536882
0.43750000	0.74898301	0.75576209	-0.00677909
0.45500000	0.76651469	0.77389457	-0.00737988
0.47250000	0.78563181	0.79275054	-0.00711873
0.49000000	0.80353513	0.80957018	-0.00603505
0.50750000	0.81747362	0.82172965	-0.00425604
0.52500000	0.82498550	0.82697132	-0.00198582
0.54250000	0.82412316	0.82360928	0.00051388
0.56000000	0.81364582	0.81069743	0.00294839
0.57750000	0.79316550	0.78814837	0.00501713
0.59500000	0.76323873	0.75679046	0.00644827
0.61250000	0.72538240	0.71835284	0.00702956
0.63000000	0.68200533	0.67536607	0.00663926
0.64750000	0.63624117	0.63096894	0.00527223
0.66500000	0.59167012	0.58861026	0.00305987
0.68250000	0.55190901	0.55163596	0.00027305
0.70000000	0.52006873	0.52275282	-0.00268409
0.71750000	0.49805388	0.50335811	-0.00530422
0.73500000	0.48569816	0.49272796	-0.00702980
0.75250000	0.47971463	0.48705520	-0.00734057
0.77000000	0.47245936	0.47832372	-0.00586936
0.78750000	0.45048052	0.45304734	-0.00256682
0.80500000	0.39285342	0.39076004	0.00209337
0.82250000	0.26927580	0.26242693	0.00684886
0.84000000	0.03791526	0.02859322	0.00932204
0.85750000	-0.35700628	-0.36262923	0.00562295
0.87500000	-0.98788451	-0.97777611	-0.01010640

CURVE FIT OF AXIAL TURBULENCE INTENSITIES

ORDER = 8 MEAN SQUARE ERROR = 0.236540E-06

NO.	COEFFICIENT
0	0.01807054
1	-0.12742432
2	1.31170846
3	-5.74350505
4	12.78351589
5	-16.09307455
6	11.91265036
7	-5.11547648
8	1.06613167

X $(R-R_i)$ ins	Y $\overline{u'^2}/U^2$ EXPT	VCALC $\overline{u'^2}/U^2$	ERROR
0.05000000	0.01431848	0.01433570	-0.00001723
0.10000000	0.01389482	0.01383052	0.00006431
0.15000000	0.01439142	0.01446281	-0.00007139
0.20000000	0.01514752	0.01510947	0.00003805
0.25000000	0.01515831	0.01528609	-0.00012778
0.30000000	0.01514107	0.01489819	0.00024287
0.35000000	0.01392834	0.01405976	-0.00013142
0.40000000	0.01293536	0.01296649	-0.00003113
0.45000000	0.01186394	0.01181284	0.00005110
0.50000000	0.01072250	0.01074365	-0.00002115
0.55000000	0.00978628	0.00983283	-0.00004655
0.60000000	0.00910763	0.00908318	0.00002445
0.65000000	0.00863445	0.00844320	0.00019125
0.70000000	0.00756528	0.00783533	-0.00027306
0.75000000	0.00729690	0.00721591	0.00008099
0.80000000	0.00667630	0.00660447	0.00007183
0.85000000	0.00613361	0.00619017	-0.00005656
0.90000000	0.00642579	0.00641438	0.00001141

$R-R_i$ ins.	$\overline{u'^2}/U^2$
0.050	0.01432
0.100	0.01389
0.150	0.01439
0.200	0.01515
0.250	0.01516
0.300	0.01514
0.350	0.01393
0.400	0.01294
0.450	0.01186
0.500	0.01072
0.550	0.00979
0.600	0.00911
0.650	0.00863
0.700	0.00757
0.750	0.00730
0.800	0.00668
0.850	0.00613
0.900	0.00643

CURVE FIT OF RADIAL TURBULENCE INTENSITIES

ORDER = 8 MEAN SQUARE ERROR = 0.662611E-06

NO.	COEFFICIENT
0	-0.00780422
1	0.30625373
2	-2.80304752
3	13.98222231
4	-37.76775024
5	56.70725003
6	-46.76204569
7	19.18159441
8	-2.82707665

$(R-R_i)$ ins	$\overline{v'^2}/U^2$
0.050	0.00208
0.100	0.00533
0.150	0.00712
0.200	0.00815
0.250	0.00974
0.300	0.01069
0.350	0.01242
0.400	0.01327
0.450	0.01273
0.500	0.01197
0.550	0.01097
0.600	0.00974
0.650	0.00805
0.700	0.00722
0.750	0.00536
0.800	0.00445
0.850	0.00293
0.900	0.00231

X $(R-R_i)$ ins.	Y $\overline{v'^2}/U^2$ EXP^T	YCALC $\overline{v'^2}/U^2$ EXP^T	ERROR
0.05000000	0.00208031	0.00202958	0.00005072
0.10000000	0.00533340	0.00551833	-0.00018492
0.15000000	0.00711726	0.00694096	0.00017630
0.20000000	0.00815420	0.00814584	0.00000836
0.25000000	0.00974114	0.00959997	0.00014117
0.30000000	0.01069040	0.01111747	-0.00042707
0.35000000	0.01241625	0.01232748	0.00008878
0.40000000	0.01327072	0.01293677	0.00033396
0.45000000	0.01272780	0.01283822	-0.00011042
0.50000000	0.01196952	0.01211171	-0.00014219
0.55000000	0.01097332	0.01095954	0.00001378
0.60000000	0.00974142	0.00961411	0.00012731
0.65000000	0.00805360	0.00825106	-0.00019745
0.70000000	0.00721523	0.00693657	0.00027866
0.75000000	0.00535850	0.00563333	-0.00027483
0.80000000	0.00445303	0.00428482	0.00016821
0.85000000	0.00293348	0.00299353	-0.00006004
0.90000000	0.00231352	0.00230388	0.00000964

CURVE FIT OF SHEAR STRESS,WALL VALUE FROM LUDWIEG ANDTILLMAN EQN

ER = 8 MEAN SQUARE ERROR = 0.556772E-07

COEFFICIENT

0.00159839
0.07141660
-0.32729183
2.68267727
-6.14536035
3.40875756
7.58999702
-11.85229707
4.78781982

X $(R-R_i)_{ins}$	Y $\frac{2}{\rho U^2}(\tau_{TURB}+\tau_{VIS})$	YCALC $\frac{2}{\rho U^2}(\tau_{TURB}+\tau_{VIS})$	ERROR
0.00000000	0.00158964	0.00159839	-0.00000875
0.05000000	0.00419530	0.00414909	0.00004621
0.10000000	0.00549605	0.00557581	-0.00007976
0.15000000	0.00674318	0.00671604	0.00002714
0.20000000	0.00789020	0.00785598	0.00003423
0.25000000	0.00899454	0.00893983	0.00005471
0.30000000	0.00961710	0.00976033	-0.00014323
0.35000000	0.01016104	0.01011014	0.00005090
0.40000000	0.00989251	0.00988150	0.00001101
0.45000000	0.00916570	0.00910881	0.00005690
0.50000000	0.00790882	0.00795660	-0.00004778
0.55000000	0.00665277	0.00666273	-0.00000996
0.60000000	0.00541972	0.00545426	-0.00003453
0.65000000	0.00455016	0.00446085	0.00008932
0.70000000	0.00359617	0.00365847	-0.00006230
0.75000000	0.00290059	0.00288317	0.00001742
0.80000000	0.00196119	0.00196266	-0.00000146
0.85000000	0.00102080	0.00102083	-0.00000003

R-Ri-ins	$2\tau_{TURB}/\rho U^2$	$2\tau_{VIS}/\rho U^2$	$2(\tau_{TURB}+\tau_{VIS})/\rho U^2$
0.000	0.0016 $2\tau_{L\&T}$		
0.050	0.0041	0.00007551	0.00420
0.100	0.0055	0.00003040	0.00550
0.150	0.0067	0.00002802	0.00674
0.200	0.0079	0.00003294	0.00789
0.250	0.0090	0.00003403	0.00899
0.300	0.0096	0.00003142	0.00962
0.350	0.0101	0.00002850	0.01016
0.400	0.0099	0.00002771	0.00989
0.450	0.0091	0.00002912	0.00917
0.500	0.0079	0.00003097	0.00791
0.550	0.0066	0.00003105	0.00665
0.600	0.0054	0.00002829	0.00542
0.650	0.0045	0.00002367	0.00455
0.700	0.0036	0.00001981	0.00360
0.750	0.0029	0.00001849	0.00290
0.800	0.0019	0.00001568	0.00196
0.850	0.0010	0.00000523	0.00102

CALCULATION OF REYNOLDS NORMAL STRESS COMPONENTS AND DISSIPATION COEFFICIENT

$(R-R_i)$ ins	$\frac{2\tau}{\rho U^2}$	$d(u/U)/dR$ ins^{-1}	$\frac{2}{\rho U^3}\int_0^{R-R_i}\tau\, du/dR\, dR$	$\int_0^{(R-R_i)}\frac{\overline{u'^2}}{U^2}dR$ - ins^{-1}	$\int_0^{(R-R_i)}\frac{\overline{v'^2}}{U^2}dR$ - ins^{-1}
0.007	0.0021	5.3979	0.00017048	0.00025779	-0.00008489
0.023	0.0030	3.8161	0.00034033	0.00049487	-0.00011763
0.037	0.0037	2.6760	0.00048743	0.00071774	-0.00011155
0.052	0.0042	1.8805	0.00060696	0.00093158	-0.00007696
0.067	0.0047	1.3488	0.00070244	0.00114043	-0.00002164
0.082	0.0051	1.0144	0.00078063	0.00134736	0.00004868
0.097	0.0055	0.8234	0.00084875	0.00155460	0.00012993
0.113	0.0059	0.7325	0.00091323	0.00176369	0.00021937
0.128	0.0062	0.7077	0.00097915	0.00197560	0.00031531
0.142	0.0065	0.7230	0.00105015	0.00219083	0.00041682
0.157	0.0069	0.7591	0.00112855	0.00240948	0.00052351
0.172	0.0072	0.8019	0.00121548	0.00263136	0.00063540
0.187	0.0076	0.8421	0.00131110	0.00285608	0.00075276
0.202	0.0079	0.8739	0.00141483	0.00308306	0.00087595
0.217	0.0083	0.8944	0.00152553	0.00331159	0.00100537
0.232	0.0086	0.9027	0.00164168	0.00354094	0.00114137
0.247	0.0089	0.8995	0.00176163	0.00377030	0.00128421
0.262	0.0092	0.8867	0.00188372	0.00399890	0.00143402
0.277	0.0094	0.8667	0.00200643	0.00422598	0.00159077
0.292	0.0097	0.8422	0.00212850	0.00445082	0.00175428
0.307	0.0098	0.8159	0.00224902	0.00467277	0.00192419
0.322	0.0100	0.7904	0.00236740	0.00489125	0.00210001
0.337	0.0101	0.7677	0.00248342	0.00510578	0.00228110
0.352	0.0101	0.7495	0.00259712	0.00531592	0.00246671
0.367	0.0101	0.7370	0.00270875	0.00552135	0.00265599
0.382	0.0100	0.7307	0.00281867	0.00572183	0.00284803
0.397	0.0099	0.7306	0.00292724	0.00591719	0.00304188
0.412	0.0097	0.7363	0.00303476	0.00610734	0.00323655
0.427	0.0095	0.7468	0.00314135	0.00629227	0.00343108
0.442	0.0093	0.7607	0.00324694	0.00647202	0.00362454
0.457	0.0090	0.7766	0.00335126	0.00664669	0.00381602
0.472	0.0086	0.7928	0.00345381	0.00681642	0.00400470
0.487	0.0083	0.8074	0.00355394	0.00698138	0.00418983
0.502	0.0079	0.8189	0.00365089	0.00714179	0.00437077
0.517	0.0075	0.8257	0.00374387	0.00729787	0.00454694
0.532	0.0071	0.8267	0.00383211	0.00744985	0.00471788
0.547	0.0067	0.8209	0.00391494	0.00759797	0.00488323
0.562	0.0063	0.8081	0.00399185	0.00774244	0.00504273
0.577	0.0060	0.7881	0.00406251	0.00788349	0.00519618
0.592	0.0056	0.7618	0.00412676	0.00802129	0.00534348
0.607	0.0053	0.7299	0.00418468	0.00815602	0.00548460
0.622	0.0050	0.6942	0.00423652	0.00828781	0.00561954
0.637	0.0047	0.6563	0.00428266	0.00841676	0.00574836
0.652	0.0044	0.6185	0.00432364	0.00854295	0.00587112
0.667	0.0042	0.5829	0.00436006	0.00866642	0.00598790
0.682	0.0039	0.5516	0.00439254	0.00878718	0.00609878
0.697	0.0037	0.5263	0.00442172	0.00890521	0.00620380
0.712	0.0035	0.5079	0.00444816	0.00902049	0.00630299
0.727	0.0032	0.4964	0.00447230	0.00913297	0.00639634
0.742	0.0030	0.4900	0.00449440	0.00924263	0.00648381
0.757	0.0028	0.4853	0.00451447	0.00934945	0.00656532
0.772	0.0025	0.4761	0.00453226	0.00945344	0.00664081
0.787	0.0022	0.4530	0.00454727	0.00955469	0.00671019
0.802	0.0019	0.4029	0.00455883	0.00965334	0.00677344
0.817	0.0016	0.3079	0.00456627	0.00974965	0.00683061
0.832	0.0013	0.2276	0.00457077	0.00984403	0.00688188
0.847	0.0011	0.1473	0.00457311	0.00993704	0.00692765
0.862	0.0009	0.0669	0.00457398	0.01002947	0.00696857

CURVE FIT OF TURBULENT SHEAR STRESS

ORDER = 8 MEAN SQUARE ERROR = 0.454055E-07

NO.	COEFFICIENT
0	0.00270116
1	0.02656515
2	0.08647848
3	-1.38500348
4	8.73501042
5	-28.20243950
6	46.39767431
7	-37.37300652
8	11.74256026

X $(R-R_i)_{ins}$	Y $\frac{2\rho(\overline{u'v'})}{\rho U^2}_{EXP^T}$	YCALC $\frac{2\overline{u'v'}}{U^2}$	ERROR
0.05000000	0.00411978	0.00411896	0.00000082
0.10000000	0.00546565	0.00547171	-0.00000606
0.15000000	0.00671516	0.00670544	0.00000972
0.20000000	0.00785726	0.00786567	-0.00000841
0.25000000	0.00896051	0.00891203	0.00004848
0.30000000	0.00958568	0.00970118	-0.00011550
0.35000000	0.01013254	0.01005580	0.00007674
0.40000000	0.00986480	0.00985538	0.00000942
0.45000000	0.00913658	0.00910378	0.00003280
0.50000000	0.00787785	0.00794626	-0.00006841
0.55000000	0.00662173	0.00662772	-0.00000599
0.60000000	0.00539144	0.00540222	-0.00001078
0.65000000	0.00452649	0.00442218	0.00010431
0.70000000	0.00357636	0.00365444	-0.00007808
0.75000000	0.00288211	0.00288859	-0.00000648
0.80000000	0.00194551	0.00192171	0.00002380
0.35000000	0.00101557	0.00102196	-0.00000640

$(R-R_i)_{ins.}$	$\frac{2(\overline{u'v'})}{U^2}_{EXP^T}$
0.050	0.00412
0.100	0.00547
0.150	0.00672
0.200	0.00786
0.250	0.00896
0.300	0.00959
0.350	0.01013
0.400	0.00986
0.450	0.00914
0.500	0.00788
0.550	0.00662
0.600	0.00539
0.650	0.00453
0.700	0.00358
0.750	0.00288
0.800	0.00195
0.850	0.00102

REFERENCE TABLE A22-10

DIFFUSER NON DIMENSIONAL LENGTH = 10.0

AXIAL DIST. FROM INLET(X) = 9.850 INS. N.D.DIST.(X/L)= 0.985

INNER WALL BLUE POSITION

DELTA*= 0.249 INS. H= 1.69 REYNOLDS NO.(BASED ON THETA)= 7758.5

DIST R-RI	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.027	1.993	0.0041	0.004	0.0006	0.09	0.012
0.100	0.054	0.802	0.0056	0.014	0.0018	0.26	0.035
0.150	0.081	0.739	0.0067	0.018	0.0024	0.31	0.042
0.200	0.107	0.869	0.0079	0.018	0.0024	0.29	0.039
0.250	0.134	0.898	0.0089	0.020	0.0027	0.30	0.040
0.300	0.161	0.829	0.0098	0.023	0.0031	0.34	0.045
0.350	0.188	0.757	0.0101	0.027	0.0036	0.38	0.051
0.400	0.215	0.731	0.0099	0.027	0.0036	0.39	0.052
0.450	0.242	0.769	0.0091	0.024	0.0032	0.35	0.047
0.500	0.269	0.817	0.0080	0.020	0.0026	0.31	0.041
0.550	0.295	0.819	0.0067	0.016	0.0022	0.28	0.038
0.600	0.322	0.746	0.0055	0.015	0.0019	0.28	0.037
0.650	0.349	0.625	0.0045	0.014	0.0019	0.30	0.040
0.700	0 376	0.523	0.0037	0.014	0.0019	0.33	0.044
0.750	0.403	0.488	0.0029	0.012	0.0016	0.31	0.042
0.800	0 430	0.414	0.0020	0.009	0.0012	0.30	0.040
0.850	0.456	0.172	0.0010	0.012	0.0016	0.53	0.071

DISSIPATION COEFFICIENT= 0.004574

REYNOLDS NORMAL STRESS, UCOMPNT= 0.01003 VCOMPNT= 0.00697

APPENDIX 19

ACCURACY OF TURBULENCE ANALYSIS

No difficulty was experienced in curve-fitting the velocity profile and turbulence data. Various orders of polynomial equation were investigated and it was found that an eighth order equation provided a stable solution with the greatest accuracy. Some error in the calculation of $d\frac{(\overline{u})}{dR}$ can be expected, particularly in the early stages of diffusion (Section A13-3), since the raw velocity profile data has an accuracy of $\pm$ 1%. Examination of the mixing length distributions (Figs. 4-10-1/2) reveals a scatter of the order of 20% in the early stages of diffusion, whilst in the latter stages of diffusion the data is free from any significant scatter. However, in view of the accuracy of the shear stress measurements it is difficult to quote an accuracy for the mixing length data although the relative changes are probably accurate to within $\pm$ 10%.

Appendix 20

Turbulence Analysis

$L/\Delta R_1 = 5$ Diffuser

TABLE A20-1

DIFFUSER NON DIMENSIONAL LENGTH = 5.0

AXIAL DIST. FROM INLET(X) = 3.000 INS. N.D.DIST.(X/L)= 0.600

INNER WALL BLUE POSITION

DELTA*= 0.050 INS. H= 1.28 REYNOLDS NO.(BASED ON THETA)= 3285.1

DIST R-RI	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.030	0.030	4.445	0.0030	0.007	0.0003	0.17	0.009
0.050	0.050	2.302	0.0029	0.013	0.0006	0.33	0.017
0.075	0.075	1.381	0.0029	0.021	0.0011	0.56	0.028
0.100	0.100	1.190	0.0028	0.024	0.0012	0.63	0.032
0.125	0.125	1.111	0.0026	0.024	0.0012	0.65	0.033
0.150	0.150	0.957	0.0024	0.025	0.0013	0.72	0.036
0.175	0.175	0.750	0.0022	0.029	0.0015	0.88	0.044
0.200	0.200	0.569	0.0020	0.035	0.0018	1.11	0.056
0.250	0.250	0.451	0.0016	0.035	0.0017	1.24	0.062
0.300	0.300	0.440	0.0011	0.025	0.0013	1.07	0.053
0.350	0.350	0.220	0.0008	0.035	0.0018	1.78	0.089
0.400	0.400	0.132	0.0004	0.032	0.0016	2.21	0.110
0.450	0.450	0.044	0.0002	0.037	0.0018	4.10	0.205

DISSIPATION COEFFICIENT= 0.001518

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00160 VCOMPNT= 0.00069

TABLE A20-2

DIFFUSER NON DIMENSIONAL LENGTH = 5.0

AXIAL DIST. FROM INLET(X) = 3.000 INS. N.D.DIST.(X/L)= 0.600

INNER WALL GREEN POSITION

DELTA*= 0.050 INS. H= 1.28 REYNOLDS NO.(BASED ON THETA)= 3285.1

DIST R-RI	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.030	0.030	4.445	0.0029	0.007	0.0003	0.17	0.009
0.050	0.050	2.302	0.0028	0.012	0.0006	0.33	0.016
0.075	0.075	1.381	0.0028	0.020	0.0010	0.54	0.027
0.100	0.100	1.190	0.0027	0.023	0.0011	0.62	0.031
0.125	0.125	1.111	0.0026	0.023	0.0012	0.65	0.032
0.150	0.150	0.957	0.0024	0.025	0.0012	0.72	0.036
0.175	0.175	0.750	0.0022	0.029	0.0014	0.88	0.044
0.200	0.200	0.569	0.0019	0.034	0.0017	1.09	0.054
0.250	0.250	0.451	0.0015	0.032	0.0016	1.20	0.060
0.300	0.300	0.440	0.0010	0.023	0.0012	1.02	0.051
0.350	0.350	0.220	0.0006	0.027	0.0013	1.56	0.078
0.400	0.400	0.132	0.0004	0.027	0.0014	2.03	0.101
0.450	0.450	0.044	0.0001	0.020	0.0010	2.98	0.149

DISSIPATION COEFFICIENT= 0.001497

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00159 VCOMPNT= 0.00084

TABLE A20-3

DIFFUSER NON DIMENSIONAL LENGTH = 5.0

AXIAL DIST. FROM INLET(X) = 3.000 INS. N.D.DIST.(X/L)= 0.600

INNER WALL RED POSITION

DELTA*= 0.050 INS. H= 1.28 REYNOLDS NO.(BASED ON THETA)= 3285.1

DIST R-RI	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.030	0.030	4.445	0.0021	0.005	0.0002	0.15	0.007
0.050	0.050	2.302	0.0022	0.010	0.0005	0.29	0.015
0.075	0.075	1.381	0.0025	0.018	0.0009	0.51	0.026
0.100	0.100	1.190	0.0026	0.021	0.0011	0.60	0.030
0.125	0.125	1.111	0.0024	0.021	0.0011	0.62	0.031
0.150	0.150	0.957	0.0022	0.022	0.0011	0.69	0.034
0.175	0.175	0.750	0.0020	0.026	0.0013	0.84	0.042
0.200	0.200	0.569	0.0018	0.032	0.0016	1.06	0.053
0.250	0.250	0.451	0.0016	0.035	0.0017	1.24	0.062
0.300	0.300	0.440	0.0012	0.027	0.0014	1.11	0.056
0.350	0.350	0.220	0.0009	0.041	0.0020	1.92	0.096
0.400	0.400	0.132	0.0006	0.045	0.0023	2.62	0.131
0.450	0.450	0.044	0.0003	0.068	0.0034	5.56	0.278

DISSIPATION COEFFICIENT= 0.001279

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00179 VCOMPNT= 0.00082

TABLE A20-4

DIFFUSER NON DIMENSIONAL LENGTH = 5.0

AXIAL DIST. FROM INLET(X) = 0.300 INS. N.D.DIST.(X/L)= 0.060

INNER WALL BLUF POSITION

DELTA*= 0.057 INS. H= 1.31 REYNOLDS NO.(BASED ON THETA)= 3633.8

DIST R-RI	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.047	2.488	0.0049	0.017	0.0009	0.35	0.019
0.075	0.071	1.460	0.0044	0.026	0.0014	0.56	0.031
0.100	0.095	1.236	0.0039	0.027	0.0015	0.62	0.034
0.125	0.119	1.132	0.0034	0.027	0.0014	0.64	0.035
0.150	0.142	0.961	0.0032	0.029	0.0016	0.73	0.039
0.175	0.166	0.752	0.0030	0.035	0.0019	0.90	0.049
0.200	0.190	0.583	0.0028	0.043	0.0023	1.13	0.061
0.250	0.237	0.503	0.0024	0.042	0.0023	1.21	0.066
0.300	0.285	0.529	0.0019	0.032	0.0017	1.02	0.055
0.350	0.332	0.309	0.0014	0.041	0.0022	1.52	0.082
0.400	0.380	0.087	0.0011	0.107	0.0058	4.66	0.252
0.450	0.427	0.049	0.0007	0.125	0.0068	6.69	0.362

DISSIPATION COEFFICIENT= 0.002405

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00173 VCOMPNT= 0.00212

TABLE A20-5

DIFFUSER NON DIMENSIONAL LENGTH = 5.0

AXIAL DIST. FROM INLET(X) = 0.750 INS. N.D.DIST.(X/L)= 0.150

INNER WALL BLUE POSITION

DELTA*= 0.075 INS. H= 1.40 REYNOLDS NO.(BASED ON THETA)= 4172.7

DIST R-RI	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.044	2.934	0.0066	0.015	0.0010	0.26	0.017
0.075	0.066	1.781	0.0056	0.021	0.0014	0.40	0.026
0.100	0.088	1.450	0.0047	0.022	0.0014	0.45	0.030
0.125	0.110	1.327	0.0042	0.021	0.0014	0.46	0.030
0.150	0.133	1.188	0.0039	0.022	0.0015	0.50	0.033
0.175	0.155	1.006	0.0038	0.025	0.0017	0.58	0.038
0.200	0.177	0.827	0.0037	0.030	0.0020	0.69	0.046
0.250	0.221	0.634	0.0032	0.033	0.0022	0.84	0.055
0.300	0.265	0.606	0.0025	0.027	0.0018	0.78	0.052
0.350	0.309	0.474	0.0020	0.028	0.0018	0.88	0.059
0.400	0.353	0.233	0.0015	0.042	0.0028	1.56	0.103
0.450	0.398	0.147	0.0009	0.039	0.0026	1.88	0.125
0.500	0.442	0.060	0.0006	0.062	0.0041	3.69	0.245

DISSIPATION COEFFICIENT= 0.003264

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00248 VCOMPNT= 0.00222

TABLE A20-6

DIFFUSER NON DIMENSIONAL LENGTH = 5.0

AXIAL DIST. FROM INLET(X) = 1.350 INS. N.D.DIST.(X/L)= 0.270

INNER WALL BLUE POSITION

DELTA*= 0.094 INS. H= 1.45 REYNOLDS NO.(BASED ON THETA)= 4696.9

DIST R-RI	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.040	3.122	0.0089	0.015	0.0012	0.23	0.017
0.075	0.061	2.036	0.0087	0.023	0.0017	0.34	0.026
0.100	0.081	1.594	0.0078	0.026	0.0020	0.42	0.032
0.125	0.101	1.415	0.0068	0.026	0.0019	0.44	0.033
0.150	0.121	1.303	0.0059	0.024	0.0018	0.44	0.034
0.175	0.141	1.179	0.0052	0.023	0.0018	0.46	0.035
0.200	0.162	1.033	0.0046	0.024	0.0018	0.50	0.038
0.250	0.202	0.752	0.0039	0.027	0.0021	0.62	0.047
0.300	0.242	0.604	0.0033	0.029	0.0022	0.71	0.054
0.350	0.283	0.551	0.0026	0.025	0.0019	0.70	0.053
0.400	0.323	0.448	0.0020	0.023	0.0018	0.74	0.056
0.450	0.363	0.272	0.0014	0.027	0.0021	1.03	0.078
0.500	0.404	0.178	0.0009	0.027	0.0020	1.27	0.096
0.550	0.444	0.085	0.0005	0.032	0.0025	2.02	0.153

DISSIPATION COEFFICIENT= 0.004082

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00444 VCOMPNT= 0.00299

TABLE A20-7

DIFFUSER NON DIMENSIONAL LENGTH = 5.0

AXIAL DIST. FROM INLET(X) = 1.950 INS. N.D.DIST.(X/L)= 0.390

INNER WALL BLUE POSITION

DELTA*= 0.118 INS. H= 1.51 REYNOLDS NO.(BASED ON THETA)= 5356.2

DIST R-RI	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.037	2.789	0.0080	0.012	0.0011	0.19	0.017
0.075	0.056	2.077	0.0088	0.018	0.0016	0.27	0.024
0.100	0.074	1.710	0.0089	0.022	0.0019	0.33	0.029
0.125	0.093	1.514	0.0084	0.023	0.0021	0.36	0.032
0.150	0.112	1.386	0.0076	0.023	0.0020	0.38	0.033
0.200	0.149	1.159	0.0057	0.021	0.0018	0.39	0.034
0.250	0.186	0.928	0.0041	0.019	0.0016	0.41	0.036
0.300	0.223	0.744	0.0031	0.017	0.0015	0.45	0.039
0.350	0.260	0.627	0.0025	0.017	0.0015	0.48	0.042
0.400	0.298	0.539	0.0022	0.017	0.0015	0.52	0.045
0.450	0.335	0.429	0.0017	0.017	0.0015	0.58	0.051
0.500	0.372	0.303	0.0012	0.016	0.0014	0.68	0.060
0.550	0.409	0.231	0.0006	0.012	0.0010	0.65	0.057
0.600	0.446	0.121	0.0003	0.012	0.0011	0.92	0.081

DISSIPATION COEFFICIENT= 0.003781

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00516 VCOMPNT= 0.00248

TABLE A20-8

DIFFUSER NON DIMENSIONAL LENGTH = 5.0

AXIAL DIST. FROM INLET(X) = 2.550 INS. N.D.DIST.(X/L)= 0.510

INNER WALL BLUE POSITION

DELTA*= 0.136 INS. H= 1.57 REYNOLDS NO.(BASED ON THETA)= 5670.2

DIST R-RI	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.034	2.503	0.0070	0.010	0.0010	0.17	0.016
0.075	0.052	1.905	0.0080	0.015	0.0015	0.24	0.023
0.100	0.069	1.677	0.0085	0.019	0.0017	0.29	0.027
0.125	0.086	1.589	0.0086	0.020	0.0019	0.30	0.028
0.150	0.103	1.521	0.0084	0.020	0.0019	0.31	0.029
0.200	0.138	1.300	0.0074	0.021	0.0020	0.34	0.032
0.250	0.172	1.026	0.0058	0.021	0.0020	0.39	0.036
0.300	0.207	0.835	0.0044	0.019	0.0018	0.41	0.039
0.350	0.241	0.752	0.0036	0.017	0.0016	0.41	0.039
0.400	0.276	0.688	0.0031	0.017	0.0016	0.42	0.040
0.450	0.310	0.549	0.0027	0.018	0.0017	0.49	0.046
0.500	0.345	0.348	0.0020	0.021	0.0020	0.67	0.063
0.550	0.379	0.215	0.0012	0.020	0.0019	0.83	0.078
0.600	0.414	0.136	0.0009	0.024	0.0023	1.14	0.107
0.650	0.448	0.056	0.0003	0.023	0.0021	1.72	0.162

DISSIPATION COEFFICIENT= 0.004063

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00657 VCOMPNT= 0.00225

TABLE A20-9

DIFFUSER NON DIMENSIONAL LENGTH = 5.0

AXIAL DIST. FROM INLET(X) = 3.150 INS. N.D.DIST.(X/L)= 0.630

INNER WALL BLUE POSITION

DELTA*= 0.155 INS. H= 1.61 REYNOLDS NO.(BASED ON THETA)= 6173.0

DIST R-RI	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.030	0.019	2.990	0.0046	0.005	0.0005	0.10	0.010
0.050	0.032	2.224	0.0057	0.008	0.0008	0.16	0.015
0.100	0.064	1.565	0.0075	0.015	0.0015	0.25	0.025
0.150	0.096	1.478	0.0085	0.018	0.0018	0.28	0.028
0.200	0.129	1.359	0.0086	0.020	0.0020	0.31	0.031
0.250	0.161	1.149	0.0077	0.022	0.0021	0.35	0.035
0.300	0.193	0.945	0.0062	0.021	0.0021	0.38	0.038
0.350	0.225	0.806	0.0048	0.019	0.0019	0.39	0.039
0.400	0.257	0.715	0.0038	0.017	0.0017	0.40	0.039
0.450	0.289	0.611	0.0034	0.018	0.0018	0.43	0.043
0.500	0.322	0.462	0.0030	0.021	0.0021	0.54	0.054
0.550	0.354	0.310	0.0023	0.024	0.0024	0.70	0.070
0.600	0.386	0.244	0.0012	0.016	0.0016	0.65	0.065
0.650	0.418	0.138	0.0005	0.011	0.0011	0.72	0.072
0.700	0.450	0.032	0.0006	0.062	0.0062	3.54	0.353

DISSIPATION COEFFICIENT= 0.004051

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00741 VCOMPNT= 0.00278

TABLE A20-10

DIFFUSER NON DIMENSIONAL LENGTH = 5.0

AXIAL DIST. FROM INLET(X) = 3.150 INS. N.D.DIST.(X/L)= 0.630

INNER WALL GREEN POSITION

DELTA*= 0.155 INS. H= 1.61 REYNOLDS NO.(BASED ON THETA)= 6173.0

DIST R-RI	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.030	0.019	2.990	0.0043	0.005	0.0005	0.10	0.010
0.050	0.032	2.224	0.0054	0.008	0.0008	0.15	0.015
0.100	0.064	1.565	0.0073	0.015	0.0015	0.25	0.025
0.150	0.096	1.478	0.0080	0.017	0.0017	0.28	0.027
0.200	0.129	1.359	0.0075	0.018	0.0018	0.29	0.029
0.250	0.161	1.149	0.0064	0.018	0.0018	0.32	0.032
0.300	0.193	0.945	0.0051	0.017	0.0017	0.34	0.034
0.350	0.225	0.806	0.0041	0.016	0.0016	0.36	0.036
0.400	0.257	0.715	0.0034	0.015	0.0015	0.37	0.037
0.450	0.289	0.611	0.0028	0.015	0.0015	0.40	0.040
0.500	0.322	0.462	0.0021	0.015	0.0015	0.45	0.045
0.550	0.354	0.310	0.0013	0.014	0.0014	0.54	0.054
0.600	0.386	0.244	0.0009	0.013	0.0012	0.57	0.057
0.650	0.418	0.138	0.0003	0.006	0.0006	0.53	0.053

DISSIPATION COEFFICIENT= 0.003646

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00670 VCOMPNT= 0.00250

TABLE A20-11

DIFFUSER NON DIMENSIONAL LENGTH = 5.0

AXIAL DIST. FROM INLET(X) = 3.150 INS. N.D.DIST.(X/L)= 0.630

INNER WALL RED POSITION

DELTA*= 0.155 INS. H= 1.61 REYNOLDS NO.(BASED ON THETA)= 6173.0

DIST R-RI	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.030	0.019	2.990	0.0042	0.005	0.0004	0.10	0.010
0.050	0.032	2.224	0.0053	0.008	0.0008	0.15	0.015
0.100	0.064	1.565	0.0072	0.015	0.0015	0.25	0.025
0.150	0.096	1.478	0.0081	0.018	0.0018	0.28	0.028
0.200	0.129	1.359	0.0081	0.019	0.0019	0.30	0.030
0.250	0.161	1.149	0.0072	0.020	0.0020	0.34	0.034
0.300	0.193	0.945	0.0060	0.020	0.0020	0.37	0.037
0.350	0.225	0.806	0.0048	0.019	0.0019	0.39	0.039
0.400	0.257	0.715	0.0039	0.017	0.0017	0.40	0.039
0.450	0.289	0.611	0.0033	0.017	0.0017	0.43	0.043
0.500	0.322	0.462	0.0029	0.020	0.0020	0.53	0.053
0.550	0.354	0.310	0.0025	0.026	0.0026	0.73	0.073
0.600	0.386	0.244	0.0018	0.024	0.0024	0.79	0.079
0.650	0.418	0.138	0.0011	0.027	0.0027	1.12	0.112
0.700	0.450	0.032	0.0008	0.078	0.0078	3.98	0.397

DISSIPATION COEFFICIENT= 0.003870

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00827 VCOMPNT= 0.00474

TABLE A20-12

DIFFUSER NON DIMENSIONAL LENGTH = 5.0

AXIAL DIST. FROM INLET(X) = 3.750 INS. N.D.DIST.(X/L)= 0.750

INNER WALL BLUE POSITION

DELTA*= 0.168 INS. H= 1.65 REYNOLDS NO.(BASED ON THETA)= 6418.6

DIST R-RI	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.030	1.961	0.0055	0.008	0.0008	0.16	0.016
0.100	0.060	1.374	0.0080	0.017	0.0018	0.27	0.028
0.150	0.090	1.460	0.0092	0.019	0.0019	0.28	0.028
0.200	0.120	1.401	0.0092	0.020	0.0020	0.29	0.029
0.250	0.151	1.177	0.0084	0.021	0.0021	0.33	0.033
0.300	0.181	0.967	0.0071	0.022	0.0022	0.37	0.037
0.350	0.211	0.867	0.0058	0.020	0.0020	0.37	0.037
0.400	0.241	0.833	0.0047	0.017	0.0017	0.35	0.035
0.450	0.271	0.755	0.0038	0.015	0.0015	0.34	0.035
0.500	0.301	0.575	0.0030	0.016	0.0016	0.40	0.041
0.550	0.331	0.366	0.0022	0.018	0.0018	0.54	0.054
0.600	0.361	0.283	0.0013	0.014	0.0014	0.54	0.055
0.650	0.392	0.160	0.0007	0.014	0.0014	0.71	0.072
0.700	0.422	0.037	0.0005	0.044	0.0044	2.65	0.269

DISSIPATION COEFFICIENT= 0.004296

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00771 VCOMPNT= 0.00522

TABLE A20-13

DIFFUSER NON DIMENSIONAL LENGTH = 5.0

AXIAL DIST. FROM INLET(X) = 4.850 INS. N.D.DIST.(X/L)= 0.970

INNER WALL BLUE POSITION

DELTA*= 0.194 INS. H= 1.69 REYNOLDS NO.(BASED ON THETA)= 7011.7

DIST R-RI	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.027	2.023	0.0046	0.006	0.0006	0.12	0.013
0.100	0.054	1.140	0.0068	0.015	0.0016	0.26	0.028
0.150	0.081	1.178	0.0084	0.018	0.0019	0.28	0.030
0.200	0.108	1.214	0.0092	0.020	0.0021	0.29	0.030
0.250	0.135	1.125	0.0095	0.022	0.0023	0.32	0.033
0.300	0.162	1.016	0.0091	0.023	0.0024	0.34	0.036
0.350	0.189	0.954	0.0081	0.022	0.0023	0.34	0.036
0.400	0.216	0.910	0.0066	0.019	0.0020	0.32	0.034
0.450	0.243	0.814	0.0049	0.016	0.0016	0.31	0.033
0.500	0.270	0.644	0.0035	0.014	0.0015	0.34	0.035
0.550	0.297	0.477	0.0027	0.014	0.0015	0.40	0.041
0.600	0.324	0.435	0.0022	0.013	0.0014	0.39	0.041
0.650	0.352	0.485	0.0017	0.009	0.0010	0.31	0.033
0.700	0.379	0.040	0.0008	0.053	0.0055	2.59	0.272

DISSIPATION COEFFICIENT= 0.004363

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00835 VCOMPNT= 0.00379

TABLE A20-14

DIFFUSER NON DIMENSIONAL LENGTH = 5.0

AXIAL DIST. FROM INLET(X) = 4.850 INS. N.D.DIST.(X/L)= 0.970

INNER WALL GREEN POSITION

DELTA*= 0.194 INS. H= 1.69 REYNOLDS NO.(BASED ON THETA)= 7011.7

DIST R-RI	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.027	2.023	0.0054	0.007	0.0007	0.13	0.014
0.100	0.054	1.140	0.0069	0.016	0.0016	0.26	0.028
0.150	0.081	1.178	0.0080	0.017	0.0018	0.28	0.029
0.200	0.108	1.214	0.0089	0.019	0.0020	0.28	0.030
0.250	0.135	1.125	0.0093	0.021	0.0022	0.31	0.033
0.300	0.162	1.016	0.0089	0.023	0.0024	0.34	0.035
0.350	0.189	0.954	0.0077	0.021	0.0022	0.34	0.035
0.400	0.216	0.910	0.0062	0.017	0.0018	0.31	0.033
0.450	0.243	0.814	0.0046	0.014	0.0015	0.30	0.032
0.500	0.270	0.644	0.0033	0.013	0.0014	0.32	0.034
0.550	0.297	0.477	0.0024	0.013	0.0014	0.37	0.039
0.600	0.324	0.435	0.0017	0.010	0.0011	0.35	0.036
0.650	0.352	0.485	0.0010	0.005	0.0006	0.24	0.025
0.700	0.379	0.040	0.0002	0.016	0.0016	1.42	0.149

DISSIPATION COEFFICIENT= 0.004340

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00827 VCOMPNT= 0.00344

TABLE A20-15

DIFFUSER NON DIMENSIONAL LENGTH = 5.0

AXIAL DIST. FROM INLET(X) = 4.850 INS. N.D.DIST.(X/L)= 0.970

INNER WALL RED POSITION

DELTA*= 0.194 INS. H= 1.69 REYNOLDS NO.(BASED ON THETA)= 7011.7

DIST R-RI	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.027	2.023	0.0042	0.005	0.0006	0.12	0.012
0.100	0.054	1.140	0.0066	0.015	0.0016	0.26	0.027
0.150	0.081	1.178	0.0084	0.018	0.0019	0.28	0.030
0.200	0.108	1.214	0.0094	0.020	0.0021	0.29	0.031
0.250	0.135	1.125	0.0096	0.022	0.0023	0.32	0.033
0.300	0.162	1.016	0.0090	0.023	0.0024	0.34	0.036
0.350	0.189	0.954	0.0081	0.022	0.0023	0.34	0.036
0.400	0.216	0.910	0.0068	0.019	0.0020	0.33	0.035
0.450	0.243	0.814	0.0055	0.017	0.0018	0.33	0.035
0.500	0.270	0.644	0.0043	0.017	0.0018	0.37	0.039
0.550	0.297	0.477	0.0032	0.017	0.0018	0.43	0.045
0.600	0.324	0.435	0.0023	0.013	0.0014	0.40	0.042
0.650	0.352	0.485	0.0013	0.007	0.0007	0.27	0.029
0.700	0.379	0.040	0.0003	0.019	0.0020	1.57	0.165

DISSIPATION COEFFICIENT= 0.004352

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00991 VCOMPNT= 0.00566

TABLE A20-16

DIFFUSER NON DIMENSIONAL LENGTH = 5.0

AXIAL DIST. FROM INLET(X) = 3.000 INS. N.D.DIST.(X/L)= 0.600

OUTER WALL BLUE POSITION

DELTA*= 0.055 INS. H= 1.30 REYNOLDS NO.(BASED ON THETA)= 3537.8

DIST RO-R	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.025	0.025	5.196	0.0025	0.004	0.0002	0.12	0.007
0.050	0.050	2.564	0.0025	0.009	0.0005	0.25	0.014
0.075	0.075	1.552	0.0025	0.015	0.0008	0.41	0.023
0.100	0.100	1.194	0.0024	0.018	0.0010	0.52	0.029
0.125	0.125	1.034	0.0022	0.019	0.0010	0.58	0.032
0.150	0.150	0.901	0.0020	0.020	0.0011	0.63	0.035
0.200	0.200	0.649	0.0017	0.024	0.0013	0.82	0.045
0.250	0.250	0.517	0.0015	0.026	0.0014	0.95	0.052
0.300	0.300	0.447	0.0011	0.022	0.0012	0.94	0.051
0.350	0.350	0.303	0.0007	0.020	0.0011	1.11	0.061
0.400	0.400	0.179	0.0006	0.028	0.0016	1.69	0.093
0.450	0.450	0.101	0.0002	0.017	0.0009	1.74	0.096
0.500	0.500	0.023	0.0000	0.017	0.0009	3.61	0.198

DISSIPATION COEFFICIENT= 0.001293

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00145 VCOMPNT= 0.00070

TABLE A20-17

DIFFUSER NON DIMENSIONAL LENGTH = 5.0

AXIAL DIST. FROM INLET(X) = 3.000 INS. N.D.DIST.(X/L)= 0.600

OUTER WALL GREEN POSITION

DELTA*= 0.055 INS. H= 1.30 REYNOLDS NO.(BASED ON THETA)= 3537.8

DIST RO-R	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.025	0.025	5.196	0.0025	0.004	0.0002	0.12	0.007
0.050	0.050	2.564	0.0024	0.009	0.0005	0.25	0.014
0.075	0.075	1.552	0.0025	0.015	0.0008	0.42	0.023
0.100	0.100	1.194	0.0025	0.019	0.0011	0.54	0.030
0.125	0.125	1.034	0.0024	0.021	0.0011	0.61	0.033
0.150	0.150	0.901	0.0022	0.022	0.0012	0.67	0.037
0.200	0.200	0.649	0.0019	0.027	0.0015	0.87	0.048
0.250	0.250	0.517	0.0017	0.030	0.0016	1.02	0.056
0.300	0.300	0.447	0.0013	0.026	0.0014	1.03	0.057
0.350	0.350	0.303	0.0009	0.027	0.0015	1.27	0.070
0.400	0.400	0.179	0.0007	0.036	0.0020	1.91	0.105
0.450	0.450	0.101	0.0003	0.030	0.0017	2.33	0.128
0.500	0.500	0.023	0.0001	0.051	0.0028	6.31	0.347

DISSIPATION COEFFICIENT= 0.001320

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00169 VCOMPNT= 0.00090

TABLE A20-18

DIFFUSER NON DIMENSIONAL LENGTH = 5.0

AXIAL DIST. FROM INLET(X) = 3.000 INS. N.D.DIST.(X/L)= 0.600

OUTER WALL RED POSITION

DELTA*= 0.055 INS. H= 1.30 REYNOLDS NO.(BASED ON THETA)= 3537.8

DIST RO-R	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.025	0.025	5.196	0.0023	0.004	0.0002	0.12	0.007
0.050	0.050	2.564	0.0023	0.008	0.0005	0.24	0.013
0.075	0.075	1.552	0.0025	0.015	0.0008	0.42	0.023
0.100	0.100	1.194	0.0025	0.019	0.0010	0.54	0.030
0.125	0.125	1.034	0.0024	0.021	0.0011	0.60	0.033
0.150	0.150	0.901	0.0022	0.022	0.0012	0.67	0.037
0.200	0.200	0.649	0.0019	0.026	0.0015	0.86	0.047
0.250	0.250	0.517	0.0015	0.027	0.0015	0.97	0.054
0.300	0.300	0.447	0.0011	0.022	0.0012	0.95	0.052
0.350	0.350	0.303	0.0009	0.026	0.0014	1.24	0.068
0.400	0.400	0.179	0.0006	0.028	0.0015	1.69	0.093
0.450	0.450	0.101	0.0003	0.025	0.0014	2.13	0.117

DISSIPATION COEFFICIENT= 0.001283

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00155 VCOMPNT= 0.00079

TABLE A20-19

DIFFUSER NON DIMENSIONAL LENGTH = 5.0

AXIAL DIST. FROM INLET(X) = 0.750 INS. N.D.DIST.(X/L)= 0.150

OUTER WALL BLUE POSITION

DELTA*= 0.090 INS. H= 1.49 REYNOLDS NO.(BASED ON THETA)= 4713.6

DIST RO-R	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.044	4.092	0.0089	0.012	0.0010	0.18	0.014
0.075	0.066	2.719	0.0063	0.013	0.0010	0.23	0.018
0.100	0.088	1.848	0.0059	0.012	0.0009	0.26	0.021
0.125	0.111	1.334	0.0022	0.009	0.0007	0.28	0.022
0.150	0.133	1.056	0.0015	0.008	0.0006	0.29	0.023
0.200	0.177	0.847	0.0015	0.010	0.0008	0.36	0.028
0.250	0.221	0.748	0.0016	0.012	0.0009	0.42	0.033
0.300	0.265	0.610	0.0013	0.012	0.0009	0.46	0.037
0.350	0.310	0.468	0.0010	0.012	0.0009	0.53	0.042
0.400	0.354	0.385	0.0009	0.013	0.0011	0.62	0.049
0.450	0.398	0.344	0.0007	0.012	0.0009	0.62	0.049
0.500	0.442	0.244	0.0004	0.009	0.0007	0.64	0.051
0.550	0.487	0.128	0.0003	0.012	0.0010	1.03	0.082

DISSIPATION COEFFICIENT= 0.003794

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00309 VCOMPNT= 0.00230

TABLE A20-20

DIFFUSER NON DIMENSIONAL LENGTH = 5.0

AXIAL DIST. FROM INLET(X) = 1.350 INS. N.D.DIST.(X/L)= 0.270

OUTER WALL BLUE POSITION

DELTA*= 0.120 INS. H= 1.69 REYNOLDS NO.(BASED ON THETA)= 5130.4

DIST RO-R	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.040	3.706	0.0079	0.009	0.0009	0.14	0.014
0.075	0.060	3.268	0.0087	0.011	0.0011	0.17	0.016
0.100	0.081	2.772	0.0083	0.013	0.0012	0.19	0.019
0.125	0.101	2.288	0.0071	0.013	0.0013	0.22	0.021
0.150	0.121	1.857	0.0055	0.012	0.0012	0.24	0.023
0.200	0.161	1.226	0.0029	0.010	0.0010	0.26	0.025
0.250	0.202	0.886	0.0018	0.009	0.0008	0.29	0.028
0.300	0.242	0.735	0.0019	0.011	0.0010	0.35	0.034
0.350	0.282	0.657	0.0020	0.012	0.0012	0.40	0.039
0.400	0.323	0.574	0.0015	0.011	0.0011	0.40	0.039
0.450	0.363	0.465	0.0009	0.008	0.0008	0.37	0.036
0.500	0.403	0.341	0.0007	0.008	0.0008	0.45	0.043
0.550	0.444	0.205	0.0009	0.018	0.0017	0.85	0.083
0.600	0.484	0.019	0.0005	0.122	0.0118	7.39	0.715

DISSIPATION COEFFICIENT= 0.003920

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00443 VCOMPNT= 0.00248

TABLE A20-21

DIFFUSER NON DIMENSIONAL LENGTH = 5.0

AXIAL DIST. FROM INLET(X) = 1.950 INS. N.D.DIST.(X/L)= 0.390

OUTER WALL BLUE POSITION

DELTA*= 0.157 INS. H= 1.91 REYNOLDS NO.(BASED ON THETA)= 5627.4

DIST RO-R	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.037	2.652	0.0051	0.006	0.0007	0.12	0.014
0.100	0.074	2.547	0.0088	0.011	0.0013	0.17	0.019
0.125	0.093	2.477	0.0095	0.012	0.0014	0.18	0.021
0.150	0.112	2.344	0.0094	0.013	0.0015	0.19	0.022
0.175	0.130	2.150	0.0086	0.013	0.0015	0.19	0.023
0.200	0.149	1.913	0.0076	0.013	0.0015	0.20	0.024
0.250	0.186	1.410	0.0052	0.012	0.0014	0.23	0.027
0.300	0.223	1.005	0.0034	0.011	0.0013	0.26	0.030
0.350	0.260	0.764	0.0025	0.011	0.0012	0.30	0.035
0.400	0.298	0.649	0.0023	0.011	0.0013	0.33	0.039
0.450	0.335	0.573	0.0022	0.012	0.0014	0.37	0.043
0.500	0.372	0.467	0.0018	0.012	0.0015	0.41	0.048
0.550	0.409	0.331	0.0013	0.012	0.0015	0.49	0.057
0.600	0.446	0.225	0.0009	0.012	0.0014	0.59	0.068
0.650	0.484	0.075	0.0006	0.027	0.0031	1.51	0.177

DISSIPATION COEFFICIENT= 0.004575

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00587 VCOMPNT= 0.00314

TABLE A20-22

DIFFUSER NON DIMENSIONAL LENGTH = 5.0

AXIAL DIST. FROM INLET(X) = 1.950 INS. N.D.DIST.(X/L)= 0.390

OUTER WALL GREEN POSITION

DELTA*= 0.157 INS. H= 1.91 REYNOLDS NO.(BASED ON THETA)= 5627.4

DIST RO-R	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.037	2.652	0.0044	0.005	0.0006	0.11	0.013
0.100	0.074	2.547	0.0083	0.010	0.0012	0.16	0.019
0.125	0.093	2.477	0.0092	0.012	0.0014	0.17	0.020
0.150	0.112	2.344	0.0093	0.013	0.0015	0.19	0.022
0.175	0.130	2.150	0.0088	0.013	0.0015	0.20	0.023
0.200	0.149	1.913	0.0078	0.013	0.0015	0.21	0.024
0.250	0.186	1.410	0.0055	0.012	0.0015	0.24	0.028
0.300	0.223	1.005	0.0037	0.012	0.0014	0.27	0.032
0.350	0.260	0.764	0.0027	0.011	0.0013	0.31	0.036
0.400	0.298	0.649	0.0024	0.012	0.0014	0.34	0.040
0.450	0.335	0.573	0.0023	0.013	0.0015	0.38	0.044
0.500	0.372	0.467	0.0020	0.014	0.0016	0.43	0.050
0.550	0.409	0.331	0.0015	0.014	0.0017	0.52	0.061
0.600	0.446	0.225	0.0010	0.014	0.0016	0.63	0.073
0.650	0.484	0.075	0.0007	0.031	0.0036	1.62	0.190

DISSIPATION COEFFICIENT= 0.004490

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00587 VCOMPNT= 0.00566

TABLE A20-23

DIFFUSER NON DIMENSIONAL LENGTH = 5.0

AXIAL DIST. FROM INLET(X) = 1.950 INS. N.D.DIST.(X/L)= 0.390

OUTER WALL RED POSITION

DELTA*= 0.157 INS. H= 1.91 REYNOLDS NO.(BASED ON THETA)= 5627.4

DIST RO-R	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.037	2.652	0.0047	0.006	0.0007	0.12	0.014
0.100	0.074	2.547	0.0080	0.010	0.0012	0.16	0.018
0.125	0.093	2.477	0.0084	0.011	0.0013	0.17	0.019
0.150	0.112	2.344	0.0080	0.011	0.0013	0.17	0.020
0.175	0.130	2.150	0.0071	0.011	0.0012	0.18	0.021
0.200	0.149	1.913	0.0061	0.010	0.0012	0.18	0.021
0.250	0.186	1.410	0.0042	0.009	0.0011	0.21	0.024
0.300	0.223	1.005	0.0031	0.010	0.0011	0.25	0.029
0.350	0.260	0.764	0.0026	0.011	0.0013	0.30	0.035
0.400	0.298	0.649	0.0021	0.011	0.0012	0.32	0.037
0.450	0.335	0.573	0.0016	0.009	0.0010	0.31	0.037
0.500	0.372	0.467	0.0011	0.008	0.0009	0.32	0.038
0.550	0.409	0.331	0.0008	0.008	0.0010	0.40	0.046
0.600	0.446	0.225	0.0004	0.006	0.0007	0.41	0.048

DISSIPATION COEFFICIENT= 0.003964

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00574 VCOMPNT= 0.00104

TABLE A20-24

DIFFUSER NON DIMENSIONAL LENGTH = 5.0

AXIAL DIST. FROM INLET(X) = 2.550 INS. N.D.DIST.(X/L)= 0.510

OUTER WALL BLUE POSITION

DELTA*= 0.209 INS. H= 2.12 REYNOLDS NO.(BASED ON THETA)= 6527.3

DIST RO-R	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.033	1.889	0.0029	0.004	0.0005	0.10	0.014
0.100	0.067	1.905	0.0049	0.006	0.0009	0.12	0.017
0.150	0.100	2.045	0.0078	0.009	0.0013	0.15	0.020
0.200	0.133	2.003	0.0097	0.012	0.0016	0.17	0.023
0.250	0.167	1.770	0.0096	0.013	0.0018	0.19	0.026
0.300	0.200	1.453	0.0075	0.012	0.0017	0.20	0.028
0.350	0.233	1.156	0.0050	0.010	0.0014	0.21	0.029
0.400	0.267	0.931	0.0032	0.008	0.0011	0.20	0.029
0.450	0.300	0.773	0.0025	0.008	0.0011	0.22	0.030
0.500	0.333	0.643	0.0024	0.009	0.0013	0.26	0.036
0.550	0.367	0.512	0.0022	0.010	0.0014	0.31	0.043
0.600	0.400	0.388	0.0014	0.009	0.0012	0.32	0.045
0.650	0.433	0.310	0.0007	0.005	0.0007	0.28	0.039
0.700	0.467	0.275	0.0010	0.008	0.0012	0.38	0.054
0.750	0.500	0.063	0.0002	0.009	0.0013	0.83	0.115

DISSIPATION COEFFICIENT= 0.004725

REYNOLDS NORMAL STRESS. UCOMPNT= 0.01114 VCOMPNT= 0.00168

TABLE A20-25

DIFFUSER NON DIMENSIONAL LENGTH = 5.0

AXIAL DIST. FROM INLET(X) = 3.150 INS. N.D.DIST.(X/L)= 0.630

OUTER WALL BLUE POSITION

DELTA*= 0.262 INS. H= 2.38 REYNOLDS NO.(BASED ON THETA)= 7073.2

DIST RO-R	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.031	1.293	0.0023	0.003	0.0006	0.10	0.016
0.100	0.063	1.409	0.0033	0.005	0.0007	0.11	0.018
0.150	0.094	1.633	0.0052	0.006	0.0010	0.12	0.020
0.200	0.125	1.778	0.0074	0.008	0.0013	0.13	0.021
0.250	0.156	1.794	0.0090	0.010	0.0016	0.14	0.023
0.300	0.187	1.698	0.0094	0.011	0.0017	0.15	0.025
0.350	0.219	1.529	0.0085	0.011	0.0017	0.16	0.027
0.400	0.250	1.325	0.0069	0.010	0.0016	0.17	0.028
0.450	0.281	1.113	0.0051	0.009	0.0014	0.17	0.028
0.500	0.313	0.908	0.0037	0.008	0.0013	0.18	0.029
0.550	0.344	0.718	0.0027	0.007	0.0012	0.20	0.032
0.600	0.375	0.556	0.0023	0.008	0.0013	0.23	0.038
0.650	0.406	0.432	0.0020	0.009	0.0014	0.28	0.045
0.700	0.437	0.352	0.0015	0.008	0.0014	0.30	0.049
0.750	0.469	0.293	0.0010	0.006	0.0010	0.28	0.047
0.800	0.500	0.121	0.0004	0.007	0.0012	0.47	0.078

DISSIPATION COEFFICIENT= 0.004932

REYNOLDS NORMAL STRESS. UCOMPNT= 0.01136 VCOMPNT= 0.00311

TABLE A20-26

DIFFUSER NON DIMENSIONAL LENGTH = 5.0

AXIAL DIST. FROM INLET(X) = 3.150 INS. N.D.DIST.(X/L)= 0.630

OUTER WALL GREEN POSITION

DELTA*= 0.262 INS. H= 2.38 REYNOLDS NO.(BASED ON THETA)= 7073.2

DIST RO-R	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.031	1.293	0.0020	0.003	0.0005	0.09	0.015
0.100	0.063	1.409	0.0038	0.005	0.0008	0.12	0.019
0.150	0.094	1.633	0.0060	0.007	0.0012	0.13	0.021
0.200	0.125	1.778	0.0079	0.008	0.0014	0.14	0.022
0.250	0.156	1.794	0.0089	0.010	0.0016	0.14	0.023
0.300	0.187	1.698	0.0089	0.010	0.0016	0.15	0.025
0.350	0.219	1.529	0.0080	0.010	0.0016	0.16	0.026
0.400	0.250	1.325	0.0066	0.010	0.0016	0.17	0.027
0.450	0.281	1.113	0.0052	0.009	0.0015	0.17	0.029
0.500	0.313	0.908	0.0039	0.008	0.0014	0.19	0.031
0.550	0.344	0.718	0.0030	0.008	0.0013	0.21	0.034
0.600	0.375	0.556	0.0023	0.008	0.0013	0.23	0.038
0.650	0.406	0.432	0.0017	0.008	0.0013	0.26	0.043
0.700	0.437	0.352	0.0012	0.007	0.0011	0.27	0.044
0.750	0.469	0.293	0.0008	0.005	0.0008	0.26	0.042
0.800	0.500	0.121	0.0006	0.009	0.0014	0.53	0.086

DISSIPATION COEFFICIENT= 0.004945

REYNOLDS NORMAL STRESS. UCOMPNT= 0.01112 VCOMPNT= 0.00626

TABLE A20-27

DIFFUSER NON DIMENSIONAL LENGTH = 5.0

AXIAL DIST. FROM INLET(X) = 3.750 INS. N.D.DIST.(X/L)= 0.750

OUTER WALL BLUE POSITION

DELTA*= 0.329 INS. H= 2.68 REYNOLDS NO.(BASED ON THETA)= 7740.0

DIST RO-R	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.029	0.882	0.0010	0.002	0.0003	0.08	0.015
0.100	0.059	1.097	0.0020	0.003	0.0005	0.09	0.017
0.150	0.088	1.280	0.0036	0.004	0.0008	0.10	0.020
0.200	0.118	1.424	0.0058	0.006	0.0012	0.11	0.022
0.250	0.147	1.523	0.0080	0.008	0.0016	0.13	0.025
0.300	0.176	1.569	0.0099	0.010	0.0019	0.14	0.026
0.350	0.206	1.562	0.0108	0.011	0.0020	0.14	0.028
0.400	0.235	1.499	0.0106	0.011	0.0021	0.15	0.029
0.450	0.265	1.385	0.0092	0.010	0.0019	0.15	0.029
0.500	0.294	1.232	0.0070	0.009	0.0017	0.15	0.028
0.550	0.324	1.054	0.0048	0.007	0.0013	0.14	0.027
0.600	0.353	0.872	0.0030	0.005	0.0010	0.14	0.026
0.650	0.382	0.709	0.0021	0.004	0.0009	0.14	0.027
0.700	0.412	0.579	0.0019	0.005	0.0010	0.16	0.031
0.750	0.441	0.487	0.0019	0.006	0.0012	0.19	0.038

DISSIPATION COEFFICIENT= 0.005500

REYNOLDS NORMAL STRESS. UCOMPNT= 0.01290 VCOMPNT= 0.00256

TABLE A20-28

DIFFUSER NON DIMENSIONAL LENGTH = 5.0

AXIAL DIST. FROM INLET(X) = 4.850 INS. N.D.DIST.(X/L)= 0.970

OUTER WALL BLUE POSITION

DELTA*= 0.487 INS. H= 3.52 REYNOLDS NO.(BASED ON THETA)= 8414.0

DIST RO-R	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.027	0.133	0.0002	0.001	0.0003	0.14	0.036
0.100	0.054	0.317	0.0002	0.001	0.0002	0.07	0.018
0.150	0.081	0.601	0.0007	0.001	0.0003	0.06	0.017
0.200	0.108	0.842	0.0017	0.002	0.0005	0.07	0.019
0.250	0.135	1.000	0.0031	0.003	0.0008	0.08	0.021
0.300	0.162	1.088	0.0047	0.004	0.0012	0.09	0.024
0.350	0.189	1.139	0.0065	0.006	0.0015	0.10	0.027
0.400	0.216	1.185	0.0082	0.007	0.0019	0.11	0.029
0.450	0.243	1.244	0.0098	0.008	0.0021	0.12	0.030
0.500	0.270	1.315	0.0111	0.009	0.0023	0.12	0.031
0.550	0.297	1.382	0.0119	0.009	0.0023	0.11	0.030
0.600	0.324	1.419	0.0121	0.009	0.0023	0.11	0.030
0.650	0.352	1.401	0.0116	0.009	0.0022	0.11	0.029
0.700	0.379	1.313	0.0104	0.008	0.0021	0.11	0.030
0.750	0.406	1.155	0.0087	0.008	0.0020	0.12	0.031
0.800	0.433	0.950	0.0066	0.007	0.0019	0.12	0.033
0.850	0.460	0.737	0.0046	0.006	0.0017	0.13	0.035
0.900	0.487	0.560	0.0030	0.006	0.0015	0.14	0.038

