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Abstract

This report describes the set of the computer programs for evaluation of the turbulent flow characteristics from hot-wire experimental data. Three different methods and, in addition, some variants are solved in these programs. This enables a comparison of the results obtained by these methods and the analysis of the influence of individual calculation parameters and calibration coefficients on the evaluated results. The results are printed in lucid numerical tables and written into files for further processing into graphs by plotting routines.

Rechenprogramm zur Ermittlung der Turbulenzstruktur aus Hitzdraht-Messungen

Zusammenfassung

Der Bericht beschreibt den Satz von Rechenprogrammen zur Ermittlung der Struktur der turbulenten Strömung aus Hitzdraht-Meßergebnissen. Drei verschiedene Methoden und zusätzlich einige Varianten werden in diesen Programmen gelöst. Dadurch wird ein Vergleich der Ergebnisse der verschiedenen Methoden und die Analyse der Einflüsse verschiedener Berechnungsparameter und Eichkoeffizienten auf die ermittelten Ergebnisse ermöglicht. Die Ergebnisse werden in Tabellen gedruckt und die Datensätze zur Weiterverarbeitung in Diagramme mit Zeichengeräten geschrieben.

Contents:

1. Introduction

In the last years different authors /1,4,7/ have elaborated a few methods for measurement of the turbulence characteristics of air flowing through test models of subassemblies. The probes mostly used are the hot-wire probes working in the so called constant temperature mode.

The computer controlled experimental rig of KfK-INR works very fast and, thus, gives the possibilitiy to compare the results measured by different methods in the same channel and to determine their accuracies.

The task of this work is to write an universal computer code for the evaluation of hot-wire measurements performed by different methods. The results of the evaluation should be printed in numerical tables. The results should also be prepared by recalculation for input into plotting routines.

For comparison the following mostly used and well known methods were selected:

1) Acrivlellis' method /1/
2) Kjellström's method /4/
3) Hooper's method /7/,/13/

2. Hot-Wire Methods Used

The methods working with single wire probes were used. For calculating all the components of the Reynolds stresses it is necessary to measure seven hot-wire values at every position: One measurement with a wire perpendicular to the rig axis and six measurements with a slanting wire. The probes with a slanting wire are rotated into the positions shown by Fig.1. Because of the universality of the program controlling the data collection on the experimental rig one value more than necessary was measured with the slanting wire for all methods used.

Everybody working with hot-wire anemometers knows of the great influence of the air temperature on the output voltage. During measurements in open experimental rigs it is impossible, to keep the air temperature constant and, thus, it is very important to correct the output voltages of the anemometer to a reference temperature.

The former works of Bearmann /11/, Hejna and Mantlik /2/,/3/ and Vosâhlo and Hejna /12/ has shown that a correlation between the temperature and the output voltage of the hot-wire can be described by the following equation

$$\frac{E_c}{E_M} = \frac{1}{1-\gamma(t_M-t_c)} ; \qquad (2.1)$$

where γ is the coefficient with the following values:

γ = 0.00211(K^{-1}) for zero flow measurements
γ = 0.00245(K^{-1}) for nonlinearized measurements
γ = 0.0143(K^{-1}) for linearized measurements.

For measurements by nonlinearized hot-wires it is necessary to correct the voltage E and E_o in Collis's law (2.10) to the same temperature.

In linearized measurements, the temperature influence was taken into consideration in setting of the proportionality factor of the linearizer.

2.1 Acrivlellis' Method

The method described in /1/, as the so called conventional method, works with a linearized output of the anemometer. That means the output signal is proportional to the time averaged value of the axial velocity $E=S\ \bar{U}$. For the slanting wire the effective cooling velocity has the form of

$$U_{eff}^2 = U_N^2 + k^2 U_T^2 + h^2 U_B^2. \qquad (2.2)$$

During setting the linearizer both the perpendicular and the slanting wire were positioned perpendicular to the flow of the calibration unit. The proportionality factor S was set to the value S=0.1 which should be valid at the calibration air temperature of 25°C, calculating the temperature dependence of hot-wire signal according to equation 2.1.

$$E_M = E_{25}\ (1-0.0143(t_M-25)); \qquad (2.3)$$

The Reynolds stresses were calculated using the following equations from the squared RMS readings of the perpendicular wire (index P) and the slanting wire (index S) in positions 1,3,4,5,6 and 7 (Fig.5).

$$\overline{u'^2} = \frac{\overline{e'^2_p}}{S_p^2}; \qquad (2.4)$$

$$\overline{v'^2} = \frac{\overline{e'^2_{S5}} + \overline{e'^2_{S1}}}{S_S^2\ (1-3k^2)} - \frac{1+k^2}{1-3k^2}\ \frac{\overline{e'^2_p}}{S_P^2}; \qquad (2.5)$$

$$\overline{w'^2} = \frac{\overline{e'^2_{S3}} + \overline{e'^2_{S7}}}{S_S^2\ (1-3k^2)} - \frac{1+k^2}{1-3k^2}\ \frac{\overline{e'^2_p}}{S_P^2}; \qquad (2.6)$$

$$\overline{u'v'} = \frac{\overline{e'^2_{S5}} - \overline{e'^2_{S1}}}{2\ S_S(1-k^2)}\ ; \qquad (2.7)$$

$$\overline{u'w'} = \frac{\overline{e'^2_{S7}} - \overline{e'^2_{S3}}}{2\ S_S(1-k^2)}; \qquad (2.8)$$

$$\overline{v'w'} = \frac{1}{S_S^2(1-3k^2)} \left(\overline{e'^2_{S6}} - \overline{e'^2_{S4}} - \frac{\overline{e'^2_{S7}} - \overline{e'^2_{S3}}}{\sqrt{2}} \right); \qquad (2.9)$$

The single wire probes DISA 55 P 11 and 55 P 12 were used for the measurements.

2.2 Kjellström's Method

Kjellström has elaborated a method /4/ based on measurements with a nonlinearized anemometer output.

The dependence of the output voltage on the velocity is then described by Collis' law /5/

$$E^2 - E_o^2 = B\ U_{eff}^n; \qquad (2.10)$$

There are different proposals in the literature how to calculate the coefficients n and B of this equation. We have chosen to use the coefficients calculated from the calibration curve of the probe used. By using the logarithm of Collis' law and applying a least square fit method we have computed values of these coefficients which are constants for the whole velocity range.

For slanting wires Kjellström chose the description of the so called "effective cooling velocity" in the form /6/

$$U_{eff} = \bar{U}(\sin^2\psi + k^2\cos^2\psi)^{1/2}; \qquad (2.11)$$

The yaw factor <u>k</u> of this correlation was calculated either from the equation

$$k^2 = 0.0505 - 0.000415\cdot\rho\cdot\bar{U}; \qquad (2.12)$$

given by Kjellström or on the basis of the calibration data by the equation

$$k_{(\psi,U)} = \frac{1}{\cos\psi}\sqrt{\left(\frac{E_\psi^2 - E_o^2}{E_{\psi=90^o}^2 - E_o^2}\right)^{2/n} - \sin^2\psi} \quad ; \qquad (2.13)$$

The coefficients of Collis' law for the slanting wire were calculated from the calibration, similar as for the perpendicular wire.

The Reynolds' stresses were evaluated using a computer program, which was already available at KfK-INR. This program solves the system of equations

$$\frac{2E}{E^2-E_o^2}\cdot\overline{e'^2} = \frac{n^2}{\bar{u}^2}\left[K_{11}\overline{u'^2}+K_{12}\overline{u'v'}+K_{13}\overline{u'w'}+K_{22}\overline{v'^2}+K_{23}\overline{v'w'}+K_{33}\overline{w'^2}\right] \quad ; \qquad (2.14)$$

for five positions of the wire by the method proposed by Kjellström /4/. The coefficients K_{ij}, are calculated as functions of the mean velocity components U,V,W, the position of probe ϕ, the angle ψ, between the wire and the mean velocity vector, and the yaw factor k. That means

$$K_{ij} = g(U,V,W,\rho,\phi,k) . \qquad (2.15)$$

Unfortunately, this method does not calculate the $\overline{v'w'}$ component of Reynolds' stresses because the coefficient K_{23} in the system of equations is very low and this causes difficulties in calculating the stress components. Kjellström has proposed to overcome this difficulty by neglecting the $\overline{v'w'}$-correlation.

The measurements were made with the probes DISA 55 P 11 and 55 P 12. The signals of the perpendicular wire and the signals of the slanting wire in the positions 1,3,5,7 (Fig.5) were used for the computations.

2.3 Hooper's Method

Hooper, in his work /7/, used a two-wire probe - see Fig.2, reproduced from this work. The method is based on the evaluation of the nonlinearized signals of the wires. Hooper recommends the use of the modified cosine correlation for the effective cooling velocity, developed by Bruun and Davies /10/.

$$U_{eff} = U \cos^{ml} \alpha ; \qquad (2.16)$$

The equation for the yawed wire then reads

$$E_\alpha^2 = E_o^2 + B\, U^n \cos^m \alpha ; \qquad (2.17)$$

This leads to a significant simplification of the expressions for the small signal sensitivity of the wire compared to Kjellström's method. The effective wire angle α is different from the optical angle and is found from three yaw up and down measurements using an incremental angle β of $\pm 5^{o}$ and covering the range $\pm 15^{o}$. The calibration was made for two velocities 25 m/s and 35 m/s. Using the equation recommended by Bradshaw /8/

$$\alpha_{eff} = \mathrm{arctg}\left[\mathrm{cotg}\,\beta - \mathrm{cosec}\,\beta\left(\frac{E^2_{\alpha+\beta} - E^2_o}{E^2_\alpha - E^2_o}\right)^{1/m}\right] \quad ; \qquad (2.18)$$

for twelve individual estimates of α_{eff}, it is possible to define the effective probe angle to a standard deviation of $\pm 0.5^{o}$.

The exponents m, n and the constant B are calculated from the wire calibration data. Using the logarithm of the Collis' law

$$\log(E^2_\alpha - E^2_o) = \log(BU^n) + m \log(\cos\alpha); \qquad (2.19)$$

for all calibration velocities and applying a least square fit method the exponent m can be computed and by a similar second step n and B using

$$\log(E^2_\alpha - E^2_o) = n \log U + \log(B \cos^m \alpha). \qquad (2.20)$$

However, Hooper's original calculation of the turbulence characteristics is based on a comparison of the output signals of the probe used with the tabulated reference values of the so-called I.S.V.R. standard probe /11/. Also, the exponents n and m are calculated from the I.S.V.R. tables depending on the axial mean veloctiy at the measuring position.

In this work the more precise way of calculating all necessary coefficients from the calibration of the probe was used.

It is important for all calculations to recalculate the value E_o measured at the temperature t_o to the temperature t_M at which

E_α was measured. This is possible for the nonlinearized wire by the expression

$$E_{oc} = E_o \frac{1}{1-0.00211(t_o-t_M)} ; \tag{2.21}$$

The hot-wire data correction then performed is based on a comparison between the mean axial velocities calculated from the hot-wire signal and the Pitot tube reading.

The solution of the system of equations for the turbulence characteristics see Appendix 1.

Evaluation of all Reynolds stresses is possible from five positions of the Hooper probe, positions No. 1,2,3,5 and 7 (Fig.5) when the signal of the perpendicular wire is taken as the mean value of this five readings.

However, an evaluation is possible also from the single wire DISA 55 P 11 and 55 P 12 readings, when their positioning is the same as above. This was found convenient because of the smaller dimensions of latter probes.

3. General Description of the Programs

The program evaluates the results of measurements in a rectangular channel which contains four circular tubes in parallel (Fig.4) simulating wall subchannels of a rod bundle. The measurement in the symmetrical part of a subchannel is divided into two parts the R/ϕ area close to the rod walls in polar coordinates and the X/Y area close to the channel walls in cartesian coordinates (Fig.5). The progress of calculation is controlled by the MAIN program.

First, the geometrical characteristics of the model cross section, the value of the reference pressure at the fixed Pitot probe and the variables controlling the calculation, that means the choice of the measurement method, the area measured, the reference value of u^+ and the variant of the input data reading are read from Unit 6. It is necessary to determine the input and output data sets in the JCL (Job Control Language). An example of the JCL is given in Tab.6.

The proper calculations are made in subroutines which are called from the MAIN program. The MAIN program contains the COMMON declarations of all variables which are transmitted from one subroutine to the others.

Each subroutine calculates one or more of the values for the total measured area. At first, the wall shear stresses are calculated, then the time mean values of the axial velocity from the Pitot tube data. It follows the computation of the lengths between the wall and the theoretical line of maximum velocity for all profiles. After this, a jump is made into the different blocks corresponding to the individual methods and their modifications. Next, the data of the hot-wire measurements and the calibration data of the probes are read. Calibration coefficients are then evaluated, the input data are corrected to the pre-set standard conditions of the experiment and the turbulent characteristics are calculated. The results of all subroutines are printed in tables and the data necessary for plotting are written into output files after some rearranging.

4. Description of Individual Subroutines

4.1 TAUWND

TAUWND calculates the values of the wall shear stress for all positions at the walls from the Preston tube readings, using Patel's calibration /9/. The outer diameter of the probe is 0.61 mm. The results are corrected to the reference value of the Reynolds number, i.e. to a temperature of 25°C, a barometric pressure of 1000 mbar and the reference Pitot tube reading ZWERT (Input in MAIN). The correction is made by the equation

$$\tau_{WC} = \tau_{WM} \frac{\left(\rho^{0.1} \cdot \nu^{0.2} \cdot \Delta p^{0.9}\right)_{REF}}{\left(\rho^{0.1} \cdot \nu^{0.2} \cdot \Delta p^{0.9}\right)_{M}} \quad ; \qquad (4.1)$$

It is necessary to note, that the experimental rig is computer controlled to a constant Reynolds number using the fixed Pitot tube reading which is kept constant to within $\pm 0.3\%$ from the ZWERT value by changing the blower speed. Using the actual values of temperature and barometric pressure the value of the pressure at the fixed Pitot tube is calculated from

$$\Delta p_M = \text{ZWERT} \cdot \frac{\rho_M}{\rho_{REF}} \cdot \left(\frac{\nu_M}{\nu_{REF}}\right)^2 \quad ; \qquad (4.2)$$

The input data for the shear stress calculation are read from Unit 7, their format is given in Tab.1.

4.2 UPITOT

UPITOT calculates the mean axial velocities in all measuring positions of the cross section from the Pitot tube readings by the expression

$$U_M = \sqrt{\frac{2 \cdot \Delta p}{\rho}} \quad ; \qquad (4.3)$$

with the air density calculated from the actual temperature and pressure using the function RO

$$\rho = RO(t,p); \qquad (4.4)$$

The calculated values of the velocities are corrected to the reference value of the Reynolds number by the equation

$$U_C = U_M \frac{\nu_{REF}}{\nu_M} \quad ; \qquad (4.5)$$

The input data are read from Unit 8. The format of the input data is given in Tab.2.

4.3 SYMAX

Based on the geometrical characteristics of the cross section AXS, AH and ARW, SYMAX calculates the lengths between the wall and the theoretical line of maximum velocity for all traverses (see Fig.2). The boundary value of the angle α and the corresponding maximum lengths of the profiles are calculated using the expressions indicated in Fig.2.

4.4 RIDHW7

RIDHW7 reads the data of single hot-wire probes and the necessary characteristic data of the experiment. The perpendicular wire data are read from Unit 9 and the slanting wire data from Unit 10. Examples of the input data and their format are given in Tabs. 3 and 4.
By changing the LV variable (tV=1 to 7) it is possible to select the hot-wire data measured (first channel, second channel, product of both e.t.c.) which will be evluated.

4.5 RIDHOP

RIDHOP reads the data measured by a Hooper probe and the necessary characteristic data of the experiment from Unit 9 (Temperature, barometric pressure, reference pressure of the fixed Pitot probe). An example of input data and their format see Tab.4. By changing the LV variable (LV=1 to 4) it is possible to select the perpendicular wire positions, which data will be evaluated.

4.6 KALGER

KALGER calculates the calibration coefficients of the perpendicular wire probe using the logarithm of the Collis' law

$$\log(E^2-E_o^2) = n \log U + \log B ; \qquad (4.6)$$

and then applying the subroutine SQRFIT. The value of E_o is corrected to the calibration temperature by

$$E_{oc} = E_o \cdot \frac{1}{1-0.00211(t_o-t_E)} ; \qquad (4.7)$$

An example of the calibration data which are read form Unit 13 see Tab.5.

4.7 KALKJE

KALKJE reads the same data as the subroutine KALGER and calculates the calibration coefficients of the slanting wire for the Kjellström method using the logarithm of Collis' law for the slanting wire

$$\log(E_\psi^2 - E_o^2) = n \log U + \log \left[B(\sin^2 \psi + k^2 \cos^2 \psi)^{n/2} \right]; \qquad (4.8)$$

and then applying the subroutine SQRFIT.
The results are the values $SB = \log \left[B(\sin^2 \psi + k^2 \cos^2 \psi)^{n/2} \right]$ and SN=n, which are used in the following calculations in subroutine KORKJE.

4.8 KALHOP

KALHØP calculates the coefficients B,n,m of the slanting wire from Collis' law in the form used by Hooper.

$$E_\alpha^2 - E_o^2 = BU^n \cos^m \alpha \; ; \qquad (4.9)$$

The calibration data are read from Unit 13. Applying the SQRFIT method on the logarithm of the Collis' law

$$\log(E_\alpha^2 - E_o^2) = m \log(\cos \alpha) + \log(BU^n); \qquad (4.10)$$

for two calibration velocities the values of the slopes SM25 and SM35 are evaluated. The values of SN=n are computed via the other logaritmic form

$$\log(E_\alpha^2 - E_o^2) = n \log U + \log(B \cos^m \alpha) ; \qquad (4.11)$$

by substituting the already known values SM25 and SM35 into

$$b = \log(B \cos^m \alpha); \qquad (4.12)$$

the values SB25 adn SB35 are calculated. An example of the input data is given in Tab.5.

4.9 YAWFAC

YAWFAC calculates the yaw factor of the slanting wire which works in the linearized mode. The calibration data are read from Unit 13. The yaw factor is calculated for two calibration velocities in the range $\pm 15^o$ from the position when the probe axis is parallel to the calibration flow, using an incremental angle of $\pm 5^o$ (see Fig.7). From all values calculated by expression

$$k = \frac{1}{\cos\psi} \sqrt{\frac{E_\psi^2}{E_{\psi=90^o}^2} - \sin^2\psi} \; ; \qquad (4.13)$$

the mean value is detemined for one velocity. The example of the input data see Tab.5.

4.10 YAWFKJ

YAWFKJ calculates the yaw factor of the slanting wire which works in the nonlinearized mode. The function and the description of the subroutine is identical with YAWFAC subroutine, only the equation for <u>k</u> is different

$$k = \frac{1}{\cos\psi} \sqrt{\left(\frac{E_\psi^2 - E_o^2}{E_{\psi=90^o}^2 - E_o^2}\right)^{2/n} - \sin^2\psi}; \qquad (4.14)$$

4.11 SQRFIT

SQRFIT calculates the linear approximation y=ax+b to a given set of (X_i, Y_i)-values by the least square fit method.

4.12 EFVIN1

EFVIN1 calculates the effective angle of the slanting wire which works in the nonlinearized mode. The calibration data are read from Unit 13. The effective angle is calculated for two velocities and three yaw up and down positions, using an incremental angle of $i = \pm 5^{\circ}$, that means covering the range $\pm 15^{\circ}$. (see Fig.7). From all values calculated by expression

$$\alpha_{eff} = \operatorname{arctg}\left\{ \operatorname{cosec}\beta \left[\cos\beta - \left(\frac{E^2_{\alpha+\beta} - E^2_o}{E^2_\alpha - E^2_o} \right)^{1/m} \right] \right\} ; \qquad (4.15)$$

the mean value is determined. The values of the exponent m are used calculated from the calibration by the subroutine KALHOP. The example of the input data see Tab.5.

4.13 EFVINK

EFVINK is identical with the subroutine EFVIN1. The only difference is that the values of the exponent m are taken from the tabulated values of the I.S.V.R. standard probe /7/.

4.14 KORAC7

KORAC7 corrects the data measured by linearized single wire probes. The data are fitted to the value which gives the same mean axial velocity as the Pitot tube at the same position. The perpendicular wire data are recalculated by

$$e'_c = e'_M \cdot \frac{S_P \cdot U_{PIT}}{E_M} ; \qquad (4.16)$$

The slanting wire data are recalculated by

$$e'_c = e'_M \, \frac{S_S \cdot U_{PIT} \cdot \sqrt{\sin^2\psi + k^2 \cos^2\psi}}{E_M} ; \qquad (4.17)$$

4.15 KORKJE

KORKJE corrects the hot-wire data measured by a nonlinearized hot wire (Kjellström method). At first, the value of E_o measured at the temperature t_o is recalculated to the temperature t_M which is the actual temperature during the hot-wire measurements

$$E_{oc} = E_o \cdot \frac{1}{1-0.00211\,(t_o - t_M)} ; \qquad (4.18)$$

In the next step, the mean axial velocity is calculated from the DC component of the hot-wire signal by Collis' law. The hot-wire output signals are then corrected to the value which gives the same mean axial velocity as the Pitot tube by equation

$$E_c = E_M \cdot \left(\frac{E_o^2 + B \cdot U_{PIT}^n}{E_o^2 + B U_{HW}^n} \right)^{1/2} \cong E_M \cdot \left(\frac{U_{PIT}}{U_{HW}} \right)^{n/2} ; \qquad (4.19)$$

for the perpendicular wire and by equation

$$E_c = E_M \cdot \left(\frac{E_o^2 + B \cdot U_{PIT}^n (\sin^2\psi + k^2 \cos^2\psi)^{n/2}}{E_o^2 + B\ U_{HW}^n (\sin^2\psi + k^2\ \cos^2\psi)^{n/2}} \right)^{1/2} \cong E_M \cdot \left(\frac{U_{PIT}}{U_{HW}} \right)^{n/2} ; \qquad (4.20)$$

for the slanting wire.

The same correction is applied to the RMS values of the hot-wire signals.

4.16 KORHOP

KORHOP corrects data measured by a Hooper probe. The function of the subroutine is the same as of the subroutine KORKJE only the equations for the calculation of the mean velocity from the hot-wire signals and the correction equations are different.

For the perpendicular wire:

a) velocity

$$U_{HW} = \left(\frac{E_p^2 - E_o^2}{B} \right)^{1/n} ; \qquad (4.21)$$

b) correction

$$E_c = E_M \cdot \left(\frac{E_o^2 + B\ U_{PIT}^n}{E_o^2 + B\ U_{HW}^n} \right)^{1/2} \cong E_M \cdot \left(\frac{U_{PIT}}{U_{HW}} \right)^{n/2} ; \qquad (4.22)$$

For the slanting wire:

a) velocity

$$U_{HW} = \left(\frac{E_S^2 - E_o^2}{B \cos^m \alpha} \right)^{1/n} ; \qquad (4.23)$$

b) correction

$$E_c = E_M \cdot \left(\frac{E_o^2 + B \cdot U_{PIT}^n \cdot \cos^m \alpha}{E_o^2 + B \cdot U_{HW}^n \cdot \cos^m \alpha} \right)^{1/2} \cong E_M \cdot \left(\frac{U_{PIT}}{U_{HW}} \right)^{n/2} ; \qquad (4.24)$$

4.17 ACRIV7

ACRIV7 calculates the Reynolds stresses for all measuring positions using the equations described in 2.1 and the data of linearized single wire probes. The yaw factor is calculated either by Kjellström's equation (2.12) or from the probe calibration using the subroutine YAWFAC.

The kinetic energy of turbulence

$$\overline{k'} = \frac{1}{2} (\overline{u'^2} + \overline{v'^2} + \overline{w'^2}) ; \qquad (4.25)$$

and the correlation coefficients

$$R_{uv} = \frac{-\overline{u'v'}}{\overline{u'} \cdot \overline{v'}} ; \quad R_{uw} = \frac{-\overline{u'w'}}{\overline{u'} \cdot \overline{w'}} ; \quad R_{vw} = \frac{-\overline{v'w'}}{\overline{v'} \cdot \overline{w'}} ; \qquad (4.26)$$

are also computed.

If the square of a turbulence intensity component turns out to be negative this value is set to 10^{-10} and the correspondig correlation coefficient is set to 10^{-5}. The calculated values are normalized by the reference value of the wall friction velocity. Also the relative distances from the walls are calculated for all measuring positions by the equation.

$$Y_{rel,i} = Y_i / Y_{MAX}. \qquad (4.27)$$

4.18 ALTME7

ALTME7 calculates the Reynolds stresses for all measuring positions using the method described in 2.2 and the data of nonlinearized single wire probes. The coefficients of Collis' law are calculated on the basis of the probes calibration via the subroutines KALGER and KALKJE.

There are two possibilites how to calculate the yaw factor of the slanting wire probe, either by Kjellström's equation(2.12), or from the probe calibration using the subroutine YAWFKJ.

If the square of a turbulence intensity component turns out to be negative this value is taken with the opposite sign in the following calculations.

Also the kinetic energy of turbulence and the correlation coefficients are calculated as in the subroutine ACRIV7.

The calculated values are normalized to the reference value of the wall friction velocity.

4.19 HOPER7

HOPER7 calculates the Reynolds stresses in all measuring positions, using the method and equations described in 2.3 and in the Appendix 1.

The data of the perpendicular wire and of the slanting wire in the positions 1,5,3,7 and 2 are used.

The coefficients of Collis' law are calculated form the calibration using the subroutines KALGER and KALHOP.

If the square of a turbulence intensity component turns out to be negative, this value is taken with the opposite sign for the following calculations.

Also the kinetic energy of turbulence and the correlation coefficients are calculated. The calculated values are normalized to the reference value of the wall friction velocity.

4.20 HOOPER

HOOPER is Hooper's original subroutine, calculating the Reynolds stresses comparing the signals of use probes with the so called I.S.V.R. standard probe. However, there are mistakes in this subroutine, which could not be overcome. The results of this subroutine are strongly different compared with those by the other subroutines.

4.21 XDRAHT - LINXDR

There is space for the subroutines still to be written which evaluate the signals of X-probes, and linearized X-probes, respectively. The use of these probes, however, offers no advantages when the measurements are performed by the computer controlled rig in KfK-INR. Only more data are produced, which gives the possibility to check the results. A disadvantage is also the probe calibration being more complicated.

4.22 PLOT

PLOT prepares the data for input to programs which produce graphic output of the results. Five plot files are written by the subroutine with the controlling variables KFALL and KO from 2 to 6 or 31 to 36, respectively.

The first file is written on Unit 31 for isovel plots. By setting the variable NORM=0, the results are normalized to the reference value of the wall friction velocity. Setting the variable NORM=1, the results are normalized to the local value of the wall shear stress of each traverse.

The second file is written on Unit 32 for plots of radial profiles; those values are normalized by the local value of the wall shear stress.

The third file is written on Unit 33 for the calculation of the relative turbulence viscosities ε_r and ε_ϕ and the respective plots.

The fourth file is written on Unit 34 for plots of the nondimensional velocity profiles.

The fifth file is written on Unit 35 for plots of the wall shear stresses.

5. Results and Conclusions

The Figures 8 - 19 show a comparison of the results of measurements in a wall subchannel with a pitch-to-diameter ratio equal to the wall-to-diameter ratio of P/D = W/D = 1.1007.

The optical impression of the isolvels of all figures is very similar, however, the absolute values of results are slightly different. The highest results are obtained by Acrivlellis' method. The results by the Hooper method are lower and the lowest are obtained by Kjellström's method.

The first conclusion is that the Hooper method is the best since all coefficients were calculated from calibration.

For the Acrivlellis method it is possible, to get systematic errors from the linearizer and, also, by neglecting higher order correlations the solution of the system of equations results in some systematic errors.

The Kjellström method probably results in systematic errors caused by neglecting of the $\overline{v'w'}$ shear stress in solving the system of equations.

However, the code enables different choices of the calculation parameters and different coefficients of the probes and, thus, makes it possible to find the sources of systematic errors.

The figures 20 - 31 show a comparison of results calculated by the Hooper and Kjellström methods for a test section with P/D = 1.148 and W/D = 1.222. The same conclusions are valid as above.

This computer code together with the computer controlled rig and the computer programs for the graphic output of the results which are now available in KfK-INR enables a very fast evaluation of the turbulence characteristics in aerodynamical models.

It is also possible to compare the results measured and evaluated by different methods. The differences between the results stem from simplifications for data evaluation and from inaccuracies of the measurements caused by the drift of the hot-wires and, the electronic circuits.

From this comparison it seems to be the best procedure to use the simplest description of the effective cooling velocity and to calculate all coefficients from the calibration of the probes used, that means: the method recommended by Hooper /7/ using the effective cooling velocity correlation in the form of Bruun and Davies /10/ (2.16) for slanting wires.

The results of hot-wire measurements evaluated by this method are in between the results of the Kjellström and Acrivlellis method, but the differences are relatively small.

At present the companies producing anemometer electronics offer new equipment, simpler to use which automatically perform temperature corrections of the output voltage, resistance compensation etc. They also offer software for evaluation of the measured data. It should be interesting to compare results measured with such means with our results.

The present work shows the possible way of additional simplification, by measuring only with one slanting wire collecting the voltages at six different positions (1,2,3,4,5 and 7 - Fig.5) and by evaluating the matrix of the corresponding system of equations. I would like to write a computer program solving this task in the near future.

6. Acknowledgements

I appreciate very much the useful discussions and practical help of my supervisor Prof. Dr.-Ing. K. Rehme, the support of the laboratory staff, especially by Mr. E. Mensinger and Mr. G. Wörner and the typing of the report by Mrs. M. Stassen.

I thank IAEA Vienna which enabled my fellowship in KfK Karlsruhe.

7. Nomenclature

B - proportionality factor (V^2sm^{-2})

D - diameter of the rods (m)

e - RMS value of the anemometer output (V)

E - DC value of the anemometer output (V)

h - binormal sensitivity factor (-)

k - yaw sensitivity factor (-)

$\overline{k'}$ - kinetic energy of turbulence (m^2s^{-2})

K - coefficient (-)

m - exponent (-)

n - exponent (-)

P - pitch of the rods (m)

p - pressure (Pa)

R - correlation coefficient (-)

S - proportionality factor ($V\ s\ m^{-1}$)

t - temperature (K)

u - immediate value of turbulence velocity, axial (ms^{-1})

v - immediate value of turbulence velocity, radial (ms^{-1})

w - immediate value of turbulence velocity, perpendicular (ms^{-1})

u' - turbulence intensity, axial (ms^{-1})

v' - turbulence intensity, radial (ms^{-1})

w' - turbulence intensity, perpendicular (ms^{-1})

U - mean velocity, axial (ms^{-1})

V - mean velocity, radial (ms^{-1})

W - mean velocity, perpendicular (ms^{-1})

W - distance between the wall and the rod plus diameter of the rod (m)

Greek

α	- angle of the wire (grad)
β	- incremental angle (grad)
γ	- temperature coefficient of anemometer output (K^{-1})
δ	- angle (grad)
Δ	- difference (-)
ψ	- angle of the wire (grad)
ν	- kinematic viscosity ($m^2 s^{-1}$)
ρ	- density ($kg\ m^{-3}$)

Indices

B	- binormal
C	- corrected
E	- calibration
eff	- effective
HW	- hot wire
M	- measured
N	- normal
P	- perpendicular wire
PIT	- Pitot tube
REF	- reference value
S	- slanting wire
T	- tangential
o	- at zero velocity
1,2..	- position of the slanting probe (Fig.5)
25	- at 25^{o}C
α	- slanting wire at yaw angle α
ψ	- slanting wire at yaw angle ψ (Kjellström's method)

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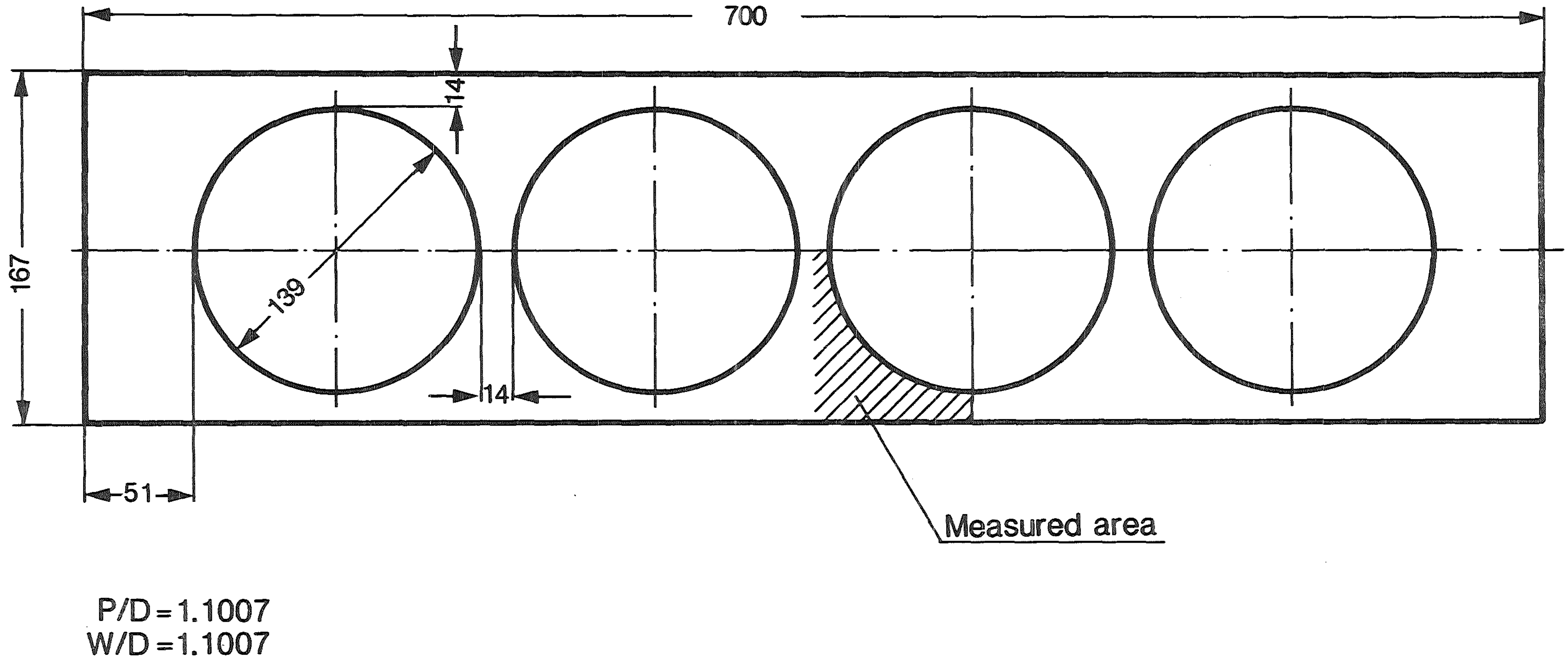
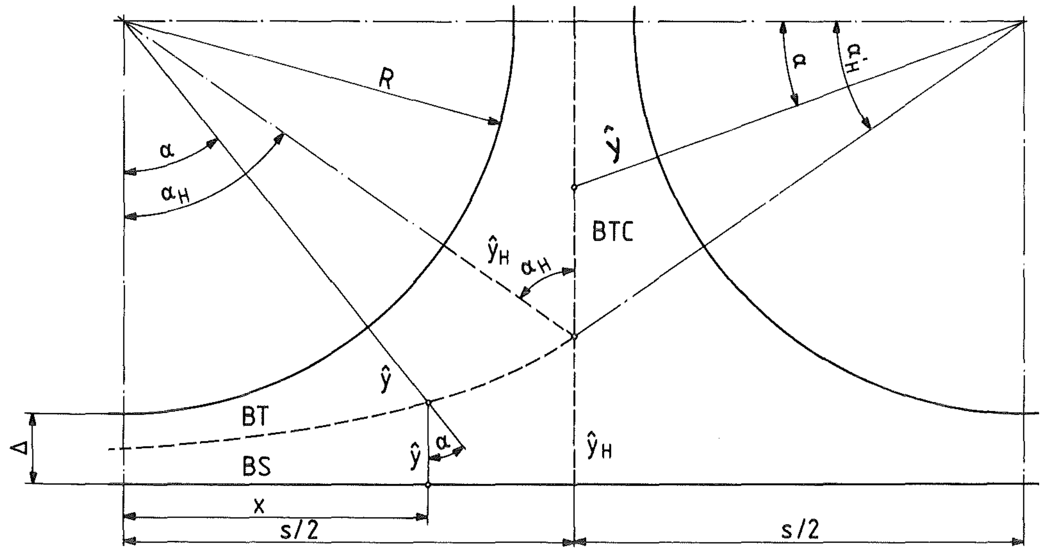


Fig. 1 Cross section of test rig.