DISSIPATION COEFFICIENT= 0.007032

REYNOLDS NORMAL STRESS. UCOMPNT= 0.01542 VCOMPNT= 0.00373

DIFFUSER NON DIMENSIONAL LENGTH = 5.0

AXIAL DIST. FROM INLET(X) = 4.850 INS N.D.DIST.(X/L)= 0.970

OUTER WALL GREEN POSITION

DELTA*= 0.487 INS. H= 3.52 REYNOLDS NO.(BASED ON THETA)= 8414.0

DIST RO-R	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.027	0.133	0.0005	0.004	0.0010	0.24	0.063
0.100	0.054	0.317	0.0003	0.001	0.0003	0.08	0.021
0.150	0.081	0.601	0.0006	0.001	0.0003	0.06	0.016
0.200	0.108	0.842	0.0016	0.002	0.0005	0.07	0.018
0.250	0.135	1.000	0.0031	0.003	0.0008	0.08	0.021
0.300	0.162	1.088	0.0049	0.005	0.0012	0.09	0.024
0.350	0.189	1.139	0.0066	0.006	0.0016	0.10	0.027
0.400	0.216	1.185	0.0083	0.007	0.0019	0.11	0.029
0.450	0.243	1.244	0.0099	0.008	0.0022	0.12	0.031
0.500	0.270	1.315	0.0113	0.009	0.0023	0.12	0.031
0.550	0.297	1.382	0.0125	0.009	0.0024	0.12	0.031
0.600	0.324	1.419	0.0131	0.010	0.0025	0.12	0.031
0.650	0.352	1.401	0.0132	0.010	0.0025	0.12	0.031
0.700	0.379	1.313	0.0125	0.010	0.0026	0.12	0.033
0.750	0.406	1.155	0.0110	0.010	0.0026	0.13	0.035
0.800	0.433	0.950	0.0088	0.010	0.0025	0.14	0.038
0.850	0.460	0.737	0.0063	0.009	0.0023	0.16	0.041

DISSIPATION COEFFICIENT= 0.007799

REYNOLDS NORMAL STRESS. UCOMPNT= 0.01892 VCOMPNT= 0.00546

TABLE A20-30

DIFFUSER NON DIMENSIONAL LENGTH = 5.0

AXIAL DIST. FROM INLET(X) = 4.850 INS. N.D.DIST.(X/L)= 0.970

OUTER WALL RED POSITION

DELTA*= 0.449 INS. H= 2.76 REYNOLDS NO.(BASED ON THETA)= 9938.3

DIST RO-R	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.027	0.588	0.0014	0.003	0.0006	0.10	0.024
0.100	0.054	0.903	0.0023	0.003	0.0007	0.08	0.020
0.150	0.081	0.990	0.0036	0.004	0.0010	0.10	0.023
0.200	0.108	1.003	0.0052	0.006	0.0014	0.11	0.027
0.250	0.135	1.011	0.0069	0.008	0.0019	0.13	0.032
0.300	0.162	1.035	0.0087	0.009	0.0023	0.14	0.035
0.350	0.189	1.073	0.0104	0.011	0.0026	0.15	0.036
0.400	0.216	1.109	0.0118	0.012	0.0029	0.15	0.037
0.450	0.243	1.129	0.0129	0.013	0.0031	0.16	0.038
0.500	0.270	1.125	0.0136	0.014	0.0033	0.16	0.040
0.550	0.297	1.092	0.0140	0.014	0.0035	0.17	0.041
0.600	0.324	1.035	0.0139	0.015	0.0036	0.18	0.044
0.650	0.352	0.959	0.0134	0.016	0.0038	0.19	0.044
0.700	0.379	0.874	0.0124	0.016	0.0038	0.20	0.049
0.750	0.406	0.786	0.0111	0.016	0.0038	0.21	0.051
0.800	0.433	0.703	0.0094	0.015	0.0036	0.22	0.053
0.850	0.460	0.626	0.0076	0.013	0.0033	0.22	0.053
0.900	0.487	0.554	0.0058	0.012	0.0028	0.22	0.053

DISSIPATION COEFFICIENT= 0.008191

REYNOLDS NORMAL STRESS. UCOMPNT= 0.02032 VCOMPNT= 0.01039

TABLE A20-31

DIFFUSER NON DIMENSIONAL LENGTH = 5.0

AXIAL DISTANCE FROM OUTLET= 3.75 INS. (1 HYDRAULIC DIAMETER)

INNER WALL BLUE POSITION

DELTA*= 0.235 INS. H= 1.68 REYNOLDS NO.(BASED ON THETA)= 7015.1

DIST R-RI	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.040	0.021	1.855	0.0034	0.004	0.0005	0.09	0.012
0.100	0.053	0.729	0.0055	0.016	0.0020	0.30	0.038
0.150	0.080	0.756	0.0070	0.020	0.0025	0.33	0.042
0.200	0.107	0.875	0.0084	0.020	0.0026	0.32	0.039
0.250	0.133	0.901	0.0094	0.022	0.0028	0.32	0.041
0.300	0.160	0.866	0.0099	0.024	0.0030	0.35	0.043
0.350	0.187	0.846	0.0098	0.025	0.0031	0.35	0.044
0.400	0.213	0.870	0.0091	0.022	0.0028	0.33	0.041
0.450	0.240	0.909	0.0081	0.019	0.0024	0.30	0.037
0.500	0.267	0.904	0.0070	0.017	0.0021	0.28	0.035
0.550	0.293	0.817	0.0060	0.016	0.0020	0.29	0.036
0.600	0.320	0.669	0.0051	0.016	0.0020	0.32	0.040
0.650	0.347	0.543	0.0043	0.017	0.0021	0.36	0.046
0.700	0.373	0.516	0.0034	0.014	0.0017	0.34	0.042
0.750	0.400	0.496	0.0021	0.009	0.0012	0.28	0.035
0.800	0.427	0.088	0.0009	0.021	0.0027	1.01	0.127

DISSIPATION COEFFICIENT= 0.004341

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00946 VCOMPNT= 0.00527

TABLE A20-32

DIFFUSER NON DIMENSIONAL LENGTH = 5.0

AXIAL DISTANCE FROM OUTLET= 7.50 INS. (2 HYDRAULIC DIAMETERS)

INNER WALL GREEN POSITION

DELTA*= 0.227 INS. H= 1.53 REYNOLDS NO.(BASED ON THETA)= 6840.2

DIST R-RI	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.027	2.015	0.0050	0.005	0.0007	0.11	0.013
0.100	0.053	0.692	0.0053	0.017	0.0020	0.33	0.040
0.150	0.080	0.482	0.0058	0.026	0.0032	0.49	0.059
0.200	0.107	0.589	0.0066	0.025	0.0030	0.43	0.052
0.250	0.133	0.683	0.0075	0.024	0.0029	0.39	0.048
0.300	0.160	0.692	0.0081	0.026	0.0031	0.40	0.049
0.350	0.187	0.654	0.0084	0.028	0.0034	0.44	0.053
0.400	0.213	0.624	0.0086	0.031	0.0037	0.46	0.056
0.450	0.240	0.629	0.0087	0.030	0.0037	0.46	0.056
0.500	0.267	0.658	0.0084	0.028	0.0034	0.43	0.053
0.550	0.293	0.672	0.0075	0.025	0.0030	0.40	0.049
0.600	0.320	0.636	0.0060	0.021	0.0025	0.38	0.046
0.650	0.347	0.544	0.0044	0.018	0.0022	0.58	0.046
0.700	0.373	0.432	0.0030	0.015	0.0019	0.40	0.048
0.750	0.400	0.371	0.0007	0.004	0.0005	0.22	0.027

DISSIPATION COEFFICIENT= 0.003699

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00922 VCOMPNT= 0.00915

TABLE A20-33

DIFFUSER NON DIMENSIONAL LENGTH = 5.0

AXIAL DISTANCE FROM OUTLET= 11.25 INS. (3 HYDRAULIC DIAMETERS)

INNER WALL RED POSITION

DELTA*= 0.123 INS. H= 1.33 REYNOLDS NO.(BASED ON THETA)= 3749.9

DIST R-RI	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.027	2.388	0.0050	0.008	0.0006	0.17	0.011
0.100	0.053	0.624	0.0053	0.035	0.0023	0.67	0.044
0.150	0.080	0.572	0.0061	0.043	0.0028	0.78	0.051
0.200	0.107	0.693	0.0070	0.041	0.0027	0.69	0.046
0.250	0.133	0.618	0.0077	0.051	0.0033	0.82	0.054
0.300	0.160	0.460	0.0081	0.072	0.0047	1.12	0.074
0.350	0.187	0.387	0.0081	0.085	0.0056	1.34	0.088
0.400	0.213	0.441	0.0080	0.073	0.0048	1.16	0.076
0.450	0.240	0.525	0.0075	0.058	0.0038	0.95	0.062
0.500	0.267	0.510	0.0067	0.054	0.0035	0.93	0.061
0.550	0.293	0.361	0.0056	0.063	0.0041	1.19	0.078
0.600	0.320	0.215	0.0043	0.081	0.0053	1.75	0.115
0.650	0.347	0.150	0.0030	0.082	0.0054	2.11	0.138
0.700	0.373	0.085	0.0015	0.071	0.0047	2.61	0.171

DISSIPATION COEFFICIENT= 0.003282

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00917 VCOMPNT= 0.00862

TABLE A20-34

DIFFUSER NON DIMENSIONAL LENGTH = 5.0

AXIAL DISTANCE FROM OUTLET= 3.75 INS. (1 HYDRAULIC DIAMETER)

OUTER WALL BLUE POSITION

DELTA*= 0.307 INS. H= 1.87 REYNOLDS NO.(BASED ON THETA)= 8217.7

DIST RO-R	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.027	1.289	0.0032	0.004	0.0007	0.10	0.016
0.100	0.053	0.485	0.0057	0.019	0.0032	0.36	0.059
0.150	0.080	0.401	0.0080	0.032	0.0053	0.51	0.084
0.200	0.107	0.532	0.0095	0.029	0.0048	0.42	0.069
0.250	0.133	0.659	0.0106	0.026	0.0043	0.36	0.059
0.300	0.160	0.727	0.0114	0.026	0.0042	0.34	0.055
0.350	0.187	0.751	0.0121	0.026	0.0043	0.34	0.055
0.400	0.213	0.765	0.0128	0.027	0.0045	0.34	0.056
0.450	0.240	0.789	0.0134	0.028	0.0045	0.34	0.055
0.500	0.267	0.821	0.0138	0.027	0.0045	0.33	0.054
0.550	0.293	0.844	0.0139	0.027	0.0044	0.32	0.053
0.600	0.320	0.836	0.0134	0.026	0.0043	0.32	0.052
0.650	0.347	0.792	0.0123	0.025	0.0041	0.32	0.053
0.700	0.373	0.726	0.0107	0.024	0.0039	0.33	0.054
0.750	0.400	0.676	0.0087	0.021	0.0034	0.32	0.052
0.800	0.427	0.677	0.0067	0.016	0.0026	0.28	0.046
0.850	0.453	0.713	0.0048	0.011	0.0018	0.22	0.037
0.900	0.480	0.634	0.0034	0.009	0.0014	0.21	0.034
0.950	0.507	0.026	0.0023	0.144	0.0236	4.23	0.693

DISSIPATION COEFFICIENT= 0.006515

REYNOLDS NORMAL STRESS. UCOMPNT= 0.01721 VCOMPNT= 0.00866

DIFFUSER NON DIMENSIONAL LENGTH = 5.0

AXIAL DISTANCE FROM OUTLET= 7.50 INS. (2 HYDRAULIC DIAMETERS)

OUTER WALL GREEN POSITION

DELTA*= 0.208 INS. H= 1.52 REYNOLDS NO.(BASED ON THETA)= 6331.8

DIST RO-R	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.027	1.959	0.0067	0.008	0.0009	0.14	0.016
0.100	0.053	0.710	0.0092	0.031	0.0035	0.46	0.051
0.150	0.080	0.381	0.0110	0.070	0.0077	0.94	0.104
0.200	0.107	0.405	0.0129	0.076	0.0085	0.95	0.105
0.250	0.133	0.502	0.0148	0.071	0.0079	0.82	0.091
0.300	0.160	0.568	0.0168	0.071	0.0079	0.78	0.086
0.350	0.187	0.590	0.0188	0.077	0.0085	0.79	0.088
0.400	0.213	0.590	0.0205	0.083	0.0093	0.82	0.091
0.450	0.240	0.593	0.0218	0.088	0.0098	0.85	0.094
0.500	0.267	0.607	0.0226	0.090	0.0099	0.84	0.094
0.550	0.293	0.624	0.0229	0.088	0.0098	0.82	0.091
0.600	0.320	0.628	0.0225	0.086	0.0095	0.81	0.090
0.650	0.347	0.604	0.0215	0.085	0.0095	0.82	0.091
0.700	0.373	0.548	0.0199	0.087	0.0097	0.88	0.097
0.750	0.400	0.471	0.0178	0.091	0.0101	0.96	0.107
0.800	0.427	0.395	0.0154	0.094	0.0104	1.07	0.118
0.850	0.453	0.324	0.0128	0.095	0.0105	1.19	0.132
0.900	0.480	0.198	0.0101	0.122	0.0135	1.72	0.191

DISSIPATION COEFFICIENT= 0.008810

REYNOLDS NORMAL STRESS. UCOMPNT= 0.01337 VCOMPNT= 0.02795

TABLE A20-36

DIFFUSER NON DIMENSIONAL LENGTH = 5.0

AXIAL DISTANCE FROM OUTLET= 11.25 INS. (3 HYDRAULIC DIAMETERS)

OUTER WALL RED POSITION

DELTA*= 0.162 INS. H= 1.37 REYNOLDS NO.(BASED ON THETA)= 4809.7

DIST RO-R	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.027	2.608	0.0033	0.004	0.0003	0.10	0.008
0.100	0.053	0.892	0.0053	0.018	0.0016	0.36	0.031
0.150	0.080	0.402	0.0077	0.059	0.0051	0.95	0.082
0.200	0.107	0.359	0.0098	0.084	0.0073	1.20	0.104
0.250	0.133	0.401	0.0115	0.089	0.0077	1.17	0.101
0.300	0.160	0.410	0.0128	0.097	0.0084	1.21	0.104
0.350	0.187	0.384	0.0139	0.111	0.0096	1.34	0.116
0.400	0.213	0.362	0.0147	0.126	0.0109	1.46	0.127
0.450	0.240	0.369	0.0155	0.130	0.0112	1.47	0.127
0.500	0.267	0.406	0.0161	0.123	0.0106	1.37	0.118
0.550	0.293	0.449	0.0166	0.114	0.0098	1.25	0.108
0.600	0.320	0.466	0.0168	0.111	0.0096	1.21	0.105
0.650	0.347	0.437	0.0165	0.117	0.0101	1.29	0.111
0.700	0.373	0.369	0.0158	0.132	0.0114	1.49	0.129
0.750	0.400	0.300	0.0145	0.149	0.0129	1.75	0.151
0.800	0.427	0.279	0.0127	0.141	0.0122	1.76	0.152
0.850	0.453	0.189	0.0106	0.172	0.0149	2.37	0.205
0.900	0.480	0.099	0.0082	0.255	0.0220	3.98	0.344

DISSIPATION COFFFICIENT= 0.005072

REYNOLDS NORMAL STRESS. UCOMPNT= 0.01564 VCOMPNT= 0.01820

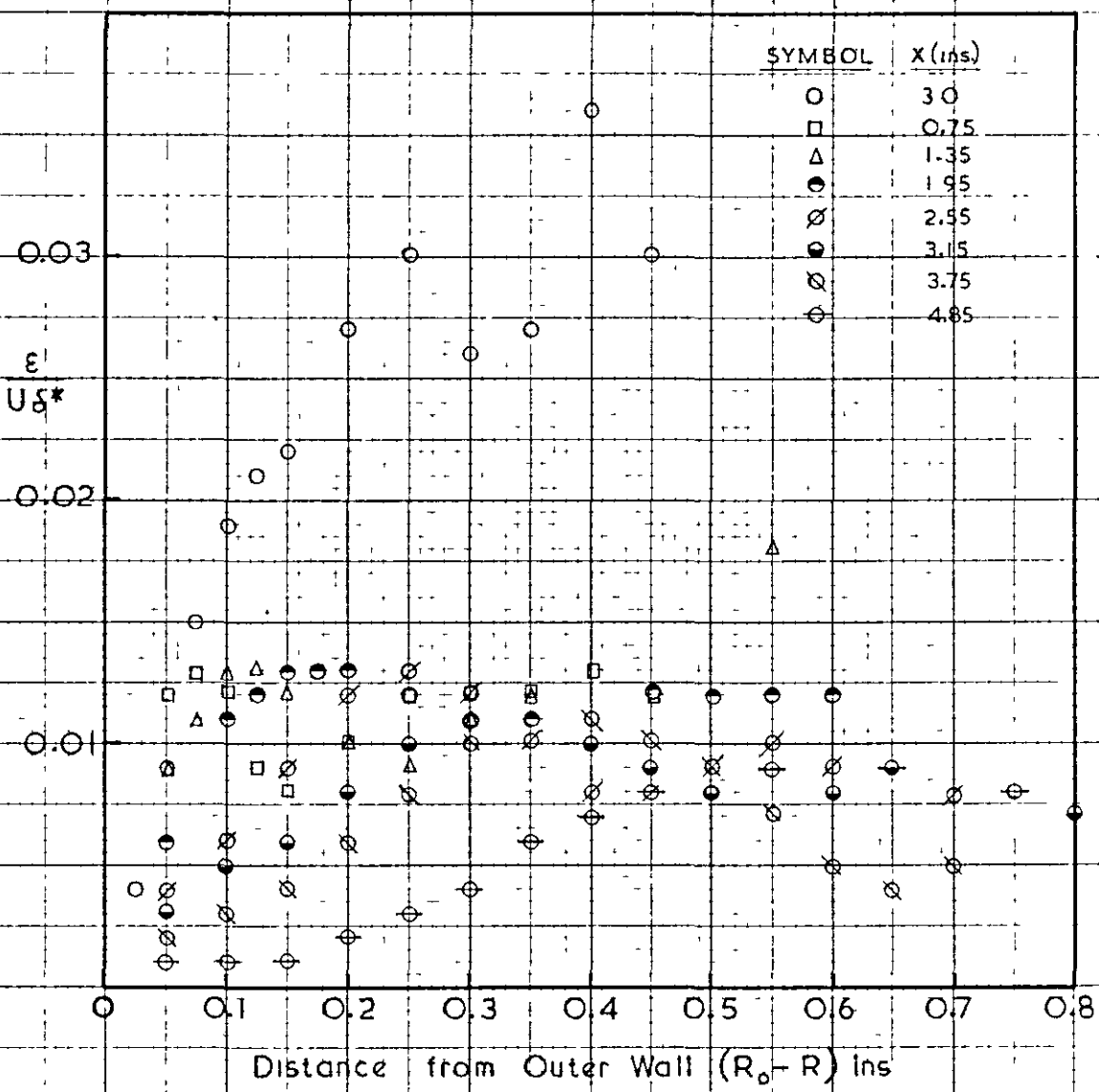

FIG. A20-1 EXPERIMENTAL EDDY VISCOSITY DISTRIBUTIONS OUTER WALL $L/\Delta R_i = 5$ DIFFUSER

Appendix 21

Turbulence Analysis

$L/\Delta R_1 = 7.5$ Diffuser

TABLE A21-1

DIFFUSER NON DIMENSIONAL LENGTH = 7.5

AXIAL DIST. FROM INLET(X) = 3.000 INS. N.D.DIST.(X/L)= 0.400

INNER WALL BLUE POSITION

DELTA*= 0.051 INS. H= 1.28 REYNOLDS NO.(BASED ON THETA)= 3291.3

DIST R-RI	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.050	2.279	0.0028	0.012	0.0006	0.32	0.016
0.100	0.100	1.165	0.0025	0.021	0.0011	0.59	0.030
0.150	0.150	0.938	0.0023	0.024	0.0012	0.70	0.036
0.200	0.200	0.583	0.0019	0.031	0.0016	1.02	0.052
0.250	0.250	0.482	0.0017	0.034	0.0017	1.17	0.060
0.300	0.300	0.463	0.0015	0.032	0.0016	1.16	0.059
0.350	0.350	0.225	0.0009	0.040	0.0020	1.86	0.095
0.400	0.400	0.135	0.0004	0.031	0.0016	2.13	0.109
0.450	0.450	0.045	0.0003	0.058	0.0029	5.01	0.255

DISSIPATION COEFFICIENT= 0.001537
REYNOLDS NORMAL STRESS. UCOMPNT= 0.00172 VCOMPNT= 0.00094

TABLE A21-2

DIFFUSER NON DIMENSIONAL LENGTH = 7.5

AXIAL DIST. FROM INLET(X) = 1.250 INS. N.D.DIST.(X/L)= 0.167

INNER WALL BLUE POSITION

DELTA*= 0.083 INS. H= 1.40 REYNOLDS NO.(BASED ON THETA)= 4354.1

DIST R-RI	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.044	3.044	0.0034	0.007	0.0005	0.16	0.012
0.100	0.087	1.481	0.0028	0.011	0.0008	0.31	0.022
0.150	0.131	1.172	0.0023	0.012	0.0009	0.35	0.025
0.200	0.175	0.847	0.0019	0.013	0.0010	0.44	0.032
0.250	0.218	0.607	0.0015	0.015	0.0011	0.54	0.039
0.300	0.262	0.566	0.0013	0.014	0.0010	0.54	0.039
0.350	0.305	0.567	0.0011	0.012	0.0009	0.50	0.036
0.400	0.349	0.422	0.0009	0.012	0.0009	0.59	0.043
0.450	0.393	0.213	0.0007	0.021	0.0015	1.08	0.079
0.500	0.436	0.128	0.0003	0.016	0.0011	1.22	0.088

DISSIPATION COEFFICIENT= 0.001825

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00377 VCOMPNT= 0.00088

TABLE A21-3

DIFFUSER NON DIMENSIONAL LENGTH = 7.5

AXIAL DIST. FROM INLET(X) = 2.200 INS. N.D.DIST.(X/L)= 0.293

INNER WALL BLUE POSITION

DELTA*= 0.107 INS. H= 1.48 REYNOLDS NO.(BASED ON THETA)= 4995.1

DIST R-RI	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.040	3.058	0.0052	0.008	0.0007	0.16	0.013
0.100	0.080	1.649	0.0059	0.017	0.0014	0.31	0.026
0.150	0.119	1.297	0.0054	0.019	0.0017	0.37	0.032
0.200	0.159	1.060	0.0047	0.021	0.0018	0.43	0.036
0.250	0.199	0.833	0.0041	0.023	0.0019	0.50	0.043
0.300	0.239	0.688	0.0035	0.024	0.0020	0.57	0.048
0.350	0.278	0.622	0.0028	0.021	0.0018	0.57	0.048
0.400	0.318	0.551	0.0022	0.019	0.0016	0.56	0.048
0.450	0.358	0.418	0.0016	0.018	0.0015	0.64	0.054
0.500	0.398	0.266	0.0012	0.021	0.0018	0.87	0.074
0.550	0.438	0.150	0.0008	0.026	0.0022	1.26	0.107
0.600	0.477	0.035	0.0005	0.072	0.0061	4.39	0.374

DISSIPATION COEFFICIENT= 0.002932

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00497 VCOMPNT= 0.00230

TABLE A21-4

DIFFUSER NON DIMENSIONAL LENGTH = 7.5

AXIAL DIST. FROM INLET(X) = 3.150 INS. N.D.DIST.(X/L)= 0.420

INNER WALL BLUE POSITION

DELTA*= 0.135 INS. H= 1.57 REYNOLDS NO.(BASED ON THETA)= 5574.0

DIST R-RI	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.025	0.018	5.086	0.0038	0.003	0.0003	0.06	0.006
0.050	0.037	2.814	0.0047	0.006	0.0006	0.13	0.013
0.100	0.073	1.432	0.0054	0.014	0.0014	0.27	0.027
0.150	0.110	1.372	0.0058	0.016	0.0015	0.29	0.029
0.200	0.146	1.290	0.0057	0.016	0.0016	0.31	0.030
0.250	0.183	1.042	0.0051	0.018	0.0018	0.36	0.036
0.300	0.219	0.811	0.0042	0.019	0.0019	0.42	0.042
0.350	0.256	0.704	0.0034	0.018	0.0018	0.43	0.043
0.400	0.293	0.663	0.0027	0.015	0.0015	0.41	0.041
0.450	0.329	0.573	0.0022	0.014	0.0014	0.42	0.042
0.500	0.366	0.414	0.0016	0.014	0.0014	0.51	0.050
0.550	0.402	0.302	0.0011	0.013	0.0013	0.57	0.056
0.600	0.439	0.277	0.0008	0.010	0.0010	0.53	0.052
0.650	0.475	0.025	0.0004	0.060	0.0059	4.21	0.415

DISSIPATION COEFFICIENT= 0.003134

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00714 VCOMPNT= 0.00086

TABLE A21-5

DIFFUSER NON DIMENSIONAL LENGTH = 7.5

AXIAL DIST. FROM INLET(X) = 3.150 INS. N.D.DIST.(X/L)= 0.420

INNER WALL GREEN POSITION

DELTA*= 0.135 INS. H= 1.57 REYNOLDS NO.(BASED ON THETA)= 5574.0

DIST R-RI	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.025	0.018	5.086	0.0048	0.004	0.0003	0.07	0.007
0.050	0.037	2.814	0.0062	0.008	0.0008	0.15	0.014
0.100	0.073	1.432	0.0068	0.018	0.0017	0.30	0.030
0.150	0.110	1.372	0.0064	0.017	0.0017	0.30	0.030
0.200	0.146	1.290	0.0056	0.016	0.0016	0.30	0.030
0.250	0.183	1.042	0.0047	0.017	0.0017	0.34	0.034
0.300	0.219	0.811	0.0037	0.017	0.0017	0.39	0.039
0.350	0.256	0.704	0.0029	0.015	0.0015	0.40	0.039
0.400	0.293	0.663	0.0022	0.012	0.0012	0.37	0.036
0.450	0.329	0.573	0.0018	0.011	0.0011	0.38	0.038
0.500	0.366	0.414	0.0014	0.013	0.0013	0.48	0.048
0.550	0.402	0.302	0.0010	0.013	0.0013	0.56	0.056
0.600	0.439	0.277	0.0005	0.007	0.0007	0.42	0.042
0.650	0.475	0.025	0.0003	0.038	0.0038	3.35	0.331

DISSIPATION COEFFICIENT= 0.003475

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00714 VCOMPNT= 0.00097

TABLE A21-6

DIFFUSER NON DIMENSIONAL LENGTH = 7.5

AXIAL DIST. FROM INLET(X) = 4.100 INS. N.D.DIST.(X/L)= 0.547

INNER WALL BLUE POSITION

DELTA*= 0.163 INS. H= 1.63 REYNOLDS NO.(BASED ON THETA)= 6182.6

DIST R-RI	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.034	2.327	0.0038	0.005	0.0005	0.11	0.013
0.100	0.068	1.367	0.0058	0.013	0.0014	0.24	0.027
0.150	0.101	1.309	0.0073	0.017	0.0019	0.28	0.031
0.200	0.135	1.294	0.0079	0.019	0.0021	0.30	0.033
0.250	0.169	1.164	0.0077	0.020	0.0022	0.33	0.036
0.300	0.203	0.998	0.0069	0.021	0.0023	0.36	0.040
0.350	0.237	0.870	0.0057	0.020	0.0022	0.38	0.042
0.400	0.271	0.784	0.0046	0.018	0.0020	0.38	0.041
0.450	0.304	0.689	0.0036	0.016	0.0018	0.38	0.042
0.500	0.338	0.553	0.0028	0.016	0.0017	0.42	0.046
0.550	0.372	0.406	0.0023	0.017	0.0019	0.51	0.056
0.600	0.406	0.321	0.0018	0.017	0.0019	0.57	0.063
0.650	0.440	0.269	0.0013	0.014	0.0016	0.57	0.063
0.700	0.474	0.062	0.0007	0.036	0.0040	1.89	0.209

DISSIPATION COEFFICIENT= 0.003621

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00857 VCOMPNT= 0.00400

TABLE A21-7

DIFFUSER NON DIMENSIONAL LENGTH = 7.5

AXIAL DIST. FROM INLET(X) = 5.050 INS. N.D.DIST.(X/L)= 0.673

INNER WALL BLUE POSITION

DELTA*= 0.185 INS. H= 1.67 REYNOLDS NO.(BASED ON THETA)= 6599.7

DIST R-RI	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.025	0.016	3.815	0.0039	0.003	0.0003	0.06	0.007
0.050	0.031	2.175	0.0053	0.007	0.0008	0.13	0.015
0.100	0.063	1.139	0.0068	0.016	0.0019	0.28	0.032
0.150	0.094	1.161	0.0074	0.017	0.0020	0.28	0.033
0.200	0.126	1.235	0.0076	0.017	0.0019	0.27	0.031
0.250	0.157	1.158	0.0076	0.018	0.0021	0.29	0.033
0.300	0.189	1.017	0.0072	0.019	0.0022	0.32	0.037
0.350	0.220	0.915	0.0066	0.020	0.0023	0.34	0.040
0.400	0.252	0.873	0.0057	0.018	0.0021	0.33	0.039
0.450	0.283	0.831	0.0047	0.015	0.0018	0.32	0.037
0.500	0.315	0.720	0.0036	0.014	0.0016	0.32	0.037
0.550	0.346	0.530	0.0027	0.014	0.0016	0.37	0.043
0.600	0.378	0.343	0.0019	0.015	0.0017	0.49	0.057
0.650	0.409	0.271	0.0013	0.013	0.0015	0.51	0.060
0.700	0.441	0.163	0.0009	0.016	0.0018	0.72	0.084
0.750	0.472	0.054	0.0005	0.023	0.0027	1.52	0.177

DISSIPATION COEFFICIENT= 0.004068

REYNOLDS NORMAL STRESS. UCOMPNT= 0.01034 VCOMPNT= 0.00366

TABLE A21-8

DIFFUSER NON DIMENSIONAL LENGTH = 7.5

AXIAL DIST. FROM INLET(X) = 6.000 INS. N.D.DIST.(X/L)= 0.800

INNER WALL BLUE POSITION

DELTA*= 0.218 INS. H= 1.70 REYNOLDS NO.(BASED ON THETA)= 7350.6

DIST R-RI	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.029	2.176	0.0050	0.005	0.0007	0.11	0.013
0.100	0.059	1.025	0.0069	0.015	0.0020	0.26	0.034
0.150	0.088	0.964	0.0080	0.019	0.0024	0.30	0.038
0.200	0.118	1.094	0.0086	0.018	0.0023	0.27	0.035
0.250	0.147	1.115	0.0088	0.018	0.0023	0.27	0.035
0.300	0.176	1.023	0.0085	0.019	0.0024	0.29	0.037
0.350	0.206	0.910	0.0077	0.019	0.0025	0.31	0.040
0.400	0.235	0.842	0.0065	0.018	0.0023	0.31	0.040
0.450	0.265	0.825	0.0051	0.014	0.0018	0.28	0.036
0.500	0.294	0.809	0.0038	0.011	0.0014	0.25	0.032
0.550	0.324	0.731	0.0028	0.009	0.0011	0.23	0.030
0.600	0.353	0.571	0.0021	0.009	0.0011	0.26	0.034
0.650	0.382	0.381	0.0018	0.011	0.0014	0.36	0.046
0.700	0.412	0.265	0.0014	0.012	0.0016	0.46	0.059
0.750	0.441	0.180	0.0008	0.010	0.0013	0.50	0.065
0.800	0.471	0.094	0.0004	0.009	0.0012	0.67	0.086

DISSIPATION COEFFICIENT= 0.004200

REYNOLDS NORMAL STRESS. UCOMPNT= 0.01281 VCOMPNT= 0.00288

TABLE A21-9

DIFFUSER NON DIMENSIONAL LENGTH = 7.5

AXIAL DIST. FROM INLET(X) = 7.350 INS. N.D.DIST.(X/L)= 0.980

INNER WALL BLUE POSITION

DELTA*= 0.241 INS. H= 1.71 REYNOLDS NO.(BASED ON THETA)= 7631.3

DIST R-RI	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.027	1.923	0.0032	0.003	0.0004	0.09	0.011
0.100	0.054	0.779	0.0049	0.013	0.0017	0.26	0.034
0.150	0.081	0.805	0.0065	0.017	0.0022	0.29	0.038
0.200	0.108	1.008	0.0076	0.016	0.0020	0.25	0.033
0.250	0.135	1.061	0.0083	0.016	0.0021	0.25	0.033
0.300	0.161	0.971	0.0085	0.018	0.0024	0.28	0.036
0.350	0.188	0.851	0.0083	0.020	0.0026	0.32	0.041
0.400	0.215	0.789	0.0079	0.021	0.0027	0.33	0.043
0.450	0.242	0.799	0.0074	0.019	0.0025	0.32	0.041
0.500	0.269	0.830	0.0067	0.017	0.0022	0.29	0.037
0.550	0.296	0.809	0.0059	0.015	0.0020	0.28	0.036
0.600	0.323	0.701	0.0050	0.015	0.0019	0.30	0.038
0.650	0.350	0.544	0.0041	0.015	0.0020	0.34	0.044
0.700	0.377	0.439	0.0031	0.014	0.0019	0.37	0.048
0.750	0.404	0.441	0.0021	0.010	0.0013	0.31	0.040
0.800	0.431	0.339	0.0013	0.008	0.0010	0.31	0.040
0.850	0.457	0.749	0.0005	0.001	0.0002	0.09	0.011

DISSIPATION COEFFICIENT= 0.004132

REYNOLDS NORMAL STRESS. UCOMPNT= 0.01336 VCOMPNT= 0.00322

TABLE A21-10

DIFFUSER NON DIMENSIONAL LENGTH = 7.5

AXIAL DIST. FROM INLET(X) = 7.350 INS. N.D.DIST.(X/L)= 0.980

INNER WALL BLUE POSITION

DELTA*= 0.241 INS. H= 1.71 REYNOLDS NO.(BASED ON THETA)= 7631.3

DIST R-RI	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.027	1.923	0.0038	0.004	0.0005	0.09	0.012
0.100	0.054	0.779	0.0055	0.015	0.0019	0.28	0.036
0.150	0.081	0.805	0.0068	0.017	0.0023	0.30	0.039
0.200	0.108	1.008	0.0076	0.016	0.0020	0.25	0.033
0.250	0.135	1.061	0.0079	0.016	0.0020	0.25	0.032
0.300	0.161	0.971	0.0078	0.017	0.0022	0.27	0.035
0.350	0.188	0.851	0.0074	0.018	0.0023	0.30	0.038
0.400	0.215	0.789	0.0068	0.018	0.0023	0.31	0.040
0.450	0.242	0.799	0.0061	0.016	0.0020	0.29	0.037
0.500	0.269	0.830	0.0054	0.013	0.0017	0.26	0.034
0.550	0.296	0.809	0.0046	0.012	0.0015	0.25	0.032
0.600	0.323	0.701	0.0039	0.011	0.0015	0.26	0.034
0.650	0.350	0.544	0.0031	0.012	0.0015	0.30	0.039
0.700	0.377	0.439	0.0022	0.011	0.0014	0.32	0.041
0.750	0.404	0.441	0.0015	0.007	0.0009	0.26	0.033
0.800	0.431	0.339	0.0009	0.006	0.0007	0.26	0.034
0.850	0.457	0.749	0.0004	0.001	0.0001	0.07	0.010

DISSIPATION COEFFICIENT= 0.003863

REYNOLDS NORMAL STRESS. UCOMPNT= 0.01336 VCOMPNT= 0.00300

TABLE A21-11

DIFFUSER NON DIMENSIONAL LENGTH = 7.5

AXIAL DIST. FROM INLET(X) = 7.350 INS. N.D.DIST.(X/L)= 0.980

INNER WALL GREEN POSITION

DELTA*= 0.241 INS. H= 1.71 REYNOLDS NO.(BASED ON THETA)= 7631.3

DIST R-RI	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.027	1.923	0.0043	0.005	0.0006	0.10	0.013
0.100	0.054	0.779	0.0057	0.015	0.0020	0.28	0.037
0.150	0.081	0.805	0.0067	0.017	0.0023	0.30	0.039
0.200	0.108	1.008	0.0078	0.016	0.0021	0.26	0.033
0.250	0.135	1.061	0.0085	0.017	0.0022	0.26	0.033
0.300	0.161	0.971	0.0089	0.019	0.0025	0.28	0.037
0.350	0.188	0.851	0.0087	0.021	0.0027	0.32	0.042
0.400	0.215	0.789	0.0080	0.021	0.0027	0.33	0.043
0.450	0.242	0.799	0.0071	0.018	0.0024	0.31	0.040
0.500	0.269	0.830	0.0060	0.015	0.0020	0.27	0.036
0.550	0.296	0.809	0.0050	0.013	0.0017	0.26	0.033
0.600	0.323	0.701	0.0042	0.012	0.0016	0.27	0.035
0.650	0.350	0.544	0.0033	0.013	0.0017	0.31	0.040
0.700	0.377	0.439	0.0025	0.012	0.0015	0.34	0.043
0.750	0.404	0.441	0.0017	0.008	0.0010	0.27	0.035
0.800	0.431	0.339	0.0009	0.006	0.0007	0.26	0.034
0.850	0.457	0.749	0.0007	0.002	0.0003	0.10	0.014

DISSIPATION COEFFICIENT= 0.004252

REYNOLDS NORMAL STRESS. UCOMPNT= 0.01336 VCOMPNT= 0.00443

TABLE A21-12

DIFFUSER NON DIMENSIONAL LENGTH = 7.5

AXIAL DIST. FROM INLET(X) = 7.350 INS. N.D.DIST.(X/L)= 0.980

INNER WALL RED POSITION

DELTA*= 0.241 INS. H= 1.71 REYNOLDS NO.(BASED ON THETA)= 7631.3

DIST R-RI	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.027	1.923	0.0038	0.004	0.0005	0.09	0.012
0.100	0.054	0.779	0.0049	0.013	0.0017	0.26	0.034
0.150	0.081	0.805	0.0059	0.015	0.0020	0.28	0.036
0.200	0.108	1.008	0.0069	0.014	0.0018	0.24	0.031
0.250	0.135	1.061	0.0079	0.015	0.0020	0.25	0.032
0.300	0.161	0.971	0.0086	0.018	0.0024	0.28	0.036
0.350	0.188	0.851	0.0089	0.022	0.0028	0.33	0.042
0.400	0.215	0.789	0.0087	0.023	0.0030	0.35	0.045
0.450	0.242	0.799	0.0081	0.021	0.0027	0.33	0.043
0.500	0.269	0.830	0.0071	0.018	0.0023	0.30	0.039
0.550	0.296	0.809	0.0060	0.015	0.0020	0.28	0.036
0.600	0.323	0.701	0.0048	0.014	0.0018	0.29	0.038
0.650	0.350	0.544	0.0038	0.014	0.0019	0.33	0.043
0.700	0.377	0.439	0.0029	0.014	0.0018	0.36	0.047
0.750	0.404	0.441	0.0020	0.010	0.0012	0.30	0.039
0.800	0.431	0.339	0.0011	0.007	0.0009	0.29	0.038
0.850	0.457	0.749	0.0002	0.001	0.0001	0.06	0.008

DISSIPATION COEFFICIENT= 0.004233

REYNOLDS NORMAL STRESS. UCOMPNT= 0.01336 VCOMPNT= 0.00319

TABLE A21-13

DIFFUSER NON DIMENSIONAL LENGTH = 7.5

AXIAL DIST. FROM INLET(X) = 3.000 INS. N.D.DIST.(X/L)= 0.400

OUTER WALL BLUE POSITION

DELTA*= 0.057 INS. H= 1.29 REYNOLDS NO.(BASED ON THETA)= 3620.4

DIST RO-R	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.065	0.065	1.911	0.0024	0.011	0.0006	0.32	0.018
0.075	0.075	1.641	0.0026	0.014	0.0008	0.38	0.022
0.125	0.125	0.986	0.0023	0.020	0.0012	0.60	0.034
0.175	0.175	0.738	0.0018	0.022	0.0012	0.72	0.041
0.225	0.225	0.603	0.0018	0.027	0.0015	0.88	0.050
0.275	0.275	0.521	0.0016	0.027	0.0015	0.95	0.054
0.325	0.325	0.415	0.0011	0.023	0.0013	0.98	0.056
0.375	0.375	0.284	0.0009	0.029	0.0016	1.33	0.076
0.425	0.425	0.175	0.0005	0.024	0.0014	1.56	0.089
0.475	0.475	0.066	0.0002	0.033	0.0019	2.96	0.169

DISSIPATION COEFFICIENT= 0.001006

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00199 VCOMPNT= 0.00020

TABLE A21-14

DIFFUSER NON DIMENSIONAL LENGTH = 7.5

AXIAL DIST. FROM INLET(X) = 1.250 INS. N.D.DIST.(X/L)= 0.167

OUTER WALL BLUE POSITION

DELTA*= 0.089 INS. H= 1.50 REYNOLDS NO.(BASED ON THETA)= 4354.1

DIST RO-R	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.025	0.022	4.912	0.0038	0.004	0.0003	0.10	0.008
0.050	0.044	3.482	0.0043	0.007	0.0005	0.15	0.012
0.075	0.065	2.600	0.0041	0.009	0.0007	0.20	0.015
0.100	0.087	2.035	0.0035	0.010	0.0007	0.23	0.018
0.125	0.109	1.648	0.0028	0.009	0.0007	0.25	0.020
0.150	0.131	1.363	0.0022	0.009	0.0007	0.27	0.021
0.175	0.153	1.143	0.0018	0.009	0.0007	0.29	0.023
0.200	0.175	0.971	0.0016	0.009	0.0007	0.33	0.026
0.250	0.218	0.746	0.0016	0.012	0.0010	0.43	0.033
0.300	0.262	0.630	0.0014	0.013	0.0010	0.48	0.037
0.350	0.305	0.541	0.0010	0.010	0.0008	0.46	0.036
0.400	0.349	0.413	0.0007	0.010	0.0007	0.51	0.040
0.450	0.393	0.267	0.0007	0.015	0.0011	0.79	0.061
0.500	0.436	0.168	0.0002	0.008	0.0006	0.73	0.057
0.550	0.480	0.069	0.0001	0.007	0.0006	1.10	0.086

DISSIPATION COEFFICIENT= 0.001970

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00277 VCOMPNT= 0.00127

TABLE A21-15

DIFFUSER NON DIMENSIONAL LENGTH = 7.5

AXIAL DIST. FROM INLET(X) = 2.200 INS. N.D.DIST.(X/L)= 0.293

OUTER WALL BLUE POSITION

DELTA*= 0.121 INS. H= 1.61 REYNOLDS NO.(BASED ON THETA)= 5203.2

DIST RO-R	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.025	0.020	3.827	0.0037	0.004	0.0004	0.09	0.009
0.050	0.040	2.881	0.0050	0.007	0.0007	0.14	0.014
0.075	0.060	2.408	0.0057	0.010	0.0009	0.18	0.018
0.100	0.080	2.140	0.0058	0.011	0.0011	0.21	0.020
0.125	0.099	1.935	0.0054	0.012	0.0011	0.22	0.021
0.150	0.119	1.734	0.0048	0.012	0.0011	0.23	0.023
0.175	0.139	1.522	0.0041	0.011	0.0011	0.25	0.024
0.200	0.159	1.310	0.0034	0.011	0.0010	0.26	0.025
0.250	0.199	0.954	0.0023	0.010	0.0010	0.30	0.028
0.300	0.239	0.747	0.0019	0.010	0.0010	0.34	0.033
0.350	0.278	0.659	0.0018	0.011	0.0011	0.37	0.036
0.400	0.318	0.592	0.0016	0.011	0.0010	0.39	0.038
0.450	0.358	0.479	0.0011	0.010	0.0009	0.41	0.039
0.500	0.398	0.333	0.0007	0.008	0.0008	0.46	0.044
0.550	0.438	0.226	0.0005	0.009	0.0009	0.58	0.056
0.600	0.477	0.128	0.0001	0.003	0.0003	0.43	0.042

DISSIPATION COEFFICIENT= 0.002632

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00473 VCOMPNT= 0.00074

TABLE A21-16

DIFFUSER NON DIMENSIONAL LENGTH = 7.5

AXIAL DIST. FROM INLET(X) = 3.150 INS. N.D.DIST.(X/L)= 0.420

OUTER WALL BLUE POSITION

DELTA*= 0.150 INS. H= 1.73 REYNOLDS NO.(BASED ON THETA)= 5638.9

DIST RO-R	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.025	0.018	3.353	0.0032	0.003	0.0004	0.08	0.009
0.050	0.037	2.376	0.0044	0.006	0.0007	0.13	0.014
0.075	0.055	1.932	0.0052	0.009	0.0010	0.18	0.019
0.100	0.073	1.773	0.0058	0.011	0.0012	0.20	0.022
0.125	0.091	1.736	0.0061	0.012	0.0013	0.21	0.023
0.150	0.110	1.724	0.0061	0.012	0.0013	0.21	0.023
0.175	0.128	1.687	0.0059	0.012	0.0013	0.21	0.023
0.200	0.146	1.607	0.0055	0.011	0.0012	0.22	0.024
0.250	0.183	1.346	0.0043	0.011	0.0012	0.23	0.025
0.300	0.219	1.053	0.0032	0.010	0.0011	0.25	0.028
0.350	0.256	0.828	0.0024	0.010	0.0010	0.28	0.030
0.400	0.293	0.685	0.0020	0.010	0.0010	0.30	0.033
0.450	0.329	0.572	0.0017	0.010	0.0011	0.34	0.037
0.500	0.366	0.446	0.0013	0.010	0.0010	0.38	0.041
0.550	0.402	0.325	0.0008	0.008	0.0009	0.42	0.046
0.600	0.439	0.274	0.0006	0.007	0.0008	0.43	0.047
0.650	0.475	0.130	0.0002	0.005	0.0006	0.52	0.057

DISSIPATION COEFFICIENT= 0.002967

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00663 VCOMPNT= 0.00118

TABLE A21-17

DIFFUSER NON DIMENSIONAL LENGTH = 7.5

AXIAL DIST. FROM INLET(X) = 3.150 INS. N.D.DIST.(X/L)= 0.420

OUTER WALL BLUE POSITION

DELTA*= 0.150 INS. H= 1.73 REYNOLDS NO.(BASED ON THETA)= 5638.9

DIST RO-R	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.025	0.018	3.353	0.0044	0.004	0.0005	0.09	0.010
0.050	0.037	2.376	0.0059	0.008	0.0009	0.15	0.017
0.075	0.055	1.932	0.0067	0.011	0.0013	0.20	0.022
0.100	0.073	1.773	0.0071	0.013	0.0015	0.22	0.025
0.125	0.091	1.736	0.0073	0.014	0.0015	0.23	0.025
0.150	0.110	1.724	0.0072	0.014	0.0015	0.23	0.025
0.175	0.128	1.687	0.0070	0.014	0.0015	0.23	0.026
0.200	0.146	1.607	0.0065	0.014	0.0015	0.24	0.026
0.250	0.183	1.346	0.0052	0.013	0.0014	0.25	0.028
0.300	0.219	1.053	0.0038	0.012	0.0013	0.28	0.030
0.350	0.256	0.828	0.0027	0.011	0.0012	0.30	0.033
0.400	0.293	0.685	0.0021	0.010	0.0011	0.31	0.035
0.450	0.329	0.572	0.0017	0.010	0.0011	0.34	0.037
0.500	0.366	0.446	0.0012	0.009	0.0010	0.37	0.041
0.550	0.402	0.325	0.0008	0.008	0.0008	0.40	0.044
0.600	0.439	0.274	0.0005	0.006	0.0007	0.39	0.043
0.650	0.475	0.130	0.0001	0.003	0.0003	0.38	0.042

DISSIPATION COEFFICIENT= 0.003631

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00663 VCOMPNT= 0.00186

TABLE A21-18

DIFFUSER NON DIMENSIONAL LENGTH = 7.5

AXIAL DIST. FROM INLET(X) = 3.150 INS. N.D.DIST.(X/L)= 0.420

OUTER WALL GREEN POSITION

DELTA*= 0.150 INS. H= 1.73 REYNOLDS NO.(BASED ON THETA)= 5638.9

DIST RO-R	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.025	0.018	3.353	0.0037	0.004	0.0004	0.09	0.009
0.050	0.037	2.376	0.0051	0.007	0.0008	0.14	0.016
0.075	0.055	1.932	0.0062	0.011	0.0012	0.19	0.021
0.100	0.073	1.773	0.0070	0.013	0.0014	0.22	0.024
0.125	0.091	1.736	0.0073	0.014	0.0015	0.23	0.025
0.150	0.110	1.724	0.0073	0.014	0.0015	0.23	0.026
0.175	0.128	1.687	0.0070	0.014	0.0015	0.23	0.026
0.200	0.146	1.607	0.0064	0.013	0.0015	0.23	0.026
0.250	0.183	1.346	0.0049	0.012	0.0013	0.24	0.027
0.300	0.219	1.053	0.0034	0.011	0.0012	0.26	0.029
0.350	0.256	0.828	0.0024	0.010	0.0011	0.28	0.031
0.400	0.293	0.685	0.0019	0.009	0.0010	0.30	0.033
0.450	0.329	0.572	0.0016	0.009	0.0010	0.33	0.036
0.500	0.366	0.446	0.0011	0.008	0.0009	0.35	0.039
0.550	0.402	0.325	0.0006	0.006	0.0007	0.36	0.040
0.600	0.439	0.274	0.0005	0.006	0.0006	0.37	0.040
0.650	0.475	0.130	0.0000	0.001	0.0001	0.24	0.026

DISSIPATION COEFFICIENT= 0.003406

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00663 VCOMPNT= 0.00178

TABLE A21-19

DIFFUSER NON DIMENSIONAL LENGTH = 7.5

AXIAL DIST. FROM INLET(X) = 3.150 INS. N.D.DIST.(X/L)= 0.420

OUTER WALL RED POSITION

DELTA*= 0.150 INS. H= 1.73 REYNOLDS NO.(BASED ON THETA)= 5638.9

DIST RO-R	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.025	0.018	3.353	0.0037	0.004	0.0004	0.08	0.009
0.050	0.037	2.376	0.0050	0.007	0.0008	0.14	0.015
0.075	0.055	1.932	0.0061	0.010	0.0012	0.19	0.021
0.100	0.073	1.773	0.0069	0.013	0.0014	0.22	0.024
0.125	0.091	1.736	0.0075	0.014	0.0016	0.23	0.026
0.150	0.110	1.724	0.0078	0.015	0.0016	0.24	0.026
0.175	0.128	1.687	0.0077	0.015	0.0017	0.25	0.027
0.200	0.146	1.607	0.0073	0.015	0.0017	0.25	0.028
0.250	0.183	1.346	0.0058	0.014	0.0016	0.27	0.029
0.300	0.219	1.053	0.0041	0.013	0.0014	0.29	0.031
0.350	0.256	0.828	0.0028	0.011	0.0012	0.30	0.033
0.400	0.293	0.685	0.0022	0.011	0.0012	0.32	0.036
0.450	0.329	0.572	0.0021	0.012	0.0013	0.38	0.041
0.500	0.366	0.446	0.0018	0.014	0.0015	0.45	0.050
0.550	0.402	0.325	0.0013	0.013	0.0014	0.51	0.056
0.600	0.439	0.274	0.0007	0.008	0.0009	0.45	0.050
0.650	0.475	0.130	0.0008	0.019	0.0021	1.00	0.109

DISSIPATION COEFFICIENT= 0.003679

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00676 VCOMPNT= 0.00399

TABLE A21-20

DIFFUSER NON DIMENSIONAL LENGTH = 7.5

AXIAL DIST. FROM INLET(X) = 4.100 INS. N.D.DIST.(X/L)= 0.547

OUTER WALL BLUE POSITION

DELTA*= 0.191 INS. H= 1.88 REYNOLDS NO.(BASED ON THETA)= 6244.4

DIST RO-R	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.025	0.017	3.429	0.0028	0.002	0.0003	0.06	0.007
0.050	0.034	2.212	0.0038	0.005	0.0006	0.10	0.013
0.075	0.051	1.706	0.0047	0.007	0.0009	0.15	0.019
0.100	0.068	1.564	0.0054	0.009	0.0012	0.17	0.022
0.150	0.101	1.610	0.0065	0.011	0.0014	0.19	0.024
0.200	0.135	1.588	0.0069	0.011	0.0015	0.19	0.025
0.250	0.169	1.418	0.0065	0.012	0.0015	0.21	0.027
0.300	0.203	1.209	0.0056	0.012	0.0016	0.23	0.030
0.350	0.237	1.039	0.0044	0.011	0.0014	0.24	0.031
0.400	0.271	0.911	0.0034	0.010	0.0013	0.24	0.031
0.450	0.304	0.786	0.0026	0.009	0.0011	0.24	0.031
0.500	0.338	0.641	0.0021	0.009	0.0011	0.27	0.034
0.550	0.372	0.497	0.0017	0.009	0.0011	0.30	0.039
0.600	0.406	0.404	0.0012	0.008	0.0010	0.32	0.041
0.650	0.440	0.369	0.0008	0.006	0.0007	0.28	0.037
0.700	0.474	0.256	0.0006	0.006	0.0008	0.35	0.045
0.750	0.507	0.023	0.0001	0.017	0.0021	1.93	0.249

DISSIPATION COEFFICIENT= 0.003586

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00800 VCOMPNT= 0.00169

TABLE A21-21

AXIAL DIST. FROM INLET(X) = 5.050 INS. N.D.DIST.(X/L)= 0.673

OUTER WALL BLUE POSITION

DELTA*= 0.224 INS. H= 1.97 REYNOLDS NO.(BASED ON THETA)= 6778.1

DIST RO-R	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.025	0.016	3.700	0.0024	0.001	0.0002	0.04	0.006
0.050	0.031	1.989	0.0033	0.004	0.0005	0.09	0.013
0.075	0.047	1.246	0.0042	0.007	0.0011	0.16	0.023
0.100	0.063	1.048	0.0050	0.011	0.0015	0.21	0.030
0.150	0.094	1.255	0.0066	0.012	0.0017	0.20	0.029
0.200	0.126	1.452	0.0078	0.012	0.0017	0.19	0.027
0.250	0.157	1.400	0.0082	0.013	0.0018	0.20	0.029
0.300	0.189	1.225	0.0077	0.014	0.0020	0.23	0.032
0.350	0.220	1.094	0.0066	0.014	0.0019	0.23	0.033
0.400	0.252	1.066	0.0054	0.011	0.0016	0.22	0.031
0.450	0.283	1.074	0.0043	0.009	0.0012	0.19	0.027
0.500	0.315	1.001	0.0034	0.008	0.0011	0.18	0.026
0.550	0.346	0.780	0.0028	0.008	0.0011	0.21	0.030
0.600	0.378	0.472	0.0021	0.010	0.0014	0.31	0.043
0.650	0.409	0.263	0.0014	0.012	0.0016	0.44	0.063
0.700	0.441	0.188	0.0006	0.008	0.0011	0.42	0.060
0.750	0.472	0.113	0.0003	0.005	0.0007	0.45	0.063
0.800	0.503	0.038	0.0004	0.022	0.0031	1.61	0.228

DISSIPATION COEFFICIENT= 0.004092

REYNOLDS NORMAL STRESS. UCOMPNT= 0.01063 VCOMPNT= 0.00233

TABLE A21-22

DIFFUSER NON DIMENSIONAL LENGTH = 7.5

AXIAL DIST. FROM INLET(X) = 6.000 INS. N.D.DIST.(X/L)= 0.800

OUTER WALL BLUE POSITION

DELTA*= 0.279 INS. H= 2.13 REYNOLDS NO.(BASED ON THETA)= 7522.8

DIST RO-R	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.025	0.015	2.895	0.0015	0.001	0.0002	0.03	0.006
0.050	0.029	1.755	0.0023	0.002	0.0004	0.07	0.011
0.100	0.059	0.954	0.0041	0.008	0.0013	0.17	0.028
0.150	0.088	0.982	0.0057	0.010	0.0017	0.19	0.032
0.200	0.118	1.151	0.0069	0.011	0.0018	0.18	0.030
0.250	0.147	1.232	0.0078	0.011	0.0019	0.18	0.030
0.300	0.176	1.217	0.0083	0.012	0.0020	0.19	0.031
0.350	0.206	1.167	0.0086	0.013	0.0022	0.20	0.033
0.400	0.235	1.129	0.0085	0.014	0.0022	0.21	0.034
0.450	0.265	1.111	0.0079	0.013	0.0021	0.20	0.033
0.500	0.294	1.086	0.0069	0.011	0.0019	0.19	0.032
0.550	0.324	1.014	0.0054	0.010	0.0016	0.18	0.030
0.600	0.353	0.873	0.0037	0.008	0.0013	0.18	0.029
0.650	0.382	0.677	0.0022	0.006	0.0010	0.18	0.029
0.700	0.412	0.480	0.0012	0.004	0.0007	0.18	0.030
0.750	0.441	0.349	0.0008	0.004	0.0006	0.20	0.033
0.800	0.471	0.314	0.0007	0.004	0.0007	0.22	0.036
0.850	0.500	0.273	0.0002	0.002	0.0003	0.14	0.023

DISSIPATION COEFFICIENT= 0.004542

REYNOLDS NORMAL STRESS. UCOMPNT= 0.01253 VCOMPNT= 0.00176

TABLE A21-23

DIFFUSER NON DIMENSIONAL LENGTH = 7.5

AXIAL DIST. FROM INLET(X) = 7.350 INS. N.D.DIST.(X/L)= 0.980

OUTER WALL BLUE POSITION

DELTA*= 0.358 INS. H= 2.35 REYNOLDS NO.(BASED ON THETA)= 8226.7

DIST RO-R	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.027	1.355	0.0028	0.003	0.0006	0.08	0.015
0.100	0.054	0.843	0.0045	0.007	0.0014	0.16	0.030
0.150	0.081	0.801	0.0059	0.010	0.0020	0.19	0.037
0.200	0.108	0.890	0.0072	0.011	0.0022	0.19	0.036
0.250	0.135	0.977	0.0084	0.012	0.0023	0.19	0.036
0.300	0.161	1.035	0.0094	0.013	0.0025	0.19	0.036
0.400	0.215	1.103	0.0107	0.014	0.0026	0.19	0.036
0.500	0.269	1.104	0.0104	0.013	0.0025	0.18	0.035
0.600	0.323	0.929	0.0090	0.013	0.0026	0.20	0.039
0.700	0.377	0.696	0.0068	0.014	0.0026	0.23	0.045
0.800	0.431	0.792	0.0036	0.006	0.0012	0.15	0.029
0.900	0.484	0.529	0.0012	0.003	0.0006	0.13	0.025

DISSIPATION COEFFICIENT= 0.006149

REYNOLDS NORMAL STRESS. UCOMPNT= 0.01747 VCOMPNT= 0.00407

TABLE A21-24

DIFFUSER NON DIMENSIONAL LENGTH = 7.5

AXIAL DIST. FROM INLET(X) = 7.350 INS. N.D.DIST.(X/L)= 0.980

OUTER WALL BLUE POSITION

DELTA*= 0.358 INS. H= 2.35 REYNOLDS NO.(BASED ON THETA)= 8226.7

DIST RO-R	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.027	1.355	0.0024	0.002	0.0005	0.07	0.014
0.100	0.054	0.843	0.0043	0.007	0.0014	0.15	0.030
0.150	0.081	0.801	0.0061	0.011	0.0020	0.19	0.037
0.200	0.108	0.890	0.0076	0.012	0.0023	0.19	0.037
0.250	0.135	0.977	0.0089	0.013	0.0024	0.19	0.037
0.300	0.161	1.035	0.0099	0.013	0.0026	0.19	0.037
0.400	0.215	1.103	0.0111	0.014	0.0027	0.19	0.036
0.500	0.269	1.104	0.0108	0.014	0.0026	0.19	0.036
0.600	0.323	0.929	0.0088	0.013	0.0025	0.20	0.038
0.700	0.377	0.696	0.0060	0.012	0.0023	0.22	0.042
0.800	0.431	0.792	0.0032	0.006	0.0011	0.14	0.027
0.900	0.484	0.529	0.0012	0.003	0.0006	0.13	0.025

DISSIPATION COEFFICIENT= 0.006163

REYNOLDS NORMAL STRESS. UCOMPNT= 0.01747 VCOMPNT= 0.00369

TABLE A21-25

DIFFUSER NON DIMENSIONAL LENGTH = 7.5

AXIAL DIST. FROM INLET(X) = 7.350 INS. N.D.DIST.(X/L)= 0.980

OUTER WALL GREEN POSITION

DELTA*= 0.358 INS. H= 2.35 REYNOLDS NO.(BASED ON THETA)= 8226.7

DIST RO-R	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.027	1.355	0.0026	0.003	0.0005	0.07	0.014
0.100	0.054	0.843	0.0035	0.006	0.0011	0.14	0.027
0.150	0.081	0.801	0.0049	0.008	0.0016	0.17	0.033
0.200	0.108	0.890	0.0067	0.011	0.0020	0.18	0.035
0.250	0.135	0.977	0.0088	0.013	0.0024	0.19	0.036
0.300	0.161	1.035	0.0105	0.014	0.0027	0.20	0.038
0.400	0.215	1.103	0.0121	0.015	0.0030	0.20	0.038
0.500	0.269	1.104	0.0115	0.015	0.0028	0.19	0.037
0.600	0.323	0.929	0.0095	0.014	0.0027	0.21	0.040
0.700	0.377	0.696	0.0066	0.013	0.0026	0.23	0.045
0.800	0.431	0.792	0.0037	0.007	0.0013	0.15	0.029
0.900	0.484	0.529	0.0021	0.006	0.0011	0.17	0.033

DISSIPATION COEFFICIENT= 0.006515

REYNOLDS NORMAL STRESS. UCOMPNT= 0.01747 VCOMPNT= 0.00832

TABLE A21-26

DIFFUSER NON DIMENSIONAL LENGTH = 7.5

AXIAL DIST. FROM INLET(X) = 7.350 INS. N.D.DIST.(X/L)= 0.980

OUTER WALL RED POSITION

DELTA*= 0.358 INS. H= 2.35 REYNOLDS NO.(BASED ON THETA)= 8226.7

DIST RO-R	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.027	1.355	0.0025	0.003	0.0005	0.07	0.014
0.100	0.054	0.843	0.0048	0.008	0.0015	0.16	0.031
0.150	0.081	0.801	0.0065	0.011	0.0022	0.20	0.038
0.200	0.108	0.890	0.0077	0.012	0.0023	0.19	0.038
0.250	0.135	0.977	0.0087	0.012	0.0024	0.19	0.036
0.300	0.161	1.035	0.0096	0.013	0.0025	0.19	0.036
0.400	0.215	1.103	0.0109	0.014	0.0027	0.19	0.036
0.500	0.269	1.104	0.0106	0.013	0.0026	0.18	0.035
0.600	0.323	0.929	0.0090	0.013	0.0026	0.20	0.039
0.700	0.377	0.696	0.0072	0.014	0.0028	0.24	0.046
0.800	0.431	0.792	0.0040	0.007	0.0013	0.16	0.030
0.900	0.484	0.529	0.0009	0.002	0.0005	0.11	0.022

DISSIPATION COEFFICIENT= 0.006277

REYNOLDS NORMAL STRESS. UCOMPNT= 0.01747 VCOMPNT= 0.00558

TABLE A21-27

DIFFUSER NON DIMENSIONAL LENGTH = 7.5

AXIAL DISTANCE FROM OUTLET= 3.75 INS. (1 HYDRAULIC DIAMETER)