$p = \frac{s}{D}$; $\omega = \frac{\Delta}{D}$; $\delta = 2\omega + \omega^2$; $\gamma = \frac{1}{2}\,\frac{p}{1+\omega}$; $D = 2 \cdot R$

BT BS	$\hat{y} = R \cdot \frac{2\omega + 1 - \cos\alpha}{1+\cos\alpha}$; $\hat{y} = R\,[\omega + (1+\omega)\,tg^2 \frac{\alpha}{2}]$;
	$x = D \cdot (1+\omega) \cdot tg\,\frac{\alpha}{2}$; $\hat{y} = \frac{X}{\sin(2 \cdot arc\,tg\,\frac{X}{D+\Delta})} - R$;
	$\alpha_H = 2 \cdot arc\,tg\,\gamma$; $\hat{y}_H = R\,[\omega + \gamma^2(1+\omega)]$;
	$F^{BT} = R^2\,[\gamma(1+\frac{2}{3}\delta) + \frac{1}{3}\gamma^3 + \frac{1}{3}\delta\gamma\,(1+\gamma^2) - \frac{\pi}{180}\,arc\,tg\,\gamma]$; $S^{BT} = \frac{\pi D}{180} \cdot arc\,tg\,\gamma$;
	$F^{BS} = R^2\left\{\frac{\gamma}{1-\gamma^2}\,[1 + 4\omega + 3\omega^2 - p \cdot \gamma \cdot \omega - \frac{p^2 \cdot \gamma^2}{4}] - \frac{\pi}{180} \cdot arc\,tg\,\gamma\right\} - F^{BT}$; $S^{BS} = \frac{s}{2}$;
BTC	$\hat{y} = R\,(\frac{p}{\cos\alpha} - 1)$; $\alpha'_H = 90 - 2 \cdot arctg\,\gamma$;
	$F^{BTC} = \frac{s \cdot D}{8}\,(1 + \omega - \frac{p \cdot \gamma}{2}) - \frac{\pi \cdot D^2}{16}(1 - \frac{arctg\,\gamma}{45})$; $S^{BTC} = \frac{\pi \cdot D}{4}(1 - \frac{arctg\,\gamma}{45})$
B	$F^B = D^2\,(\frac{p}{4} + \frac{\omega p}{2} - \frac{\pi}{16})$; $S^B = R \cdot (p + \frac{\pi}{2})$;
	$d_h^B = 2 \cdot D\,\frac{1 + 2\omega - \frac{\pi}{4p}}{1 + \frac{\pi}{2p}}$

Fig.2. Geometrical Parameters of Test Section.

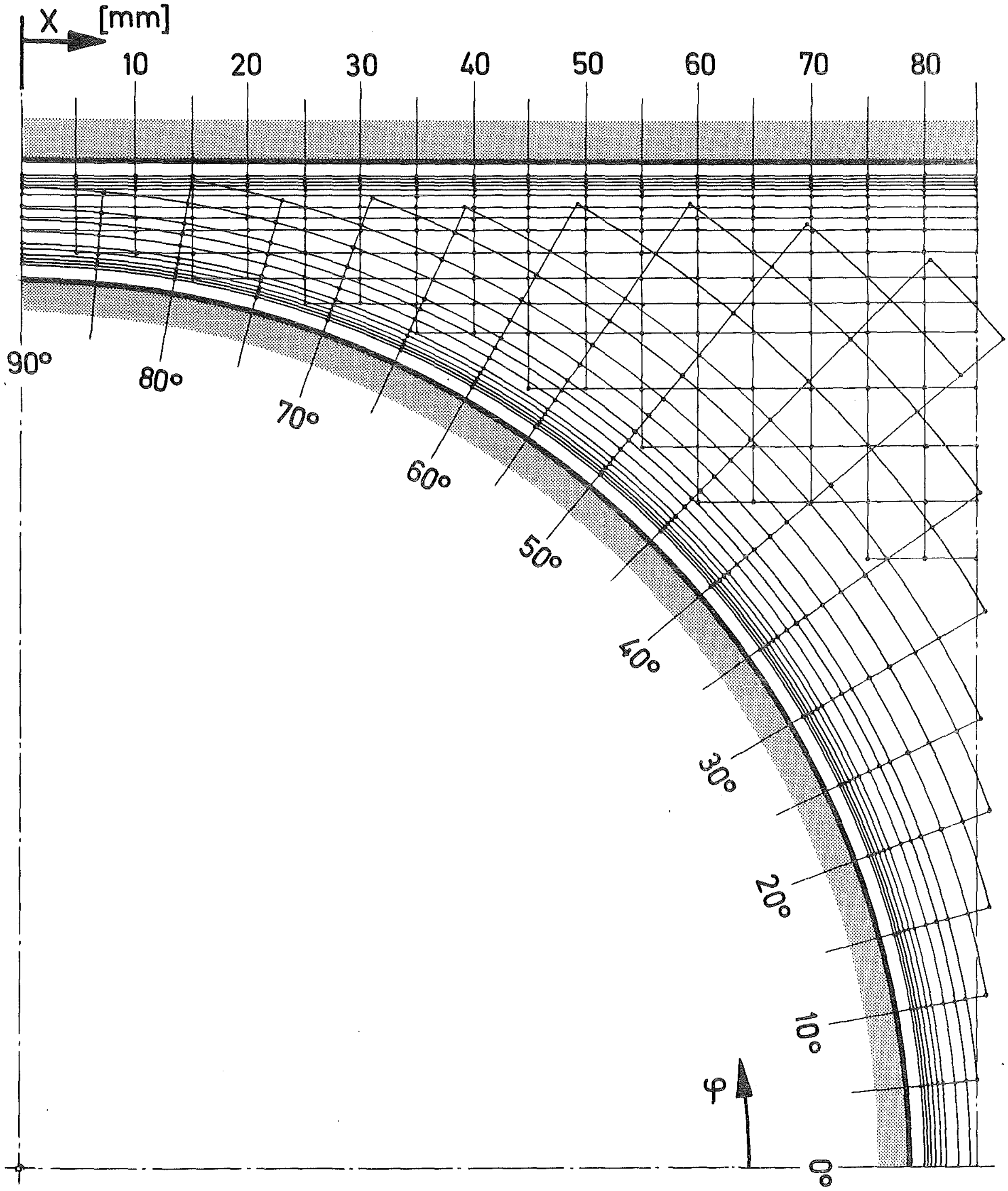


Fig.3. Plan of Measuring Positions.

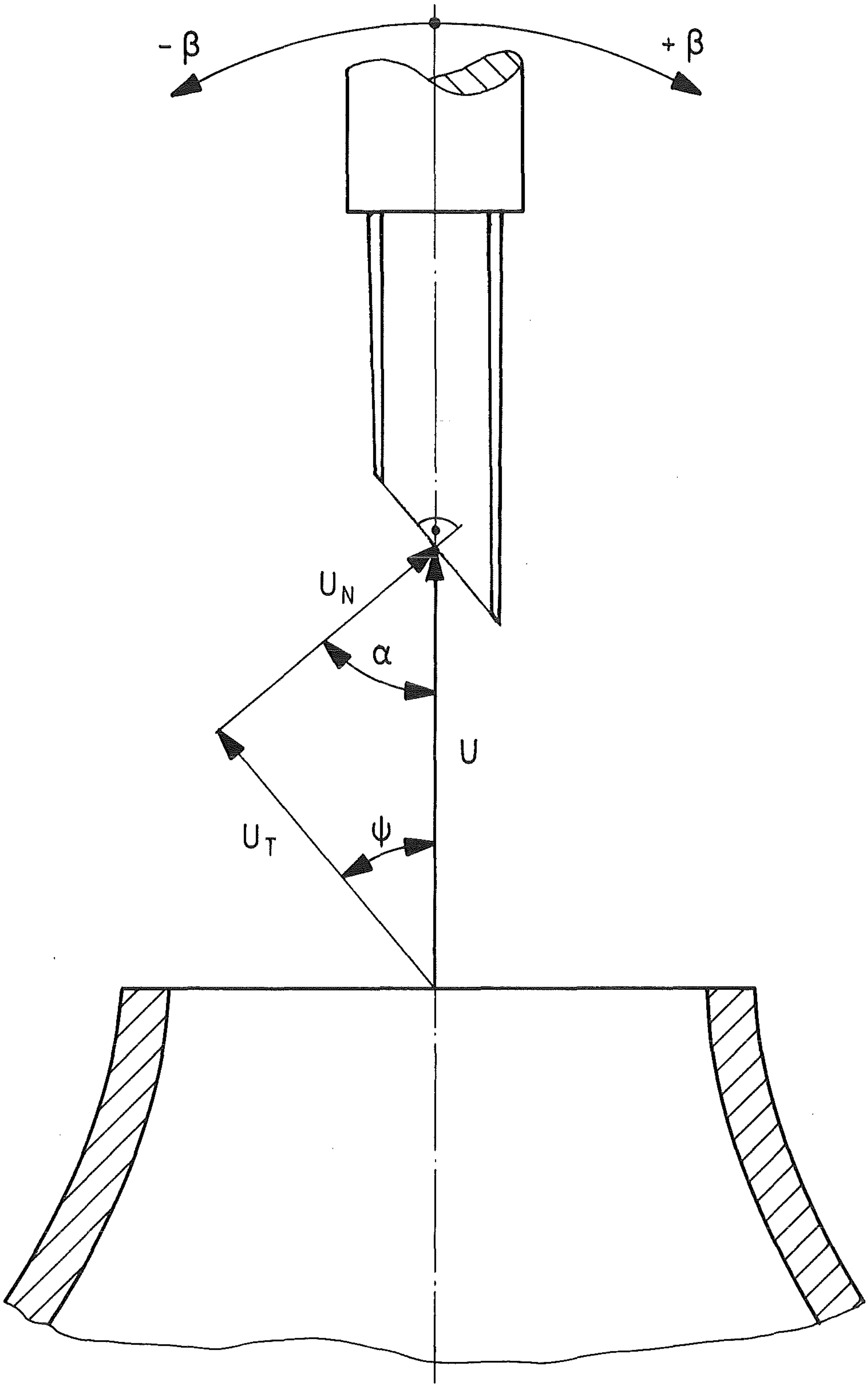


Fig.4. Positioning of the slanting probe during calibration.

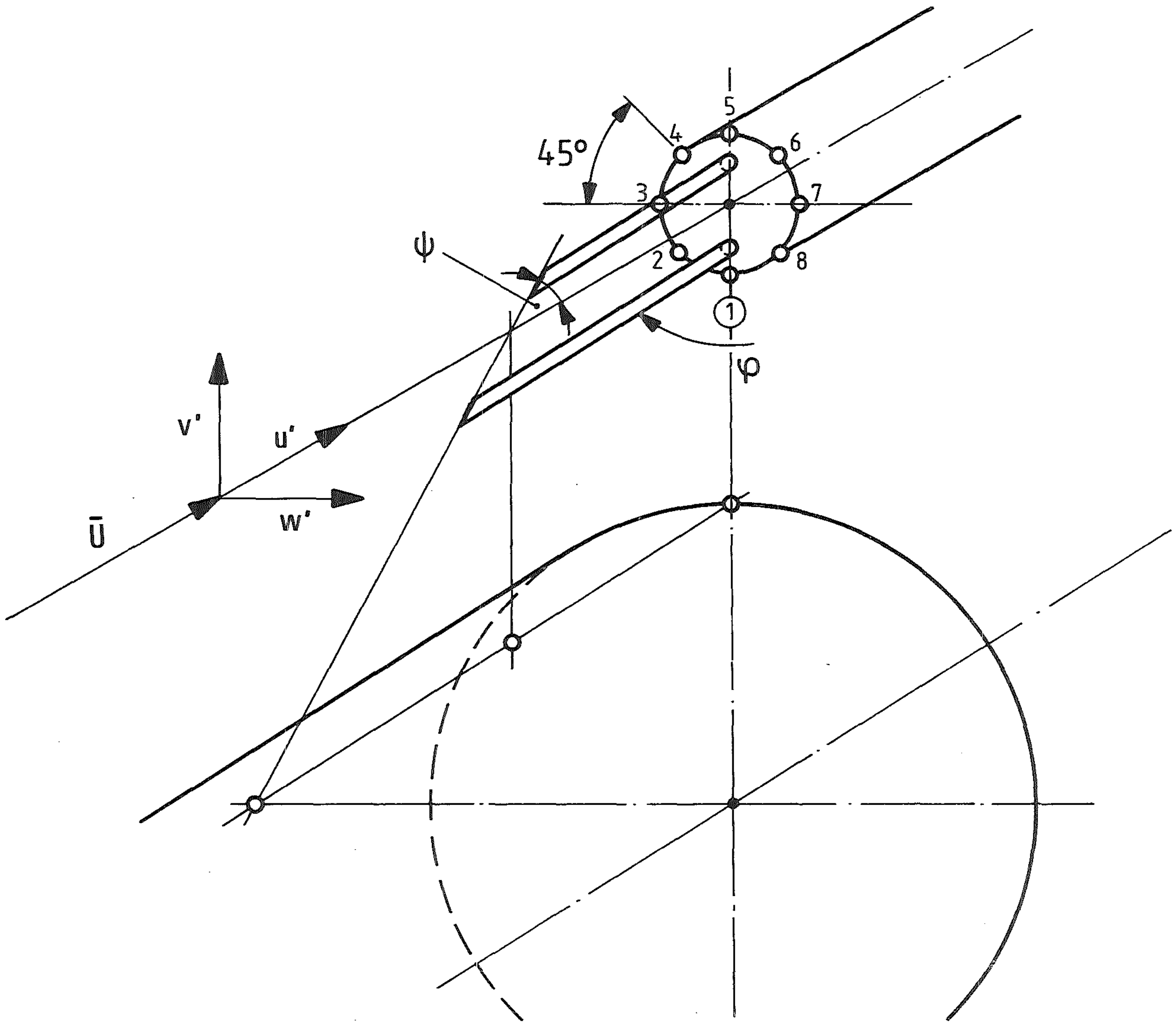


Fig.5. Positioning of the slanting probe during measurement.

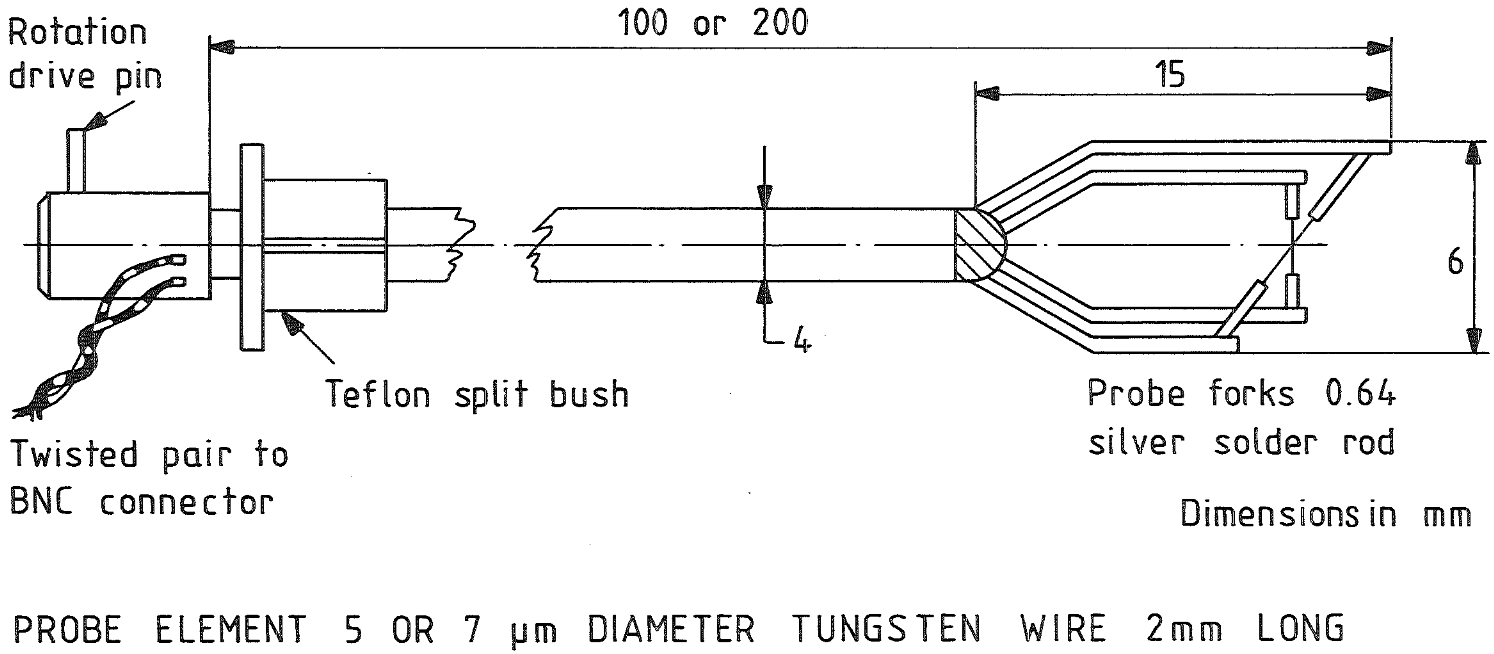


Fig.6. Hooper probe.

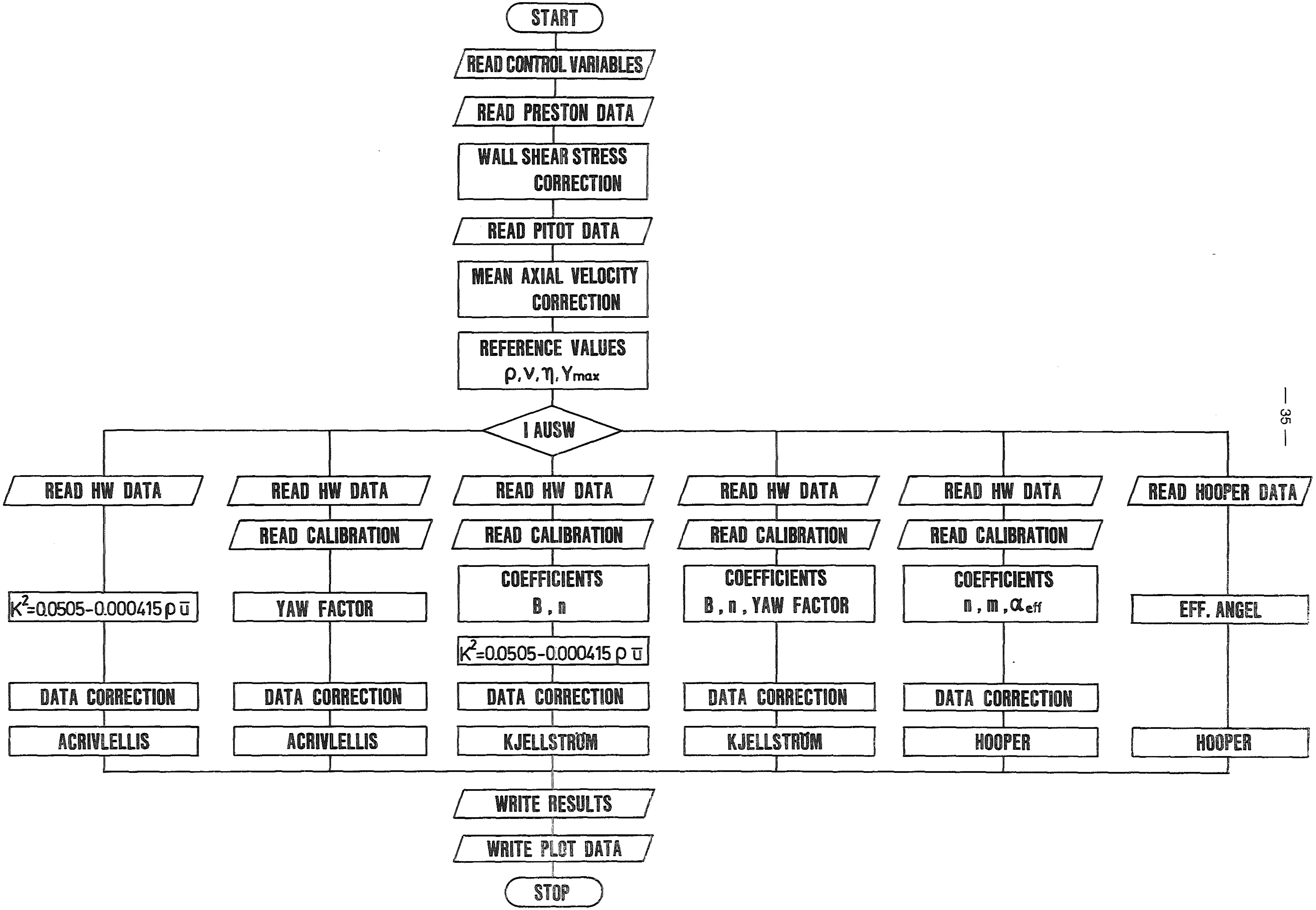


Fig.7. Flow diagram of program.

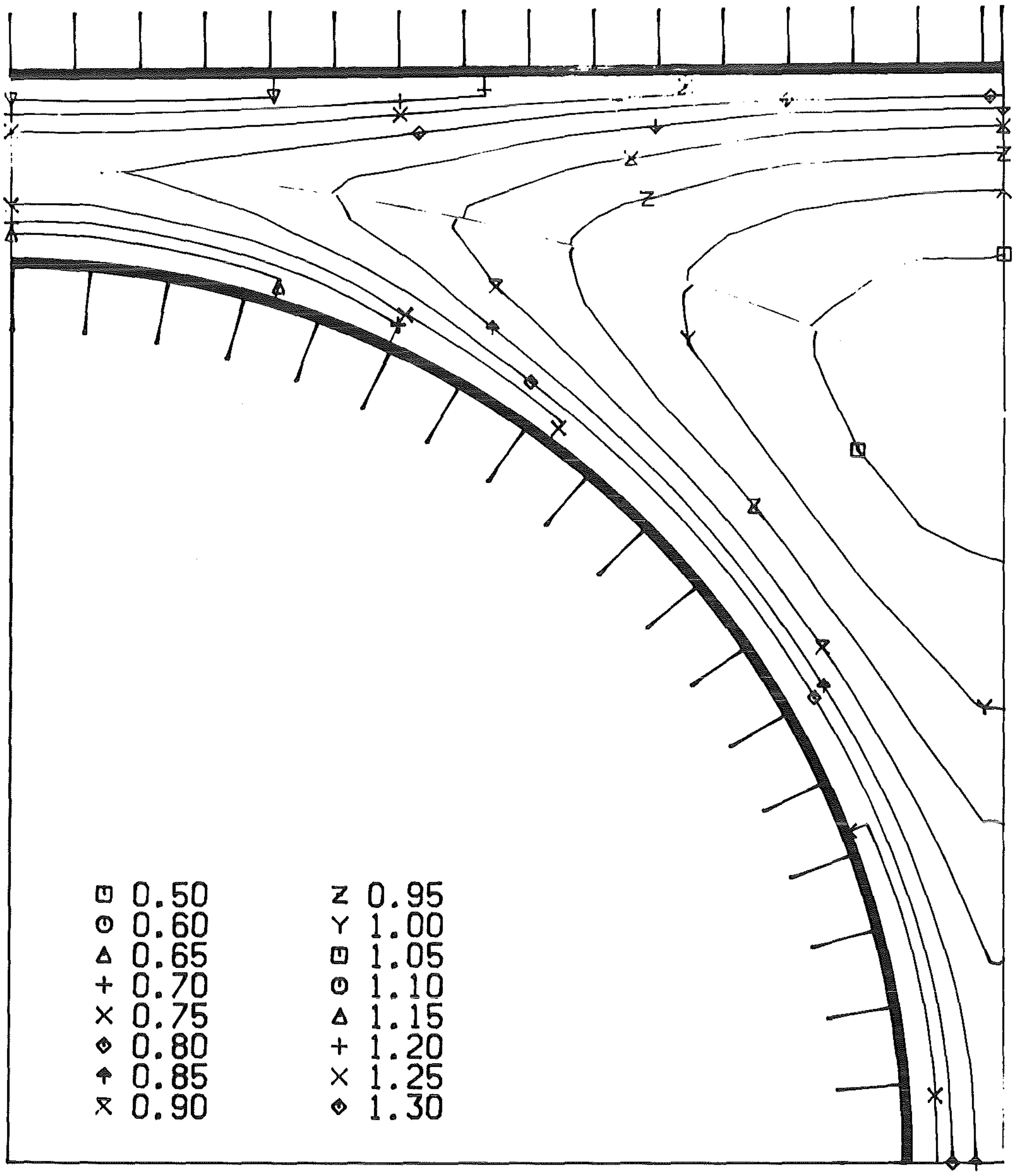


Fig.8. Relative axial mean velocity P/D = W/D = 1.1007.

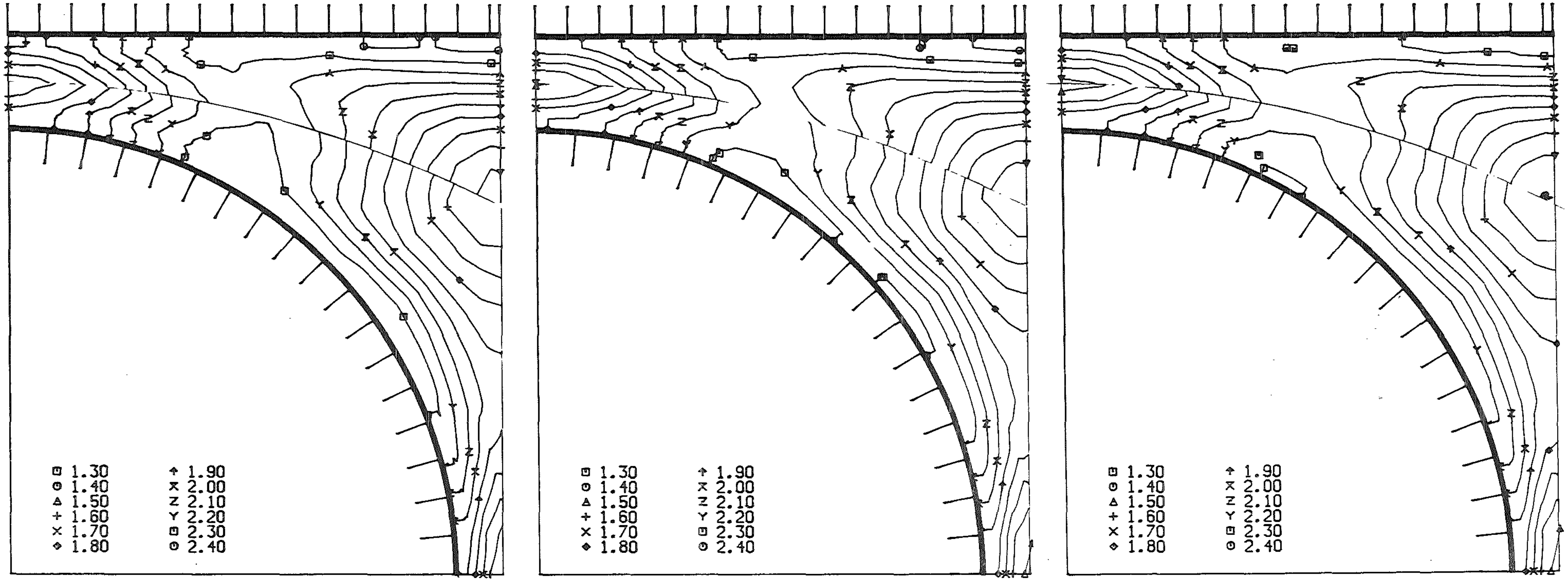


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Fig.9. Relative axial turbulence intensity.

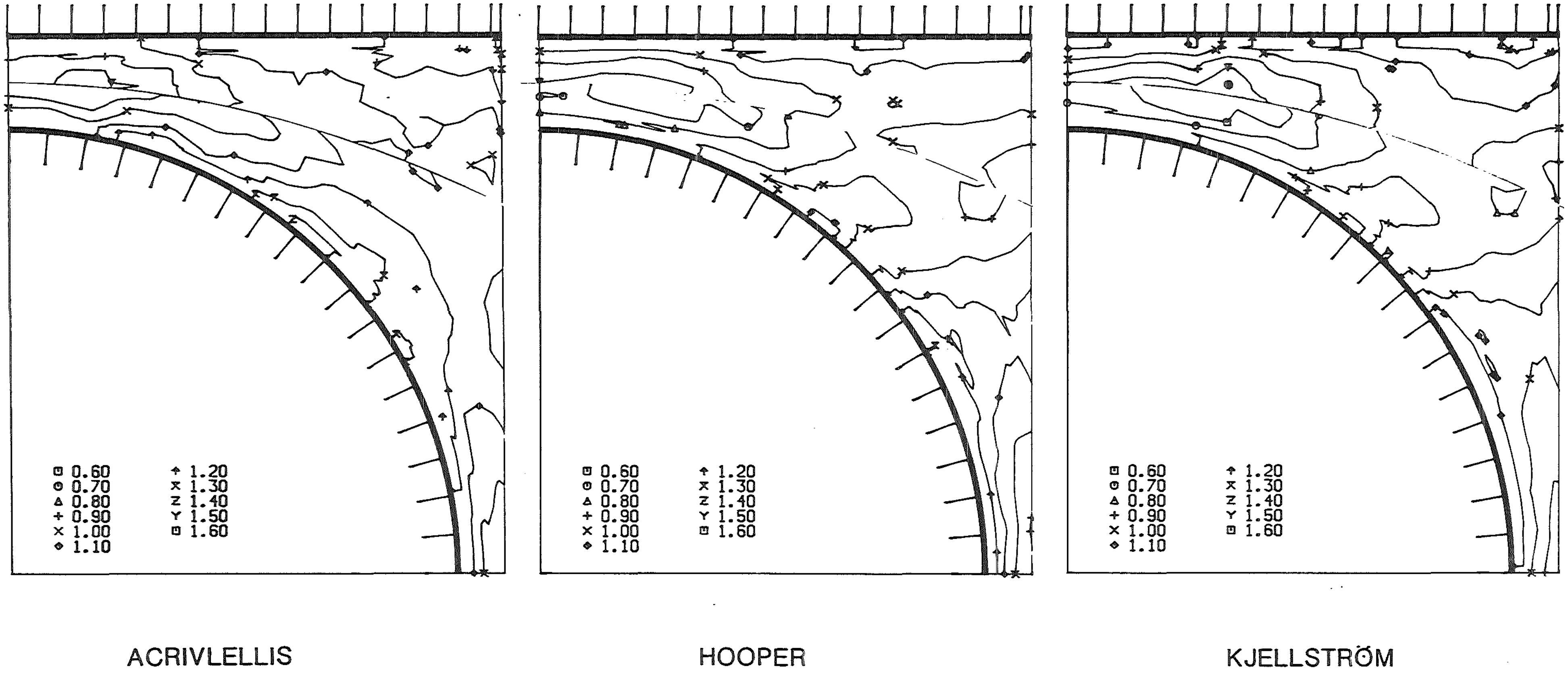

Fig.10. Relative radial turbulence intensity.

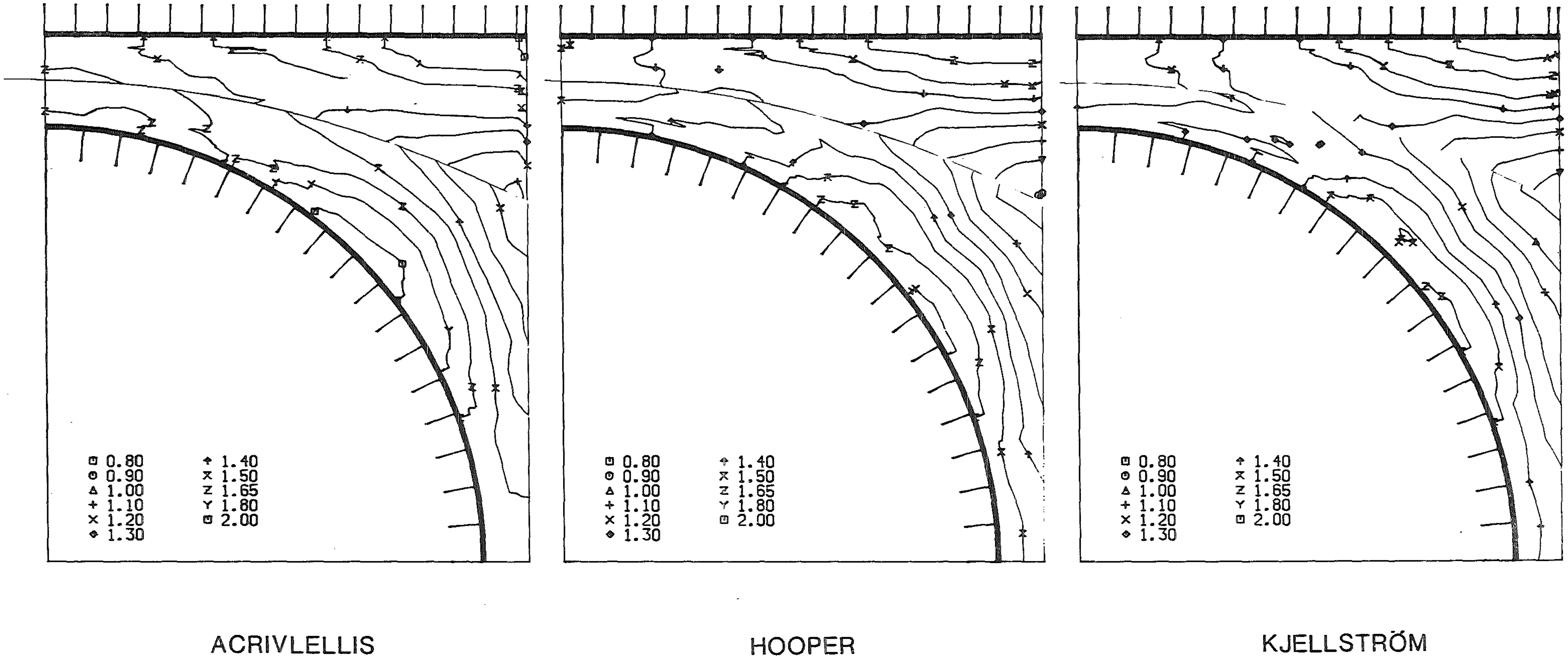

Fig.11. Relative perpendicular turbulence intensity.

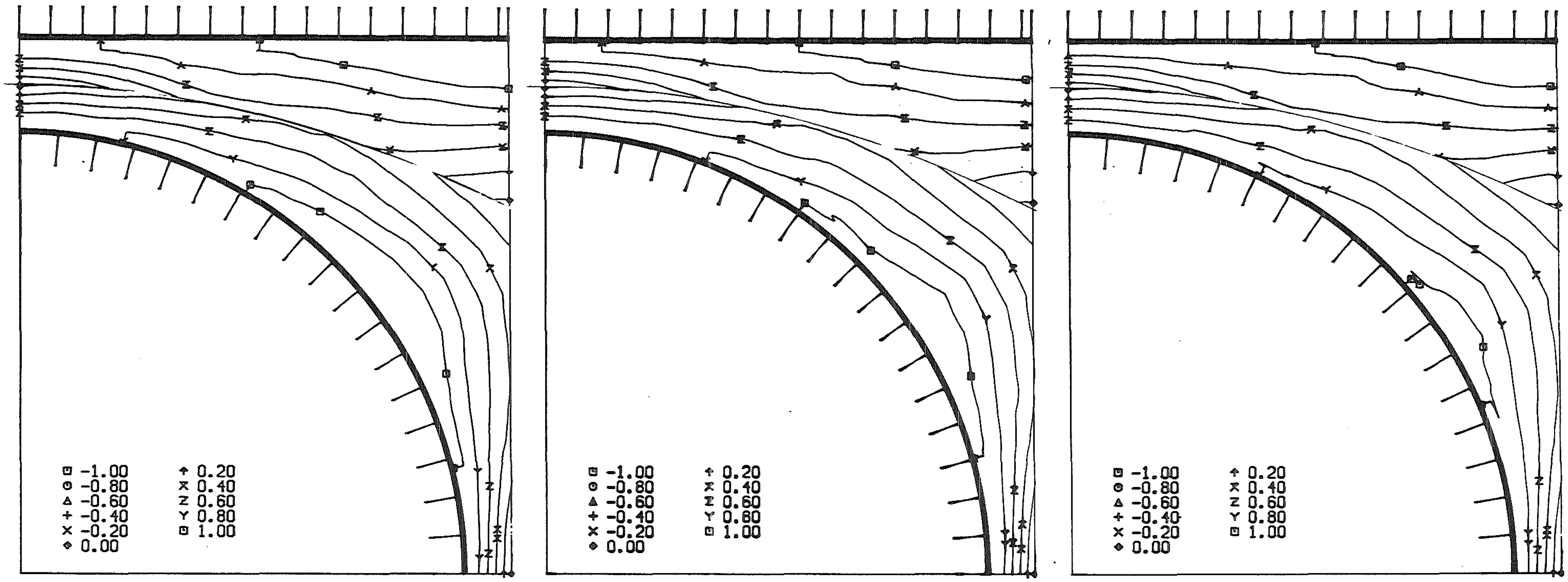

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Fig.12. Relative radial shear stress $\overline{u'v'}$.

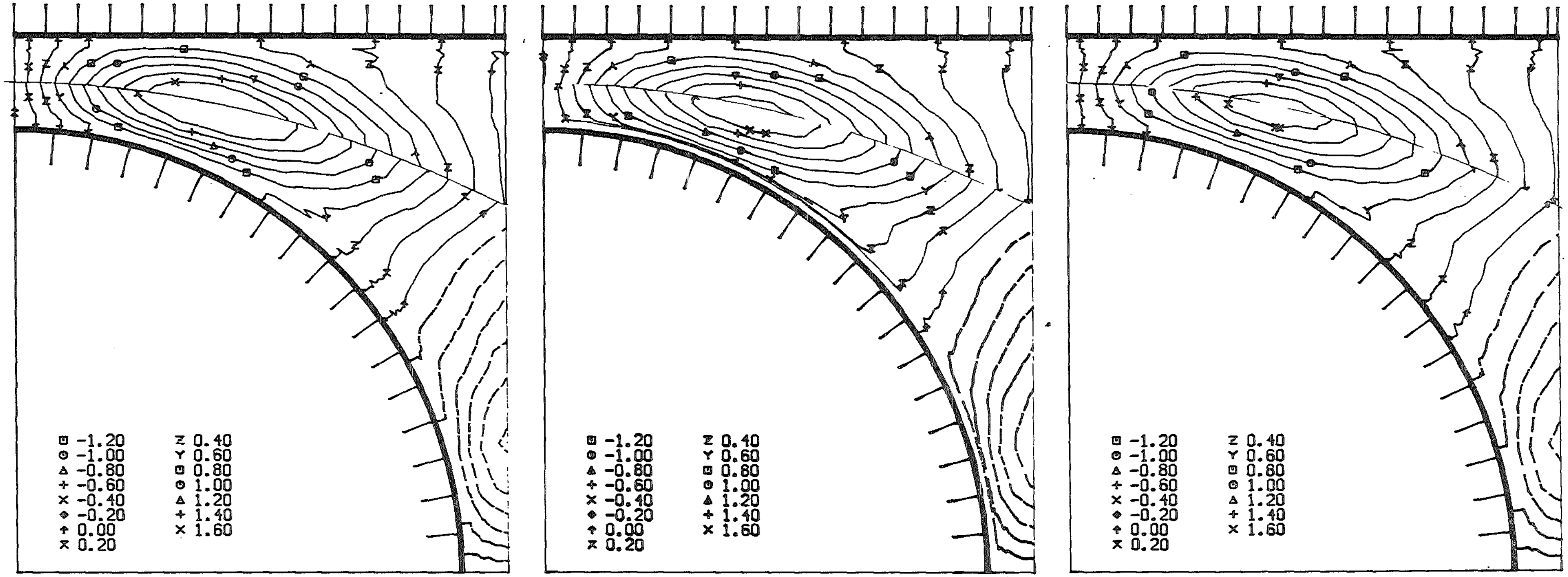

Fig.13. Relative azimuthal shear stress $\overline{u'w'}$.

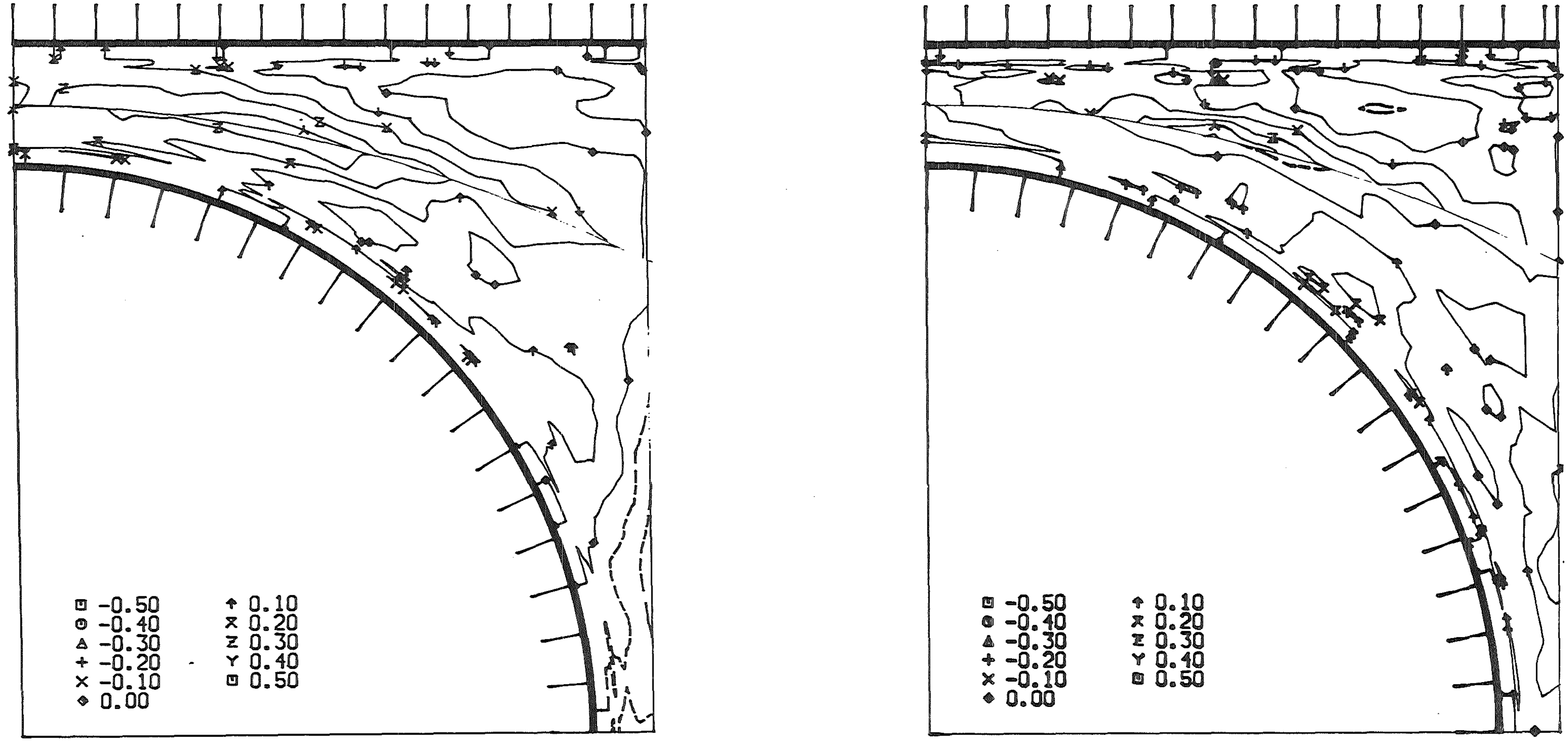

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Fig.14. Relative transverse shear stress $\overline{v'w'}$.

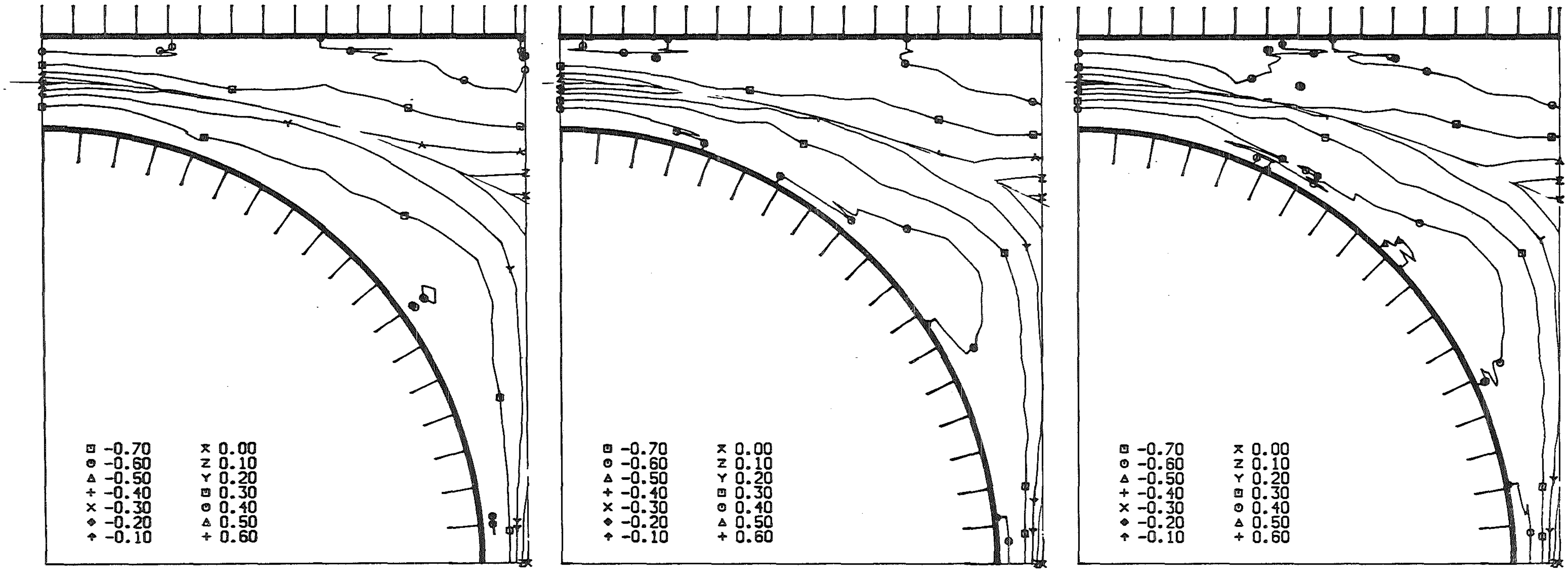

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Fig.15. Correlation coefficient R_{uv}.

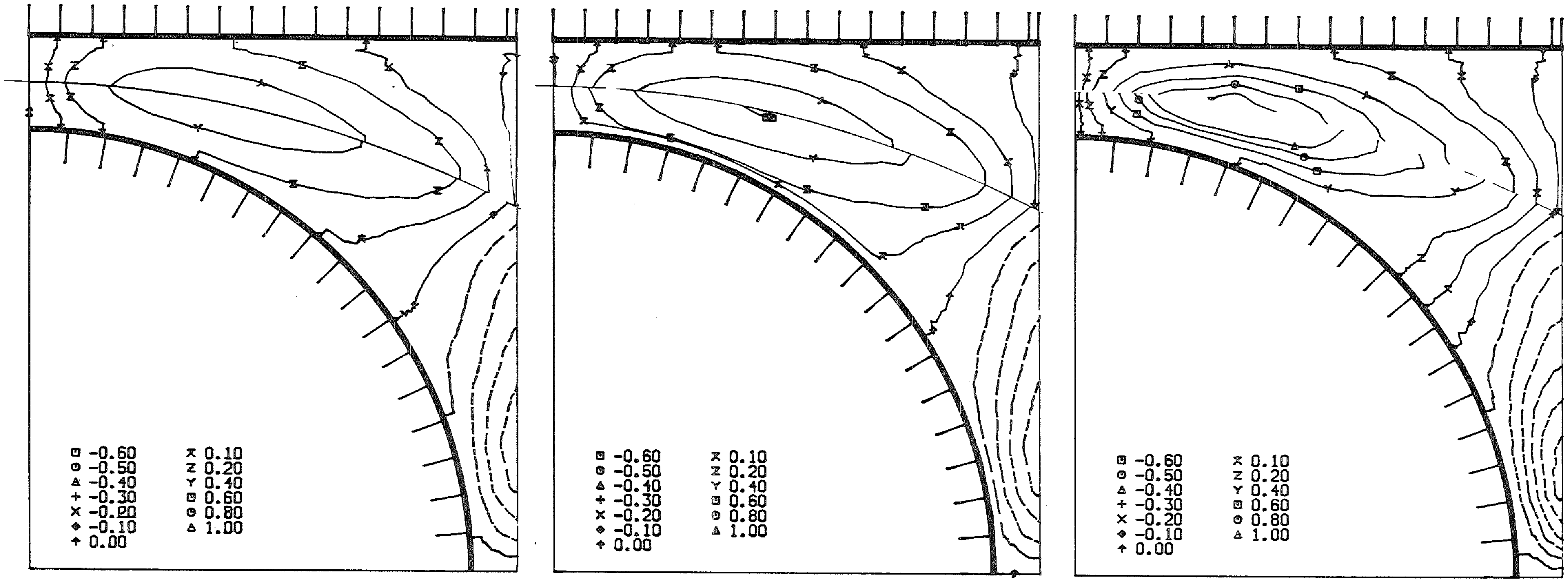

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Fig.16. Correlation coefficient R_{uw}.

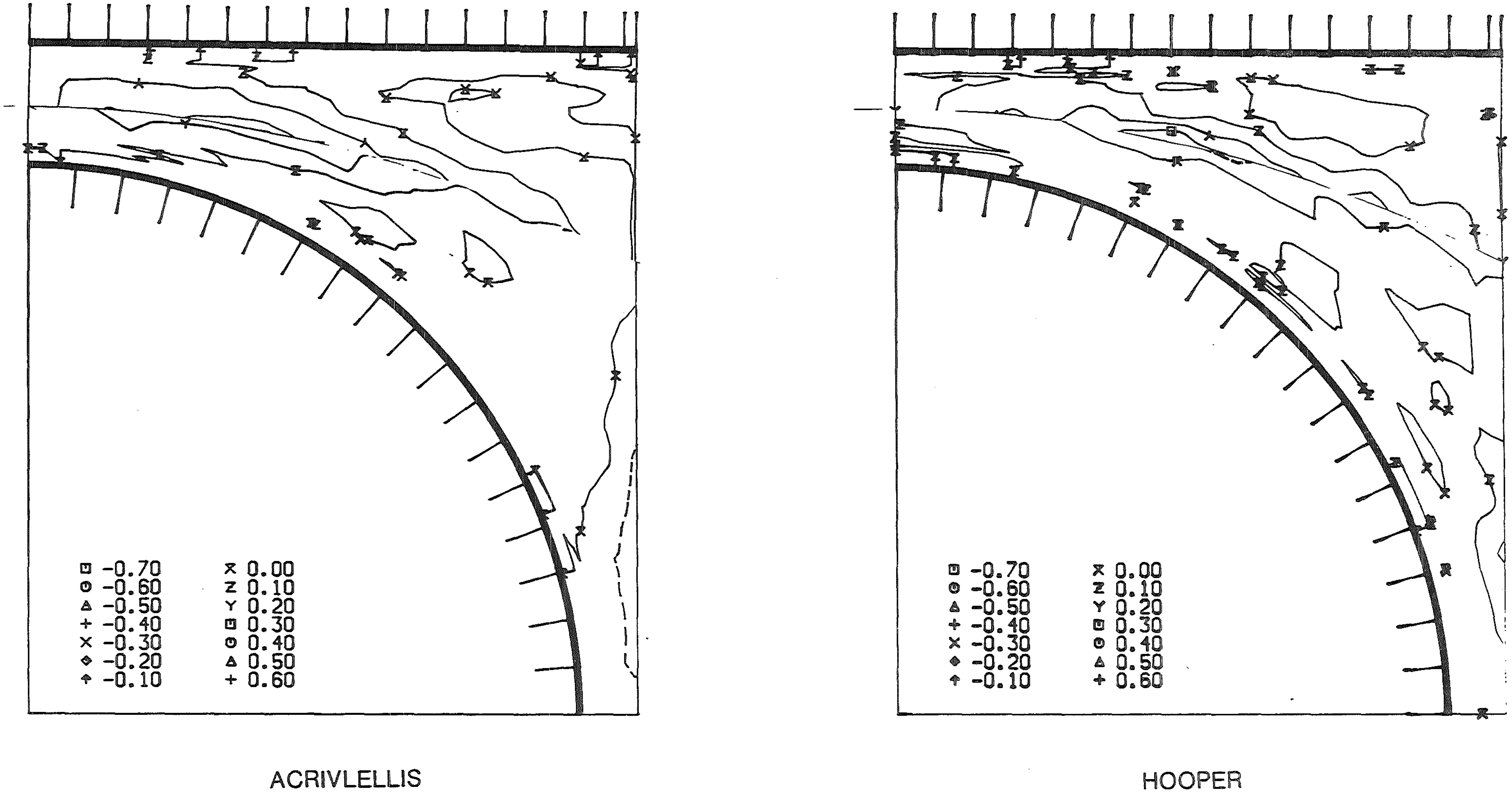


Fig.17. Correlation coefficient R_{vw}.

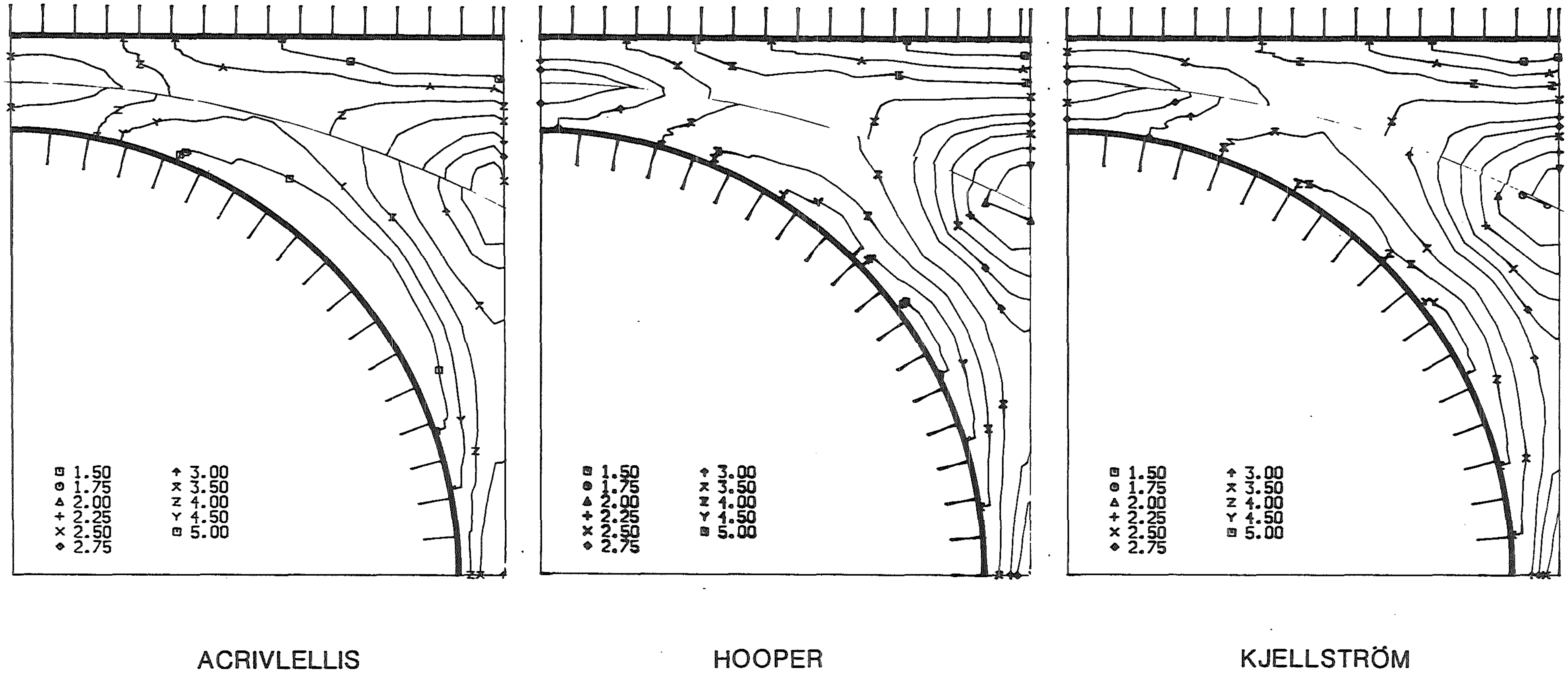
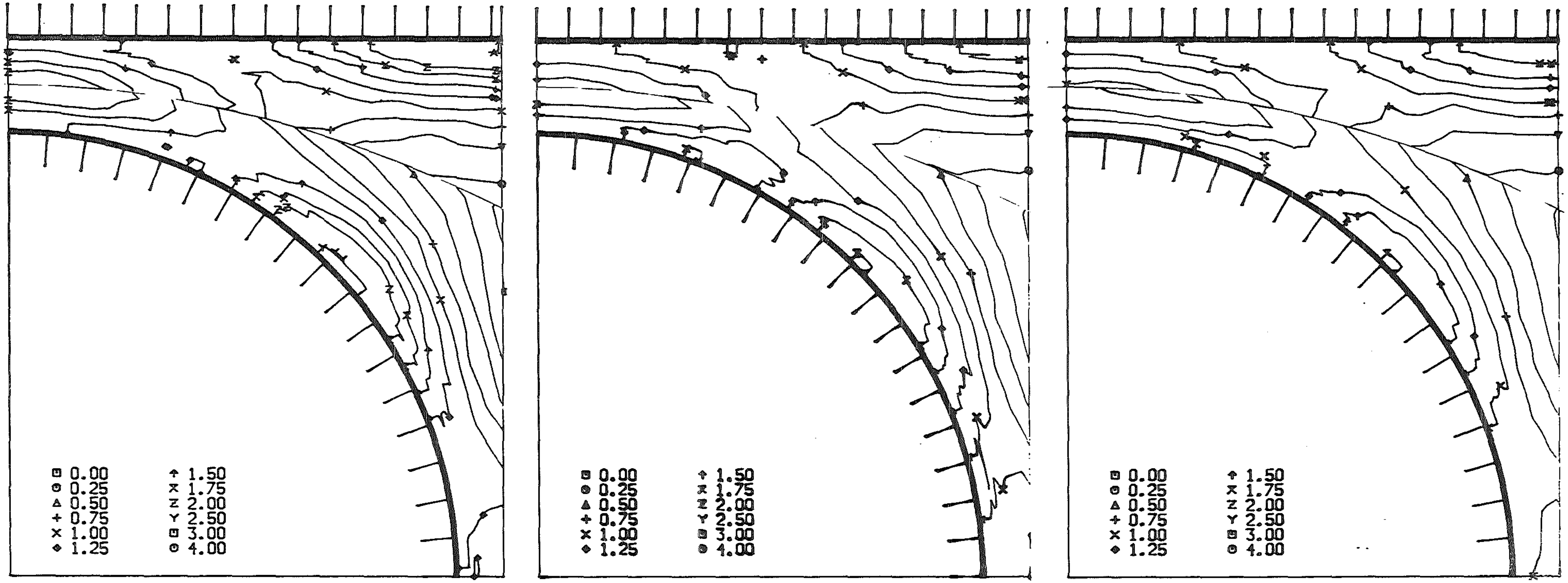


Fig.18. Relative kinetic energy of turbulence.



ACRIVLELLIS HOOPER KJELLSTRÖM

Fig.19. $\overline{w'^2} - \overline{v'^2}$.

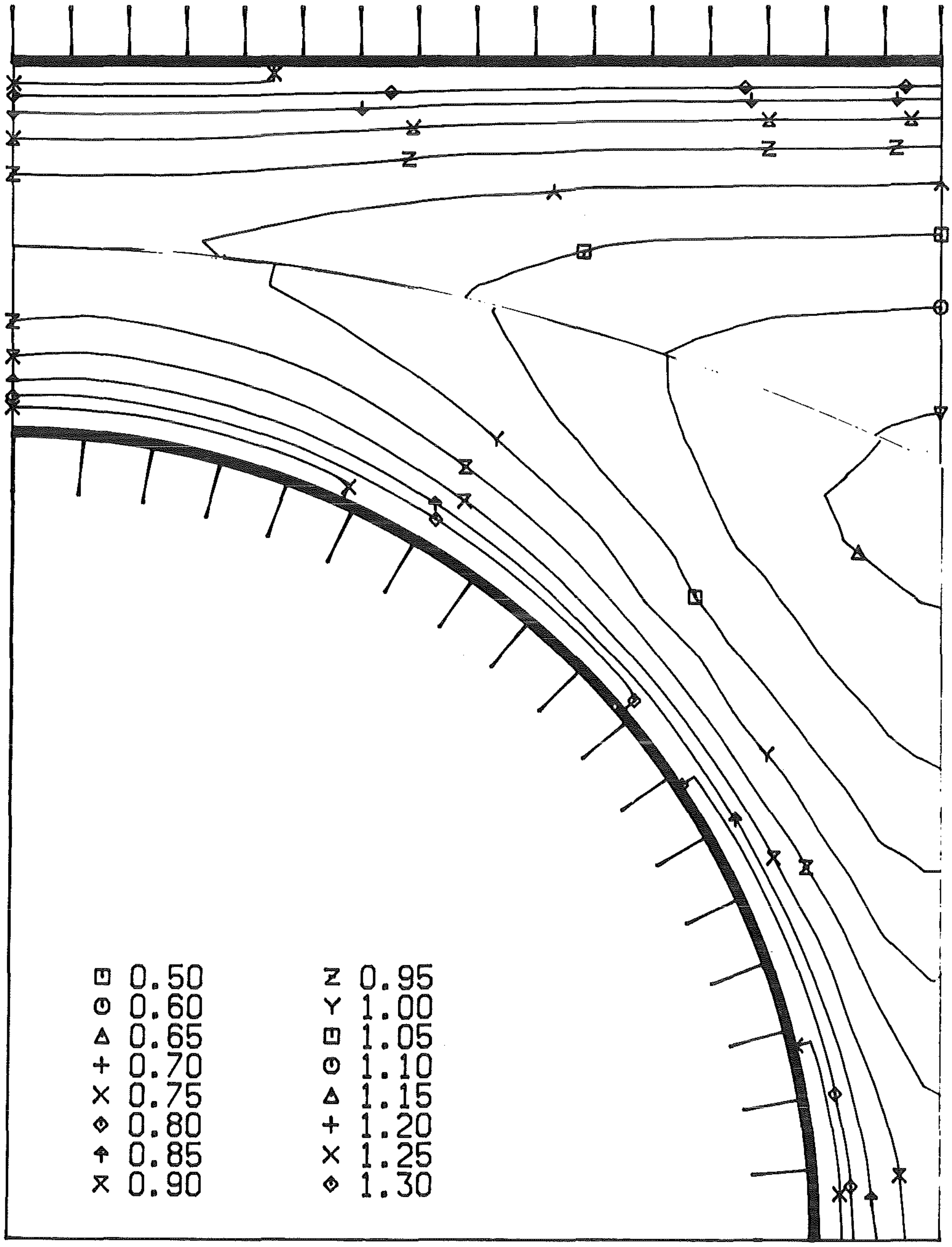


Fig.20. Relative axial mean velocity P/D = 1.1482, W/D = 1.2223.

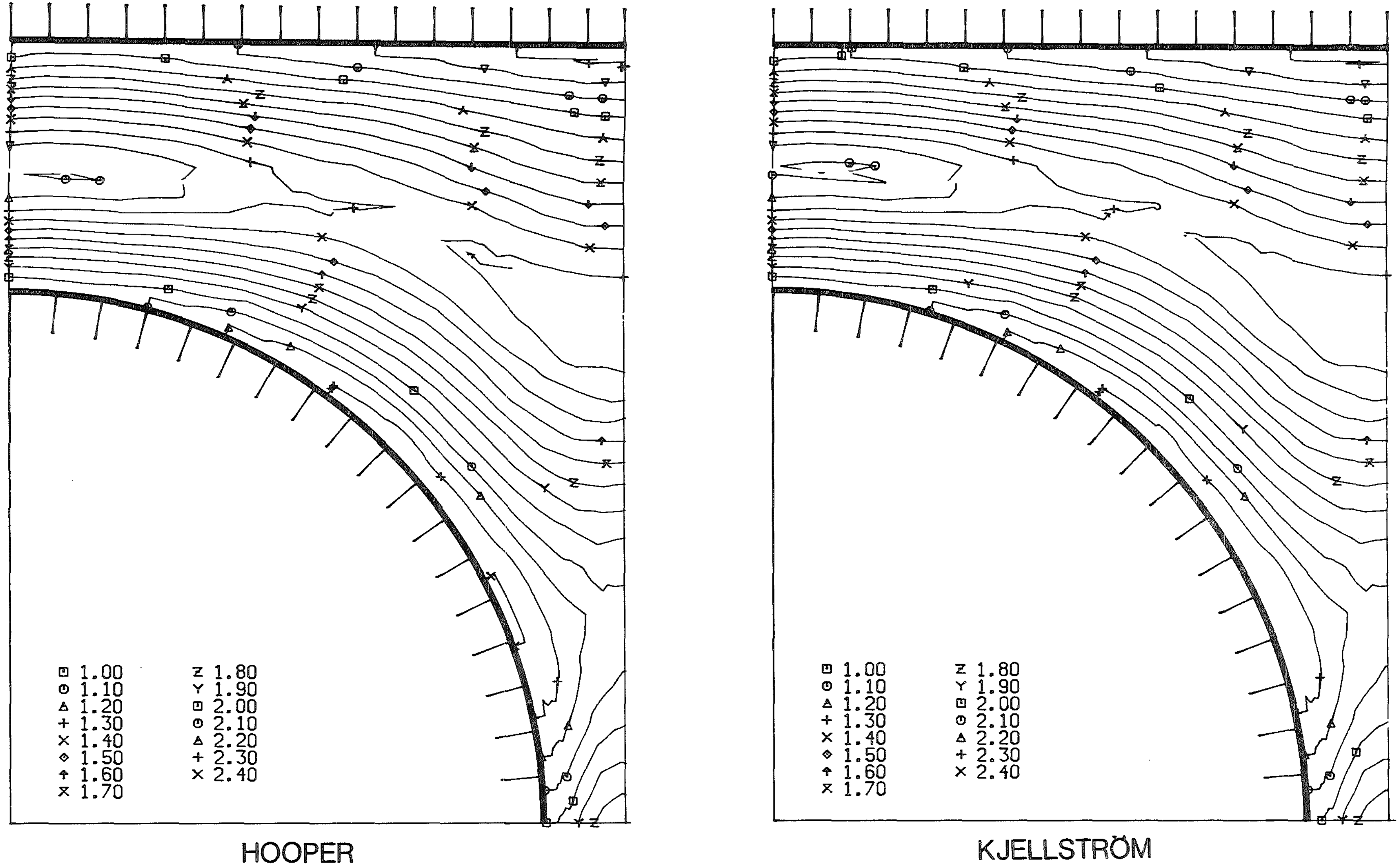


Fig. 21 Relative axial intensity.

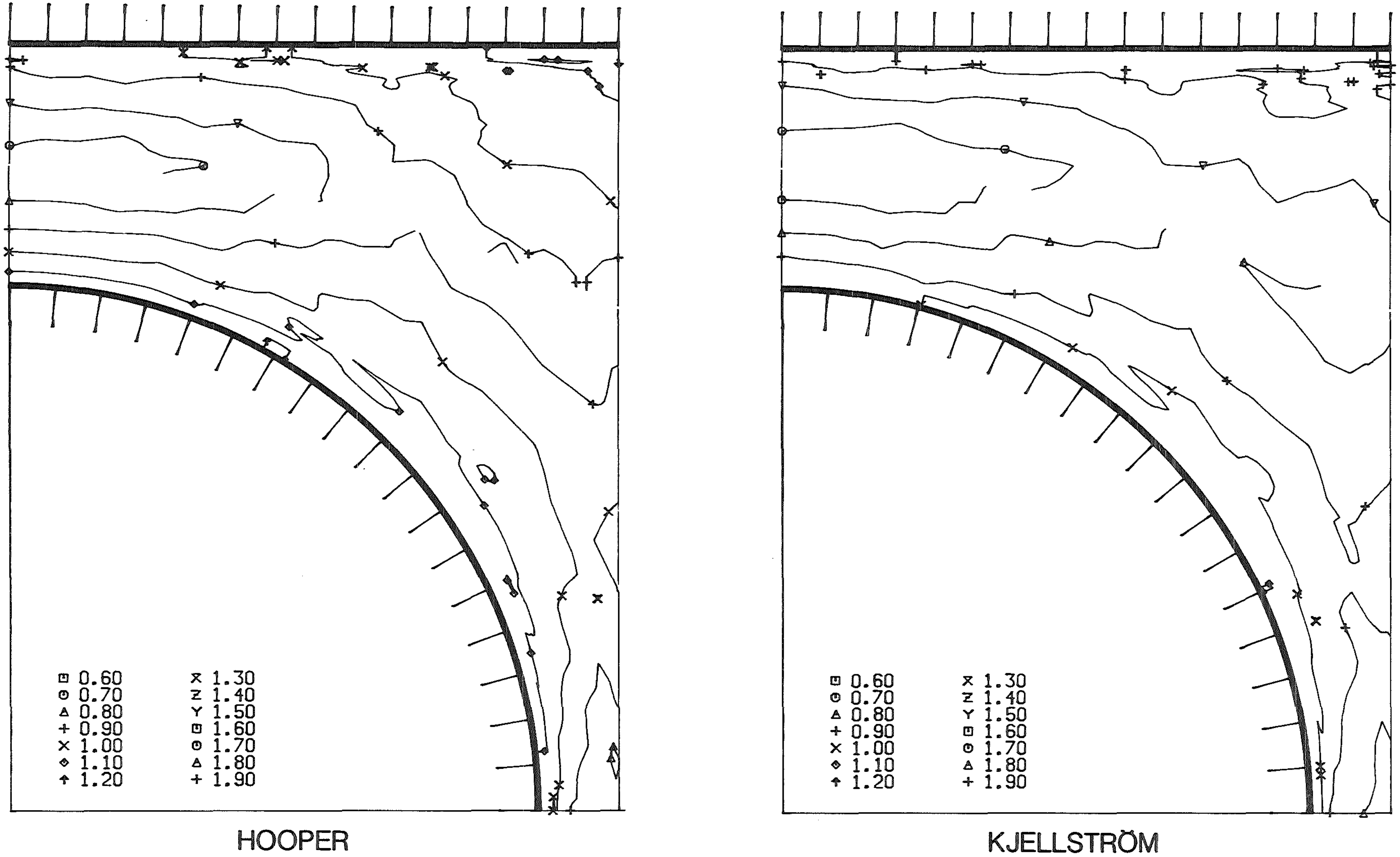


Fig. 22 Relative radial intensity.