INNER WALL BLUE POSITION

DELTA*= 0.245 INS. H= 1.62 REYNOLDS NO.(BASED ON THETA)= 7629.6

DIST R-RI	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.025	0.013	3.982	0.0031	0.002	0.0002	0.04	0.005
0.050	0.027	1.824	0.0038	0.004	0.0006	0.10	0.013
0.100	0.053	0.446	0.0048	0.022	0.0029	0.45	0.059
0.200	0.107	0.847	0.0068	0.016	0.0021	0.28	0.037
0.300	0.160	0.716	0.0081	0.023	0.0030	0.36	0.048
0.400	0.213	0.551	0.0084	0.031	0.0041	0.48	0.063
0.500	0.267	0.810	0.0081	0.020	0.0027	0.32	0.042
0.600	0.320	0.812	0.0069	0.017	0.0023	0.30	0.039
0.700	0.373	0.442	0.0045	0.021	0.0027	0.44	0.057
0.800	0.427	0.536	0.0023	0.009	0.0011	0.26	0.034
0.850	0.453	0.416	0.0013	0.006	0.0008	0.25	0.032

DISSIPATION COEFFICIENT= 0.004035

REYNOLDS NORMAL STRESS. UCOMPNT= 0.01234 VCOMPNT= 0.00410

TABLE A21-28

DIFFUSER NON DIMENSIONAL LENGTH = 7.5

AXIAL DISTANCE FROM OUTLET= 7.50 INS. (2 HYDRAULIC DIAMETERS)

INNER WALL GREEN POSITION

DELTA*= 0.191 INS. H= 1.45 REYNOLDS NO.(BASED ON THETA)= 5974.5

DIST R-RI	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RJ)	MIX L DEL*	MIX L (RO-RI)
0.025	0.013	2.697	0.0031	0.003	0.0003	0.08	0.008
0.050	0.027	2.095	0.0035	0.004	0.0004	0.10	0.011
0.100	0.053	1.228	0.0044	0.009	0.0009	0.20	0.020
0.150	0.080	0.721	0.0051	0.018	0.0019	0.37	0.037
0.200	0.107	0.476	0.0056	0.031	0.0032	0.58	0.059
0.250	0.133	0.406	0.0060	0.038	0.0039	0.70	0.072
0.300	0.160	0.442	0.0060	0.036	0.0037	0.65	0.066
0.350	0.187	0.523	0.0059	0.030	0.0030	0.54	0.055
0.400	0.213	0.606	0.0055	0.024	0.0024	0.45	0.046
0.450	0.240	0.659	0.0049	0.020	0.0020	0.39	0.040
0.500	0.267	0.663	0.0040	0.016	0.0016	0.35	0.036
0.550	0.293	0.613	0.0027	0.011	0.0012	0.31	0.032
0.600	0.320	0.520	0.0009	0.004	0.0004	0.21	0.021

DISSIPATION COEFFICIENT= 0.002144

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00759 VCOMPNT= 0.00584

TABLE A21-29

DIFFUSER NON DIMENSIONAL LENGTH = 7.5

AXIAL DISTANCE FROM OUTLET= 11.25 INS. (3 HYDRAULIC DIAMETERS)

INNER WALL RED POSITION

DELTA*= 0.129 INS. H= 1.32 REYNOLDS NO.(BASED ON THETA)= 4065.9

DIST R-RI	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.025	0.013	4.755	0.0023	0.002	0.0001	0.06	0.004
0.050	0.027	2.455	0.0026	0.004	0.0003	0.11	0.008
0.100	0.053	0.658	0.0039	0.023	0.0016	0.52	0.036
0.200	0.107	0.543	0.0051	0.037	0.0025	0.72	0.050
0.300	0.160	0.441	0.0061	0.053	0.0037	0.97	0.067
0.400	0.213	0.369	0.0058	0.061	0.0042	1.13	0.078
0.500	0.267	0.503	0.0054	0.042	0.0029	0.80	0.055
0.600	0.320	0.358	0.0043	0.047	0.0032	1.01	0.069
0.700	0.373	0.231	0.0024	0.040	0.0027	1.16	0.080

DISSIPATION COEFFICIENT= 0.003438

REYNOLDS NORMAL STRESS. UCOMPNT= 0.01026 VCOMPNT= 0.00608

TABLE A21-30

DIFFUSER NON DIMENSIONAL LENGTH = 7.5

AXIAL DISTANCE FROM OUTLET= 3.75 INS. (1 HYDRAULIC DIAMETER)

OUTER WALL BLUF POSITION

DELTA*= 0.258 INS. H= 1.71 REYNOLDS NO.(BASED ON THETA)= 7579.5

DIST RO-R	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.027	1.440	0.0041	0.005	0.0007	0.12	0.017
0.100	0.053	0.483	0.0061	0.025	0.0034	0.44	0.061
0.150	0.080	0.410	0.0079	0.037	0.0051	0.59	0.082
0.200	0.107	0.570	0.0094	0.032	0.0044	0.47	0.064
0.250	0.133	0.693	0.0108	0.030	0.0041	0.41	0.056
0.300	0.160	0.723	0.0119	0.032	0.0044	0.41	0.057
0.400	0.213	0.680	0.0134	0.038	0.0052	0.47	0.064
0.500	0.267	0.752	0.0134	0.035	0.0048	0.42	0.058
0.600	0.320	0.840	0.0122	0.028	0.0039	0.36	0.050
0.700	0.373	0.715	0.0097	0.026	0.0036	0.38	0.052
0.800	0.427	0.509	0.0060	0.023	0.0032	0.42	0.058
0.900	0.480	0.281	0.0025	0.017	0.0023	0.48	0.067

DISSIPATION COEFFICIENT= 0.006114

REYNOLDS NORMAL STRESS. UCOMPNT= 0.01850 VCOMPNT= 0.00594

TABLE A21-31

DIFFUSER NON DIMENSIONAL LENGTH = 7.5

AXIAL DISTANCE FROM OUTLET= 7.50 INS. (2 HYDRAULIC DIAMETERS)

OUTER WALL GREEN POSITION
DELTA*= 0.193 INS. H= 1.47 REYNOLDS NO.(BASED ON THETA)= 5974.5

DIST RO-R	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.027	1.497	0.0042	0.007	0.0008	0.16	0.016
0.100	0.053	0.722	0.0062	0.022	0.0023	0.40	0.041
0.150	0.080	0.493	0.0079	0.042	0.0043	0.66	0.068
0.200	0.107	0.468	0.0095	0.052	0.0054	0.76	0.078
0.300	0.160	0.499	0.0126	0.065	0.0067	0.82	0.085
0.400	0.213	0.503	0.0163	0.084	0.0087	0.93	0.096
0.500	0.267	0.554	0.0204	0.095	0.0098	0.94	0.097
0.600	0.320	0.600	0.0233	0.101	0.0104	0.93	0.096
0.700	0.373	0.538	0.0244	0.117	0.0121	1.06	0.109
0.800	0.427	0.402	0.0233	0.150	0.0155	1.39	0.143
0.900	0.480	0.124	0.0204	0.427	0.0440	4.23	0.436

DISSIPATION COEFFICIENT= 0.007771

REYNOLDS NORMAL STRESS. UCOMPNT= 0.02600 VCOMPNT= 0.01402

TABLE A21-32

DIFFUSER NON DIMENSIONAL LENGTH = 7.5

AXIAL DISTANCE FROM OUTLET= 11.25 INS. (3 HYDRAULIC DIAMETERS)

OUTER WALL RED POSITION
DELTA*= 0.126 INS. H= 1.28 REYNOLDS NO.(BASED ON THETA)= 4107.4

DIST RO-R	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.027	1.895	0.0038	0.008	0.0005	0.18	0.012
0.100	0.053	0.870	0.0047	0.021	0.0014	0.44	0.030
0.150	0.080	0.518	0.0058	0.044	0.0030	0.82	0.055
0.200	0.107	0.430	0.0069	0.063	0.0043	1.08	0.073
0.300	0.160	0.384	0.0088	0.091	0.0061	1.37	0.092
0.400	0.213	0.305	0.0103	0.133	0.0090	1.86	0.125
0.500	0.267	0.275	0.0107	0.154	0.0104	2.11	0.142
0.600	0.320	0.214	0.0101	0.187	0.0126	2.63	0.177
0.700	0.373	0.154	0.0089	0.230	0.0154	3.44	0.231
0.800	0.427	0.094	0.0072	0.306	0.0205	5.09	0.342

DISSIPATION COEFFICIENT= 0.002583

REYNOLDS NORMAL STRESS. UCOMPNT= 0.01902 VCOMPNT= 0.00885

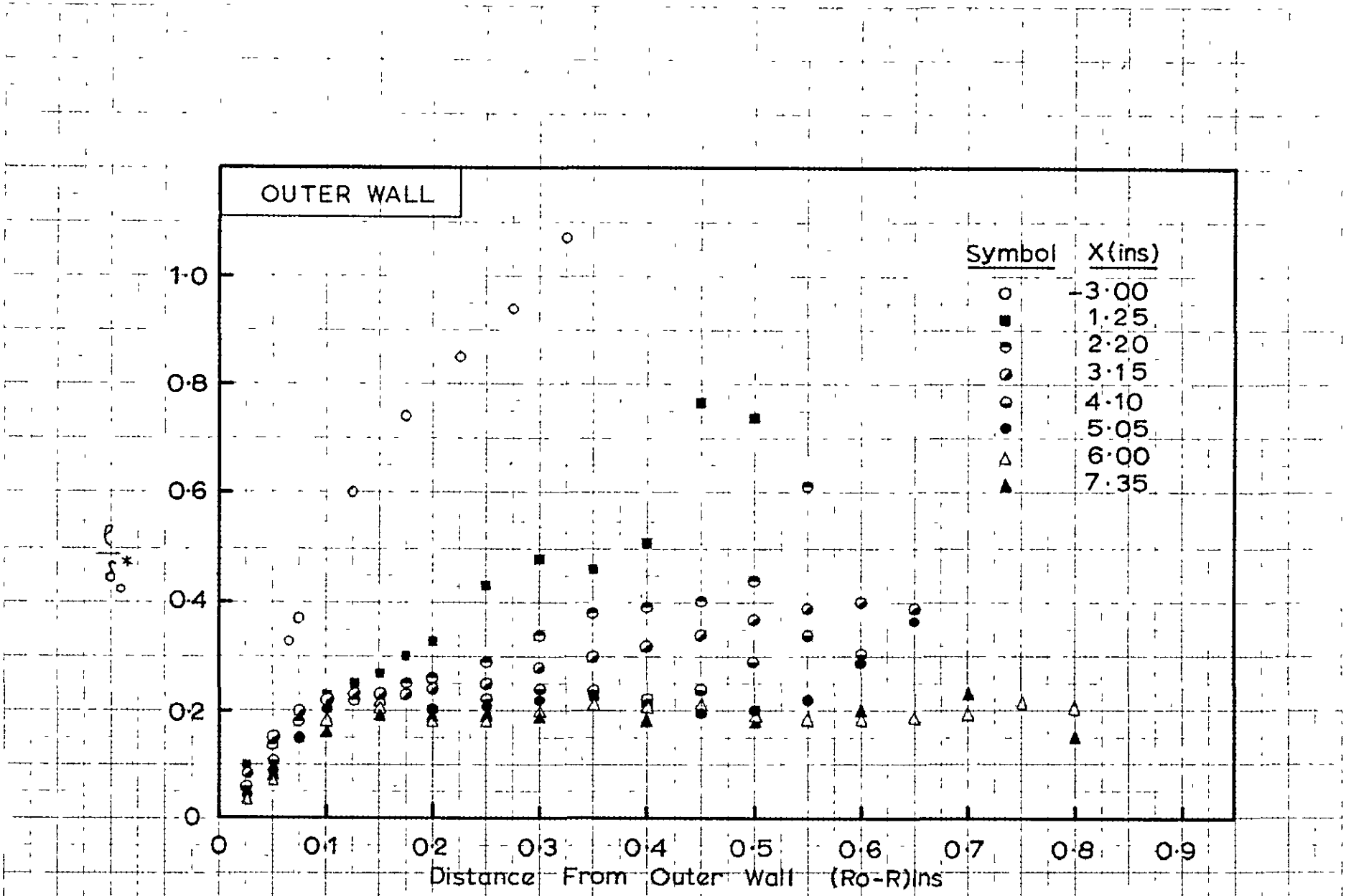

FIG. A 21-1 EXPERIMENTAL MIXING LENGTH DISTRIBUTIONS. L/ΔR=7·5 DIFFUSER.

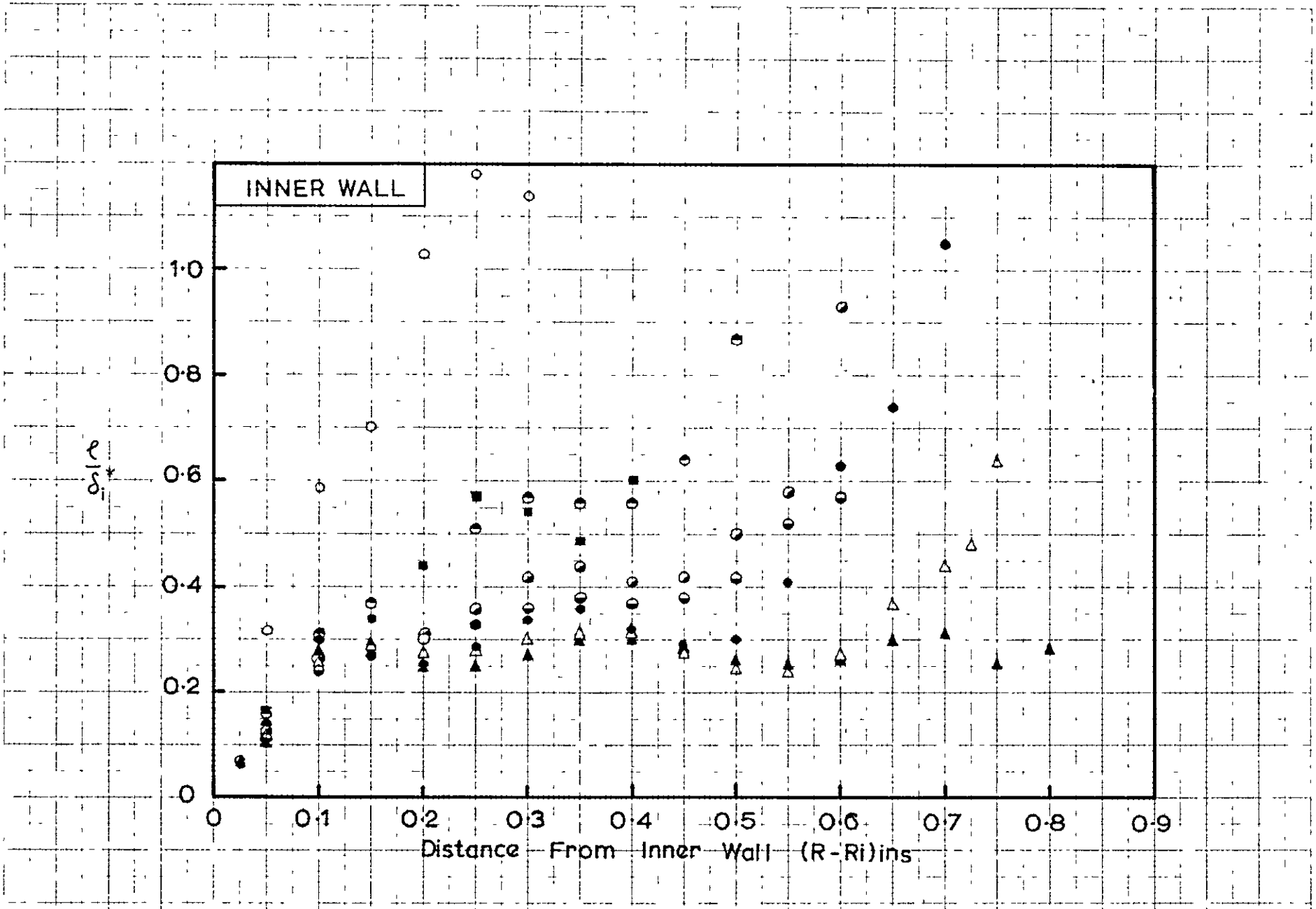

FIG A 21-2 EXPERIMENTAL MIXING LENGTH DISTRIBUTIONS. L/ΔR=7·5 DIFFUSER.

Appendix 22

Turbulence Analysis

$L/\Delta R_1 = 10$ Diffuser

TABLE A22-1

DIFFUSER NON DIMENSIONAL LENGTH = 10.0

AXIAL DIST. FROM INLET(X) = -3.000 INS. N.D.DIST.(X/L)=-0.300

INNER WALL BLUE POSITION

DELTA*= 0.050 INS. H= 1.28 REYNOLDS NO.(BASED ON THETA)= 3285.1

DIST R-RI	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.030	0.030	4.675	0.0025	0.005	0.0003	0.15	0.008
0.040	0.040	3.286	0.0024	0.007	0.0004	0.21	0.011
0.090	0.090	1.250	0.0025	0.020	0.0010	0.57	0.029
0.140	0.140	1.041	0.0023	0.022	0.0011	0.65	0.033
0.190	0.190	0.644	0.0019	0.029	0.0015	0.95	0.048
0.240	0.240	0.492	0.0016	0.032	0.0016	1.14	0.057
0.290	0.290	0.491	0.0013	0.026	0.0013	1.02	0.051
0.340	0.340	0.285	0.0009	0.030	0.0015	1.46	0.073
0.390	0.390	0.149	0.0005	0.034	0.0017	2.14	0.107

DISSIPATION COEFFICIENT= 0.001432

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00142 VCOMPNT= 0.00085

TABLE A22-2

DIFFUSER NON DIMENSIONAL LENGTH = 10.0

AXIAL DIST. FROM INLET(X) = 1.000 INS. N.D.DIST.(X/L)= 0.100

INNER WALL BLUE POSITION

DELTA*= 0.073 INS. H= 1.32 REYNOLDS NO.(BASED ON THETA)= 3794.3

DIST R-RI	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.025	0.023	3.676	0.0037	0.007	0.0005	0.16	0.011
0.050	0.046	2.606	0.0034	0.009	0.0006	0.22	0.015
0.100	0.092	1.387	0.0028	0.014	0.0009	0.37	0.025
0.150	0.138	0.906	0.0027	0.021	0.0014	0.56	0.038
0.200	0.184	0.725	0.0024	0.023	0.0015	0.66	0.044
0.250	0.230	0.616	0.0018	0.020	0.0014	0.67	0.045
0.300	0.276	0.514	0.0013	0.017	0.0011	0.67	0.045
0.350	0.322	0.435	0.0010	0.016	0.0011	0.70	0.047
0.400	0.368	0.380	0.0008	0.014	0.0009	0.71	0.048
0.450	0.414	0.296	0.0005	0.011	0.0007	0.70	0.047
0.500	0.460	0.167	0.0001	0.006	0.0004	0.68	0.046

DISSIPATION COEFFICIENT= 0.001411

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00215 VCOMPNT= 0.00100

TABLE A22-3

DIFFUSER NON DIMENSIONAL LENGTH = 10.0

AXIAL DIST. FROM INLET(X) = 2.250 INS. N.D.DIST.(X/L)= 0.225

INNER WALL BLUE POSITION

DELTA*= 0.092 INS. H= 1.43 REYNOLDS NO.(BASED ON THETA)= 4602.4

DIST R-RI	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.025	0.021	4.921	0.0038	0.004	0.0003	0.10	0.007
0.050	0.042	2.908	0.0037	0.007	0.0005	0.16	0.012
0.100	0.084	1.493	0.0030	0.011	0.0008	0.28	0.022
0.150	0.125	1.210	0.0026	0.012	0.0009	0.33	0.025
0.200	0.167	1.007	0.0024	0.013	0.0010	0.38	0.029
0.250	0.209	0.767	0.0021	0.015	0.0011	0.46	0.035
0.300	0.251	0.594	0.0017	0.016	0.0012	0.54	0.042
0.350	0.292	0.509	0.0014	0.015	0.0012	0.57	0.044
0.400	0.334	0.434	0.0011	0.014	0.0011	0.59	0.045
0.450	0.376	0.307	0.0008	0.013	0.0010	0.69	0.053
0.500	0.418	0.185	0.0005	0.015	0.0012	0.94	0.072
0.550	0.459	0.082	0.0003	0.019	0.0015	1.60	0.123

DISSIPATION COEFFICIENT= 0.001857

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00319 VCOMPNT= 0.00129

TABLE A22-4

DIFFUSER NON DIMENSIONAL LENGTH = 10.0

AXIAL DIST. FROM INLET(X) = 3.250 INS. N.D.DIST.(X/L)= 0.325

INNER WALL BLUE POSITION

DELTA*= 0.109 INS. H= 1.46 REYNOLDS NO.(BASED ON THETA)= 4490.7

DIST R-RI	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.025	0.019	3.746	0.0034	0.004	0.0004	0.10	0.009
0.050	0.039	2.536	0.0044	0.008	0.0007	0.17	0.014
0.100	0.078	1.506	0.0053	0.016	0.0014	0.31	0.027
0.150	0.117	1.225	0.0049	0.018	0.0016	0.37	0.031
0.200	0.156	1.086	0.0040	0.017	0.0014	0.38	0.032
0.250	0.195	0.929	0.0032	0.016	0.0013	0.40	0.034
0.300	0.234	0.765	0.0028	0.017	0.0014	0.45	0.038
0.350	0.273	0.632	0.0025	0.018	0.0016	0.52	0.044
0.400	0.312	0.538	0.0021	0.018	0.0015	0.56	0.047
0.450	0.350	0.453	0.0016	0.016	0.0014	0.58	0.049
0.500	0.389	0.343	0.0012	0.015	0.0013	0.64	0.054
0.550	0.428	0.202	0.0008	0.019	0.0016	0.93	0.079
0.600	0.467	0.018	0.0006	0.139	0.0118	8.33	0.707

DISSIPATION COEFFICIENT= 0.002282

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00421 VCOMPNT= 0.00234

TABLE A22-5

DIFFUSER NON DIMENSIONAL LENGTH = 10.0

AXIAL DIST. FROM INLET(X) = 4.250 INS. N.D.DIST.(X/L)= 0.425

INNER WALL BLUE POSITION

DELTA*= 0.132 INS. H= 1.52 REYNOLDS NO.(BASED ON THETA)= 4919.8

DIST R-RI	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.036	2.432	0.0049	0.008	0.0007	0.15	0.015
0.100	0.073	1.436	0.0063	0.017	0.0016	0.30	0.028
0.150	0.109	1.207	0.0061	0.019	0.0018	0.35	0.033
0.200	0.146	1.119	0.0052	0.018	0.0017	0.35	0.033
0.250	0.182	1.000	0.0043	0.016	0.0016	0.35	0.034
0.300	0.219	0.864	0.0037	0.016	0.0015	0.38	0.036
0.350	0.255	0.749	0.0032	0.016	0.0016	0.40	0.039
0.400	0.292	0.658	0.0027	0.016	0.0015	0.42	0.041
0.450	0.328	0.561	0.0021	0.014	0.0014	0.44	0.042
0.500	0.364	0.436	0.0015	0.013	0.0013	0.48	0.047
0.550	0.401	0.303	0.0011	0.013	0.0013	0.58	0.056
0.600	0.437	0.212	0.0007	0.013	0.0012	0.67	0.064
0.650	0.474	0.049	0.0003	0.026	0.0025	1.99	0.191

DISSIPATION COEFFICIENT= 0.002755

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00544 VCOMPNT= 0.00235

TABLE A22-6

DIFFUSER NON DIMENSIONAL LENGTH = 10.0

AXIAL DIST. FROM INLET(X) = 4.250 INS. N.D.DIST.(X/L)= 0.425

INNER WALL GREEN POSITION

DELTA*= 0.132 INS. H= 1.52 REYNOLDS NO.(BASED ON THETA)= 4919.8

DIST R-RI	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.036	2.432	0.0054	0.008	0.0008	0.16	0.016
0.100	0.073	1.436	0.0066	0.017	0.0017	0.30	0.029
0.150	0.109	1.207	0.0069	0.022	0.0021	0.37	0.035
0.200	0.146	1.119	0.0065	0.022	0.0021	0.39	0.037
0.250	0.182	1.000	0.0057	0.022	0.0021	0.40	0.039
0.300	0.219	0.864	0.0048	0.021	0.0020	0.43	0.041
0.350	0.255	0.749	0.0039	0.020	0.0019	0.45	0.043
0.400	0.292	0.658	0.0033	0.019	0.0018	0.46	0.045
0.450	0.328	0.561	0.0027	0.019	0.0018	0.50	0.048
0.500	0.364	0.436	0.0023	0.020	0.0019	0.59	0.057
0.550	0.401	0.303	0.0018	0.023	0.0022	0.76	0.073
0.600	0.437	0.212	0.0014	0.024	0.0023	0.93	0.090
0.650	0.474	0.049	0.0009	0.071	0.0069	3.32	0.320

DISSIPATION COEFFICIENT= 0.003203

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00544 VCOMPNT= 0.00422

TABLE A22-7

DIFFUSER NON DIMENSIONAL LENGTH = 10.0

AXIAL DIST. FROM INLET(X) = 4.250 INS. N.D.DIST.(X/L)= 0.425

INNER WALL RED POSITION

DELTA*= 0.132 INS. H= 1.52 REYNOLDS NO.(BASED ON THETA)= 4919.8

DIST R-RI	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.036	2.432	0.0058	0.009	0.0009	0.17	0.016
0.100	0.073	1.436	0.0072	0.019	0.0018	0.32	0.030
0.150	0.109	1.207	0.0073	0.023	0.0022	0.38	0.037
0.200	0.146	1.119	0.0068	0.023	0.0022	0.40	0.038
0.250	0.182	1.000	0.0060	0.023	0.0022	0.42	0.040
0.300	0.219	0.864	0.0052	0.023	0.0022	0.45	0.043
0.350	0.255	0.749	0.0043	0.022	0.0021	0.47	0.045
0.400	0.292	0.658	0.0035	0.020	0.0020	0.48	0.047
0.450	0.328	0.561	0.0028	0.019	0.0018	0.51	0.049
0.500	0.364	0.436	0.0022	0.019	0.0019	0.58	0.056
0.550	0.401	0.303	0.0017	0.021	0.0020	0.72	0.070
0.600	0.437	0.212	0.0012	0.022	0.0021	0.88	0.085
0.650	0.474	0.049	0.0009	0.066	0.0063	3.19	0.307

DISSIPATION COEFFICIENT= 0.003404

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00544 VCOMPNT= 0.00484

TABLE A22-8

DIFFUSER NON DIMENSIONAL LENGTH = 10.0

AXIAL DIST. FROM INLET(X) = 5.450 INS. N.D.DIST.(X/L)= 0.545

INNER WALL BLUE POSITION

DELTA*= 0.158 INS. H= 1.58 REYNOLDS NO.(BASED ON THETA)= 5677.9

DIST R-RI	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.034	1.922	0.0043	0.007	0.0008	0.15	0.016
0.100	0.068	1.247	0.0057	0.014	0.0015	0.27	0.029
0.150	0.102	1.160	0.0063	0.017	0.0018	0.31	0.033
0.200	0.135	1.134	0.0062	0.017	0.0019	0.31	0.033
0.250	0.169	1.059	0.0058	0.017	0.0018	0.32	0.034
0.300	0.203	0.967	0.0051	0.017	0.0018	0.33	0.035
0.350	0.237	0.889	0.0043	0.015	0.0016	0.33	0.035
0.400	0.271	0.818	0.0035	0.014	0.0015	0.32	0.035
0.450	0.305	0.722	0.0028	0.012	0.0013	0.33	0.035
0.500	0.339	0.585	0.0021	0.011	0.0012	0.35	0.038
0.550	0.372	0.440	0.0016	0.011	0.0012	0.40	0.043
0.600	0.406	0.338	0.0012	0.011	0.0012	0.45	0.048
0.650	0.440	0.229	0.0008	0.010	0.0011	0.54	0.058
0.700	0.474	0.021	0.0002	0.028	0.0030	2.91	0.311

DISSIPATION COEFFICIENT= 0.002835

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00685 VCOMPNT= 0.00159

TABLE A22-9

DIFFUSER NON DIMENSIONAL LENGTH = 10.0

AXIAL DIST. FROM INLET(X) = 7.250 INS. N.D.DIST.(X/L)= 0.725

INNER WALL BLUE POSITION

DELTA*= 0.186 INS. H= 1.62 REYNOLDS NO.(BASED ON THETA)= 6042.3

DIST R-RI	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.031	1.925	0.0057	0.008	0.0009	0.15	0.017
0.100	0.061	1.086	0.0069	0.017	0.0019	0.29	0.033
0.150	0.092	1.047	0.0078	0.020	0.0023	0.32	0.036
0.200	0.122	1.098	0.0087	0.021	0.0024	0.32	0.037
0.250	0.153	1.053	0.0092	0.023	0.0027	0.35	0.039
0.300	0.183	0.952	0.0092	0.026	0.0029	0.38	0.043
0.350	0.214	0.871	0.0085	0.026	0.0030	0.40	0.046
0.400	0.245	0.835	0.0074	0.024	0.0027	0.39	0.045
0.450	0.275	0.811	0.0062	0.021	0.0024	0.37	0.042
0.500	0.306	0.741	0.0051	0.019	0.0021	0.37	0.042
0.550	0.336	0.606	0.0042	0.019	0.0021	0.41	0.046
0.600	0.367	0.450	0.0034	0.020	0.0023	0.49	0.056
0.650	0.398	0.354	0.0026	0.020	0.0023	0.55	0.063
0.700	0.428	0.280	0.0018	0.018	0.0020	0.58	0.066
0.750	0.459	0.065	0.0011	0.047	0.0053	1.97	0.224

DISSIPATION COEFFICIENT= 0.004468

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00940 VCOMPNT= 0.00501

TABLE A22-10

DIFFUSER NON DIMENSIONAL LENGTH = 10.0

AXIAL DIST. FROM INLET(X) = 9.850 INS. N.D.DIST.(X/L)= 0.985

INNER WALL BLUE POSITION

DELTA*= 0.249 INS. H= 1.69 REYNOLDS NO.(BASED ON THETA)= 7758.5

DIST R-RI	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.027	2.001	0.0042	0.004	0.0006	0.09	0.012
0.100	0.054	0.803	0.0056	0.014	0.0019	0.26	0.035
0.150	0.081	0.733	0.0067	0.018	0.0025	0.32	0.042
0.200	0.107	0.866	0.0079	0.018	0.0024	0.29	0.039
0.250	0.134	0.901	0.0089	0.020	0.0027	0.30	0.040
0.300	0.161	0.834	0.0098	0.023	0.0031	0.34	0.045
0.350	0.188	0.755	0.0101	0.027	0.0036	0.38	0.051
0.400	0.215	0.729	0.0099	0.027	0.0036	0.39	0.052
0.450	0.242	0.764	0.0091	0.024	0.0032	0.35	0.047
0.500	0.269	0.814	0.0080	0.020	0.0026	0.31	0.042
0.550	0.295	0.820	0.0067	0.016	0.0022	0.28	0.038
0.600	0.322	0.750	0.0055	0.015	0.0020	0.28	0.037
0.650	0.349	0.627	0.0045	0.014	0.0019	0.30	0.040
0.700	0.376	0.521	0.0037	0.014	0.0019	0.33	0.044
0.750	0.403	0.484	0.0029	0.012	0.0016	0.32	0.042
0.800	0.430	0.415	0.0020	0.010	0.0013	0.30	0.041
0.850	0.456	0.169	0.0010	0.012	0.0016	0.54	0.072

DISSIPATION COEFFICIENT= 0.004574

REYNOLDS NORMAL STRESS. UCOMPNT= 0.01003 VCOMPNT= 0.00695

TABLE A22-11

DIFFUSER NON DIMENSIONAL LENGTH = 10.0

AXIAL DIST. FROM INLET(X) = 9.850 INS. N.D.DIST.(X/L)= 0.985

INNER WALL GREEN POSITION

DELTA*= 0.249 INS. H= 1.69 REYNOLDS NO.(BASED ON THETA)= 7758.5

DIST R-RI	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.027	2.001	0.0039	0.004	0.0005	0.09	0.012
0.100	0.054	0.803	0.0055	0.014	0.0018	0.26	0.035
0.150	0.081	0.733	0.0067	0.018	0.0025	0.32	0.042
0.200	0.107	0.866	0.0078	0.018	0.0024	0.29	0.039
0.250	0.134	0.901	0.0088	0.020	0.0026	0.30	0.040
0.300	0.161	0.834	0.0096	0.023	0.0031	0.33	0.045
0.350	0.188	0.755	0.0100	0.027	0.0036	0.38	0.050
0.400	0.215	0.729	0.0101	0.028	0.0037	0.39	0.052
0.450	0.242	0.764	0.0097	0.025	0.0034	0.37	0.049
0.500	0.269	0.814	0.0090	0.022	0.0030	0.33	0.044
0.550	0.295	0.820	0.0080	0.020	0.0026	0.31	0.041
0.600	0.322	0.750	0.0069	0.018	0.0025	0.31	0.042
0.650	0.349	0.627	0.0057	0.018	0.0024	0.34	0.046
0.700	0.376	0.521	0.0045	0.017	0.0023	0.37	0.049
0.750	0.403	0.484	0.0034	0.014	0.0019	0.34	0.046
0.800	0.430	0.415	0.0024	0.012	0.0016	0.34	0.045
0.850	0.456	0.169	0.0014	0.017	0.0022	0.63	0.084

DISSIPATION COEFFICIENT= 0.004780

REYNOLDS NORMAL STRESS. UCOMPNT= 0.01000 VCOMPNT= 0.00814

TABLE A22-12

DIFFUSER NON DIMENSIONAL LENGTH = 10.0

AXIAL DIST. FROM INLET(X) = 9.850 INS. N.D.DIST.(X/L)= 0.985

INNER WALL RED POSITION

DELTA*= 0.249 INS. H= 1.69 REYNOLDS NO.(BASED ON THETA)= 7758.5

DIST R-RI	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.027	2.001	0.0043	0.004	0.0006	0.09	0.012
0.100	0.054	0.803	0.0061	0.015	0.0021	0.28	0.037
0.150	0.081	0.733	0.0075	0.021	0.0028	0.34	0.045
0.200	0.107	0.866	0.0086	0.020	0.0027	0.30	0.041
0.250	0.134	0.901	0.0094	0.021	0.0028	0.31	0.041
0.300	0.161	0.834	0.0098	0.024	0.0032	0.34	0.045
0.350	0.188	0.755	0.0099	0.026	0.0035	0.37	0.050
0.400	0.215	0.729	0.0097	0.027	0.0036	0.38	0.051
0.450	0.242	0.764	0.0093	0.024	0.0033	0.36	0.048
0.500	0.269	0.814	0.0087	0.021	0.0029	0.32	0.043
0.550	0.295	0.820	0.0079	0.019	0.0026	0.31	0.041
0.600	0.322	0.750	0.0069	0.018	0.0025	0.31	0.042
0.650	0.349	0.627	0.0056	0.018	0.0024	0.34	0.045
0.700	0.376	0.521	0.0043	0.016	0.0022	0.36	0.048
0.750	0.403	0.484	0.0029	0.012	0.0016	0.31	0.042
0.800	0.430	0.415	0.0016	0.008	0.0010	0.27	0.037
0.850	0.456	0.169	0.0008	0.009	0.0012	0.46	0.062

DISSIPATION COEFFICIENT= 0.004872

REYNOLDS NORMAL STRESS. UCOMPNT= 0.01000 VCOMPNT= 0.01029

TABLE A22-13

DIFFUSER NON DIMENSIONAL LENGTH = 10.0

OUTER WALL BLUE POSITION

DELTA*= 0.055 INS. H= 1.30 REYNOLDS NO.(BASED ON THETA)= 3493.9

DIST RO-R	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.045	0.045	3.165	0.0025	0.007	0.0004	0.20	0.011
0.060	0.060	2.181	0.0025	0.011	0.0006	0.30	0.016
0.110	0.110	1.178	0.0024	0.019	0.0010	0.54	0.030
0.160	0.160	0.847	0.0021	0.022	0.0012	0.69	0.038
0.210	0.210	0.544	0.0018	0.031	0.0017	1.01	0.056
0.260	0.260	0.471	0.0014	0.028	0.0015	1.03	0.057
0.310	0.310	0.476	0.0009	0.018	0.0010	0.82	0.045
0.360	0.360	0.311	0.0007	0.021	0.0011	1.10	0.061
0.410	0.410	0.191	0.0004	0.020	0.0011	1.39	0.076
0.460	0.460	0.091	0.0002	0.022	0.0012	2.08	0.114

DISSIPATION COEFFICIENT= 0.001405

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00170 VCOMPNT= 0.00049

TABLE A22-14

DIFFUSER NON DIMENSIONAL LENGTH = 10.0

AXIAL DIST. FROM INLET(X) = 1.000 INS. N.D.DIST.(X/L)=-0.100

OUTER WALL BLUE POSITION

DELTA*= 0.067 INS. H= 1.38 REYNOLDS NO.(BASED ON THETA)= 3380.4

DIST RO-R	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.025	0.023	4.977	0.0026	0.004	0.0002	0.11	0.007
0.050	0.046	2.961	0.0026	0.007	0.0004	0.18	0.011
0.100	0.092	1.436	0.0027	0.014	0.0009	0.38	0.024
0.150	0.138	0.979	0.0024	0.018	0.0011	0.52	0.032
0.200	0.184	0.787	0.0019	0.018	0.0011	0.58	0.036
0.250	0.230	0.708	0.0015	0.016	0.0010	0.59	0.036
0.300	0.276	0.615	0.0013	0.016	0.0010	0.62	0.038
0.350	0.322	0.432	0.0010	0.018	0.0011	0.79	0.048
0.400	0.368	0.272	0.0008	0.022	0.0013	1.09	0.067
0.450	0.414	0.142	0.0006	0.032	0.0020	1.83	0.112

DISSIPATION COEFFICIENT= 0.001417

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00189 VCOMPNT= 0.00112

TABLE A22-15

DIFFUSER NON DIMENSIONAL LENGTH = 10.0

AXIAL DIST. FROM INLET(X) = 2.150 INS. N.D.DIST.(X/L)=-0.215

OUTER WALL BLUE POSITION

DELTA*= 0.099 INS. H= 1.50 REYNOLDS NO.(BASED ON THETA)= 4746.3

DIST RO-R	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.025	0.021	3.848	0.0038	0.005	0.0004	0.11	0.009
0.050	0.042	2.939	0.0039	0.007	0.0006	0.15	0.013
0.100	0.084	1.903	0.0032	0.008	0.0007	0.21	0.018
0.150	0.125	1.382	0.0026	0.009	0.0008	0.26	0.022
0.200	0.167	1.071	0.0021	0.010	0.0008	0.31	0.026
0.250	0.209	0.856	0.0017	0.010	0.0008	0.34	0.028
0.300	0.251	0.696	0.0012	0.009	0.0007	0.36	0.030
0.350	0.292	0.565	0.0009	0.008	0.0007	0.39	0.032
0.400	0.334	0.443	0.0008	0.009	0.0007	0.44	0.037
0.450	0.376	0.324	0.0006	0.009	0.0008	0.53	0.044
0.500	0.418	0.219	0.0004	0.009	0.0007	0.63	0.052
0.550	0.459	0.138	0.0003	0.009	0.0008	0.83	0.068
0.600	0.501	0.057	0.0000	0.002	0.0001	0.54	0.045

DISSIPATION COEFFICIENT= 0.001714

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00305 VCOMPNT= 0.00126

TABLE A22-16

DIFFUSER NON DIMENSIONAL LENGTH = 10.0

AXIAL DIST. FROM INLET(X) = 3.250 INS. N.D.DIST.(X/L)=-0.325

OUTER WALL BLUE POSITION

DELTA*= 0.114 INS. H= 1.57 REYNOLDS NO.(BASED ON THETA)= 4370.9

DIST RO-R	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.025	0.019	3.124	0.0040	0.006	0.0005	0.13	0.011
0.050	0.039	2.414	0.0044	0.008	0.0007	0.17	0.015
0.100	0.078	1.763	0.0038	0.010	0.0008	0.22	0.019
0.150	0.117	1.496	0.0032	0.009	0.0008	0.23	0.021
0.200	0.156	1.284	0.0026	0.009	0.0008	0.25	0.022
0.250	0.195	1.069	0.0020	0.008	0.0007	0.26	0.023
0.300	0.234	0.876	0.0015	0.007	0.0006	0.27	0.024
0.350	0.273	0.726	0.0011	0.007	0.0006	0.28	0.025
0.400	0.312	0.608	0.0009	0.006	0.0005	0.30	0.027
0.450	0.350	0.489	0.0006	0.006	0.0005	0.32	0.028
0.500	0.389	0.349	0.0004	0.005	0.0004	0.34	0.030
0.550	0.428	0.182	0.0001	0.003	0.0002	0.37	0.033

DISSIPATION COEFFICIENT= 0.001842

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00389 VCOMPNT= 0.00099

TABLE A22-17

DIFFUSER NON DIMENSIONAL LENGTH = 10.0

AXIAL DIST. FROM INLET(X) = 4.250 INS. N.D.DIST.(X/L)=-0.425

OUTER WALL BLUE POSITION

DELTA*= 0.133 INS. H= 1.62 REYNOLDS NO.(BASED ON THETA)= 4637.1

DIST RO-R	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.036	2.168	0.0050	0.009	0.0008	0.17	0.017
0.100	0.073	1.446	0.0059	0.015	0.0015	0.28	0.027
0.150	0.109	1.389	0.0058	0.016	0.0015	0.29	0.028
0.200	0.146	1.370	0.0052	0.014	0.0014	0.28	0.027
0.250	0.182	1.235	0.0043	0.013	0.0013	0.28	0.027
0.300	0.219	1.036	0.0033	0.012	0.0012	0.29	0.029
0.350	0.255	0.858	0.0025	0.011	0.0011	0.31	0.030
0.400	0.292	0.731	0.0020	0.010	0.0010	0.33	0.032
0.450	0.328	0.620	0.0016	0.010	0.0009	0.34	0.033
0.500	0.364	0.469	0.0011	0.009	0.0009	0.38	0.037
0.550	0.401	0.268	0.0007	0.009	0.0009	0.51	0.049
0.600	0.437	0.127	0.0004	0.011	0.0011	0.81	0.079

DISSIPATION COEFFICIENT= 0.002750

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00521 VCOMPNT= 0.00203

TABLE A22-18

DIFFUSER NON DIMENSIONAL LENGTH = 10.0

AXIAL DIST. FROM INLET(X) = 4.250 INS. N.D.DIST.(X/L)=-0.425

OUTER WALL GREEN POSITION

DELTA*= 0.133 INS. H= 1.62 REYNOLDS NO.(BASED ON THETA)= 4637.1

DIST RO-R	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.036	2.168	0.0057	0.010	0.0010	0.19	0.018
0.100	0.073	1.446	0.0070	0.018	0.0018	0.31	0.030
0.150	0.109	1.389	0.0073	0.020	0.0019	0.33	0.032
0.200	0.146	1.370	0.0066	0.018	0.0018	0.32	0.031
0.250	0.182	1.235	0.0053	0.016	0.0016	0.31	0.030
0.300	0.219	1.036	0.0039	0.014	0.0014	0.32	0.031
0.350	0.255	0.858	0.0028	0.012	0.0012	0.33	0.032
0.400	0.292	0.731	0.0021	0.011	0.0010	0.33	0.032
0.450	0.328	0.620	0.0013	0.008	0.0008	0.31	0.030
0.500	0.364	0.469	0.0009	0.007	0.0007	0.33	0.032
0.550	0.401	0.268	0.0005	0.007	0.0007	0.45	0.043

DISSIPATION COEFFICIENT= 0.003224

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00499 VCOMPNT= 0.00242

TABLE A22-19

DIFFUSER NON DIMENSIONAL LENGTH = 10.0

AXIAL DIST. FROM INLET(X) = 4.250 INS. N.D.DIST.(X/L)=-0.425

OUTER WALL RED POSITION

DELTA*= 0.133 INS. H= 1.62 REYNOLDS NO.(BASED ON THETA)= 4637.1

DIST RO-R	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.036	2.168	0.0066	0.012	0.0011	0.20	0.019
0.100	0.073	1.446	0.0072	0.019	0.0018	0.31	0.030
0.150	0.109	1.389	0.0068	0.019	0.0018	0.32	0.031
0.200	0.146	1.370	0.0060	0.017	0.0016	0.30	0.029
0.250	0.182	1.235	0.0049	0.015	0.0015	0.30	0.029
0.300	0.219	1.036	0.0038	0.014	0.0013	0.32	0.031
0.350	0.255	0.858	0.0029	0.013	0.0012	0.33	0.032
0.400	0.292	0.731	0.0022	0.011	0.0011	0.34	0.033
0.450	0.328	0.620	0.0016	0.010	0.0009	0.34	0.033
0.500	0.364	0.469	0.0010	0.008	0.0008	0.36	0.035
0.550	0.401	0.268	0.0006	0.009	0.0008	0.49	0.048
0.600	0.437	0.127	0.0002	0.006	0.0006	0.58	0.056

DISSIPATION COEFFICIENT= 0.003310

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00512 VCOMPNT= 0.00208

TABLE A22-20

DIFFUSER NON DIMENSIONAL LENGTH = 10.0

AXIAL DIST. FROM INLET(X) = 5.450 INS. N.D.DIST.(X/L)=-0.545

OUTER WALL BLUE POSITION

DELTA*= 0.173 INS. H= 1.69 REYNOLDS NO.(BASED ON THETA)= 5790.4

DIST RO-R	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.034	2.219	0.0043	0.006	0.0007	0.12	0.014
0.100	0.068	1.288	0.0059	0.013	0.0016	0.24	0.029
0.150	0.102	1.210	0.0067	0.016	0.0019	0.28	0.032
0.200	0.135	1.264	0.0067	0.015	0.0018	0.26	0.031
0.250	0.169	1.217	0.0059	0.014	0.0016	0.26	0.030
0.300	0.203	1.073	0.0047	0.013	0.0015	0.26	0.031
0.350	0.237	0.908	0.0037	0.012	0.0014	0.27	0.032
0.400	0.271	0.779	0.0029	0.011	0.0013	0.28	0.033
0.450	0.305	0.694	0.0023	0.010	0.0011	0.29	0.033
0.500	0.339	0.620	0.0018	0.008	0.0010	0.28	0.033
0.550	0.372	0.521	0.0013	0.007	0.0008	0.28	0.033
0.600	0.406	0.390	0.0010	0.007	0.0008	0.33	0.038
0.650	0.440	0.268	0.0006	0.006	0.0007	0.36	0.043

DISSIPATION COEFFICIENT= 0.003057

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00695 VCOMPNT= 0.00101

TABLE A22-21

DIFFUSER NON DIMENSIONAL LENGTH = 10.0

AXIAL DIST. FROM INLET(X) = 7.250 INS. N.D.DIST.(X/L)= 0.725

OUTER WALL BLUE POSITION

DELTA*= 0.218 INS. H= 1.77 REYNOLDS NO.(BASED ON THETA)= 6567.7

DIST RO-R	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.031	1.756	0.0071	0.009	0.0012	0.16	0.021
0.100	0.061	0.948	0.0085	0.021	0.0028	0.32	0.042
0.150	0.092	1.086	0.0088	0.019	0.0025	0.28	0.037
0.200	0.122	1.169	0.0088	0.017	0.0023	0.26	0.035
0.250	0.153	1.064	0.0083	0.018	0.0024	0.28	0.037
0.300	0.183	0.917	0.0075	0.019	0.0025	0.31	0.041
0.350	0.214	0.853	0.0065	0.018	0.0023	0.31	0.041
0.400	0.245	0.887	0.0055	0.014	0.0019	0.27	0.036
0.450	0.275	0.940	0.0047	0.011	0.0015	0.24	0.032
0.500	0.306	0.917	0.0040	0.010	0.0013	0.22	0.030
0.550	0.336	0.773	0.0033	0.010	0.0013	0.24	0.032
0.600	0.367	0.553	0.0024	0.010	0.0013	0.29	0.038
0.650	0.398	0.366	0.0015	0.010	0.0013	0.35	0.046
0.700	0.428	0.320	0.0009	0.007	0.0009	0.31	0.041
0.750	0.459	0.410	0.0008	0.004	0.0006	0.22	0.029
0.800	0.489	0.404	0.0001	0.000	0.0000	0.06	0.009

DISSIPATION COEFFICIENT= 0.004405

REYNOLDS NORMAL STRESS. UCOMPNT= 0.01057 VCOMPNT= 0.00324

TABLE A22-22

DIFFUSER NON DIMENSIONAL LENGTH = 10.0

AXIAL DIST. FROM INLET(X) = 9.850 INS. N.D.DIST.(X/L)=-0.985

OUTER WALL BLUE POSITION

DELTA*= 0.327 INS. H= 2.06 REYNOLDS NO.(BASED ON THETA)= 8286.3

DIST RO-R	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.027	1.242	0.0046	0.006	0.0010	0.12	0.021
0.100	0.054	0.869	0.0068	0.012	0.0021	0.20	0.036
0.150	0.081	0.749	0.0083	0.017	0.0030	0.26	0.046
0.200	0.107	0.747	0.0095	0.019	0.0034	0.28	0.050
0.250	0.134	0.789	0.0105	0.020	0.0036	0.28	0.049
0.300	0.161	0.836	0.0112	0.020	0.0036	0.27	0.048
0.350	0.188	0.874	0.0115	0.020	0.0035	0.26	0.047
0.400	0.215	0.901	0.0114	0.019	0.0034	0.26	0.045
0.450	0.242	0.919	0.0110	0.018	0.0032	0.25	0.043
0.500	0.269	0.930	0.0103	0.017	0.0030	0.24	0.042
0.550	0.295	0.932	0.0095	0.016	0.0027	0.23	0.040
0.600	0.322	0.921	0.0084	0.014	0.0025	0.22	0.038
0.650	0.349	0.893	0.0073	0.012	0.0022	0.21	0.036
0.700	0.376	0.840	0.0060	0.011	0.0019	0.20	0.035
0.750	0.403	0.761	0.0048	0.010	0.0017	0.20	0.035
0.800	0.430	0.654	0.0036	0.008	0.0015	0.20	0.035
0.850	0.456	0.524	0.0026	0.008	0.0014	0.21	0.037
0.900	0.483	0.376	0.0017	0.007	0.0012	0.24	0.042
0.950	0.510	0.211	0.0004	0.003	0.0005	0.20	0.03

DISSIPATION COEFFICIENT= 0.006033

REYNOLDS NORMAL STRESS. UCOMPNT= 0.01568 VCOMPNT= 0.00339

TABLE A22-23

DIFFUSER NON DIMENSIONAL LENGTH = 10.0

AXIAL DIST. FROM INLET(X) = 9.850 INS. N.D.DIST.(X/L)=-0.985

OUTER WALL GREEN POSITION

DELTA*= 0.327 INS. H= 2.06 REYNOLDS NO.(BASED ON THETA)= 8249.0

DIST RO-R	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.027	1.242	0.0030	0.004	0.0006	0.09	0.017
0.100	0.054	0.869	0.0051	0.009	0.0016	0.18	0.031
0.150	0.081	0.749	0.0068	0.014	0.0024	0.24	0.042
0.200	0.107	0.747	0.0082	0.017	0.0029	0.26	0.046
0.250	0.134	0.789	0.0093	0.018	0.0032	0.26	0.046
0.300	0.161	0.836	0.0100	0.018	0.0032	0.26	0.045
0.350	0.188	0.874	0.0105	0.018	0.0032	0.25	0.044
0.400	0.215	0.901	0.0105	0.018	0.0031	0.25	0.043
0.450	0.242	0.919	0.0101	0.017	0.0030	0.24	0.042
0.500	0.269	0.930	0.0093	0.015	0.0027	0.22	0.040
0.550	0.295	0.932	0.0082	0.014	0.0024	0.21	0.037
0.600	0.322	0.921	0.0070	0.012	0.0020	0.20	0.034
0.650	0.349	0.893	0.0057	0.010	0.0017	0.18	0.032
0.700	0.376	0.840	0.0045	0.008	0.0014	0.17	0.030
0.750	0.403	0.761	0.0035	0.007	0.0012	0.17	0.030
0.800	0.430	0.654	0.0026	0.006	0.0010	0.17	0.029
0.850	0.456	0.524	0.0015	0.004	0.0008	0.16	0.028

DISSIPATION COEFFICIENT= 0.005050

REYNOLDS NORMAL STRESS. UCOMPNT= 0.01520 VCOMPNT= 0.00190

TABLE A22-24

DIFFUSER NON DIMENSIONAL LENGTH = 1.0

AXIAL DIST. FROM INLET(X) = 9.850 INS. N.D.DIST.(X/L)=-9.850

OUTER WALL RED POSITION

DELTA*= 0.327 INS. H= 2.06 REYNOLDS NO.(BASED ON THETA)= 8249.0

DIST RO-R	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.027	1.242	0.0049	0.006	0.0011	0.12	0.021
0.100	0.054	0.869	0.0070	0.012	0.0022	0.21	0.037
0.150	0.081	0.749	0.0085	0.017	0.0030	0.27	0.047
0.200	0.107	0.747	0.0098	0.020	0.0035	0.29	0.050
0.250	0.134	0.789	0.0109	0.021	0.0037	0.29	0.050
0.300	0.161	0.836	0.0117	0.021	0.0038	0.28	0.049
0.350	0.188	0.874	0.0121	0.021	0.0037	0.27	0.048
0.400	0.215	0.901	0.0120	0.020	0.0036	0.26	0.046
0.450	0.242	0.919	0.0115	0.019	0.0034	0.25	0.044
0.500	0.269	0.930	0.0106	0.017	0.0030	0.24	0.042
0.550	0.295	0.932	0.0094	0.015	0.0027	0.22	0.039
0.600	0.322	0.921	0.0081	0.013	0.0023	0.21	0.037
0.650	0.349	0.893	0.0067	0.012	0.0020	0.20	0.035
0.700	0.376	0.840	0.0054	0.010	0.0017	0.19	0.033
0.750	0.403	0.761	0.0043	0.009	0.0015	0.19	0.033
0.800	0.430	0.654	0.0032	0.007	0.0013	0.19	0.033
0.850	0.456	0.524	0.0022	0.006	0.0011	0.19	0.033

DISSIPATION COEFFICIENT= 0.006072

REYNOLDS NORMAL STRESS. UCOMPNT= 0.01548 VCOMPNT= 0.00648

TABLE A22-25

DIFFUSER NON DIMENSIONAL LENGTH = 10.0

AXIAL DISTANCE FROM OUTLET= 3.75 INS. (1 HYDRAULIC DIAMETER)

INNER WALL BLUE POSITION

DELTA*= 0.233 INS. H= 1.55 REYNOLDS NO.(BASED ON THETA)= 6892.0

DIST R-RI	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.027	1.847	0.0034	0.004	0.0005	0.10	0.012
0.100	0.053	0.659	0.0053	0.017	0.0021	0.34	0.042
0.150	0.080	0.531	0.0068	0.027	0.0034	0.47	0.059
0.200	0.107	0.637	0.0078	0.026	0.0033	0.42	0.052
0.250	0.133	0.689	0.0086	0.027	0.0033	0.41	0.051
0.300	0.160	0.665	0.0092	0.030	0.0037	0.44	0.054
0.400	0.213	0.617	0.0101	0.035	0.0044	0.49	0.061
0.500	0.267	0.703	0.0097	0.030	0.0037	0.43	0.053
0.600	0.320	0.677	0.0081	0.026	0.0032	0.40	0.050
0.700	0.373	0.479	0.0060	0.027	0.0034	0.49	0.061
0.800	0.427	0.450	0.0031	0.015	0.0018	0.38	0.047
0.900	0.480	0.212	0.0001	0.001	0.0002	0.17	0.021

DISSIPATION COEFFICIENT= 0.004203

REYNOLDS NORMAL STRESS. UCOMPNT= 0.01141 VCOMPNT= 0.00819

TABLE A22-26

DIFFUSER NON DIMENSIONAL LENGTH = 10.0

AXIAL DISTANCE FROM OUTLET= 7.50 INS. (2 HYDRAULIC DIAMETERS)

INNER WALL GREEN POSITION

DELTA*= 0.198 INS. H= 1.43 REYNOLDS NO.(BASED ON THETA)= 5771.0

DIST R-RI	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.027	2.236	0.0037	0.004	0.0004	0.10	0.010
0.100	0.053	0.709	0.0042	0.015	0.0016	0.32	0.034
0.150	0.080	0.447	0.0050	0.028	0.0030	0.57	0.060
0.200	0.107	0.505	0.0060	0.030	0.0032	0.55	0.058
0.250	0.133	0.541	0.0067	0.031	0.0033	0.54	0.057
0.300	0.160	0.509	0.0070	0.035	0.0037	0.59	0.062
0.400	0.213	0.462	0.0074	0.040	0.0042	0.66	0.070
0.500	0.267	0.560	0.0072	0.032	0.0034	0.54	0.057
0.600	0.320	0.549	0.0056	0.026	0.0027	0.48	0.051
0.700	0.373	0.390	0.0021	0.013	0.0014	0.42	0.044

DISSIPATION COEFFICIENT= 0.002838

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00954 VCOMPNT= 0.00609

TABLE A22-27

DIFFUSER NON DIMENSIONAL LENGTH = 10.0

AXIAL DISTANCE FROM OUTLET= 11.25 INS. (3 HYDRAULIC DIAMETERS)

INNER WALL RED POSITION

DELTA*= 0.153 INS. H= 1.32 REYNOLDS NO.(BASED ON THETA)= 4656.5

DIST R-RI	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.027	2.297	0.0047	0.007	0.0005	0.14	0.011
0.100	0.053	0.498	0.0044	0.029	0.0024	0.62	0.050
0.150	0.080	0.352	0.0043	0.040	0.0033	0.87	0.071
0.200	0.107	0.525	0.0047	0.029	0.0024	0.60	0.049
0.250	0.133	0.568	0.0052	0.030	0.0025	0.59	0.048
0.300	0.160	0.460	0.0057	0.040	0.0033	0.76	0.062
0.400	0.213	0.265	0.0059	0.073	0.0059	1.34	0.110
0.500	0.267	0.216	0.0058	0.088	0.0072	1.63	0.133
0.600	0.320	0.167	0.0056	0.110	0.0089	2.07	0.169
0.700	0.373	0.119	0.0046	0.126	0.0103	2.63	0.215

DISSIPATION COEFFICIENT= 0.002762

REYNOLDS NORMAL STRESS. UCOMPNT= 0.00946 VCOMPNT= 0.00703

TABLE A22-28

DIFFUSER NON DIMENSIONAL LENGTH = 10.0

AXIAL DISTANCE FROM OUTLET= 3.75 INS. (1 HYDRAULIC DIAMETER)

OUTER WALL BLUE POSITION

DELTA*= 0.223 INS. H= 1.58 REYNOLDS NO.(BASED ON THETA)= 6478.4

DIST RO-R	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.027	2.056	0.0066	0.007	0.0008	0.12	0.015
0.100	0.053	0.767	0.0086	0.025	0.0030	0.38	0.045
0.150	0.080	0.468	0.0100	0.048	0.0057	0.68	0.081
0.200	0.107	0.510	0.0114	0.050	0.0060	0.66	0.079
0.250	0.133	0.591	0.0127	0.048	0.0057	0.61	0.072
0.300	0.160	0.615	0.0137	0.050	0.0060	0.60	0.072
0.350	0.187	0.593	0.0143	0.054	0.0064	0.64	0.076
0.400	0.213	0.567	0.0143	0.057	0.0067	0.67	0.080
0.500	0.267	0.611	0.0132	0.049	0.0058	0.60	0.071
0.600	0.320	0.691	0.0109	0.035	0.0042	0.48	0.057
0.700	0.373	0.593	0.0076	0.029	0.0034	0.47	0.055
0.800	0.427	0.418	0.0045	0.024	0.0029	0.51	0.060

DISSIPATION COEFFICIENT= 0.005994

REYNOLDS NORMAL STRESS. UCOMPNT= 0.01568 VCOMPNT= 0.00897

TABLE A22-29

DIFFUSER NON DIMENSIONAL LENGTH = 10.0

AXIAL DISTANCE FROM OUTLET= 7.50 INS. (2 HYDRAULIC DIAMETERS)

OUTER WALL GREEN POSITION

DELTA*= 0.155 INS. H= 1.40 REYNOLDS NO.(BASED ON THETA)= 4641.9

DIST RO-R	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.027	2.477	0.0047	0.006	0.0005	0.13	0.010
0.100	0.053	0.411	0.0052	0.041	0.0034	0.80	0.066
0.150	0.080	0.364	0.0056	0.050	0.0041	0.94	0.077
0.200	0.107	0.601	0.0061	0.033	0.0027	0.59	0.049
0.250	0.133	0.623	0.0066	0.034	0.0028	0.59	0.049
0.300	0.160	0.478	0.0072	0.048	0.0040	0.81	0.067
0.350	0.187	0.351	0.0079	0.073	0.0060	1.16	0.096
0.400	0.213	0.354	0.0089	0.081	0.0067	1.22	0.101
0.500	0.267	0.609	0.0118	0.062	0.0052	0.81	0.067
0.600	0.320	0.525	0.0144	0.089	0.0073	1.04	0.086
0.700	0.373	0.229	0.0149	0.211	0.0174	2.44	0.201
0.800	0.427	0.112	0.0133	0.384	0.0318	4.72	0.390

DISSIPATION COEFFICIENT= 0.004981

REYNOLDS NORMAL STRESS. UCOMPNT= 0.01257 VCOMPNT= 0.01317

TABLE A22-30

DIFFUSER NON DIMENSIONAL LENGTH = 10.0

AXIAL DISTANCE FROM OUTLET= 11.25 INS. (3 HYDRAULIC DIAMETERS)

OUTER WALL RED POSITION

DELTA*= 0.112 INS. H= 1.29 REYNOLDS NO.(BASED ON THETA)= 3492.4

DIST RO-R	DIST RO-RI	DU/UMAX DR	SHEAR STRESS	ED.VIS. U.DEL*	ED.VIS. U(RO-RI)	MIX L DEL*	MIX L (RO-RI)
0.050	0.027	1.918	0.0034	0.008	0.0005	0.19	0.011
0.100	0.053	0.832	0.0041	0.022	0.0013	0.49	0.029
0.150	0.080	0.565	0.0049	0.039	0.0023	0.78	0.047
0.200	0.107	0.497	0.0055	0.049	0.0029	0.94	0.056
0.250	0.133	0.437	0.0060	0.061	0.0036	1.12	0.067
0.300	0.160	0.370	0.0063	0.076	0.0046	1.36	0.081
0.350	0.187	0.329	0.0066	0.090	0.0054	1.56	0.093
0.400	0.213	0.328	0.0068	0.092	0.0055	1.58	0.095
0.500	0.267	0.374	0.0067	0.079	0.0047	1.38	0.082
0.600	0.320	0.332	0.0058	0.078	0.0047	1.45	0.086
0.700	0.373	0.256	0.0045	0.078	0.0047	1.65	0.099
0.800	0.427	0.101	0.0026	0.117	0.0070	3.22	0.192

DISSIPATION COEFFICIENT= 0.002233

REYNOLDS NORMAL STRESS. UCOMPNT= 0.01033 VCOMPNT= 0.00658

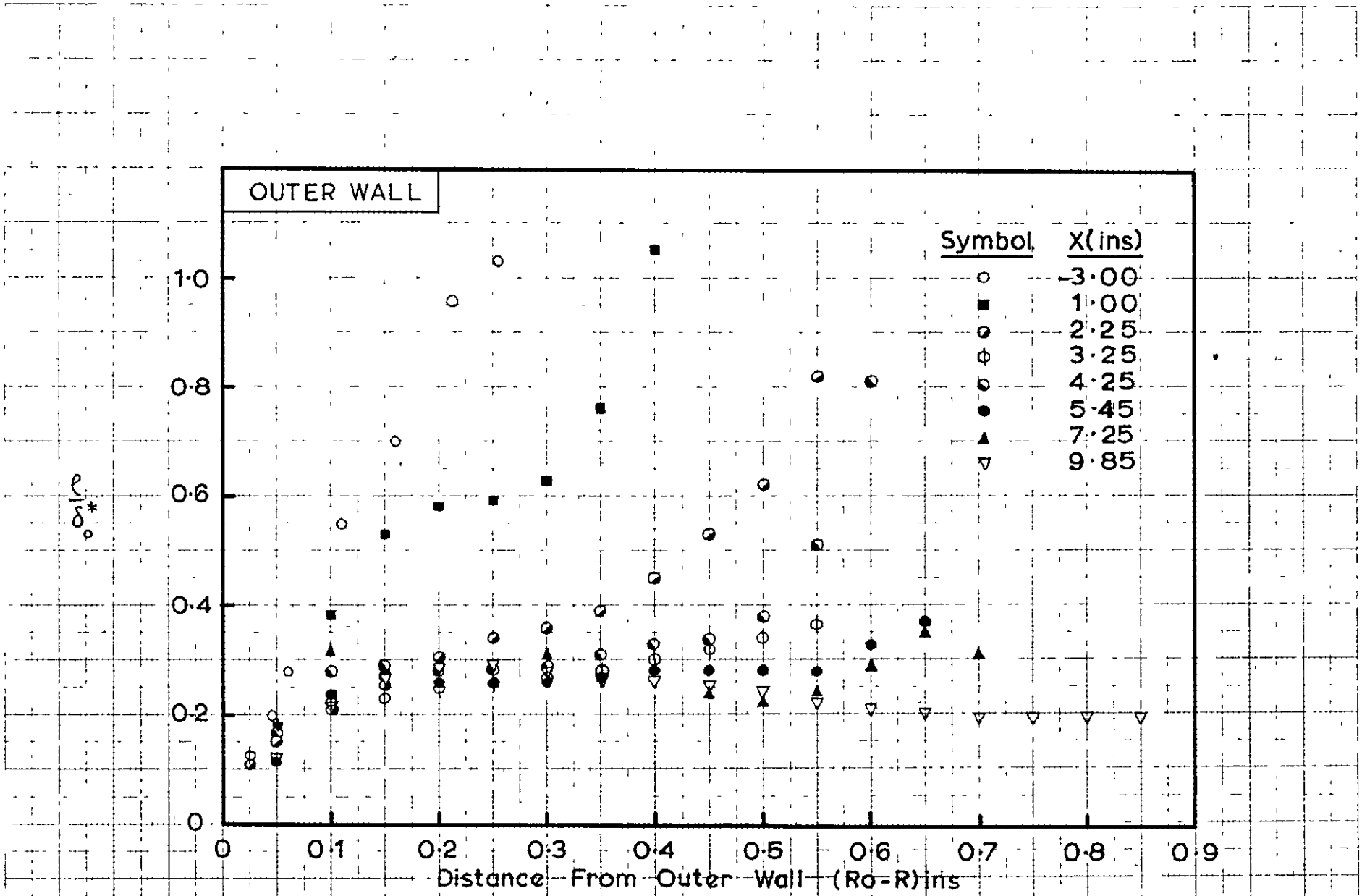

FIG. A 2 2-1 EXPERIMENTAL MIXING LENGTH DISTRIBUTIONS. L/ΔR=10 DIFFUSER.