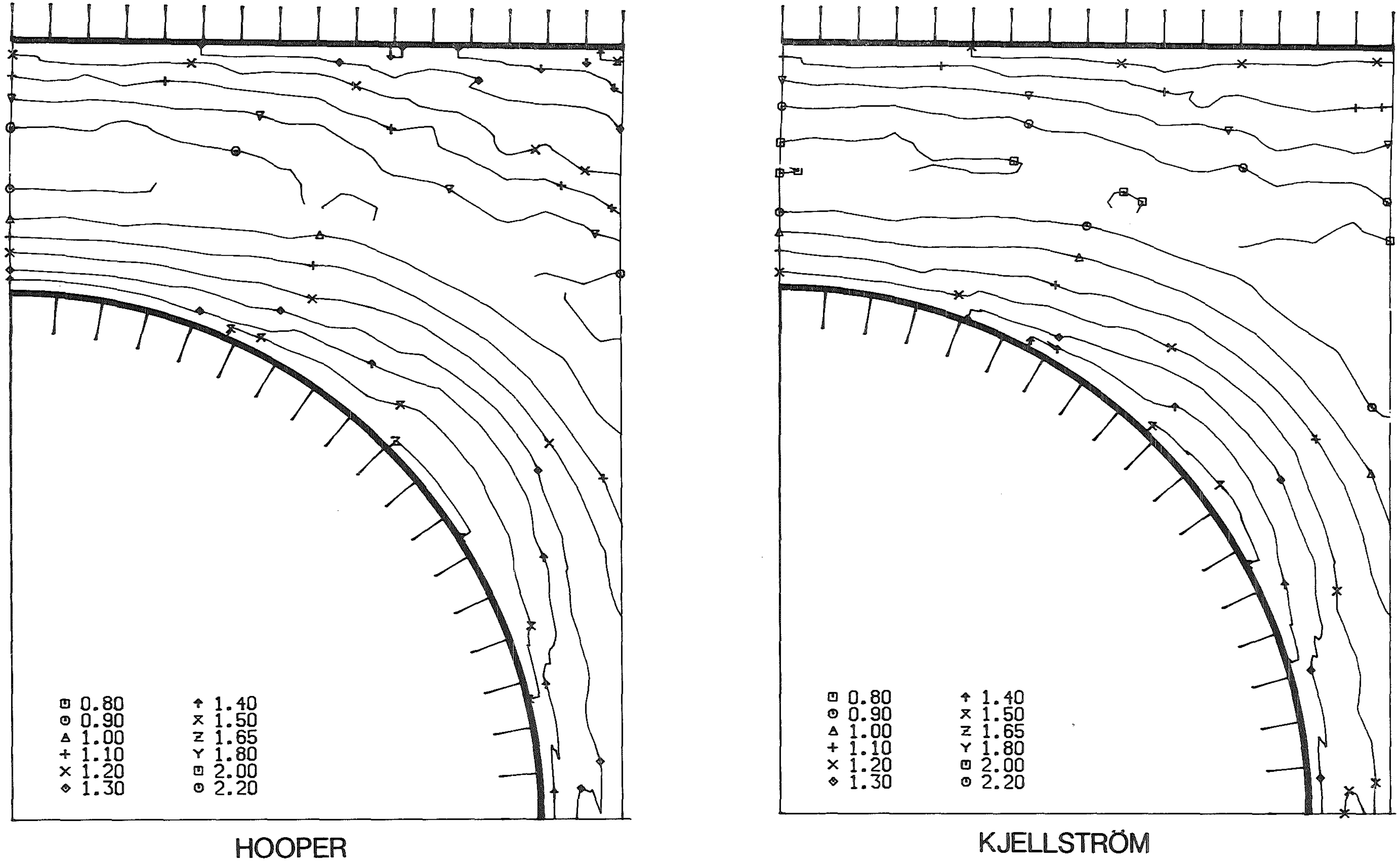


Fig. 23 Relative perpendicular intensity.

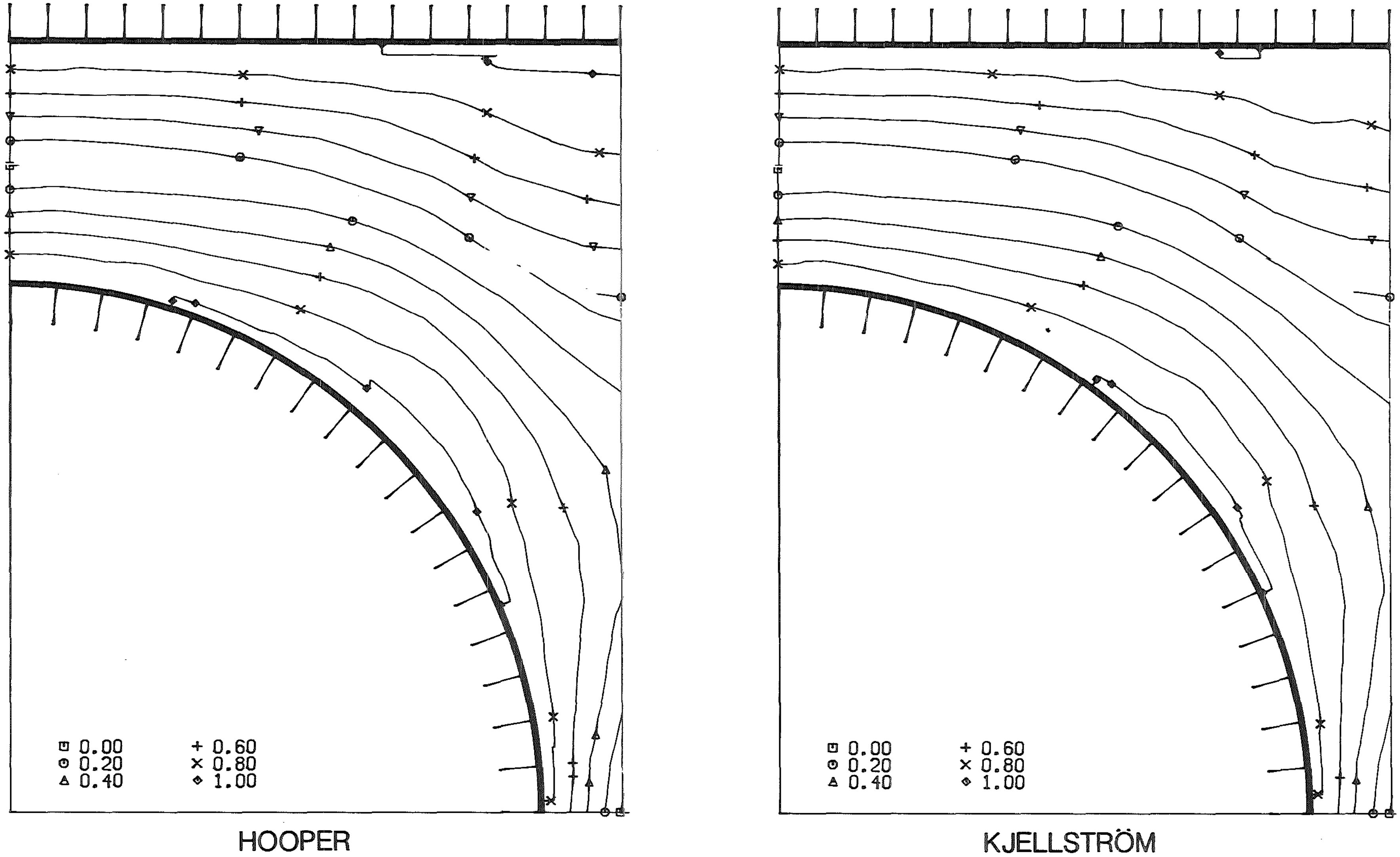


Fig. 24 Relative radial shear stress.

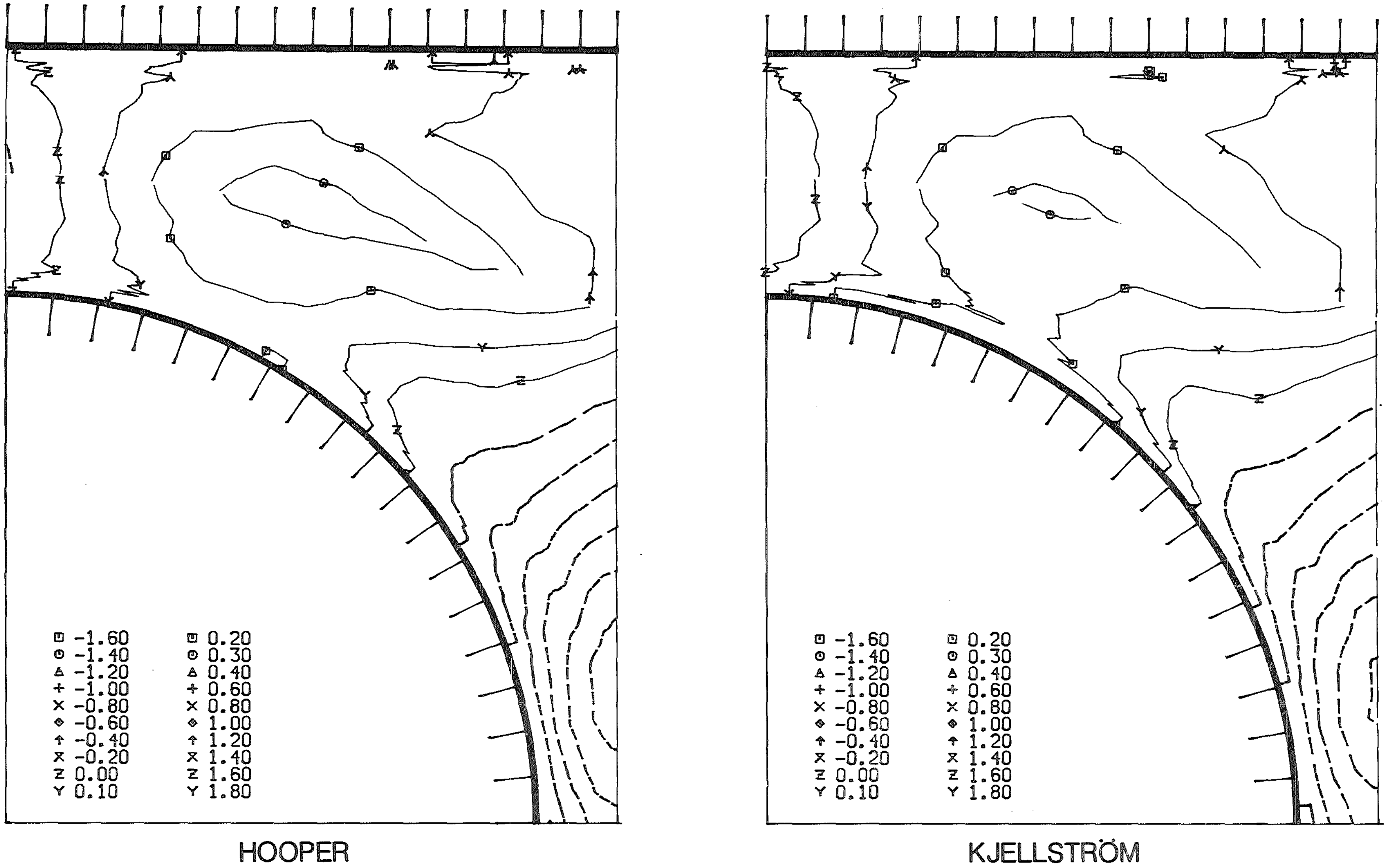


Fig. 25 Relative azimuthal shear stress.

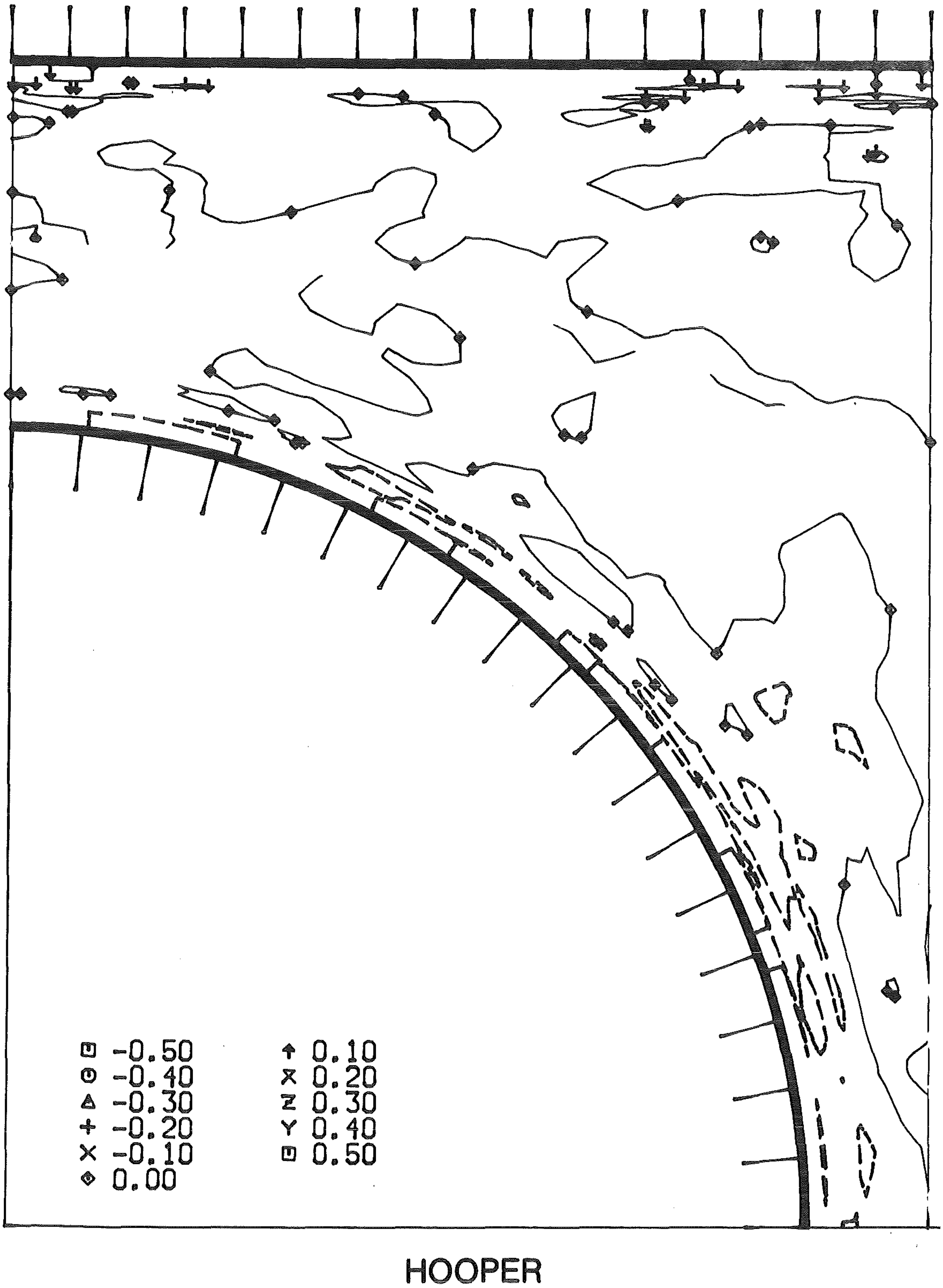


Fig. 26 Relative transverse shear stress.

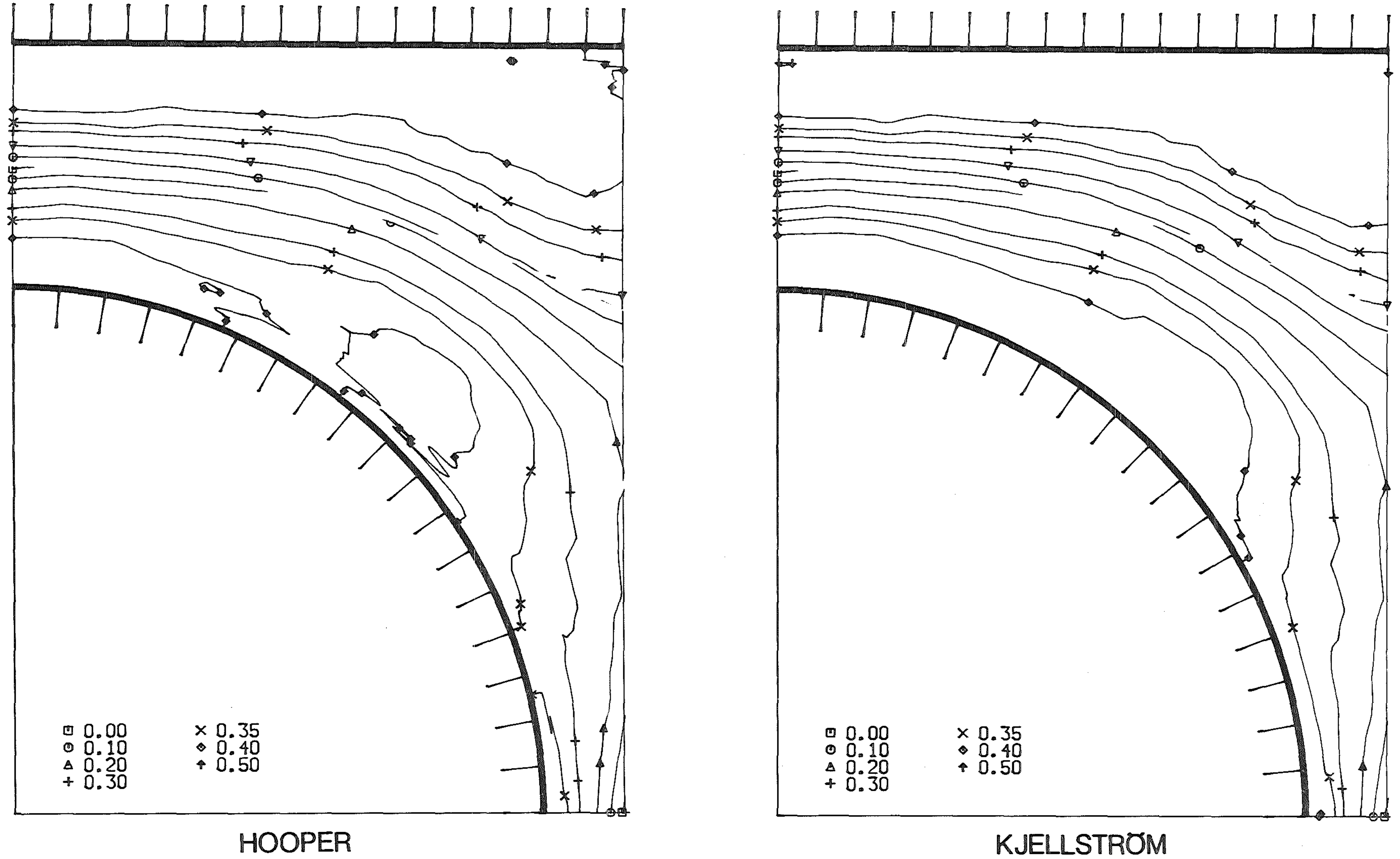


Fig. 27 Correlation coefficient R_{uv}.

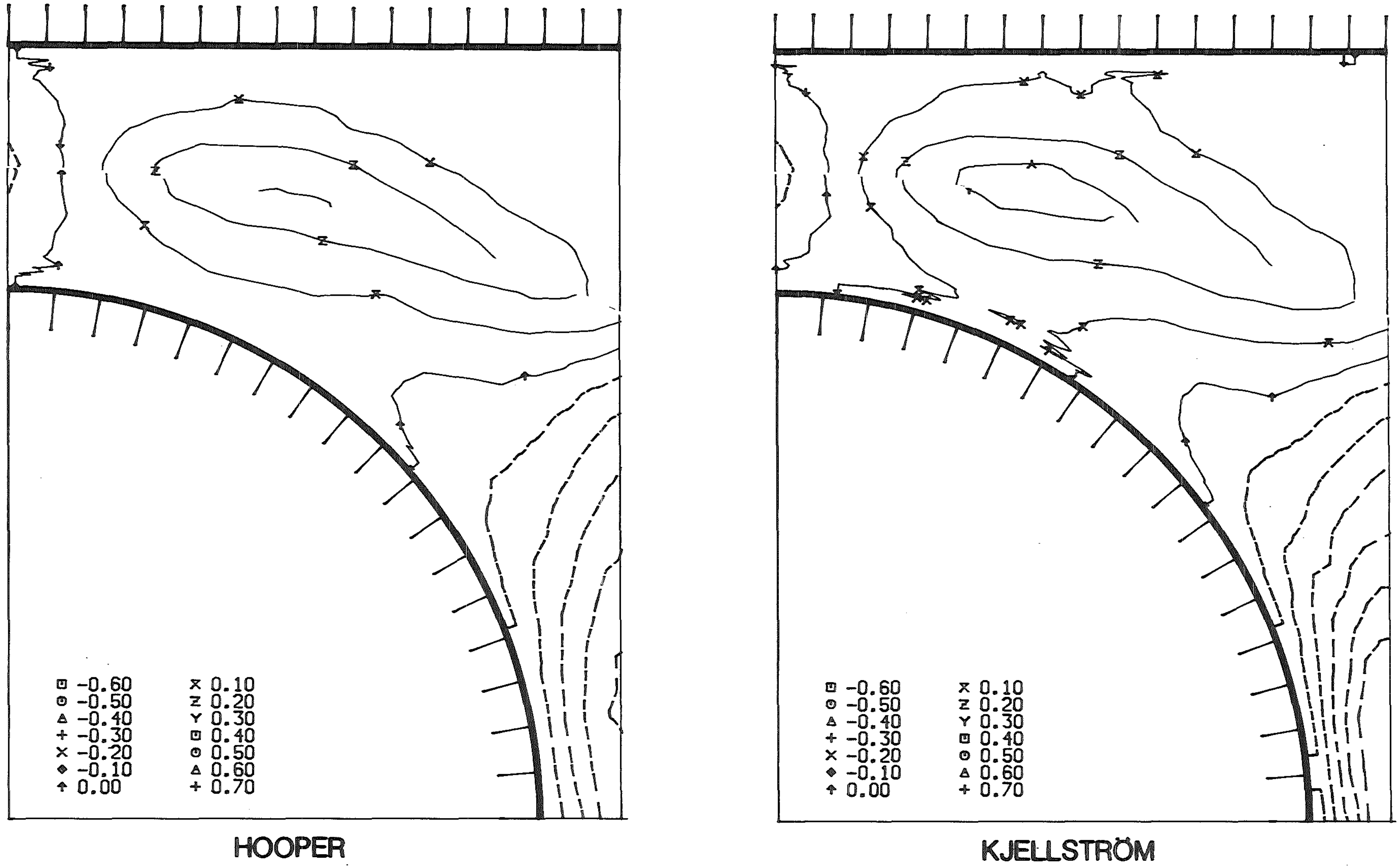
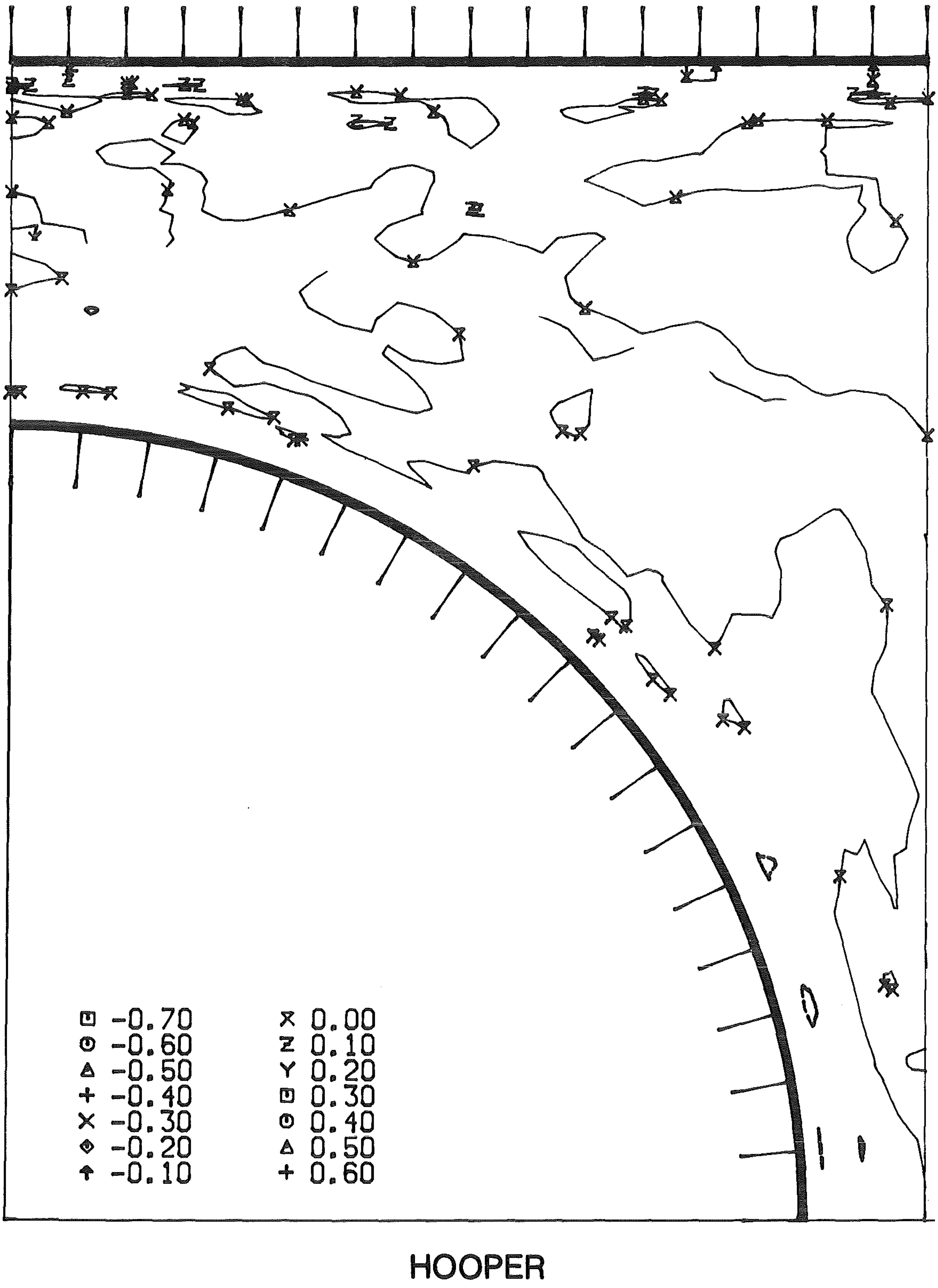


Fig. 28 Correlation coefficient R_{uw}.



KfK

Fig. 29 Correlation coefficient R_{vw}.

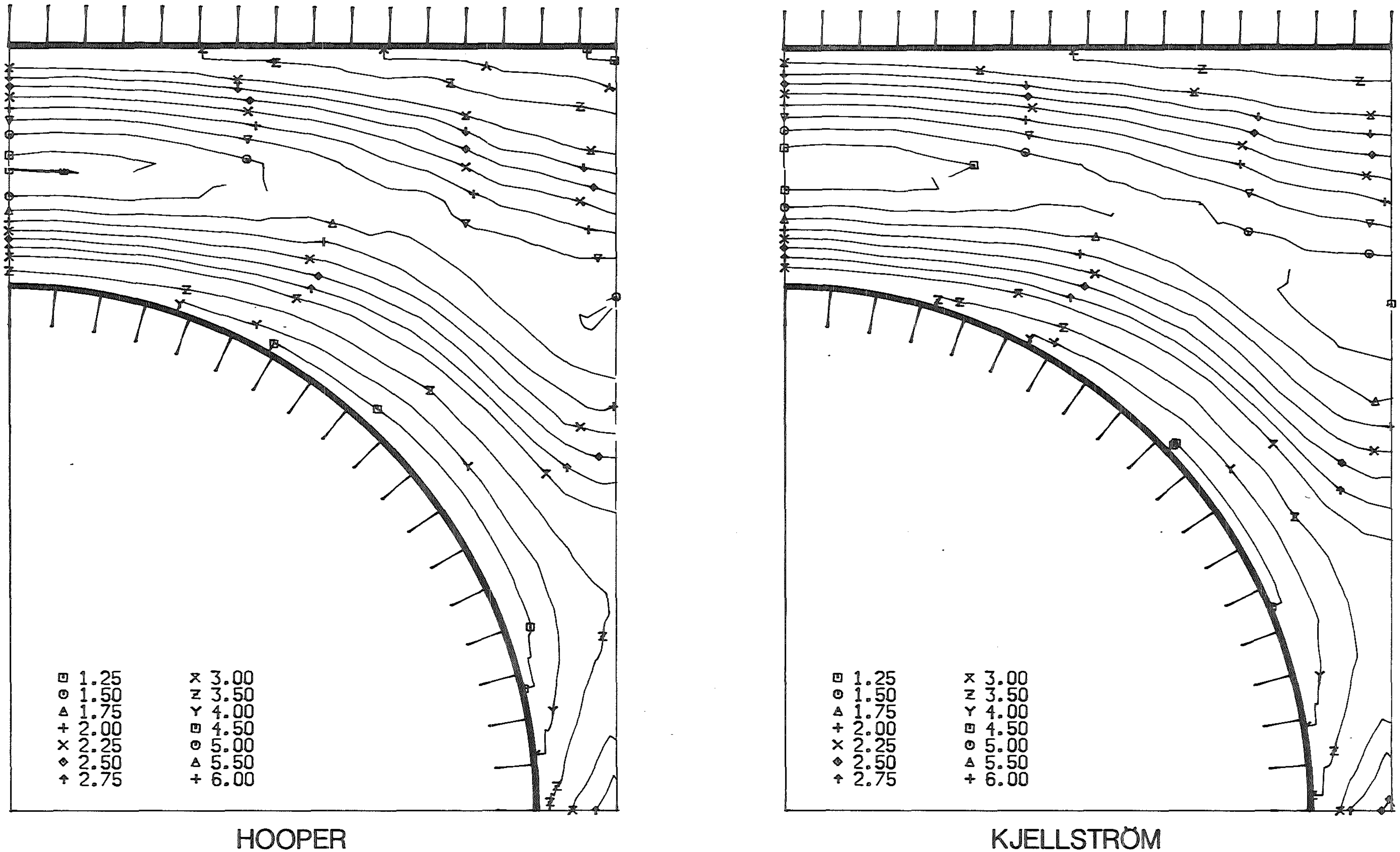


Fig. 30 Relative kinetic energy of turbulence.

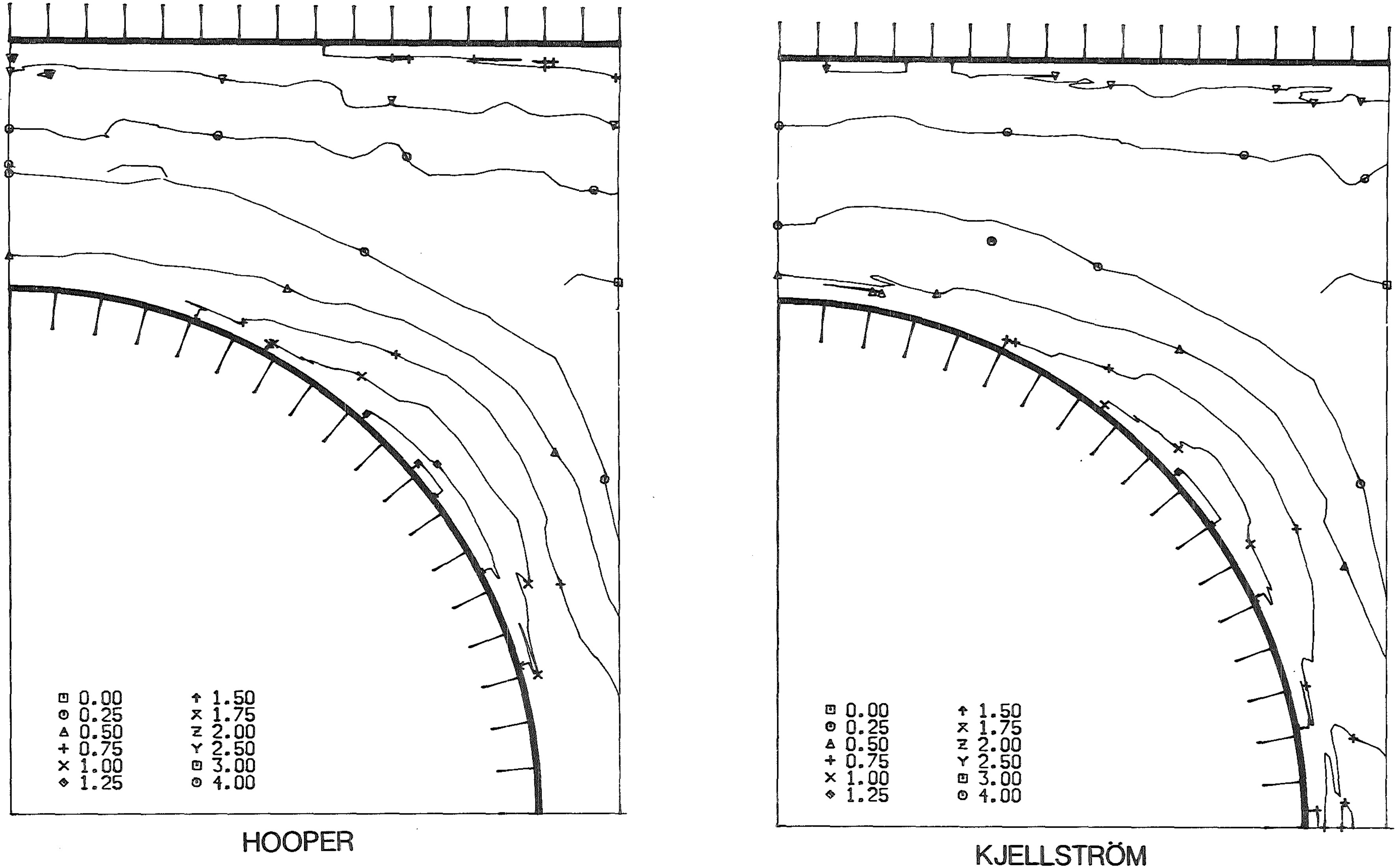


Fig. 31 $\overline{w'^2} - \overline{v'^2}$

Tables: 1 to 6

NREI: 20

DAT JA: 20.04 1983

POS	FESTPIT	DPPREST	BAR	TEMP
-5.00	4.26007	1.15259	998.54785	27.30403
0.0	4.24949	1.15250	998.65771	27.29953
5.00	4.25576	1.17762	998.69971	27.30008
10.00	4.26206	1.20853	998.66382	27.34572
15.00	4.25744	1.27117	998.62402	27.33971
20.00	4.24496	1.33044	998.66455	27.34413
25.00	4.24775	1.39878	998.59570	27.35489
30.00	4.26877	1.44397	998.54517	27.36966
35.00	4.24827	1.48566	998.52979	27.39847
40.00	4.24839	1.51246	998.58276	27.44365
45.00	4.25917	1.49495	998.50317	27.48198
50.00	4.24237	1.44691	998.49487	27.46590
55.00	4.23922	1.36452	998.46826	27.55075
60.00	4.24827	1.28656	998.45825	27.60091
65.00	4.25052	1.17806	998.44751	27.68845
70.00	4.24624	1.11701	998.50781	27.70436
75.00	4.24758	1.05572	998.41479	27.75070
80.00	4.26052	1.03345	998.45752	27.80815
85.00	4.25312	0.99512	998.38281	27.87321
90.00	4.25146	1.01206	998.40625	27.85356

Tab.1 Preston probe data.

```
   NREI
  Y(I)(I=1,MNPNKT)
 DAT   JA
      POS      NPKT                                                    *
      FESTPIT    TEMP          DPPREST   BAR          * NPKT  * NREI
*************************************************************************
   20
  1.50 1.70 2.00 2.50 3.00 4.00 5.00 7.5010.0012.5015.0020.0025.0030.00
 35.0040.0045.0050.0055.0060.00 0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
 21.08 1983
      -5.00    10
      4.43511    30.42583      2.33521  1003.36816
      4.50327    31.95950      2.43563  1003.30298
      4.51777    32.21724      2.56979  1003.31226
      4.51451    32.39828      2.76229  1003.27271
      4.53283    32.59943      2.90911  1003.21460
      4.54114    32.69333      3.15665  1003.18604
      4.53255    32.79893      3.34052  1003.14307
      4.51619    32.88731      3.50281  1003.10181
      4.52324    32.93466      3.29065  1003.07544
      4.54125    32.95401      2.69538  1003.04346
       0.0      9
      4.54234    33.03377      2.38336  1003.03516
      4.53605    33.06123      2.45179  1003.02100
      4.53102    33.08539      2.57845  1002.97534
      4.52188    33.10118      2.73631  1002.92139
      4.51453    33.13475      2.87509  1002.88745
      4.50931    33.15320      3.11544  1002.90918
      4.51926    33.15320      3.29568  1002.88599
      4.53566    33.16721      3.42431  1002.82397
      4.51400    33.19792      3.12891  1002.83569
      .
      .
      .
      90.00     8
      4.46306    31.88342      1.76438  1004.21289
      4.46497    31.86862      1.84107  1004.20728
      4.45648    31.86113      1.95914  1004.20532
      4.48414    31.86916      2.12709  1004.17456
      4.45929    31.85091      2.27319  1004.15112
      4.48026    31.85068      2.50511  1004.15747
      4.47090    31.84009      2.69658  1004.19458
      4.46650    31.83841      2.85286  1004.21729
```

Tab.2 Pitot probe data.

```
   20
 1.50 1.70 2.00 2.50 3.00 4.00 5.00 7.5010.0012.5015.0020.0025.0030.00
35.0040.0045.0050.0055.0060.00
 5 883
   2.950   2.950
     -5.00   10
          4.260          1005.233            26.250    23   22
 0.709167E-01 0.700104E-01 0.480498E+01 0.480593E+01 0.502029E-02 0.497036E-02
          4.297          1005.232            26.661    22   21
 0.697790E-01 0.686349E-01 0.481501E+01 0.481612E+01 0.483694E-02 0.478093E-02
          4.290          1005.271            26.799    22   20
 0.680475E-01 0.667115E-01 0.482971E+01 0.483070E+01 0.457533E-02 0.450839E-02
          4.287          1005.320            26.849    20   19
 0.648252E-01 0.642953E-01 0.485170E+01 0.485279E+01 0.421423E-02 0.420578E-02
          4.283          1005.370            26.950    19   19
 0.625646E-01 0.617649E-01 0.486763E+01 0.486860E+01 0.389996E-02 0.388147E-02
          4.288          1005.352            27.048    17   17
 0.573466E-01 0.566123E-01 0.489323E+01 0.489403E+01 0.327600E-02 0.326192E-02
          4.293          1005.388            27.098    15   17
 0.536378E-01 0.526237E-01 0.491072E+01 0.491168E+01 0.285290E-02 0.283370E-02
          4.326          1005.352            27.151    13   14
 0.486458E-01 0.478606E-01 0.492665E+01 0.492764E+01 0.234786E-02 0.233492E-02
          4.298          1005.357            27.234    15   15
 0.556039E-01 0.546967E-01 0.489819E+01 0.489920E+01 0.306544E-02 0.304333E-02
          4.296          1005.364            27.235    19   19
 0.678703E-01 0.669981E-01 0.482268E+01 0.482369E+01 0.459515E-02 0.458187E-02
 5 883
   2.950   2.950
      0.0     9
          4.302          1005.334            27.201    19   19
 0.686103E-01 0.676885E-01 0.479287E+01 0.479382E+01 0.469240E-02 0.467989E-02
          4.317          1005.336            27.247    20   19
 0.671690E-01 0.665283E-01 0.480314E+01 0.480413E+01 0.451374E-02 0.451511E-02
          4.309          1005.352            27.251    19   19
 0.651922E-01 0.643721E-01 0.481965E+01 0.482072E+01 0.424045E-02 0.423528E-02
          4.295          1005.298            27.300    19   20
 0.626871E-01 0.616081E-01 0.484005E+01 0.484103E+01 0.391330E-02 0.390113E-02
          4.293          1005.307            27.369    18   19
 0.598278E-01 0.595047E-01 0.485609E+01 0.485709E+01 0.359731E-02 0.362211E-02
          4.307          1005.338            27.453    17   19
 0.551594E-01 0.547752E-01 0.488139E+01 0.488245E+01 0.305049E-02 0.308162E-02
          4.315          1005.324            27.506    16   16
 0.512297E-01 0.505887E-01 0.489768E+01 0.489887E+01 0.261843E-02 0.262173E-02
          4.304          1005.344            27.551    12   13
 0.475276E-01 0.468107E-01 0.490716E+01 0.490837E+01 0.224423E-02 0.224404E-02
          4.318          1005.341            27.602    16   16
 0.561463E-01 0.554170E-01 0.487171E+01 0.487276E+01 0.315277E-02 0.315362E-02
 5 883
   2.950   2.950
      5.00   10
          4.317          1005.381            27.657    20   20
 0.702122E-01 0.692932E-01 0.478260E+01 0.478387E+01 0.490300E-02 0.489771E-02
.
.
.
.
```

Tab.3 Perpendicular wire data.

```
   20
1.5  1.7  2.   2.5  3.   4.   5.   7.5  10.  12.5 15.  20.  25.  30.
35.  40.  45.  50.  55.  60.
 7 983
   2.949    2.949
     -5.00    10
          4.345         1006.049         27.649   31   32
 0.888896E-01 0.967888E-01 0.458482E+01 0.458711E+01 0.861958E-02 0.948639E-02
          4.307         1006.040         27.740   31   31
 0.896140E-01 0.900106E-01 0.457409E+01 0.457675E+01 0.809922E-02 0.824275E-02
          4.342         1005.969         27.783   29   29
 0.827222E-01 0.830361E-01 0.456925E+01 0.457139E+01 0.690190E-02 0.700975E-02
          4.318         1005.962         27.807   24   23
 0.724388E-01 0.665486E-01 0.457224E+01 0.457465E+01 0.483347E-02 0.450196E-02
          4.341         1005.942         27.849   22   21
 0.668775E-01 0.617590E-01 0.458264E+01 0.458522E+01 0.414871E-02 0.387741E-02
          4.352         1005.902         27.854   22   22
 0.763101E-01 0.765014E-01 0.458528E+01 0.458759E+01 0.586737E-02 0.594085E-02
          4.313         1005.921         27.886   27   28
 0.860898E-01 0.938811E-01 0.458597E+01 0.458834E+01 0.809509E-02 0.892074E-02
          4.330         1005.885         27.896   27   29
 0.829533E-01 0.985057E-01 0.459344E+01 0.459573E+01 0.819803E-02 0.982270E-02
          4.330         1005.860         27.933   28   29
 0.843322E-01 0.921133E-01 0.458558E+01 0.458795E+01 0.780452E-02 0.862613E-02
          4.312         1005.853         27.943   28   28
 0.813020E-01 0.816154E-01 0.458042E+01 0.458270E+01 0.665589E-02 0.676737E-02
          4.323         1005.881         27.965   23   23
 0.682855E-01 0.684677E-01 0.458340E+01 0.458607E+01 0.467950E-02 0.474935E-02
          4.307         1005.863         27.960   20   20
 0.628985E-01 0.631049E-01 0.459126E+01 0.459355E+01 0.397827E-02 0.403578E-02
          4.348         1005.810         27.954   21   22
 0.720531E-01 0.785384E-01 0.459710E+01 0.459912E+01 0.567711E-02 0.624572E-02
          4.349         1005.763         27.957   26   25
 0.921230E-01 0.852889E-01 0.459609E+01 0.459824E+01 0.791700E-02 0.741968E-02
          4.356         1005.779         27.970   27   26
 0.919758E-01 0.840141E-01 0.461134E+01 0.461386E+01 0.777405E-02 0.718275E-02
          4.350         1005.743         27.990   27   27
 0.846865E-01 0.849739E-01 0.460080E+01 0.460345E+01 0.722938E-02 0.732340E-02
          4.341         1005.751         27.982   26   27
 0.749080E-01 0.825252E-01 0.459703E+01 0.459923E+01 0.619958E-02 0.689707E-02
          4.328         1005.743         27.993   26   27
 0.625685E-01 0.690178E-01 0.459888E+01 0.460100E+01 0.434135E-02 0.486370E-02
          4.313         1005.675         27.995   21   21
 0.617874E-01 0.620084E-01 0.460753E+01 0.460980E+01 0.383901E-02 0.389863E-02
          4.346         1005.645         27.999   21   21
 0.737438E-01 0.739719E-01 0.461080E+01 0.461338E+01 0.547725E-02 0.555019E-02
          4.346         1005.656         28.000   24   24
 0.869792E-01 0.872077E-01 0.461220E+01 0.461438E+01 0.761869E-02 0.771812E-02
          4.320         1005.618         28.000   25   25
 0.830318E-01 0.832989E-01 0.463035E+01 0.463274E+01 0.696271E-02 0.705584E-02
          4.351         1005.624         27.999   26   25
 0.845665E-01 0.783280E-01 0.462188E+01 0.462416E+01 0.664616E-02 0.622910E-02
 .
 .
 .
 .
```

Tab.4 Slanting wire data.

05.08 1983 07 0			DAT	JA	NPKT	NTYP	
136.800	89.900		ANG1	ANG2			
2.963	2.950		VO1	VO2			
22.100	23.200		TO1	TO2			FUER VO
21.900	23.000		TE1	TE2			BEI EICHUNG
10.000	4.222	4.386	U	E1	E2		* NPKT
15.000	4.466	4.637					
20.000	4.656	4.832					
25.000	4.813	4.991					
30.000	4.947	5.127					
35.000	5.065	5.244					
40.000	5.173	5.350					
25.000	35.000		U1	U2			BEI YAW EICHUNG
15.000	4.588	4.820	BETA	E1	E2		* NPKT+1
10.000	4.670	4.910					
5.000	4.745	4.991					
0.0	4.813	5.065					
-5.000	4.868	5.125					
-10.000	4.917	5.177					
-15.000	4.958	5.222					
-45.000	5.072	5.344					

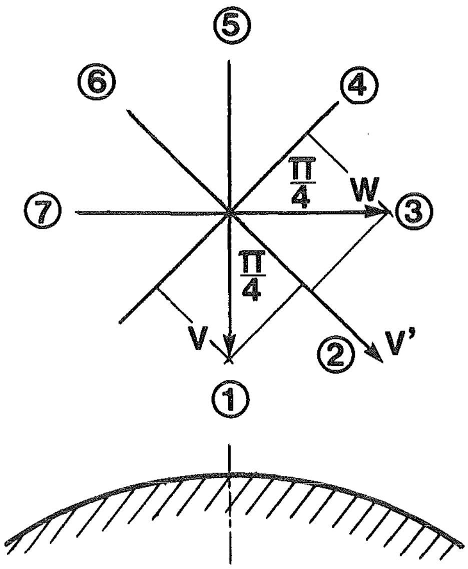
Tab.5 Calibration data.

```
//INR432KR JOB (0432,104,POD7L),ROTH,MSGCLASS=H,
// NOTIFY=INR432
//**MAIN LINES=10
//*MAIN ORG=RM003
//************************************************************************
//**
//**   TSO432.UT.CNTL(RUNKJE)  HOT-WIRE  KJELLSTOEM-METHODE
//**
//************************************************************************
// EXEC F7CLG
//C.SYSPRINT DD DUMMY
//C.SYSIN DD DISP=SHR,DSN=TSO432.PROG.FORT(MAIN)
//L.DD1 DD DISP=SHR,DSN=INR340.GAS
//L.DD2 DD DISP=SHR,DSN=INR432.HW.OBJ
//L.DD3 DD DISP=SHR,DSN=INR432.HW1.OBJ
//L.DD4 DD DISP=SHR,DSN=INR432.HW2.OBJ
//L.DD5 DD DISP=SHR,DSN=INR432.HW3.OBJ
//L.SYSIN DD *
 ENTRY MAIN
 INCLUDE DD1
 INCLUDE DD2
 INCLUDE DD3
 INCLUDE DD4
 INCLUDE DD5
//G.FT07F001 DD DISP=SHR,DSN=INR340.MESSK.DATA(PRERP2)
//G.FT08F001 DD DISP=SHR,DSN=INR340.MESSK.DATA(PRP)
//G.FT09F001 DD DISP=SHR,DSN=INR340.MESSK.DATA(GRP)
//G.FT10F001 DD DISP=SHR,DSN=INR340.MESSK.DATA(SRP)
//G.FT13F001 DD DISP=SHR,DSN=INR340.MESSK.DATA(CALSRP)
//G.FT20F001 DD DUMMY
//G.FT29F001 DD DISP=SHR,DSN=INR432.PLOT.DATA(REFKW)
//G.FT31F001 DD DISP=SHR,DSN=INR432.PLOT.DATA(HLKRW)
//G.FT32F001 DD DISP=SHR,DSN=INR432.PLOT.DATA(PROKRW)
//G.FT33F001 DD DISP=SHR,DSN=TSO432.PLOT.DATA(EPSKRW)
//G.FT34F001 DD DISP=SHR,DSN=INR432.OUT1.DATA(UPLKRW)
//G.FT35F001 DD DISP=SHR,DSN=INR432.OUT2.DATA(TAUKRW)
//** DATEN FUER STEUERUNG DER AUSWERTUNGEN
//** KFALL   LV      NORM      (2I3)
//** AXS     AH      ARW    ZWERT  (4F6.2)
//** IDRUCK  IAUSW  MNPNKT   (3I3)
//*G.SYSIN DD *
  0  4  0
 76.5  83.5  69.5  4.25
  1  3 16
/*
```

Tab.6 Job control language.

Appendix 1: Hooper's method

Hooper in /7/, /13/ recommends following signal analysis:



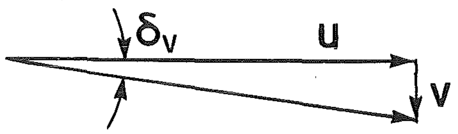
Axial velocity U, u out of the paper

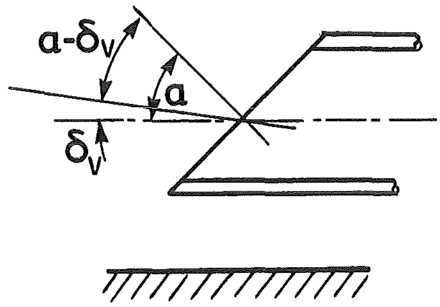
①, ③ Principal axes for V, W, v, w

Sketch of the Probe Positions

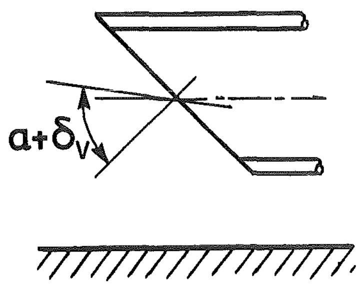
Secondary flow components V and W.

Plane in ①÷⑤ axis and rig axis





Hot-wire in ① position



Hot-wire in ⑤ position

For pos. ①:

$$E_{\alpha 1}^2 - E_o^2 = B\, U^n \cos^m(\alpha - \delta_v)\ ; \qquad (A.1)$$

For pos. ⑤ :

$$E_{\alpha 5}^2 - E_o^2 = B\, U^n \cos^m(\alpha + \delta_v)\ ; \qquad (A.2)$$

Hence

$$\frac{\cos(\alpha-\delta_V)}{\cos(\alpha+\delta_V)} = \left(\frac{E_{\alpha 1}^2 - E_o^2}{E_{\alpha 5}^2 - E_o^2}\right)^{1/m} = CV \quad ; \qquad (A.3)$$

By inserting

$$\cos(\alpha-\delta_V) = \cos\alpha \cdot \cos\delta_V + \sin\alpha \quad \sin\delta_V$$

$$\cos(\alpha+\delta_V) = \cos\alpha \cdot \cos\delta_V - \sin\alpha \quad \sin\delta_V$$

into the equation A.3, we obtain

$$tg\ \delta_V = \frac{V}{U} = \frac{CV\cdot\cos\alpha - \cos\alpha}{CV\cdot\sin\alpha + \sin\alpha} \ ; \qquad (A.4)$$

Note: The angle α is the effective wire angle, calculated from the calibration by the equation 4.15.

Similarly for position ③ ÷ ⑦

$$tg\ \delta_W = \frac{W}{U} = \frac{CW\cdot\cos\alpha - \cos\alpha}{CW\cdot\sin\alpha + \sin\alpha} \ ; \qquad (A.5)$$

where $$CW = \left(\frac{E_{\alpha 3}^2 - E_o^2}{E_{\alpha 7}^2 - E_o^2}\right)^{1/m} \ ; \qquad (A.6)$$

Components of V and W in the ② direction

$$V' = \frac{1}{\sqrt{2}} (V + W) \ ; \qquad (A.7)$$

and $$\delta_2 = \text{arctg}\ \frac{V'}{U} \ ; \qquad (A.8)$$

Reynolds stress calculation

In /7/ the response equations are derived for a perpendicular from which $\overline{u'}$ will be calculated

$$\overline{u'^2} = \frac{4\ E^2 U^2}{n^2 (E^2 - E_o^2)}\ e^2 ; \qquad (A.9)$$

and for a slanting wire

$$\frac{n}{U}\ (u + \frac{m}{n}\ \ tg\ \alpha \cdot v) = \frac{2\ e_\alpha\ E_\alpha}{E_\alpha^2 - E_o^2} ; \qquad (A.10)$$

Writing the equations for the corresponding positions of the slanting wire:

The positions ① and ⑤ gives a solution of $\overline{v'^2}$ and $\overline{u'w'}$

$$(u + \frac{m}{n}\ tg(\alpha - \delta_v) v)^2 = e_{\alpha 1}^2 \cdot \frac{4 \cdot E_{\alpha 1}^2 \cdot U^2}{n^2 (E_{\alpha 1}^2 - E_o^2)^2} ; \qquad (A.11)$$

$$(u - \frac{m}{n}\ tg(\alpha + \delta_v) v)^2 = e_{\alpha 5}^2 \cdot \frac{4 \cdot E_{\alpha 5}^2 \cdot U^2}{n^2 (E_{\alpha 5}^2 - E_o^2)^2} ; \qquad (A.12)$$

Writing:

$$\frac{m}{n}\,tg(\alpha-\delta_v) = A; \quad \frac{4E_{\alpha 1}^2\ U^2}{n^2(E_{\alpha 1}^2 - E_o^2\ )^2} = C \ ; \qquad (A.13;\ A.14)$$

$$\frac{m}{n}\,tg(\alpha+\delta_v) = B; \quad \frac{4E_{\alpha 5}^2\ U^2}{n^2(E_{\alpha 5}^2 - E_c^2\ )^2} = D \ ; \qquad (A.15;\ A.16)$$

the solution of equations A.11 and A.12 is

$$\overline{v'^2} = \frac{1}{A+B}\left(\frac{D\ e_{\alpha 5}^2 - \overline{u'^2}}{B} + \frac{C\ e_{\alpha 1}^2 - \overline{u'^2}}{A}\right); \qquad (A.17)$$

$$\overline{u'v'} = \frac{1}{2A}\ (e_{\alpha 1}^2 \cdot C - A^2\overline{v'^2} - \overline{u'^2}) \ ; \qquad (A.18)$$

Similar, for positions ③ and ⑦

$$\overline{w'^2} = \frac{1}{A+B}\left(\frac{D\ e_{\alpha 7}^2 - \overline{u'^2}}{B} + \frac{C\ e_{\alpha 3}^2 - \overline{u'^2}}{A}\right); \qquad (A.19)$$

$$\overline{u'w'} = \frac{1}{2A}\ (e_{\alpha 3}^2 \cdot C - \overline{A^2 w'^2} - \overline{u'^2}) \ ; \qquad (A.20)$$

where

$$A = \frac{m}{n}\,tg(\alpha-\delta_W); \quad C = \frac{4\ E_{\alpha 3}^2\ U^2}{n^2(E_{\alpha 3}^2\ -\ E^2{}_o)^2} \ ; \qquad (A.21;\ A.22)$$

$$B = \frac{m}{n}\,tg(\alpha+\delta_W); \quad D = \frac{4E_{\alpha 7}^2\ U^2}{n^2(E_{\alpha 7}^2\ -\ E^2{}_o)^2} \ ; \qquad (A.23;\ A.24)$$

The Reynolds stress $\overline{v'w'}$ can be computed from the measurement in position ② :

$$(u + \frac{m}{n}\,tg(\alpha-\delta_2)\ \frac{1}{\sqrt{2}}(v + w\ ))^2 = e_{\alpha 2}^2\ \frac{4\ E_{\alpha 2}^2 \cdot U^2}{n^2(E_{\alpha 2}^2\ -\ E_o^2\ )^2} \ ; \qquad (A.25)$$

writing

$$E = \frac{m}{n\sqrt{2}} \; tg(\alpha-\delta_2) \quad \text{and} \quad F = \frac{4\, E_{\alpha 2}^2 \cdot U^2}{n^2 (E_{\alpha 2}^2 - E_o^2)^2}; \qquad (A.26;\ A.27)$$

$$\overline{v'w'} = \frac{1}{2E^2} \left(F\, e_{\alpha 2}^2 - \overline{u'^2} - E^2\overline{v'^2} - E^2\overline{w'^2} - 2E\overline{u'v'} - 2E\overline{u'w'}\right); \quad (A.28)$$