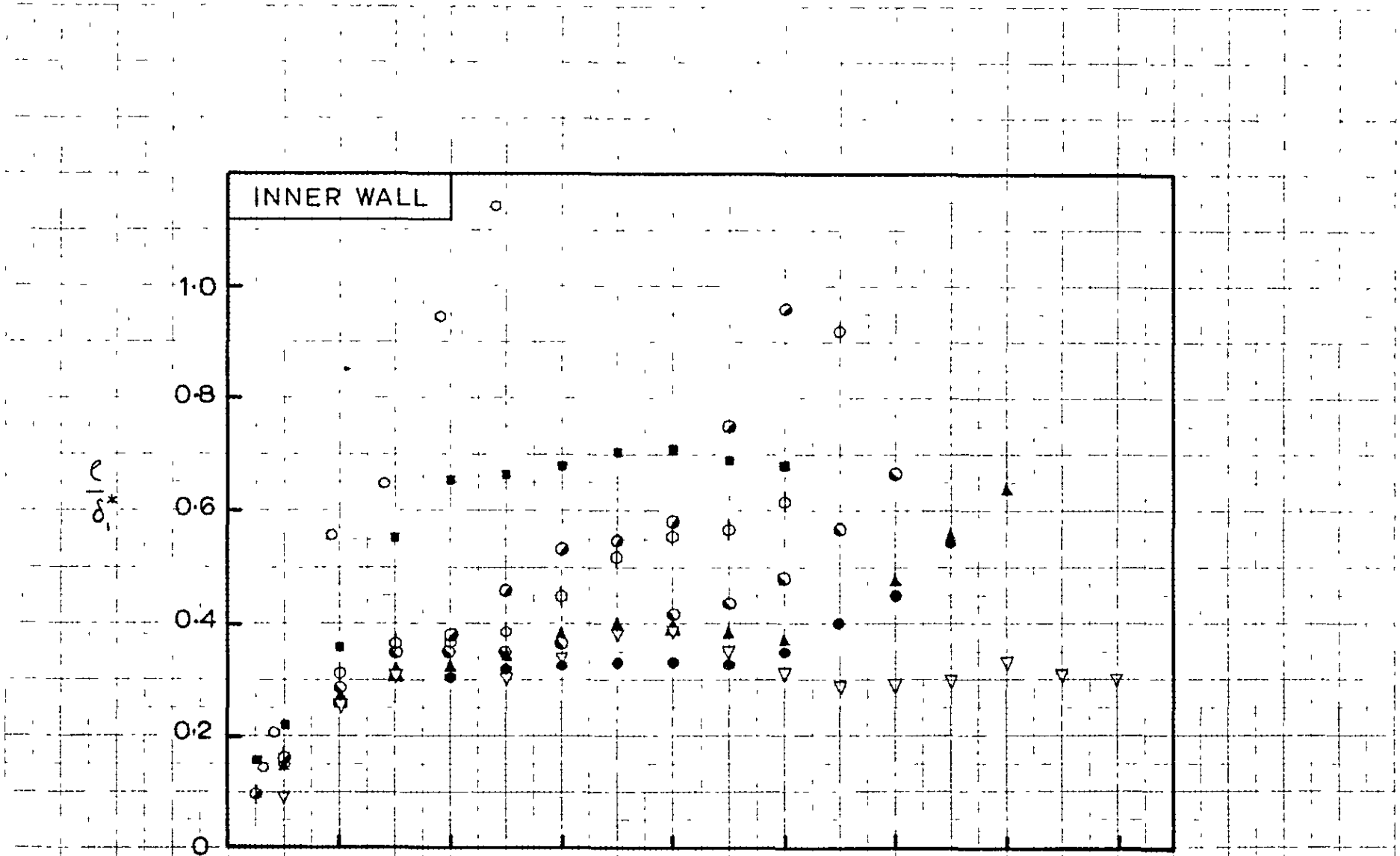

FIG. A 22-2 EXPERIMENTAL MIXING LENGTH DISTRIBUTIONS L/ΔR=10 DIFFUSER.

APPENDIX 23

INVESTIGATION OF MOMENTUM BALANCE IN THE OUTER AND INNER WALL BOUNDARY LAYERS

A23-1 Introduction

A calculation of the magnitude of the terms in the momentum equation, for the inner and outer wall boundary layers, was carried out for all three diffusers. In this calculation the experimental values of wall shear stress, shape parameter, pressure gradient, Reynolds normal stresses, etc. were used to calculate the terms on the right-hand-side of the equation. The calculated value of $\frac{d\theta}{dx}$ was then compared with the values of obtained from a plot of the experimental values of momentum thickness. Apart from indicating the relative significance of the various terms, this approach also gives a guide to the overall accuracy of the experiment. A similar technique has been adopted by Coles and Hirst[44], and Goldberg[29].

A sample calculation is given in Section A23-2 to indicate the method of analysis employed. The calculations are summarised in Tables A23-1 to A23-6, and the results are shown in Figures A23-1 to A23-4, and 4-12-2/3. In Figures A23-5/6, and 4-12-4, the values of momentum thickness obtained from the right-hand-side of the momentum equation are compared with the experimental values.

A23-2 Sample Calculation

Diffuser $L/\Delta R_1 = 5.0$, X = 1.95 ins. Outer Wall Boundary Layer.

The outer wall momentum equation is:-

$$\frac{d\theta_o}{dx} = \frac{C_{fo}}{2} - \frac{\theta_o}{R_o}\frac{dR_o}{dx} - \frac{\theta_o}{U}\frac{dU}{dx}(H_o+2) + \frac{R_o^2 - R_m^2}{R_o}\frac{1}{2\rho U^2}\left(\frac{dP_T}{dx}\right)_m + \frac{1}{U^2}\frac{d}{dx}\int_{R_m}^{R_o}(\overline{u'}^2 + \overline{v}_m^2 - \overline{v'}^2)\frac{R}{R_o}\,dR$$

A23-1

(i) Outer Wall Surface Friction Coefficient (Cfo)

From the Law of the Wall Plot (Fig.4-11-2) $C_{f_o} \simeq 0.00070$

$$\frac{C_{f_o}}{2} = 0.00035$$

(ii) Influence of Transverse Curvature $\frac{\theta_o}{R_o}\frac{dR_o}{dx}$

From Table A4-5 $\theta_o = 0.083$ ins., however from Fig. 4-7-10 a value of 0.085 is obtained.

$R_o = 6.34$ ins & $\frac{dR_o}{dx} = 0.1763$

$$\therefore \frac{\theta_o}{R_o}\frac{dR_o}{dx} = 0.00236$$

(iii) Pressure Gradient $\frac{\theta_o}{U}\frac{dU}{dx}(H_o+2)$

From Table A4-5 $H_o = 1.91$, a value of 1.88 is obtained from Fig. 4-7-10.

The term $\frac{1}{U}\frac{dU}{dx}$ can be calculated in two ways, firstly from the continuity equation to find $\overline{u}$, and from the boundary layer data $(\frac{\overline{u}}{U})$ to obtain U. The variation of U with 'x' is then plotted and $(\frac{dU}{dx})$ obtained graphically. However, this approach was found to be inaccurate due to the relatively low value of $(\frac{dU}{dx})$, particularly as $\frac{x}{L} \rightarrow 1.0$. The following technique was therefore adopted.

Writing Bernoulli's Equation at the point of Maximum Velocity

$$P_{T_m} = P_m + \frac{1}{2}\rho U^2$$

$$\therefore \left(\frac{dP_T}{dx}\right)_m = \left(\frac{dP}{dx}\right)_m + \rho U\frac{dU}{dx}$$

and $$\frac{2}{\rho U^2}\left(\frac{dP_T}{dx}\right)_m = \frac{2}{\rho U^2}\left(\frac{dP}{dx}\right) + \frac{2}{U}\frac{dU}{dx}$$

A23-2

Estimating the gradient from Fig. A10-5 at X = 1.95 we obtain

$$\frac{dP}{dx}\left(\frac{2}{\rho\bar{u}_1^2}\right) = 0.11 \quad \& \quad \frac{A_x}{A_1} = 1.385$$

and from continuity $\left(\frac{\bar{u}_1}{\bar{u}_x}\right)^2 = 1.385^2$.

hence $$\frac{dP}{dx}\left(\frac{2}{\rho\bar{u}_x^2}\right) = 0.11 \times 1.385^2 = 0.211$$

From Table A4-5 $\left(\frac{\bar{u}}{U}\right)_x = 0.791$, $\therefore$ $\frac{dP}{dx}\left(\frac{2}{\rho U^2}\right) = 0.211 \times 0.791^2 = 0.132$

From Fig.A10-4 $$\frac{2}{\rho\bar{u}_1^2}\left(\frac{dP_T}{dx}\right)_m = -0.008$$

and proceeding as above

$$\left(\frac{dP_T}{dx}\right)_m \frac{2}{\rho U^2} = -0.008 \times 1.385^2 \times 0.791^2 = -0.0096$$

$$\therefore \frac{2}{U}\frac{dU}{dx} = -0.0096 - 0.132 = -0.1416$$

$$\therefore \frac{1}{U}\frac{dU}{dx} = -0.0708$$

$$\therefore \frac{\theta_o}{U}\frac{dU}{dx}(H_o+2) = 0.085 \times (-0.0708) \times 3.88 = -0.0234$$

(iv) Total Pressure Loss Term $\frac{R_o^2 - R_m^2}{R_o}\frac{1}{2\rho U^2}\left(\frac{dP_T}{dx}\right)_m$

From section (iii) $$\frac{2}{\rho U^2}\left(\frac{dP_T}{dx}\right)_m = -0.0096$$

$$\therefore \frac{1}{2\rho U^2}\left(\frac{dP_T}{dx}\right)_m = -0.0024$$

From Fig. A3-15, Ro - Rm = 0.67 ins. $\therefore$ Rm = 6.34 - 0.67 = 5.67 ins.

$$\frac{R_o^2 - R_m^2}{R_o}\frac{1}{2\rho U^2}\left(\frac{dP_T}{dx}\right)_m = \frac{6.34^2 - 5.67^2}{6.34} \times (-0.0024) = -0.00304$$

(v) Reynolds Normal Stresses $\frac{1}{U^2}\frac{d}{dx}\int_{R_m}^{R_o}(\bar{u}'^2 + \bar{v}_m'^2 - \bar{v}'^2)\frac{R}{R_o}dR$

$$\frac{1}{U^2}\frac{d}{dx}\int(\bar{u}'^2 + \bar{v}_m'^2 - \bar{v}'^2)dR = 0.0025$$

within experimental error $\frac{1}{U^2}\frac{d}{dx}\int_{R_m}^{R_o}(\bar{u}'^2 + \bar{v}_m'^2 - \bar{v}'^2)\frac{R}{R_o}dR = \frac{1}{U^2}\frac{d}{dx}\int_{R_m}^{R_o}(\bar{u}'^2 - \bar{v}'^2)dR$ *

Adding terms $$\frac{d\theta_o}{dx} = 0.00035 - 0.00236 - (-0.0234) + (-0.00304) + 0.0025$$

$$\therefore \frac{d\theta_o}{dx} = 0.02085$$

compared with an experimental value of $\frac{d\theta_o}{dx} = 0.022$

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* In view of the large radius ratio (R_1/R_o), see Appendix 25, the two-dimensional version has been used.

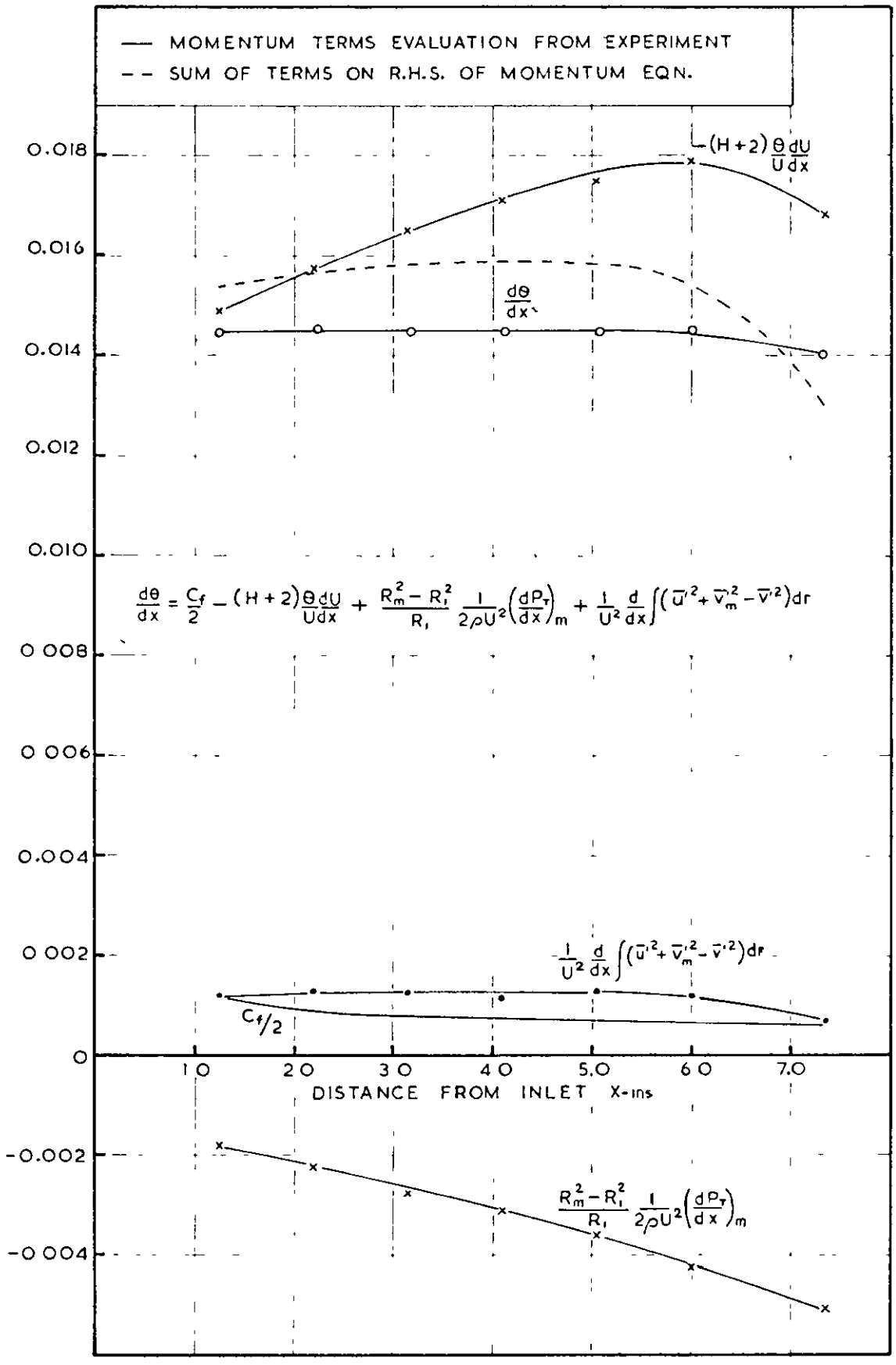


FIG.A23-1 MOMENTUM BALANCE FOR THE INNER WALL BOUNDARY LAYER $L/\Delta R_i$=7.5 DIFFUSER

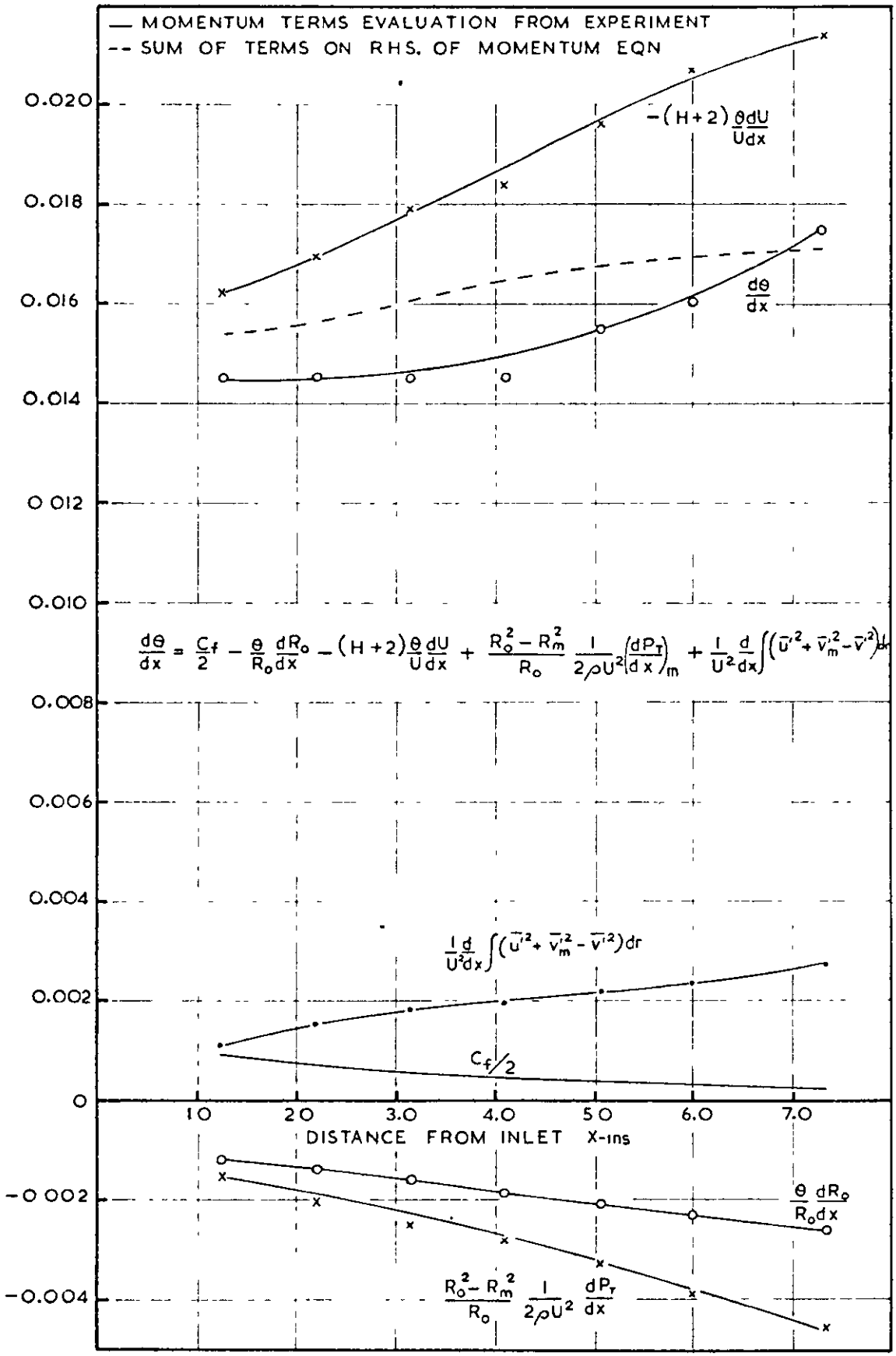


FIG. A23-2 MOMENTUM BALANCE FOR THE OUTER WALL BOUNDARY LAYER $L/\Delta R_i = 7.5$ DIFFUSER

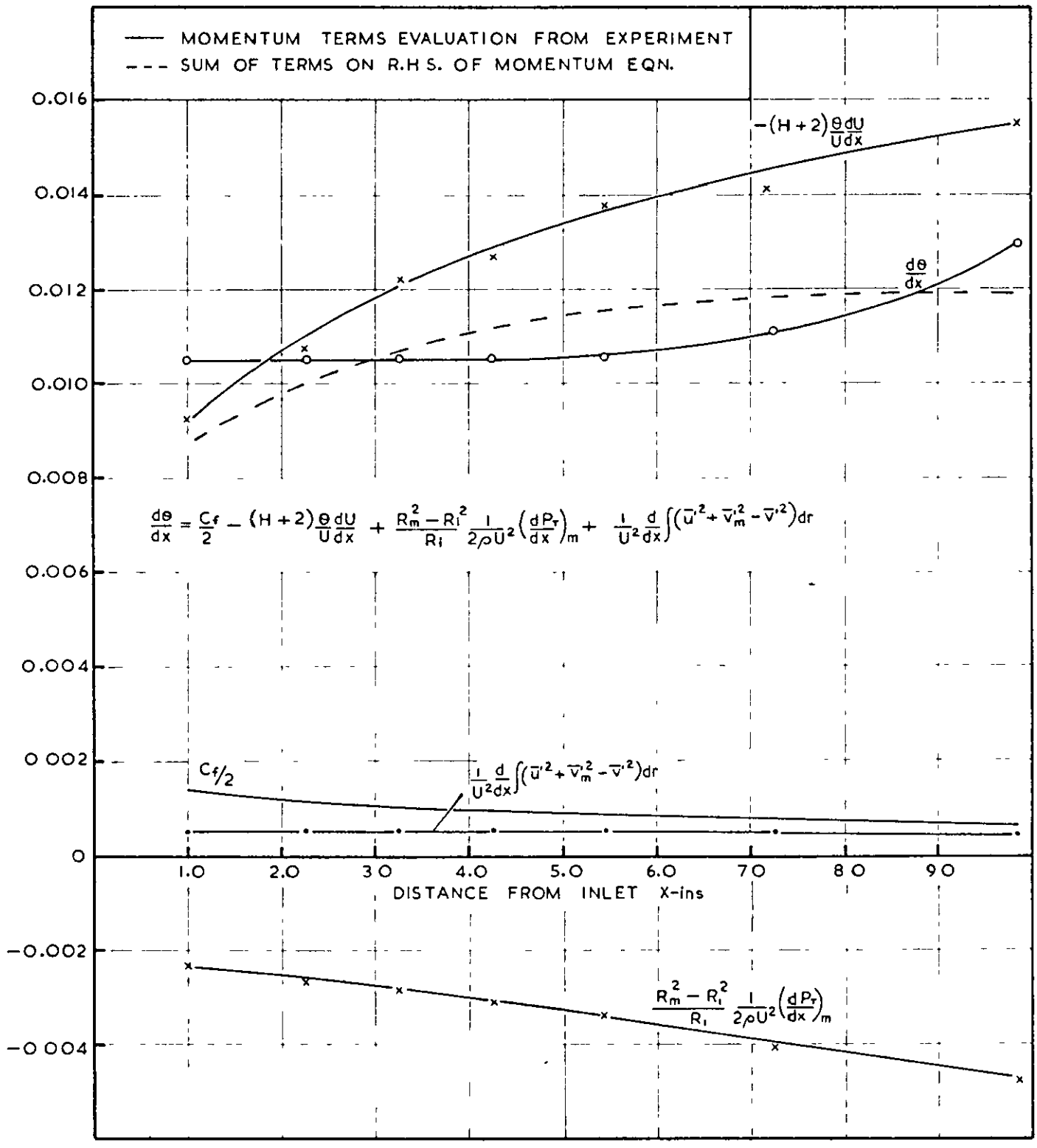


FIG. A23-3 MOMENTUM BALANCE FOR THE INNER WALL BOUNDARY LAYER $L/\Delta R_i = 10.0$ DIFFUSER

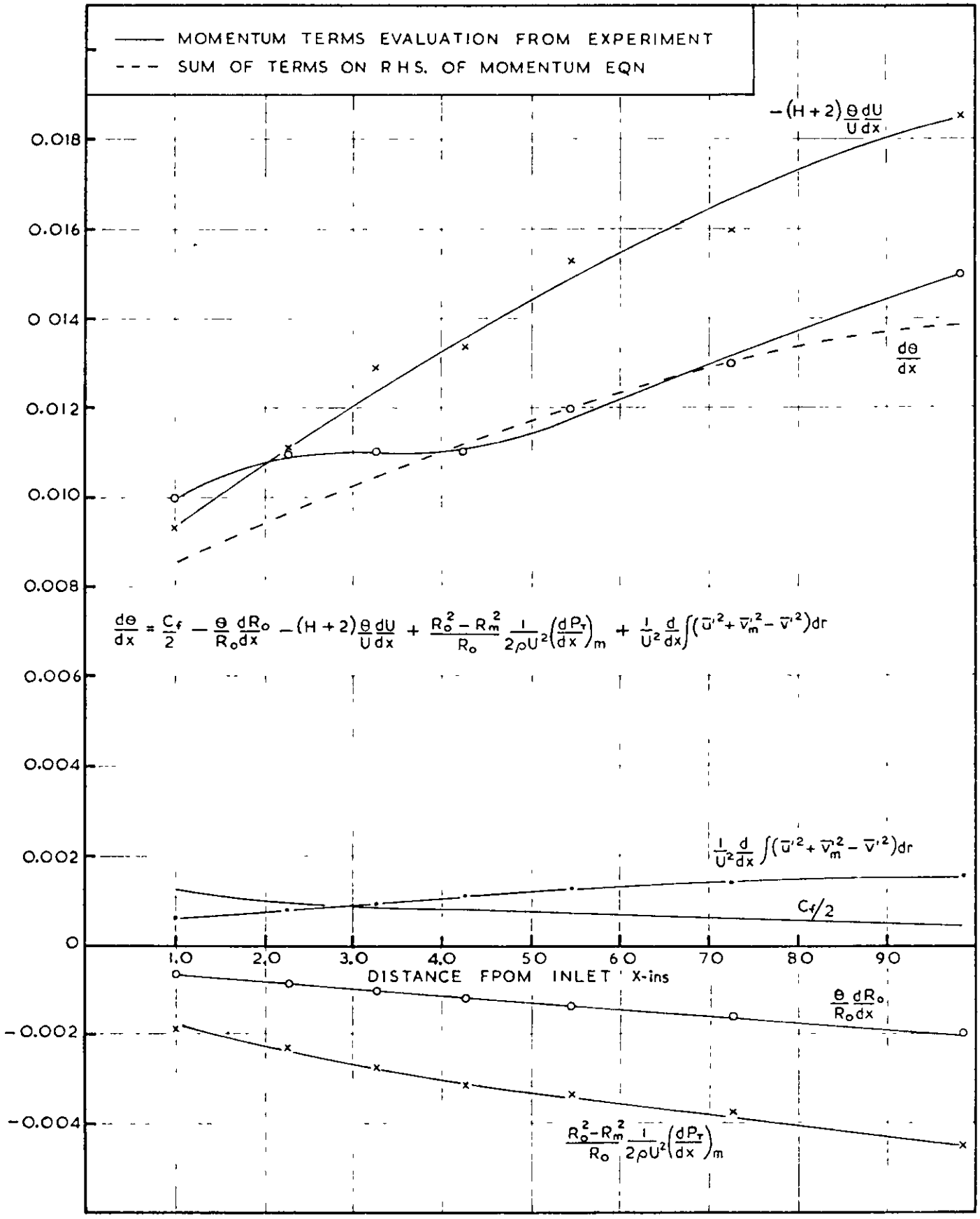


FIG.A23-4 MOMENTUM BALANCE FOR THE OUTER WALL BOUNDARY LAYER $L/\Delta R_1$=10.0 DIFFUSER

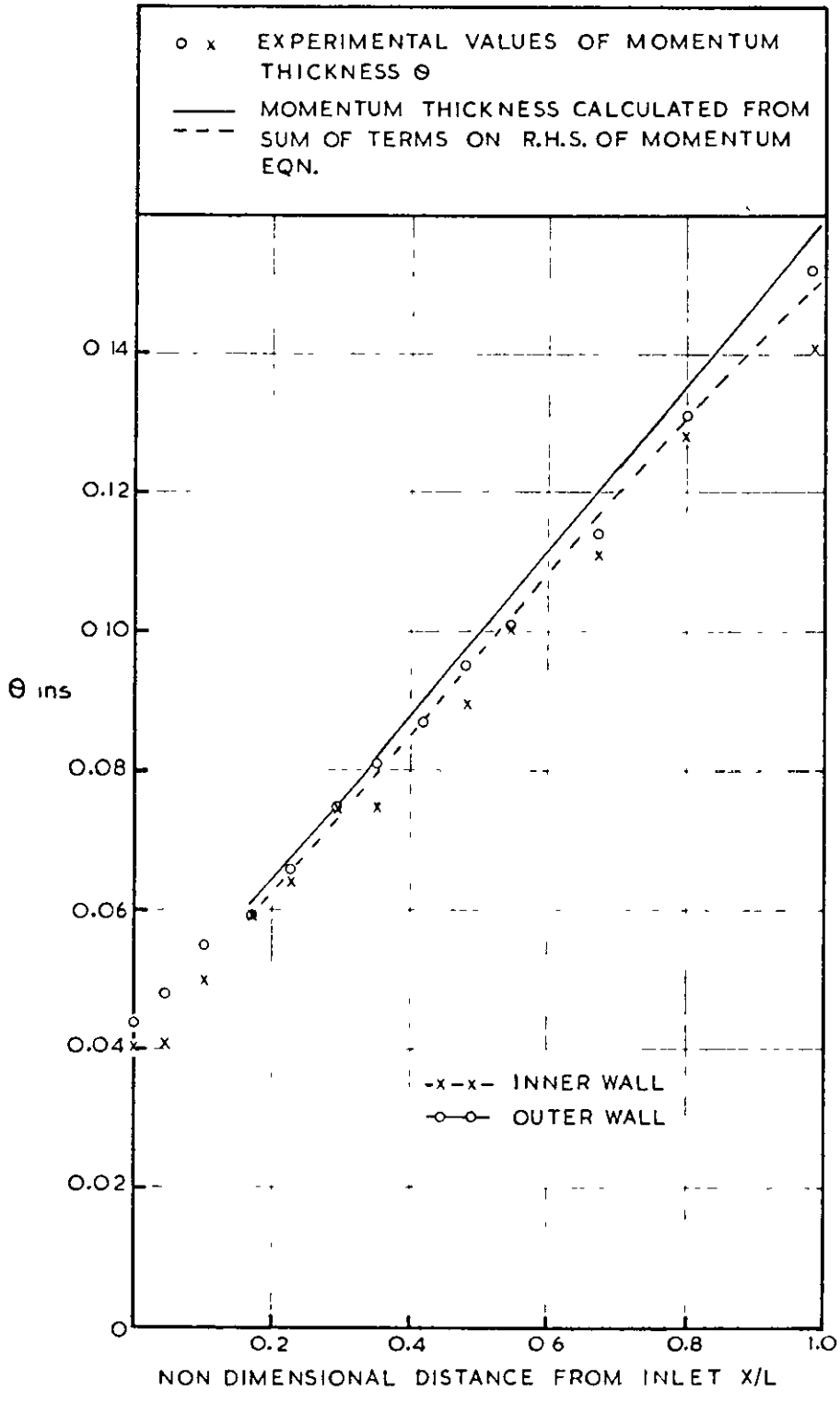


FIG. A23-5 COMPARISON OF MOMENTUM THICKNESS CALCULATIONS WITH DATA $L/\Delta R_1 = 7.5$ DIFFUSER

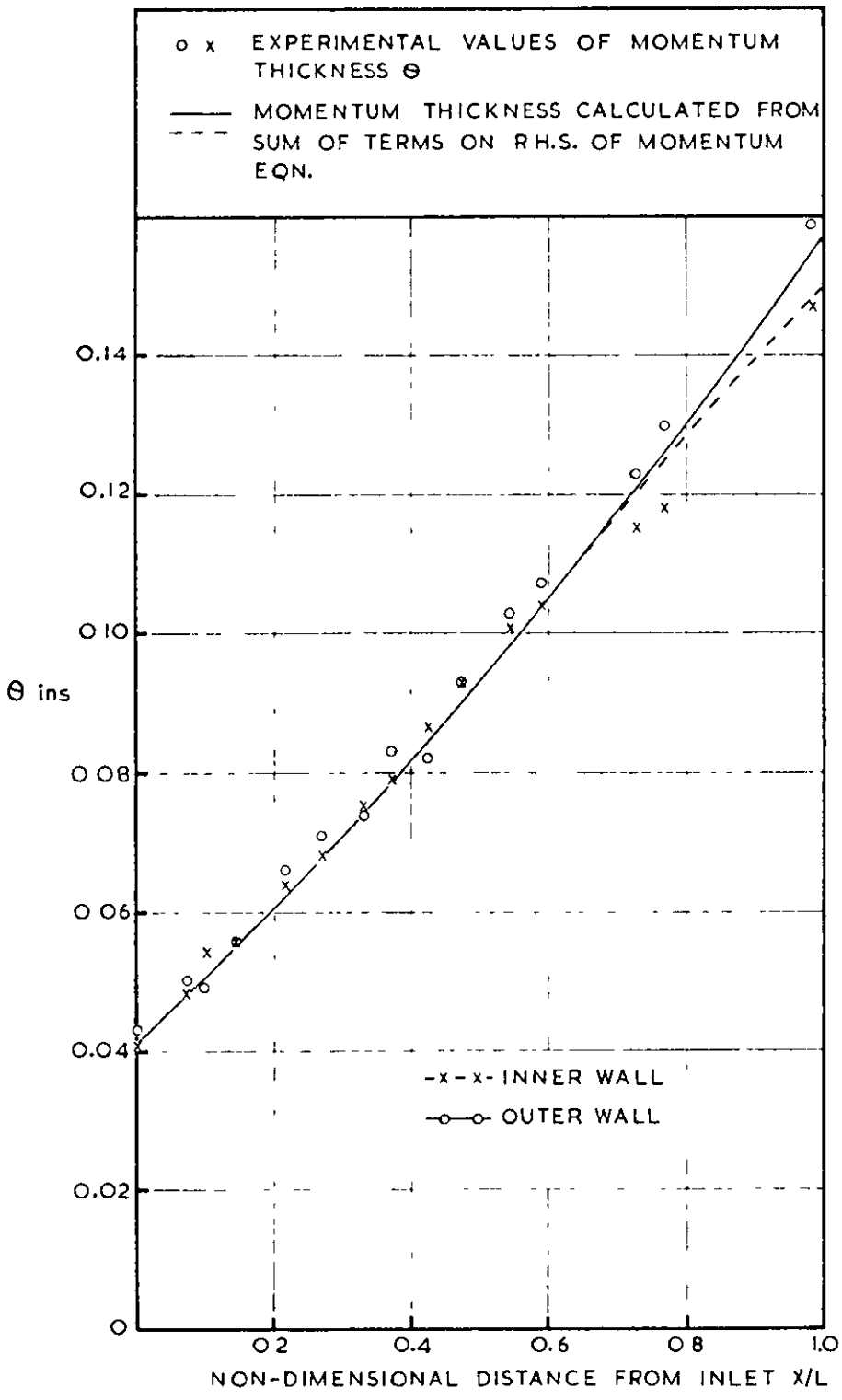


FIG.A23-6 COMPARISON OF MOMENTUM THICKNESS CALCULATIONS WITH DATA $L/\Delta R_i = 10$ DIFFUSER

TERMS IN MOMENTUM INTEGRAL EQUATIONS

$L/\Delta R_i = 5.0$ DIFFUSER — INNER WALL

TABLE A23-I

X ins	0.30	0.75	1.35	1.95	2.55	3.15	3.75	4.28	4.85
C_f	0.0031	0.0025	0.002	0.0018	0.0015	0.0014	0.0014	0.0014	0.0014
$C_f/2$	0.00155	0.00125	0.001	0.0009	0.00075	0.0007	0.0007	0.0007	0.0007
θ_i ins	0.044	0.054	0.060	0.077	0.086	0.095	0.103	0.109	0.114
$-\frac{1}{U}\frac{dU}{dx}$	0.1617	0.1344	0.0972	0.0709	0.054	0.0454	0.0382	0.0331	0.0309
H_i (From graph)	1.32	1.38	1.45	1.505	1.57	1.61	1.65	1.67	1.69
$-(H+2)\frac{\theta}{U}\frac{dU}{dx}$	0.0236	0.0245	0.0222	0.0192	0.0166	0.0156	0.0143	0.0133	0.0130
R_m (Est^m)	5.52	5.53	5.62	5.67	5.69	5.73	5.76	5.81	5.67
R_i ins	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
$R_m^2 - R_i^2$	5.45	5.5	6.8	7.1	7.3	7.9	8.2	8.8	7.1
$R_m^2 - R_i^2 / R_i$	1.09	1.10	1.36	1.42	1.46	1.58	1.64	1.76	1.42
$-\left(\frac{dP_T}{dx}\right)_m \frac{1}{2\rho U^2}$	0.0021	0.0022	0.0023	0.0024	0.0025	0.0026	0.0026	0.0025	0.0024
$\frac{1}{U^2}\int\left(\overline{u'^2}+\overline{v'^2}_m-\overline{v'^2}\right)dr$	0.00096	0.00157	0.00254	0.0038	0.0044	0.0051	0.0058	/	0.0071
$\frac{1}{U^2}\frac{d}{dx}\int\left(\overline{u'^2}+\overline{v'^2}_m-\overline{v'^2}\right)dr$	0.0011	0.0014	0.0017	0.0013	0.0011	0.0009	0.0009	0.0009	0.0009
$\frac{d\theta_i}{dx}$ PREDICTED	0.0234	0.0248	0.0218	0.0180	0.0148	0.0131	0.0116	0.0105	0.0112
$\frac{d\theta_i}{dx}$ MEASURED	0.0195	0.0225	0.0195	0.0170	0.0150	0.0135	0.0125	0.0115	0.0110
$-\frac{R_m^2-R_i^2}{R_i}\frac{1}{2\rho U^2}\left(\frac{dP_T}{dx}\right)_m$	0.0029	0.0024	0.0031	0.0034	0.0037	0.0041	0.0043	0.0044	0.0034

L/ΔR$_i$=5 O DIFFUSER — OUTER WALL

TABLE A23-2

X ins	0 30	0 75	1·35	1 95	2·55	3 15	3 75	4·28	4·85
C_f	0.0031	0.0021	0.0012	0.00075	0.0005	0.0003	0.00018	0.0001	0.00003
$C_f/2$	0.00155	0.00105	0.0006	0.00038	0.00025	0.00015	0.00009	0.00005	0.000015
θ_o ins	0 046	0.057	0 072	0.085	0 099	0.111	0.122	0.13	0.138
R_o ins	6.05	6.13	6.24	6.34	6.45	6.56	6.66	6 76	6.85
$\frac{\theta}{R}\frac{dR}{dx}$	0.00134	0.00164	0.00203	0.00236	0.0027	0.00298	0.00323	0.0034	0.00355
A_x/A_1	1.057	1.148	1.263	1.385	1.51	1.63	1.76	1.87	1.99
$\frac{dP}{dx}\frac{2}{\rho\bar{u}_1^2}$	0.36	0.27	0.17	0.11	0.075	0 058	0 045	0.038	0.035
$(\bar{u}/U)$	0 885	0 856	0.825	0.791	0.756	0.723	0.687	0.650	0.612
$\frac{dP}{dx}\left(\frac{2}{\rho U^2}\right)$	0.315	0.260	0.185	0.132	0.098	0.0805	0.066	0 056	0.052
$-\frac{dP_T}{dx}\left(\frac{2}{\rho U^2}\right)$	0.0084	0.0088	0 0093	0.0096	0.010	0.0103	0.0104	0 0102	0.0098
$-\frac{2}{U}\frac{dU}{dx}$	0.3234	0.2688	0.1943	0.1416	0.108	0 0908	0.0764	0.0662	0.0618
$-\frac{1}{U}\frac{dU}{dx}$	0.1617	0.1344	0 0972	0.0709	0.054	0.0454	0.0382	0.0331	0.0309
H_o (From graph)	1 39	1.50	1.69	1.88	2.12	2.38	2.68	3.10	3.50
$-(H+2)\frac{\theta}{U}\frac{dU}{dx}$	0.0252	0 0268	0.0258	0.0234	0.022	0.0221	0.0218	0 0219	0.0232
$-\left(\frac{dP_T}{dx}\right)_m\frac{2}{\rho\bar{u}_1^2}$	0.0096	0.0092	0 0086	0.008	0 0077	0.0074	0.0071	0 0069	0.0066
$\left(\frac{dP_T}{dx}\right)_m\frac{2}{\rho U^2}$	0 0084	0.0088	0.0093	0 0096	0 010	0 0103	0.0104	0 0102	0.0098
R_o ins	6.05	6.13	6.24	6.34	6 45	6.56	6 66	6.76	6.85
R_m (Est^m)	5.52	5.53	5.62	5.67	5.69	5.73	5.76	5.81	5.67
$R_o^2-R_m^2$	6 10	7.0	7.3	8.1	9.3	10.1	11.2	11.9	14.9
$R_o^2-R_m^2/R_o$	1.01	1.14	1.17	1 28	1.44	1.54	1.68	1.76	2.18
$-\left(\frac{dP_T}{dx}\right)_m\frac{1}{2\rho U^2}$	0 0021	0.0022	0.0023	0.0024	0 0025	0.0026	0 0026	0 0025	0 0024
$-\frac{R_o^2-R_m^2}{R_o}\left(\frac{dP_T}{dx}\right)_m\frac{1}{2\rho U^2}$	0.0021	0.0025	0.0027	0.0030	0.0036	0 004	0.0044	0.0044	0.0052
$\frac{1}{U^2}\int(\bar{u}'^2+\bar{v}_m'^2-\bar{v}'^2)dr$	0.0017	0 0023	0 0037	0.0054	0 0073	0.0089	0.0108	0.013	0.0156
$\frac{1}{U^2}\frac{d}{dx}\int(\bar{u}'^2+\bar{v}_m'^2-\bar{v}'^2)dr$	0.0008	0 0008	0.002	0.0025	0.0028	0.003	0.003	0.0035	0 004
$\left(\frac{d\theta}{dx}\right)$ PREDICTED BY LHS	0.0241	0 0245	0.0237	0.0208	0 0188	0.0183	0.0173	0.0177	0 0184
$\left(\frac{d\theta}{dx}\right)_{MEASURED}$	0.022	0.0225	0 023	0 022	0.0195	0.018	0.0166	0.016	0.016

$L/\Delta R_i = 7.5$ DIFFUSER — INNER WALL

TABLE A 23-3

X ins	1.25	2.20	3.15	4.10	5.05	6 00	7.35
C_f	0.0023	0.00185	0 0016	0 0015	0.00135	0.00133	0.0013
$C_{f/2}$	0 00115	0 00093	0 0008	0 00075	0.00068	0.00067	0.00065
θ_i ins	0 058	0.0715	0 085	0 0985	0.1120	0.1250	0.143
$-\frac{1}{U}\frac{dU}{dx}$	0 0759	0.0628	0.0547	0 0481	0.0427	0.0387	0 0316
H_i (From graph)	1.39	1.485	1.565	1.627	1.67	1.695	1.715
$-(H+2)\frac{\theta}{U}\frac{dU}{dx}$	0 0149	0.0156	0.0165	0 0171	0 0175	0.0179	0.0168
R_m (Est^m)	5.566	5. 624	5.677	5.723	5.769	5.820	5 896
R_i ins	5.0	5.0	5.0	5.0	5.0	5.0	5.0
$R_m^2 - R_i^2$	6 0	6 6	7.2	7 8	8.3	8.9	9.7
$R_m^2 - R_i^2/R_i$	1.2	1.32	1.45	1.56	1.66	1.78	1.94
$-\left(\frac{dP_T}{dx}\right)_m \frac{1}{2\rho U^2}$	0.0015	0 0017	0 0019	0 0020	0 0022	0.0024	0 0026
$-\frac{R_m^2 - R_i^2}{R_i}\frac{1}{2\rho U^2}\left(\frac{dP_T}{dx}\right)_m$	0 0018	0.0022	0 0028	0 0031	0.0037	0.0043	0.0051
$\frac{1}{U^2}\int(\overline{u'^2}+\overline{v'^2}_m-\overline{v'^2})dr$	0 00253	0.00366	0.00512	0 00643	0.00798	0.00973	0 01099
$\frac{1}{U^2}\frac{d}{dx}\int(\overline{u'^2}+\overline{v'^2}_m-\overline{v'^2})dr$	c.0012	0 0013	0.0012	0 0012	0.0012	0.0012	0.0007
$\frac{d\theta_i}{dx}$ PREDICTED	0 01545	0 0156	0.01575	0 01585	0.01583	0.0155	0.01305
$\frac{d\theta_i}{dx}$ MEASURED	0.0145	0 0145	0.0145	0 0145	0 0145	0.0145	0.014

L/ΔR₁=7.5 DIFFUSER — OUTER WALL

TABLE A23-4

X ins	1.25	2.2	3.15	4.10	5.05	6.0	7.35
C_f	0.00184	0.00144	0.00118	0.00095	0.00078	0.00062	0.0004
$C_{f/2}$	0.00092	0.00072	0.00059	0 00048	0 00039	0 00031	0 0002
θ_o ins	0.0615	0 075	0.088	0.102	0.115	0.130	0.155
R_o ins	6.146	6.257	6.367	6.478	6 589	6.7	6.857
$\frac{\theta}{R}\frac{dR}{dx}$	0 00117	0.0014	0 00161	0 00184	0 00204	0 00226	0 00264
A_x/A_1	1.162	1.285	1.413	1.542	1.674	1.81	1.98
$\frac{dP}{dx}\frac{2}{\rho\bar{u}_1^2}$	0.15	0.108	0.082	0.064	0.05	0.042	0 03
$(\bar{u}/U)$	0.85	0 818	0.79	0.758	0.739	0.702	0.669
$\frac{dP}{dx}\left(\frac{2}{\rho U^2}\right)$	0.146	0.119	0.102	0.088	0 0765	0.0677	0.053
$-\left(\frac{dP_T}{dx}\right)_m\left(\frac{2}{\rho U^2}\right)$	0.0058	0.0066	0.0075	0 0082	0.009	0.0097	0.0103
$-\frac{2}{U}\frac{dU}{dx}$	0.1518	0.1256	0.1095	0.0962	0.0855	0.0774	0.0633
$-\frac{1}{U}\frac{dU}{dx}$	0.0759	0.0628	0.0547	0.0481	0 0427	0 0387	0.0316
H_o(From graph)	1.5	1 61	1.73	1.86	2 0	2.14	2 35
$-(H+2)\frac{\theta}{U}\frac{dU}{dx}$	0 01618	0 0169	0 018	0.0184	0.0196	0 0207	0 0214
R_o	6.146	6.257	6.367	6.478	6.589	6.70	6 856
R_m (Est^m)	5.566	5.624	5.677	5.723	5.769	5.82	5.896
$R_o^2 - R_m^2$	6.70	7.60	8.30	9.20	10 00	11 00	12.10
$R_o^2-R_m^2/R_o$	1.09	1.215	1.304	1.420	1.520	1.640	1.765
$-\left(\frac{dP_T}{dx}\right)_m\frac{1}{2\rho U^2}$	0.0015	0.0017	0 0019	0.002	0 0022	0.0024	0 0026
$-\frac{R_o^2-R_m^2}{R_o}\left(\frac{dP_T}{dx}\right)_m\frac{1}{2\rho U^2}$	0.00163	0 00207	0 00248	0 00284	0.00334	0 00394	0 0046
$\frac{1}{U^2}\int(\bar{u'^2}+\bar{v}_m^2-\bar{v'^2})\,dr$	0.0025	0 0038	0.0055	0.0074	0.0099	0.0124	0.0165
$\frac{1}{U^2}\frac{d}{dx}\int(\bar{u'^2}+\bar{v}_m^2-\bar{v'^2})dr$	0.0011	0.0015	0 0018	0.0019	0.0022	0 0023	0.0027
$\frac{d\theta_o}{dx}$ PREDICTED	0.0154	0.0156	0.01625	0.0161	0 0168	0.0171	0.0171
$\frac{d\theta_o}{dx}$ MEASURED	0.0145	0.0145	0.0145	0.0145	0.0155	0.0160	0.0175

$L/\Delta R_i = 10.0$ DIFFUSER — INNER WALL

TABLE A23-5

X ins	1.0	2.25	3.25	4.25	5.45	7.25	9.85
C_f	0.0027	0.0023	0 00205	0 00185	0 00165	0.0015	0.0013
$C_f/2$	0 00135	0 00115	0.00103	0.00093	0.00083	0.00075	0.00065
θ_i ins	0.051	0.064	0.075	0 086	0 098	0.115	0.147
$-\frac{1}{U}\frac{dU}{dx}$	0.054	0 0489	0.0469	0.042	0.0406	0.0338	0 0287
H_i (From graph)	1 36	1.43	1.48	1.53	1 58	1.63	1.69
$-(H+2)\frac{\theta}{U}\frac{dU}{dx}$	0.00924	0.01072	0.01223	0.01271	0.0138	0.0141	0.01554
R_m (Est^m)	5.56	5 60	5.62	5.65	5.695	5.80	5.88
R_i ins	5.0	5.0	5 0	5 0	5.0	5.0	5 0
$R_m^2 - R_i^2$	5.95	6.4	6 5	6 9	7.4	8.6	9 6
$R_m^2 - R_i^2/R_i$	1.19	1.28	1.30	1 38	1.48	1.72	1.92
$-\left(\frac{dP_T}{dx}\right)_m \frac{1}{2\rho U^2}$	0 002	0 0021	0 0022	0 0023	0 0023	0.0024	0 0025
$-\frac{R_m^2 - R_i^2}{R_i}\frac{1}{2\rho U^2}\left(\frac{dP_T}{dx}\right)_m$	0 00238	0 00269	0 00286	0 00317	0.0034	0.00413	0.0048
$\frac{1}{U^2}\int\left(\overline{u'^2} + \overline{v'^2}_m - \overline{v'^2}\right)dr$	0 0014	0 0021	0 0027	0.0033	0 0042	0 0053	0.0066
$\frac{1}{U^2}\frac{d}{dx}\int\left(\overline{u'^2} + \overline{v'^2}_m - \overline{v'^2}\right)dr$	0.0005	0 0005	0.0005	0 0005	0.0005	0.0005	0.0005
$\frac{d\theta_i}{dx}$ PREDICTED	0 00871	0.00968	0.0109	0.01097	0.01173	0.01117	0 01189
$\frac{d\theta_i}{dx}$ MEASURED	0 0105	0 0105	0 0105	0.0105	0 0105	0.011	0.013

L/ΔR₁ = 10.0 DIFFUSER — OUTER WALL

TABLE A 23-6

X_{ins}	1.0	2.25	3.25	4.25	5.45	7.25	9.85		
C_f	0.0025	0.0019	0.00175	0.0015	0.00135	0.00115	0.00075		
$C_f/2$	0.00125	0.00095	0.00088	0.00075	0.00068	0.00058	0.00038		
θ_o ins	0.051	0.065	0.077	0.088	0.102	0.123	0.159		
R_o ins	6.088	6.20	6.284	6 37	6.477	6.635	6.862		
$\frac{\theta}{R}\frac{dR}{dx}$	0 00073	0 00092	0 00107	0.00121	0 00139	0.00162	0.00202		
A_x/A_1	1.1	1.225	1.325	1.425	1.545	1.725	1.985		
$\frac{dP}{dx}\frac{2}{\rho\bar{u}_1^2}$	0.11	0.085	0.073	0.058	0 05	0.035	0.025		
$(\bar{u}/U)$	0.87	0.841	0.82	0.802	0.78	0.745	0.69		
$\frac{dP}{dx}\left(\frac{2}{\rho U^2}\right)$	0.10	0 0895	0.0852	0.075	0.072	0 058	0 0475		
$-\left(\frac{dP_T}{dx}\right)_m\left(\frac{2}{\rho U^2}\right)$	0.0081	0.0084	0.0087	0.0091	0 0092	0.0096	0.0100		
$-\frac{2}{U}\frac{dU}{dx}$	0.1081	0.0979	0.0939	0.0841	0 0812	0.0676	0.0575		
$-\frac{1}{U}\frac{dU}{dx}$	0.054	0.0489	0.0469	0.0420	0.0406	0.0338	0.0287		
H_o (From graph)	1.385	1.5	1.57	1.63	1.71	1 845	2.06		
$-(H+2)\frac{\theta}{U}\frac{dU}{dx}$	0 0093	0.0111	0.0129	0 01338	0.0153	0.0160	0.0186		
R_o	6.088	6 20	6 284	6.37	6.477	6.635	6.85		
R_m (Est^m)	5.56	5.60	5.62	5.65	5.695	5.80	5.88		
$R_o^2 - R_m^2$	6 05	7.0	7.9	8.7	9.55	10.4	12.5		
$R_o^2 - R_m^2/R_o$	0.955	1.13	1.26	1.367	1.475	1.57	1.82		
$-\left(\frac{dP_T}{dx}\right)_m\frac{1}{2\rho U^2}$	0 002	0.0021	0.0022	0.0023	0.0023	0.0024	0 0025		
$-\frac{R_o^2-R_m^2}{R_o}\left(\frac{dP_T}{dx}\right)_m\frac{1}{2\rho U^2}$	0.0019	0.00237	0.00278	0 00314	0 0034	0.00377	0 00455		
$\frac{1}{U^2}\int\left(\bar{u}'^2+\bar{v}_m'^2-\bar{v}'^2\right)dr$	0.00165	0.0024	0.0032	0.0044	0.006	0.0085	0.0140		
$\frac{1}{U^2}\frac{d}{dx}\int\left(\bar{u}'^2+\bar{v}_m'^2-\bar{v}'^2\right)dr$	0.0006	0 00075	0 0009	0.0011	0 00125	0 0013	0 0015		
$\frac{d\theta_o}{dx}$ PREDICTED	0.0085	0.0095	0.0108	0.0109	0.0124	0.0124	0.0139		
$\frac{d\theta_o}{dx}$ MEASURED	0.010	0.011	0.011	0 011	0.012	0.013	0.015		

APPENDIX 24

INVESTIGATION OF ENERGY BALANCE IN THE OUTER AND INNER WALL BOUNDARY LAYERS

A24-1 Introduction

A calculation of the magnitude of the various terms in the energy integral equation was carried out for all three diffusers. A similar approach to that outlined in Appendix 23 was employed, the experimental values of, dissipation coefficient, energy thickness, pressure gradient, etc. were used to calculate values of $\frac{d\delta^{**}}{dx}$

A24-2 Basic Equations

The rotationally symmetric form of the energy equation for the inner wall layer, neglecting Reynolds normal stresses, is derived in Appendix 25.

$$\frac{d}{dx}\left[\pi R_i U^3 \delta_i^{**}\right] = \frac{Q_i}{\rho}\left(\frac{dP_T}{dx}\right)_m + \frac{2\pi}{\rho}\int_{R_i}^{R_m} u\,\frac{\partial}{\partial R}(R\tau)\,dR \qquad \text{A24-1}$$

Using 'y' to denote the co-ordinate at right angles to the inner wall, we may write;

$$\frac{d}{dx}\left[\pi R_i U^3 \delta_i^{**}\right] = \frac{Q_i}{\rho}\left(\frac{dP_T}{dx}\right)_m + \frac{2\pi}{\rho}\int_{R_i}^{R_m} u\,\frac{\partial}{\partial y}\left[(R_i + y)\,\tau\right]dR$$

and

$$U^3\frac{d\delta_i^{**}}{dx} = \frac{2U}{\rho}\left(\frac{R_m^2 - R_i^2}{2R_i} - \delta_i^*\right)\left(\frac{dP_T}{dx}\right)_m - \frac{2}{\rho}\int_{R_i}^{R_m} u\,\frac{\partial}{\partial y}\left[\left(1+\frac{y}{R_i}\right)\tau\right]dy - \delta^{**}3U^2\frac{d\delta_i^{**}}{dx} - \frac{dR_i}{dx}\frac{U^3}{R_i}\delta_i^{**} \qquad \text{....A24-2}$$

where $$\delta_i^{**} = \int_{R_i}^{R_m}\frac{u}{U}\left(1-\left(\frac{u}{U}\right)^2\right)\frac{R}{R_i}\,dR = \int_{R_i}^{R_m}\frac{u}{U}\left(1-\left(\frac{u}{U}\right)^2\right)\left(1+\frac{y}{R_i}\right)dy$$

and $$Q_i = 2\pi R_i U\left[\frac{R_m^2 - R_i^2}{2R_i} - \delta_i^*\right]$$

In view of the large radius ratio $(\frac{Ri}{Ro})$, and the fact that

$\frac{dR_1}{dx} = 0$, equation A24-2 may be approximated to

$$\frac{d\delta^{**}}{dx} = (\delta - \delta_1^*)\left(\frac{dP_T}{dx}\right)_m \frac{2}{\rho U^2} + \frac{2}{\rho U^3}\int u \frac{d\tau}{dy}\, dy - 3\frac{\delta_1^{**}}{U}\frac{dU}{dx} \qquad \text{A 24-3}$$

where δ = Rm-Ri

Consider now the two-dimensional form of the energy equation

$$\frac{d}{dx}\left[U^3\delta_1^{**}\right] = 2\frac{Q_1}{\rho}\left(\frac{dP_T}{dx}\right)_m + \frac{2}{\rho}\int_0^\delta \tau \frac{du}{dy}\, dy \qquad \text{A24-4}$$

where $Q = U(\delta - \delta^*)$ and therefore expanding A24-4 we obtain

$$\frac{d\delta_1^{**}}{dx} = (\delta - \delta_1^*)\left(\frac{dP_T}{dx}\right)_m \frac{2}{\rho U^2} + \frac{2}{\rho U^3}\int_0^\delta \tau \frac{du}{dy}\, dy - 3\frac{\delta_1^{**}}{U}\frac{dU}{dx} \qquad \text{A24-5}$$

The laminar form of the dissipation integral can be written as

$$\int_0^\delta \tau \frac{du}{dy}\, dy = \mu\int_0^\delta \left(\frac{du}{dy}\right)^2 dy = \mu\left[\left(u\frac{du}{dy}\right)_0^\delta - \int_0^\delta u\frac{d^2u}{dy^2}\, dy\right]$$

at $y = \delta$, $\frac{du}{dy} = 0.$, and at $y = 0.$, $u = 0.$

so the first term is zero, and we may write

$$\int_0^\delta \tau \frac{du}{dy}\, dy = \mu\int_0^\delta u\frac{d^2u}{dy^2}\, dy = \int_0^\delta u\frac{d\tau}{dy}\, dy$$

Therefore it is more convenient to express the dissipation coefficient $C_D = \frac{2}{\rho U^3}\int u\frac{d\tau}{dy}\, dy$ in the more usual form

$$2\int \frac{\tau}{\rho U^2}\frac{d(u/U)}{dy}\, dy$$

and Equation A24-3 becomes

$$\frac{d\delta_1^{**}}{dx} = (\delta - \delta_1^*)\left(\frac{dP_T}{dx}\right)_m \frac{2}{\rho U^2} + C_{D_1} - 3\frac{\delta_1^{**}}{U}\frac{dU}{dx} \qquad \text{A24-6}$$

Bearing in mind the possible errors in the shear stress measurements, and the large radius ratio, the two dimensional

form of the dissipation integral has been used without incurring any significant error. The remaining boundary layer parameters are based on axisymmetric definitions.

A24-3 Presentation of Results

The calculations are summarised in Tables A24-1 to A24-3, the values of energy thickness obtained from the right hand side of the energy equation are compared with the values obtained from the mean velocity profile data in Figs. A24-1 to A24-3.