Appendix 2: Listing of the programs

1 MAIN
2 ACRIV7
3 ALTME7
- FHIT
- CKØEFF
- VKØMP
- DRUCK

4 EFVINK
5 EFVIN1
6 HOOPER
7 HOPER7
8 KALGLR
9 KALHOP
10 KALKJE
11 KØRAC7
12 KØRHOP
13 KØRKJE
14 PLØT
15 RIDHOP
16 RIDHW7
17 SQRFIT
18 SYMAX
19 TAUWND
20 UPITOT
21 YAWFAC
22 YAWFKJ

```
C ****************************************************************************
C ****************************************************************************
C
C  MAIN PROGRAM FUER TURBULENZ AUSWERTUNG
C
C     STAND : 24.01.1984
C
C     AUTOR : L. VOSAHLO
C .
C ****************************************************************************
C ****************************************************************************
C
C  COMMON BLOCS FUER INPUT - OUTPUT
C
      COMMON/HAND/REI(20),NPNKT(25),Y(25),YMAX(20),ZET(7),VOLZ(7),YAXS
      COMMON/TAU/TAU(20),UST(20),POSP(20),NREI,POSB(21),ALFAMR
      COMMON/PITOUT/UPIT(20,25),CORU(20,25)
      COMMON/REF/ROREF,ETREF,XNUERF,TAUREF,USTREF,UFESTR
      COMMON/GERADE/POSG(20),NPKTG(20),DPFG(20,25),BARG(20,25),TEMPG(20,
     125),M1G(20,25),M2G(20,25),RMSG(20,25),EG(20,25),EG11(20,25),
     2EG22(20,25),NREIG
      COMMON/SCHVHX/POSS(20),NPKTS(20),DPFS(20,25,7),BARS(20,25,7),TEMPS
     1(20,25,7),M1S(20,25,7),M2S(20,25,7),RMSS(20,25,7),ES(20,25,7),
     2ES11(20,25,7),ES22(20,25,7),NREIS
      COMMON/TURBUL/US(20,25),VS(20,25),WS(20,25),UVS(20,25),UWS(21,25),
     1VWS(20,25),UVK(20,25),UWK(20,25),VWK(20,25),EKIN(20,25),VKO(20,25)
     2,WKO(20,25)
      COMMON/TURREL/USREL(20,25),VSREL(20,25),WSREL(20,25),UVSREL(20,25)
     1,UWSREL(20,25),VWSREL(20,25),EKIREL(20,25),YREL(20,25)
      COMMON/GAS/IGAS
      COMMON/MAINV/AH,ARW,AXS,IDRUCK,PI,LV,MNPNKT,NORM,IAUSW
      COMMON/EICH/ANG1,ANG2,VO1,VO2,TO1,TO2,GN,GB,SN,SM25,SM35,SB25,SB35
     1,SB,WK25,WK35
      COMMON/TAUZ/ZWERT
C
C
      IGAS=4
      PI=3.141592654
C     IN JCL KARTEN
C   7  INPUT UNIT FUER PRESTON
C   8      - " -   FUER PITOT
C   9      - " -   FUER GERADEN HITZ-DRAHT
C   10     - " -   FUER SCHRAEGEN HITZ DRAHT
C   11     - " -   FUER HOOPER ODER X-DRAHT
C   13     - " -   FUER EICH-DATEN
C
C   KO  OUTPUT UNIT
C
C EINGABE DATEN ZUR STEUERUNG DER AUSWERTUNGEN
C
      READ(5,100) KFALL,LV,NORM
      WRITE(6,200)KFALL,LV,NORM
C
C   KFALL=1  SCHREIBT PLOT DATEN
C   KFALL=0  SPRINGT UEBER SUBROUTINE PLOT
C   NORM.GT.0 - PLOTS AUF LOKAL U* BEZOGEN
C
```

```
      READ(5,101) AXS,AH,ARW,ZWERT
      WRITE(6,201) AXS,AH,ARW,ZWERT
C
C    AXS  0.5*ROHRMITTELPUNKTSABSTAND
C    AH   ABSTAND ROHRMITTELPUNKT-WAND
C    ARW  ROHRRADIUS
C
      READ(5,102)  IDRUCK,IAUSW,MNPNKT
      WRITE(6,202) IDRUCK,IAUSW,MNPNKT
C
C    MAXIMALE ZAHL DER REIHEN  = 20
C    IDRUCK=-1    FUER X/Y
C    IDRUCK=1     FUER R/PHI
C    IDRUCK.LE.0  X/Y
C    IDRUCK.GT.0  R/PHI
C    IAUSW   -  SWITCH FUER MESSUNGS- UND AUSWERTE METHODEN
C    IAUSW = 1  LINEARISIERTER EINZELDRAHT -  ACRIVLELLIS METHODE
C            2  WIE  1   +   YAW FACTOR AUS EICHUNG
C            3  NICHTLINEARIS. EINZELDRAHT -  KJELLSTROEM METHODE
C            4  WIE  3   +   YAW FACTOR AUS EICHUNG
C            5  NICHTLIN. EINZELDRAHT -  HOPER7 SUBROUTINE
C            6  HOOPER SONDE          -  HOPER6 SUBROUTINE
C            7  NICHTLIN. EINZELDTAHT -  HOOPER ORIG. METHODE
C            8  HOOPER SONDE          -  HOOPER ORIG. METHODE
C            9  NICHTLIN. EINZELDRAHT -  KJELLSTROEM MODIFIZIERT
C
C    MNPNKT =  ZAHL DER WANDABSTAENDE IN DER LAENGSTE TRAVERSE
C
  100 FORMAT(3I3)
  101 FORMAT(4F6.2)
  102 FORMAT(3I3)
C
  200 FORMAT(' ',T4,'KFALL=',I3,T25,'LV=',I3,T49,'NORM=',I3)
  201 FORMAT(' ',T6,'AXS=',F6.2,T25,'AH=',F6.2,T50,'ARW=',F6.2,T75,
     $'ZWERT = ',F6.2)
  202 FORMAT(' ',T3,'IDRUCK=',I3,T22,'IAUSW=',I3,T46,'MNPNKT=',I3)
  203 FORMAT(/,' ',T4,'ROREF=',F7.4,T22,'ETREF=',F11.8,T45,'XNUERF='
     1,F11.8,T65,'UFESTR=',F9.4,/)
C
      ROREF=RO(1.E5,298.15)
      ETREF=ET(1.E5,298.15)
      XNUERF=ETREF/ROREF
      UFESTR=SQRT(200*ZWERT/ROREF)
      WRITE(6,203)ROREF,ETREF,XNUERF,UFESTR
C
C     IF(IGAS.EQ.4)GOTO 31
      CALL TAUWND
   31 CONTINUE
C     IF(IGAS.EQ.4)GOTO 32
      CALL UPITOT
   32 CONTINUE
      CALL SYMAX
C
C     SWITCH AUSWERTE-METHODEN
      GO TO (1,2,3,4,5,6,7,8,9,10,11),IAUSW
C
```

```
    1 CALL RIDHW7
      CALL KORAC7
      CALL ACRIV7
      GOTO 13
    2 CALL RIDHW7
      CALL YAWFAC
      CALL KORAC7
      CALL ACRIV7
      GOTO 13
    3 CALL RIDHW7
      CALL KALGER
      CALL KALKJE
      CALL KORKJE
      CALL ALTME7
      GOTO 13
    4 CALL RIDHW7
      CALL KALGER
      CALL KALKJE
      CALL YAWFKJ
      CALL KORKJE
      CALL ALTME7
      GOTO 13
    5 CALL RIDHW7
      CALL KALGER
      CALL KALHOP
      CALL EFVIN1
      CALL KORHOP
      CALL HOPER7
      GOTO 13
    6 CALL RIDHOP
      CALL KALGER
      CALL KALHOP
      CALL EFVIN1
      CALL KORHOP
      CALL HOPER6
      GOTO 13
    7 CALL RIDHW7
      CALL EFVINK
      CALL HOOPER
      GOTO 13
    8 CALL RIDHOP
      CALL EFVINK
      CALL HOOPER
      GOTO 13
    9 CALL RIDHW7
      CALL KALGER
      CALL KALKJE
      CALL KORKJE
      CALL ALTMEN
      GOTO 13
   10 CALL XDRAHT
      GOTO 13
   11 CALL LINXDR
C
   13 IF(KFALL.LE.0)GOTO 14
      CALL PLOT
```

```
14 STOP
   END
```

```
      SUBROUTINE ACRIV7
C *****************************************************************************
C *****************************************************************************
C
C  AUSWERTUNG VON TURBULENZ MESSUNGEN NACH DER ACRIVLELLIS METHODE
C  FUER LINEARIZIERTEN EINZEL-DRAHT
C
C *****************************************************************************
C *****************************************************************************
C
C  COMMON BLOCS FUER INPUT - OUTPUT
C
      COMMON/HAND/REI(20),NPNKT(25),Y(25),YMAX(20),ZET(7),VOLZ(7),YAXS
      COMMON/TAU/TAU(20),UST(20),POSP(20),NREI,POSB(21),ALFAMR
      COMMON/PITOUT/UPIT(20,25),CORU(20,25)
      COMMON/REF/ROREF,ETREF,XNUERF,TAUREF,USTREF,UFESTR
      COMMON/GERADE/POSG(20),NPKTG(20),DPFG(20,25),BARG(20,25),TEMPG(20,
     125),M1G(20,25),M2G(20,25),RMSG(20,25),EG(20,25),EG11(20,25),
     2EG22(20,25),NREIG
      COMMON/SCHVHX/POSS(20),NPKTS(20),DPFS(20,25,7),BARS(20,25,7),TEMPS
     1(20,25,7),M1S(20,25,7),M2S(20,25,7),RMSS(20,25,7),ES(20,25,7),
     2ES11(20,25,7),ES22(20,25,7),NREIS
      COMMON/TURBUL/US(20,25),VS(20,25),WS(20,25),UVS(20,25),UWS(21,25),
     1VWS(20,25),UVK(20,25),UWK(20,25),VWK(20,25),EKIN(20,25),VKO(20,25)
     2,WKO(20,25)
      COMMON/TURREL/USREL(20,25),VSREL(20,25),WSREL(20,25),UVSREL(20,25)
     1,UWSREL(20,25),VWSREL(20,25),EKIREL(20,25),YREL(20,25)
      COMMON/GAS/IGAS
      COMMON/MAINV/AH,ARW,AXS,IDRUCK,PI,LV,MNPNKT,NORM,IAUSW
      COMMON/EICH/ANG1,ANG2,VO1,VO2,TO1,TO2,GN,GB,SN,SM25,SM35,SB25,SB35
     1,SB,WK25,WK35
C
      DO 50 I=1,NREIG
      IF(NPKTG(I).NE.NPKTS(I))GOTO 60
      NPKT=NPKTG(I)
      DO 51 J=1,NPKT
      S=0.1
      WK=0.0505-0.000415*ROREF*UPIT(I,J)
      IF(IAUSW.EQ.2.)WK=WK25*WK25
      IF(IAUSW.EQ.2..AND.UPIT(I,J).GT.30.)WK=WK35*WK35
C
      VKO(I,J)=0.
      WKO(I,J)=0.
C
      US(I,J)=RMSG(I,J)**2/S**2
      IF(US(I,J).LE.0)US(I,J)=1.E-10
      US(I,J)=SQRT(US(I,J))
      VS(I,J)=((RMSS(I,J,5)**2+RMSS(I,J,1)**2)/(S**2*(1-3*WK)))-
     1((1+WK)/(1-3*WK)*RMSG(I,J)**2/S**2)
      IF(VS(I,J).LE.0)VS(I,J)=1.E-10
      VS(I,J)=SQRT(VS(I,J))
      WS(I,J)=((RMSS(I,J,3)**2+RMSS(I,J,7)**2)/(S**2*(1-3*WK)))-
     1((1+WK)/(1-3*WK)*RMSG(I,J)**2/S**2)
      IF(WS(I,J).LE.0)WS(I,J)=1.E-10
      WS(I,J)=SQRT(WS(I,J))
      UVS(I,J)=(RMSS(I,J,5)**2-RMSS(I,J,1)**2)/(2*(1-WK)*S**2)
```

```
      UWS(I,J)=(RMSS(I,J,7)**2-RMSS(I,J,3)**2)/(2*(1-WK)*S**2)
      VWS(I,J)=(RMSS(I,J,6)**2-RMSS(I,J,4)**2-(RMSS(I,J,7)**2-RMSS(I,J,3
     1)**2)/1.414)/((1-3*WK)*S**2)
      EKIN(I,J)=(US(I,J)**2+VS(I,J)**2+WS(I,J)**2)/2
      UVK(I,J)=-UVS(I,J)/US(I,J)/VS(I,J)
      UWK(I,J)=-UWS(I,J)/US(I,J)/WS(I,J)
      VWK(I,J)=-VWS(I,J)/VS(I,J)/WS(I,J)
      IF (VS(I,J).LT.1.E-3) UVK(I,J)=1.E-5
      IF (VS(I,J).LT.1.E-3) UWK(I,J)=1.E-5
      IF (WS(I,J).LT.1.E-3) UVK(I,J)=1.E-5
      IF (WS(I,J).LT.1.E-3) UWK(I,J)=1.E-5
      USREL(I,J)=US(I,J)/USTREF
      VSREL(I,J)=VS(I,J)/USTREF
      WSREL(I,J)=WS(I,J)/USTREF
      UVSREL(I,J)=UVS(I,J)/USTREF**2
      UWSREL(I,J)=UWS(I,J)/USTREF**2
      VWSREL(I,J)=VWS(I,J)/USTREF**2
      EKIREL(I,J)=EKIN(I,J)/USTREF
      YREL(I,J)=Y(J)/YMAX(I)
   51 CONTINUE
      WRITE(6,201) POSS(I)
  201 FORMAT(' ',/,T5,'POS= ',F8.2,'  GRD ODER MM')
      WRITE(6,202)
  202 FORMAT(' ',/,'  J  US            VS            WS            UVS
     1    UWS           VWS           EKIN          UVK           UWK
     2    VWK')
      DO 52 J=1,NPKT
      WRITE(6,203)J,US(I,J),VS(I,J),WS(I,J),UVS(I,J),UWS(I,J),VWS(I,J),
     1EKIN(I,J),UVK(I,J),UWK(I,J),VWK(I,J)
   52 CONTINUE
  203 FORMAT(' ',I2,10E13.6)
      WRITE(6,204)
  204 FORMAT(' ',/,'  J   Y   USREL         VSREL         WSREL         UVS
     1REL          UWSREL        VWSREL        EKINREL       YREL')
      DO 53 J=1,NPKT
      WRITE(6,205)J,Y(J),USREL(I,J),VSREL(I,J),WSREL(I,J),UVSREL(I,J),
     1UWSREL(I,J),VWSREL(I,J),EKIREL(I,J),YREL(I,J)
   53 CONTINUE
  205 FORMAT(' ',I2,F6.2,8E13.6)
   50 CONTINUE
      GOTO 54
   60 WRITE(6,206)
  206 FORMAT(' ',/,T5,'FEHLER IN DATEN')
C
   54 RETURN
      END
```

```
      SUBROUTINE ALTME7
C ******************************************************************************
C ******************************************************************************
C
C        AUSWERTUNG VON TURBULENZMESSUNGEN
C        NACH ALTER METHODE (KJELLSTROEM)
C
C ******************************************************************************
C ******************************************************************************
C
C  COMMON BLOCS FUER INPUT - OUTPUT
C
      COMMON/HAND/REI(20),NPNKT(25),Y(25),YMAX(20),ZET(7),VOLZ(7),YAXS
      COMMON/TAU/TAU(20),UST(20),POSP(20),NREI,POSB(21),ALFAMR
      COMMON/PITOUT/UPIT(20,25),CORU(20,25)
      COMMON/REF/ROREF,ETREF,XNUERF,TAUREF,USTREF,UFESTR
      COMMON/GERADE/POSG(20),NPKTG(20),DPFG(20,25),BARG(20,25),TEMPG(20,
     125),M1G(20,25),M2G(20,25),RMSG(20,25),EG(20,25),EG11(20,25),
     2EG22(20,25),NREIG
      COMMON/SCHVHX/POSS(20),NPKTS(20),DPFS(20,25,7),BARS(20,25,7),TEMPS
     1(20,25,7),M1S(20,25,7),M2S(20,25,7),RMSS(20,25,7),ES(20,25,7),
     2ES11(20,25,7),ES22(20,25,7),NREIS
      COMMON/TURBUL/US(20,25),VS(20,25),WS(20,25),UVS(20,25),UWS(21,25),
     1VWS(20,25),UVK(20,25),UWK(20,25),VWK(20,25),EKIN(20,25),VKO(20,25)
     2,WKO(20,25)
      COMMON/TURREL/USREL(20,25),VSREL(20,25),WSREL(20,25),UVSREL(20,25)
     1,UWSREL(20,25),VWSREL(20,25),EKIREL(20,25),YREL(20,25)
      COMMON/GAS/IGAS
      COMMON/MAINV/AH,ARW,AXS,IDRUCK,PI,LV,MNPNKT,NORM,IAUSW
      COMMON/EICH/ANG1,ANG2,VO1,VO2,TO1,TO2,GN,GB,SN,SM25,SM35,SB25,SB35
     1,SB,WK25,WK35
      COMMON/TAUZ/ZWERT
C
C
      COMMON/DRUKK/DAT,JA,ANG(20),NMASS(20),UPAT(20,25)
      COMMON/EVO/ VOL(30,6),EZU(30,6),DPF(30,6),TR(30,6),BARO(30,6),
     *C1(6),NMESS
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
      DIMENSION TVOL(6),VOLO(6),VOLS(30,6),
     *BET(6),CIF(5,5),COF(6,6),X1(5),BI(6),B1(30,6),CC(30,6),
     *U(30),V(30),W(30),UKOM(30),VKOM(30),WKOM(30),F23(30),F56(30),
     *V1(30,6),V11(30),WK(30),UREL(30),VSWS(30)
C    *VSWS(30),EZU1(30,6),EZU2(30,6),EVOL(30,6),AB1(30,6),AB2(30,6),
C    *AB3(30,6),AB4(30,6),EZU3(30,6)
      IGAS=4
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      C1(1)=GN
      C1(2)=SN
      C1(3)=SN
      C1(4)=GN
      C1(5)=SN
      C1(6)=SN
      ZET(1)=ANG2
```

```
      ZET(2)=180-ANG1
      ZET(3)=ANG1
      ZET(4)=ANG2
      ZET(5)=ANG1
      ZET(6)=180-ANG1
      VOLO(1)=VO2
      VOLO(2)=VO1
      VOLO(3)=VO1
      VOLO(4)=VO2
      VOLO(5)=VO1
      VOLO(6)=VO1
      TVOL(1)=TO2
      TVOL(2)=TO1
      TVOL(3)=TO1
      TVOL(4)=TO2
      TVOL(5)=TO1
      TVOL(6)=TO1
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      DO 50 I=1,NREI
      DO 52 J=1,NPKTG(I)
      TR(J,1)=TEMPG(I,J)
      TR(J,2)=TEMPS(I,J,1)
      TR(J,3)=TEMPS(I,J,5)
      TR(J,4)=TEMPG(I,J)
      TR(J,5)=TEMPS(I,J,7)
      TR(J,6)=TEMPS(I,J,3)
C
      VOL(J,1)=EG(I,J)
      VOL(J,2)=ES(I,J,1)
      VOL(J,3)=ES(I,J,5)
      VOL(J,4)=EG(I,J)
      VOL(J,5)=ES(I,J,7)
      VOL(J,6)=ES(I,J,3)
C
      EZU(J,1)=RMSG(I,J)
      EZU(J,2)=RMSS(I,J,1)
      EZU(J,3)=RMSS(I,J,5)
      EZU(J,4)=RMSG(I,J)
      EZU(J,5)=RMSS(I,J,7)
      EZU(J,6)=RMSS(I,J,3)
   52 CONTINUE
      NMESS=NPKTG(I)
      UREF=UFESTR
      ANG(I)=POSG(I)
      NMASS(I)=NPKTG(I)
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      DO 30 L=1,6
      DO30J=1,NMESS
      VOLS(J,L)=VOLO(L)/(1.-.00211*(TVOL(L)-TR(J,L)))
C     VOLS(J,L)=VOLO(L)/(1.-.00211*(TVOL(L)-25.)
   30 V1(J,L)=VOL(J,L)**2-VOLS(J,L)**2
      WRITE(6 ,108)(UPIT(I,J),(V1(J,L),L=1,6),J=1,NMESS)
      WRITE(6 ,117)((VOLS(J,L),L=1,6),J=1,NMESS)
  117 FORMAT(' ','VOLO KORRIGIERT FUER TEMPERATUR'/(' ',6F10.4))
      DO 31 L=1,6
      BET(L)=ZET(L)/180.*3.141593
```

```
      DO32J=1,NMESS
   32 V11(J)=V1(J,L)
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
   31 CONTINUE
      YTAU=YMAX(I)
      DO 33 J=1,NMESS
      WK(J)=.0505-.000415*ROREF*UPIT(I,J)
      IF(IAUSW.EQ.4)WK(J)=WK25*WK25
      IF(IAUSW.EQ.4.AND.UPIT(I,J).GT.30)WK(J)=WK35*WK35
      DO76L=1,6
   76 CC(J,L)=C1(L)
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C FUNKTIONEN F23 UND F56
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
      F2=FHIT(CC(J,2),VOL(J,2),VOLS(J,2),EZU(J,2))
      F3=FHIT(CC(J,3),VOL(J,3),VOLS(J,3),EZU(J,3))
      F23(J)=F2/F3
      F5=FHIT(CC(J,5),VOL(J,5),VOLS(J,5),EZU(J,5))
      F6=FHIT(CC(J,6),VOL(J,6),VOLS(J,6),EZU(J,6))
      F56(J)=F5/F6
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C GESCHWINDIGKEITSKOMPONENTEN
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
      CALL VKOMP(U(J),V(J),W(J),BET(2),BET(3),BET(5),BET(6),WK(J),F23(J)
     1,F56(J))
      UKOM(J)=U(J)*UPIT(I,J)/UREF*100.
      VKOM(J)=V(J)*UPIT(I,J)/UREF*100.
      WKOM(J)=W(J)*UPIT(I,J)/UREF*100.
   33 CONTINUE
      WRITE(6 ,113)(U(J),V(J),W(J),F23(J),F56(J),WK(J),UKOM(J),VKOM(J),
     1WKOM(J),J=1,NMESS)
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C  TAU
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
      WRITE(6 ,402) TAU(I),UST(I)
  402 FORMAT(' ','TAUW = ',F10.6,'    USTM = ',F10.6)
      STROEM=1./UST(I)**2
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C KOEFFIZIENTEN
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
      DO 34 J=1,NMESS
      CALL CKOEFF(U(J),V(J),W(J),BET,WK(J),COF)
      DO 35 L=1,6
      BB=2.*VOL(J,L)*EZU(J,L)*UPIT(I,J)/(V1(J,L)*CC(J,L))
   35 B1(J,L)=BB*BB
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C REYNOLDSSCHE SCHUBSPANNUNGEN
```

```
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
      DO 37 K3=1,5
      IF(K3-4)41,42,42
   41 DO38 K4=1,5
      IF(K4-5)40,39,39
   40 CIF(K3,K4)=COF(K3,K4)
      GOTO 38
   39 CIF(K3,K4)=COF(K3,K4+1)
   38 CONTINUE
      GOTO 37
   42 DO 43 K4=1,5
      IF(K4-5)45,44,44
   45 CIF(K3,K4)=COF(K3+1,K4)
      GOTO 43
   44 CIF(K3,K4)=COF(K3+1,K4+1)
   43 CONTINUE
   37 CONTINUE
      DO 46 L=1,6
      IF(L-4)47,48,48
   47 BI(L)=B1(J,L)
      GO TO 46
   48 BI(L)=B1(J,L+1)
   46 CONTINUE
      CALL LINAL(CIF,5,5,CIF,BI,1,5,X1)
      US(I,J)=X1(1)
      UVS(I,J)=X1(2)
      UWS(I,J)=X1(3)
      VS(I,J)=X1(4)
      WS(I,J)=X1(5)
      VWS(I,J)=0.
      EKIN(I,J)=  (US(I,J)+VS(I,J)+WS(I,J))*.5
      WRITE(6 ,116)J,US(I,J),VS(I,J),WS(I,J),UVS(I,J),UWS(I,J)
  116 FORMAT(' ','ROH J=',I3,'  ',5E13.6)
   34 CONTINUE
      WRITE(6 ,114)(US(I,J),UVS(I,J),UWS(I,J),VS(I,J),
     1VWS(I,J),WS(I,J),EKIN(I,J),J=1,NMESS)
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      DO 36 J=1,NMESS
      UPAT(I,J)=UPIT(I,J)/UREF
      USREL(I,J)=SQRT(US(I,J))/USTREF
      UVSREL(I,J)=UVS(I,J)/USTREF**2
      UWSREL(I,J)=UWS(I,J)/USTREF**2
C ******************************************************
      IF(VS(I,J).LT.0.)WRITE(6 ,110)Y(J)
      IF(VS(I,J).LT.0.)VS(I,J)=-VS(I,J)
      IF(WS(I,J).LT.0.)WRITE(6 ,111)Y(J)
      IF(WS(I,J).LT.0.)WS(I,J)=-WS(I,J)
C ******************************************************
      VSREL(I,J)=SQRT(VS(I,J))/USTREF
      WSREL(I,J)=SQRT(WS(I,J))/USTREF
      VWSREL(I,J)=VWS(I,J)/USTREF**2
      VKO(I,J)=V(J)
      WKO(I,J)=W(J)
      UREL(J)=UPIT(I,J)/UREF
```

```
      YREL(I,J)=Y(J)/YTAU
      UVK(I,J)=UVSREL(I,J)/USREL(I,J)/VSREL(I,J)
      UWK(I,J)=UWSREL(I,J)/USREL(I,J)/VSREL(I,J)
      VSWS(J)=WSREL(I,J)**2-VSREL(I,J)**2
   36 EKIREL(I,J)=EKIN(I,J)/USTREF**2
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      CALL DRUCK(I)
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
   50 CONTINUE
  108 FORMAT(1H ,7E13.6)
  110 FORMAT(' ','VS.LT.0 FUER Y = ',F8.2)
  111 FORMAT(' ','WS.LT.0 FUER Y = ',F8.2)
  113 FORMAT(' ',6E13.6,3F13.4)
  114 FORMAT(' ',7E13.6)
      RETURN
      END
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      FUNCTION FHIT(C,W,WZ,EW)
C **********************************************************************
C **********************************************************************
C
C    BERECHNUNG DER HITZDRAHTFUNKTION
C    C = EICHKURVENEXPONENT
C    W = SPANNUNG
C    WZ= NULLSPANNUNG
C    EW= EFFEKTIVWERT(RMS)
C
C **********************************************************************
C **********************************************************************
      A=2./C
      E=W*W
      F=WZ*WZ
      B=E-F
      G=EW*EW
      FHIT=B**A*(1.+A*G/B*(1.+(A-1.)*2.*E/B))
      RETURN
      END
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      SUBROUTINE CKOEFF(U,V,W,A,WK,C)
C **********************************************************************
C **********************************************************************
C
C    BERECHNUNG DER KOEFFIZIENTEN DES GLEICHUNGSSYSTEMS
C    ZUR BERECHNUNG DER REYNOLDSSCHEN SCHUBSPANNUNGEN
C
C     U,V,W GESCHWINDIGKEITSVEKTOR BEZOGEN AUF DEN GESAMTVEKTOR
C     A= WINKEL ZWISCHEN HITZDRAHT UND STROEMUNG (6 POSITIONEN)
C     WK= RICHTUNGSEMPFINDLICHKEIT DES HITZDRAHTES
C     C= KOEFFIZIENTEN
C
C **********************************************************************
C **********************************************************************
```

```
      DIMENSION A(6),C(6,6)
      U2=U*U
      V2=V*V
      W2=W*W
      DO1I=1,3
      B1=SIN(A(I))
      B2=B1*B1
      D1=COS(A(I))
      D2=D1*D1
      PS1=ARCOS(U*D1-V*B1)
      P1=COS(PS1)
      P2=P1*P1
      IF(ABS(PS1/1.570796-1.)-1.E-5)6,6,7
    6 F1=0.
      GOTO 8
    7 F1=(1.-WK)/(SIN(PS1)*(TAN(PS1)+WK*COTAN(PS1)))
    8 F2=F1*F1
      C(I,1)=U2+2.*F1*(U2*P1-U*D1)+F2*(D2+U2*P2-2.*U*P1*D1)
      C(I,2)=2.*U*V+2.*F1*(U*B1+2.*U*V*P1-V*D1)+2.*F2*(U*B1*P1-B1*D1-V*D
     11*P1+U*V*P2)
      C(I,3)=2.*U*W+2.*F1*(2.*U*W*P1-W*D1)+2.*F2*(U*W*P2-W*D1*P1)
      C(I,4)=V2+2.*F1*(V*B1+V2*P1)+F2*(B2+V2*P2+2.*V*B1*P1)
      C(I,5)=2.*V*W+2.*F1*(2.*V*W*P1+W*B1)+2.*F2*(W*B1*P1+V*W*P2)
    1 C(I,6)=W2+2.*F1*W2*P1+F2*W2*P2
      DO2I=4,6
      B1=SIN(A(I))
      B2=B1*B1
      D1=COS(A(I))
      D2=D1*D1
      PS1=ARCOS(U*D1-W*B1)
      P1=COS(PS1)
      P2=P1*P1
      IF(ABS(PS1/1.570796-1.)-1.E-5)3,3,4
    3 F1=0.
      GOTO 5
    4 F1=(1.-WK)/(SIN(PS1)*(TAN(PS1)+WK*COTAN(PS1)))
    5 F2=F1*F1
      C(I,1)=U2+2.*F1*(U2*P1-U*D1)+F2*(D2+U2*P2-2.*U*P1*D1)
      C(I,3)=2.*U*W+2.*F1*(U*B1+2.*U*W*P1-W*D1)+2.*F2*(U*B1*P1-B1*D1-W*D
     11*P1+U*W*P2)
      C(I,2)=2.*U*V+2.*F1*(2.*U*V*P1-V*D1)+2.*F2*(U*V*P2-V*D1*P1)
      C(I,6)=W2+2.*F1*(W*B1+W2*P1)+F2*(B2+W2*P2+2.*W*B1*P1)
      C(I,5)=2.*W*V+2.*F1*(2.*W*V*P1+V*B1)+2.*F2*(V*B1*P1+W*V*P2)
    2 C(I,4)=V2+2.*F1*V2*P1+F2*V2*P2
      RETURN
      END
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      SUBROUTINE VKOMP(U,V,W,P2,P3,P5,P6,WK,F23,F56)
C ***********************************************************************
C ***********************************************************************
C
C     BERECHNUNG DER GESCHWINDIGKEITSKOMPONENTEN
C
C     U,V,W=GESCHWINDIGKEITSKOMPONENTEN BEZOGEN AUF DEN GESAMTVEKTOR
C     P2,P3=ANSTELLWINKEL DES HITZDRAHTES UV-EBENE
C     P5,P6=ANSTELLWINKEL DES HITZDRAHTES UW-EBENE
```

```
C    WK=RICHTUNGSEMPFINDLICHKEIT DES HITZDRAHTES
C    F23,F56 HITZDRAHTFAKTOREN IN DEN EBENEN
C
C **************************************************************************
C **************************************************************************
      A1=COS(P2)**2-F23*COS(P3)**2
      A2=SIN(P2)**2-F23*SIN(P3)**2
      A3=-2.*(COS(P2)*SIN(P2)-F23*COS(P3)*SIN(P3))
      A4=(F23-1.)/(1.-WK)
      A5=COS(P5)**2-F56*COS(P6)**2
      A6=SIN(P5)**2-F56*SIN(P6)**2
      A7=-2.*(COS(P5)*SIN(P5)-F56*COS(P6)*SIN(P6))
      A8=(F56-1.)/(1.-WK)
      IT=0
      U1=1.
    4 A9=-.5*A3*U1/A2
      A10=-(A4+A1*U1*U1)/A2
      A13=SQRT(A9*A9+A10)
      IF(A9)5,5,6
    5 V1=A9+A13
      GOTO 7
    6 V1=A9-A13
    7 A11=-A7*U1*.5/A6
      A12=-(A8+A5*U1*U1)/A6
      A14=SQRT(A11*A11+A12)
      IF(A11)8,8,9
    8 W1=A11+A14
      GOTO 10
    9 W1=A11-A14
   10 U2=SQRT(1.-V1*V1-W1*W1)
      IF(ABS(1.-U1/U2)-1.E-06)1,1,2
    2 IF(IT-20)3,3,1
    3 U1=U2
      IT=IT+1
      GOTO4
    1 U=U1
      V=V1
      W=W1
      RETURN
      END
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      SUBROUTINE DRUCK(I)
C **************************************************************************
C **************************************************************************
C
C     AUSDRUCK FUER REPRO
C
C **************************************************************************
C **************************************************************************
C
C   COMMON BLOCS FUER INPUT - OUTPUT
C
      COMMON/HAND/REI(20),NPNKT(25),Y(25),YMAX(20),ZET(7),VOLZ(7),YAXS
      COMMON/TAU/TAU(20),UST(20),POSP(20),NREI,POSB(21),ALFAMR
      COMMON/PITOUT/UPIT(20,25),CORU(20,25)
```

```
      COMMON/REF/ROREF,ETREF,XNUERF,TAUREF,USTREF,UFESTR
      COMMON/GERADE/POSG(20),NPKTG(20),DPFG(20,25),BARG(20,25),TEMPG(20,
     125),M1G(20,25),M2G(20,25),RMSG(20,25),EG(20,25),EG11(20,25),
     2EG22(20,25),NREIG
      COMMON/SCHVHX/POSS(20),NPKTS(20),DPFS(20,25,7),BARS(20,25,7),TEMPS
     1(20,25,7),M1S(20,25,7),M2S(20,25,7),RMSS(20,25,7),ES(20,25,7),
     2ES11(20,25,7),ES22(20,25,7),NREIS
      COMMON/TURBUL/US(20,25),VS(20,25),WS(20,25),UVS(20,25),UWS(21,25),
     1VWS(20,25),UVK(20,25),UWK(20,25),VWK(20,25),EKIN(20,25),VKO(20,25)
     2,WKO(20,25)
      COMMON/TURREL/USREL(20,25),VSREL(20,25),WSREL(20,25),UVSREL(20,25)
     1,UWSREL(20,25),VWSREL(20,25),EKIREL(20,25),YREL(20,25)
      COMMON/GAS/IGAS
      COMMON/MAINV/AH,ARW,AXS,IDRUCK,PI,LV,MNPNKT,NORM,IAUSW
      COMMON/EICH/ANG1,ANG2,VO1,VO2,TO1,TO2,GN,GB,SN,SM25,SM35,SB25,SB35
     1,SB,WK25,WK35
      COMMON/TAUZ/ZWERT
C
C
      COMMON/DRUKK/DAT,JA,ANG(20),NMASS(20),UPAT(20,30)
C
      NR=83
      IF(IDRUCK.LT.0)NR=84
      WRITE(6,100)NR
      N=NMASS(I)
  100 FORMAT(1H1,//////,T20,'VERSUCH NR.',I3,T37,'(WANDKANAL)',//)
    2 DO10L=1,100
      II=2*L
      IF(NR.EQ.II)GOTO3
   10 CONTINUE
      WRITE(6,102) DAT,JA,ANG(I),TAU(I)
  102 FORMAT(1H ,T20,'DATUM',6X,F5.2,'.',
     1                               I4//1H ,T20,'POSITION',5X,F4.0,2X,'
     2GRAD',//1H ,T20,'WANDSCHUBSPANNUNG  TAUW =',F7.3,2X,'(N/M**2)',///
     31H ,T20,'BEZUGSWERTE',//)
      GOTO4
    3 WRITE(6,103) DAT,JA,ANG(I),TAU(I)
  103 FORMAT(1H ,T20,'DATUM',6X,F5.2,'.',
     1                               I4//1H ,T20,'POSITION',5X,F4.0,2X,'
     2(MM)',//1H ,T20,'WANDSCHUBSPANNUNG  TAUW =',F7.3,2X,'(N/M**2)',///
     31H ,T20,'BEZUGSWERTE',//)
    4 WRITE(6,104)UFESTR,UST(I),YMAX(I)
  104 FORMAT(1H ,T20,'REFERENZGESCHWINDIGKEIT',5X,'UREF =',F7.3,2X,'(M/S
     1)',//1H ,T20,'SCHUBSPANNUNGSGESCHWINDIGKEIT U* =',F7.3,2X,'(M/S)',
     2//1H ,T20,'PROFILLAENGE (UMAX)',T48,'YMAX =',F7.3,2X,'(MM)',////1H
     3 ,T5,'Y',T10,'U',T17,'U''',T24,'V''',T31,'W''',T37,'K''',T44,'U''V
     4''',T52,'U''W''',T60,'U''V''',T68,'U''W''',T77,'Y',T84,'Y+',T92,'U
     5+'/T3,'(MM)',T9,'UREF',T17,'U*',T24,'U*',T31,'U*',T35,'(U*)**2 (U*
     6)**2 (U*)**2 U''*V''   U''*W''    YMAX',//)
      WRITE(6,105)(Y(J),UPAT(I,J),USREL(I,J),VSREL(I,J),WSREL(I,J),EKIRE
     1L(I,J),UVSREL(I,J),UWSREL(I,J),UVK(I,J),UWK(I,J),J=1,N)
  105 FORMAT(1H ,F5.1,5F7.4,4F8.4)
C     WRITE(6,106)
C 106 FORMAT(1H1)
      RETURN
      END
```

```
      SUBROUTINE EFVINK
C ***************************************************************************
C ***************************************************************************
C
C   BERECHNET EFFEKTIVEN WINKEL
C   EXPONENTEN 'M' AUS ISVR TABELLE
C
C ***************************************************************************
C ***************************************************************************
C
C  COMMON BLOCS FUER INPUT - OUTPUT
C
      COMMON/HAND/REI(20),NPNKT(25),Y(25),YMAX(20),ZET(7),VOLZ(7),YAXS
      COMMON/TAU/TAU(20),UST(20),POSP(20),NREI,POSB(21),ALFAMR
      COMMON/PITOUT/UPIT(20,25),CORU(20,25)
      COMMON/REF/ROREF,ETREF,XNUERF,TAUREF,USTREF,UFESTR
      COMMON/GERADE/POSG(20),NPKTG(20),DPFG(20,25),BARG(20,25),TEMPG(20,
     125),M1G(20,25),M2G(20,25),RMSG(20,25),EG(20,25),EG11(20,25),
     2EG22(20,25),NREIG
      COMMON/SCHVHX/POSS(20),NPKTS(20),DPFS(20,25,7),BARS(20,25,7),TEMPS
     1(20,25,7),M1S(20,25,7),M2S(20,25,7),RMSS(20,25,7),ES(20,25,7),
     2ES11(20,25,7),ES22(20,25,7),NREIS
      COMMON/TURBUL/US(20,25),VS(20,25),WS(20,25),UVS(20,25),UWS(21,25),
     1VWS(20,25),UVK(20,25),UWK(20,25),VWK(20,25),EKIN(20,25),VKO(20,25)
     2,WKO(20,25)
      COMMON/TURREL/USREL(20,25),VSREL(20,25),WSREL(20,25),UVSREL(20,25)
     1,UWSREL(20,25),VWSREL(20,25),EKIREL(20,25),YREL(20,25)
      COMMON/GAS/IGAS
      COMMON/MAINV/AH,ARW,AXS,IDRUCK,PI,LV,MNPNKT,NORM,IAUSW
      COMMON/EICH/ANG1,ANG2,VO1,VO2,TO1,TO2,GN,GB,SN,SM25,SM35,SB25,SB35
     1,SB,WK25,WK35
C
      DIMENSION A1(25),B1(25),E1(25),E2(25),ES1(25),ES2(25),FI(25),U(25)
      DIMENSION D1(14),D2(14),CK1(14),CK2(14)
C
      READ(13,140) DAT,JA,NPKT,NTYP
      READ(13,141) ANG1,ANG2
      READ(13,141) VO1,VO2
      READ(13,141) TO1,TO2
      READ(13,141) TE1,TE2
      DO 11 I=1,NPKT
      READ(13,142) U(I),E1(I),E2(I)
   11 CONTINUE
      READ(13,141) U1,U2
      DO 12 I=1,NPKT
      READ(13,142) FI(I),ES1(I),ES2(I)
   12 CONTINUE
      VO1K=VO1/(1-.00211*(TO1-TE1))
      DO 13 I=1,NPKT
      IF (FI(I).GT.0) GOTO 13
      IF (FI(I).EQ.0) GOTO 14
      ES1(I-1)=ES1(I)
      ES2(I-1)=ES2(I)
      FI(I-1)=FI(I)
      GOTO 13
   14 ES10=ES1(I)
```

```
      ES20=ES2(I)
      FI0=FI(I)
   13 CONTINUE
      DO 15 I=1,NPKT-1
      D1(I)=FI(I)*PI/180
      CK1(I)=(ES1(I)*ES1(I)-VO1K*VO1K)/(ES10*ES10-VO1K*VO1K)
      CK=CK1(I)**(1/.395)
      A1(I)=ATAN((1/SIN(D1(I)))*(COS(D1(I))-CK))
      A1(I)=A1(I)*180/PI
   15 CONTINUE
      DO 16 I=1,NPKT-1
      D2(I)=FI(I)*PI/180
      CK2(I)=(ES2(I)*ES2(I)-VO1K*VO1K)/(ES20*ES20-VO1K*VO1K)
      CK=CK2(I)**(1/.385)
      B1(I)=ATAN((1/SIN(D2(I)))*(COS(D2(I))-CK))
      B1(I)=B1(I)*180/PI
   16 CONTINUE
      WRITE(6,102) VO1,VO1K,ES10,ES20
      DO 18 I=1,NPKT-1
      WRITE(6,101)A1(I),B1(I),D1(I),D2(I),CK1(I),CK2(I),ES1(I),ES2(I)
   18 CONTINUE
      SUMA=0.0
      DO 17 I=1,NPKT-1
      SUMA=SUMA+A1(I)+B1(I)
   17 CONTINUE
      ANG1=SUMA/2/(NPKT-1)
      WRITE(6,100) ANG1
  100 FORMAT(/,' ','EFEKTIVER WINKEL =  ',F8.2)
  101 FORMAT(' ',8F10.4)
  102 FORMAT(/,T13,4F10.3)
  140 FORMAT(F5.2,I5,I3,I2)
  141 FORMAT(2F7.3)
  142 FORMAT(3F7.3)
      RETURN
      END
```

```
      SUBROUTINE EFVIN1
C ********************************************************************************
C ********************************************************************************
C
C  EXPONENTEN 'SM25' UND 'SM35' AUS EICHUNG
C
C ********************************************************************************
C ********************************************************************************
C
C  COMMON BLOCS FUER INPUT - OUTPUT
C
      COMMON/HAND/REI(20),NPNKT(25),Y(25),YMAX(20),ZET(7),VOLZ(7),YAXS
      COMMON/TAU/TAU(20),UST(20),POSP(20),NREI,POSB(21),ALFAMR
      COMMON/PITOUT/UPIT(20,25),CORU(20,25)
      COMMON/REF/ROREF,ETREF,XNUERF,TAUREF,USTREF,UFESTR
      COMMON/GERADE/POSG(20),NPKTG(20),DPFG(20,25),BARG(20,25),TEMPG(20,
     125),M1G(20,25),M2G(20,25),RMSG(20,25),EG(20,25),EG11(20,25),
     2EG22(20,25),NREIG
      COMMON/SCHVHX/POSS(20),NPKTS(20),DPFS(20,25,7),BARS(20,25,7),TEMPS
     1(20,25,7),M1S(20,25,7),M2S(20,25,7),RMSS(20,25,7),ES(20,25,7),
     2ES11(20,25,7),ES22(20,25,7),NREIS
      COMMON/TURBUL/US(20,25),VS(20,25),WS(20,25),UVS(20,25),UWS(21,25),
     1VWS(20,25),UVK(20,25),UWK(20,25),VWK(20,25),EKIN(20,25),VKO(20,25)
     2,WKO(20,25)
      COMMON/TURREL/USREL(20,25),VSREL(20,25),WSREL(20,25),UVSREL(20,25)
     1,UWSREL(20,25),VWSREL(20,25),EKIREL(20,25),YREL(20,25)
      COMMON/GAS/IGAS
      COMMON/MAINV/AH,ARW,AXS,IDRUCK,PI,LV,MNPNKT,NORM,IAUSW
      COMMON/EICH/ANG1,ANG2,VO1,VO2,TO1,TO2,GN,GB,SN,SM25,SM35,SB25,SB35
     1,SB,WK25,WK35
C
      DIMENSION A1(25),B1(25),E1(25),E2(25),ES1(25),ES2(25),FI(25),U(25)
      DIMENSION D1(14),D2(14),CK1(14),CK2(14)
C
      READ(13,140) DAT,JA,NPKT,NTYP
      READ(13,141) ANG1,ANG2
      READ(13,141) VO1,VO2
      READ(13,141) TO1,TO2
      READ(13,141) TE1,TE2
      DO 11 I=1,NPKT
      READ(13,142) U(I),E1(I),E2(I)
   11 CONTINUE
      READ(13,141) U1,U2
      DO 12 I=1,NPKT
      READ(13,142) FI(I),ES1(I),ES2(I)
   12 CONTINUE
      VO1K=VO1/(1-.00211*(TO1-TE1))
      DO 13 I=1,NPKT
      IF (FI(I).GT.0) GOTO 13
      IF (FI(I).EQ.0) GOTO 14
      ES1(I-1)=ES1(I)
      ES2(I-1)=ES2(I)
      FI(I-1)=FI(I)
      GOTO 13
   14 ES10=ES1(I)
      ES20=ES2(I)
```

```
      FI0=FI(I)
   13 CONTINUE
      DO 15 I=1,NPKT-1
      D1(I)=FI(I)*PI/180
      CK1(I)=(ES1(I)*ES1(I)-VO1K*VO1K)/(ES10*ES10-VO1K*VO1K)
      CK=CK1(I)**(1/SM25)
      A1(I)=ATAN((1/SIN(D1(I)))*(COS(D1(I))-CK))
      A1(I)=A1(I)*180/PI
   15 CONTINUE
      DO 16 I=1,NPKT-1
      D2(I)=FI(I)*PI/180
      CK2(I)=(ES2(I)*ES2(I)-VO1K*VO1K)/(ES20*ES20-VO1K*VO1K)
      CK=CK2(I)**(1/SM35)
      B1(I)=ATAN((1/SIN(D2(I)))*(COS(D2(I))-CK))
      B1(I)=B1(I)*180/PI
   16 CONTINUE
      WRITE(6,102) VO1,VO1K,ES10,ES20
      DO 18 I=1,NPKT-1
      WRITE(6,101)A1(I),B1(I),D1(I),D2(I),CK1(I),CK2(I),ES1(I),ES2(I)
   18 CONTINUE
      SUMA=0.0
      DO 17 I=1,NPKT-1
      SUMA=SUMA+A1(I)+B1(I)
   17 CONTINUE
      ANG1=SUMA/2/(NPKT-1)
      WRITE(6,100) ANG1
  100 FORMAT(/,' ','EFFEKTIVER WINKEL =  ',F8.2)
  101 FORMAT(' ',8F10.4)
  102 FORMAT(/,T13,4F10.3)
  140 FORMAT(F5.2,I5,I3,I2)
  141 FORMAT(2F7.3)
  142 FORMAT(3F7.3)
      RETURN
      END
```

```
      SUBROUTINE HOOPER
C ************************************************************************
C ************************************************************************
C
C  AUSWERTUNG VON TURBULENZMESSUNGEN HOOPER-VERGLEICHS METHODE
C
C ************************************************************************
C ************************************************************************
C
C  COMMON BLOCS FUER INPUT - OUTPUT
C
      COMMON/HAND/REI(20),NPNKT(25),Y(25),YMAX(20),ZET(7),VOLZ(7),YAXS
      COMMON/TAU/TAU(20),UST(20),POSP(20),NREI,POSB(21),ALFAMR
      COMMON/PITOUT/UPIT(20,25),CORU(20,25)
      COMMON/REF/ROREF,ETREF,XNUERF,TAUREF,USTREF,UFESTR
      COMMON/GERADE/POSG(20),NPKTG(20),DPFG(20,25),BARG(20,25),TEMPG(20,
     125),M1G(20,25),M2G(20,25),RMSG(20,25),EG(20,25),EG11(20,25),
     2EG22(20,25),NREIG
      COMMON/SCHVHX/POSS(20),NPKTS(20),DPFS(20,25,7),BARS(20,25,7),TEMPS
     1(20,25,7),M1S(20,25,7),M2S(20,25,7),RMSS(20,25,7),ES(20,25,7),
     2ES11(20,25,7),ES22(20,25,7),NREIS
      COMMON/TURBUL/US(20,25),VS(20,25),WS(20,25),UVS(20,25),UWS(21,25),
     1VWS(20,25),UVK(20,25),UWK(20,25),VWK(20,25),EKIN(20,25),VKO(20,25)
     2,WKO(20,25)
      COMMON/TURREL/USREL(20,25),VSREL(20,25),WSREL(20,25),UVSREL(20,25)
     1,UWSREL(20,25),VWSREL(20,25),EKIREL(20,25),YREL(20,25)
      COMMON/GAS/IGAS
      COMMON/MAINV/AH,ARW,AXS,IDRUCK,PI,LV,MNPNKT,NORM,IAUSW
      COMMON/EICH/ANG1,ANG2,VO1,VO2,TO1,TO2,GN,GB,SN,SM25,SM35,SB25,SB35
     1,SB,WK25,WK35
C
      DIMENSION UU(30,12),UUR(30,12),CST(30),CAST(30,7)
      DIMENSION ANG(7),VR(16),CN(16),CM(16),EST(16)
C
C     UU(I,J) REYNOLDS STRESS. I=1 U. I=2 V. I=3 W. I=4 UV. I=5 UW
C     I=6 VW. I=7 V SEC FLOW. I=8 W SEC FLOW. I=9 CORRELATION UV.
C     I=10 CORRELATION UW. I=11 CORRELATION VW. I=12 KINETIC ENERGY.
C
C     UUR(I,J) NORMALISED REYNOLDS STRESS. UPIT(IREI,I) MEAN VEL. (M/S)
C     VOLZ(6) NO FLOW VOLT. EVOL(I,J) SIG VAR. VOL(I,J) MEAN VOLT.
C
      LI=5
      LO=6
C **
      DO 50 IREI=1,NREI
C
      DO 51 KK=1,7
   51 ANG(KK)=ANG1+4.
C
      NMESS=NPKTG(IREI)
C **
      WRITE(LO,135)POSS(IREI)
      WRITE(LO,116)NMESS,UST(IREI)
      WRITE(LO,111)(ANG(J),J=1,7)
C     WRITE(LO,112)
C     WRITE(LO,101)(UPIT(IREI,J),J=1,NMESS)
C     WRITE(LO,113)
```

```
C       WRITE(LO,101)(VOLZ(J),J=1,6)
C       DO 4 J=1,6
C       WRITE(LO,114)J
C       WRITE(LO,101)(VOL(K,J),K=1,NMESS)
C       WRITE(LO,115)
C       WRITE(LO,101)(EVOL(K,J),K=1,NMESS)
C     4 CONTINUE
C       WRITE(LO,120)
C
        DO 5 K=1,7
      5 ANG(K)=ANG(K)*PI/180
C
C       INPUT OF STANDARD I.S.V.R. PROBE CALIBRATION.
C       VELOCITY RANGE 4 TO 40 M/S.
        DATA VR/4.,5.,6.,7.,8.,9.,10.,12.,14.,16.,18.,20.,
       125.,30.,35.,40./
        ESN=1.167
        DATA EST/1.711,1.764,1.810,1.852,1.889,1.923,1.955,2.012
       1,2.062,2.108,2.149,2.187,2.270,2.341,2.405,2.458/
        DATA CN/.5,.5,.495,.49,.49,.485,.485,.48,.48,.475,
       1.47,.465,.46,.45,.445,.44/
        DATA CM/.455,.445,.44,.435,.43,.425,.42,.415,.415,
       1.41,.405,.4,.395,.39,.385,.38/
C
        DO 1 I=1,NMESS
C
C       INTERPOLATION OF ESP,CNN,CMM FROM I.S.V.R. TABLE.
C       EST IS THE STANDARD PROBE VOLTAGE (NORMAL WIRE).
        DO 2 J=1,16
        JN=J-1
        JK=J
        IF(UPIT(IREI,I).LE.VR(J)) GO TO 3
      2 CONTINUE
      3 DUM=(UPIT(IREI,I)-VR(JN))/(VR(JK)-VR(JN))
        CNN=CN(JN)+(CN(JK)-CN(JN))*DUM
        CMM=CM(JN)+(CM(JK)-CM(JN))*DUM
        ESP=EST(JN)+(EST(JK)-EST(JN))*DUM
C
C
        WRITE(LO,121)UPIT(IREI,I),CNN,CMM,ESP
C
C       CALCULATION OF PROBE STEADY STATE RATIOS.
C
        CST(I)=(EG(IREI,I)*EG(IREI,I)-VO2*VO2)
        DUM=(ESP*ESP-ESN*ESN)
        CST(I)=CST(I)/DUM
C
        DO 6 K=1,7
        CAST(I,K)=(ES(IREI,I,K)*ES(IREI,I,K)-VO1*VO1)/DUM
        CAST(I,K)=CAST(I,K)/(COS(ANG(K))**CMM)
      6 CONTINUE
C
C       CALCULATION OF PROBE SENSITIVITY AND SECONDARY FLOW V,W.
C
        CV=(ES(IREI,I,1)*ES(IREI,I,1)-VO1*VO1)/(ES(IREI,I,5)*ES(IREI,I,5)
       1-VO1*VO1)*(CAST(I,5)/CAST(I,1))
```

```
      CV=CV**(1.0/CMM)
      DV=(CV*COS(ANG(5))-COS(ANG(1)))/(CV*SIN(ANG(5))+SIN(ANG(1)))
      UU(I,7)=DV
      DV=ATAN(DV)
C
      CW=(ES(IREI,I,3)*ES(IREI,I,3)-VO1*VO1)/(ES(IREI,I,7)*ES(IREI,I,7)
     1-VO1*VO1)*(CAST(I,7)/CAST(I,3))
      CW=CW**(1.0/CMM)
      DW=(CW*COS(ANG(7))-COS(ANG(3)))/(CW*SIN(ANG(7))+SIN(ANG(3)))
      UU(I,8)=DW
      DW=ATAN(DW)
C
      DVS=0.707107*(UU(I,7)+UU(I,8))
      D2=ATAN(DVS)
C
C
C     REYNOLDS STRESS CALCULATION.
C
      CKU=2.0*EG(IREI,I)*UPIT(IREI,I)/(CNN*(EG(IREI,I)*EG(IREI,I)
     1-VO2*VO2))
      CKU=CKU*CKU
      UU(I,1)=CKU*RMSG(IREI,I)*RMSG(IREI,I)
C
C     V**2, UV.
C
      CKV1=2.0*UPIT(IREI,I)*ES(IREI,I,1)/(CNN*(ES(IREI,I,1)*ES(IREI,I,1)
     1-VO1*VO1))
      CKV1=CKV1*CKV1
      CKV5=2.0*UPIT(IREI,I)*ES(IREI,I,5)/(CNN*(ES(IREI,I,5)*ES(IREI,I,5)
     1-VO1*VO1))
      CKV5=CKV5*CKV5
      C1=(CMM/CNN)*TAN(ANG(1)-DV)
      C5=(CMM/CNN)*TAN(ANG(5)+DV)
      VV=((CKV5*RMSS(IREI,I,5)*RMSS(IREI,I,5)-UU(I,1))/C5
     1+(CKV1*RMSS(IREI,I,1)*RMSS(IREI,I,1)-UU(I,1))/C1)/(C5+C1)
      UU(I,2)=VV
      UV=(CKV1*RMSS(IREI,I,1)*RMSS(IREI,I,1)-UU(I,1)-C1*C1*UU(I,2))/
     1(2.0*C1)
      UU(I,4)=UV
C
C     PATCH FOR NEGATIVE VV.
      IF(UU(I,2).LT.0.0) UU(I,2)=-UU(I,2)
C
C
C     WW**2, UW.
C
      CKV3=2.0*UPIT(IREI,I)*ES(IREI,I,3)/(CNN*(ES(IREI,I,3)*ES(IREI,I,3)
     1-VO1*VO1))
      CKV3=CKV3*CKV3
      CKV7=2.0*UPIT(IREI,I)*ES(IREI,I,7)/(CNN*(ES(IREI,I,7)*ES(IREI,I,7)
     1-VO1*VO1))
      CKV7=CKV7*CKV7
      C3=(CMM/CNN)*TAN(ANG(3)-DW)
      C7=(CMM/CNN)*TAN(ANG(7)+DW)
      WW=((CKV7*RMSS(IREI,I,7)*RMSS(IREI,I,7)-UU(I,1))/C7
     1+(CKV3*RMSS(IREI,I,3)*RMSS(IREI,I,3)-UU(I,1))/C3)/(C7+C3)
```

```
      UU(I,3)=WW
      UW=(CKV3*RMSS(IREI,I,3)*RMSS(IREI,I,3)-UU(I,1)-C3*C3*UU(I,3))/
     1(2.0*C3)
      UU(I,5)=UW
C
      IF(UU(I,3).LT.0.0) UU(I,3)=-UU(I,3)
C
      C2=(CMM/CNN/1.414214)*TAN(ANG(2)-D2)
      CKV2=2.0*UPIT(IREI,I)*ES(IREI,I,2)/(CNN*(ES(IREI,I,2)*ES(IREI,I,2)
     1-VO1*VO1))
      CKV2=CKV2*CKV2
      VW=(CKV2*RMSS(IREI,I,2)*RMSS(IREI,I,2)-UU(I,1)-C2*C2*(UU(I,2)+
     1UU(I,3))-2.0*C2*(UU(I,4)+UU(I,5)))/(2.0*C2*C2)
      UU(I,6)=VW
C
C
C     CALCULATION FINISHED.
C
      UUR(I,1)=SQRT(UU(I,1))/USTREF
      UUR(I,2)=SQRT(UU(I,2))/USTREF
      UUR(I,3)=SQRT(UU(I,3))/USTREF
      UUR(I,4)=UU(I,4)/(USTREF*USTREF)
      UUR(I,5)=UU(I,5)/(USTREF*USTREF)
      UUR(I,6)=UU(I,6)/(USTREF*USTREF)
      UUR(I,7)=UU(I,7)
      UUR(I,8)=UU(I,8)
      UUR(I,9)=UU(I,4)/SQRT(UU(I,1)*UU(I,2))
      UUR(I,10)=UU(I,5)/SQRT(UU(I,1)*UU(I,3))
      UUR(I,11)=UU(I,6)/SQRT(UU(I,2)*UU(I,3))
      UUR(I,12)=(UU(I,1)+UU(I,2)+UU(I,3))/(2.0*USTREF*USTREF)
C *
      USREL(IREI,I)=UUR(I,1)
      VSREL(IREI,I)=UUR(I,2)
      WSREL(IREI,I)=UUR(I,3)
      UVSREL(IREI,I)=UUR(I,4)
      UWSREL(IREI,I)=UUR(I,5)
      VWSREL(IREI,I)=UUR(I,6)
      VKO(IREI,I)=UU(I,7)
      WKO(IREI,I)=UU(I,8)
      UVK(IREI,I)=UUR(I,9)
      UWK(IREI,I)=UUR(I,10)
      VWK(IREI,I)=UUR(I,11)
      EKIREL(IREI,I)=UUR(I,12)
C *
    1 CONTINUE
C
C
C     PRINT OUT CALCULATED VARIABLES
C
C     WRITE(LO,117)
C     WRITE(LO,101)(Y(I),I=1,NMESS)
C     WRITE(LO,100)
C     WRITE(LO,101)(UUR(I,1),I=1,NMESS)
C     WRITE(LO,102)
C     WRITE(LO,101)(UUR(I,2),I=1,NMESS)
C     WRITE(LO,103)
C     WRITE(LO,101)(UUR(I,3),I=1,NMESS)
```

```
C     WRITE(LO,104)
C     WRITE(LO,101)(UUR(I,4),I=1,NMESS)
C     WRITE(LO,105)
C     WRITE(LO,101)(UUR(I,5),I=1,NMESS)
C     WRITE(LO,106)
C     WRITE(LO,101)(UUR(I,6),I=1,NMESS)
      WRITE(LO,107)
      WRITE(LO,101)(UU(I,7),I=1,NMESS)
      WRITE(LO,108)
      WRITE(LO,101)(UU(I,8),I=1,NMESS)
C     WRITE(LO,109)
C     WRITE(LO,101)(UUR(I,9),I=1,NMESS)
C     WRITE(LO,110)
C     WRITE(LO,101)(UUR(I,10),I=1,NMESS)
C     WRITE(LO,131)
C     WRITE(LO,101)(UUR(I,11),I=1,NMESS)
C     WRITE(LO,132)
C     WRITE(LO,101)(UUR(I,12),I=1,NMESS)
C
      WRITE(LO,133)
      DO 52 I=1,NMESS
      WRITE(LO,134)I,Y(I),UPIT(IREI,I),USREL(IREI,I),VSREL(IREI,I),
     1WSREL(IREI,I),UVSREL(IREI,I),UWSREL(IREI,I),VWSREL(IREI,I),
     2UVK(IREI,I),UWK(IREI,I),VWK(IREI,I),EKIREL(IREI,I)
   52 CONTINUE
C
      CSM=0.0
      DO 8 K=1,NMESS
    8 CSM=CSM+CST(K)
      ANM=NMESS
      CSM=CSM/ANM
      DO 9 K=1,NMESS
    9 CST(K)=CST(K)/CSM
      WRITE(LO,122)CSM
      WRITE(LO,101)(CST(I),I=1,NMESS)
      WRITE(LO,123)
      DO 7 K=1,4
      CSM=0.0
      DO 10 L=1,NMESS
   10 CSM=CSM+CAST(L,K)
      CSM=CSM/ANM
      DO 11 L=1,NMESS
   11 CAST(L,K)=CAST(L,K)/CSM
      WRITE(LO,124)K,CSM
      WRITE(LO,101)(CAST(I,K),I=1,NMESS)
    7 CONTINUE
C     WRITE(LO,120)
C
C
  100 FORMAT(///,15X,'UU COMPONENT OF REYNOLDS STRESS',/)
  101 FORMAT(10(1PE11.3,2X))
  102 FORMAT(//,15X,'VV COMPONENT',/)
  103 FORMAT(//,15X,'WW COMPONENT',/)
  104 FORMAT(//,15X,'UV COMPONENT',/)
  105 FORMAT(//,15X,'UW COMPONENT',/)
  106 FORMAT(//,15X,'VW COMPONENT',/)
```

```
107 FORMAT(//,15X,'V CALC. SECONDARY FLOW',/)
108 FORMAT(//,15X,'W SECONDARY FLOW',/)
109 FORMAT(//,15X,'CORRELATION UV',/)
110 FORMAT(//,15X,'CORRELATION UW',/)
131 FORMAT(//,15X,'CORRELATION VW',/)
132 FORMAT(//,15X,'KINETIC ENERGY',/)
111 FORMAT(//,10X,'YAW PROBE ANGLES  1 TO 7     ',7F8.2,//)
112 FORMAT(//,15X,'MEAN VELOCITY DATA',/)
113 FORMAT(//,15X,'PROBE NO. FLOW VOLTS - POSN 1 TO 6',/)
114 FORMAT(///,15X,'PROBE MEAN VOLTS. POSITION NO. ',I3,/)
115 FORMAT(/,10X,'R.M.S. SIGNAL VOLTS - SAME POSN.',/)
116 FORMAT(' ',//,10X,'NO. OF MEASUREMENTS ',I3,
   1'    FRICTION VELOCITY   ',F10.4,/)
117 FORMAT(1H1,//,10X,'WALL DISTANCES (MM).',/)
120 FORMAT('1')
121 FORMAT(' ',' VELOCITY M/S ',F10.4,'     CNN',F10.4,'     CMM',F10.4,
   1'    STD PROBE V. ',F10.4)
122 FORMAT(///,15X,'ST. WIRE PROBE STD. RATIO.',F10.4,/)
123 FORMAT(///,15X,'INC WIRE PROBE STD. RATIO.',/)
124 FORMAT(//,10X,'PROBE (YAW) NO. ',I4,'    MEAN RTO. ',F10.5,/)
133 FORMAT(//,' ',' I  Y     UPIT     USREL       VSREL       WSREL
   1UVSREL      UWSREL       VWSREL       UVK          UWK          VWK
   2    EKIREL '/)
134 FORMAT(' ',I2,F5.1,F6.2,9E12.5,F7.3)
135 FORMAT(1H1,///,10X,'POS= ',F6.2,'   GRD ODER MM')
 50 CONTINUE
    RETURN
    END
```

```
      SUBROUTINE HOPER7
C ******************************************************************************
C ******************************************************************************
C
C     HOOPER-METHODE  SIEBEN MESSWERTE PRO PUNKT
C
C ******************************************************************************
C ******************************************************************************
C .
C  COMMON BLOCS FUER INPUT - OUTPUT
C
      COMMON/HAND/REI(20),NPNKT(25),Y(25),YMAX(20),ZET(7),VOLZ(7),YAXS
      COMMON/TAU/TAU(20),UST(20),POSP(20),NREI,POSB(21),ALFAMR
      COMMON/PITOUT/UPIT(20,25),CORU(20,25)
      COMMON/REF/ROREF,ETREF,XNUERF,TAUREF,USTREF,UFESTR
      COMMON/GERADE/POSG(20),NPKTG(20),DPFG(20,25),BARG(20,25),TEMPG(20,
     125),M1G(20,25),M2G(20,25),RMSG(20,25),EG(20,25),EG11(20,25),
     2EG22(20,25),NREIG
      COMMON/SCHVHX/POSS(20),NPKTS(20),DPFS(20,25,7),BARS(20,25,7),TEMPS
     1(20,25,7),M1S(20,25,7),M2S(20,25,7),RMSS(20,25,7),ES(20,25,7),
     2ES11(20,25,7),ES22(20,25,7),NREIS
      COMMON/TURBUL/US(20,25),VS(20,25),WS(20,25),UVS(20,25),UWS(21,25),
     1VWS(20,25),UVK(20,25),UWK(20,25),VWK(20,25),EKIN(20,25),VKO(20,25)
     2,WKO(20,25)
      COMMON/TURREL/USREL(20,25),VSREL(20,25),WSREL(20,25),UVSREL(20,25)
     1,UWSREL(20,25),VWSREL(20,25),EKIREL(20,25),YREL(20,25)
      COMMON/GAS/IGAS
      COMMON/MAINV/AH,ARW,AXS,IDRUCK,PI,LV,MNPNKT,NORM,IAUSW
      COMMON/EICH/ANG1,ANG2,VO1,VO2,TO1,TO2,GN,GB,SN,SM25,SM35,SB25,SB35
     1,SB,WK25,WK35
C
      DIMENSION UU(30,12),UUR(30,12),ANG(7)
C
C     UU(I,J) REYNOLDS STRESS. I=1 U. I=2 V. I=3 W. I=4 UV. I=5 UW
C     I=6 VW. I=7 V SEC FLOW. I=8 W SEC FLOW. I=9 CORRELATION UV.
C     I=10 CORRELATION UW. I=11 CORRELATION VW. I=12 KINETIC ENERGY.
C
C     UUR(I,J) NORMALISED REYNOLDS STRESS. UPIT(IREI,I) MEAN VEL. (M/S)
C     VOLZ(6) NO FLOW VOLT. EVOL(I,J) SIG VAR. VOL(I,J) MEAN VOLT.
C
      LI=5
      LO=6
C **
      DO 50 IREI=1,NREI
C
      DO 51 KK=1,7
   51 ANG(KK)=ANG1
C
      NMESS=NPKTS(IREI)
C **
      WRITE(LO,135)POSS(IREI)
      WRITE(LO,116)NMESS,UST(IREI)
      WRITE(LO,111)(ANG(J),J=1,7)
C
      DO 5 K=1,7
    5 ANG(K)=ANG(K)*PI/180
C
```

```
      DO 1 I=1,NMESS
C
      CNN=SN
      CMM=SM25
      IF(UPIT(IREI,I).GT.30.0)CMM=SM35
C
      WRITE(LO,121)UPIT(IREI,I),CNN,CMM
C
C     CALCULATION OF SECONDARY FLOW V,W.
C
      CV=(ES(IREI,I,1)*ES(IREI,I,1)-VO1*VO1)/(ES(IREI,I,5)*ES(IREI,I,5)
     1-VO1*VO1)
      CV=CV**(1.0/CMM)
      DV=(CV*COS(ANG(5))-COS(ANG(1)))/(CV*SIN(ANG(5))+SIN(ANG(1)))
      UU(I,7)=DV
      DV=ATAN(DV)
C
      CW=(ES(IREI,I,3)*ES(IREI,I,3)-VO1*VO1)/(ES(IREI,I,7)*ES(IREI,I,7)
     1-VO1*VO1)
      CW=CW**(1.0/CMM)
      DW=(CW*COS(ANG(7))-COS(ANG(3)))/(CW*SIN(ANG(7))+SIN(ANG(3)))
      UU(I,8)=DW
      DW=ATAN(DW)
C
      DVS=0.707107*(UU(I,7)+UU(I,8))
      D2=ATAN(DVS)
C
C
C     REYNOLDS STRESS CALCULATION.
C
      CKU=2.0*EG(IREI,I)*UPIT(IREI,I)/(GN*(EG(IREI,I)*EG(IREI,I)
     1-VO2*VO2))
      CKU=CKU*CKU
      UU(I,1)=CKU*RMSG(IREI,I)*RMSG(IREI,I)
C
C     V**2, UV.
C
      CKV1=2.0*UPIT(IREI,I)*ES(IREI,I,1)/(CNN*(ES(IREI,I,1)*ES(IREI,I,1)
     1-VO1*VO1))
      CKV1=CKV1*CKV1
      CKV5=2.0*UPIT(IREI,I)*ES(IREI,I,5)/(CNN*(ES(IREI,I,5)*ES(IREI,I,5)
     1-VO1*VO1))
      CKV5=CKV5*CKV5
      C1=(CMM/CNN)*TAN(ANG(1)-DV)
      C5=(CMM/CNN)*TAN(ANG(5)+DV)
      VV=((CKV5*RMSS(IREI,I,5)*RMSS(IREI,I,5)-UU(I,1))/C5
     1+(CKV1*RMSS(IREI,I,1)*RMSS(IREI,I,1)-UU(I,1))/C1)/(C5+C1)
      UU(I,2)=VV
      UV=(CKV1*RMSS(IREI,I,1)*RMSS(IREI,I,1)-UU(I,1)-C1*C1*UU(I,2))/
     1(2.0*C1)
      UU(I,4)=UV
C
C     PATCH FOR NEGATIVE VV.
      IF(UU(I,2).LT.0.0) UU(I,2)=-UU(I,2)
C
C
C     WW**2, UW.
C
```

```
      CKV3=2.0*UPIT(IREI,I)*ES(IREI,I,3)/(CNN*(ES(IREI,I,3)*ES(IREI,I,3)
     1-VO1*VO1))
      CKV3=CKV3*CKV3
      CKV7=2.0*UPIT(IREI,I)*ES(IREI,I,7)/(CNN*(ES(IREI,I,7)*ES(IREI,I,7)
     1-VO1*VO1))
      CKV7=CKV7*CKV7
      C3=(CMM/CNN)*TAN(ANG(3)-DW)
      C7=(CMM/CNN)*TAN(ANG(7)+DW)
      WW=((CKV7*RMSS(IREI,I,7)*RMSS(IREI,I,7)-UU(I,1))/C7
     1+(CKV3*RMSS(IREI,I,3)*RMSS(IREI,I,3)-UU(I,1))/C3)/(C7+C3)
      UU(I,3)=WW
      UW=(CKV3*RMSS(IREI,I,3)*RMSS(IREI,I,3)-UU(I,1)-C3*C3*UU(I,3))/
     1(2.0*C3)
      UU(I,5)=UW
C
      IF(UU(I,3).LT.0.0) UU(I,3)=-UU(I,3)
C
      C2=(CMM/CNN/1.414214)*TAN(ANG(2)-D2)
      CKV2=2.0*UPIT(IREI,I)*ES(IREI,I,2)/(CNN*(ES(IREI,I,2)*ES(IREI,I,2)
     1-VO1*VO1))
      CKV2=CKV2*CKV2
      VW=(CKV2*RMSS(IREI,I,2)*RMSS(IREI,I,2)-UU(I,1)-C2*C2*(UU(I,2)+
     1UU(I,3))-2.0*C2*(UU(I,4)+UU(I,5)))/(2.0*C2*C2)
      UU(I,6)=VW
C
C
C     CALCULATION FINISHED.
C
      UUR(I,1)=SQRT(UU(I,1))/USTREF
      UUR(I,2)=SQRT(UU(I,2))/USTREF
      UUR(I,3)=SQRT(UU(I,3))/USTREF
      UUR(I,4)=UU(I,4)/(USTREF*USTREF)
      UUR(I,5)=UU(I,5)/(USTREF*USTREF)
      UUR(I,6)=UU(I,6)/(USTREF*USTREF)
      UUR(I,7)=UU(I,7)
      UUR(I,8)=UU(I,8)
      UUR(I,9)=UU(I,4)/SQRT(UU(I,1)*UU(I,2))
      UUR(I,10)=UU(I,5)/SQRT(UU(I,1)*UU(I,3))
      UUR(I,11)=UU(I,6)/SQRT(UU(I,2)*UU(I,3))
      UUR(I,12)=(UU(I,1)+UU(I,2)+UU(I,3))/(2.0*USTREF*USTREF)
C *
      USREL(IREI,I)=UUR(I,1)
      VSREL(IREI,I)=UUR(I,2)
      WSREL(IREI,I)=UUR(I,3)
      UVSREL(IREI,I)=UUR(I,4)
      UWSREL(IREI,I)=UUR(I,5)
      VWSREL(IREI,I)=UUR(I,6)
      VKO(IREI,I)=UU(I,7)
      WKO(IREI,I)=UU(I,8)
      UVK(IREI,I)=UUR(I,9)
      UWK(IREI,I)=UUR(I,10)
      VWK(IREI,I)=UUR(I,11)
      EKIREL(IREI,I)=UUR(I,12)
      YREL(IREI,I)=Y(I)/YMAX(IREI)
C *
    1 CONTINUE
C
```

```
C
C     PRINT OUT CALCULATED VARIABLES
C
      WRITE(LO,107)
      WRITE(LO,101)(UU(I,7),I=1,NMESS)
      WRITE(LO,108)
      WRITE(LO,101)(UU(I,8),I=1,NMESS)
C
      WRITE(LO,133)
      DO 52 I=1,NMESS
      WRITE(LO,134)I,Y(I),UPIT(IREI,I),USREL(IREI,I),VSREL(IREI,I),
     1WSREL(IREI,I),UVSREL(IREI,I),UWSREL(IREI,I),VWSREL(IREI,I),
     2UVK(IREI,I),UWK(IREI,I),VWK(IREI,I),EKIREL(IREI,I)
   52 CONTINUE
C
C
  100 FORMAT(///,15X,'UU COMPONENT OF REYNOLDS STRESS',/)
  101 FORMAT(10(1PE11.3,2X))
  107 FORMAT(//,15X,'V CALC. SECONDARY FLOW',/)
  108 FORMAT(//,15X,'W SECONDARY FLOW',/)
  111 FORMAT(//,10X,'YAW PROBE ANGLES  1 TO 7     ',7F8.2,//)
  112 FORMAT(//,15X,'MEAN VELOCITY DATA',/)
  113 FORMAT(//,15X,'PROBE NO. FLOW VOLTS - POSN 1 TO 7',/)
  114 FORMAT(///,15X,'PROBE MEAN VOLTS. POSITION NO. ',I3,/)
  115 FORMAT(/,10X,'R.M.S. SIGNAL VOLTS - SAME POSN.',/)
  116 FORMAT(' ',//,10X,'NO. OF MEASUREMENTS ',I3,
     1'    FRICTION VELOCITY   ',F10.4,/)
  117 FORMAT(1H1,//,10X,'WALL DISTANCES (MM).',/)
  120 FORMAT('1')
  121 FORMAT(' ','VELOCITY (M/S) =',F9.3,' CNN =',F9.5,' CMM =',F9.5)
  133 FORMAT(//,' ',' I  Y     UPIT     USREL       VSREL       WSREL
     1UVSREL      UWSREL      VWSREL      UVK         UWK         VWK
     2    EKIREL '/)
  134 FORMAT(' ',I2,F5.1,F6.2,9E12.5,F7.3)
  135 FORMAT(1H1,///,10X,'POS= ',F6.2,'   GRD ODER MM')
   50 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE KALGER
C ******************************************************************************
C ******************************************************************************
C
C     KOEFFIZIENTEN FUER GERADEN HITZ-DRAHT  GB, GN
C
C ******************************************************************************
C ******************************************************************************
C
C  COMMON BLOCS FUER INPUT - OUTPUT
C
      COMMON/HAND/REI(20),NPNKT(25),Y(25),YMAX(20),ZET(7),VOLZ(7),YAXS
      COMMON/TAU/TAU(20),UST(20),POSP(20),NREI,POSB(21),ALFAMR
      COMMON/PITOUT/UPIT(20,25),CORU(20,25)
      COMMON/REF/ROREF,ETREF,XNUERF,TAUREF,USTREF,UFESTR
      COMMON/GERADE/POSG(20),NPKTG(20),DPFG(20,25),BARG(20,25),TEMPG(20,
     125),M1G(20,25),M2G(20,25),RMSG(20,25),EG(20,25),EG11(20,25),
     2EG22(20,25),NREIG
      COMMON/SCHVHX/POSS(20),NPKTS(20),DPFS(20,25,7),BARS(20,25,7),TEMPS
     1(20,25,7),M1S(20,25,7),M2S(20,25,7),RMSS(20,25,7),ES(20,25,7),
     2ES11(20,25,7),ES22(20,25,7),NREIS
      COMMON/TURBUL/US(20,25),VS(20,25),WS(20,25),UVS(20,25),UWS(21,25),
     1VWS(20,25),UVK(20,25),UWK(20,25),VWK(20,25),EKIN(20,25),VKO(20,25)
     2,WKO(20,25)
      COMMON/TURREL/USREL(20,25),VSREL(20,25),WSREL(20,25),UVSREL(20,25)
     1,UWSREL(20,25),VWSREL(20,25),EKIREL(20,25),YREL(20,25)
      COMMON/GAS/IGAS
      COMMON/MAINV/AH,ARW,AXS,IDRUCK,PI,LV,MNPNKT,NORM,IAUSW
      COMMON/EICH/ANG1,ANG2,VO1,VO2,TO1,TO2,GN,GB,SN,SM25,SM35,SB25,SB35
     1,SB,WK25,WK35
C
      DIMENSION XK(25),YK(25),E1(25),E2(25),U(25)
C
      READ(13,130) DAT,JA,NPKT,NTYP