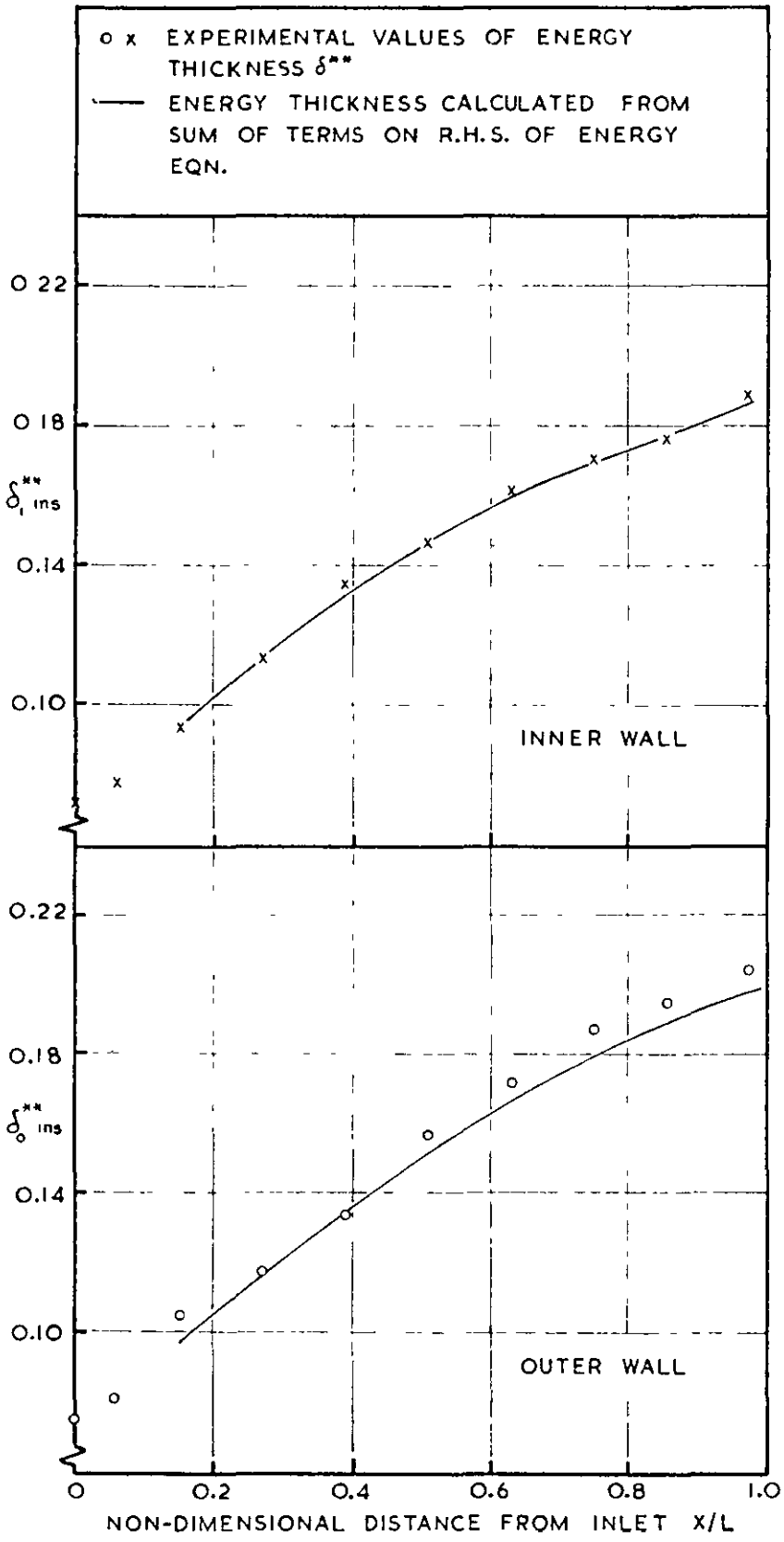


FIG. A24-1 COMPARISON OF ENERGY THICKNESS CALCULATIONS WITH DATA $L/\Delta R_i = 5$ DIFFUSER

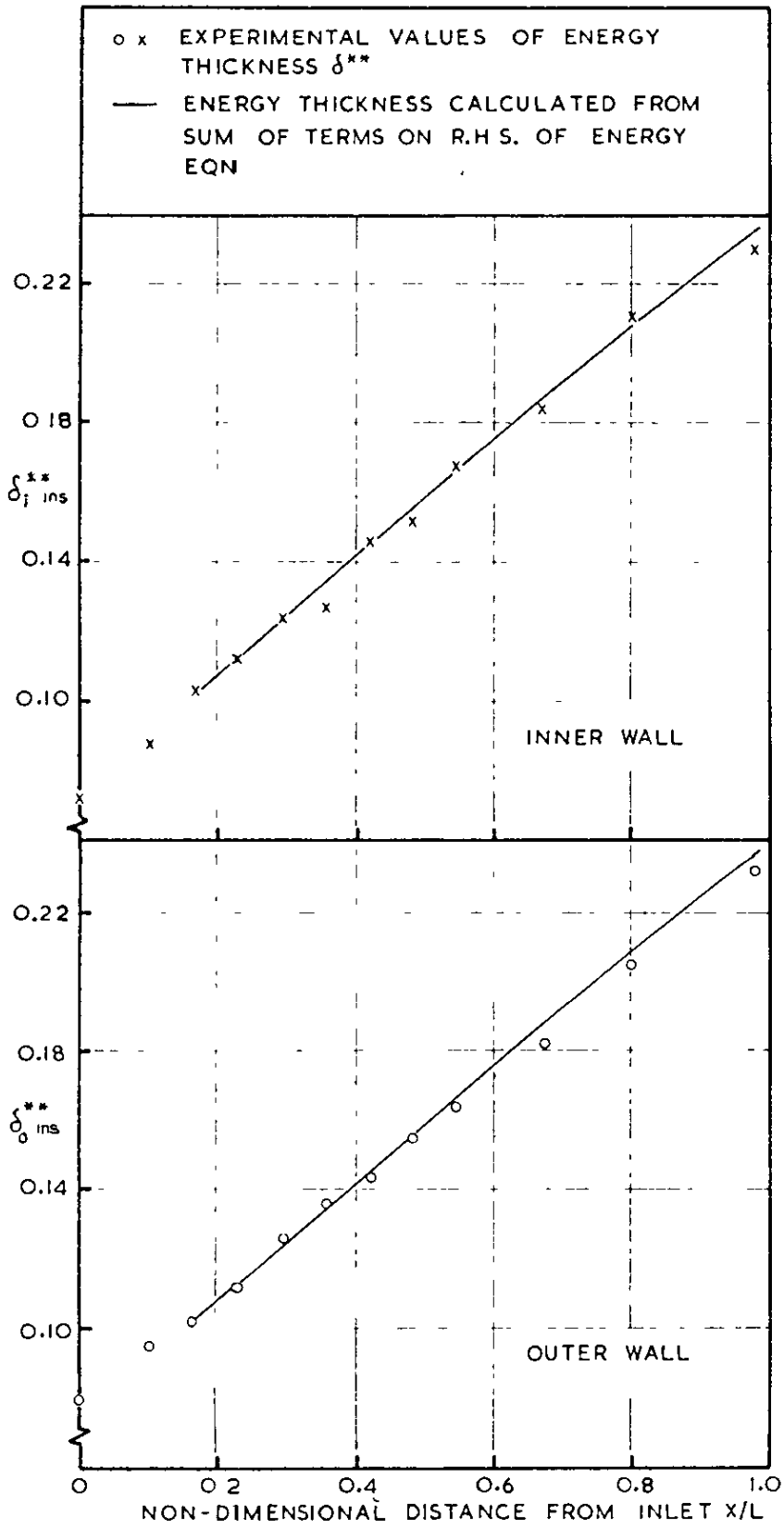


FIG. A 24-2 COMPARISON OF ENERGY THICKNESS CALCULATIONS WITH DATA $L/\Delta R_i = 7.5$ DIFFUSER

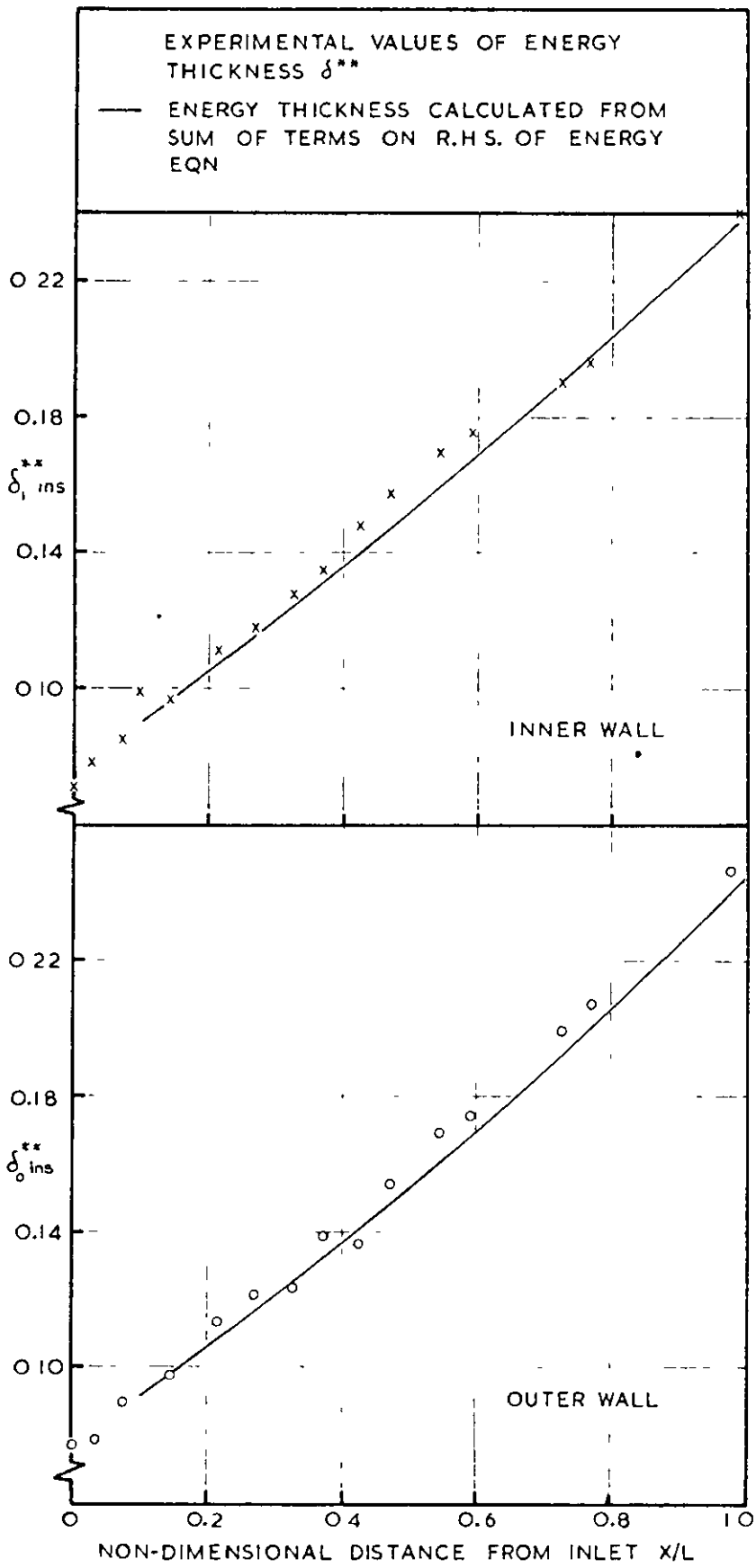


FIG. A 24-3 COMPARISON OF ENERGY THICKNESS CALCULATIONS WITH DATA $L/\Delta R_i = 10$ DIFFUSER

TERMS IN ENERGY INTEGRAL EQUATIONS

TABLE A 24-1

$L/\Delta R_i = 5.0$ DIFFUSER

OUTER WALL

X ins	0.30	0.75	1.35	1.95	2.55	3.15	3.75	4.28	4.85
$-\left(\frac{dP_T}{dx}\right)_m \frac{2}{\rho U^2}$	0.0084	0.0088	0.0093	0.0096	0.010	0.0103	0.0104	0.0102	0 0098
$R_o - R_m = \delta_o$ ins	0.53	0.60	0.62	0.67	0.76	0.83	0.90	0.95	1.18
δ_o^* ins	0 064	0.090	0.120	0.157	0.209	0.262	0.329	0.404	0.487
$\delta_o - \delta_o^*$	0.466	0.510	0.500	0.513	0.551	0.568	0.571	0.546	0.693
$-\frac{2}{\rho U^2}(\delta-\delta^*)\left(\frac{dP_T}{dx}\right)_m$	0.0039	0.0045	0 0047	0.0050	0.0055	0.0059	0.0059	0.0056	0.0068
$-\frac{1}{U}\frac{dU}{dx}$	0.1617	0.1344	0.0972	0.0709	0.054	0 0454	0.0382	0.0331	0.0309
δ_o^{**}	0.081	0.096	0.118	0.134	0.157	0.171	0.187	0.195	0.204
$-\frac{3\delta^{**}}{U}\frac{dU}{dx}$	0.0393	0.0387	0 0344	0.0285	0.0255	0.0232	0.0214	0.0194	0.019
C_{D_o}	0.0029	0.0038	0.0039	0.0045	0.0047	0.005	0.0055	0.0062	0.0070
$\frac{d\delta^{**}}{dx}$	0 0383	0.038	0.0336	0.028	0.0247	0.0223	0.0210	0 0200	0 0192

INNER WALL

X ins	0.30	0.75	1.35	1.95	2.55	3.15	3.75	4.28	4.85
$-\left(\frac{dP_T}{dx}\right)_m \frac{2}{\rho U^2}$	0.0084	0.0088	0 0093	0.0096	0.010	0.0103	0.0104	0.0102	0.0098
$R_m - R_i = \delta_i$ ins	0.52	0.53	0.64	0.67	0.69	0.73	0.76	0.81	0.67
δ_i^* ins	0.057	0.075	0 094	0.118	0.136	0.155	0.168	0.175	0 194
$\delta_i - \delta_i^*$	0 463	0.455	0.546	0.552	0 554	0.575	0.592	0.635	0.476
$-\frac{2}{\rho U^2}(\delta-\delta^*)\left(\frac{dP_T}{dx}\right)_m$	0.0039	0.004	0.0051	0.0054	0.0055	0 0059	0.0062	0.0065	0.0047
$-\frac{1}{U}\frac{dU}{dx}$	0.1617	0 1344	0 0972	0 0709	0.054	0.0454	0.0382	0 0331	0.0309
δ_i^{**}	0.078	0.094	0.113	0.135	0.146	0.161	0.170	0.176	0.189
$-\frac{3\delta^{**}}{U}\frac{dU}{dx}$	0.0377	0.0379	0 0330	0.0286	0.0236	0.0219	0.0195	0.0175	0.0175
C_{D_i}	0.0025	0.0033	0.0041	0.0038	0 0041	0.0041	0.0043	0 0044	0.0044
$\frac{d\delta^{**}}{dx}$	0.0363	0.0362	0 0320	0.0270	0.0222	0 0201	0.0176	0.0154	0.0172

TABLE A24-2

$L/\Delta R_i$=7.5 DIFFUSER — OUTER WALL

X ins	1.25	2.2	3.15	4.10	5.05	6.0	7.35
$-\left(\frac{dP_T}{dx}\right)_m \frac{2}{\rho U^2}$	0.0058	0.0066	0.0075	0.0082	0.009	0.0097	0.0103
$R_o - R_m = \delta_o$ ins	0.580	0.633	0.690	0.755	0.820	0.880	0.960
δ_o^* ins	0.089	0.121	0.150	0.191	0.224	0.279	0.358
$\delta_o - \delta_o^*$	0.491	0.512	0.540	0.564	0.596	0.601	0.602
$-\frac{2}{\rho U^2}(\delta-\delta^*)\left(\frac{dP_T}{dx}\right)_m$	0.0029	0.0034	0.0041	0.0047	0.0054	0.0057	0.0061
$-\frac{1}{U}\frac{dU}{dx}$	0.0759	0.0628	0.0547	0.0481	0.0427	0.0387	0.0316
δ_o^{**}	0.102	0.126	0.143	0.164	0.181	0.205	0.232
$-\frac{3\delta^{**}}{U}\frac{dU}{dx}$	0.0232	0.0237	0.0235	0.0237	0.0232	0.0238	0.0207
C_{D_o}	0.0020	0.0026	0.0034	0.0036	0.0041	0.0046	0.0061
$\frac{d\delta^{**}}{dx}$	0 0223	0.0229	0.0228	0.0226	0.0219	0.0227	0.0207

INNER WALL

X ins	1.25	2.2	3.15	4.10	5.05	6.0	7.35
$-\left(\frac{dP_T}{dx}\right)_m \frac{2}{\rho U^2}$	0.0058	0.0066	0.0075	0.0082	0 009	0.0097	0.0103
$R_m - R_i = \delta_i$ ins	0.566	0.624	0.677	0.723	0.769	0.820	0.896
δ_i^* ins	0.083	0.107	0.135	0.163	0.185	0. 218	0.241
$\delta_i - \delta_i^*$	0.483	0.517	0 542	0 560	0.584	0.602	0.655
$-\frac{2}{\rho U^2}(\delta-\delta^*)\left(\frac{dP_T}{dx}\right)_m$	0.0028	0.0034	0.0041	0.0047	0.0052	0.0057	0.0068
$-\frac{1}{U}\frac{dU}{dx}$	0.0759	0.0628	0.0547	0.0481	0.0427	0.0387	0.0316
δ_i^{**}	0.103	0.124	0.146	0.167	0.184	0.211	0.230
$-\frac{3\delta^{**}}{U}\frac{dU}{dx}$	0.0234	0.0233	0.024	0.0242	0.0235	0 0245	0.0218
C_{D_i}	0.0018	0.0029	0.0031	0.0036	0.0041	0.0042	0.0043
$\frac{d\delta^{**}}{dx}$	0.0224	0.0228	0.0230	0.0231	0.0224	0.0230	0 0193

TABLE A24-3

$L/\Delta R_1 = 100$ DIFFUSER — OUTER WALL

X ins	1.0	2 25	3.25	4.25	5 45	7.25	9 85
$-\left(\frac{dP_T}{dx}\right)_m \frac{2}{\rho U^2}$	0 0081	0 0084	0 0087	0.0091	0 0092	0 0096	0 0100
$R_o - R_m = \delta_o$ ins	0.528	0.600	0.664	0.720	0.782	0.835	0.982
δ_o^* ins	0.067	0.099	0.114	0.133	0.173	0.218	0. 327
$\delta_o - \delta_o^*$	0.461	0. 501	0.550	0.587	0.609	0 617	0.655
$-\frac{2}{\rho U^2}(\delta-\delta^*)\left(\frac{dP_T}{dx}\right)_m$	0 0038	0.0043	0 0049	0 0054	0.0056	0 0060	0 0066
$-\frac{1}{U}\frac{dU}{dx}$	0 054	0 0489	0 0469	0 042	0 0406	0 0338	0.0287
δ_o^{**}	0.086	0.113	0.123	0.136	0.169	0.199	0.246
$-\frac{3\delta^{**}}{U}\frac{dU}{dx}$	0.0139	0 0165	0.0173	0 0171	0.0206	0 0202	0.0212
C_{D_o}	0 0014	0 0017	0 0018	0.0027	0 0031	0 0044	0 0060
$\frac{d\delta^{**}}{dx}$	0 0115	0 0139	0 0142	0 0144	0.0181	0.0186	0 0206

INNER WALL

X ins	1 0	2 25	3.25	4 25	5.45	7 25	9 85
$-\left(\frac{dP_T}{dx}\right)_m \frac{2}{\rho U^2}$	0 0081	0 0084	0.0087	0.0091	0.0092	0 0096	0 0100
$R_m - R_i = \delta_i$ ins	0.560	0.600	0.620	0.650	0.695	0.800	0.880
δ_i^* ins	0.073	0.092	0.109	0.132	0.158	0.186	0.249
$\delta_i - \delta_i^*$	0.487	0.508	0.511	0.518	0 537	0 614	0 631
$-\frac{2}{\rho U^2}(\delta-\delta^*)\left(\frac{dP_T}{dx}\right)_m$	0.0040	0.0043	0.0045	0 0048	0.0049	0.0060	0.0063
$-\frac{1}{U}\frac{dU}{dx}$	0 054	0.0489	0 0469	0.042	0.0406	0 0338	0.0287
δ_i^{**}	0.099	0.112	0.128	0.148	0.169	0.190	0.241
$-\frac{3\delta^{**}}{U}\frac{dU}{dx}$	0.0161	0.0164	0.0180	0.0187	0.0206	0 0192	0.0208
C_{D_i}	0 0014	0.0019	0.0023	0.0028	0 0028	0 0045	0.0046
$\frac{d\delta^{**}}{dx}$	0.0135	0.0140	0.0158	0.0167	0.0185	0 0177	0 0191

Appendix 25

Basic Equations for Rotationally Symmetric Flow

APPENDIX 25

MOMENTUM INTEGRAL EQUATION FOR ROTATIONALLY SYMMETRICAL FLOW

The Navier-Stokes equations for steady (non-turbulent) flow, swirl free, expressed in cylindrical co-ordinates are given by Schlichting (84) as:

$$u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial R} = -\frac{1}{\rho}\frac{\partial P}{\partial x} + \nu\left[\frac{\partial^2 u}{\partial R^2} + \frac{1}{R}\frac{\partial u}{\partial R} + \frac{\partial^2 u}{\partial x^2}\right] \qquad \text{- A25-1}$$

$$u\frac{\partial v}{\partial x} + v\frac{\partial v}{\partial R} = -\frac{1}{\rho}\frac{\partial P}{\partial R} + \nu\left[\frac{\partial^2 v}{\partial R^2} + \frac{1}{R}\frac{\partial v}{\partial R} - \frac{v}{R^2} + \frac{\partial^2 v}{\partial x^2}\right] \qquad \text{- A25-2}$$

and the continuity eqn.

$$\frac{\partial}{\partial x}(Ru) + \frac{\partial}{\partial R}(Rv) = 0. \qquad \text{- A25-3}$$

The order of magnitude of the terms in equations A25-1/2/3 is estimated with the object of neglecting those which are numerically very small.

Thus we assume $v \ll u$, $\frac{\partial v}{\partial x} \ll \frac{\partial u}{\partial x}$, $\frac{\partial v}{\partial R} \ll \frac{\partial u}{\partial R}$

and we neglect $\frac{\partial^2 u}{\partial x^2}$, $\frac{\partial^2 v}{\partial x^2}$, & $\frac{v^2}{R}$

Thus the simplified equations of motion become

$$u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial R} = -\frac{1}{\rho}\frac{\partial P}{\partial x} + \nu\left[\frac{\partial^2 u}{\partial R^2} + \frac{1}{R}\frac{\partial u}{\partial R}\right] \qquad \text{- A25-4}$$

$$0. = \frac{1}{\rho}\frac{\partial P}{\partial R} \quad \text{i.e. } P = P(R) = \text{const.}$$

$$\frac{\partial}{\partial x}(Ru) + \frac{\partial}{\partial R}(Rv) = 0. \qquad \text{A 25-5}$$

Since $\tau = \mu\frac{\partial u}{\partial R}$ and $\frac{\partial \tau}{\partial R} = \mu\frac{\partial^2 u}{\partial R^2}$ we may write

$$\nu\left[\frac{\partial^2 u}{\partial R^2} + \frac{1}{R}\frac{\partial u}{\partial R}\right] = \frac{1}{\rho}\left[\frac{\partial \tau}{\partial R} + \frac{\tau}{R}\right] = \frac{1}{\rho R}\frac{\partial (R\tau)}{\partial R} \qquad \text{A25-6}$$

Eqn. 25-4 becomes: $$u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial R} = -\frac{1}{\rho}\frac{\partial P}{\partial x} + \frac{1}{\rho R}\frac{\partial (R\tau)}{\partial R} \qquad \text{-A25-7}$$

Expanding $\frac{\partial}{\partial x}(Ru^2) + \frac{\partial}{\partial R}(RuV)$ we obtain;

$$\frac{\partial R}{\partial x} u^2 + 2uR\frac{\partial u}{\partial x} + uV + RV\frac{\partial u}{\partial R} + Ru\frac{\partial V}{\partial R} = \frac{\partial}{\partial x}(Ru^2) + \frac{\partial}{\partial R}(RuV) \quad \text{A25-8}$$

From Eqn. A25-3 $$\frac{\partial}{\partial x}(Ru) + \frac{\partial}{\partial R}(RV) = u\frac{\partial R}{\partial x} + R\frac{\partial u}{\partial x} + V + R\frac{\partial V}{\partial R} = 0. \quad \text{A25-9}$$

$$\therefore u^2\frac{\partial R}{\partial x} + Ru\frac{\partial u}{\partial x} + uV + Ru\frac{\partial V}{\partial R} = 0 \quad \text{A25-10}$$

Using Eqn.A25-10 to cancel terms in Eqn. A25-8 we obtain

$$\frac{\partial}{\partial x}(Ru^2) + \frac{\partial}{\partial R}(RuV) = Ru\frac{\partial u}{\partial x} + RV\frac{\partial u}{\partial R} = R\left[u\frac{\partial u}{\partial x} + V\frac{\partial u}{\partial R}\right]$$

Thus Eqn. A25-7 can be written as:

$$\frac{\partial}{\partial x}(Ru^2) + \frac{\partial}{\partial R}(RuV) = -\frac{R}{\rho}\frac{\partial P}{\partial x} + \frac{1}{\rho}\frac{\partial}{\partial R}(R\tau) \quad \text{A25-11}$$

Writing

$$\frac{\partial}{\partial x}(RUu) + \frac{\partial}{\partial R}(RUV) = \frac{\partial R}{\partial x}(Uu) + Ru\frac{\partial U}{\partial x} + RU\frac{\partial u}{\partial x} + RU\frac{\partial V}{\partial R} + UV + RV\frac{\partial U}{\partial R}$$

Substituting Eqn.A25-10 and noting $\frac{\partial U}{\partial R} = 0$.

$$\frac{\partial}{\partial x}(RUu) + \frac{\partial}{\partial R}(RUV) = Ru\frac{\partial U}{\partial x} \quad \text{A25-12}$$

Subtracting Eqns. A25-11 and A25-12

$$\frac{\partial}{\partial x}\left[Ru(U-u^2)\right] + \frac{\partial}{\partial R}\left[RV(U-u)\right] = Ru\frac{\partial U}{\partial x} + \frac{R}{\rho}\frac{\partial P}{\partial x} - \frac{1}{\rho}\frac{\partial}{\partial R}(R\tau) \quad \text{A25-13}$$

We obtain $\frac{1}{\rho}\frac{\partial P}{\partial x}$ by writing Bernoulli's Eqn. at the point of maximum velocity

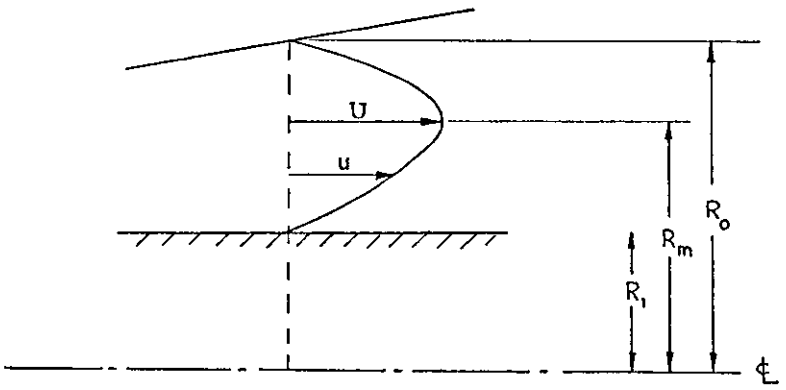
$$P_{T_m} = P_m + \frac{1}{2}\rho U^2 \qquad \therefore \left(\frac{1}{\rho}\frac{\partial P}{\partial x}\right)_m = \frac{1}{\rho}\left(\frac{\partial P_T}{\partial x}\right)_m - U\frac{dU}{dx} \quad \text{A25-14}$$

If no swirl is present $$\left(\frac{\partial P}{\partial x}\right)_m = \left(\frac{\partial P}{\partial x}\right)$$

The term $\frac{1}{\rho}\left(\frac{\partial P_T}{\partial x}\right)_m$ is zero if a potential core exists, however, if the flow is fully developed $\frac{1}{\rho}\left(\frac{\partial P_T}{\partial x}\right)_m \neq 0$ and this term is included in the equations. Substituting in Eqn. A25-13 we obtain

$$\frac{\partial}{\partial x}\left[R\,u\,(U-u)\right] + \frac{\partial}{\partial R}\left[R\,v\,(U-u)\right] = R\frac{dU}{dx}(u-U) + \frac{R}{\rho}\left(\frac{dP_T}{dx}\right)_m - \frac{1}{\rho}\frac{\partial}{\partial R}(R\tau) \qquad \text{-A25-15}$$

Consider the application of Eqn. A25-15 to the flow in an annular diffuser as illustrated below.



The boundary conditions are:

$R = R_o$, $u = 0.$, $v = 0$

$R = R_m$, $u = U$, $\frac{\partial u}{\partial R} = 0$

$R = R_i$, $u = 0$, $v = 0.$

Consider the inner wall boundary layer, assuming that the flow is fully developed. Integrating Eqn. A25-15 w.r.t. R from R_i to R_m we obtain:

$$\frac{d}{dx}\int_{R_i}^{R_m} u(U-u)R\,dR + \left[Rv(U-u)\right]_{R=R_i}^{R=R_m} = \frac{dU}{dx}\int_{R_i}^{R_m}(u-U)R\,dR + \frac{1}{\rho}\left(\frac{dP_T}{dx}\right)_m\int_{R_i}^{R_m}R\,dR$$

$$-\frac{1}{\rho}\left[R\tau\right]_{R=R_i}^{R=R_m} \qquad \text{-A25-16}$$

Defining $\delta_i^* = \int_{R_i}^{R_m}\left(1-\frac{u}{U}\right)\frac{R}{R_i}\,dR$ & $\theta_i = \int_{R_i}^{R_m}\left(1-\frac{u}{U}\right)\frac{u}{U}\frac{R}{R_i}\,dR$

and introducing the boundary conditions, then

$$\frac{d}{dx}\left(U^2 \theta_i R_i \right) = - R_i U \frac{dU}{dx} \delta_i^* + \frac{1}{\rho}\left(\frac{dP_T}{dx}\right)_m \left(\frac{R_m^2 - R_i^2}{2} \right) + \frac{R_i \tau_{\omega i}}{\rho}$$

differentiating

$$U^2 \theta_i \frac{dR_i}{dx} + R_i \theta_i 2U \frac{dU}{dx} + R_i U^2 \frac{d\theta_i}{dx} + R_i U \frac{dU}{dx} \delta_i^* = \frac{R_m^2 - R_i^2}{2\rho}\left(\frac{dP_T}{dx}\right)_m + \frac{R_i \tau_{\omega i}}{\rho}$$

dividing through by $R_i U^2$ and defining $H_i = \delta_i^* / \theta_i$, then

$$\frac{d\theta_i}{dx} + \frac{\theta_i}{R_i}\frac{dR_i}{dx} + \frac{\theta_i}{U}\frac{dU}{dx}\left(H_i + 2 \right) = \frac{R_m^2 - R_i^2}{R_i} \frac{1}{2\rho U^2}\left(\frac{dP_T}{dx}\right)_m + \frac{\tau_{\omega i}}{\rho U^2} \quad \text{- A25-17}$$

Equation A25-17 is the momentum integral equation for the inner wall boundary layer, it differs from the two-dimensional equation viz. $\left[\frac{d\theta}{dx} + \frac{\theta}{U}\frac{dU}{dx}\left(H+2 \right) = \frac{\tau_\omega}{\rho U^2} \right]$ in the following respects:

(i) The influence of transverse curvature as given by the term $\frac{\theta_i}{R_i}\frac{dR_i}{dx}$ and the redefining of the boundary layer parameters

(ii) The inclusion of the term $\left(\frac{R_m^2 - R_i^2}{R_i} \right)\frac{1}{2\rho U^2}\left(\frac{dP_T}{dx}\right)_m$ to take account of the total pressure loss at the point of maximum velocity when the boundary layers merge.

Adopting a similar technique to the outer wall boundary layer yields,

$$\frac{d\theta_o}{dx} + \frac{\theta_o}{R_o}\frac{dR_o}{dx} + \frac{\theta_o}{U}\frac{dU}{dx}\left(H_o + 2 \right) = \frac{R_o^2 - R_m^2}{R_o} \frac{1}{2\rho U^2}\left(\frac{dP_T}{dx}\right)_m + \frac{\tau_{\omega o}}{\rho U^2} \quad \text{- A25-18}$$

where $\delta_o^* = \int_{R_m}^{R_o} \left(1 - \frac{u}{U}\right)\frac{R}{R_o}\, dR$, $\theta_o = \int_{R_m}^{R_o} \left(1 - \frac{u}{U}\right)\frac{u}{U}\frac{R}{R_o}\, dR$, & $H_o = \delta_o^*/\theta_o$

ENERGY INTEGRAL EQUATION

Expanding $\frac{\partial}{\partial x}\left(R u^3 \right) + \frac{\partial}{\partial R}\left(R u^2 v \right)$ we obtain

$$R\, 3u^2 \frac{\partial u}{\partial x} + u^3 \frac{\partial R}{\partial x} + R u^2 \frac{\partial v}{\partial R} + R v\, 2u \frac{\partial u}{\partial R} + u^2 v = \frac{\partial}{\partial x}\left(R u^3 \right) + \frac{\partial}{\partial R}\left(R u^2 v \right)$$

A25-19

From Eqn. A25-9 $\quad u\frac{\partial R}{\partial x} + R\frac{\partial u}{\partial x} + V + R\frac{\partial V}{\partial R} = 0.$

$$\therefore \quad u^3\frac{\partial R}{\partial x} + Ru^2\frac{\partial u}{\partial x} + u^2V + Ru^2\frac{\partial V}{\partial R} = 0. \qquad \text{A25-20}$$

Substituting in Eqn. A25-19

$$\frac{\partial}{\partial x}\left(Ru^3\right) + \frac{\partial}{\partial R}\left(Ru^2V\right) = 2Ru^2\frac{\partial u}{\partial x} + 2RuV\frac{\partial u}{\partial R} = 2Ru\left(u\frac{\partial u}{\partial x} + V\frac{\partial u}{\partial R}\right)$$

Using this result in conjunction with Eqn. A25-7 we obtain

$$\frac{\partial}{\partial x}\left(Ru^3\right) + \frac{\partial}{\partial R}\left(Ru^2V\right) = -\frac{2Ru}{\rho}\frac{\partial P}{\partial x} + \frac{2u}{\rho}\frac{\partial(R\tau)}{\partial R} \qquad \text{A25-21}$$

Substituting for $\frac{\partial P}{\partial x}$ from Eqn. A25-14

$$\frac{\partial}{\partial x}\left(Ru^3\right) + \frac{\partial}{\partial R}\left(Ru^2V\right) = 2Ru\,U\frac{dU}{dx} - \frac{2Ru}{\rho}\left(\frac{dP_T}{dx}\right)_m + \frac{2u}{\rho}\frac{\partial(R\tau)}{\partial R} \qquad \text{A25-22}$$

Expanding $\quad \frac{\partial}{\partial x}\left(RU^2u\right) + \frac{\partial}{\partial R}\left(RU^2V\right) = RU^2\frac{\partial u}{\partial x} + Ru\,2U\frac{dU}{dx} + U^2u\frac{\partial R}{\partial x} +$

$$U^2V + RV\,2U\frac{\partial U}{\partial R} + RU^2\frac{\partial V}{\partial R} \qquad \text{A25-23}$$

From Eqn. A25-9

$$U^2u\frac{\partial R}{\partial x} + RU^2\frac{\partial u}{\partial x} + U^2V + RU^2\frac{\partial V}{\partial R} = 0.$$

Subst. in Eqn. A25-23, and noting that $\frac{\partial U}{\partial R} = 0.$

$$\text{Then} \quad \frac{\partial}{\partial x}\left(RU^2u\right) + \frac{\partial}{\partial R}\left(RU^2V\right) = 2Ru\,U\frac{\partial U}{\partial x} \qquad \text{A25-24}$$

Subtracting Eqn. A25-22 from Eqn. A25-24 gives

$$\frac{\partial}{\partial x}\left[Ru\left(U^2-u^2\right)\right] + \frac{\partial}{\partial R}\left[RV\left(U^2-u^2\right)\right] = 2R\frac{u}{\rho}\left(\frac{\partial P_T}{\partial x}\right)_m - \frac{2u}{\rho}\frac{\partial(R\tau)}{\partial R} \qquad \text{A25-25}$$

Consider again the inner wall boundary layer. Integrating

Eqn. A25-15 we obtain:

$$\frac{d}{dx}\int_{R_i}^{R_m} u\left(U^2-u^2\right)R\,dR + \left[RV\left(U^2-u^2\right)\right]_{R=R_i}^{R=R_m} = \frac{1}{\rho}\left(\frac{dP_T}{dx}\right)_m\int_{R_i}^{R_m} 2Ru\,dR - \frac{2}{\rho}\int_{R_i}^{R_m} u\frac{d(R\tau)}{dR}dR$$

defining $\quad \delta_i^{**} = \int_{R_i}^{R_m}\frac{u}{U}\left(1-\left(\frac{u}{U}\right)^2\right)\frac{R}{R_i}\,dR$ and introducing boundary conditions

we obtain

$$\frac{d}{dx}\left[\pi R_i U^3\delta_i^{**}\right] = \frac{Q_i}{\rho}\left(\frac{dP_T}{dx}\right)_m - \frac{2\pi}{\rho}\int_{R_i}^{R_m} u\frac{d(R\tau)}{dR}\,dR \qquad \text{A25-26}$$

where $\quad Q_i = \int_{R_i}^{R_m} 2\pi Ru\,dR \qquad 2\pi R_i U\left[\frac{R_m^2 - R_i^2}{2R_i} - \delta_i^*\right] \qquad$ 5-16-6

The corresponding two-dimensional form of the energy equation is:

$$\frac{d}{dx}\left(U^3\delta_1^{**}\right) = \frac{2Q_1}{\rho}\left(\frac{dP_T}{dx}\right)_m - \frac{2}{\rho}\int_0^{\delta}\tau\frac{du}{dy}\,dy \qquad \text{- A25-27}$$

Expanding Eqn. A25-27 and, noting that $Q = U(\delta-\delta^*)$ gives

$$U^3\frac{d\delta_1^{**}}{dx} + \delta_1^{**}3U^2\frac{dU}{dx} = \frac{2U}{\rho}(\delta-\delta_1^*)\left(\frac{dP_T}{dx}\right)_m - \frac{2}{\rho}\int_0^{\delta}\tau\frac{du}{dy}\,dy$$

$$\text{or}\quad \frac{d\delta_1^{**}}{dx} = \frac{2}{\rho U^2}(\delta-\delta_1^*)\left(\frac{dP_T}{dx}\right)_m - 2\int_0^{\delta}\frac{\tau}{\rho U^2}\frac{d\left(\frac{u}{U}\right)}{dy}dy - 3\frac{\delta_1^{**}}{U}\frac{dU}{dx} \qquad \text{A25-28}$$

The term $2\int_0^{\delta}\frac{\tau}{\rho U^2}\frac{d\left(\frac{u}{U}\right)}{dy}dy = C_D$, the disspation coefficient.

Expanding Eqn. A25-26 in a similar manner gives

$$\frac{d\delta_i^{**}}{dx} = \frac{2}{\rho U^2}\left[\frac{R_m^2-R_i^2}{2R_i} - \delta_i^*\right]\left(\frac{dP_T}{dx}\right)_m - 2\int_{R_i}^{R_m}\frac{u}{U}\frac{d\left(\frac{R}{R_i}\frac{\tau}{\rho U^2}\right)}{dR}dR - 3\frac{\delta_i^{**}}{U}\frac{dU}{dx} - \frac{\delta_i^{**}}{R_i}\frac{dR_i}{dx}$$

- A25-29

and for the outer wall boundary layer

$$\frac{d\delta_o^{**}}{dx} = \frac{2}{\rho U^2}\left[\frac{R_o^2-R_m^2}{2R_o} - \delta_o^*\right]\left(\frac{dP_T}{dx}\right)_m - 2\int_{R_m}^{R_o}\frac{u}{U}\frac{d\left(\frac{R}{R_o}\frac{\tau}{\rho U^2}\right)}{dR}dR - 3\frac{\delta_o^{**}}{U}\frac{dU}{dx} - \frac{\delta_o^{**}}{R_o}\frac{dR_o}{dx}$$

- A25-30

TURBULENT FORM OF MOMENTUM INTEGRAL EQUATION

The turbulent form of the Navier-Stokes equations after suitable averaging with respect to time is given by Goldstein[85] and Chaturvedi[86]

$$u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial R} = -\frac{1}{\rho}\frac{\partial P}{\partial x} + \nu\left[\frac{\partial^2 u}{\partial R^2} + \frac{1}{R}\frac{\partial u}{\partial R}\right] - \frac{\partial}{\partial R}(\overline{u'v'}) - \frac{\partial}{\partial x}(\overline{u'^2}) - \frac{\overline{u'v'}}{R}$$

- A25-31

and neglecting viscous terms in the 'R' direction

$$u\frac{\partial v}{\partial x} + v\frac{\partial v}{\partial R} = -\frac{1}{\rho}\frac{\partial P}{\partial R} - \frac{\partial}{\partial R}(\overline{v'^2}) - \frac{\partial}{\partial x}(\overline{u'v'}) - \frac{\overline{v'^2}}{R} \qquad \text{- A25-32}$$

using similar arguments to those outlined in the previous section

$$0 = \frac{1}{\rho}\frac{\partial P}{\partial R} - \frac{\partial}{\partial R}(\overline{v'^2}) - \frac{\partial}{\partial x}(\overline{u'v'}) \qquad \text{- A 25-33}$$

also the term $\frac{\partial}{\partial x}(\overline{u'v'})$ is at least one order magnitude smaller than the term $\frac{\partial}{\partial R}(\overline{v'^2})$ and will consequently be suppressed. Eqn. A25-33 can then be integrated to give

$$\overline{v'^2} = -\frac{P}{\rho} + \text{const.} \qquad \text{- A25-34}$$

Rearranging Eqn. A25-31

$$u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial R} = -\frac{1}{\rho}\frac{\partial P}{\partial x} - \frac{\partial}{\partial x}(\overline{u'^2}) + \left(\frac{\mu}{\rho}\frac{1}{R}\frac{\partial u}{\partial R} - \frac{\overline{u'v'}}{R}\right) + \left(\frac{\mu}{R}\frac{\partial^2 u}{\partial R^2} - \frac{\partial}{\partial R}(\overline{u'v'})\right)$$

The total shear stress is given by

$$\frac{\tau}{\rho} = \left(-\overline{u'v'} + \frac{\mu}{\rho}\frac{\partial u}{\partial R}\right) \quad \& \quad \frac{1}{\rho}\frac{\partial \tau}{\partial R} = \left(-\frac{\partial}{\partial R}(\overline{u'v'}) + \frac{\mu}{\rho}\frac{\partial^2 u}{\partial R^2}\right)$$

$$\therefore\ u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial R} = -\frac{1}{\rho}\frac{\partial P}{\partial x} - \frac{\partial}{\partial x}(\overline{u'^2}) + \frac{1}{\rho}\left[\frac{\tau}{R} + \frac{\partial \tau}{\partial R}\right]$$

$$\therefore\ u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial R} = -\frac{1}{\rho}\frac{\partial P}{\partial x} - \frac{\partial}{\partial x}(\overline{u'^2}) + \frac{1}{\rho R}\frac{\partial (R\tau)}{\partial R} \qquad \text{- A25-35}$$

The constant of integration in Eqn. A25-34 is determined by the conditions at the edge of the layer ($R = R_m$) thus

$$\overline{v'^2}_m = -\frac{P_m}{\rho} + \text{const.} \qquad \therefore\ \frac{P}{\rho} = \frac{P_m}{\rho} + (\overline{v'^2}_m - \overline{v'^2})$$

and $$\frac{1}{\rho}\frac{\partial P}{\partial x} = \frac{1}{\rho}\frac{\partial P_m}{\partial x} + \frac{\partial}{\partial x}(\overline{v'^2}_m - \overline{v'^2}) \qquad \text{- A25-36}$$

Writing the Bernoulli Equation at R_m

$$P_{T_m} = P_m + \frac{1}{2}\rho U^2$$

$$\frac{1}{\rho}\left(\frac{\partial P_T}{\partial x}\right)_m = \frac{1}{\rho}\frac{\partial P_m}{\partial x} + U\frac{\partial U}{\partial x}$$

Substituting in Eqn. A25-36 we obtain

$$\frac{1}{\rho}\frac{\partial P}{\partial x} = \frac{1}{\rho}\left(\frac{\partial P_T}{\partial x}\right)_m - U\frac{\partial U}{\partial x} + \frac{\partial}{\partial x}(\overline{v'^2}_m - \overline{v'^2}) \qquad \text{- A25-37}$$

Eqn. A25-11 for turbulent flow becomes

$$\frac{\partial}{\partial x}(Ru^2) + \frac{\partial}{\partial R}(Ruv) = -\frac{R}{\rho}\frac{\partial P}{\partial x} + \frac{1}{\rho}\frac{\partial (R\tau)}{\partial R} - R\frac{\partial}{\partial x}(\overline{u'^2}) \qquad \text{- A25-38}$$

Subtracting Eqns. A25-12 and A25-38 we obtain

$$\frac{\partial}{\partial x}\left[Ru\left(U-u\right)\right]+\frac{\partial}{\partial R}\left[RV\left(U-u\right)\right]=Ru\frac{\partial U}{\partial x}+\frac{R}{\rho}\frac{\partial P}{\partial x}-\frac{1}{\rho}\frac{\partial}{\partial R}\left(R\tau\right)+R\frac{\partial}{\partial x}\left(\overline{u'^2}\right)$$

Substituting for $\frac{R}{\rho}\frac{\partial P}{\partial x}$ from Eqn. A25-37

$$\frac{\partial}{\partial x}\left[Ru\left(U-u\right)\right]+\frac{\partial}{\partial R}\left[RV\left(U-u\right)\right]=R\frac{\partial U}{\partial x}\left(u-U\right)+\frac{R}{\rho}\left(\frac{\partial P_T}{\partial x}\right)_m-\frac{1}{\rho}\frac{\partial}{\partial R}\left(R\tau\right)+$$

$$R\frac{\partial}{\partial x}\left(\overline{u'^2}+\overline{v'_m}-\overline{v'^2}\right)- \quad \text{A25-39}$$

Eqn. A25-39 is the turbulent version of Eqn. A25-15

Applying Eqn. A25-39 to the inner wall boundary layer and proceeding as before yields

$$\frac{d\theta_1}{dx}+\frac{\theta_1}{R_1}\frac{dR_1}{dx}+\frac{\theta_1}{U}\frac{dU}{dx}\left(H_1+2\right)=\frac{R_m^2-R_1^2}{R_1}\frac{1}{2\rho U^2}\left(\frac{dP_T}{dx}\right)_m+\frac{\tau\omega_1}{\rho U^2}+\frac{1}{U^2}\frac{d}{dx}\int_{R_1}^{R_m}\left(\overline{u'^2}+\overline{v'^2_m}-\overline{v'}^2\right)\frac{R}{R_i}\,dR$$

$$- \text{A25-40}$$

In view of possible errors in the turbulence measurements and the large radius ratio $\left(\frac{R_i}{R_o}\right)$, we may write, without incurring any significant error;

$$\frac{1}{U^2}\frac{d}{dx}\int\left(\overline{u'}^2+\overline{v'}^2_m-\overline{v'}^2\right)\frac{R}{R_1}\,dR=\frac{1}{U^2}\frac{d}{dx}\int\left(\overline{u'^2}+\overline{v'}^2_m-\overline{v'^2}\right)dR$$

Appendix 26

Computer Programme

Power Law Prediction Method

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C                PROGRAMME BASED ON POWER LAW VELOCITY PROFILE EQUATION


COMMENT**PREDICTION OF BOUNDARY LAYER PROFILES IN AN ANNULAR DIFFUSER
CXXXXXTHIS PROGRAM STARTS WITH KNOWN INLET CONDITIONS AND CALCULATES THE
C      VARIATION OF THE SHAPE PARAMETER ON INNER AND OUTER WALLS IN A
C      STEP BY STEP CALCULATION ALONG THE LENGTH OF THE DIFFUSER
CXXXXXWARNINGXXXXIT IS ASSUMED THAT FULLY DEVELOPED FLOW IS PRESENT AT
C      DIFFUSER INLET I.E. NO POTENTIAL CORE EXISTS
CXXXXXINNER AND OUTER LAYERS ARE ANALYSED SEPARATELY ON THE ASSUMPION
C      THAT NO NET MASS TRANSFER TAKES PLACE . THE INNER AND OUTER LAYERS
C      ARE MATCHED AT THE POSITION OF MAXIMUM VELOCITY SINCE THE MAX.
C      VELOCITY IN EACH LAYER MUST BE THE SAME


       DIMENSION X(100),Y(100),A(10,10),U(9),BP(60),DCDEL(60)
       DIMENSION DELTHO(50),DISNO(50),ENGRAD(50),DPTDX(50),DELTHI(50)
       DIMENSION DISNI(50),SHSTO(50),CFO(50),GRADPO(50),GEOMPO(50)
       DIMENSION SHSTI(50),CFI(50),GRADPI(50)
       DIMENSION ARA(50),LOS(50),CPA(50),RHA(50)
       DIMENSION ALPHA(50),DPTMA(50)
       DIMENSION YAC(50),HDA(50),THETO(50),HIA(50),THETI(50),UMMA(50)
       DIMENSION F(10,10),V(9),DPTDXC(20),MAXIOC(20)
       REAL LOS,LOSCOF


CXXXXXINPUT DATA

C      MAXIOC & DPTDXC ARE THE VALUES OF OUTER WALL SHAPE PARAMETER AND
C      TOTAL PRESSURE GRADIENT AT THE POINT OF MAXIMUM VELOCITY USED IN
C      THE CORRELATION OF THE EXPERIMENTAL DATA
C      RO1-OUTER WALL RADIUS AT INLET(INS)
C      RI1-INNER WALL RADIUS AT INLET(INS)
C      RM1-RADIUS OF POINT OF MAXIMUM VELOCITY AT INLET(FT/SEC)
C      HO1-A FUNCTION OF THE EXPONENT OF OUTER WALL VELOCITY PROFILE EQN.
C      HI1-A FUNCTION OF THE EXPONENT OF INNER WALL VELOCITY PROFILE EQN.
C      DRDXO-TANGENT OF OUTER WALL ANGLE
C      DRDXI-TANGENT OF INNER WALL ANGLE
C      RHO-INLET DENSITY (LB/CUBIC FEET)
C      DX-STEP LENGTH(INS)
C      DH-STEP CHANGE IN SHAPE PARAMETER REQUIRED FOR ITERATION PROCEDURE
C      DRM-STEP IN RADIUS OF POINT OF MAXIMUM VELOCITY REQUIRED FOR
C      ITERATION PROCEDURE
C      DUM-ALLOWABLE DIFFERENCE BETWEEN UMAX CALCULATED FOR INNER AND
C      OUTER LAYERS AT ANY STATION
C      DH-ALLOWABLE DIFFERENCE BETWEEN L.H.S. & R.H.S. OF MOMENTUM EQN.
C      PS1-INLET STATIC PRESSURE(LB/SQIN)
C      ENU-KINEMATIC VISCOSITY(SQFT/SEC)
C      UMO1-MAXIMUM VELOCITY OF OUTER LAYER AT INLET(FT/SEC)
C      UMI1-MAXIMUM VELOCITY OF INNER LAYER AT INLET(EQUAL TO UM01)FT/SEC
C      WALANO-OUTER WALL ANGLE(DEGREES)
C      WALANI-INNER WALL ANGLE(DEGREES)
C      XLIMIT-THE MAXIMUM DISTANCE ALONG THE LENGTH OF THE DIFFUSER TO
C      WHICH THE CALCULATIONS PROCEED
C      DIFNDL-DIFFUSER NON-DIMENSIONAL LENGTH
C      XACTIN-STATION AT WHICH CALCULATIONS COMMENCE
C      CPINT-INITIAL VALUE OF CP, USUALLY ZERO UNLESS CALCULATIONS START
C      DOWNSTREAM OF DIFFUSER INLET
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C       RMLOSI-INITIAL TOTAL PRESSURE LOSS AT POINT OF MAXIMUM VELOCITY
C       (ZERO UNLESS CALCULATIONS START DOWNSTREAM OF DIFFUSER INLET)
C       DPTMO-INITIAL GRADIENT OF TOTAL PRESSURE AT POINT OF MAXIMUM
C       VELOCITY (BASED ON OUTER WALL LAYER)
C       DPTMI-INITIAL GRADIENT OF TOTAL PRESSURE AT POINT OF MAXIMUM
C       VELOCITY (BASED ON INNER WALL LAYER)
C       CD1O-INITIAL VALUE OF DISSIPATION COEFFICIENT (OUTER WALL LAYER)
C       CD1I-INITIAL VALUE OF DISSIPATION COEFFICIENY (INNER WALL LAYER)
C       G1,G5,G6,G7-CONTROL CARDS

C*****ITERATION LIMITS

C       DUM=0.05 FT/SEC  (APPROX. 0.05%)
C       DM=0.001


        READ(1,993) (MAXIOC(I),I=1,12)
  993   FORMAT(12F0.0)
        READ(1,993) (DPTDXC(I),I=1,12)
  701   READ(1,20)RO1,RI1,RM1
   20   FORMAT(3F0.0)
        READ(1,21)HO1,HI1,DRDXO,DRDXI,RHO
   21   FORMAT(5F0.0)
        READ(1,22)DX,DH,DRM
   22   FORMAT(3F0.0)
        READ(1,23)DUM,DM
   23   FORMAT(2F0.0)
        READ(1,24)PS1,ENU,UMO1,UMI1
   24   FORMAT(4F0.0)
        READ(1,25)WALANO,WALANI,XLIMIT,DIFNDL
   25   FORMAT(4F0.0)
        READ(1,502)XACTIN,CPINT,RMLOSI,DPTMO,DPTMI,CD1O,CD1I
  502   FORMAT(7F0.0)
        READ(1,400)G1,G5,G6,G7
  400   FORMAT(4F0.0)


        M=0

C       CURVE FIT FOR CORRELATION OF EXPERIMENTAL VALUES OF TOTAL PRESSURE
C       GRADIENT AT THE POINT OF MAXIMUM VELOCITY

        N=0
        DO 994 I=1,12
        N=N+1
        Y(I)=DPTDXC(I)
  994   X(I)=MAXIOC(I)
        CALL CURVEFIT(N,X,Y,F,SE,V)

CXXXXXCALCULATION OF INLET BOUNDARY LAYER PARAMETERS ASSUMING POWER LAW
C       VELOCITY PROFILES



CXXXXXWARNINGXXXXHO1 & HI1 ARE RELATED TO THE EXPONENT OF THE VELOCITY
C       PROFILE EQUATION VIZ. 0.5(HO1-1.). THEY ARE NOT TO BE CONFUSED
C       WITH THE BOUNDARY LAYER SHAPE PARAMETERS CALCULATED FROM THE
C       AXISYMMETRIC DEFINITIONS OF BOUNDARY LAYER THICKNESS.
```

```
C       OUTER WALL BOUNDARY LAYER



C       CALCULATION OF OUTER WALL MOMENTUM THICKNESS (THETO1-INS)
        HP1=(H01+1.)/2.
        HP2=(H01+3.)/2.
        HP2=HP1*HP2
        HP3=H01*(H01+1.)
        B1=1./HP2
        HP4=(((3.*H01)-1.0)/2.)
        HP5=HP4*(((3.*H01)+1.0)/2.)
        B2=1 /HP3
        B2=B1-B2
        B3=(R01-RM1)/R01
        B3=B2*B3
        B4=(1./HP1)-(1./H01)
        B4=(RM1*B4)/R01
        THETO1=(B4+B3)*(R01-RM1)

C       CALCULATION OF OUTER WALL DISPLACEMENT THICKNESS (DLSTO1-INS)

        A1=RM1/HP1
        A2=(R01-RM1)/HP2
        A3=A1+A2
        A3=A3/R01
        A4=(R01+RM1)/(2.*R01)
        A4=A4-A3
        DLSTO1=A4*(R01-RM1)

C       CALCULATION OF OUTER WALL ENERGY THICKNESS (ENTHO1-INS)

        A1=(R01-RM1)*RM1
        A2=(R01-RM1)**2.
        A1=A1/HP4
        A2=A2/HP5
        A3=(A2+A1)/R01
        A4=((R01*R01)-(RM1*RM1))/(2.*R01)
        ENTHO1=A4-DLSTO1-A3

C       URATO1-RATIO OF MEAN TO MAXIMUM VELOCITY IN OUTER LAYER
C       HBARO1-OUTER WALL B.L. SHAPE PARAMETER BASED ON AXISYMMETRIC
C       DEFINITIONS OF BOUNDARY LAYER THICKNESS
C       UMNO1-MEAN VELOCITY IN OUTER LAYER(FT/SEC)
C       RENO1-REYNOLDS NO. BASED ON MOMENTUM THICKNESS OF OUTER LAYER
C       TAUO1=OUTER WALL SKIN FRICTION COEFFICIENT/2. BASED ON LUDWIEG AND
C       TILLMAN EQN.

        C1=(2*R01*DLSTO1)/((R01**2.)-(RM1**2.))
        URATO1=1.-C1
        HBARO1=DLSTO1/THETO1
        UMNO1=URATO1*UMO1
        RENO1=(UMO1*THETO1)/(ENU*12.)
        TAUO1=(0.123)/((10.**(0.678*H01))*(RENO1**0.268))

C       INNER WALL BOUNDARY LAYER

C       CALCULATION OF INNER WALL MOMENTUM THICKNESS (THETI1-INS)

        HR1=(HI1+1.)/2.
        HR2=(HI1+3.)/2.
        HR2=HR1*HR2
        HR3=HI1*(HI1+1.)
        HR4=(((3.*HI1)-1.0)/2.)
```

```
      HR5=HR4*(((3 *HI1)+1.0)/2.)
      D1=1./HR2
      D2=1 /HR3
      D2=D1-D2
      D3=(RM1-RI1)/RI1
      D3=D2*D3
      D4=(1./HR1)-(1./HI1)
      D4=(RM1*D4)/RI1
      THETI1=(D4-D3)*(RM1-RI1)

C     CALCULATION OF INNER WALL DISPLACEMENT THICKNESS (DLSTI1-INS)

      E1=RM1/HR1
      E2=(RM1-RI1)/HR2
      E3=E1-E2
      E3=E3/RI1
      E4=(RM1+RI1)/(2.*RI1)
      E4=E4-E3
      DLSTI1=E4*(RM1-RI1)

C     CALCULATION OF INNER WALL ENERGY THICKNESS (ENTHI1-INS)

      E1=(RM1-RI1)*RM1
      E2=(RM1-RI1)**2.
      E1=E1/HR4
      E2=E2/HR5
      E3=(E1-E2)/RI1
      E4=((RM1*RM1)-(RI1*RI1))/(2.*RI1)
      ENTHI1=E4-DLSTI1-E3

C     URATI1-RATIO OF MEAN TO MAXIMUM VELOCITY IN INNER LAYER
C     HBARI1-INNER WALL B.L. SHAPE PARAMETER BASED ON AXISYMMETRIC
C     DEFINITIONS OF BOUNDARY LAYER THICKNESS
C     UMNI1-MEAN VELOCITY IN INNER LAYER(FT/SEC)
C     RENI1-REYNOLDS NO. BASED ON MOMENTUM THICKNESS OF INNER LAYER
C     TAUI1-INNER WALL SKIN FRICTION COEFFICIENT/2. (L.&T.EQN.)
C     PT-TOTAL PRESSURE AT POSITION OF MAXIMUM VELOCITY (ASSUMING
C     CONSTANT STATIC PRESSURE ACROSS THE ANNULUS)
C     PCF-STATIC PRESSURE RISE COEFFICIENT (SET AT ZERO AT INLET)

      URATI1=1.-(2 *RI1*DLSTI1)/((RM1**2.)-(RI1**2.))
      HBARI1=DLSTI1/THETI1
      UMNI1=URATI1*UMI1
      RENI1=(UMI1*THETI1)/(ENU*12.)
      TAUI1=(0.123)/((10.**(0.678*HI1))*(RENI1**0.268))
      UMNX1=(UMNO1+UMNI1)/2.

C     CALCULATION OF RATIO OF MEAN TO MAXIMUM VELOCITY (UMMAX)

      UMMAX=1 0-(2 *RO1*DLSTO1)/((RO1*RO1)-(RI1*RI1))-(2.*RI1*DLSTI1)/((
     1RO1*RO1)-(RI1*RI1))

C     CALCULATION OF VELOCITY PROFILE ENERGY COEFFICIENT (ALPH)

      ALPH=A1+A2+E1-E2
      ALPH=(2 *ALPH)/((RO1*RO1)-(RI1*RI1))
      UMMAX=1 -((RO1*DLSTO1)+(RI1*DLSTI1))/(0.5*((RO1*RO1)-(RI1*RI1)))
      ALPH=ALPH/(UMMAX*UMMAX*UMMAX)
      ALPHIN=ALPH
      WRITE(2,700)ENTHO1,ENTHI1,ALPH
  700 FORMAT(3E10.6)
```

```
      RIINT=RI1
      ROINT=RO1
      HOINT=HBARO1
      HIINT=HBARI1
      THOINT=THETO1
      THIINT=THETI1
      UMINT=UMO1
      RMINT=RM1
      XACT=XACTIN


CXXXXXCALCULATION OF BOUNDARY LAYER PARAMETERS AT A STATION DISTANCE DX
C     FROM INLET.
CXXXXXIT IS ASSUMED THAT NO NET MASS TRANSFER TAKES PLACE BETWEEN THE
C     LAYERS. INITIALLY IT IS ALSO ASSUMED THAT THE RADIUS OF THE
C     POSITION OF MAX. VELOCITY REMAINS UNALTERED. THIS ASSUMPTION WILL
C     LEAD TO A DIFFERENCE IN THE MAX. VELOCITY CALCULATED FOR INNER AND
C     OUTER LAYERS AND IN ORDER TO SATISFY THE CONDITION THAT UMO2=UMI2
C     THE RADIUS OF THE POSITION OF MAX. VELOCITY (RM2) IS ADJUSTED


C     RO2-OUTER WALL RADIUS AT X+DX
C     RI2-INNER WALL RADIUS AT X+DX
C     HO2 A FUNCTION OF THE EXPONENT OF THE VELOCITY PROFILE EQUATION
C     IT IS INITIALLY SET AT THE INLET VALUE
C     HP1-EXPONENT OF VELOCITY PROFILE EQN
C     RM2-RADIUS OF POSITION OF MAXIMUM VELOCITY INITIALLY SET AT INLET
C     VALUE
C     UU&EU ARE USED FOR COUNTING THE NO. OF ITERATIONS

   10 XACT=XACT+DX
      IF(XACT-XLIMIT)402,8,8
  402 CONTINUE
      RO2=RO1+DRDXO*DX
      RI2=RI1+DRDXI*DX
      HO2=HO1
      RM2=RM1
 1000 UU=0
  300 EU=0

CXXXXXCALCULATION OF OUTER WALL BOUNDARY LAYER PARAMETERS AT X+DX

C     THETO2-OUTER WALL MOMENTUM THICKNESS

    1 HP1=(HO2+1.)/2.
      HP2=(HO2+3.)/2.
      HP2=HP1*HP2
      HP3=HO2*(HO2+1.)
      HP4=(((3.*HO2)**2)-1.0)/2.)
      HP5=HP4*(((3.*HO2)+1.0)/2.)
      B1=1./HP2
      B2=1./HP3
      B2=B1-B2
      B3=(RO2-RM2)/RO2
      B3=B3*B2
      B4=(1./HP1)-(1./HO2)
      B4=(RM2*B4)/RO2
      THETO2=(B4+B3)*(RO2-RM2)

C     DLSTO2-OUTER WALL DISPLACEMENT THICKNESS
```

```
      A1=RM2/HP1
      A2=(RO2-RM2)/HP2
      A3=A1+A2
      A3=A3/RO2
      A4=(RO2+RM2)/(2.*RO2)
      A4=A4-A3
      DLSTO2=A4*(RO2-RM2)

C     ENTHO2-OUTER WALL ENERGY THICKNESS

      A1=(RO2-RM2)*RM2
      A2=(RO2-RM2)**2.
      A1=A1/HP4
      A2=A2/HP5
      A3=(A2+A1)/RO2
      A4=((RO2*RO2)-(RM2*RM2))/(2.*RO2)
      ENTHO2=A4-DLSTO2-A3

C     URATO2-RATIO OF MEAN TO MAX. VELOCITY IN OUTER LAYER
C     DTHXO-RATE OF CHANGE OF MOMENTUM THICKNESS IN OUTER LAYER
C     UMO2-MAX. VELOCITY IN OUTER LAYER AT X+DX CALCULATED FROM
C     CONTINUITY EQN.
C     DUMDXO-RATE OF CHANGE OF MAXIMUM VELOCITY IN OUTER LAYER
C     UMNO2-MEAN VELOCITY IN OUTER LAYER
C     TAUO2-OUTER WALL SKIN FRICTION COEFFICIENT/2. (L.& T. EQN)
C     TAUOX-MEAN OUTER WALL SKIN FRICTION COEFFICIENT
C     HBARO2-OUTER WALL BOUNDARY LAYER SHAPE PARAMETER

      C1=(2.*RO2*DLSTO2)/((RO2**2.)-(RM2**2.))
      URATO2=1.-C1
      DTHXO=(THETO2-THETO1)/DX
      UMO2=(((RO1**2.)-(RM1**2.))*URATO1*UMO1)/(((RO2**2.)-(RM2**2.))*UR
     1ATO2)
      DUMDXO=(UMO2-UMO1)/DX
      UMNO2=URATO2*UMO2
      RENO2=(UMO2*THETO2)/(ENU*12.)
      TAUO2=(0.123)/((10.**(0.678*HO2))*(RENO2**0.268))
      CF2O=2.*TAUO2
      TAUOX=(TAUO1+TAUO2)/2.
      HBARO2=DLSTO2/THETO2
      GRADPX=THETO1*((DUMDXO*(HBARO1+2.))/UMO1)
      GEOMPX=THETO1*(DRDXO/RO1)

C     SUBROUTINE FOR CALCULATING NORMAL STRESS TERM

      IF(G1.EQ.1.0)GO TO 7500
      DDELTA=DLSTO2-DLSTO1
      DDELDX=DDELTA/DX
      REYSCO=0.0345*(HBARO2-1.0)*DDELDX
      GO TO 7501
 7500 REYSCO=0.0
 7501 CONTINUE
      DPTDXO=0.0

C     CALCULATION OF TOTAL PRESSURE LOSS FROM TEST DATA

      IF(G5.EQ.1.0)GO TO 7505
      D=HBARO2
      DPTDXO=V(1)+V(2)*D+V(3)*(D**2)+V(4)*(D**3)+V(5)*(D**4)+V(6)*(D**5)
     1+V(7)*(D**6)+V(8)*(D**7)+V(9)*(D**8)
      DHYRAU=(((RO2*RO2)-(RM2*RM2))/RO2)*2.
```

```
      DPTDX0=-DPTDX0/DHYRAU
      WRITE(2,6802)DPTDX0
 6802 FORMAT(2X,F10.6)
 7505 CONTINUE

C     CALCULATION OF DISSIPATION COEFFICIENT DUE TO GOLDBERG

      PSGDN=(THET01*DUMDX0)/UM01
      CDECDP=1.-(25000000.0*(PSGDN**3))+(100.0*PSGDN)
      REN01=(UM01*THET01)/(ENU*12.)
      CDFP=0.0112/(REN01**.1667)
      CDEQL=CDFP*CDECDP
      DCDDX=(0.009*(CDEQL-CD10))/THET01
      DCD=DCDDX*DX
      CD20=CD10+DCD
      CD=CD20

C     CALCULATION OF TOTAL PRESSURE GRADIENT TERM IN MOMENTUM EQN (BASED
C     ON OUTER WALL CALCULATIONS)

      IF(G6.EQ.1.0)GO TO 136
      DPTM02=(((R02*R02)-(RM2*RM2))/R02)*DPTDX0*0.25
      GO TO 137
  136 DPTM0=0.0
      DPTDX0=0.0

C     DMLHS-LEFT HAND SIDE OF MOMENTUM EQN. (OUTER WALL)
CXXXXXIF THE CORRECT EXPONENT OF THE VELOCITY PROFILE EQN. HAS BEEN
C     ASSUMED DMLHS WILL BE ZERO OR WITHIN THE LIMITS SPECIFIED BY DM
C     IF DMLHS IS OUTSIDE THE SPECIFIED LIMITS THEN A NEW VALUE OF
C     EXPONENT IS ESTIMATED AND THE CALCULATION REPEATED UNTIL DMLHS
C     COMES WITHIN LIMITS

  137 DMLHS=DTHX0+THET01*((DRDX0/R01)+(DUMDX0*(HBAR01+2.))/UM01)-TAUOX+D
     1PTM0-REYSC0
      DPTDXR=DPTDX0
      WRITE(2,500)DMLHS,H02,HBAR02,DPTM0,REYSC0
  500 FORMAT(5E10.6)

CXXXXXREITERATION PROCEDURE TO FIND CORRECT EXPONENT OF OUTER WALL
C     VELOCITY PROFILE EQN.

      EU=1.+EU
      EV=EU-2
      IF(EV)80,81,81
   80 S1=ABS(DMLHS)
      S2=S1-DM
      IF(S2)2,2,83
   83 S3=DMLHS
      ERROR=DMLHS-DM
      S4=H02
      IF(ERROR)84,2,85
   84 H02=H02+DH
      GO TO 1
   85 H02=H02-DH
      GO TO 1
   81 S1=ABS(DMLHS)
      S2=S1-DM
      IF(S2)2,2,86
   86 S5=S3-DMLHS
      S6=H02-S4
```

```
      S7=S5/S6
      S8=S3/S7
      H02=S4+S8
      GO TO 1

CXXXXXCALCULATION OF INNER WALL BOUNDARY LAYER PARAMETERS AT X+DX

C     TU=USED FOR COUNTING THE NO. OF ITERATIONS

C     THETI2=INNER WALL MOMENTUM THICKNESS

    2 HI2=HI1
      TU=0
    3 HR1=(HI2+1.)/2.
      HR2=(HI2+3.)/2.
      HR2=HR1*HR2
      HR3=HI2*(HI2+1.)
      HR4=(((3.*HI2)-1.0)/2.)
      HR5=HR4*(((3.*HI2)+1.0)/2.)
      D1=1./HR2
      D2=1./HR3
      D2=D1-D2
      D3=(RM2-RI2)/RI2
      D3=D2*D3
      D4=(1./HR1)-(1./HI2)
      D4=(RM2*D4)/RI2
      THETI2=(D4-D3)*(RM2-RI2)

C     DLSTI2=INNER WALL DISPLACEMENT THICKNESS

      E1=RM2/HR1
      E2=(RM2-RI2)/HR2
      E3=E1-E2
      E3=E3/RI2
      E4=(RM2+RI2)/(2.*RI2)
      E4=E4-E3
      DLSTI2=E4*(RM2-RI2)

C     ENTHI2=INNER WALL ENERGY THICKNESS

      E1=(RM2-RI2)*RM2
      E2=(RM2-RI2)**2.
      E1=E1/HR4
      E2=E2/HR5
      E3=(E1-E2)/RI2
      E4=((RM2*RM2)-(RI2*RI2))/(2.*RI2)
      ENTHI2=E4-DLSTI2-E3

C     URATI2=RATIO OF MEAN TO MAX. VELOCITY IN INNER LAYER
C     DTHXI=RATE OF CHANGE OF MOMENTUM THICKNESS IN INNER LAYER
C     UMI2=MAX. VELOCITY IN INNER LAYER AT X+DX CALCULATED FROM
C     CONTINUITY EQN.

      URATI2=1.-(2.*RI2*DLSTI2)/((RM2**2.)-(RI2**2.))
      DTHXI=(THETI2-THETI1)/DX
      UMI2=(((RM1**2.)-(RI1**2.))*URATI1*UMI1)/(((RM2**2.)-(RI2**2.))*UR
     1ATI2)

C     DUMDXI=RATE OF CHANGE OF MAXIMUM VELOCITY IN INNER LAYER
```

```
C       UMNI2-MEAN VELOCITY IN INNER LAYER
C       TAUI2-INNER WALL SKIN FRICTION COEFFICIENT/2. (L. & T.EQN)
C       HBARI2-INNER WALL BOUNDARY LAYER SHAPE PARAMETER

        DUMDXI=(UMI2-UMI1)/DX
        UMNI2=URATI2*UMI2
        RENI2=(UMI2*THETI2)/(ENU*12.)
        TAUI2=(0.123)/((10.**(0.678*HI2))*(RENI2**0.268))
        CF2I=2.*TAUI2
        TAUIX=(TAUI1+TAUI2)/2.
        HBARI2=DISTI2/THETI2
        GRADPY=THETI1*((DUMDXI*(HBARI1+2.))/UMI1)

C       CALCULATION OF DISSIPATION COEFFICIENT USING THE CORRELATION DUE
C       TO GOLDBERG

        PSGDN=(THETI1*DUMDXI)/UMI1
        CDECDP=1.-(25000000.0*(PSGDN**3))-(100.0*PSGDN)
        RENI1=(UMI1*THETI1)/(ENU*12.)
        CDFP=0.0112/(RENI1**0.1667)
        CDEQI=CDFP*CDECDP
        DCDDX=(0.002*(CDEQL-CD1I))/THETI1
        DCD=DCDDX*DX
        CD2I=CD1I+DCD
        CDI=CD2I

C       SUBROUTINE FOR CALCULATING NORMAL STRESS TERM

        IF(G1.EQ.1.0)GO TO 7506
        DDELTA=DLSTI2-DLSTI1
        DDELDX=DDELTA/DX
        REYSCI=0.0365*(HBARI2-1.0)*DDELDX
        GO TO 7507
 7506   REYSCI=0.0
 7507   CONTINUE

C       CALCULATION OF TOTAL PRESSURE GRADIENT TERM IN MOMENTUM EQN (BASED
C       ON THE OUTER WALL VALUE OF THE TOTAL PRESSURE GRADIENT)

        IF(G6.EQ.1.0)GO TO 138
        DPTMI2=(((R12*RH2)-(RI2*RI2))/RI2)*DPTDX0*0.25
        GO TO 139
  138   DPTMI=0.0

C       DMLHT-LEFT HAND SIDE OF MOMENTUM EQN. (INNER WALL)

  139   DMLHT=DTHXI+THETI1*((DRDXI/RI1)+(DUMDXI*(HBARI1+2.))/UMI1)-TAUIX-D
       1PTMI-REYSCI
        WRITE(2,500)DMLHT,HI2,HBARI2,DPTMI,REYSCI

CXXXXXSAME PROCEDURE AS OUTLINED IN OUTER WALL CALCULATION FOR BALANCING
C       INNER WALL MOMENTUM EQN.
CXXXXXITERATION PROCEDURE TO FIND CORRECT EXPONENT OF INNER WALL
C       VELOCITY PROFILE EQN.

        TU=1.+TU
        TV=TU-2
        IF(TV)180,181,181
  180   S1=ABS(DMLHT)
        S2=S1-DU
        IF(S2)4,4,183
```

```
  183 S3=DMLHT
      ERRIR=DMLHT-DM
      S4=HI2
      IF(ERRIR)184,4,185
  184 HI2=HI2+DH
      GO TO 3
  185 HI2=HI2-DH
      GO TO 3
  181 S1=ABS(DMLHT)
      S2=S1-DM
      IF(S2)4,4,186
  186 S5=S3-DMLHT
      S6=HI2-S4
      S7=S5/S6
      S8=S3/S7
      HI2=S4+S8
      GO TO 3


CXXXXXHAVING SOLVED THE MOMENTUM EQUATIONS THE VALUES OF MAX. VELOCITY
C     FOR THE TWO LAYERS ARE COMPARED. IF THEY ARE THE SAME OR WITHIN
C     THE LIMITS SPECIFIED BY DUM THEN THE CORRECT VALUE OF THE POSITION
C     OF MAXIMUM VELOCITY(RM2) HAS BEEN ASSUMED. IF THE DIFFERENCE IN
C     VELOCITY(UMLHS) IS OUTSIDE THE SPECIFIED LIMITS THEN A NEW VALUE
C     OF RM2 IS ESTIMATED AND THE CALCULATIONS REPEATED UNTIL (UMLHS)
C     COMES WITHIN LIMITS.


    4 CONTINUE
      UMLHS=UM02-UM12
      WRITE(2,501)UM02,UM12,UMLHS,RM2
  501 FORMAT(10X,4F12.6)

CXXXXXITERATION PROCEDURE TO FIND CORRECT VALUE OF RM2

      UU=1 +UM
      UV=UU-2
      IF(UV)280,281,281
  280 T1=ABS(UMLHS)
      T2=T1-DUM
      IF(T2)6,6,283
  283 T3=UMLHS
      ERRER=UMLHS-DUM
      T4=RM2
      IF (ERRER) 284,6,285
  284 RM2=RM2+DRM
      GO TO 300
  285 RM2=RM2-DRM
      GO TO 300
  281 T1=ABS(UMLHS)
      T2=T1-DUM
      IF(T2)6,6,286
  286 T5=T3-UMLHS
      T6=RM2-T4
      T7=T5/T6
      T8=T3/T7
      RM2=T4+T8
      GO TO 300


CXXXXXIF (UMLHS) IS WITHIN LIMITS THEN THE CALCULATIONS AT (X+DX) ARE
```

```
C       COMPLETE AND ALL THE DATA OBTAINED AT (X+DX) IS RE-SPECIFIED TO
C       BECOME THE DATA AT INLET TO THE NEXT STEP

    6   CONTINUE
        UMMAX=1.-((RO2*DLSTO2)*(RI2*DLSTI2))/(0.5*((RO2*RO2)-(RI2*RI2)))
        ENGRAX=3.*ENTHO2*DUMDXO/UMI1
        AREARO=((RO2*RO2)-(RI2*RI2))/11.
         UMEAN2=UMMAX*UMO2
        UMEANI=UMEAN2*AREARO
        ALPH=A1+A2+E1-E2
        ALPH=(2.*ALPH)/((RO2*RO2)-(RI2*RI2))
        ALPH=ALPH/(UMMAX*UMMAX*UMMAX)
        WRITE(2,700)ENTHO2,ENTHI2,ALPH

C       CALCULATION OF LOSS COEFFICIENT

        RMLOSC=RMLOSI+ABS((DPTDXR*UMO2*UMO2*DX)/(UMEANI*UMEANI))
        RMLOSI=RMLOSC

C*****WARNING IF CALCULATION DOES NOT COMMENCE AT X=0.0 THEN THE
C       INITIAL VALUE OF CP MUST BE THE IDEAL VALUE SO THAT WHEN THE INITI
C       INITIAL LOSS COEFF IS SUBTRACTED THE ACTUAL CP IS OBTAINED

        IF(G6.EQ.1.0)GO TO 387
        GO TO 386
  387   RMLOSC=0.0
  386   CONTINUE
        CP=CPINT+(((UMINT*UMINT)-(UMO2*UMO2))/(UMEANI*UMEANI))*RMLOSC
        CPIDI=1.047-(ALPH/(AREARO*AREARO))
        LOSCOF=CPIDI-CP

C*****STORAGE OF VALUES AT (X+DX) PRIOR TO THESE VALUES BECOMING THE
C*****INITIAL CONDITIONS TO THE NEXT STEP

        M=M+1
        I=M
        ALPHA(I)=ALPH
        RMA(I)=RM2
        DPTMA(I)=DPTMO
        CPA(I)=CP
        LOS(I)=LOSCOF
        ARA(I)=AREARO
        UMMA(I)=UMMAX
        THETI(I)=THETI2
        HIA(I)=HBARI2
        THETO(I)=THETO2
        HOA(I)=HBARO2
        XAC(I)=XACT
        DELTHO(I)=ENTHO2
        ENGRAD(I)=ENGRAX
        DPTDX(I)=DPTDXR
        DELTHI(I)=ENTHI2
        SHSTO(I)=REYSCO
        CFO(I)=CF2O
        GRADPO(I)=GRADPX
        GEOMPO(I)=GEOMPX
        SHSTI(I)=REYSCI
        CFI(I)=CF2I
        GRADPI(I)=GRADPY
        DISMI(I)=CDI
        DISMO(I)=CD
```

```
      WRITE(2,120)XACT,ARFARO,HBARO2,THETO2,HBARI2,THETI2,UNO2,CP,ALPH
  120 FORMAT(17X,F6.2,1X,F6.2,2X,F5.2,3X,F6.3,3X,F6.3,2X,F6.3,1X,F8.3,1X
     1,F6.3,3X,F6.3)
    9 DIFI=3.5-HBARO2
      IF(DIFI)8,8,11

C*****REVISED INLET CONDITIONS TO NEXT STEP

   11 HO1=HO2
      HI1=HI2
      RM1=RM2
      RO1=RO2
      RI1=RI2
      UNO1=UNO2
      UNI1=UNI2
      THETO1=THETO2
      DLSTO1=DLSTO2
      URATO1=URATO2
      HBARO1=HBARO2
      UMNO1=UMNO2
      RENO1=RENO2
      TAUO1=TAUO2
      THETI1=THETI2
      DLSTI1=DLSTI2
      URATI1=URATI2
      HBARI1=HBARI2
      UMNI1=UMNI2
      RENI1=RENI2
      TAUI1=TAUI2
      ENTHI1=ENTHI2
      ENTHO1=ENTHO2
      DPTHI=DPTHI2
      DPTHO=DPTHO2
      CD1I=CD2I
      CD1O=CD2O
      DRM=RM2-T4
      GO TO 10
    8 CONTINUE

C*****PRINT OUT OF RESULTS

      WRITE(2,141)
  141 FORMAT(1H1)
      WRITE(2,145)
  145 FORMAT(///)
      WRITE(2,100)
  100 FORMAT(30X,42HPREDICTION OF ANNULAR DIFFUSER PERFORMANCE)
      WRITE(2,101)
  101 FORMAT(/13X,18HDIFFUSER GEOMETRY.)
      WRITE(2,102)WALANO,WALANI
  102 FORMAT(/18X,19HWALL ANGLES. OUTER=,F7.3,1X,9HDEGREES ,,6HINNER=,F6
     1.3,1X,7HDEGREES)
      WRITE(2,103)ROINT,RIINT
  103 FORMAT(18X,19HINLET RADII. OUTER=,F5.2,1X,6HINS. ,,6HINNER=,F5.2,1
     1X,4HINS.)
      WRITE(2,104)DIFNDL
  104 FORMAT(18X,25HDIFFUSER NON DIMENSIONAL=,F5.1)
      WRITE(2,105)XACTIN
  105 FORMAT(/13X,45HINLET CONDITIONS (CALCULATIONS COMMENCE AT X=,F6.3,
     11X,5HINS.))
      WRITE(2,106)HOINT,HIINT
```

```
 106 FORMAT(/18X,29HSHAPE PARAMETERS. OUTER WALL=,F6.3,1X,11HINNER WALL
    1=,F6.3)
     WRITE(2,107)THOINT,THIINT
 107 FORMAT(18X,31HMOMENTUM THICKNESS. OUTER WALL=,F6.3,1X,4HINS.,11HIN
    1NER WALL=,F6.3,1X,3HINS)
     WRITE(2,108)UMINT
 108 FORMAT(18X,17HMAXIMUM VELOCITY=,F8.3,1X,6HFT/SEC)
     WRITE(2,109)RMINT
 109 FORMAT(18X,30HRADIUS OF POSITION OF MAXIMUM VELOCITY=,F6.3,1X,4HIN
    1S.//)
     WRITE(2,8926)
8926 FORMAT(/18X,58HDIST   HO   THETA   HI   THETA   UMEAN  AREA   LOSS
    1      CP,OH      RMAX)
     WRITE(2,8927)
8927 FORMAT(19X,51HX           OUTER         INNER    UMAX  RATIO  COEFF,
    114H             INS)
     DO 8922 I=1,M
8922 WRITE(2,8923)XAC(I),HOA(I),THETO(I),HIA(I),THETI(I),UMMA(I),ARA(I)
    1,LOS(I),CPA(I),RMA(I),ALPHA(I),DPTMA(I)
8923 FORMAT(17X,F5.2,1X,F5.2,1X,F6.3,1X,F5.2,1X,F6.3,2X,F6.3,1X,F5.2,2X
    1,F6.3,2X,F6.3,2X,F6.3,10X,F6.3,2X,F8.5)
     WRITE(2,110)
 110 FORMAT(/18X,49H(FOR ADDITIONAL BOUNDARY LAYER DATA SEE OVERLEAF))
     WRITE(2,141)
     WRITE(2,145)
     WRITE(2,140)
 140 FORMAT(35X,42HPREDICTION OF ANNULAR DIFFUSER PERFORMANCE)
     WRITE(2,111)
 111 FORMAT(/40X,32H(ADDITIONAL BOUNDARY LAYER DATA))
     WRITE(2,112)
 112 FORMAT(/35X,23HTHEORETICAL ASSUMPTIONS)
     WRITE(2,114)
 114 FORMAT(/35X,28HVELOCITY PROFILE = POWER LAW)
     WRITE(2,115)
 115 FORMAT(35X,46HSKIN FRICTION COEFFICIENT = LUDWIEG & TILLMANN)
     IF(G1 EQ.1.0)GO TO 156
     WRITE(2,121)
 121 FORMAT(35X,45HESTIMATE OF REYNOLDS NORMAL STRESSES INCLUDED)
     GO TO 150
 156 CONTINUE
     WRITE(2,119)
 119 FORMAT(35X,49HESTIMATE OF REYNOLDS NORMAL STRESSES NOT INCLUDED)
 150 CONTINUE
 127 IF(G5.EQ.1.0)GO TO 129
     WRITE(2,128)
 128 FORMAT(35X,51HTOTAL PRESSURE LOSS INCLUDED (EXPERIMENTAL RESULTS))
 129 IF(G6.EQ.1.0)GO TO 157
     GO TO 829
 157 CONTINUE
     WRITE(2,130)
 130 FORMAT(35X,32HTOTAL PRESSURE LOSS NOT INCLUDED)
 829 CONTINUE
     IF(G7.EQ.1.0)GO TO 8989
     WRITE(2,8988)
8988 FORMAT(35X,50HTOTAL PRESSURE LOSS INCLUDED (SHEAR STRESS GRADIENT
    1AT RMAX))
8989 CONTINUE
 131 WRITE(2,132)
 132 FORMAT(35X,49HNO NET MASS TRANSFER BETWEEN INNER & OUTER LAYERS)
     WRITE(2,133)
 133 FORMAT(35X,17HNO POTENTIAL CORE/)
```

```
      URITE(2,8928)
 8928 FORMAT(/5X,99HDIST  DEL**  DISPN.                    DEL**  DISPN.
     1N.S.C.      CF                        N.S.C.      CF)
      URITE(2,8929)
 8929 FORMAT(6X,99HX     OUTER    CDO                        INNER    CDI     OU
     1TER     OUTER                          INNER     INNER)
      DO 8924 I=1,11
 8924 URITE(2,8925)XAC(I),DELTHO(I),DISNO(I),ENGRAD(I),DPTDX(I),DELTHI(I
     1),DISNI(I),SHSTO(I),CFO(I),GRADPO(I),GFOMPO(I),SHSTI(I),CFI(I),GRA
     2DPI(I)
 8925 FORMAT(4X,F5.2,1X,F6.3,1X,F7.4,1X,F7.4,1X,F7.4,1X,F6.3,1X,F7.4,1X,
     1F7.4,1X,F8.5,1X,F7.4,1X,F8.5,1X,F7.4,1X,F8.5,1X,F7.4)
      GO TO 701
      STOP
      END
```

END OF SEGMENT, LENGTH 2378, NAME B201

```
      SUBROUTINE CURVEFIT(N,X,Y,A,S2,Z)
      DIMENSION X(100),Y(100),A(10,10),SUMX(31),SUMY(10),Z(9)
      ISW2=0
      ISW3=0
      NCASES=1
      LAST=8
      DO 173 ICASE=1,NCASES
      WRITE(2,1)
    1 FORMAT(1H1)
   70 SUMX(1)=0.
      SUMX(2)=0.
      SUMX(3)=0.
      SUMY(1)=0.
      SUMY(2)=0.
      DO 90 I=1,N
      CX=X(I)
      CY=Y(I)
      SUMX(1)=SUMX(1)+1.
      SUMX(2)=SUMX(2)+CX
      SUMX(3)=SUMX(3)+CX*CX
      SUMY(1)=SUMY(1)+CY
   90 SUMY(2)=SUMY(2)+CX*CY
      NORD=1
   91 L=NORD+1
      KK=L+1
      DO 101 I=1,L
      DO 100 J=1,L
      IK=J-1+I
  100 A(I,J)=SUMX(IK)
  101 A(I,KK)=SUMY(I)
      DO 140 I=1,L
      A(KK,I)=-1.
      KKK=I+1
      DO 110 J=KKK,KK
  110 A(KK,J)=0.
      C=1./A(1,I)
      DO 120 II=2,KK
      DO 120 J=KKK,KK
  120 A(II,J)=A(II,J)-A(1,J)*A(II,I)*C
      DO 140 II=1,I
      DO 140 J=KKK,KK
  140 A(II,J)=A(II+1,J)
      S2=0
      DO 160 J=1,N
      YJ=Y(J)
      XJ=X(J)
      S1=0.
      S1=S1+A(1,KK)
      DO 150 I=1,NORD
  150 S1=S1+A(I+1,KK)*XJ**I
  160 S2=S2+(S1-YJ)**2
      IF (ISW2) 161,161,163
  161 IF (NORD-LAST) 171,163,171
  163 WRITE(2,1020)NORD,S2
      WRITE(2,1090)
      DO 164 I=1,L
      J=I-1
      Z(I)=A(I,KK)
  164 WRITE(2,1030)J,A(I,KK)
      IF (ISW3) 165,165,167
  165 IF (NORD-LAST) 171,167,171
```

```
  167 WRITE(2,1100)
      DO 169 I=1,N
      S1=0.
      S1=A(1,KK)
      DO 168 J=1,NORD
  168 S1=S1+A(J+1,KK)*X(I)**J
      S3=Y(I)-S1
  169 WRITE(2,1040)X(I),Y(I),S1,S3
      IF (NORD-LAST) 171,173,173
  171 NORD=NORD+1
      J=2*NORD
      SUMX(J)=0.
      SUMX(J+1)=0.
      SUMY(NORD+1)=0
      DO 172 I=1,N
      CX=X(I)
      CY=Y(I)
      SUMX(J)=SUMX(J)+CX**(J-1)
      SUMX(J+1)=SUMX(J+1)+CX**J
  172 SUMY(NORD+1)=SUMY(NORD+1)+CY*CX**NORD
      GO TO 91
  173 CONTINUE
 1030 FORMAT(1X13,5XE20.8)
 1020 FORMAT(1X8HORDER = I3,5X20HMEAN SQUARE ERROR = E12.6//)
 1090 FORMAT(4H NO 10X11HCOEFFICIENT//)
 1100 FORMAT(12X1HX19X1HY16X5HYCALC19X5HERROR)
 1040 FORMAT(1X4E20.8)
      RETURN
      STOP
      END
```

END OF SEGMENT, LENGTH 726, NAME CURVEFIT

Appendix 27

Theoretical Bounday Layer Growth

Power Law Prediction Method

TABLE A27-1

O, PNE.

PREDICTION OF ANNULAR DIFFUSER PERFORMANCE

DIFFUSER GEOMETRY.

WALL ANGLES. OUTER= 10.000 DEGREES ,INNER= 0.000 DEGREES
INLET RADII. OUTER= 6.00 INS. ,INNER= 5.00 INS.
DIFFUSER NON DIMENSIONAL= 5.0

INLET CONDITIONS (CALCULATIONS COMMENCE AT X= 0.000 INS.)

SHAPE PARAMETERS. OUTER WALL= 1.304 INNER WALL= 1.281
MOMENTUM THICKNESS. OUTER WALL= 0.049 INS. INNER WALL= 0.050 INS
MAXIMUM VELOCITY= 140.000 FT/SEC
RADIUS OF POSITION OF MAXIMUM VELOCITY= 5.500 INS.

DIST X	HO	THETA OUTER	HI	THETA INNER	UMEAN UMAX	AREA RATIO	LOSS COEFF	CP	RMAX INS
0.25	1.34	0 054	1.31	0.055	0.861	1.05	0.000	0.086	5.522
0 50	1.37	0 060	1.34	0.061	0.850	1.10	0.002	0.160	5.545
0.75	1.40	0 065	1.37	0.067	0.838	1.15	0.003	0.225	5.567
1 00	1.44	0 071	1.40	0.073	0.826	1.20	0.004	0.282	5.590
1.25	1.48	0.077	1.43	0.080	0.814	1.24	0.005	0.332	5.612
1.50	1.52	0.082	1.47	0.086	0.801	1.29	0.006	0.376	5.634
1.75	1.57	0.088	1.50	0.092	0.789	1.35	0.007	0.415	5.656
2 00	1.61	0.094	1.54	0.099	0.776	1.40	0.009	0.449	5.679
2.25	1.66	0 099	1.58	0.105	0.763	1.45	0.011	0.480	5.700
2 50	1.71	0.105	1.61	0.112	0.750	1.50	0.012	0.507	5.722
2 75	1.76	0.111	1.65	0.118	0.737	1.55	0.014	0.531	5.744
3.00	1.82	0.116	1.69	0.124	0.724	1.60	0.016	0.552	5.765
3.25	1.88	0.121	1.74	0.130	0.711	1.65	0.017	0.572	5.786
3.50	1.94	0 127	1.78	0.136	0.699	1.71	0.019	0.589	5.807
3.75	2.00	0 132	1.82	0.142	0.686	1.76	0.021	0.604	5.827
4 00	2.07	0 137	1.86	0.147	0.673	1.81	0.023	0.618	5.847
4 25	2.14	0.141	1.90	0.152	0.660	1.87	0.025	0.630	5.867
4.50	2.22	0 146	1.94	0.157	0.648	1.92	0.027	0.641	5.885
4.75	2.29	0 150	1.98	0.162	0.635	1.98	0.029	0.650	5.904
5 00	2.38	0.155	2.02	0.167	0.623	2.03	0.032	0.658	5.921

(FOR ADDITIONAL BOUNDARY LAYER DATA SEE OVERLEAF)

TABLE A27-2

O, PNE.

PREDICTION OF ANNULAR DIFFUSER PERFORMANCE

(ADDITIONAL BOUNDARY LAYER DATA)

THEORETICAL ASSUMPTIONS

VELOCITY PROFILE - POWER LAW
SKIN FRICTION COEFFICIENT - LUDWIEG & TILLMANN
ESTIMATE OF REYNOLDS NORMAL STRESSES INCLUDED
TOTAL PRESSURE LOSS INCLUDED (EXPERIMENTAL RESULTS)
NO NET MASS TRANSFER BETWEEN INNER & OUTER LAYERS
NO POTENTIAL CORE

DIST X	DEL** OUTER	DISPN. CDO	$\frac{3\delta^{**}}{U}\frac{dU}{dx}$	$\frac{2}{\rho U^2}\left[\frac{dP_T}{dx}\right]_m$	DEL** INNER	DISPN. CDI	N.S.C. OUTER	CF OUTER	$\theta_o\frac{(H_o+2)}{U}\frac{dU}{dx}$	$\frac{\theta_o}{R_o}\frac{dR_o}{dx}$	N.S.C. INNER	CF INNER	$(H_i+2)\frac{\theta_i}{U}\frac{dU}{dx}$
0.25	0.096	0 0026	-0.0391	-0.0048	0.099	0.0029	0.0004	0.00335	-0.0219	0.00144	0.0004	0.00343	-0.0222
0.50	0.105	0.0036	-0.0394	-0.0053	0.109	0.0040	0.0005	0.00313	-0 0226	0.00158	0.0005	0.00322	-0.0230
0.75	0.114	0.0045	-0.0399	-0.0057	0.119	0.0049	0.0006	0.00292	-0.0235	0.00173	0.0005	0.00301	-0.0240
1.00	0.123	0.0054	-0.0406	-0.0062	0.129	0.0058	0.0007	0.00272	-0.0244	0.00187	0.0006	0.00282	-0.0246
1.25	0.132	0 0062	-0.0403	-0.0067	0.139	0.0067	0.0008	0.00252	-0.0249	0.00202	0.0007	0.00263	-0.0254
1.50	0.140	0.0069	-0.0399	-0.0071	0.149	0.0074	0.0009	0.00234	-0.0253	0.00217	0.0008	0.00245	-0.0260
1.75	0.149	0.0076	-0.0393	-0.0075	0.158	0.0081	0.0010	0.00216	-0.0255	0.00232	0.0009	0.00229	-0.0265
2.00	0.157	0.0081	-0.0386	-0.0078	0.168	0.0088	0.0012	0.00200	-0.0256	0.00246	0.0011	0.00213	-0.0269
2.25	0.166	0 0086	-0.0380	-0.0082	0.178	0.0093	0.0014	0.00183	-0.0258	0.00260	0.0011	0.00198	-0.0265
2.50	0.174	0.0091	-0.0372	-0.0085	0.188	0.0098	0.0015	0.00168	-0.0260	0.00274	0.0013	0.00184	-0.0267
2.75	0.182	0.0094	-0.0358	-0.0087	0.197	0.0102	0.0017	0.00154	-0.0257	0.00288	0.0014	0.00171	-0.0267
3.00	0.189	0 0097	-0.0345	-0.0090	0.206	0.0106	0.0019	0.00140	-0.0253	0.00301	0.0015	0.00158	-0.0261
3.25	0.196	0.0100	-0.0333	-0.0091	0.215	0.0109	0.0021	0.00127	-0.0251	0.00313	0.0017	0.00147	-0.0260
3.50	0.204	0.0102	-0.0319	-0.0093	0.223	0.0111	0.0024	0.00115	-0.0246	0.00325	0.0018	0.00136	-0.0251
3.75	0.210	0.0103	-0.0304	-0.0094	0.231	0.0113	0.0027	0.00104	-0.0241	0.00337	0.0019	0.00126	-0.0249
4.00	0.217	0 0104	-0.0289	-0.0094	0.239	0.0114	0.0030	0.00093	-0.0234	0.00348	0.0020	0.00117	-0.0238
4.25	0.223	0.0105	-0.0273	-0.0094	0.246	0.0115	0.0033	0.00084	-0 0227	0.00359	0.0022	0.00108	-0.0234
4.50	0.229	0 0106	-0.0258	-0.0094	0.253	0.0115	0.0037	0.00074	-0.0220	0.00369	0.0022	0.00101	-0.0220
4.75	0.234	0 0106	-0.0240	-0.0094	0.260	0.0116	0.0040	0.00066	-0.0211	0.00379	0.0023	0.00093	-0.0216
5.00	0.239	0.0106	-0.0216	-0 0093	0.266	0.0116	0.0046	0.00058	-0.0194	0.00387	0.0023	0.00087	-0.0199

TABLE A27-3

O, PNE.

PREDICTION OF ANNULAR DIFFUSER PERFORMANCE

DIFFUSER GEOMETRY

WALL ANGLES. OUTER= 6.650 DEGREES .INNER= 0.000 DEGREES
INLET RADII OUTER= 6 00 INS. .INNER= 5 00 INS.
DIFFUSER NON DIMENSIONAL= 7.5

INLET CONDITIONS (CALCULATIONS COMMENCE AT X= 0.000 INS.)

SHAPE PARAMETERS. OUTER WALL= 1.304 INNER WALL= 1 281
MOMENTUM THICKNESS. OUTER WALL= 0 049 INS INNER WALL= 0 050 INS
MAXIMUM VELOCITY= 140 000 FT/SEC
RADIUS OF POSITION OF MAXIMUM VELOCITY= 5 500 INS.

DIST X	Ho	THETA OUTER	HI	THETA INNER	UMEAN UMAX	AREA RATIO	LOSS COEFF	CP	RMAX INS
0 25	1.33	0 052	1.30	0 054	0.865	1 03	0.002	0 057	5.515
0 50	1.35	0 056	1.32	0.058	0.857	1 06	0.004	0 108	5.530
0 75	1.37	0 060	1.34	0.062	0.849	1 10	0.005	0 155	5.545
1 00	1.40	0 063	1.36	0.066	0.841	1 13	0.007	0 197	5.560
1 25	1.42	0 067	1.38	0 070	0.833	1 16	0 009	0 236	5.574
1 50	1.45	0 071	1.40	0.074	0.825	1.19	0.011	0 272	5.589
1 75	1.47	0 075	1.42	0.078	0.816	1 23	0.011	0 307	5.604
2 00	1.50	0 079	1.45	0.082	0.808	1 26	0.013	0 336	5.619
2 25	1.53	0 082	1.47	0 086	0.800	1 20	0.015	0 364	5.634
2 50	1.56	0 086	1.50	0 091	0.791	1 33	0.017	0 389	5.648
2 75	1.59	0 090	1.52	0.095	0.783	1 36	0.017	0 414	5.663
3 00	1.62	0 094	1.54	0 099	0.775	1 39	0 018	0 437	5.677
3 25	1.65	0 098	1.57	0 103	0.766	1 43	0.021	0 455	5.692
3 50	1.68	0 101	1.59	0.107	0.757	1 46	0 022	0 475	5.706
3 75	1.72	0 105	1.62	0 111	0.749	1 49	0 023	0 492	5.720
4 00	1.75	0 109	1.64	0.115	0.741	1 53	0 024	0 509	5.734
4 25	1.79	0 112	1.67	0 119	0.732	1.56	0 026	0 524	5.748
4 50	1.82	0 116	1.69	0.123	0.724	1 60	0 027	0 538	5.762
4 75	1.86	0 119	1.72	0.127	0.715	1 63	0 029	0 550	5.776
5 00	1.90	0 123	1.75	0 131	0.707	1 67	0 031	0 562	5.790
5 25	1.94	0 126	1.78	0.135	0.699	1 70	0 033	0 573	5.805
5 50	1.98	0 129	1.80	0 139	0 691	1 74	0.035	0 583	5.819
5 75	2.02	0 133	1.83	0.143	0.682	1 77	0 036	0 593	5.831
6 00	2.07	0 136	1.85	0.146	0.674	1 81	0 036	0 602	5.844
6 25	2.12	0 139	1.88	0.149	0.666	1 84	0 037	0 611	5.856
6 50	2.16	0 143	1 90	0.153	0 658	1 88	0 039	0 619	5.868
6 75	2.21	0 145	1.93	0.156	0.650	1 92	0 041	0 626	5.882
7 00	2.25	0 148	1.96	0.160	0 642	1 95	0.043	0 631	5.896
7 25	2.30	0 151	1.99	0.163	0.634	1 99	0 044	0 638	5.907
7 50	2.36	0 154	2.01	0.166	0.626	2 02	0.045	0 644	5.918

(FOR ADDITIONAL BOUNDARY LAYER DATA SEE OVERLEAF)

PREDICTION OF ANNULAR DIFFUSER PERFORMANCE
(ADDITIONAL BOUNDARY LAYER DATA)
THEORETICAL ASSUMPTIONS
VELOCITY PROFILE - POWER LAW
SKIN FRICTION COEFFICIENT - LUDWIEG & TILLMANN
ESTIMATE OF REYNOLDS NORMAL STRESSES INCLUDED
TOTAL PRESSURE LOSS INCLUDED (EXPERIMENTAL RESULTS)
NO NET MASS TRANSFER BETWEEN INNER & OUTER LAYERS
NO POTENTIAL CORE

DIST X	DFL** OUTER	DISPN. CDO	$\frac{3\delta^{**}}{U}\frac{dU}{dx}$	$\frac{2}{\rho U^2}\left[\frac{dP_T}{dx}\right]_m$	DFL** INNER	DISPN. CDI	N.S.C. OUTER	CF OUTER	$(H_o+2)\frac{\theta_o}{U}\frac{dU}{dx}$	$\frac{\theta_o}{R_o}\frac{dR_o}{dx}$	N.S.C. INNER	CF INNER	$(H_i+2)\frac{\theta_i}{U}\frac{dU}{dx}$
0.25	0 093	0.0019	-0 0251	-0 0046	0 .96	0 0022	0.0003	0 00343	-0 0145	0.00095	0.0002	0.00350	-0.0149
0 50	0.099	0.0023	-0 0253	-0 0049	0.103	0 0026	0.0003	0.00327	-0.0148	0.00101	0.0003	0.00335	-0.0150
0.75	0 105	0 0026	-0 0256	-0 0053	0 109	0 0029	0.0003	0.00312	-0.0152	0.00108	0.0003	0.00320	-0.0155
1.00	0 111	0 0029	-0 0258	-0 0056	0 116	0.0032	0.0004	0.00298	-0 0156	0.00114	0.0004	0.00306	-0.0160
1.25	0 117	0 0032	-0 0260	-0 0060	0 123	0.0035	0.0004	0.00284	-0 0159	0.00121	0.0004	0 00292	-0.0164
1.50	0 123	0 0035	-0 0261	-0 0063	0 129	0.0038	0.0005	0 00270	-0 0162	0.00128	0.0004	0.00279	-0.0168
1.75	0 129	0 0038	-0 0272	-0 0066	0.136	0.0041	0.0005	0.00257	-0 0172	0.00134	0.0005	0.00267	-0.0166
2.00	0.135	0 0040	-0 0256	-0 0069	0 142	0 0043	0.0006	0.00244	-0 0164	0.00141	0.0005	0.00255	-0.0174
2.25	0 140	0 0042	-0 0259	-0 0072	0 149	0.0046	0.0006	0 00232	-0 0169	0.00147	0.0006	0 00243	-0.0177
2.50	0.146	0 0044	-0 0257	-0 0074	0 156	0.0048	0 0007	0.00221	-0 0170	0.00153	0.0006	0.00232	-0.0180
2.75	0 152	0 0046	-0 0263	-0 0077	0 162	0.0050	0.0008	0 00209	-0 0177	0.00160	0.0006	0.00221	-0.0174
3.00	0.158	0 0048	-0 0261	-0 0079	0.168	0.0051	0 0008	0 00198	-0 0178	0.00166	0.0007	0.00211	-0.0175
3 25	0.163	0 0049	-0 0230	-0 0082	0.175	0.0053	0 0009	0 00187	-0 0166	0.00173	0.0008	0 00201	-0.0185
3.50	0.169	0 0051	-0 0252	-0 0084	0 181	0.0055	0.0010	0 00176	-0 0178	0.00179	0.0008	0.00192	-0.0178
3.75	0 174	0 0052	-0 0249	-0 0086	0 187	0.0056	0.0010	0.00166	-0 0178	0.00185	0.0008	0.00183	-0.0179
4.00	0 179	0 0053	-0 0244	-0 0087	0 193	0.0057	0.0011	0.00157	-0 0177	0.00191	0.0009	0 00174	-0.0180
4.25	0 184	0 0055	-0 0238	-0 0088	0 199	0.0059	0.0012	0 00148	-0 0176	0.00196	0.0010	0.00166	-0.0180
4.50	0 189	0 0055	-0 0232	-0 0090	0 205	0.0060	0.0013	0 00139	-0.0175	0 00202	0.0010	0.00158	-0.0181
4.75	0 194	0 0056	-0 0226	-0 0091	0 211	0.0061	0.0014	0.00131	-0 0173	0.00207	0.0011	0.00151	-0.0181
5.00	0 198	0 0057	-0 0220	-0 0092	0 217	0.0062	0.0014	0.00123	-0 0171	0.00213	0.0011	0.00143	-0.0181
5.25	0 203	0 0058	-0 0214	-0 0093	0 222	0 0062	0.0015	0.00116	-0 0168	0.00218	0.0012	0.00136	-0.0180
5.50	0 207	0 0058	-0 0207	-0 0093	0 228	0.0063	0.0016	0.00108	-0 0166	0.00223	0.0013	0.00129	-0.0180
5.75	0.212	0 0059	-0 0206	-0 0094	0 233	0 0063	0.0019	0.00101	-0 0167	0.00227	0.0012	0.00124	-0.0160
6.00	0 216	0 0059	-0 0201	-0 0094	0 238	0.0064	0.0020	0.00094	-0 0170	0.00232	0.0012	0.00118	-0.0160
6.25	0.220	0 0059	-0 0190	-0 0094	0 242	0 0064	0 0022	0 00087	-0 0166	0.00237	0.0013	0 00113	-0.0159
6.50	0 224	0 0060	-0 0190	-0 0094	0 247	0.0064	0 0023	0.00081	-0 0162	0.00242	0.0013	0.00108	-0.0158
6.75	0 228	0 0060	-0 0182	-0 0094	0.252	0.0064	0.0021	0.00076	-0 0158	0.00246	0.0016	0.00102	-0.0173
7.00	0 231	0 0060	-0 0165	-0 0094	0 257	0 0065	0.0023	0.00071	-0 0146	0.00250	0.0017	0.00097	-0.0172
7.25	0 235	0 0060	-0 0175	-0 0093	0.261	0.0065	0.0028	0.00065	-0 0156	0.00253	0.0013	0.00093	-0.0142
7.50	0.239	0 0060	-0 0166	-0 0093	0 265	0 0065	0 0030	0 00060	-0 0151	0.00257	0.0014	0.00089	-0.0141

TABLE A27-5

0, PNE

PREDICTION OF ANNULAR DIFFUSER PERFORMANCE

DIFFUSER GEOMETRY

WALL ANGLES OUTER= 5.000 DEGREES ,INNER= 0.000 DEGREES
INLET RADII OUTER= 6 00 INS. ,INNER= 5 00 INS.
DIFFUSER NON DIMENSIONAL= 10 0

INLET CONDITIONS (CALCULATIONS COMMENCE AT X= 0.000 INS)

SHAPE PARAMETERS. OUTER WALL= 1.304 INNER WALL= 1.281
MOMENTUM THICKNESS. OUTER WALL= 0.049 INS INNER WALL= 0 050 INS
MAXIMUM VELOCITY= 140 000 FT/SEC
RADIUS OF POSITION OF MAXIMUM VELOCITY= 5 500 INS

DIST X	H0	THETA OUTER	HI	THETA INNER	UMEAN UMAX	AREA RATIO	LOSS COEFF	CP	RMAX INS
0 50	1.33	0 054	1.31	0 055	0.862	1 05	0 001	0 085	5.523
1 00	1.37	0 059	1.34	0.061	0.850	1 10	0.005	0 156	5.545
1 50	1.40	0 065	1.37	0.067	0.838	1 14	0 006	0 220	5.567
2 00	1.44	0 070	1.40	0.073	0.827	1 19	0.009	0 275	5.589
2 50	1.48	0 076	1.43	0 080	0.815	1 24	0 012	0 323	5.612
3 00	1.52	0 082	1.46	0.086	0.803	1 29	0.013	0 367	5.634
3 50	1.56	0 087	1.50	0 092	0.791	1 34	0.015	0 406	5.656
4 00	1.60	0 093	1.53	0.098	0.779	1 39	0 017	0 440	5.677
4 50	1.65	0 098	1.57	0 104	0.767	1 44	0 019	0 471	5.699
5 00	1.69	0 104	1.60	0.111	0.755	1 49	0.022	0 498	5.721
5 50	1.74	0 109	1.64	0 117	0 743	1 55	0 025	0 521	5.743
6 00	1.79	0 114	1.68	0.123	0 731	1 60	0.027	0.543	5.765
6 50	1.84	0 119	1.71	0 129	0.719	1 65	0.028	0 564	5.786
7 00	1.89	0 125	1.75	0.134	0.708	1 70	0.030	0 582	5.807
7 50	1.95	0 130	1.79	0 140	0.696	1 76	0.032	0 598	5.828
8 00	2.01	0 134	1.83	0.146	0.684	1 81	0 034	0 612	5.848
8 50	2.07	0 139	1.87	0.151	0.673	1 86	0 037	0.624	5.869
9 00	2.13	0 143	1.91	0.157	0.662	1 92	0.040	0 635	5.890
9 50	2 19	0 148	1.94	0 162	0.651	1 97	0 041	0 647	5.908
10 00	2.26	0 152	1.98	0.166	0.639	2 02	0 043	0.657	5.927

(FOR ADDITIONAL BOUNDARY LAYER DATA SEE OVERLEAF)

TABLE A27-6

O, PNE

PREDICTION OF ANNULAR DIFFUSER PERFORMANCE

(ADDITIONAL BOUNDARY LAYER DATA)

THEORETICAL ASSUMPTIONS

VELOCITY PROFILE - POWER LAW
SKIN FRICTION COEFFICIENT - LUDWIEG & TILLMANN
ESTIMATE OF REYNOLDS NORMAL STRESSES INCLUDED
TOTAL PRESSURE LOSS INCLUDED (EXPERIMENTAL RESULTS)
NO NET MASS TRANSFER BETWEEN INNER & OUTER LAYERS
NO POTENTIAL CORE

DIST X	DEL** OUTER	DISPN CDO	$3\frac{\delta^{**}}{U}\frac{dU}{dx}$	$\frac{2}{\rho U^2}\left[\frac{dP_T}{dx}\right]_m$	DEL** INNER	DISPN CDI	N.S.C. OUTER	CF OUTER	$(H_o+2)\frac{\theta_o}{U}\frac{dU}{dx}$	$\frac{\theta_o}{R_o}\frac{dR_o}{dx}$	N.S.C. INNER	CF INNER	$(H_i+2)\frac{\theta_i}{U}\frac{dU}{dx}$
0.50	0.096	0.0020	-0.0196	-0.0047	0.099	0.0022	0.0002	0.00337	-0.0110	0.00071	0.0002	0.00343	-0.0112
1.00	0.104	0.0023	-0.0192	-0.0052	0.109	0.0026	0.0002	0.00315	-0.0110	0.00078	0.0002	0.00321	-0.0115
1.50	0.113	0.0027	-0.0212	-0.0057	0.119	0.0029	0.0003	0.00294	-0.0118	0.00085	0.0003	0.00301	-0.0117
2.00	0.122	0.0029	-0.0197	-0.0062	0.129	0.0032	0.0003	0.00274	-0.0119	0.00092	0.0003	0.00282	-0.0124
2.50	0.131	0.0032	-0.0210	-0.0066	0.138	0.0035	0.0004	0.00255	-0.0123	0.00100	0.0004	0.00264	-0.0129
3.00	0.139	0.0034	-0.0206	-0.0070	0.148	0.0037	0.0004	0.00237	-0.0130	0.00107	0.0004	0.00247	-0.0130
3.50	0.148	0.0036	-0.0202	-0.0074	0.158	0.0039	0.0005	0.00220	-0.0131	0.00114	0.0004	0.00231	-0.0133
4.00	0.156	0.0038	-0.0200	-0.0077	0.167	0.0041	0.0006	0.00204	-0.0132	0.00121	0.0005	0.00216	-0.0136
4.50	0.164	0.0040	-0.0197	-0.0080	0.177	0.0042	0.0006	0.00188	-0.0134	0.00128	0.0005	0.00201	-0.0139
5.00	0.172	0.0041	-0.0193	-0.0083	0.186	0.0044	0.0007	0.00174	-0.0134	0.00135	0.0006	0.00188	-0.0141
5.50	0.180	0.0042	-0.0189	-0.0085	0.195	0.0045	0.0008	0.00161	-0.0134	0.00141	0.0007	0.00175	-0.0143
6.00	0.187	0.0043	-0.0184	-0.0087	0.205	0.0046	0.0008	0.00148	-0.0134	0.00147	0.0007	0.00163	-0.0144
6.50	0.194	0.0044	-0.0193	-0.0089	0.213	0.0047	0.0009	0.00136	-0.0144	0.00153	0.0008	0.00153	-0.0139
7.00	0.201	0.0045	-0.0178	-0.0090	0.222	0.0048	0.0011	0.00125	-0.0135	0.00159	0.0008	0.00142	-0.0140
7.50	0.208	0.0046	-0.0172	-0.0091	0.230	0.0049	0.0011	0.00114	-0.0134	0.00165	0.0009	0.00133	-0.0140
8.00	0.214	0.0046	-0.0165	-0.0092	0.238	0.0049	0.0012	0.00104	-0.0131	0.00170	0.0010	0.00124	-0.0140
8.50	0.221	0.0046	-0.0158	-0.0092	0.246	0.0050	0.0014	0.00095	-0.0129	0.00175	0.0010	0.00115	-0.0140
9.00	0.226	0.0046	-0.0151	-0.0092	0.254	0.0050	0.0015	0.00086	-0.0126	0.00180	0.0011	0.00107	-0.0139
9.50	0.232	0.0047	-0.0150	-0.0092	0.260	0.0050	0.0017	0.00077	-0.0135	0.00185	0.0010	0.00101	-0.0125
10.00	0.238	0.0047	-0.0145	-0.0092	0.267	0.0050	0.0019	0.00069	-0.0126	0.00190	0.0011	0.00095	-0.0124

TABLE A27-7

0.75, PNE

PREDICTION OF ANNULAR DIFFUSER PERFORMANCE

DIFFUSER GEOMETRY

WALL ANGLES OUTER= 10.000 DEGREES ,INNER= 0.000 DEGREES
INLET RADII OUTER= 6 13 INS ,INNER= 5.00 INS.
DIFFUSER NON DIMENSIONAL= 5 0

INLET CONDITIONS (CALCULATIONS COMMENCE AT X= 0.750 INS)

SHAPE PARAMETERS, OUTER WALL= 1.485 INNER WALL= 1.397
MOMENTUM THICKNESS, OUTER WALL= 0.073 INS INNER WALL= 0 069 INS
MAXIMUM VELOCITY= 137 400 FT/SEC
RADIUS OF POSITION OF MAXIMUM VELOCITY= 5 555 INS.

DIST X	H0	THETA OUTER	HI	THETA INNER	UMEAN UMAX	AREA RATIO	LOSS COEFF	CP	RMAX INS
1 00	1.53	0 078	1.43	0.075	0.806	1 19	0.034	0 232	5.576
1 25	1.58	0 085	1.46	0.080	0.793	1 24	0 036	0 281	5.597
1 50	1.63	0 090	1.50	0 086	0.779	1 29	0.037	0 324	5.618
1 75	1.68	0 097	1.53	0.092	0.766	1 34	0 039	0 362	5.638
2 00	1.74	0 102	1.57	0.098	0.752	1 39	0.041	0 396	5.659
2 25	1.80	0 108	1.60	0.104	0.738	1 44	0.043	0 425	5.678
2 50	1.87	0 114	1.64	0.109	0.725	1 50	0.045	0 451	5.698
2 75	1.93	0 120	1.68	0 115	0.711	1 55	0 048	0 474	5.716
3 00	2.01	0 125	1.71	0.120	0.697	1 60	0 050	0 494	5.735
3 25	2.08	0 131	1.75	0.125	0.683	1 65	0.053	0 511	5.752
3 50	2.16	0 136	1.78	0.130	0.670	1 71	0.056	0 527	5.770
3 75	2.25	0 141	1.82	0.134	0.656	1 76	0.057	0 541	5.785
4 00	2.35	0 146	1.85	0 138	0.642	1 81	0 060	0 553	5.800
4 25	2.44	0 150	1.88	0 142	0.629	1 87	0.062	0 563	5.815
4 50	2.55	0 155	1.91	0.145	0.616	1 92	0.065	0 572	5.827
4 75	2.65	0 159	1.93	0.148	0.603	1 97	0.068	0 580	5.839
5 00	2.78	0 163	1.95	0.151	0.590	2 03	0.071	0 586	5.848

(FOR ADDITIONAL BOUNDARY LAYER DATA SEE OVERLEAF)

TABLE A27-8

0.75, PNE

PREDICTION OF ANNULAR DIFFUSER PERFORMANCE

(ADDITIONAL BOUNDARY LAYER DATA)

THEORETICAL ASSUMPTIONS

VELOCITY PROFILE - POWER LAW
SKIN FRICTION COEFFICIENT - LUDWIEG & TILLMANN
ESTIMATE OF REYNOLDS NORMAL STRESSES INCLUDED
TOTAL PRESSURE LOSS INCLUDED (EXPERIMENTAL RESULTS)
NO NET MASS TRANSFER BETWEEN INNER & OUTER LAYERS
NO POTENTIAL CORE

DIST X	DEL** OUTER	DISPN. CDO	$\frac{3\delta^{**}}{U}\frac{dU}{dx}$	$\frac{2}{\rho U^2}\left[\frac{dP_T}{dx}\right]_m$	DEL** INNER	DISPN. CDI	N.S.C. OUTER	CF OUTER	$(H_o+2)\frac{\theta_o}{U}\frac{dU}{dx}$	$\frac{\theta_o}{R_o}\frac{dR_o}{dx}$	N.S.C. INNER	CF INNER	$(H_i+2)\frac{\theta_i}{U}\frac{dU}{dx}$
1.00	0.134	0.0048	-0.0423	-0.0075	0.130	0.0042	0.0009	0.00227	-0.0267	0.00209	0.0006	0.00262	-0.0250
1.25	0.143	0.0056	-0.0410	-0.0080	0.139	0.0050	0.0011	0.00208	-0.0265	0.00224	0.0007	0.00245	-0.0243
1.50	0.152	0.0063	-0.0403	-0.0084	0.148	0.0056	0.0013	0.00190	-0.0268	0.00240	0.0008	0.00229	-0.0248
1.75	0.160	0.0069	-0.0394	-0.0088	0.157	0.0062	0.0015	0.00173	-0.0268	0.00255	0.0009	0.00213	-0.0246
2.00	0.169	0.0074	-0.0382	-0.0091	0.166	0.0067	0.0017	0.00157	-0.0268	0.00270	0.0010	0.00199	-0.0248
2.25	0.177	0.0079	-0.0371	-0.0094	0.175	0.0071	0.0020	0.00142	-0.0268	0.00284	0.0011	0.00186	-0.0241
2.50	0.185	0.0082	-0.0356	-0.0096	0.183	0.0075	0.0022	0.00127	-0.0264	0.00299	0.0012	0.00173	-0.0242
2.75	0.193	0.0085	-0.0342	-0.0097	0.191	0.0077	0.0026	0.00114	-0.0260	0.00312	0.0013	0.00162	-0.0232
3.00	0.200	0.0088	-0.0323	-0.0098	0.199	0.0080	0.0029	0.00101	-0.0253	0.00326	0.0014	0.00151	-0.0231
3.25	0.207	0.0089	-0.0297	-0.0099	0.206	0.0081	0.0034	0.00089	-0.0240	0.00338	0.0014	0.00142	-0.0215
3.50	0.214	0.0091	-0.0287	-0.0099	0.213	0.0083	0.0037	0.00079	-0.0238	0.00350	0.0015	0.00133	-0.0214
3.75	0.220	0.0092	-0.0282	-0.0099	0.218	0.0083	0.0043	0.00069	-0.0241	0.00362	0.0014	0.00125	-0.0189
4.00	0.226	0.0092	-0.0256	-0.0098	0.224	0.0084	0.0048	0.00059	-0.0221	0.00373	0.0015	0.00118	-0.0187
4.25	0.231	0.0092	-0.0245	-0.0097	0.230	0.0084	0.0052	0.00051	-0.0215	0.00383	0.0016	0.00111	-0.0185
4.50	0.237	0.0092	-0.0211	-0.0096	0.235	0.0084	0.0062	0.00044	-0.0198	0.00392	0.0013	0.00106	-0.0155
4.75	0.242	0.0092	-0.0185	-0.0095	0.239	0.0084	0.0067	0.00037	-0.0180	0.00401	0.0014	0.00101	-0.0153
5.00	0.246	0.0092	-0.0168	-0.0093	0.242	0.0083	0.0079	0.00031	-0.0168	0.00410	0.0010	0.00098	-0.0123

TABLE A27-9

1.25, PNE

PREDICTION OF ANNULAR DIFFUSER PERFORMANCE

DIFFUSER GEOMETRY.

WALL ANGLES. OUTER= 6.650 DEGREES ,INNER= 0.000 DEGREES
INLET RADII. OUTER= 6.15 INS. ,INNER= 5.00 INS.
DIFFUSER NON DIMENSIONAL= 7.5

INLET CONDITIONS (CALCULATIONS COMMENCE AT X= 1.250 INS.)

SHAPE PARAMETERS. OUTER WALL= 1.501 INNER WALL= 1.404
MOMENTUM THICKNESS. OUTER WALL= 0.074 INS.INNER WALL= 0.071 INS
MAXIMUM VELOCITY= 127.000 FT/SEC
RADIUS OF POSITION OF MAXIMUM VELOCITY= 5.566 INS.

DIST X	Ho	THETA OUTER	HI	THETA INNER	UMEAN UMAX	AREA RATIO	LOSS COEFF	CP	RMAX INS
1.50	1.53	0.078	1.43	0.075	0.806	1.19	0.033	0.235	5.580
1.75	1.57	0.082	1.45	0.079	0.797	1.23	0.034	0.268	5.594
2.00	1.60	0.086	1.47	0.083	0.788	1.26	0.036	0.297	5.608
2.25	1.63	0.090	1.49	0.086	0.779	1.29	0.038	0.325	5.621
2.50	1.67	0.094	1.52	0.090	0.771	1.33	0.040	0.349	5.635
2.75	1.70	0.098	1.54	0.094	0.762	1.36	0.042	0.372	5.649
3.00	1.74	0.102	1.56	0.098	0.753	1.39	0.044	0.394	5.662
3.25	1.78	0.106	1.59	0.102	0.744	1.43	0.045	0.413	5.675
3.50	1.82	0.110	1.61	0.106	0.735	1.46	0.047	0.431	5.689
3.75	1.86	0.113	1.63	0.109	0.726	1.49	0.049	0.447	5.702
4.00	1.91	0.117	1.66	0.113	0.717	1.53	0.051	0.463	5.714
4.25	1.95	0.121	1.68	0.116	0.708	1.56	0.052	0.478	5.726
4.50	2.00	0.124	1.70	0.120	0.700	1.60	0.054	0.491	5.738
4.75	2.05	0.128	1.72	0.123	0.691	1.63	0.056	0.503	5.750
5.00	2.10	0.131	1.75	0.126	0.682	1.67	0.058	0.513	5.762
5.25	2.15	0.135	1.77	0.129	0.673	1.70	0.060	0.524	5.773
5.50	2.21	0.138	1.79	0.132	0.665	1.74	0.062	0.533	5.784
5.75	2.26	0.141	1.81	0.135	0.656	1.77	0.064	0.542	5.794
6.00	2.32	0.144	1.83	0.138	0.647	1.81	0.066	0.549	5.805
6.25	2.38	0.148	1.85	0.140	0.639	1.84	0.067	0.557	5.814
6.50	2.45	0.151	1.86	0.143	0.630	1.88	0.069	0.564	5.822
6.75	2.51	0.154	1.88	0.145	0.622	1.92	0.071	0.570	5.831
7.00	2.58	0.156	1.90	0.147	0.614	1.95	0.074	0.575	5.840
7.25	2.65	0.159	1.91	0.149	0.605	1.99	0.074	0.581	5.847
7.50	2.73	0.162	1.92	0.150	0.597	2.02	0.076	0.585	5.853

(FOR ADDITIONAL BOUNDARY LAYER DATA SEE OVERLEAF)

TABLE A27-10

1.25, PNE

PREDICTION OF ANNULAR DIFFUSER PERFORMANCE

(ADDITIONAL BOUNDARY LAYER DATA)

THEORETICAL ASSUMPTIONS

VELOCITY PROFILE = POWER LAW
SKIN FRICTION COEFFICIENT = LUDWIEG & TILLMANN
ESTIMATE OF REYNOLDS NORMAL STRESSES INCLUDED
TOTAL PRESSURE LOSS INCLUDED (EXPERIMENTAL RESULTS)
NO NET MASS TRANSFER BETWEEN INNER & OUTER LAYERS
NO POTENTIAL CORE

DIST X	DEL** OUTER	DISPN. CDO	$3\delta^{**}\frac{dU}{U\,dx}$	$\frac{2}{\rho U^2}\left[\frac{dP_t}{dx}\right]_m$	DEL** INNER	DISPN. CDI	N.S.C. OUTER	CF OUTER	$(H_o+2)\frac{\theta_o}{U}\frac{dU}{dx}$	$\frac{\theta_o}{R_o}\frac{dR_o}{dx}$	N.S.C. INNER	CF INNER	$(H_i+2)\frac{\theta_i}{U}\frac{dU}{dx}$
1.50	0.134	0.0023	-0.0269	-0.0076	0.130	0.0021	0.0007	0.00230	-0.0175	0.00141	0.0004	0.00268	-0.0158
1.75	0.140	0.0026	-0.0271	-0.0079	0.136	0.0024	0.0007	0.00217	-0.0179	0.00148	0.0005	0.00256	-0.0163
2.00	0.146	0.0029	-0.0268	-0.0082	0.142	0.0026	0.0008	0.00204	-0.0180	0.00155	0.0005	0.00245	-0.0166
2.25	0.151	0.0031	-0.0264	-0.0085	0.149	0.0029	0.0009	0.00193	-0.0181	0.00162	0.0006	0.00234	-0.0168
2.50	0.157	0.0034	-0.0259	-0.0087	0.155	0.0031	0.0009	0.00181	-0.0181	0.00168	0.0006	0.00224	-0.0170
2.75	0.162	0.0036	-0.0254	-0.0090	0.161	0.0033	0.0010	0.00170	-0.0180	0.00175	0.0006	0.00214	-0.0172
3.00	0.168	0.0038	-0.0255	-0.0092	0.166	0.0035	0.0011	0.00160	-0.0184	0.00181	0.0007	0.00204	-0.0166
3.25	0.173	0.0039	-0.0250	-0.0093	0.172	0.0037	0.0012	0.00149	-0.0184	0.00187	0.0007	0.00196	-0.0163
3.50	0.179	0.0041	-0.0243	-0.0095	0.178	0.0038	0.0013	0.00140	-0.0182	0.00194	0.0008	0.00187	-0.0169
3.75	0.184	0.0042	-0.0236	-0.0096	0.183	0.0040	0.0014	0.00131	-0.0179	0.00199	0.0008	0.00179	-0.0169
4.00	0.189	0.0043	-0.0238	-0.0097	0.189	0.0041	0.0016	0.00121	-0.0183	0.00205	0.0008	0.00171	-0.0158
4.25	0.194	0.0045	-0.0230	-0.0098	0.194	0.0042	0.0017	0.00113	-0.0181	0.00211	0.0008	0.00164	-0.0159
4.50	0.199	0.0045	-0.0222	-0.0099	0.199	0.0042	0.0019	0.00104	-0.0177	0.00217	0.0009	0.00157	-0.0159
4.75	0.203	0.0046	-0.0213	-0.0099	0.204	0.0043	0.0020	0.00097	-0.0174	0.00222	0.0009	0.00151	-0.0159
5.00	0.208	0.0047	-0.0204	-0.0099	0.208	0.0044	0.0021	0.00090	-0.0169	0.00227	0.0010	0.00144	-0.0159
5.25	0.212	0.0047	-0.0196	-0.0099	0.213	0.0045	0.0025	0.00082	-0.0166	0.00232	0.0009	0.00139	-0.0142
5.50	0.217	0.0048	-0.0196	-0.0099	0.217	0.0045	0.0026	0.00075	-0.0168	0.00238	0.0009	0.00134	-0.0142
5.75	0.221	0.0048	-0.0185	-0.0099	0.221	0.0045	0.0028	0.00069	-0.0163	0.00243	0.0009	0.00129	-0.0142
6.00	0.225	0.0049	-0.0175	-0.0098	0.225	0.0046	0.0029	0.00063	-0.0157	0.00247	0.0010	0.00124	-0.0141
6.25	0.228	0.0049	-0.0171	-0.0098	0.228	0.0046	0.0034	0.00057	-0.0156	0.00251	0.0008	0.00120	-0.0122
6.50	0.232	0.0049	-0.0163	-0.0097	0.232	0.0046	0.0036	0.00052	-0.0152	0.00256	0.0009	0.00117	-0.0122
6.75	0.236	0.0049	-0.0152	-0.0096	0.235	0.0046	0.0038	0.00047	-0.0144	0.00260	0.0009	0.00113	-0.0122
7.00	0.239	0.0049	-0.0142	-0.0095	0.238	0.0046	0.0040	0.00042	-0.0137	0.00264	0.0009	0.00110	-0.0121
7.25	0.242	0.0049	-0.0149	-0.0095	0.241	0.0046	0.0046	0.00038	-0.0147	0.00268	0.0007	0.00107	-0.0098
7.50	0.246	0.0049	-0.0128	-0.0094	0.243	0.0046	0.0049	0.00034	-0.0129	0.00271	0.0007	0.00105	-0.0098

TABLE A27-11

1.0, PNE

PREDICTION OF ANNULAR DIFFUSER PERFORMANCE

DIFFUSER GEOMETRY.

WALL ANGLES. OUTER= 5.000 DEGREES ,INNER= 0.000 DEGREES
INLET RADII. OUTER= 6.09 INS. ,INNER= 5.00 INS.
DIFFUSER NON DIMENSIONAL= 10.0

INLET CONDITIONS (CALCULATIONS COMMENCE AT X= 1.000 INS.)

SHAPE PARAMETERS. OUTER WALL= 1.392 INNER WALL= 1.359
MOMENTUM THICKNESS. OUTER WALL= 0.060 INS.INNER WALL= 0.066 INS
MAXIMUM VELOCITY= 131.000 FT/SEC
RADIUS OF POSITION OF MAXIMUM VELOCITY= 5.560 INS.

DIST X	Ho	THETA OUTER	HI	THETA INNER	UMEAN UMAX	AREA RATIO	LOSS COEFF	CP	RMAX INS
1.50	1.43	0.066	1.39	0.071	0.830	1.14	0.022	0.198	5.582
2.00	1.47	0.071	1.42	0.078	0.818	1.19	0.026	0.252	5.605
2.50	1.51	0.077	1.45	0.084	0.805	1.24	0.029	0.300	5.628
3.00	1.55	0.082	1.49	0.090	0.793	1.29	0.029	0.344	5.650
3.50	1.60	0.088	1.52	0.096	0.781	1.34	0.031	0.383	5.672
4.00	1.65	0.093	1.56	0.103	0.769	1.39	0.035	0.415	5.695
4.50	1.69	0.098	1.59	0.109	0.757	1.44	0.036	0.447	5.717
5.00	1.74	0.104	1.63	0.115	0.744	1.49	0.040	0.472	5.739
5.50	1.80	0.109	1.66	0.121	0.732	1.55	0.041	0.497	5.760
6.00	1.85	0.114	1.70	0.127	0.720	1.60	0.044	0.518	5.781
6.50	1.91	0.119	1.74	0.133	0.708	1.65	0.046	0.537	5.802
7.00	1.97	0.124	1.77	0.138	0.696	1.70	0.049	0.554	5.823
7.50	2.03	0.129	1.81	0.144	0.684	1.76	0.052	0.569	5.844
8.00	2.10	0.134	1.85	0.149	0.673	1.81	0.055	0.582	5.863
8.50	2.17	0.138	1.88	0.154	0.661	1.86	0.057	0.595	5.883
9.00	2.24	0.143	1.91	0.159	0.649	1.92	0.059	0.606	5.900
9.50	2.32	0.147	1.95	0.164	0.638	1.97	0.061	0.616	5.918
10.00	2.39	0.151	1.98	0.168	0.627	2.02	0.064	0.625	5.936

(FOR ADDITIONAL BOUNDARY LAYER DATA SEE OVERLEAF)

TABLE A27-12

1.0, PNE

PREDICTION OF ANNULAR DIFFUSER PERFORMANCE

(ADDITIONAL BOUNDARY LAYER DATA)

THEORETICAL ASSUMPTIONS

VELOCITY PROFILE = POWER LAW
SKIN FRICTION COEFFICIENT = LUDWIEG & TILLMANN
ESTIMATE OF REYNOLDS NORMAL STRESSES INCLUDED
TOTAL PRESSURE LOSS INCLUDED (EXPERIMENTAL RESULTS)
NO NET MASS TRANSFER BETWEEN INNER & OUTER LAYERS
NO POTENTIAL CORE

DIST X	DEL** OUTER	DISPN. CDO	$\frac{3\delta^{**}}{U}\frac{dU}{dx}$	$\frac{2}{\rho U^2}\left[\frac{dP_T}{dx}\right]_m$	DEL** INNER	DISPN. CDI	N.S.C. OUTER	CF OUTER	$(H_o+2)\frac{\theta_o}{U}\frac{dU}{dx}$	$\frac{\theta_o}{R_o}\frac{dR_o}{dx}$	N.S.C. INNER	CF INNER	$(H_i+2)\frac{\theta_i}{U}\frac{dU}{dx}$
1.50	0.114	0.0018	-0.0196	-0.0064	0.125	0.0018	0.0003	0.00279	-0.0117	0.00086	0.0003	0.00287	-0.0125
2.00	0.123	0.0021	-0.0194	-0.0069	0.135	0.0022	0.0004	0.00259	-0.0119	0.00094	0.0003	0.00268	-0.0130
2.50	0.131	0.0024	-0.0196	-0.0074	0.145	0.0025	0.0004	0.00240	-0.0124	0.00101	0.0004	0.00250	-0.0134
3.00	0.139	0.0027	-0.0203	-0.0078	0.155	0.0028	0.0005	0.00223	-0.0131	0.00108	0.0004	0.00234	-0.0135
3.50	0.148	0.0029	-0.0198	-0.0081	0.165	0.0030	0.0005	0.00206	-0.0131	0.00115	0.0005	0.00219	-0.0138
4.00	0.155	0.0031	-0.0186	-0.0085	0.175	0.0033	0.0006	0.00190	-0.0126	0.00122	0.0005	0.00204	-0.0145
4.50	0.163	0.0033	-0.0201	-0.0088	0.184	0.0035	0.0007	0.00175	-0.0139	0.00128	0.0006	0.00191	-0.0141
5.00	0.171	0.0035	-0.0179	-0.0090	0.193	0.0037	0.0008	0.00161	-0.0127	0.00135	0.0007	0.00178	-0.0147
5.50	0.178	0.0036	-0.0188	-0.0093	0.202	0.0038	0.0009	0.00147	-0.0136	0.00141	0.0007	0.00167	-0.0138
6.00	0.186	0.0037	-0.0178	-0.0094	0.211	0.0039	0.0010	0.00134	-0.0133	0.00147	0.0007	0.00156	-0.0142
6.50	0.193	0.0038	-0.0176	-0.0096	0.219	0.0040	0.0011	0.00122	-0.0134	0.00153	0.0008	0.00146	-0.0142
7.00	0.199	0.0039	-0.0169	-0.0097	0.228	0.0041	0.0012	0.00111	-0.0132	0.00159	0.0009	0.00136	-0.0143
7.50	0.205	0.0040	-0.0162	-0.0097	0.236	0.0042	0.0013	0.00101	-0.0129	0.00164	0.0009	0.00127	-0.0143
8.00	0.212	0.0040	-0.0154	-0.0097	0.243	0.0043	0.0015	0.00090	-0.0126	0.00169	0.0009	0.00119	-0.0135
8.50	0.218	0.0040	-0.0152	-0.0097	0.251	0.0044	0.0016	0.00081	-0.0127	0.00175	0.0010	0.00112	-0.0135
9.00	0.223	0.0041	-0.0147	-0.0097	0.257	0.0044	0.0019	0.00072	-0.0126	0.00179	0.0009	0.00105	-0.0126
9.50	0.229	0.0041	-0.0140	-0.0096	0.264	0.0044	0.0020	0.00064	-0.0123	0.00184	0.0010	0.00099	-0.0125
10.00	0.234	0.0041	-0.0131	-0.0095	0.270	0.0044	0.0022	0.00057	-0.0118	0.00189	0.0010	0.00093	-0.0125

Appendix 28

Computer Programme

Coles Law Prediction Method

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C                                APPENDIX 28

C          PROGRAMME BASED ON COLES VELOCITY PROFILE EQUATION

COMMENT**PREDICTION OF BOUNDARY LAYER PROFILES IN AN ANNULAR DIFFUSER

CXXXXXTHIS PROGRAM STARTS WITH KNOWN INLET CONDITIONS AND CALCULATES THE
C      VARIATION OF THE SHAPE PARAMETER ON INNER AND OUTER WALLS IN A
C      STEP BY STEP CALCULATION ALONG THE LENGTH OF THE DIFFUSER
CXXXXXWARNINGXXXXIT IS ASSUMED THAT FULLY DEVELOPED FLOW IS PRESENT AT
C      DIFFUSER INLET I.E. NO POTENTIAL CORE EXISTS
CXXXXXINNER AND OUTER LAYERS ARE ANALYSED SEPARATELY ON THE ASSUMPION
C      THAT NO NET MASS TRANSFER TAKES PLACE . THE INNER AND OUTER LAYERS
C      ARE MATCHED AT THE POSITION OF MAXIMUM VELOCITY SINCE THE MAX.
C      VELOCITY IN EACH LAYER MUST BE THE SAME


       DIMENSION F(10,10),Z(9),RPI(60),ZZI(60)
       DIMENSION X(100),Y(100),A(10,10),W(9),BP(60),DCDEL(60)
       DIMENSION DELTHO(50),DISNO(50),ENGRAD(50),DPTDX(50),DELTHI(50)
       DIMENSION DISNI(50),SHSTO(50),CFO(50),GRADPO(50),GEOMPO(50)
       DIMENSION SHSTI(50),CFI(50),GRADPI(50)
       DIMENSION ARA(50),LOS(50),CPA(50),RHA(50)
       DIMENSION ALPHA(50),DPTHA(50)
       DIMENSION XAC(50),HOA(50),THETO(50),HIA(50),THETI(50),UMMA(50)
       DIMENSION E(10,10),V(9),DPTDXC(20),MAXIOC(20)
       REALLOS
       REAL LOSINT
       REALLOSCOF
       REALNDPTDX
       REAL MIXLND,MIXL


CXXXXXINPUT DATA

C      DCDEL & BP ARE THE VALUES OF THE CORRECTION FACTOR APPLIED TO THE
C      BOUNDARY LAYER THICKNESS AND THE COLES FREE PARAMETER IN THE WAKE
C      FUNCTION
C      MAXIOC & DPTDXC ARE THE VALUES OF OUTER WALL SHAPE PARAMETER AND
C      TOTAL PRESSURE GRADIENT AT THE POINT OF MAXIMUM VELOCITY USED IN
C      THE CORRELATION OF THE EXPERIMENTAL DATA
C      HO1-SPECIFIED SHAPE PARAMETER OF OUTER WALL LAYER AT INLET
C      HI1-SPECIFIED SHAPE PARAMETER OF INNER WALL LAYER AT INLET
C      XLIMIT-THE MAXIMUM DISTANCE ALONG THE LENGTH OF THE DIFFUSER TO
C      WHICH THE CALCULATIONS PROCEED
C      CF1O-SKIN FRICTION COEFFICIENT OF OUTER WALL LAYER AT INLET
C      CF1I-SKIN FRICTION COEFFICIENT OF INNER WALL LAYER AT INLET
C      RO1-OUTER WALL RADIUS AT INLET(INS)
C      RM1-RADIUS OF POINT OF MAXIMUM VELOCITY AT INLET (INS)
C      RI1-INNER WALL RADIUS AT INLET(INS)
C      UMO1-MAXIMUM VELOCITY OF OUTER LAYER AT INLET(FT/SEC)
C      UMI1-MAXIMUM VELOCITY OF INNER LAYER AT INLET(EQUAL TO UMO1)FT/SEC
C      ENU-KINEMATIC VISCOSITY(SQFT/SEC)
C      DHAXI-ALLOWABLE DIFFERENCE BETWEEN ACTUAL AND SPECIFIED SHAPE
C      PARAMETERS AT INLET
C      DCFINT-STEP CHANGE IN SKIN FRICTION COEFFICIENT REQUIRED IN
C      ITERATION PROCEDURE USING COLES VELOCITY PROFILE EQUATION
C      DRMINT-STEP CHANGE IN RADIUS OF POINT OF MAXIMUM VELOCITY REQUIRED
```

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C      IN ITERATION PROCEDURE
C      DM-ALLOWABLE DIFFERENCE BETWEEN L.H.S. & R.H.S. OF MOMENTUM EQN.
C      DUM-ALLOWABLE DIFFERENCE BETWEEN UMAX CALCULATED FOR INNER AND
C      OUTER LAYERS AT ANY STATION
C      NS-THE NUMBER OF ELEMENTAL STRIPS USED IN THE NUMERICAL
C      INTEGRATION OF THE VELOCITY PROFILE TO DETERMINE THE BOUNDARY
C      LAYER PARAMETERS
C      COLEKO & COLEKI = COLES VALUE OF 0.4
C      COLECO & COLECI = COLES VALUE OF 5.1
C      DRDXO-TANGENT OF OUTER WALL ANGLE
C      DRDXI-TANGENT OF INNER WALL ANGLE
C      DX-STEP LENGTH(INS)
C      CD1O-INITIAL VALUE OF DISSIPATION COEFFICIENT (OUTER WALL LAYER)
C      CD1I-INITIAL VALUE OF DISSIPATION COEFFICIENY (INNER WALL LAYER)
C      DPTHI-INITIAL GRADIENT OF TOTAL PRESSURE AT POINT OF MAXIMUM
C      VELOCITY (BASED ON INNER WALL LAYER)
C      DPTHO-INITIAL GRADIENT OF TOTAL PRESSURE AT POINT OF MAXIMUM
C      VELOCITY (BASED ON OUTER WALL LAYER)
C      WALANO-OUTER WALL ANGLE(DEGREES)
C      WALANI-INNER WALL ANGLE(DEGREES)
C      DIFNDL-DIFFUSER NON-DIMENSIONAL LENGTH
C      XACTIN-STATION AT WHICH CALCULATIONS COMMENCE
C      CPINT-INITIAL VALUE OF CP, USUALLY ZERO UNLESS CALCULATIONS START
C      DOWNSTREAM OF DIFFUSER INLET
C      RHLOSI-INITIAL TOTAL PRESSURE LOSS AT POINT OF MAXIMUM VELOCITY
C      (ZERO UNLESS CALCULATIONS START DOWNSTREAM OF DIFFUSER INLET)
C      GA,G1,G2,G3,G4,G5,G6,G7- CONTROL CARDS

C*****ITERATION  LIMITS

C      DUM=0.05 FT/SEC  (APPROX 0.05%)
C      DM=0.001
C      DMAXI=0.001


      READ(1,992) (BP(I),I=1,21)
  992 FORMAT(21F0.0)
      READ(1,90) (DCDEL(I),I=1,21)
   90 FORMAT(21F0.0)
      READ(1,993) (MAXIOC(I),I=1,12)
  993 FORMAT(12F0.0)
      READ(1,993) (DPTDXC(I),I=1,12)
    1 READ(1,4)RO1,RI1,XLIMIT,CF1O,CF1I
    4 FORMAT(5F0.0)
    3 READ(1,4)RO1,RM1,RI1,UMO1,UMI1
    5 READ(1,6)FNU,DMAXI,DCFINT,DRMINT,DM,DUM
    6 FORMAT(6F0.0)
    7 READ(1,8)NS
    8 FORMAT(I2)
    9 READ(1,10)COLEKO,COLECO,COLEKI,COLECI
   10 FORMAT(4F0.0)
   11 READ(1,12)DRDXO,DRDXI,DX
   12 FORMAT(3F0.0)
      READ(1,10)CD1O,CD1I,DPTHO,DPTHI
      READ(1,8304)WALANO,WALANI,DIFNDL,XACTIN,CPINT,RHLOSI
 8304 FORMAT(6F0.0)
      READ(1,143)GA,G1,G2,G3,G4,G5,G6,G7
  143 FORMAT(3F0.0)


C      CURVEFIT FOR CORRELATION OF DCDEL AND BP  (SEE FIG. 5-6-2)
```

ITERATION LIMITS		
DM =	0.001	
DUM =	0.050	ft/sec

```
      N=0
      M=0
      DO 991 I=1,21
      N=N+1
      Y(I)=DCDEL(I)
  991 X(I)=BP(I)
      CALL CURVEFIT(N,X,Y,A,SA,W)

C     CURVE FIT FOR CORRELATION OF EXPERIMENTAL VALUES OF TOTAL PRESSURE
C     GRADIENT AT THE POINT OF MAXIMUM VELOCITY


      N=0
      DO 994 I=1,12
      N=N+1
      Y(I)=DPTDXC(I)
  994 X(I)=HAXIOC(I)
      CALL CURVEFIT(N,X,Y,F,SF,V)


C*****CALCULATION OF INLET VELOCITY PROFILE FOR SPECIFIED VALUES OF
C     SHAPE PARAMETERS


C     THE TECHNIQUE ADOPTED IS TO ASSUME A  VALUE OF SKIN FRICTION
C     COEFFICIENT AND TO OBTAIN THE VALUE OF THE FREE PARAMETER   FROM
C     THE BOUNDARY CONDITIONS. THE LAYER IS THEN SPLIT UP INTO ELEMENTAL
C     STRIPS AND INTEGRATED NUMERICALLY TO OBTAIN THE BOUNDARY LAYER
C     PARAMETERS. IF THE SPECIFIED VALUE OF SHAPE PARAMETER IS NOT,
C     OBTAINED A NEW VALUE OF SKIN FRICTION COEFFICIENT IS ASSUMED UNTIL
C     THE CORRECT   VALUE IS OBTAINED


C*****OUTER WALL BOUNDARY LAYER

      N=NS
      FB=0.
      ED=0.0

C     COMPUTATION OF HAXI USING COLES LAW

C     CALCULATION OF BOUNDARY CONDITIONS WITH NO CORRECTION APPLIED TO
C     BOUNDARY LAYER THICKNESS

   29 ROOT10=SQRT(CF10*0.5)
      XB=0.
      UTAUO=UI01*ROOT10
      B1A=(COLEKO*0.5)/ROOT10
      DELCO1=RO1-RH1
      B1B=.5*ALOG(UTAUO*(DELCO1)/(ENU*12.))
      B1C=COLECO*COLEKO*0.5
      B1=B1A-B1B-B1C
      IF(GA.EQ.1.0)GO TO 3303
      B=B1

C     B=THE FREE PARAMETER   IN WAKE FUNCTION

      IF(B)61,61,62
```

```
C       REVISED BOUNDARY CONDITIONS WITH CORRECTION APPLIED TO BOUNDARY
C       LAYER THICKNESS

   61 DELCO1=0.81*(RO1-RW1)
      GO TO 3301
   62 CONTINUE
      DELUDD=U(1)+U(2)*B+U(3)*(B**2.)+W(4)*(B**3.)+W(5)*(B**4.)+W(6)*(B*
     1*5.)+W(7)*(B**6.)+U(8)*(B**7.)+W(9)*(B**8.)
      DELCO1=DELUDD*(RO1-RW1)
 3301 B1A=(COLEKO*0.5)/ROOT10
      B1B=.5*ALOG(UTAUO*(DELCO1)/(ENU*12.))
      B1C=COLECO*COLEKO*0.5
      B1=B1A-B1B-B1C
      B=B1

C       FURTHER REVISION OF BOUNDARY CONDITIONS

      DELUDD=U(1)+U(2)*B+U(3)*(B**2.)+W(4)*(B**3.)+W(5)*(B**4.)+W(6)*(B*
     1*5.)+W(7)*(B**6.)+U(8)*(B**7.)+W(9)*(B**8.)
      DELCO1=DELUDD*(RO1-RW1)
      B1A=(COLEKO*0.5)/ROOT10
      B1B=.5*ALOG(UTAUO*(DELCO1)/(ENU*12.))
      B1C=COLECO*COLEKO*0.5
      B1=B1A-B1B-B1C
      B=B1
      DELUDD=U(1)+U(2)*B+U(3)*(B**2.)+W(4)*(B**3.)+W(5)*(B**4.)+W(6)*(B*
     1*5.)+W(7)*(B**6.)+U(8)*(B**7.)+W(9)*(B**8.)
      DELCO2=DELUDD*(RO1-RW1)
      S601=DELCO2-DELCO1
      WRITE(2,382)DELCO2,DELCO1,B
  382 FORMAT(F9.6,4X,F9.6,4X,F10.6)
      DELCO1=DELCO2
 3303 DELCOL=DELCO1

C       NUMERICAL INTEGRATION PROCEDURE

      RDELO=RO1-DELCOL
      DRO=DELCOL/N
      RRO=RO1-(DRO*0.5)
      SUM11=0.
      SUM21=0.
      SUM31=0.
      SUM41=0.
      SUM51=0.
      SUM71=0.0
      SUM91=0.0
      DO 30,I=1,N
      RATIO1=RRO/RO1
      DIFRO=RO1-RRO
      U10A=(UTAUO/COLEKO)*ALOG(UTAUO*DIFRO/(ENU*12.))
      U10B=UTAUO*COLECO
      DISOND=(RO1-PRO)/DELCOL
      UAKEO=B1*(1./COLEKO)*(1.+SIN(3.1416*(DISOND-.5)))*UTAUO
      U10=U10A+U10B+UAKEO
      UND10=U10/U101
      C10=(1.-UND10)*DRO
      D10=C10*UND10
      E10=C10*RATIO1
      F10=F10*UND10
      END0=UND10*UND10
      FN20=U10*U10*U10*DRO*RRO*6.2834
```

```
      G10=(1.-FJD1)*UND10*RATIO1*DRO
      QO=2.*3.1417*RRO*DRO*UMO1*UND10
      SUM11=SUM11+C10
      SUM21=SUM21+D10
      SUM31=SUM31+E10
      SUM41=SUM41+E10
      SUM51=SUM51+G10
      SUM71=SUM71+EN2O
      SUM91=SUM91+QO
   30 RRO=RRO-DRO
      H2DO1=SUM11/SUM21
      HAXIO1=SUM31/SUM41

C     HAXIO1=SHAPE PARAMETER -OUTER WALL

      EN2O=SUM71*(3.1417*(UMO1**3.)*((RDELO**2.)-(RH1**2.)))
      UUMAXO=1.-(2.*RO1*SUM31/((RO1**2.)-(RH1**2.)))

C     UUMAXO=RATIO OF MEAN TO MAXIMUM VELOCITY IN OUTER WALL LAYER

      UMEANO=UMO1*UUMAXO
      FLOWO=UMEANO*((RO1**2.)-(RH1**2.))

C     FLOWO=VOLUME FLOW IN OUTER WALL LAYER

      WRITE(2,77)UUMAXO,UMEANO,UMO1,FLOWO
   77 FORMAT(F6.3,4X,F8.3,4X,F8.3,4X,F12.5)
      S101=HAXIO1-HO1
      WRITE(2,2211)CF10,HAXIO1,S101,H2DO1,DELUDD,B1,SUM41
 2211 FORMAT(F9.6,4X,F9.6,4X,F9.6,4X,F9.6,4X,F9.6,4X,F9.5,4X,F9.6)
      S102=ABS(S101)-DHAXI

C     CHECK TO SEE HAXIO1 IS WITHIN LIMITS

      IF(S102)35,35,399

C     ITERATION PROCEDURE TO OBTAIN THE CORRECT VALUE OF SKIN FRICTION
C     COEFFICIENT (SHAPE PARAMETER)

C     NUMBER OF ITERARTIONS ATTEMPTED

  399 EB=EB+1.
      EC=EB-2.
      EE=EB-3.
      IF(EC)400,401,401
C     AFTER INITIAL ATTEMPT FEEDS IN A STEP CHANGE AND STORES INIT VALU
  400 S121=S101
      S122=CF10
      CF10=CF10-(2.*DCFINT)
      GO TO 29
C     ITERATION AFTER INITIAL STEP CHANGE
  401 IF(EE)402,404,404
C     HAS SIGN CHANGED AFTER STEP CHANGE
  402 IF(S101)403,35,409
  403 IF(S121)406,35,407
C     TRANSFER TO 406 INDICATES NO CHANGE BOTH VALUES NEGATIVE
  406 S103=ABS(S101)
      S104=ABS(S121)
      S105=S103-S104
      S106=CF10-S122
      S107=S106/S105
```

```
C       STORAGE OF VALUES REQUIRED IF SIGN CHANGE OCCURS
        S108=S101
        S109=CF10
        DCF=S121*S107
        CF10=S122+DCF
        GO TO 20
C       TRANSFER TO 407 INDICATES SIGN CHANGE +TO- DURING STEP CHANGE
  407   S131=ABS(S101)
        S132=ABS(S121)
        S133=S131+S132
        S134=CF10-S122
        S135=S134/S133
        S108=S101
        S109=CF10
        DCF=S135*S101
        CF10=CF10+DCF
        GO TO 20
  409   IF(S121)410,35,411
C       TRANSFER TO 410 INDICATES SIGN CHANGE -TO+ DURING STEP CHANGE
  410   S141=ABS(S101)
        S142=ABS(S121)
        S143=S141+S142
        S144=CF10-S122
        S108=S101
        S109=CF10
        S145=S144/S143
        DCF=S145*S101
        CF10=CF10-DCF
        GO TO 20
C       TRANSFER TO 411 INDICATES NO CHANGE BOTH VALUES POSITIVE
  411   S113=ABS(S101)
        S114=ABS(S121)
        S115=S113-S114
        S116=CF10-S122
        S117=S116/S115
C       STORAGE OF VALUES IF SIGN CHANGE OCCURS
        S108=S101
        S109=CF10
        DCF=S117*S121
        CF10=S122-DCF
        GO TO 20
  404   IF(S101)405,35,412
C       HAS SIGN CHANGED DURING SUBSEQUENT ITERATION
  405   IF(S108)406,35,408
C       TRANSFER TO 408 INDICATES SIGN CHANGE +TO- DURING SUBSQ ITERATIONS
  408   S131=ABS(S101)
        S132=ABS(S108)
        S133=S131+S132
        S134=CF10-S109
        S135=S134/S133
        S108=S101
        S109=CF10
        DCF=S135*S101
        CF10=CF10+DCF
        GO TO 20
  412   IF(S108)413,35,411
C       TRANSFER TO 413 INDICATES SIGN CHANGE -TO+ DURING SUBSQ ITERATIONS
  413   S151=ABS(S101)
        S152=ABS(S108)
        S153=S151+S152
        S154=CF10-S109
```

```
      S155=S154/S153
      S108=S101
      S109=CF10
      DCF=S155*S101
      CF10=CF10-DCF
      GO TO 29
   35 CONTINUE
      EB=0.
 8500 CONTINUE

C     QEXTRO=VOLUME FLOW IN THE REGION BETWEEN THE EDGE OF THE BOUNDARY
C     LAYER AND THE POINT OF MAXIMUM VELOCITY
C     QO=TOTAL FLOW IN OUTER WALL LAYER
C     DLSTO1=INITIAL DISPLACEMENT THICKNESS OF OUTER WALL BOUNDARY LAYER
C     THETO1=INITIAL MOMENTUM THICKNESS OF OUTER WALL BOUNDARY LAYER
C     ENTHO1=INITIAL ENERGY THICKNESS OF OUTER WALL BOUNDARY LAYER

      QEXTRO=3.1417*UMO1*((RDELO**2.)-(RM1**2.))
      QO=SUM31+QEXTRO
      DLSTO1=SUM31
      THETO1=SUM41
      ENTHO1=SUM51
      TAUO1=CF10*0.5
      WRITE(2,9008)DLSTO1,THETO1
 9008 FORMAT(F9.6,4X,F9.6)


C*****INNER WALL BOUNDARY LAYER


C     THE PROCEDURE FOR CONSTRUCTING THE VELOCITY PROFILE FROM AN
C     ASSUMED VALUE OF SKIN FRICTION COEFFICIENT IS THE SAME AS THAT
C     OUTLINED FOR THE OUTER WALL PROFILE AT INLET

   36 ROOT1I=SQRT(CF1I*0.5)
      XB=0.
      UTAUI=UMI1*ROOT1I
      B1AI=(COLEKI*0.5)/ROOT1I
      DELCI1=RM1-RI1
      B1BI=.5*ALOG(UTAUI*(DELCI1)/(ENU*12.))
      B1CI=COLECI*COLEKI*0.5
      B1I=B1AI-B1BI-B1CI
      IF(GA.EQ.1.0)GO TO 31
      B=B1I
      IF(B)63,63,64
   63 DELCI1=0.81*(RM1-RI1)
      GO TO 3304
   64 CONTINUE
      DELUDD=U(1)+U(2)*B+U(3)*(B**2)+U(4)*(B**3)+U(5)*(B**4)+U(6)*(B**5)
     1+U(7)*(B**6)+U(8)*(B**7)+U(9)*(B**8)
      DELCI1=DELUDD*(RM1-RI1)
 3304 B1AI=(COLEKI*0.5)/ROOT1I
      B1BI=.5*ALOG(UTAUI*(DELCI1)/(ENU*12.))
      B1CI=COLECI*COLEKI*0.5
      B1I=B1AI-B1BI-B1CI
      B=B1I
      DELUDD=U(1)+U(2)*B+U(3)*(B**2)+U(4)*(B**3)+U(5)*(B**4)+U(6)*(B**5)
     1+U(7)*(B**6)+U(8)*(B**7)+U(9)*(B**8)
      DELCI1=DELUDD*(RM1-RI1)
      B1AI=(COLEKI*0.5)/ROOT1I
      B1BI=.5*ALOG(UTAUI*(DELCI1)/(ENU*12.))
```

```
      B1CI=COLECI*COLEKI*0.5
      B11I=B1AI+B1BI+B1CI
      B=B11I
      DELUDD=U(1)+U(2)*B+U(3)*(B**2)+U(4)*(B**3)+U(5)*(B**4)+U(6)*(B**5)
     1+U(7)*(B**6)+U(8)*(B**7)+U(9)*(B**8)
      DELCI2=DELUDD*(RM1-RI1)
      WRITE(2,74)DELCI2,DELCI1,B
   74 FORMAT(F9.6,4X,F9.6,4X,F10.6)
      DELCI1=DELCI2
   81 DELCOL=DELCI1
      RDELI=DELCOL+RI1
      DRI=DELCOL/N
      RRI=RI1+(DRI*.5)
      SUM12=0.
      SUM22=0.
      SUM32=0
      SUM42=0.
      SUM52=0.
      SUM72=0.0
      SUM92=0.
      DO 37,I=1,N
      RATII1=RRI/RI1
      DIFRI=RRI-RI1
      U1IA=(UTAUI/COLEKI)*ALOG(UTAUI*DIFRI/(ENU*12.))
      U1IB=UTAUI*COLECI
      DISIND=(RRI-RI1)/DELCOL
      WAKEI=B11I*(1./COLEKI)*(1.+SIN(3.1416*(DISIND-.5)))*UTAUI
      U1I=U1IA+U1IB+WAKEI
      UND1I=U1I/UMI1
      C1I=(1.-UND1I)*DRI
      D1I=C1I*UND1I
      E1I=C1I*RATII1
      F1I=E1I*UND1I
      END1=UND1I*UND1I
      EN2I=U1I*U1I*U1I*DRI*RRI*6.2834
      G1I=(1.-END1)*UND1I*RATII1*DRI
      QI=2.*3.1417*RRI*DRI*UMI1*UND1I
      SUM12=SUM12+C1I
      SUM22=SUM22+D1I
      SUM32=SUM32+F1I
      SUM42=SUM42+E1I
      SUM52=SUM52+G1I
      SUM72=SUM72+EN2I
      SUM92=SUM92+QI
   37 RRI=RRI+DRI
      EN2I=SUM72+(3.1417*(UMI1**3.)*((RM1**2.)-(RDELI**2.)))
      H2DI1=SUM12/SUM22
      HAXII1=SUM32/SUM42

C     HAXII1=SHAPE PARAMETER- INNER WALL

      S2D1=HAXII1-HI1
      TAUI1=CFII*0.5
      UUMAXI=1.-(2.*RI1*SUM32/((RM1**2.)-(RI1**2.)))
      UMEANI=UMI1*UUMAXI
      FLOUI=UMEANI*((RM1**2.)-(RI1**2.))
      WRITE(2,77)UUMAXI,UMEANI,UMI1,FLOUI
      WRITE(2,2211)CFII,HAXII1,S2D1,H2DI1,DELUDD,B1,SUM42

C     CHECK TO SEE IF HAXII1 IS WITHIN LIMITS
```

```
      S202=ABS(S201)-DMAXI
      IF(S202)42,42,499

C*****ITERATION PROCEDURE TO OBTAIN CORRECT VALUE OF SKIN FRICTION
C     COEFFICIENT ON INNER WALL

  499 ED=ED+1.
      EF=ED-2.
      EG=ED-3
      IF(EF)500,501,501
  500 S221=S201
      S222=CF1I
      CF1I=CF1I-(2.*DCFINIT)
      GO TO 36
  501 IF(EG)502,504,504
  502 IF(S201)503,42,509
  503 IF(S221)506,42,507
  506 S203=ABS(S201)
      S204=ABS(S221)
      S205=S203-S204
      S206=CF1I-S222
      S207=S206/S205
      S208=S201
      S209=CF1I
      DCF=S221*S207
      CF1I=S222+DCF
      GO TO 36
  507 S231=ABS(S201)
      S232=ABS(S221)
      S233=S231+S232
      S234=CF1I-S222
      S235=S234/S233
      S208=S201
      S209=CF1I
      DCF=S235*S201
      CF1I=CF1I+DCF
      GO TO 36
  509 IF(S221)510,42,511
  510 S241=ABS(S201)
      S242=ABS(S221)
      S243=S241+S242
      S244=CF1I-S222
      S245=S244/S243
      S208=S201
      S209=CF1I
      DCF=S245*S201
      CF1I=CF1I-DCF
      GO TO 36
  511 S213=ABS(S201)
      S214=ABS(S221)
      S215=S213-S214
      S216=CF1I-S222
      S217=S216/S215
      S208=S201
      S209=CF1I
      DCF=S217*S221
      CF1I=S222-DCF
      GO TO 36
  504 IF(S201)505,42,512
  505 IF(S208)506,42,508
  508 S231=ABS(S201)
```

```
      S232=ABS(S208)
      S233=S231+S232
      S234=CF11-S209
      S235=S234/S233
      S208=S201
      S209=CF11
      DCF=S235*S201
      CF1I=CF11+DCF
      GO TO 36
  512 IF(S208)513,42,511
  513 S251=ABS(S201)
      S252=ABS(S208)
      S253=S251+S252
      S254=CF11-S209
      S255=S254/S253
      S208=S201
      S209=CF11
      DCF=S255*S201
      CF1I=CF11-DCF
      GO TO 36
   42 CONTINUE
      ED=0.
 8700 CONTINUE

C     QEXTRI=VOLUME FLOW IN THE REGION BETWEEN THE EDGE OF THE BOUNDARY
C     LAYER AND THE POINT OF MAXIMUM VELOCITY
C     QI=TOTAL FLOW IN INNER WALL LAYER
C     QT=TOTAL FLOW AT INLET
C     DLSTI1=INITIAL DISPLACEMENT THICKNESS OF INNER WALL BOUNDARY LAYER
C     THETI1=INITIAL MOMENTUM THICKNESS OF INNER WALL BOUNDARY LAYER
C     ENTHI1=INITIAL ENERGY THICKNESS OF INNER WALL BOUNDARY LAYER

      QEXTRI=3.1417*UMI1*((RM1**2.)-(RDELI**2.))
      QI=SUM92+QEXTRI
      QT=Q0+QI
      UMEAN1=QT/(3.1417*((R01*R01)-(RI1*RI1)))

C     CALCULATION OF INITIAL VALUE OF VELOCITY PROFILE ENERGY
C     COEFFICIENT (ALPHIN)

      ALPHIN=(EN20+EN21)/((UMEAN1**3.)*3.1417*((R01*R01)-(RI1*RI1)))
      WRITE(2,148)UMEAN1,ALPHIN
  148 FORMAT(2X,2E8.3)
      DLSTI1=SUM32
      THETI1=SUM42
      ENTHI1=SUM52
      WRITE(2,14)Q0,QI,QT
   14 FORMAT(F12.5,4X,F12.5,4X,F12.5)
      UMINT=UM01
      XACT=XACTIN
      RMINT=RM1
      HIINT=HAXII1
      HOINT=HAXI01
      THIINT=THETI1
      THOINT=THET01
      RIINT=RI1
      ROINT=R01
      DCINO=DCFINT
      DCINI=DCFINT
```

```
CXXXXXCALCULATION OF BOUNDARY LAYER PARAMETERS AT A STATION DISTANCE DX
C      FROM INLET.


CXXXXXIT IS ASSUMED THAT NO NET MASS TRANSFER TAKES PLACE BETWEEN THE
C      LAYERS. INITIALLY IT IS ALSO ASSUMED THAT THE RADIUS OF THE
C      POSITION OF MAX. VELOCITY REMAINS UNALTERED. THIS ASSUMPTION WILL
C      LEAD TO A DIFFERENCE IN THE MAX. VELOCITY CALCULATED FOR INNER AND
C      OUTER LAYERS AND IN ORDER TO SATISFY THE CONDITION THAT UM02=UMI2
C      THE RADIUS OF THE POSITION OF MAX. VELOCITY (RM2) IS ADJUSTED


C      SPECIFICATION OF INLET CONDITIONS

C      RO2-OUTER WALL RADIUS AT X+DX
C      RI2-INNER WALL RADIUS AT X+DX
C      RM2-RADIUS OF POSITION OF MAXIMUM VELOCITY INITIALLY SET AT INLET
C      VALUE
C      CF2O-INITIAL ESTIMATE OF SKIN FRICTION COEFFICIENT ON OUTER WALL
C      CF2I-INITIAL ESTIMATE OF SKIN FRICTION COEFFICIENT ON INNER
C      DD,UU,DB,XB,AND XU ARE USED FOR COUNTING THE NO. OF ITERATIONS


   60  XACT=XACT+DX
       XNOW=XACT-XLIMIT
       IF(XNOW)8950,9100,9100
 8950  CONTINUE
       RO2=RO1+DRDXO*DX
       RI2=RI1+DRDXI*DX
       CF2O=CF1O
       CF2I=CF1I
       RM2=RM1
       UMO2=UMO1
       UMI2=UMI1
       UU=0.
  558  DD=0.
       DB=0.
       XB=0.
       XW=0.


C      OUTER PROFILE


C**** THE TECHNIQUE ADOPTED IS TO ASSUME AN INITIAL VALUE OF SKIN
C*****FRICTION COEFFICIENT AND COMPUTE THE OUTER WALL BOUNDARY LAYER
C*****VELOCITY PROFILE. THE SHAPE PARAMETER , MAXIMUM VELOCITY, ETC,
C*****ARE THEN CHECKED TO SEE IF THEY SATISFY THE MOMENTUM INTEGRAL EQN.
C*****IF NOT A NEW VALUE OF SKIN FRICTION COEFFICIENT IS ASSUMED

   53  CONTINUE

C      THE PROCEDURE FOR CONSTRUCTING THE VELOCITY PROFILE FROM AN
C      ASSUMED VALUE OF SKIN FRICTION COEFFICIENT IS THE SAME AS THAT
C      OUTLINED FOR THE OUTER WALL PROFILE AT INLET

       XXU=0.
       IF(CF2O)853,853,854
  853  CF2O=0.00004
```

```
 854 ROOT20=SQRT(CF20*0.5)
1002 CONTINUE
 855 DELCO1=RO2-RM2
 856 CONTINUE
     UTAUO=UM02*ROOT20
  72 B2A=(COLEKO*0.5)/ROOT20
     B2B=.5*ALOG(UTAUO*(DELCO1)/(ENU*12.))
     B2C=COLECO*COLEKO*0.5
     B2=B2A-B2B-B2C
     IF(GA.EQ.1.0)GO TO 8401
     B=B2
     BMAX=B-9.
     IF(BMAX)8400,8401,3401
8400 CONTINUE
     IF(B)65,65,66
  65 DELCO1=0.81*(RO2-RM2)
     GO TO 67
  66 CONTINUE
     DELUDD=U(1)+U(2)*B+U(3)*(B**2)+W(4)*(B**3)+W(5)*(B**4)+W(6)*(B**5)
    1+W(7)*(B**6)+U(8)*(B**7)+W(9)*(B**8)
     DELCO1=DELUDD*(RO2-RM2)
  67 CONTINUE
     B2A=(COLEKO*0.5)/ROOT20
     B2B=.5*ALOG(UTAUO*(DELCO1)/(ENU*12.))
     B2C=COLECO*COLEKO*0.5
     B2=B2A-B2B-B2C
     B=B2
     DELUDD=U(1)+U(2)*B+U(3)*(B**2)+W(4)*(B**3)+W(5)*(B**4)+W(6)*(B**5)
    1+W(7)*(B**6)+U(8)*(B**7)+W(9)*(B**8)
     DELCO1=DELUDD*(RO2-RM2)
     B2A=(COLEKO*0.5)/ROOT20
     B2B=.5*ALOG(UTAUO*(DELCO1)/(ENU*12.))
     B2C=COLECO*COLEKO*0.5
     B2=B2A-B2B-B2C
     ROTTAA=B2A-B2B
     B=B2
     DELUDD=U(1)+U(2)*B+U(3)*(B**2)+W(4)*(B**3)+W(5)*(B**4)+W(6)*(B**5)
    1+W(7)*(B**6)+U(8)*(B**7)+W(9)*(B**8)
     DELCO1=DELUDD*(RO2-RM2)
     B2A=(COLEKO*0.5)/ROOT20
     B2B=.5*ALOG(UTAUO*(DELCO1)/(ENU*12.))
     B2C=COLECO*COLEKO*0.5
     B2=B2A-B2B-B2C
     B=B2
     DELUDD=U(1)+U(2)*B+U(3)*(B**2.)+W(4)*(B**3.)+W(5)*(B**4.)+W(6)*(B*
    1*5.)+W(7)*(B**6.)+U(8)*(B**7.)+W(9)*(B**8.)
     DELCO2=DELUDD*(RO2-RM2)
     DELCO1=DELCO2
     GO TO 73
8401 DELCO1=RO2-RM2
  73 DELCOL=DELCO1
     RDELO=RO2-DELCOL
     DRO=DELCOL/N
     RRO=RO2-(DRO*0.5)
     SUM11=0.
     SUM21=0.
     SUM31=0
     SUM41=0.
     SUM51=0.
     SUM71=0.0
     SUM91=0.
```

```
      DO 50,I=1,N
      RATIO2=RRO/RO2
      DIFRO=RO2-RRO
      U2OA=(UTAUO/COLFKO)*ALOG(UTAUO*DIFRO/(ENU*12.))
      U2OB=UTAUO*COLFCO
      DISOND=(RO2-RRO)/DELCOL
      WAKEO=R2*(1./COLFKO)*(1.+SIN(3.1416*(DISOND-.5)))*UTAUO
      U2O=U2OA+U2OB+UAKEO
      UND2O=U2O/UMO2
      C2O=(1.-UND2O)*DRO
      D2O=C2O*UND2O
      E2O=C2O*RATIO2
      F2O=F2O*UND2O
      ENDO=UND2O*UND2O
      EN2O=U2O*U2O*U2O*DRO*RRO*6.2834
      G2O=(1.-F*DO)*UND2O*RATIO2*DRO
      QO2=2.*3.1416*RRO*DRO*UMO2*UND2O
      SUM11=SUM11+C2O
      SUM21=SUM21+D2O
      SUM31=SUM31+E2O
      SUM41=SUM41+F2O
      SUM51=SUM51+G2O
      SUM71=SUM71+EN2O
      SUM91=SUM91+QO2
   50 RRO=RRO-DRO
 5000 QO2=SUM91+(3.1417*UMO2*((RDELO**2.)-(RM2**2.)))
      EN2O=SUM71+(3.1417*(UMO2**3.)*((RDELO**2.)-(RM2**2.)))
      UMO2=(QO/QO2)*UMO2
C     THIS IS THE CORRECT UMO2 FROM CONTINUITY NO APPREC. ERROR IN UTAU
      UMEO2=FLOWO/((RO2**2.)-(RM2**2.))
      UUMAXO=1.-(2.*RO2*SUM31/((RO2**2.)-(RM2**2.)))
      UMO2AT=UMEO2/UUMAXO
      XXU=XXU+1.
      XDU=XXU-1.
      IF(XDU)354,354,8303
 8303 CONTINUE

C     DLSTO2=OUTER WALL BOUNDARY LAYER DISPLACEMENT THICKNESS
C     THETO2=OUTER WALL BOUNDARY LAYER MOMENTUM THICKNESS
C     ENTHO2=OUTER WALL BOUNDARY LAYER ENERGY THICKNESS
C     HAXIO2=OUTER WALL BOUNDARY LAYER SHAPE PARAMETER
C     UMO2   OUTER WALL BOUNDARY LAYER MAXIMUM VELOCITY
C     IF HAXIO2 IS GREATER THAN 3.5 CALCULATIONS CEASE

      DLSTO2=SUM31
      THETO2=SUM41
      ENTHO2=SUM51
      HAXIO2=SUM31/SUM41
      IF(HAXIO2-3.5)8900,9100,9100
 8900 CONTINUE


      IF(G1.EQ.1.0)GO TO 7500

C     SUBROUTINE FOR CALCULATING NORMAL STRESS TERM

C     OUTER WALL

      DDELTA=DLSTO2-DLSTO1
      DDELDX=DDELTA/DX
      REYSCO=0.0365*(HAXIO2-1.)*DDELDX
```

```
C       REYSCO=REYNOLDS NORMAL STRESS COEFFICIENT
C       CORRELATION DUE TO GOLDBERG
C       END OF SUBROUTINE

        GO TO 7501
 7500   REYSCO=0.0
 7501   CONTINUE

C       SUBROUTINE FOR CALCULATING TOTAL PRESSURE LOSS FROM ENERGY EQN.
C       DTHXO=RATE OF CHANGE OF MOMENTUM THICKNESS (OUTER WALL)
C       DUMDXO=RATE OF CHANGE OF MAXIMUM VELOCITY
C       DTHDXO=RATE OF CHANGE OF ENERGY THICKNESS

        DTHXO=(THET02-THET01)/DX
        DUMDXO=(UMO2-UMO1)/DX
        DTHDXO=(ENTHO2-ENTHO1)/DX
        E2=DELO01-DISTO2
        E1=(3.*ENTHO2*DUMDXO)/UMO1
        DPTDXO=0.0

 7502   CONTINUE
 6800   FORMAT(8F9.5,1X,F4.2)

C       CALCULATION OF DISSIPATION COEFFICIENT USING MIXING LENGTH THEORY
C       RAMP MIXING LENGTH FUNCTION DUE TO SPALDING

        SUMDIS=0.
        DRINT=DELO01/60.0
        RR=DRINT
        R=DRINT/2.
        DO 6803 I=1,59
        RND=RR/DELO01
        IF(RND-0.2)6804,6805,6805
 6804   MIXLND=RND*1.5
        MIXL=MIXLND*DLSTO2
        GO TO 6806
 6805   MIXL=0.3*DLSTO2
 6806   CONTINUE
        U1OA=(UTAUO/COLFKO)*ALOG(UTAUO*R/(ENU*12.))
        U1OB=UTAUO*COLFCO
        DISOND=R/DELO01
        WAKEO=B2*(1./COLFKO)*(1.+SIN(3.1416*(DISOND-.5)))*UTAUO
        U1O=U1OA+U1OB+WAKEO
        UND1R=U1O/UMO2
        R=R+DRINT
        U1OA=(UTAUO/COLFKO)*ALOG(UTAUO*R/(ENU*12.))
        U1OB=UTAUO*COLFCO
        DISOND=R/DELO01
        WAKEO=B2*(1./COLFKO)*(1.+SIN(3.1416*(DISOND-.5)))*UTAUO
        U1O=U1OA+U1OB+WAKEO
        UND2R=U1O/UMO2
        DUND=(UND2R-UND1R)/DRINT
        DUND=ABS(DUND)
        DISPAT=2.*MIXL*MIXL*(DUND**3.)*DRINT
        SUMDIS=SUMDIS+DISPAT
        SHST=2.*MIXL*MIXL*DUND*DUND
 6803   RR=RR+DRINT
        CD=SUMDIS
 7503   CONTINUE
        IF(G4.EQ.1.0)GO TO 7504
```

```
C       CALCULATION OF DISSIPATION COEFFICIENT DUE TO GOLDBERG

        PSGDN=(THET01*DUMDX0)/UM01
        CDECDP=1.-(25000000.0*(PSGDN**3))-(100.0*PSGDN)
        RENO1=(UM01*THET01)/(ENU*12.)
        CDFP=0.0112/(RENO1**.1667)
        CDEQL=CDFP*CDECDP
        DCDDX=(0.009*(CDEQL-CD10))/THET01
        DCD=DCDDX*DX
        CD20=CD10+DCD
        CD=CD20

C       CD-DISSIPATION COEFFICIENT

 6801   FORMAT(7F10.6)
 7504   CONTINUE
        IF(G2.EQ.1.0)GO TO 3701
        DPTDX0=(DTHDX0-CD+E1)/E2
        WRITE(2,3700)DPTDX0,CD
 3700   FORMAT(4X,2F10.6)
 3701   CONTINUE
        IF(G3.EQ.1.0)GO TO 3702
        DPTDX0=(DTHDX0-CD+E1)/E2
        WRITE(2,3700)DPTDX0,CD
 3702   CONTINUE
        IF(G4.EQ.1.0)GO TO 3703
        DPTDX0=(DTHDX0-CD+E1)/E2
        WRITE(2,3700)DPTDX0,CD
 3703   CONTINUE
        IF(G5.EQ.1.0)GO TO 7505

C       CALCULATION OF TOTAL PRESSURE LOSS FROM TEST DATA

        D=MAXI02
        DPTDX0=V(1)+V(2)*D+V(3)*(D**2)+V(4)*(D**3)+V(5)*(D**4)+V(6)*(D**5)
       1+V(7)*(D**6)+V(8)*(D**7)+V(9)*(D**8)
        DHYRAU=(((R02*R02)-(RH2*RH2))/R02)*2.
        DPTDX0=-DPTDX0/DHYRAU
        WRITE(2,6802)DPTDX0
 6802   FORMAT(2X,F10.6)
 7505   CONTINUE

C       CALCULATION OF SHEAR STRESS GRADIENT AT RMAX

        IF(G7.EQ.1.0)GO TO 9565
        MIXL=0.25*DIST02
        DRINT=DELC01/60.0
        R=DELC01-(DRINT*0.5)
        U10A=(UTAU0/COLFK0)*ALOG(UTAU0*R/(ENU*12.))
        U10B=UTAU0*COLFC0
        DISOND=R/DELC01
        WAKE0=B2*(1./COLFK0)*(1.+SIN(3.1416*(DISOND-.5)))*UTAU0
        U10=U10A+U10B+WAKE0
        UND1R=U10/UI02
        R=R-DRINT
        U10A=(UTAU0/COLFK0)*ALOG(UTAU0*R/(ENU*12.))
        U10B=UTAU0*COLFC0
        DISOND=R/DELC01
        WAKE0=B2*(1./COLFK0)*(1.+SIN(3.1416*(DISOND-.5)))*UTAU0
        U10=U10A+U10B+WAKE0
```

```
      UND2R=U10/U402
      DUND=(UND1R-UND2R)/DRINT
      DUND=ABS(DUND)
      SHST1=2.*MIXL*MIXL*DUND*DUND
      R=R-DRINT
      U10A=(UTAU0/COLEK0)*ALOG(UTAU0*R/(ENU*12.))
      U10B=UTAU0*COLEC0
      DISOND=R/DELC01
      WAKE0=R2*(1./COLEK0)*(1.+SIN(3.1416*(DISOND-.5)))*UTAU0
      U10=U10A+U10B+WAKE0
      UND3R=U10/U402
      DUND=(UND2R-UND3R)/DRINT
      DUND=ABS(DUND)
      SHST2=2.*MIXL*MIXL*DUND*DUND
      DPTDX0=-((SHST2-SHST1)/DRINT)
      WRITE(2,9566)UND1R,UND2R,UND3R,DRINT,SHST1,SHST2,DPTDX0
 9566 FORMAT(7F10.6)
 9565 CONTINUE
      TAU02=CF20*0.5
      TAUOX=(TAU01+TAU02)/2.
      GRADPX=THET01*((DUNDX0*(HAXI01+2.))/UM01)
      GEOMPX=THET01*(DRDX0/R01)

C     CALCULATION OF TOTAL PRESSURE GRADIENT TERM IN MOMENTUM EQN (BASED
C     ON OUTER WALL CALCULATIONS)

      IF(G6.EQ.1.0)GO TO 136
      DPTM02=(((R02*R02)-(RM2*RM2))/R02)*DPTDX0*0.25
      GO TO 137
  136 DPTM0=0.0
      DPTDX0=0.0

C*****DMLHS=LEFT HAND SIDE OF MOMENTUM EQN. (OUTER WALL)
C     IF THE CORRECT SHAPE PARAMETER (SKIN FRICTION COEFFICIENT) HAS
C     BEEN ASSUMED DMLHS WILL BE ZERO OR WITHIN THE LIMITS SPECIFIED BY
C     DM. IF DMLHS IS OUTSIDE THE LIMITS THEN A NEW VALUE OF CF20 IS
C     ESTIMATED AND THE CALCULATIONS REPEATED UNTIL DMLHS COMES WITHIN
C     LIMITS

  137 DMLHS=DTHX0+THET01*((DRDX0/R01)+(DUNDX0*(HAXI01+2.))/UM01)-TAUOX-D
     1PTM0-REYSC0
      DPTDXR=DPTDX0
      S101=DMLHS
      WRITE(2,8301)DMLHS,CF20,HAXI02,DELC01,DPTM0,THET02
 8301 FORMAT(F9.6,4X,F9.6,4X,F9.6,4X,F7.4,4X,F8.5,4X,F8.5)
      S102=ABS(S101)-DM
      IF(S102)51,51,52

C*****ITERATION PROCEDURE TO FIND THE CORRECT VALUE OF CF20

   52 DB=DB+1.
      DC=DB-2.
      DE=DB-3.
      IF(DC)600,601,601
  600 S121=S101
      S122=CF20
      CF20=CF20-DCINC
      GO TO 53
  601 IF(DE)602,604,604
  602 IF(S101)603,51,609
  603 IF(S121)606,51,607
```

```
606 S103=ABS(S101)
    S104=ABS(S121)
    S105=S103-S104
    S106=CF20-S122
    S107=S106/S105
    S108=S101
    S109=CF20
    DCF=S121*S107
    CF20=S122+DCF
    GO TO 53
607 S131=ABS(S101)
    S132=ABS(S121)
    S133=S131+S132
    S134=CF20-S122
    S135=S134/S133
    S108=S101
    S109=CF20
    DCF=S135*S101
    CF20=CF20+DCF
    GO TO 53
609 IF(S121)610,51,611
610 S141=ABS(S101)
    S142=ABS(S121)
    S143=S141+S142
    S144=CF20-S122
    S145=S144/S143
    S108=S101
    S109=CF20
    DCF=S145*S101
    CF20=CF20-DCF
    GO TO 53
611 S113=ABS(S101)
    S114=ABS(S121)
    S115=S113-S114
    S116=CF20-S122
    S117=S116/S115
    S108=S101
    S109=CF20
    DCF=S117*S121
    CF20=S122-DCF
    GO TO 53
604 IF(S101)605,51,612
605 IF(S108)606,51,608
608 S131=ABS(S101)
    S132=ABS(S108)
    S133=S131+S132
    S134=CF20-S109
    S135=S134/S133
    S108=S101
    S109=CF20
    DCF=S135*S101
    CF20=CF20+DCF
    GO TO 53
612 IF(S108)613,51,611
613 S151=ABS(S101)
    S152=ABS(S108)
    S154=CF20-S109
    S153=S151+S152
    S155=S154/S153
    S108=S101
    S109=CF20
```

```
      DCF=S155*S101
      CF20=CF20-DCF
      GO TO 53
   51 CONTINUE
   91 CONTINUE
C
C
   57 CONTINUE


C*****CALCULATION OF INNER WALL BOUNDARY LAYER PARAMETERS AT (X+DX)

C     THE PROCEDURE FOR CONSTRUCTING THE VELOCITY PROFILE FROM AN
C     ASSUMED VALUE OF SKIN FRICTION COEFFICIENT IS THE SAME AS THAT
C     OUTLINED FOR THE OUTER WALL PROFILE AT INLET

      XXU=0.0
      IF(CF2I)859,859,860
  859 CF2I=0.00005
  860 ROOT2I=SQRT(CF2I*0.5)
      DELCI1=RM2-RI2
      UTAUI=U1I2*ROOT2I
   75 B2AI=(COLEKI*0.5)/ROOT2I
      B2BI=.5*ALOG(UTAUI*(DELCI1)/(ENU*12.))
      B2CI=COLECI*COLEKI*0.5
      B2I=B2AI-B2BI-B2CI
      IF(GA.EQ.1.0)GO TO 8403
      B=B2I
      BMAX=B-9.
      IF(BMAX)8402,8403,8403
 8402 CONTINUE
      IF(B)68,68,69
   68 DELCI1=0.81*(RM2-RI2)
      GO TO 79
   69 CONTINUE
      DELUDD=U(1)+U(2)*B+U(3)*(B**2)+U(4)*(B**3)+U(5)*(B**4)+U(6)*(B**5)
     1+U(7)*(B**6)+U(8)*(B**7)+U(9)*(B**8)
      DELCI1=DELUDD*(RM2-RI2)
   79 CONTINUE
      B2AI=(COLEKI*0.5)/ROOT2I
      B2BI=.5*ALOG(UTAUI*(DELCI1)/(ENU*12.))
      B2CI=COLECI*COLEKI*0.5
      B2I=B2AI-B2BI-B2CI
      B=B2I
      DELUDD=U(1)+U(2)*B+U(3)*(B**2)+U(4)*(B**3)+U(5)*(B**4)+U(6)*(B**5)
     1+U(7)*(B**6)+U(8)*(B**7)+U(9)*(B**8)
      DELCI1=DELUDD*(RM2-RI2)
      B2AI=(COLEKI*0.5)/ROOT2I
      B2BI=.5*ALOG(UTAUI*(DELCI1)/(ENU*12.))
      B2CI=COLECI*COLEKI*0.5
      B2I=B2AI-B2BI-B2CI
      ROTTAA=B2AI-B2BI
      B=B2I
      DELUDD=U(1)+U(2)*B+U(3)*(B**2)+U(4)*(B**3)+U(5)*(B**4)+U(6)*(B**5)
     1+U(7)*(B**6)+U(8)*(B**7)+U(9)*(B**8)
      DELCI1=DELUDD*(RM2-RI2)
      B2AI=(COLEKI*0.5)/ROOT2I
      B2BI=.5*ALOG(UTAUI*(DELCI1)/(ENU*12.))
      B2CI=COLECI*COLEKI*0.5
      B2I=B2AI-B2BI-B2CI
      B=B2I
```

```
      DELUDD=U(1)+U(2)*B+U(3)*(B**2)+U(4)*(B**3)+U(5)*(B**4)+U(6)*(B**5)
     1+U(7)*(B**6)+U(8)*(B**7)+U(9)*(B**8)
      DELCI2=DELUDD*(RM2-RI2)
      DELCI1=DELCI2
      GO TO 76
 8403 DELCI1=RM2-RI2
   76 DELCOL=DELCI1
      RDELI=DELCOL+RI2
      DRI=DELCOL/N
      RRI=RI2+(DRI*.5)
      SUM12=0.
      SUM22=0.
      SUM32=0.
      SUM42=0.
      SUM52=0.
      SUM72=0.0
      SUM92=0.
      DO 54,I=1,N
      RATII2=RRI/RI2
      DIFRI=RRI-RI2
      U2IA=(UTAUI/COLEKI)*ALOG(UTAUI*DIFRI/(ENU*12.))
      U2IB=UTAUI*COLFCI
      DISIND=(RRI-RI2)/DELCOL
      WAKEI=B2I*(1 /COLEKI)*(1.+SIN(3.1416*(DISIND-.5)))*UTAUI
      U2I=U2IA+U2IB+WAKEI
      UND2I=U2I/UMI2
      C2I=(1.-UND2I)*DRI
      D2I=C2I*UND2I
      E2I=C2I*RATII2
      F2I=E2I*UND2I
      EN2I=U2I*U2I*U2I*DRI*RRI*6.2834
      END1=UND2I*UND2I
      G2I=(1.-END1)*UND2I*RATII2*DRI
      Q12=2.*3.1416*RRI*DRI*UMI2*UND2I
      SUM12=SUM12+C2I
      SUM22=SUM22+D2I
      SUM32=SUM32+F2I
      SUM42=SUM42+E2I
      SUM52=SUM52+G2I
      SUM72=SUM72+EN2I
      SUM92=SUM92+Q12
   54 RRI=RRI+DRI
 1140 H2DI2=SUM12/SUM22

C     HAXII2=INNER WALL SHAPE PARAMETER
C     DLSTI2=DISPLACEMENT THICKNESS
C     THETI2=MOMENTUM THICKNESS
C     UMI2=MAX. VELOCITY IN INNER LAYER AT (X+DX) CALCULATED FROM
C     CONTINUITY EQN.
C     UUMAXI=RATIO OF MEAN TO MAXIMUM VELOCITY IN INNER WALL LAYER

      HAXII2=SUM32/SUM42
      DLSTI2=SUM32
      EN2I=SUM72*(3.1417*(UMI2**3.)*((RM2**2.)-(RDELI**2.)))
      THETI2=SUM42
      ENTHI2=SUM52
      Q12=SUM92*(3.1417*UMI2*((RM2**2.)-(RDELI**2.)))
      UMI2=(Q1/Q12)*UMI2
      XXU=XXU+1.
      XDU=XXU-1.
      IF(XDU)860,860,555
```

```
  555 CONTINUE
      UMEI2=FLOUI/((RH2**2.)-(RI2**2.))
      UUMAXI=1.-(2.*RI2*SUM32/((RH2**2.)-(RI2**2.)))

      IF(G1.EQ.1.0)GO TO 7506

C     SUBROUTINE FOR CALCULATING NORMAL STRESS TERM
C     INNER WALL
C     REYSCI=REYNOLDS NORMAL STRESS COEFFICIENT

      DDELTA=DLSTI2-DLSTI1
      DDELDX=DDELTA/DX
      REYSCI=0.0365*(MAXII2-1.)*DDELDX
C     END OF SUBROUTINE
      GO TO 7507
 7506 REYSCI=0.0
 7507 CONTINUE


C     DTHXI=RATE OF CHANGE OF MOMENTUM THICKNESS (INNER WALL)
C     DUMDXI=RATE OF CHANGE OF MAXIMUM VELOCITY
C     DTHDXI=RATE OF CHANGE OF ENERGY THICKNESS

      DTHXI=(THETI2-THETI1)/DX
      DUMDXI=(UMI2-UMI1)/DX
      DTHDXI=(ENTHI2-ENTHI1)/DX
      F1=(3.*ENTHI2*DUMDXI)/UMI1
      E2=DELCI1-DLSTI2
      DPTDXI=0.0
      IF(G2.EQ.1.0)GO TO 388
      CDI=CD
      CDCF1=CD/CF2I
  388 CONTINUE
      IF(G3.EQ.1.0)GO TO 7508

C     CALCULATION OF DISSIPATION COEFFICIENT USING MIXING LENGTH THEORY

      SUMDIS=0.0
      DRINT=DELCI1/60.0
      RR=DRINT
      R=DRINT/2.
      DO 7511 I=1,59
      RND=RR/DELCI1
      IF(RND-0.2)7512,7514,7514
 7512 MIXLND=RND*1.75
      MIXL=MIXLND*DLSTI2
      GO TO 7515
 7514 MIXL=0.35*DLSTI2
 7515 CONTINUE
      U2IA=(UTAUI/COLEKI)*ALOG(UTAUI*R/(ENU*12.))
      U2IB=UTAUI*COLECI
      DISIND=R/DELCI1
      WAKEI=B2I*(1./COLEKI)*(1.+SIN(3.1416*(DISIND-.5)))*UTAUI
      U2I=U2IA+U2IB+WAKEI
      UND1R=U2I/UMI2
      R=R+DRINT
      U2IA=(UTAUI/COLEKI)*ALOG(UTAUI*R/(ENU*12.))
      U2IB=UTAUI*COLECI
      DISIND=R/DELCI1
      WAKEI=B2I*(1./COLEKI)*(1.+SIN(3.1416*(DISIND-.5)))*UTAUI
      U2I=U2IA+U2IB+WAKEI
```

```
      UND2R=U2I/UMI2
      DUND=ABS((UND2R-UND1R)/DRINT)
      DISPAT=2.*MIXL*MIXL*(DUND**3.)*DRINT
      SUMDIS=SUMDIS+DISPAT
 7511 RR=RR+DRINT
      CDI=SUMDIS
 7508 CONTINUE
      IF(G4.EQ.1.0)GO TO 7509

C     CALCULATION OF DISSIPATION COEFFICIENT USING THE CORRELATION DUE
C     TO GOLDBERG

      PSGDN=(THETI1*DUMDXI)/UMI1
      CDECDP=1.-(25000000.0*(PSGDN**3))+(100.0*PSGDN)
      RENI1=(UMI1*THETI1)/(ENU*12.)
      CDFP=0.0112/(RENI1**0.1667)
      CDEQL=CDFP*CDECDP
      DCDDX=(0.009*(CDEQL-CD1I))/THETI1
      DCD=DCDDX*DX
      CD2I=CD1I+DCD
      CDI=CD2I
      WRITE(2,6301)DPTDXI,CD2I,CD1I,CDECDP,PSGDN,CDFP,CDEQL
 7509 CONTINUE

C     CALCULATION OF TOTAL PRESSURE GRADIENT FROM THE ENERGY INTEGRAL
C     EQUATION

      DPTDXI=(DTHDXI-CDI*E1)/E2
      WRITE(2,6300)DPTDXI,CDI
      IF(G5.EQ.1.0)GO TO 7510
 7510 CONTINUE
      TAUI2=CF2I*0.5
      TAUIX=(TAUI1+TAUI2)/2.
      GEOMPI=THETI1*(DRDXI/RI1)
      GRADPY=THETI1*((DUMDXI*(HAXII1+2.))/UMI1)

C     CALCULATION OF TOTAL PRESSURE GRADIENT TERM IN MOMENTUM EQN
      IF(G6.EQ.1.0)GO TO 138
      DPTMI2=(((R12*RM2)-(RI2*RI2))/RI2)*DPTDX0*0.25
      GO TO 139
  138 DPTMI=0.0

C     DMLHT-LEFT HAND SIDE OF MOMENTUM EQN. (INNER WALL)

  139 DMLHT=DTHXI+THETI1*((DRDXI/RI1)+(DUMDXI*(HAXII1+2.))/UMI1)-TAUIX+D
     1PTMI-REYSCI

C     IF THE CORRECT SHAPE PARAMETER (SKIN FRICTION COEFFICIENT) HAS
C     BEEN ASSUMED DMLHT WILL BE ZERO OR WITHIN THE LIMITS SPECIFIED BY
C     DM. IF DMLHT IS OUTSIDE THE LIMITS THEN A NEW VALUE OF CF2I IS
C     ESTIMATED AND THE CALCULATIONS REPEATED UNTIL DMLHT COMES WITHIN
C     LIMITS

      S201=DMLHT
      WRITE(2,8301)DMLHT,CF2I,HAXII2,DELCI1,DPTMI,THETI2
      S202=ABS(S201)-DM
      IF(S202)55,55,56

C     ITERATION PROCEDURE TO FIND CORRECT VALUE OF CF2I

   56 DD=DD+1
```

```
      DF=DD-2.
      DG=DD-3.
      IF(DF)700,701,701
  700 S221=S201
      S222=CF2I
      CF2I=CF2I-DCINT
      GO TO 57
  701 IF(DG)702,704,704
  702 IF(S201)703,55,709
  703 IF(S221)706,55,707
  706 S203=ABS(S201)
      S204=ABS(S221)
      S205=S203-S204
      S206=CF2I-S222
      S207=S206/S205
      S208=S201
      S209=CF2I
      DCF=S221*S207
      CF2I=S222+DCF
      GO TO 57
  707 S231=ABS(S201)
      S232=ABS(S221)
      S233=S231+S232
      S234=CF2I-S222
      S235=S234/S233
      S208=S201
      S209=CF2I
      DCF=S235*S201
      CF2I=CF2I+DCF
      GO TO 57
  709 IF(S221)710,55,711
  710 S241=ABS(S201)
      S242=ABS(S221)
      S243=S241+S242
      S244=CF2I-S222
      S245=S244/S243
      S208=S201
      S209=CF2I
      DCF=S245*S201
      CF2I=CF2I-DCF
      GO TO 57
  711 S213=ABS(S201)
      S214=ABS(S221)
      S215=S213-S214
      S216=CF2I-S222
      S217=S216/S215
      S208=S201
      S209=CF2I
      DCF=S217*S221
      CF2I=S222-DCF
      GO TO 57
  704 IF(S201)705,55,712
  705 IF(S208)706,55,708
  708 S231=ABS(S201)
      S232=ABS(S208)
      S233=S231+S232
      S234=CF2I-S209
      S235=S234/S233
      S208=S201
      S209=CF2I
      DCF=S235*S201
```

```
      CF2I=CF2I+DCF
      GO TO 57
  712 IF(S208)713,55,711
  713 S251=ABS(S201)
      S252=ABS(S208)
      S253=S251+S252
      S254=CF2I-S209
      S255=S254/S253
      S208=S201
      S209=CF2I
      DCF=S255*S201
      CF2I=CF2I-DCF
      GO TO 57
   55 CONTINUE
   98 CONTINUE
      DLDASI=DELDAS

CXXXXXHAVING SOLVED THE MOMENTUM EQUATIONS THE VALUES OF MAX. VELOCITY
C     FOR THE TWO LAYERS ARE COMPARED. IF THEY ARE THE SAME OR WITHIN
C     THE LIMITS SPECIFIED BY DUM THEN THE CORRECT VALUE OF THE POSITION
C     OF MAXIMUM VELOCITY(RM2) HAS BEEN ASSUMED. IF THE DIFFERENCE IN
C     VELOCITY(UMLHS) IS OUTSIDE THE SPECIFIED LIMITS THEN A NEW VALUE
C     OF RM2 IS ESTIMATED AND THE CALCULATIONS REPEATED UNTIL (UMLHS)
C     COMES WITHIN LIMITS.


      S302=ABS(S301)-DUM
      WRITE(2,2231)RM2,UM02,UM12
 2231 FORMAT(F12.6,4X,F12.6,4X,F12.6)
      IF(S302)59,59,799

CXXXXXREITERATION PROCEDURE TO FIND CORRECT VALUE OF RM2

  799 UU=UU+1.
      UV=UU-2.
      UW=UU-3.
      IF(UV)800,801,801
  800 S321=S301
      S322=RM2
      IF(UM02-UM12)82,59,83
   82 CONTINUE
      RM2=RM2+DRMINT
      GO TO 558
   83 DUM=10.0
      GO TO 59
  801 IF(UW)802,804,804
  802 IF(S301)803,59,809
  803 IF(S321)806,59,807
  806 S303=ABS(S301)
      S304=ABS(S321)
      S305=S303-S304
      S306=RM2-S322
      S307=S306/S305
      S308=S301
      S309=RM2
      DRM=S321*S307
      RM2=S322+DRM
      GO TO 558
  807 S331=ABS(S301)
      S332=ABS(S321)
```

```
      S333=S331+S332
      S334=RM2-S322
      S335=S334/S333
      S308=S301
      S309=RM2
      DRM=S335*S301
      RM2=RM2+DRM
      GO TO 558
  809 IF(S321)810,59,811
  810 S341=ABS(S301)
      S342=ABS(S321)
      S343=S341+S342
      S344=RM2-S322
      S345=S344/S343
      S308=S301
      S309=RM2
      DRM=S345*S301
      RM2=RM2-DRM
      GO TO 558
  811 S313=ABS(S301)
      S314=ABS(S321)
      S315=S313-S314
      S316=RM2-S322
      S317=S316/S315
      S308=S301
      S309=RM2
      DRM=S317*S321
      RM2=S322-DRM
      GO TO 558
  804 IF(S301)805,59,812
  805 IF(S308)806,59,808
  808 S331=ABS(S301)
      S332=ABS(S308)
      S333=S331+S332
      S334=RM2-S309
      S335=S334/S333
      S308=S301
      S309=RM2
      DRM=S335*S301
      RM2=RM2+DRM
      GO TO 558
  812 IF(S308)813,59,811
  813 S351=ABS(S301)
      S352=ABS(S308)
      S353=S351+S352
      S354=RM2-S309
      S355=S354/S353
      S308=S301
      S309=RM2
      DRM=S355*S301
      RM2=RM2-DRM
      GO TO 558


CXXXXXIF (UNLHS) IS WITHIN LIMITS THEN THE CALCULATIONS AT (X+DX) ARE
C     COMPLETE AND ALL THE DATA OBTAINED AT (X+DX) IS RE-SPECIFIED TO
C     BECOME THE DATA AT INLET TO THE NEXT STEP

   59 CONTINUE
      UMMAX=1.-((R02*DLST02)+(RI2*DLSTI2))/(0.5*((R02*R02)-(RI2*RI2)))
      ENGRAX=3.*ENTH02*DUMDX0/UMI1
```

```
      AREARO=((RO2*RO2)-(RI2*RI2))/11.
       UMEAN2=UMMAX*UMO2
      UMEANI=UMEAN2*AREARO

C     CALCULATION OF VELOCITY PROFILE ENERGY COEFFICIENT AT (X+DX)

      ALPH=(EN2O+EN2I)/((UMEAN2**3.)*3.1417*((RO2*RO2)-(RI2*RI2)))

C     CALCULATION OF LOSS COEFFICIENT

      RMLOSC=RMLOSI+ABS((DPTDXR*UMO2*UMO2*DX)/(UMEANI*UMEANI))
      RMLOSI=RMLOSC

C*****WARNING IF CALCULATION DOES NOT COMMENCE AT X=0.0 THEN THE
C     INITIAL VALUE OF CP MUST BE THE IDEAL VALUE SO THAT WHEN THE INITIA
C     INITIAL LOSS COEFF IS SUBTRACTED THE ACTUAL CP IS OBTAINED

      IF(G6.EQ.1.0)GO TO 387
      GO TO 386
  387 RMLOSC=0.0
  386 CONTINUE
      CP=CPINT+(((UMINT*UMINT)-(UMO2*UMO2))/(UMEANI*UMEANI))-RMLOSC
      CPIDL=1.045-(ALPH/(AREARO*AREARO))
      LOSCOF=CPIDL-CP

C*****STORAGE OF VALUES AT (X+DX) PRIOR TO THESE VALUES BECOMING THE
C*****INITIAL CONDITIONS TO THE NEXT STEP

      M=M+1
      I=M
      ALPHA(I)=ALPH
      RMA(I)=RM2
      DPTMA(I)=DPTMO
      CPA(I)=CP
      LOS(I)=LOSCOF
      ARA(I)=AREARO
      UMMA(I)=UMMAX
      THETI(I)=THETI2
      HIA(I)=HAXII2
      THETO(I)=THETO2
      HOA(I)=HAXIO2
      XAC(I)=XACT
      DELTHO(I)=DELTHO2
      DISMO(I)=CD
      ENGRAD(I)=ENGRAX
      DPTDX(I)=DPTDXR
      DELTHI(I)=DELTHI2
      DISMI(I)=CDI
      SHSTO(I)=REYSCO
      CFO(I)=CF2O
      GRADPO(I)=GRADPX
      GEOMPO(I)=GEOMPX
      SHSTI(I)=REYSCI
      CFI(I)=CF2I
      GRADPI(I)=GRADPY
      WRITE(2,4431)XACT,HAXIO2,HAXII2,RO2,RM2,RI2,UMO2
 4431 FORMAT(2X,F5.2,3X,F6.3,3X,F6.3,3X,F6.3,3X,F6.3,3X,F6.3,3X,F8.3)
      WRITE(2,8000)DPTDXO,GEOMPX,GRADPX,TAUOX,THETO2,THETO1
 8000 FORMAT(F9.6,2X,F9.6,2X,F9.6,2X,F9.6,2X,F9.6,2X,F9.6)
      WRITE(2,8000)DPTDXI,GEOMPI,GRADPY,TAUIX,THETI2,THETI1
```

```
C*****REVISED INLET CONDITIONS TO NEXT STEP

      RO1=RO2
      RI1=RI2
      RM1=RM2
      UMO1=UMO2
      UMI1=UMI2
      CF1O=CF2O
      CF1I=CF2I
      TAUO1=TAUO2
      DPTHI=DPTHI2
      DPTHO=DPTHO2
      HAXIO1=HAXIO2
      HAXII1=HAXII2
      DLSTO1=DLSTO2
      DLSTI1=DLSTI2
      THETO1=THETO2
      THETI1=THETI2
      TAUI1=TAUI2
      DRMINT=RM2-S32?
      ENTHI1=ENTHI2
      ENTHO1=ENTHO2
      CD1O=CD2O
      DCINO=S122-CF2O
      DCINI=S222-CF2I
      CD1I=CD2I
      GO TO 60
 9100 CONTINUE

C*****PRINT OUT OF RESULTS

      WRITE(2,141)
  141 FORMAT(1H1)
      WRITE(2,145)
  145 FORMAT(///)
      WRITE(2,100)
  100 FORMAT(30X,42HPREDICTION OF ANNULAR DIFFUSER PERFORMANCE)
      WRITE(2,101)
  101 FORMAT(/18X,18HDIFFUSER GEOMETRY.)
      WRITE(2,102)WALANO,WALANI
  102 FORMAT(/18X,19HWALL ANGLES. OUTER=,F7.3,1X,9HDEGREES ,,6HINNER=,F6
     1.3,1X,7HDEGREES)
      WRITE(2,103)ROINT,RIINT
  103 FORMAT(18X,19HINLET RADII. OUTER=,F5.2,1X,6HINS. ,,6HINNER=,F5.2,1
     1X,4HINS.)
      WRITE(2,104)DIFNDL
  104 FORMAT(18X,25HDIFFUSER NON DIMENSIONAL=,F5.1)
      WRITE(2,105)XACTIN
  105 FORMAT(/18X,45HINLET CONDITIONS (CALCULATIONS COMMENCE AT X=,F6.3,
     11X,5HINS.))
      WRITE(2,106)HOINT,HIINT
  106 FORMAT(/18X,29HSHAPE PARAMETERS. OUTER WALL=,F6.3,1X,11HINNER WALL
     1=,F6.3)
      WRITE(2,107)THOINT,THIINT
  107 FORMAT(18X,31HMOMENTUM THICKNESS. OUTER WALL=,F6.3,1X,4HINS.,11HIN
     1NER WALL=,F6.3,1X,3HINS)
      WRITE(2,108)UMINT
  108 FORMAT(18X,17HMAXIMUM VELOCITY=,F8.3,1X,6HFT/SEC)
      WRITE(2,109)RMINT
  109 FORMAT(18X,39HRADIUS OF POSITION OF MAXIMUM VELOCITY=,F6.3,1X,4HIN
     1S.//)
```

```
      WRITE(2,8926)
 8926 FORMAT(/18X,58HDIST   HO   THETA   HI   THETA   UMEAN  AREA   LOSS
     1      CP,9H      RMAX)
      WRITE(2,8927)
 8927 FORMAT(19X,51HX           OUTER         INNER    UMAX  RATIO  COEFF,
     114H             INS)
      DO 8922 I=1,N
 8922 WRITE(2,8923)XAC(I),HOA(I),THETO(I),HIA(I),THETI(I),UMMA(I),ARA(I)
     1,LOS(I),CPA(I),RMA(I),ALPHA(I),DPTMA(I)
 8923 FORMAT(17X,F5.2,1X,F5.2,1X,F6.3,1X,F5.2,1X,F6.3,2X,F6.3,1X,F5.2,2X
     1,F6.3,2X,F6.3,2X,F6.3,10X,F6.3,2X,F8.5)
      WRITE(2,110)
  110 FORMAT(/18X,49H(FOR ADDITIONAL BOUNDARY LAYER DATA SEE OVERLEAF))
      WRITE(2,141)
      WRITE(2,145)
      WRITE(2,140)
  140 FORMAT(35X,42HPREDICTION OF ANNULAR DIFFUSER PERFORMANCE)
      WRITE(2,111)
  111 FORMAT(/40X,32H(ADDITIONAL BOUNDARY LAYER DATA))
      WRITE(2,112)
  112 FORMAT(/35X,23HTHEORETICAL ASSUMPTIONS)
      WRITE(2,114)
  114 FORMAT(/35X,28HVELOCITY PROFILE = COLES LAW)
      WRITE(2,115)
  115 FORMAT(35X,37HSKIN FRICTION COEFFICIENT = COLES LAW)
      IF(GA.EQ.1.0)GO TO 117
      WRITE(2,116)
  116 FORMAT(35X,59HMODIFICATION TO BOUNDARY LAYER THICKNESS INCLUDED (R
     1EVISED))
      GO TO 149
  117 WRITE(2,118)
  118 FORMAT(35X,53HMODIFICATION TO BOUNDARY LAYER THICKNESS NOT INCLUDE
     1D)
  149 CONTINUE
      IF(G1.EQ.1.0)GO TO 156
  120 WRITE(2,121)
  121 FORMAT(35X,45HESTIMATE OF REYNOLDS NORMAL STRESSES INCLUDED)
      GO TO 150
  156 CONTINUE
      WRITE(2,119)
  119 FORMAT(35X,49HESTIMATE OF REYNOLDS NORMAL STRESSES NOT INCLUDED)
  150 CONTINUE
      IF(G2.EQ.1.0)GO TO 123
      WRITE(2,122)
  122 FORMAT(35X,36HTOTAL PRESSURE LOSS INCLUDED (ROTTA))
  123 IF(G3.EQ.1.0)GO TO 125
      WRITE(2,124)
  124 FORMAT(35X,44HTOTAL PRESSURE LOSS INCLUDED (MIXING LENGTH))
  125 IF(G4.EQ.1.0)GO TO 127
      WRITE(2,126)
  126 FORMAT(35X,39HTOTAL PRESSURE LOSS INCLUDED (GOLDBERG))
  127 IF(G5.EQ.1.0)GO TO 129
      WRITE(2,128)
  128 FORMAT(35X,51HTOTAL PRESSURE LOSS INCLUDED (EXPERIMENTAL RESULTS))
  129 IF(G6.EQ.1.0)GO TO 157
      GO TO 829
  157 CONTINUE
      WRITE(2,130)
  130 FORMAT(35X,32HTOTAL PRESSURE LOSS NOT INCLUDED)
  829 CONTINUE
      IF(G7.EQ.1.0)GO TO 8989
```

```
      WRITE(2,8988)
 8988 FORMAT(35X,40HTOTAL PRESSURE LOSS INCLUDED (SHEAR STRESS GRADIENT
     1AT RMAX))
 8989 CONTINUE
  131 WRITE(2,132)
  132 FORMAT(35X,49HNO NET MASS TRANSFER BETWEEN INNER & OUTER LAYERS)
      WRITE(2,133)
  133 FORMAT(35X,17HNO POTENTIAL CORE/)
      WRITE(2,8928)
 8928 FORMAT(/5X,99HDIST  DEL**  DISPN.                    DEL**  DISPN.
     1N.S.C.     CF                        N.S.C.     CF)
      WRITE(2,8929)
 8929 FORMAT(6X,99HX    OUTER   CDO                    INNER   CDI    OU
     1TER    OUTER                        INNER    INNER)
      DO 8924 I=1,M
 8924 WRITE(2,8925)XAC(I),DELTHO(I),DISNO(I),FNGRAD(I),DPTDX(I),DELTHI(I
     1),DISNI(I),SHSTO(I),CFO(I),GRADPO(I),GFOMPO(I),SHSTI(I),CFI(I),GRA
     2DPI(I)
 8925 FORMAT(4X,F5.2,1X,F6.3,1X,F7.4,1X,F7.4,1X,F7.4,1X,F6.3,1X,F7.4,1X,
     1F7.4,1X,F8.5,1X,F7.4,1X,F8.5,1X,F7.4,1X,F8.5,1X,F7.4)
      GO TO 1
      STOP
      END
```

END OF SEGMENT, LENGTH 6669, NAME B201

Appendix 29

Theoretical Boundary Layer Growth

Coles Law Prediction Method

TABLE A29-1

0.75, CNEA, (Boundary Layer Thickness modified using correlation 'A' - Fig. 5-6-2)

PREDICTION OF ANNULAR DIFFUSER PERFORMANCE

DIFFUSER GEOMETRY

WALL ANGLES OUTER= 10.000 DEGREES ,INNER= 0.000 DEGREES
INLET RADII. OUTER= 6 13 INS. ,INNER= 5.00 INS.
DIFFUSER NON DIMENSIONAL= 5 0

INLET CONDITIONS (CALCULATIONS COMMENCE AT X= 0.750 INS)

SHAPE PARAMETERS. OUTER WALL= 1 481 INNER WALL= 1.403
MOMENTUM THICKNESS OUTER WALL= 0.056 INS.INNER WALL= 0 041 INS
MAXIMUM VELOCITY= 137.400 FT/SEC
RADIUS OF POSITION OF MAXIMUM VELOCITY= 5.555 INS.

DIST X	HO	THETA OUTER	HI	THETA INNER	UMEAN UMAX	AREA RATIO	LOSS COEFF	CP	RMAX INS
1 00	1.50	0 062	1.39	0 045	0.865	1.19	0 041	0 238	5.576
1 25	1.52	0 068	1.41	0.049	0.855	1.24	0.042	0 290	5.596
1 50	1.55	0 074	1.42	0.054	0.846	1 29	0 045	0.336	5.617
1 75	1.58	0 080	1.43	0 059	0.835	1.34	0.046	0.377	5.637
2 00	1.62	0 086	1.44	0 063	0.825	1.39	0.048	0 414	5.657
2 25	1.66	0 092	1.46	0.068	0.815	1 44	0.049	0 447	5.677
2 50	1.70	0 098	1.47	0.073	0.804	1.50	0 050	0 476	5.696
2 75	1.75	0 105	1.49	0 078	0.793	1.55	0.052	0 502	5.714
3 00	1.80	0 111	1.50	0.083	0.781	1 60	0 054	0 525	5.732
3 25	1.86	0 117	1.51	0.088	0.770	1 65	0.056	0 545	5.750
3 50	1.92	0 124	1.53	0.092	0.758	1 71	0 057	0 563	5.766
3 75	1.99	0 130	1.54	0.096	0.746	1.76	0 058	0.580	5.781
4 00	2.06	0 136	1.55	0.100	0.734	1.81	0 060	0 594	5.795
4 25	2.14	0 142	1.56	0.104	0.721	1 87	0 062	0 606	5.809
4 50	2.23	0 148	1.58	0.107	0.709	1 92	0 063	0 617	5.821
4 75	2.35	0 152	1.58	0.110	0.695	1.97	0 065	0 625	5.831
5 00	2.52	0 156	1.59	0.110	0.679	2 03	0.065	0.629	5.835

(FOR ADDITIONAL BOUNDARY LAYER DATA SEE OVERLEAF)

TABLE A29-2

0.75, CNEA, CORRELATION - A

PREDICTION OF ANNULAR DIFFUSER PERFORMANCE

(ADDITIONAL BOUNDARY LAYER DATA)

THEORETICAL ASSUMPTIONS

VELOCITY PROFILE - COLES LAW
SKIN FRICTION COEFFICIENT - COLES LAW
MODIFICATION TO BOUNDARY LAYER THICKNESS INCLUDED
ESTIMATE OF REYNOLDS NORMAL STRESSES INCLUDED
TOTAL PRESSURE LOSS INCLUDED (EXPERIMENTAL RESULTS)
NO NET MASS TRANSFER BETWEEN INNER & OUTER LAYERS
NO POTENTIAL CORE

DIST X	DEL** OUTER	DISPN. CDO	$\frac{3\delta^{**}dU}{U\,dx}$	$\frac{2}{\rho U^2}\left[\frac{dP_T}{dx}\right]_m$	DEL** INNER	DISPN. CDI	N.S.C. OUTER	CF OUTER	$\frac{\Theta_o}{U}(H_o+2)\frac{dU}{dx}$	$\frac{\Theta_o}{R_o}\frac{dR_o}{dx}$	N.S.C. INNER	CF INNER	$(H_i+2)\frac{\Theta_i}{U}\frac{dU}{dx}$
1.00	0.105	0 0000	-0 0410	-0 0070	0 079	0 0000	0.0007	0 00225	-0 0255	0.00162	0.0003	0.00290	-0.0181
1.25	0.114	0 0000	-0.0400	-0 0072	0 086	0 0000	0.0008	0 00211	-0 0252	0.00176	0.0004	0.00280	-0.0176
1.50	0.124	0 0000	-0.0403	-0 0074	0 094	0.0000	0.0009	0 00199	-0 0259	0.00192	0.0004	0.00269	-0.0185
1.75	0.133	0 0000	-0 0414	-0 0075	0 102	0.0000	0.0010	0 00186	-0 0271	0.00207	0.0005	0.00260	-0.0191
2.00	0.142	0 0000	-0 0418	-0 0077	0 109	0 0000	0.0011	0.00173	-0 0280	0.00223	0.0005	0.00250	-0.0198
2.25	0.151	0 0000	-0 0417	-0 0079	0.117	0.0000	0.0013	0.00161	-0 0285	0.00238	0.0005	0.00241	-0.0201
2.50	0.161	0 0000	-0 0407	-0 0081	0 125	0 0000	0.0015	0 00147	-0 0284	0.00253	0.0006	0.00233	-0.0197
2.75	0.169	0 0000	-0.0406	-0 0083	0.133	0.0000	0.0017	0 00134	-0 0291	0 00269	0.0006	0.00225	-0.0202
3.00	0.178	0 0000	-0 0390	-0 0085	0.141	0 0000	0.0020	0 00121	-0 0286	0.00285	0.0006	0.00217	-0.0203
3.25	0.187	0 0000	-0 0379	-0 0086	0.148	0 0000	0.0023	0.00109	-0 0285	0.00299	0.0006	0.00209	-0.0200
3.50	0.195	0 0000	-0.0371	-0 0088	0 155	0.0000	0.0026	0 00097	-0 0287	0.00314	0.0006	0.00203	-0.0195
3.75	0 204	0 0000	-0 0370	-0 0088	0 161	0.0000	0.0030	0 00085	-0 0293	0 00329	0.0006	0.00197	-0.0186
4.00	0.212	0 0000	-0.0340	-0 0089	0 168	0 0000	0.0034	0 00075	-0 0278	0 00344	0.0006	0.00191	-0.0191
4.25	0.219	0 0000	-0 0319	-0 0089	0.174	0 0000	0 0039	0 00065	-0 0268	0.00358	0.0006	0.00186	-0.0175
4.50	0.226	0 0000	-0.0297	-0 0089	0.179	0 0000	0.0046	0 00055	-0 0257	0.00371	0.0005	0.00182	-0.0151
4.75	0.231	0 0000	-0.0235	-0 0089	0.183	0 0000	0.0055	0 00045	-0 0211	0 00383	0.0005	0.00178	-0.0137
5.00	0 234	0 0000	-0.0135	-0 0089	0.184	0 0000	0 0079	0 00033	-0 0128	0 00393	0.0002	0.00177	-0 0069

TABLE A29-3

1.25, CNEA, CORRELATION - A

PREDICTION OF ANNULAR DIFFUSER PERFORMANCE

DIFFUSER GEOMETRY

WALL ANGLES. OUTER= 6.650 DEGREES ,INNER= 0.000 DEGREES
INLET RADII. OUTER= 6.15 INS. ,INNER= 5.00 INS.
DIFFUSER NON DIMENSIONAL= 7.5

INLET CONDITIONS (CALCULATIONS COMMENCE AT X= 1.250 INS.)

SHAPE PARAMETERS. OUTER WALL= 1.400 INNER WALL= 1.396
MOMENTUM THICKNESS. OUTER WALL= 0.058 INS. INNER WALL= 0.036 INS
MAXIMUM VELOCITY= 127.000 FT/SEC
RADIUS OF POSITION OF MAXIMUM VELOCITY= 5.566 INS.

DIST X	HO	THETA OUTER	HI	THETA INNER	UMEAN UMAX	AREA RATIO	LOSS COEFF	CP	RMAX INS
1.50	1.50	0.062	1.37	0.039	0.873	1.19	0.043	0.239	5.579
1.75	1.52	0.066	1.37	0.041	0.866	1.23	0.046	0.273	5.592
2.00	1.54	0.070	1.38	0.044	0.860	1.26	0.047	0.305	5.606
2.25	1.56	0.074	1.39	0.047	0.854	1.29	0.049	0.335	5.619
2.50	1.58	0.078	1.39	0.049	0.847	1.33	0.050	0.362	5.632
2.75	1.60	0.082	1.40	0.052	0.841	1.36	0.053	0.388	5.646
3.00	1.62	0.086	1.41	0.055	0.835	1.39	0.053	0.412	5.658
3.25	1.64	0.090	1.41	0.058	0.828	1.43	0.054	0.434	5.671
3.50	1.67	0.094	1.42	0.060	0.821	1.46	0.055	0.454	5.684
3.75	1.70	0.098	1.43	0.063	0.815	1.49	0.057	0.473	5.696
4.00	1.73	0.102	1.43	0.066	0.807	1.53	0.058	0.490	5.708
4.25	1.77	0.107	1.44	0.068	0.800	1.56	0.060	0.505	5.719
4.50	1.81	0.111	1.45	0.071	0.793	1.60	0.060	0.520	5.730
4.75	1.84	0.115	1.45	0.073	0.786	1.63	0.062	0.533	5.741
5.00	1.89	0.120	1.46	0.076	0.778	1.67	0.063	0.546	5.751
5.25	1.93	0.124	1.46	0.078	0.770	1.70	0.063	0.558	5.761
5.50	1.97	0.128	1.47	0.081	0.763	1.74	0.065	0.569	5.771
5.75	2.01	0.132	1.47	0.083	0.755	1.77	0.067	0.579	5.781
6.00	2.06	0.136	1.48	0.085	0.748	1.81	0.068	0.588	5.790
6.25	2.11	0.140	1.48	0.087	0.740	1.84	0.068	0.597	5.798
6.50	2.17	0.144	1.49	0.089	0.732	1.88	0.070	0.604	5.807
6.75	2.23	0.148	1.49	0.091	0.723	1.92	0.072	0.611	5.814
7.00	2.30	0.151	1.50	0.093	0.715	1.95	0.072	0.617	5.821
7.25	2.37	0.155	1.50	0.094	0.706	1.99	0.073	0.622	5.827
7.50	2.50	0.156	1.50	0.094	0.695	2.02	0.074	0.624	5.829

(FOR ADDITIONAL BOUNDARY LAYER DATA SEE OVERLEAF)

1.25, CNEA, CORRELATION - A

PREDICTION OF ANNULAR DIFFUSER PERFORMANCE

(ADDITIONAL BOUNDARY LAYER DATA)

THEORETICAL ASSUMPTIONS

VELOCITY PROFILE - COLES LAW
SKIN FRICTION COEFFICIENT - COLES LAW
MODIFICATION TO BOUNDARY LAYER THICKNESS INCLUDED
ESTIMATE OF REYNOLDS NORMAL STRESSES INCLUDED
TOTAL PRESSURE LOSS INCLUDED (EXPERIMENTAL RESULTS)
NO NET MASS TRANSFER BETWEEN INNER & OUTER LAYERS
NO POTENTIAL CORE

DIST X	DEL** OUTER	DISPN. CDO	$\frac{3\delta^{**}}{U}\frac{dU}{dx}$	$\frac{2}{\rho U^2}\left[\frac{dP_T}{dx}\right]_m$	DEL** INNER	DISPN. CDI	N.S.C. OUTER	CF OUTER	$(H_o+2)\frac{\theta_o}{U}\frac{dU}{dx}$	$\frac{\theta_o}{R_o}\frac{dR_o}{dx}$	N.S.C. INNER	CF INNER	$(H_i+2)\frac{\theta_i}{U}\frac{dU}{dx}$
1.50	0.105	0.0000	-0.0268	-0.0071	0.068	0.0000	0.0005	0.00227	-0.0172	0.00109	0.0001	0.00322	-0.0104
1.75	0.111	0.0000	-0.0250	-0.0072	0.072	0.0000	0.0005	0.00218	-0.0168	0.00117	0.0002	0.00315	-0.0104
2.00	0.117	0.0000	-0.0273	-0.0073	0.077	0.0000	0.0006	0.00209	-0.0179	0.00123	0.0002	0.00308	-0.0105
2.25	0.123	0.0000	-0.0270	-0.0074	0.081	0.0000	0.0006	0.00201	-0.0180	0.00130	0.0002	0.00301	-0.0110
2.50	0.130	0.0000	-0.0278	-0.0075	0.086	0.0000	0.0007	0.00192	-0.0187	0.00137	0.0002	0.00294	-0.0110
2.75	0.136	0.0000	-0.0278	-0.0077	0.091	0.0000	0.0007	0.00184	-0.0189	0.00144	0.0002	0.00288	-0.0117
3.00	0.142	0.0000	-0.0286	-0.0078	0.096	0.0000	0.0008	0.00175	-0.0197	0.00151	0.0003	0.00282	-0.0116
3.25	0.148	0.0000	-0.0284	-0.0079	0.100	0.0000	0.0008	0.00167	-0.0198	0.00157	0.0002	0.00276	-0.0123
3.50	0.154	0.0000	-0.0282	-0.0080	0.105	0.0000	0.0009	0.00158	-0.0200	0.00164	0.0003	0.00271	-0.0120
3.75	0.160	0.0000	-0.0278	-0.0081	0.109	0.0000	0.0010	0.00150	-0.0199	0.00171	0.0003	0.00266	-0.0122
4.00	0.166	0.0000	-0.0275	-0.0083	0.114	0.0000	0.0011	0.00141	-0.0200	0.00178	0.0003	0.00261	-0.0116
4.25	0.172	0.0000	-0.0269	-0.0084	0.118	0.0000	0.0013	0.00131	-0.0199	0.00185	0.0003	0.00256	-0.0119
4.50	0.178	0.0000	-0.0271	-0.0085	0.122	0.0000	0.0014	0.00122	-0.0204	0.00192	0.0003	0.00252	-0.0117
4.75	0.184	0.0000	-0.0263	-0.0086	0.126	0.0000	0.0015	0.00114	-0.0201	0.00198	0.0003	0.00249	-0.0121
5.00	0.190	0.0000	-0.0262	-0.0087	0.130	0.0000	0.0017	0.00106	-0.0204	0.00205	0.0003	0.00245	-0.0113
5.25	0.196	0.0000	-0.0259	-0.0088	0.134	0.0000	0.0018	0.00098	-0.0205	0.00212	0.0003	0.00241	-0.0109
5.50	0.201	0.0000	-0.0249	-0.0088	0.138	0.0000	0.0019	0.00090	-0.0201	0.00219	0.0003	0.00237	-0.0116
5.75	0.206	0.0000	-0.0248	-0.0088	0.142	0.0000	0.0021	0.00083	-0.0204	0.00225	0.0003	0.00234	-0.0112
6.00	0.212	0.0000	-0.0246	-0.0089	0.146	0.0000	0.0022	0.00077	-0.0205	0.00231	0.0003	0.00231	-0.0111
6.25	0.217	0.0000	-0.0231	-0.0089	0.149	0.0000	0.0025	0.00070	-0.0196	0.00237	0.0002	0.00228	-0.0103
6.50	0.222	0.0000	-0.0220	-0.0089	0.152	0.0000	0.0027	0.00064	-0.0190	0.00243	0.0002	0.00225	-0.0104
6.75	0.227	0.0000	-0.0197	-0.0089	0.155	0.0000	0.0031	0.00057	-0.0174	0.00249	0.0002	0.00223	-0.0093
7.00	0.231	0.0000	-0.0187	-0.0088	0.157	0.0000	0.0035	0.00050	-0.0169	0.00254	0.0002	0.00221	-0.0083
7.25	0.235	0.0000	-0.0177	-0.0088	0.160	0.0000	0.0038	0.00044	-0.0163	0.00259	0.0002	0.00219	-0.0081
7.50	0.236	0.0000	-0.0086	-0.0068	0.160	0.0000	0.0052	0.00035	-0.0082	0.00264	0.0000	0.00219	-0.0039

TABLE A29-5

1.25, CNEA, CORRELATION - B

PREDICTION OF ANNULAR DIFFUSER PERFORMANCE

DIFFUSER GEOMETRY.

WALL ANGLES. OUTER= 6.650 DEGREES ,INNER= 0.000 DEGREES
INLET RADII. OUTER= 6.15 INS. ,INNER= 5.00 INS.
DIFFUSER NON DIMENSIONAL= 7.5

INLET CONDITIONS (CALCULATIONS COMMENCE AT X= 1.250 INS.)

SHAPE PARAMETERS. OUTER WALL= 1.502 INNER WALL= 1.392
MOMENTUM THICKNESS. OUTER WALL= 0.071 INS. INNER WALL= 0.062 INS
MAXIMUM VELOCITY= 127.000 FT/SEC
RADIUS OF POSITION OF MAXIMUM VELOCITY= 5.566 INS.

DIST X	Ho	THETA OUTER	HI	THETA INNER	UMEAN UMAX	AREA RATIO	LOSS COEFF	CP	RMAX INS
1.50	1.53	0.075	1.41	0.066	0.822	1.19	0.032	0.235	5.580
1.75	1.56	0.079	1.43	0.070	0.813	1.23	0.033	0.268	5.594
2.00	1.59	0.083	1.44	0.074	0.805	1.26	0.034	0.300	5.607
2.25	1.62	0.086	1.46	0.077	0.798	1.29	0.035	0.328	5.621
2.50	1.65	0.090	1.47	0.081	0.789	1.33	0.037	0.353	5.634
2.75	1.69	0.094	1.49	0.085	0.781	1.36	0.038	0.377	5.647
3.00	1.73	0.098	1.51	0.088	0.772	1.39	0.039	0.399	5.659
3.25	1.78	0.102	1.52	0.091	0.764	1.43	0.040	0.419	5.672
3.50	1.83	0.106	1.54	0.095	0.755	1.46	0.041	0.436	5.684
3.75	1.88	0.109	1.56	0.098	0.746	1.49	0.043	0.453	5.696
4.00	1.94	0.113	1.58	0.101	0.737	1.53	0.044	0.468	5.707
4.25	1.99	0.116	1.60	0.104	0.728	1.56	0.045	0.481	5.718
4.50	2.05	0.120	1.61	0.107	0.719	1.60	0.047	0.494	5.730
4.75	2.11	0.123	1.63	0.110	0.710	1.63	0.048	0.505	5.740
5.00	2.17	0.127	1.65	0.113	0.701	1.67	0.050	0.516	5.750
5.25	2.23	0.130	1.67	0.116	0.692	1.70	0.051	0.526	5.760
5.50	2.30	0.133	1.68	0.118	0.683	1.74	0.053	0.535	5.769
5.75	2.38	0.136	1.70	0.120	0.674	1.77	0.054	0.542	5.777
6.00	2.52	0.138	1.70	0.121	0.663	1.81	0.055	0.545	5.780
6.25	2.70	0.139	1.70	0.120	0.651	1.84	0.056	0.545	5.780
6.50	2.90	0.139	1.69	0.120	0.639	1.88	0.061	0.541	5.780
6.75	3.14	0.137	1.69	0.120	0.626	1.92	0.069	0.534	5.780

(FOR ADDITIONAL BOUNDARY LAYER DATA SEE OVERLEAF)

TABLE A29-6

1.25, CNEA, CORRELATION - B

PREDICTION OF ANNULAR DIFFUSER PERFORMANCE

(ADDITIONAL BOUNDARY LAYER DATA)

THEORETICAL ASSUMPTIONS

VELOCITY PROFILE - COLES LAW
SKIN FRICTION COEFFICIENT - COLES LAW
MODIFICATION TO BOUNDARY LAYER THICKNESS INCLUDED (REVISED)
ESTIMATE OF REYNOLDS NORMAL STRESSES INCLUDED
TOTAL PRESSURE LOSS INCLUDED (EXPERIMENTAL RESULTS)
NO NET MASS TRANSFER BETWEEN INNER & OUTER LAYERS
NO POTENTIAL CORE

DIST X	DEL** OUTER	DISPN. CDO	$3\frac{\delta^{**}}{U}\frac{dU}{dx}$	$\frac{2}{\rho U^2}\left[\frac{dP_T}{dx}\right]_m$	DEL** INNER	DISPN. CDI	N.S.C. OUTER	CF OUTER	$(H_o+2)\frac{\theta_o}{U}\frac{dU}{dx}$	$\frac{\theta_o}{R_o}\frac{dR_o}{dx}$	N.S.C. INNER	CF INNER	$(H_i+2)\frac{\theta_i}{U}\frac{dU}{dx}$
1.50	0.126	0.0000	-0.0262	-0.0076	0.115	0.0000	0.0006	0.00206	-0.0172	0.00134	0.0004	0.00260	-0.0149
1.75	0.132	0.0000	-0.0271	-0.0078	0.121	0.0000	0.0007	0.00195	-0.0180	0.00141	0.0004	0.00250	-0.0152
2.00	0.138	0.0000	-0.0275	-0.0081	0.127	0.0000	0.0007	0.00184	-0.0186	0.00148	0.0004	0.00241	-0.0160
2.25	0.143	0.0000	-0.0272	-0.0083	0.133	0.0000	0.0008	0.00173	-0.0187	0.00155	0.0004	0.00233	-0.0162
2.50	0.149	0.0000	-0.0261	-0.0086	0.138	0.0000	0.0009	0.00161	-0.0183	0.00161	0.0005	0.00224	-0.0158
2.75	0.154	0.0000	-0.0261	-0.0088	0.144	0.0000	0.0010	0.00150	-0.0186	0.00168	0.0005	0.00216	-0.0156
3.00	0.160	0.0000	-0.0260	-0.0090	0.149	0.0000	0.0011	0.00139	-0.0190	0.00174	0.0005	0.00209	-0.0158
3.25	0.165	0.0000	-0.0249	-0.0093	0.154	0.0000	0.0013	0.00128	-0.0185	0.00181	0.0005	0.00201	-0.0155
3.50	0.169	0.0000	-0.0237	-0.0095	0.160	0.0000	0.0014	0.00117	-0.0180	0.00187	0.0006	0.00193	-0.0151
3.75	0.174	0.0000	-0.0235	-0.0097	0.165	0.0000	0.0016	0.00106	-0.0183	0.00193	0.0006	0.00186	-0.0150
4.00	0.178	0.0000	-0.0226	-0.0098	0.169	0.0000	0.0018	0.00096	-0.0179	0.00198	0.0006	0.00180	-0.0150
4.25	0.182	0.0000	-0.0217	-0.0099	0.174	0.0000	0.0019	0.00087	-0.0176	0.00204	0.0006	0.00173	-0.0143
4.50	0.187	0.0000	-0.0206	-0.0100	0.178	0.0000	0.0021	0.00079	-0.0171	0.00209	0.0006	0.00167	-0.0144
4.75	0.191	0.0000	-0.0205	-0.0100	0.182	0.0000	0.0023	0.00071	-0.0173	0.00214	0.0006	0.00161	-0.0137
5.00	0.196	0.0000	-0.0200	-0.0100	0.186	0.0000	0.0025	0.00064	-0.0173	0.00220	0.0006	0.00155	-0.0132
5.25	0.200	0.0000	-0.0194	-0.0100	0.190	0.0000	0.0027	0.00057	-0.0171	0.00225	0.0006	0.00150	-0.0132
5.50	0.203	0.0000	-0.0174	-0.0100	0.193	0.0000	0.0031	0.00050	-0.0157	0.00230	0.0006	0.00145	-0.0121
5.75	0.207	0.0000	-0.0150	-0.0100	0.196	0.0000	0.0035	0.00044	-0.0147	0.00234	0.0005	0.00141	-0.0114
6.00	0.208	0.0000	-0.0070	-0.0100	0.197	0.0000	0.0052	0.00034	-0.0076	0.00239	0.0001	0.00141	-0.0058
6.25	0.208	0.0000	-0.0037	-0.0100	0.197	0.0000	0.0066	0.00024	-0.0037	0.00240	-0.0001	0.00142	-0.0027
6.50	0.206	0.0000	0.0010	-0.0099	0.197	0.0000	0.0077	0.00016	0.0020	0.00241	-0.0001	0.00143	-0.0026
6.75	0.203	0.0000	0.0170	-0.0098	0.196	0.0000	0.0090	0.00010	0.0078	0.00239	-0.0001	0.00144	-0.0026

TABLE A29-7

1.0, CNEA, CORRELATION - B

PREDICTION OF ANNULAR DIFFUSER PERFORMANCE

DIFFUSER GEOMETRY.

WALL ANGLES. OUTER= 5.000 DEGREES ,INNER= 0.000 DEGREES
INLET RADII. OUTER= 6.09 INS. ,INNER= 5.00 INS.
DIFFUSER NON DIMENSIONAL= 10.0

INLET CONDITIONS (CALCULATIONS COMMENCE AT X= 1.000 INS.)

SHAPE PARAMETERS. OUTER WALL= 1.399 INNER WALL= 1.358
MOMENTUM THICKNESS. OUTER WALL= 0.055 INS.INNER WALL= 0.057 INS
MAXIMUM VELOCITY= 131.000 FT/SEC
RADIUS OF POSITION OF MAXIMUM VELOCITY= 5.560 INS.

DIST X	H0	THETA OUTER	HI	THETA INNER	UMEAN UMAX	AREA RATIO	LOSS COEFF	CP	RMAX INS
1.50	1.43	0.060	1.38	0.063	0.848	1.14	0.020	0.200	5.583
2.00	1.46	0.066	1.40	0.068	0.837	1.19	0.022	0.256	5.605
2.50	1.49	0.071	1.43	0.074	0.826	1.24	0.025	0.305	5.627
3.00	1.53	0.077	1.45	0.081	0.814	1.29	0.028	0.349	5.650
3.50	1.57	0.082	1.48	0.087	0.803	1.34	0.031	0.387	5.672
4.00	1.61	0.088	1.51	0.093	0.791	1.39	0.034	0.421	5.694
4.50	1.66	0.093	1.54	0.099	0.780	1.44	0.035	0.452	5.716
5.00	1.71	0.099	1.57	0.105	0.768	1.49	0.037	0.479	5.738
5.50	1.76	0.104	1.60	0.111	0.756	1.55	0.040	0.503	5.759
6.00	1.82	0.108	1.64	0.117	0.744	1.60	0.041	0.525	5.780
6.50	1.89	0.113	1.67	0.122	0.732	1.65	0.042	0.544	5.801
7.00	1.96	0.118	1.71	0.128	0.720	1.70	0.044	0.560	5.821
7.50	2.03	0.122	1.75	0.133	0.708	1.76	0.045	0.575	5.841
8.00	2.10	0.127	1.79	0.138	0.696	1.81	0.047	0.588	5.861
8.50	2.17	0.131	1.84	0.143	0.684	1.86	0.050	0.600	5.881
9.00	2.24	0.136	1.88	0.148	0.673	1.92	0.052	0.610	5.900
9.50	2.34	0.140	1.91	0.152	0.661	1.97	0.054	0.619	5.917
10.00	2.49	0.143	1.93	0.154	0.647	2.02	0.055	0.625	5.926

(FOR ADDITIONAL BOUNDARY LAYER DATA SEE OVERLEAF)

TABLE A29-8

1.0, CNEA, CORRELATION - B

PREDICTION OF ANNULAR DIFFUSER PERFORMANCE

(ADDITIONAL BOUNDARY LAYER DATA)

THEOPETICAL ASSUMPTIONS

VELOCITY PROFILE - COLES LAW
SKIN FRICTION COEFFICIENT - COLES LAW
MODIFICATION TO BOUNDARY LAYER THICKNESS INCLUDED (REVISED)
ESTIMATE OF REYNOLDS NORMAL STRESSES INCLUDED
TOTAL PRESSURE LOSS INCLUDED (EXPERIMENTAL RESULTS)
NO NET MASS TRANSFER BETWEEN INNER & OUTER LAYERS
NO POTENTIAL CORE

DIST X	DFL** OUTER	DISPN. CDO	$\frac{3\delta^{**}dU}{U\,dx}$	$\frac{2}{\rho U^2}\left[\frac{dR_T}{dx}\right]_m$	DFL** INNER	DISPN. CDI	N.S.C. OUTER	CF OUTER	$\frac{(H_o+2)\Theta_o dU}{U\,dx}$	$\frac{\Theta_o dR_o}{R_o dx}$	N.S.C. INNER	CF INNER	$\frac{(H_i+2)\Theta_i dU}{U\,dx}$
1.50	0.104	0.0000	-0.0192	-0.0063	0.110	0.0000	0.0003	0.00258	-0.0115	0.00079	0.0002	0.00276	-0.0118
2.00	0.112	0.0000	-0.0191	-0.0067	0.119	0.0000	0.0003	0.00241	-0.0117	0.00086	0.0003	0.00261	-0.0120
2.50	0.121	0.0000	-0.0192	-0.0070	0.129	0.0000	0.0004	0.00224	-0.0120	0.00093	0.0003	0.00247	-0.0123
3.00	0.130	0.0000	-0.0193	-0.0074	0.139	0.0000	0.0004	0.00208	-0.0123	0.00100	0.0004	0.00232	-0.0126
3.50	0.138	0.0000	-0.0195	-0.0077	0.148	0.0000	0.0005	0.00192	-0.0128	0.00107	0.0004	0.00219	-0.0132
4.00	0.146	0.0000	-0.0193	-0.0080	0.158	0.0000	0.0005	0.00177	-0.0129	0.00114	0.0004	0.00206	-0.0135
4.50	0.153	0.0000	-0.0193	-0.0083	0.167	0.0000	0.0006	0.00162	-0.0133	0.00121	0.0005	0.00194	-0.0134
5.00	0.161	0.0000	-0.0186	-0.0086	0.176	0.0000	0.0007	0.00148	-0.0132	0.00128	0.0005	0.00181	-0.0135
5.50	0.167	0.0000	-0.0178	-0.0089	0.185	0.0000	0.0008	0.00134	-0.0130	0.00134	0.0006	0.00169	-0.0136
6.00	0.174	0.0000	-0.0180	-0.0092	0.193	0.0000	0.0009	0.00120	-0.0135	0.00140	0.0006	0.00158	-0.0136
6.50	0.180	0.0000	-0.0171	-0.0094	0.201	0.0000	0.0011	0.00106	-0.0131	0.00145	0.0006	0.00147	-0.0135
7.00	0.186	0.0000	-0.0162	-0.0096	0.209	0.0000	0.0012	0.00094	-0.0129	0.00151	0.0007	0.00137	-0.0131
7.50	0.191	0.0000	-0.0155	-0.0097	0.216	0.0000	0.0013	0.00083	-0.0126	0.00156	0.0008	0.00126	-0.0128
8.00	0.197	0.0000	-0.0149	-0.0097	0.223	0.0000	0.0014	0.00073	-0.0125	0.00161	0.0009	0.00116	-0.0123
8.50	0.202	0.0000	-0.0143	-0.0097	0.229	0.0000	0.0015	0.00064	-0.0123	0.00166	0.0009	0.00107	-0.0130
9.00	0.207	0.0000	-0.0138	-0.0097	0.235	0.0000	0.0018	0.00056	-0.0122	0.00170	0.0009	0.00099	-0.0121
9.50	0.212	0.0000	-0.0133	-0.0097	0.240	0.0000	0.0021	0.00048	-0.0111	0.00175	0.0009	0.00092	-0.0110
10.00	0.215	0.0000	-0.0094	-0.0096	0.243	0.0000	0.0032	0.00036	-0.0088	0.00179	0.0004	0.00089	-0.0081

TABLE A29-9

O, CNEA, CORRELATION - B

PREDICTION OF ANNULAR DIFFUSER PERFORMANCE

DIFFUSER GEOMETRY.

WALL ANGLES. OUTER= 10.000 DEGREES ,INNER= 0.000 DEGREES
INLET RADII. OUTER= 6.00 INS. ,INNER= 5.00 INS.
DIFFUSER NON DIMENSIONAL= 5.0

INLET CONDITIONS (CALCULATIONS COMMENCE AT X= 0.000 INS.)

SHAPE PARAMETERS. OUTER WALL= 1.301 INNER WALL= 1.288
MOMENTUM THICKNESS. OUTER WALL= 0.039 INS.INNER WALL= 0.040 INS
MAXIMUM VELOCITY= 140.000 FT/SEC
RADIUS OF POSITION OF MAXIMUM VELOCITY= 5.500 INS.

DIST X	HO	THETA OUTER	HI	THETA INNER	UMEAN UMAX	AREA RATIO	LOSS COEFF	CP	RMAX INS
0.25	1.32	0.044	1.30	0.045	0.888	1.05	0.001	0.088	5.523
0.50	1.34	0.049	1.32	0.050	0.879	1.10	0.002	0.164	5.545
0.75	1.36	0.054	1.34	0.056	0.869	1.15	0.004	0.231	5.568
1.00	1.39	0.059	1.36	0.061	0.859	1.20	0.005	0.290	5.591
1.25	1.41	0.064	1.39	0.067	0.849	1.24	0.005	0.342	5.613
1.50	1.44	0.070	1.41	0.073	0.839	1.29	0.008	0.387	5.636
1.75	1.47	0.075	1.44	0.080	0.828	1.35	0.008	0.428	5.659
2.00	1.50	0.081	1.47	0.086	0.817	1.40	0.010	0.464	5.682
2.25	1.53	0.087	1.50	0.093	0.806	1.45	0.011	0.496	5.705
2.50	1.57	0.092	1.53	0.100	0.795	1.50	0.013	0.525	5.728
2.75	1.60	0.097	1.56	0.107	0.783	1.55	0.014	0.551	5.751
3.00	1.64	0.103	1.60	0.114	0.771	1.60	0.014	0.574	5.774
3.25	1.69	0.108	1.65	0.120	0.760	1.65	0.015	0.594	5.798
3.50	1.74	0.113	1.69	0.127	0.747	1.71	0.016	0.612	5.821
3.75	1.79	0.118	1.74	0.133	0.735	1.76	0.018	0.627	5.844
4.00	1.85	0.123	1.80	0.139	0.722	1.81	0.018	0.641	5.867
4.25	1.92	0.127	1.85	0.145	0.710	1.87	0.019	0.653	5.889
4.50	1.98	0.131	1.91	0.150	0.697	1.92	0.020	0.664	5.911
4.75	2.05	0.136	1.96	0.156	0.685	1.98	0.021	0.674	5.933
5.00	2.11	0.140	2.02	0.161	0.673	2.03	0.022	0.683	5.956

(FOR ADDITIONAL BOUNDARY LAYER DATA SEE OVERLEAF)

TABLE A29-10

O, CNEA, CORRELATION - B

PREDICTION OF ANNULAR DIFFUSER PERFORMANCE

(ADDITIONAL BOUNDARY LAYER DATA)

THEORETICAL ASSUMPTIONS

VELOCITY PROFILE - COLES LAW
SKIN FRICTION COEFFICIENT - COLES LAW
MODIFICATION TO BOUNDARY LAYER THICKNESS INCLUDED (REVISED)
ESTIMATE OF REYNOLDS NORMAL STRESSES INCLUDED
TOTAL PRESSURE LOSS INCLUDED (EXPERIMENTAL RESULTS)
NO NET MASS TRANSFER BETWEEN INNER & OUTER LAYERS
NO POTENTIAL CORE

DIST X	DEL** OUTER	DISPN. CDO	$3\frac{\delta^{**}dU}{U\,dx}$	$\frac{2}{\rho U^2}\left[\frac{dP_T}{dx}\right]_m$	DEL** INNER	DISPN. CDI	N.S.C. OUTER	CF OUTER	$(H_o+2)\frac{\Theta_o dU}{U\,dx}$	$\frac{\Theta_o dR_o}{R_o dx}$	N.S.C. INNER	CF INNER	$(H_i+2)\frac{\Theta_i dU}{U\,dx}$
0.25	0.078	0.0000	-0.0345	-0.0044	0.081	0.0000	0.0003	0.00328	-0.0191	0.00116	0.0003	0.00334	-0.0193
0.50	0.086	0.0000	-0.0354	-0.0047	0.089	0.0000	0.0004	0.00312	-0.0199	0.00128	0.0004	0.00318	-0.0205
0.75	0.095	0.0000	-0.0366	-0.0049	0.098	0.0000	0.0004	0.00296	-0.0210	0.00141	0.0004	0.00303	-0.0214
1.00	0.103	0.0000	-0.0375	-0.0052	0.108	0.0000	0.0005	0.00280	-0.0219	0.00155	0.0005	0.00287	-0.0223
1.25	0.112	0.0000	-0.0382	-0.0055	0.118	0.0000	0.0005	0.00264	-0.0228	0.00169	0.0006	0.00271	-0.0231
1.50	0.120	0.0000	-0.0387	-0.0058	0.128	0.0000	0.0006	0.00249	-0.0233	0.00183	0.0006	0.00257	-0.0247
1.75	0.129	0.0000	-0.0392	-0.0060	0.138	0.0000	0.0007	0.00234	-0.0243	0.00197	0.0007	0.00242	-0.0248
2.00	0.138	0.0000	-0.0384	-0.0063	0.148	0.0000	0.0008	0.00220	-0.0244	0.00211	0.0008	0.00227	-0.0259
2.25	0.146	0.0000	-0.0383	-0.0066	0.159	0.0000	0.0009	0.00206	-0.0248	0.00225	0.0009	0.00212	-0.0262
2.50	0.154	0.0000	-0.0380	-0.0069	0.169	0.0000	0.0010	0.00192	-0.0251	0.00238	0.0010	0.00198	-0.0271
2.75	0.162	0.0000	-0.0375	-0.0071	0.179	0.0000	0.0011	0.00178	-0.0253	0.00252	0.0012	0.00184	-0.0272
3.00	0.170	0.0000	-0.0367	-0.0074	0.189	0.0000	0.0012	0.00165	-0.0253	0.00265	0.0013	0.00170	-0.0270
3.25	0.177	0.0000	-0.0349	-0.0077	0.198	0.0000	0.0013	0.00151	-0.0247	0.00278	0.0015	0.00156	-0.0271
3.50	0.183	0.0000	-0.0333	-0.0079	0.208	0.0000	0.0015	0.00138	-0.0241	0.00290	0.0017	0.00142	-0.0265
3.75	0.189	0.0000	-0.0308	-0.0082	0.216	0.0000	0.0017	0.00125	-0.0229	0.00301	0.0019	0.00128	-0.0264
4.00	0.195	0.0000	-0.0298	-0.0084	0.224	0.0000	0.0020	0.00112	-0.0227	0.00312	0.0020	0.00116	-0.0245
4.25	0.201	0.0000	-0.0279	-0.0086	0.232	0.0000	0.0022	0.00100	-0.0218	0.00322	0.0022	0.00104	-0.0247
4.50	0.206	0.0000	-0.0268	-0.0088	0.239	0.0000	0.0024	0.00089	-0.0215	0.00332	0.0025	0.00093	-0.0236
4.75	0.211	0.0000	-0.0257	-0.0088	0.246	0.0000	0.0026	0.00079	-0.0212	0.00341	0.0027	0.00084	-0.0235
5.00	0.216	0.0000	-0.0246	-0.0089	0.253	0.0000	0.0028	0.00071	-0.0208	0.00350	0.0029	0.00075	-0.0234