      READ(13,131) DD,ANG2
      READ(13,131) DD,VO2
      READ(13,131) DD,TO2
      READ(13,131) DD,TE2
      DO 11 I=1,NPKT
      READ(13,134) U(I),E1(I),E2(I)
   11 CONTINUE
      VO2K=VO2/(1.-.00211*(TO2-TE2))
      DO 12 I=1,NPKT
      YK(I)=ALOG10(E2(I)**2.-VO2K**2.)
      XK(I)=ALOG10(U(I))
   12 CONTINUE
      WRITE(6,231)(U(I),E2(I),XK(I),YK(I),I=1,NPKT)
      CALL SQRFIT(XK,YK,NPKT,A,B)
      GN=A
      GB=10.**B
      WRITE(6,230) GN,GB
      REWIND 13
  130 FORMAT(F5.2,I5,I3,I2)
  131 FORMAT(2F7.3)
  132 FORMAT(2F7.3,F7.2)
  133 FORMAT(F7.2)
```

```
  134 FORMAT(3F7.3)
C
  230 FORMAT(' ',//' ','KOEFFIZIENTEN FUER GERADEN DRAHT'//' ','GN=',
     1E13.6,'    GB=',E13.6)
  231 FORMAT(' ',//,T5,'U(I)         E2(I)        XK(I)         YK(I)'//(T3,
     14E13.6))
      RETURN
      END
```

```
      SUBROUTINE KALHOP
C ***************************************************************************
C ***************************************************************************
C
C     EICH-KOEFFIZIENTEN : SB, SN, SM
C
C ***************************************************************************
C ***************************************************************************
C
C  COMMON BLOCS FUER INPUT - OUTPUT
C
      COMMON/HAND/REI(20),NPNKT(25),Y(25),YMAX(20),ZET(7),VOLZ(7),YAXS
      COMMON/TAU/TAU(20),UST(20),POSP(20),NREI,POSB(21),ALFAMR
      COMMON/PITOUT/UPIT(20,25),CORU(20,25)
      COMMON/REF/ROREF,ETREF,XNUERF,TAUREF,USTREF,UFESTR
      COMMON/GERADE/POSG(20),NPKTG(20),DPFG(20,25),BARG(20,25),TEMPG(20,
     125),M1G(20,25),M2G(20,25),RMSG(20,25),EG(20,25),EG11(20,25),
     2EG22(20,25),NREIG
      COMMON/SCHVHX/POSS(20),NPKTS(20),DPFS(20,25,7),BARS(20,25,7),TEMPS
     1(20,25,7),M1S(20,25,7),M2S(20,25,7),RMSS(20,25,7),ES(20,25,7),
     2ES11(20,25,7),ES22(20,25,7),NREIS
      COMMON/TURBUL/US(20,25),VS(20,25),WS(20,25),UVS(20,25),UWS(21,25),
     1VWS(20,25),UVK(20,25),UWK(20,25),VWK(20,25),EKIN(20,25),VKO(20,25)
     2,WKO(20,25)
      COMMON/TURREL/USREL(20,25),VSREL(20,25),WSREL(20,25),UVSREL(20,25)
     1,UWSREL(20,25),VWSREL(20,25),EKIREL(20,25),YREL(20,25)
      COMMON/GAS/IGAS
      COMMON/MAINV/AH,ARW,AXS,IDRUCK,PI,LV,MNPNKT,NORM,IAUSW
      COMMON/EICH/ANG1,ANG2,VO1,VO2,TO1,TO2,GN,GB,SN,SM25,SM35,SB25,SB35
     1,SB,WK25,WK35
C
      DIMENSIONXK(25),YK(25),E1(25),E2(25),ES1(25),ES2(25),U(25),FI(25)
C
      READ(13,140) DAT,JA,NPKT,NTYP
      READ(13,141) ANG1,ANG2
      READ(13,141) VO1,VO2
      READ(13,141) TO1,TO2
      READ(13,141) TE1,TE2
      DO 11 I=1,NPKT
      READ(13,144) U(I),E1(I),E2(I)
   11 CONTINUE
      READ(13,145) U1,U2
      DO 12 I=1,NPKT
      READ(13,146) FI(I),ES1(I),ES2(I)
   12 CONTINUE
      VO1K=VO1/(1-.00211*(TO1-TE1))
      DO 13 I=1,NPKT
      ALFA=ANG1-90.
      YK(I)=ALOG10(ES1(I)**2-VO1K**2)
      XK(I)=ALOG10(COS((ALFA+FI(I))*PI/180))
   13 CONTINUE
      WRITE(6,241)(FI(I),ES1(I),XK(I),YK(I),I=1,NPKT)
      CALL SQRFIT(XK,YK,NPKT,A,B)
      SM25=A
      DO 14 I=1,NPKT
      YK(I)=ALOG10(ES2(I)**2-VO1K**2)
```

```
 14 CONTINUE
    WRITE(6,241)(FI(I),ES2(I),XK(I),YK(I),I=1,NPKT)
    CALL SQRFIT(XK,YK,NPKT,A,B)
    SM35=A
    DO 15 I=1,NPKT
    YK(I)=ALOG10(E1(I)**2-VO1K**2)
    XK(I)=ALOG10(U(I))
 15 CONTINUE
    WRITE(6,241)(U(I),E1(I),XK(I),YK(I),I=1,NPKT)
    CALL SQRFIT(XK,YK,NPKT,A,B)
    SN=A
    CSA=COS(ALFA*PI/180)
    SB25=10**B/CSA**SM25
    SB35=10**B/CSA**SM35
    WRITE(6,240) SM25,SM35,SN,SB25,SB35
    REWIND 13
140 FORMAT(F5.2,I5,I3,I2)
141 FORMAT(2F7.3)
142 FORMAT(2F7.3,F7.2)
143 FORMAT(F7.2)
144 FORMAT(3F7.3)
145 FORMAT(2F7.3)
146 FORMAT(3F7.3)
240 FORMAT(' '/' ','KOEFFIZIENTEN FUER SCHRAEGEN DRAHT'// ' ','SM25='
   1,E13.6,'   SM35=',E13.6,'    SN=',E13.6,'    SB25=',E13.6,'    SB35='
   2,E13.6,//)
241 FORMAT(' ',//,T5,'FI - U       E             X(I)          Y(I)'
   1//(T3,4E13.6))
    RETURN
    END
```

```
      SUBROUTINE KALKJE
C ******************************************************************************
C ******************************************************************************
C
C       EICHUNGS KOEFFIZIENTEN FUER SCHRAEGEN DRAHT: SB, SN
C
C ******************************************************************************
C ******************************************************************************
C
C  COMMON BLOCS FUER INPUT - OUTPUT
C
      COMMON/HAND/REI(20),NPNKT(25),Y(25),YMAX(20),ZET(7),VOLZ(7),YAXS
      COMMON/TAU/TAU(20),UST(20),POSP(20),NREI,POSB(21),ALFAMR
      COMMON/PITOUT/UPIT(20,25),CORU(20,25)
      COMMON/REF/ROREF,ETREF,XNUERF,TAUREF,USTREF,UFESTR
      COMMON/GERADE/POSG(20),NPKTG(20),DPFG(20,25),BARG(20,25),TEMPG(20,
     125),M1G(20,25),M2G(20,25),RMSG(20,25),EG(20,25),EG11(20,25),
     2EG22(20,25),NREIG
      COMMON/SCHVHX/POSS(20),NPKTS(20),DPFS(20,25,7),BARS(20,25,7),TEMPS
     1(20,25,7),M1S(20,25,7),M2S(20,25,7),RMSS(20,25,7),ES(20,25,7),
     2ES11(20,25,7),ES22(20,25,7),NREIS
      COMMON/TURBUL/US(20,25),VS(20,25),WS(20,25),UVS(20,25),UWS(21,25),
     1VWS(20,25),UVK(20,25),UWK(20,25),VWK(20,25),EKIN(20,25),VKO(20,25)
     2,WKO(20,25)
      COMMON/TURREL/USREL(20,25),VSREL(20,25),WSREL(20,25),UVSREL(20,25)
     1,UWSREL(20,25),VWSREL(20,25),EKIREL(20,25),YREL(20,25)
      COMMON/GAS/IGAS
      COMMON/MAINV/AH,ARW,AXS,IDRUCK,PI,LV,MNPNKT,NORM,IAUSW
      COMMON/EICH/ANG1,ANG2,VO1,VO2,TO1,TO2,GN,GB,SN,SM25,SM35,SB25,SB35
     1,SB,WK25,WK35
C
      DIMENSION XK(25),YK(25),E1(25),E2(25),U(25)
C
      READ(13,140) DAT,JA,NPKT,NTYP
      READ(13,141) ANG1,DD
      READ(13,141) VO1,DD
      READ(13,141) TO1,DD
      READ(13,141) TE1,DD
      DO 11 I=1,NPKT
      READ(13,144) U(I),E1(I),E2(I)
   11 CONTINUE
      VO1K=VO1/(1.-.00211*(TO1-TE1))
      DO 12 I=1,NPKT
      YK(I)=ALOG10(E1(I)**2.-VO1K**2.)
      XK(I)=ALOG10(U(I))
   12 CONTINUE
      WRITE(6,241)(I,U(I),E1(I),XK(I),YK(I),I=1,NPKT)
      CALL SQRFIT(XK,YK,NPKT,A,B)
      SN=A
      SB=B
CC   SB=LOG(B(COSPSI**2+K**2*SINPSI**2)**(N/2))
      WRITE(6,240) SN,SB
  140 FORMAT(F5.2,I5,I3,I2)
  141 FORMAT(2F7.3)
  142 FORMAT(2F7.3,F7.2)
  143 FORMAT(F7.2)
```

```
144 FORMAT(3F7.3)
240 FORMAT(' '//' ','KOEFFIZIENTEN FUER SCHRAEGEN DRAHT'// ' ','SN='
   1,E13.6,'    SB=',E13.6)
241 FORMAT(' ',//,T5,'I    U                E          XK(I)        YK(I)'
   1//(T5,I2,4E13.6))
    RETURN
    END
```

```
      SUBROUTINE KORAC7
C ***************************************************************************
C ***************************************************************************
C
C       DATEN-KORREKTUR
C
C ***************************************************************************
C ***************************************************************************
C
C  COMMON BLOCS FUER INPUT - OUTPUT
C
      COMMON/HAND/REI(20),NPNKT(25),Y(25),YMAX(20),ZET(7),VOLZ(7),YAXS
      COMMON/TAU/TAU(20),UST(20),POSP(20),NREI,POSB(21),ALFAMR
      COMMON/PITOUT/UPIT(20,25),CORU(20,25)
      COMMON/REF/ROREF,ETREF,XNUERF,TAUREF,USTREF,UFESTR
      COMMON/GERADE/POSG(20),NPKTG(20),DPFG(20,25),BARG(20,25),TEMPG(20,
     125),M1G(20,25),M2G(20,25),RMSG(20,25),EG(20,25),EG11(20,25),
     2EG22(20,25),NREIG
      COMMON/SCHVHX/POSS(20),NPKTS(20),DPFS(20,25,7),BARS(20,25,7),TEMPS
     1(20,25,7),M1S(20,25,7),M2S(20,25,7),RMSS(20,25,7),ES(20,25,7),
     2ES11(20,25,7),ES22(20,25,7),NREIS
      COMMON/TURBUL/US(20,25),VS(20,25),WS(20,25),UVS(20,25),UWS(21,25),
     1VWS(20,25),UVK(20,25),UWK(20,25),VWK(20,25),EKIN(20,25),VKO(20,25)
     2,WKO(20,25)
      COMMON/TURREL/USREL(20,25),VSREL(20,25),WSREL(20,25),UVSREL(20,25)
     1,UWSREL(20,25),VWSREL(20,25),EKIREL(20,25),YREL(20,25)
      COMMON/GAS/IGAS
      COMMON/MAINV/AH,ARW,AXS,IDRUCK,PI,LV,MNPNKT,NORM,IAUSW
      COMMON/EICH/ANG1,ANG2,VO1,VO2,TO1,TO2,GN,GB,SN,SM25,SM35,SB25,SB35
     1,SB,WK25,WK35
C
      DIMENSION CORG(25),ROG(25),UFESTG(25),CORUFG(25),CORS(25,7),ROS(25
     *,7),UFESTS(25,7),CORUFS(25,7)
C
C
      DO 50 I=1,NREIG
      IF(NPKTG(I).NE.NPKTS(I)) GOTO 60
      NPKT=NPKTG(I)
      DO 51 J=1,NPKT
      TEMPG(I,J)=TEMPG(I,J)+273.15
      BARG(I,J)=BARG(I,J)*100.
      ROG(J)=RO(BARG(I,J),TEMPG(I,J))
      UFESTG(J)=SQRT(2.*DPFG(I,J)*100./ROG(J))
      CORUFG(J)=UFESTG(J)/UFESTR
      CORG(J)=0.1*UPIT(I,J)/EG(I,J)
      RMSG(I,J)=RMSG(I,J)*CORG(J)
C!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
C
C           WICHTIG!!  WICHTIG!!  WICHTIG !!
C
C   *  SCHRAEGER HITZ-DRAHT WAEHREND EICHUNG UND LINEARISATOR
C   *  EINSTELLUNG LIEGT SENKRECHT ZUR EICH-STROEMUNG, D.H. FI=-45 GRAD
C
C           WICHTIG!!  WICHTIG!!  WICHTIG !!
C
C!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
```

```
      WK=0.0505-0.000415*ROREF*UPIT(I,J)
      IF(IAUSW.EQ.1)ANG1=135
      IF(IAUSW.EQ.2.)WK=WK25*WK25
      IF(IAUSW.EQ.2..AND.UPIT(I,J).GT.30.)WK=WK35*WK35
C
      PSI=180-ANG1
      CS=COS(PSI*PI/180)
      SN=SIN(PSI*PI/180)
      SQER=SQRT(SN**2+WK*CS**2)
C
      DO 52 K=1,7
      TEMPS(I,J,K)=TEMPS(I,J,K)+273.15
      BARS(I,J,K)=BARS(I,J,K)*100.
      ROS(J,K)=RO(BARS(I,J,K),TEMPS(I,J,K))
      UFESTS(J,K)=SQRT(2.*DPFS(I,J,K)*100./ROS(J,K))
      CORUFS(J,K)=UFESTS(J,K)/UFESTR
      CORS(J,K)=0.1*UPIT(I,J)*SQER/ES(I,J,K)
      RMSS(I,J,K)=RMSS(I,J,K)*CORS(J,K)
   52 CONTINUE
   51 CONTINUE
      WRITE(6 ,204) POSS(I)
  204 FORMAT(' ',/,T3,'POS = ',F8.2,'  GRD  ODER  MM  -  KORIGIERTE DATE
     *N')
      WRITE(6 ,206)
  206 FORMAT(' ',/,' J    Y   UPIT    RMSG          RMSS1         RMSS2
     *     RMSS3          RMSS4         RMSS5         RMSS6        RMSS7',/)
      DO 53 J=1,NPKT
      WRITE(6 ,205)J,Y(J),UPIT(I,J),RMSG(I,J),RMSS(I,J,1),RMSS(I,J,2),
     *RMSS(I,J,3),RMSS(I,J,4),RMSS(I,J,5),RMSS(I,J,6),RMSS(I,J,7)
      WRITE(6 ,207)CORG(J),CORS(J,1),CORS(J,2),CORS(J,3),CORS(J,4),
     1CORS(J,5),CORS(J,6),CORS(J,7)
      WRITE(6 ,208)CORUFG(J),CORUFS(J,1),CORUFS(J,2),CORUFS(J,3),
     2CORUFS(J,4),CORUFS(J,5),CORUFS(J,6),CORUFS(J,7)
  207 FORMAT(' ','KORREKTUR',T17,8E13.6)
  208 FORMAT(' ','FEST PITOT',T17,8E13.6)
   53 CONTINUE
   50 CONTINUE
      GOTO 54
   60 WRITE(6 ,209)
  205 FORMAT(' ',I2,F6.2,F7.3,8E13.6)
  209 FORMAT(' ',//,T5,'FEHLER IN DATEN')
   54 RETURN
      END
```

```
      SUBROUTINE KORHOP
C ****************************************************************************
C ****************************************************************************
C
C     KORREKTUR FUER HOOPER METHODE
C
C ****************************************************************************
C ****************************************************************************
C
C  COMMON BLOCS FUER INPUT - OUTPUT
C
      COMMON/HAND/REI(20),NPNKT(25),Y(25),YMAX(20),ZET(7),VOLZ(7),YAXS
      COMMON/TAU/TAU(20),UST(20),POSP(20),NREI,POSB(21),ALFAMR
      COMMON/PITOUT/UPIT(20,25),CORU(20,25)
      COMMON/REF/ROREF,ETREF,XNUERF,TAUREF,USTREF,UFESTR
      COMMON/GERADE/POSG(20),NPKTG(20),DPFG(20,25),BARG(20,25),TEMPG(20,
     125),M1G(20,25),M2G(20,25),RMSG(20,25),EG(20,25),EG11(20,25),
     2EG22(20,25),NREIG
      COMMON/SCHVHX/POSS(20),NPKTS(20),DPFS(20,25,7),BARS(20,25,7),TEMPS
     1(20,25,7),M1S(20,25,7),M2S(20,25,7),RMSS(20,25,7),ES(20,25,7),
     2ES11(20,25,7),ES22(20,25,7),NREIS
      COMMON/TURBUL/US(20,25),VS(20,25),WS(20,25),UVS(20,25),UWS(21,25),
     1VWS(20,25),UVK(20,25),UWK(20,25),VWK(20,25),EKIN(20,25),VKO(20,25)
     2,WKO(20,25)
      COMMON/TURREL/USREL(20,25),VSREL(20,25),WSREL(20,25),UVSREL(20,25)
     1,UWSREL(20,25),VWSREL(20,25),EKIREL(20,25),YREL(20,25)
      COMMON/GAS/IGAS
      COMMON/MAINV/AH,ARW,AXS,IDRUCK,PI,LV,MNPNKT,NORM,IAUSW
      COMMON/EICH/ANG1,ANG2,VO1,VO2,TO1,TO2,GN,GB,SN,SM25,SM35,SB25,SB35
     1,SB,WK25,WK35
C
      DIMENSION CORG(25),CORS(25,7),UGHD(25),USHD(25,7)
C
      DO 50 I=1,NREI
      DO 51 J=1,NPKTS(I)
      VO2K=VO2/(1.-.00211*(TO2-TEMPG(I,J)))
      UGHD(J)=((EG(I,J)**2.-VO2K**2.)/GB)**(1./GN)
C     CORG(J)=(UPIT(I,J)/UGHD(J))**(GN/2.)
      CORG(J)=((VO2K*VO2K+GB*UPIT(I,J)**GN)/(VO2K*VO2K+GB*UGHD(J)**GN))
     1**.5
      RMSG(I,J)=RMSG(I,J)*CORG(J)
      EG(I,J)=EG(I,J)*CORG(J)
C
      DO 52 K=1,7
      VO1K=VO1/(1.-.00211*(TO1-TEMPS(I,J,K)))
      SB=SB25
      IF(UPIT(I,J).GT.30.)SB=SB35
      SM=SM25
      IF(UPIT(I,J).GT.30.)SM=SM35
      ALFA=ANG1*PI/180
      USHD(J,K)=((ES(I,J,K)**2.-VO1K**2.)/(SB*COS(ALFA)**SM))
     1**(1./SN)
C     CORS(J,K)=(UPIT(I,J)/USHD(J,K))**(SN/2.)
      CORS(J,K)=((VO1K*VO1K+SB*UPIT(I,J)**SN*COS(ALFA)**SM)/
     1(VO1K*VO1K+SB*USHD(J,K)**SN*COS(ALFA)**SM))**.5
      RMSS(I,J,K)=RMSS(I,J,K)*CORS(J,K)
```

```
      ES(I,J,K)=ES(I,J,K)*CORS(J,K)
   52 CONTINUE
   51 CONTINUE
C ***********************************
      WRITE(6 ,201) POSS(I)
      WRITE(6 ,202)
      DO 53 J=1,NPKTS(I)
      WRITE(6 ,203)J,Y(J),UPIT(I,J),RMSG(I,J),RMSS(I,J,1),RMSS(I,J,2),
     *RMSS(I,J,3),RMSS(I,J,4),RMSS(I,J,5),RMSS(I,J,6),RMSS(I,J,7)
      WRITE(6 ,205)EG(I,J),ES(I,J,1),ES(I,J,2),ES(I,J,3),ES(I,J,4),
     *ES(I,J,5),ES(I,J,6),ES(I,J,7)
      WRITE(6 ,204)CORG(J),CORS(J,1),CORS(J,2),CORS(J,3),
     1CORS(J,4),CORS(J,5),CORS(J,6),CORS(J,7)
   53 CONTINUE
   50 CONTINUE
  201 FORMAT(' ',/,T3,'POS = ',F6.2,'  GRD  ODER  MM  -  KORRIGIERTE DAT
     *EN')
  202 FORMAT(' ',/,' ','J  Y   UPIT   RMSG         RMSS1         RMSS2
     *     RMSS3         RMSS4         RMSS5         RMSS6      RMSS7',/)
  203 FORMAT(' ',I2,F6.2,F7.3,8E13.6)
  204 FORMAT(' ','KORREKTUR',T17,8E13.6)
  205 FORMAT(' ','GLEICHSPAN',T17,8E13.6)
      RETURN
      END
```

```
      SUBROUTINE KORKJE
C ****************************************************************************
C ****************************************************************************
C
C       KORREKTUR FUER KJELLSTROEM-DATEN *** EINFACHE
C
C ****************************************************************************
C ****************************************************************************
C
C  COMMON BLOCS FUER INPUT - OUTPUT
C
      COMMON/HAND/REI(20),NPNKT(25),Y(25),YMAX(20),ZET(7),VOLZ(7),YAXS
      COMMON/TAU/TAU(20),UST(20),POSP(20),NREI,POSB(21),ALFAMR
      COMMON/PITOUT/UPIT(20,25),CORU(20,25)
      COMMON/REF/ROREF,ETREF,XNUERF,TAUREF,USTREF,UFESTR
      COMMON/GERADE/POSG(20),NPKTG(20),DPFG(20,25),BARG(20,25),TEMPG(20,
     125),M1G(20,25),M2G(20,25),RMSG(20,25),EG(20,25),EG11(20,25),
     2EG22(20,25),NREIG
      COMMON/SCHVHX/POSS(20),NPKTS(20),DPFS(20,25,7),BARS(20,25,7),TEMPS
     1(20,25,7),M1S(20,25,7),M2S(20,25,7),RMSS(20,25,7),ES(20,25,7),
     2ES11(20,25,7),ES22(20,25,7),NREIS
      COMMON/TURBUL/US(20,25),VS(20,25),WS(20,25),UVS(20,25),UWS(21,25),
     1VWS(20,25),UVK(20,25),UWK(20,25),VWK(20,25),EKIN(20,25),VKO(20,25)
     2,WKO(20,25)
      COMMON/TURREL/USREL(20,25),VSREL(20,25),WSREL(20,25),UVSREL(20,25)
     1,UWSREL(20,25),VWSREL(20,25),EKIREL(20,25),YREL(20,25)
      COMMON/GAS/IGAS
      COMMON/MAINV/AH,ARW,AXS,IDRUCK,PI,LV,MNPNKT,NORM,IAUSW
      COMMON/EICH/ANG1,ANG2,VO1,VO2,TO1,TO2,GN,GB,SN,SM25,SM35,SB25,SB35
     1,SB,WK25,WK35
C
      DIMENSION CORG(25),CORS(25,7),UGHD(25),USHD(25,7)
C
      DO 50 I=1,NREI
      DO 51 J=1,NPKTG(I)
      VO2K=VO2/(1.-.00211*(TO2-TEMPG(I,J)))
      UGHD(J)=((EG(I,J)**2.-VO2K**2.)/GB)**(1./GN)
      CORG(J)=(UPIT(I,J)/UGHD(J))**(GN/2.)
C*GENAUERE KOREKTUR ABER BRINGT FEHLER 251 IN VKOMP INS26 REI 45 GRAD 10
C*    CORG(J)=((VO2K**2.+GB*UPIT(I,J)**GN)/
C*   1(VO2K**2.+GB*UGHD(J)**GN))**0.5
      RMSG(I,J)=RMSG(I,J)*CORG(J)
      EG(I,J)=EG(I,J)*CORG(J)
C
CC    CSPSI=COS(ANG1*PI/180)
CC    SNPSI=SIN(ANG1*PI/180)
CC    WK=.0505-.000415*ROREF*UPIT(I,J)
CC    B=10.**SB/(SNPSI**2.+WK*CSPSI**2.)**(SN/2.)
C
      DO 52 K=1,7
      VO1K=VO1/(1.-.00211*(TO1-TEMPS(I,J,K)))
      USHD(J,K)=((ES(I,J,K)**2.-VO1K**2.)/10.**SB)**(1./SN)
      CORS(J,K)=(UPIT(I,J)/USHD(J,K))**(SN/2.)
C
C*    CORS(J,K)=((VO1K**2.+UPIT(I,J)**SN*10.**SB)/
C*   1(VO1K**2.+USHD(J,K)**SN*10.**SB))**0.5
```

```
      RMSS(I,J,K)=RMSS(I,J,K)*CORS(J,K)
      ES(I,J,K)=ES(I,J,K)*CORS(J,K)
   52 CONTINUE
   51 CONTINUE
C ************************************
      WRITE(6 ,201) POSS(I)
      WRITE(6 ,202)
      DO 53 J=1,NPKTG(I)
      WRITE(6 ,203)J,Y(J),UPIT(I,J),RMSG(I,J),RMSS(I,J,1),RMSS(I,J,2),
     *RMSS(I,J,3),RMSS(I,J,4),RMSS(I,J,5),RMSS(I,J,6),RMSS(I,J,7)
      WRITE(6 ,205)EG(I,J),ES(I,J,1),ES(I,J,2),ES(I,J,3),ES(I,J,4),
     *ES(I,J,5),ES(I,J,6),ES(I,J,7)
      WRITE(6 ,204)CORG(J),CORS(J,1),CORS(J,2),CORS(J,3),
     1CORS(J,4),CORS(J,5),CORS(J,6),CORS(J,7)
   53 CONTINUE
   50 CONTINUE
  201 FORMAT(' ',/,T3,'POS = ',F6.2,'  GRD  ODER  MM  -  KORRIGIERTE DAT
     *EN')
  202 FORMAT(' ',/,' ','J  Y   UPIT    RMSG          RMSS1         RMSS2
     *     RMSS3        RMSS4         RMSS5         RMSS6       RMSS7',/)
  203 FORMAT(' ',I2,F6.2,F7.3,8E13.6)
  204 FORMAT(' ','KORREKTUR',T17,8E13.6)
  205 FORMAT(' ','GLEICHSPAN',T17,8E13.6)
      RETURN
      END
```

```
      SUBROUTINE PLOT
C ********************************************************************
C ********************************************************************
C
C    SCHREIBT DATEN ZUM PLOTTEN
C
C ********************************************************************
C ********************************************************************
C
C  COMMON BLOCS FUER INPUT - OUTPUT
C
      COMMON/HAND/REI(20),NPNKT(25),Y(25),YMAX(20),ZET(7),VOLZ(7),YAXS
      COMMON/TAU/TAU(20),UST(20),POSP(20),NREI,POSB(21),ALFAMR
      COMMON/PITOUT/UPIT(20,25),CORU(20,25)
      COMMON/REF/ROREF,ETREF,XNUERF,TAUREF,USTREF,UFESTR
      COMMON/GERADE/POSG(20),NPKTG(20),DPFG(20,25),BARG(20,25),TEMPG(20,
     125),M1G(20,25),M2G(20,25),RMSG(20,25),EG(20,25),EG11(20,25),
     2EG22(20,25),NREIG
      COMMON/SCHVHX/POSS(20),NPKTS(20),DPFS(20,25,7),BARS(20,25,7),TEMPS
     1(20,25,7),M1S(20,25,7),M2S(20,25,7),RMSS(20,25,7),ES(20,25,7),
     2ES11(20,25,7),ES22(20,25,7),NREIS
      COMMON/TURBUL/US(20,25),VS(20,25),WS(20,25),UVS(20,25),UWS(21,25),
     1VWS(20,25),UVK(20,25),UWK(20,25),VWK(20,25),EKIN(20,25),VKO(20,25)
     2,WKO(20,25)
      COMMON/TURREL/USREL(20,25),VSREL(20,25),WSREL(20,25),UVSREL(20,25)
     1,UWSREL(20,25),VWSREL(20,25),EKIREL(20,25),YREL(20,25)
      COMMON/GAS/IGAS
      COMMON/MAINV/AH,ARW,AXS,IDRUCK,PI,LV,MNPNKT,NORM,IAUSW
      COMMON/EICH/ANG1,ANG2,VO1,VO2,TO1,TO2,GN,GB,SN,SM25,SM35,SB25,SB35
     1,SB,WK25,WK35
C
      DIMENSION A1(25,20),A2(25,20),A3(25,20),A4(25,20),A5(25,20),A6(25,
     *20),A7(25,20),A8(25,20),A9(25,20),A10(25,20),A11(25,20),A12(25,20)
     *,A13(25,20),A14(25,20),A15(25,20),A16(25,20),A17(25,20),NMASS(20),
     *APHI(30),YYY(30),R(30),REND(30)
      DIMENSION UREL(30),URAL(30),UVSRAL(30),UWSRAL(30),VSWS(30),YKO(30)
     *,UP(30),YP(30),V(30),W(30)
C
C  KFALL=1 ======== REPRO AUSGABE
C  KFALL=2,KO=31 == DATEN AUF U*REF BEZOGEN   == HOEHENLINIEN PLOTS
C  KFALL=3,KO=32 == DATEN AUF U*LOKAL BEZOGEN == RADIALE PROFILLE
C  KFALL=4,KO=33 == EPSI DATEN
C  KFALL=5,KO=34 == UPLUS DATEN
C  KFALL=5,KO=35 == TAU DATEN
C
      KFALL=2
      KO=31
C  NMMAX=ANZAHL DER WANDABSTAENDE MAXIMAL +2 (R/PHI) +1 (X/Y)
      NMMAX=MNPNKT+2
      IF(IDRUCK.LT.0)NMMAX=MNPNKT+1
      M=2
      IF(IDRUCK.LT.0)M=1
    2 CONTINUE
      DO 3 I=1,25
      DO 3 J=1,20
      A1(I,J)=0
```

```
      A2(I,J)=0
      A3(I,J)=0
      A4(I,J)=0
      A5(I,J)=0
      A6(I,J)=0
      A7(I,J)=0
      A8(I,J)=0
      A9(I,J)=0
      A10(I,J)=0
      A11(I,J)=0
      A12(I,J)=0
      A13(I,J)=0
      A14(I,J)=0
      A15(I,J)=0
      A16(I,J)=0
    3 A17(I,J)=0
      DO 50 IREI=1,NREI
      NMESS=NPKTS(IREI)
      YTAU=YMAX(IREI)
      TAUW=TAU(IREI)
      STROEM=1./UST(IREI)**2
      R(1)=0.
      R(2)=ARW
      ALORX=POSS(IREI)
C     POSW(IREI)=ALORX
      APHI(IREI)=ALORX*PI/180
      IF(IDRUCK.LT.0)APHI(IREI)=ALORX
      IF(IDRUCK.LT.0)APHI(IREI)=AXS-ALORX
      YYY(1)=0.
      DO 405 I=1,NMMAX
      II=I+1
  405 YYY(II)=Y(I)
      DO 62 I=1,NMESS
      R(I+M)=ARW+Y(I)
      IF(IDRUCK.LT.0)R(I+M)=Y(I)
   62 CONTINUE
      REND(IREI)=ARW+YTAU
      IF(IDRUCK.LT.0)REND(IREI)=YTAU
      DO 52 I=1,NMMAX
      URAL(I)=0
      UVSRAL(I)=0
   52 UWSRAL(I)=0
      DO 51 I=1,NMESS
      DPIT=0.61
      YKO(I)=Y(I)+.15*DPIT
      UP(I)=UPIT(IREI,I)/UST(IREI)
      YP(I)=YKO(I)*UST(IREI)/XNUERF*1.E-3
      V(I)=VKO(IREI,I)
      W(I)=WKO(IREI,I)
      UREL(I)=UPIT(IREI,I)/UFESTR
      URAL(I+M)=UREL(I)
      UVSRAL(I+M)=UVSREL(IREI,I)*USTREF/UST(IREI)
      UWSRAL(I+M)=UWSREL(IREI,I)*USTREF/UST(IREI)
      VSWS(I)=WSREL(IREI,I)**2-VSREL(IREI,I)**2
   51 CONTINUE
C
```

```
      IF(KFALL.NE.4)GOTO255
      IF(IREI.EQ.1)GOTO 50
      IF(IDRUCK.LT.0.AND.IREI.EQ.NREI)GOTO 50
C
C     INPUT FUER EPSI
C
      WRITE(KO,219)(UVSRAL(I),I=1,NMMAX)
      WRITE(KO,219)(UWSRAL(I),I=1,NMMAX)
      WRITE(KO,219) STROEM
      WRITE(KO,219)(URAL(I),I=1,NMMAX)
      GOTO 50
C
  255 CONTINUE
      FK=1.0
      IF(NORM.EQ.0.) GOTO 20
      FK=USTREF/UST(IREI)
   20 CONTINUE
      IF(KFALL.EQ.3)FK=USTREF/UST(IREI)
      NMASS(IREI)=NMESS+1
      DO235I=1,NMESS
      II=I+1
      A1(II,IREI)=UREL(I)
      A2(II,IREI)=USREL(IREI,I)*FK
      A3(II,IREI)=VSREL(IREI,I)*FK
      A4(II,IREI)=WSREL(IREI,I)*FK
      A5(II,IREI)=UVK(IREI,I)
      A6(II,IREI)=UWK(IREI,I)
      A7(II,IREI)=VWK(IREI,I)
      A8(II,IREI)=UVSREL(IREI,I)*FK*FK
      A9(II,IREI)=UWSREL(IREI,I)*FK*FK
      A10(II,IREI)=VWSREL(IREI,I)*FK*FK
      A11(II,IREI)=EKIREL(IREI,I)*FK*FK
      A12(II,IREI)=VSWS(I)*FK*FK
      IF(KFALL.NE.2)GOTO280
      A13(II,IREI)=W(I)
      A14(II,IREI)=V(I)
  280 CONTINUE
      IF(KFALL.EQ.2)GOTO235
      A15(II,IREI)=YREL(IREI,I)
      A16(II,IREI)=UP(I)
      A17(II,IREI)=YP(I)
  235 CONTINUE
   50 CONTINUE
      K=2
      IF(IDRUCK.LT.0)GOTO 21
      IF(KFALL.EQ.4)K=2
   21 CONTINUE
      IF(KFALL.EQ.4)GOTO237
      NRAI=NREI
      IF(IDRUCK.LE.0)NRAI=NREI-1
      IF(KFALL.EQ.3)WRITE(KO,400)(NMASS(I),I=K,NRAI)
      IF(KFALL.EQ.5)GOTO250
      IF(KFALL.NE.3)GOTO406
      DO401I=K,NRAI
      N=NMASS(I)
  401 WRITE(KO,239)(A15(J,I),J=1,N)
```

```
      IF(IDRUCK.LE.0)WRITE(KO,403)(APHI(J),J=K,NRAI)
      IF(IDRUCK.GT.0)WRITE(KO,403)(POSS(J),J=K,NRAI)
  406 CONTINUE
      IF(KFALL.NE.2)GOTO404
C
C  AUSGABE FUER HOEHENLINIEN
      NREIX=NRAI-1
      WRITE(KO,400)NREIX,NMMAX
      WRITE(KO,239)(APHI(I),I=K,NRAI)
      WRITE(KO,239)(YYY(I),I=1,NMMAX)
      N1=NREI+1
      IF(IDRUCK.LT.0)GOTO 15
      DO 11 I=1,N1
      IF(ALFAMR.GT.POSB(N1-I)) GOTO 12
      YMAX(N1+1-I)=YMAX(N1-I)
      POSB(N1+1-I)=POSB(N1-I)
   11 CONTINUE
   12 YMAX(N1+1-I)=YAXS
      POSB(N1+1-I)=ALFAMR
   15 CONTINUE
      IF(IDRUCK.GT.0)WRITE(KO,239)(YMAX(I),I=K,N1)
      IF(IDRUCK.LE.0)WRITE(KO,239)(YMAX(I),I=K,NRAI)
      IF(IDRUCK.GT.0)WRITE(KO,239)(POSB(I),I=K,N1)
      WRITE(KO,400)(NMASS(I),I=K,NRAI)
  404 CONTINUE
      DO238I=K,NRAI
      N=NMASS(I)
  238 WRITE(KO,239)  (A1(J,I),J=1,N)
      DO240I=K,NRAI
      N=NMASS(I)
  240 WRITE(KO,239)  (A2(J,I),J=1,N)
      DO241I=K,NRAI
      N=NMASS(I)
  241 WRITE(KO,239)  (A3(J,I),J=1,N)
      DO242I=K,NRAI
      N=NMASS(I)
  242 WRITE(KO,239)  (A4(J,I),J=1,N)
      DO243I=K,NRAI
      N=NMASS(I)
  243 WRITE(KO,239)  (A5(J,I),J=1,N)
      DO244I=K,NRAI
      N=NMASS(I)
  244 WRITE(KO,239)  (A6(J,I),J=1,N)
      DO245I=K,NRAI
      N=NMASS(I)
  245 WRITE(KO,239)  (A7(J,I),J=1,N)
      DO246I=K,NRAI
      N=NMASS(I)
  246 WRITE(KO,239)  (A8(J,I),J=1,N)
      DO247I=K,NRAI
      N=NMASS(I)
  247 WRITE(KO,239)  (A9(J,I),J=1,N)
      DO100I=K,NRAI
      N=NMASS(I)
  100 WRITE(KO,239)  (A10(J,I),J=1,N)
      DO101I=K,NRAI
```

```
      N=NMASS(I)
  101 WRITE(KO,239)  (A11(J,I),J=1,N)
      DO257I=K,NRAI
      N=NMASS(I)
  257 WRITE(KO,239)(A12(J,I),J=1,N)
      IF(KFALL.EQ.3)GOTO237
      DO248I=K,NRAI
      N=NMASS(I)
  248 WRITE(KO,239) (A13(J,I),J=1,N)
      DO249I=K,NRAI
      N=NMASS(I)
  249 WRITE(KO,239) (A14(J,I),J=1,N)
  250 IF(KFALL.NE.5)GOTO237
      NRAIK=NRAI-1
      WRITE(KO,400) NRAIK
      WRITE(KO,400)(NMASS(I),I=K,NRAI)
      IF(IDRUCK.LE.0)WRITE(KO,403)(APHI(J),J=K,NRAI)
      IF(IDRUCK.GT.0)WRITE(KO,403)(POSS(J),J=K,NRAI)
      DO251I=K,NRAI
      N=NMASS(I)
  251 WRITE(KO,219) (A16(J,I),J=1,N)
      DO252I=K,NRAI
      N=NMASS(I)
  252 WRITE(KO,219) (A17(J,I),J=1,N)
 237  CONTINUE
      IF(KFALL.NE.4)GOTO1
      J=2
      WRITE(6,227) NREI,NMMAX
      WRITE(6,228)AXS,AH,ARW,ROREF,ETREF,UFESTR
      IF(IDRUCK.LE.0)WRITE(6,229)(APHI(I),I=J,NREI)
      IF(IDRUCK.GT.0)WRITE(6,229)(POSS(I),I=J,NREI)
      WRITE(6,229)(R(I),I=1,NMMAX)
      WRITE(6,229)(REND(I),I=J,NREI)
      WRITE(6,229)YAXS,ALFAMR
      IF(NORM.NE.0.) GOTO 17
      WRITE(6,217)
   17 IF(NORM.EQ.0.) GOTO 18
      WRITE(6,218)
   18 CONTINUE
      NRAI=NREI
      IF(IDRUCK.LE.0)NRAI=NREI-1
      NREIX=NRAI-1
      WRITE(KO,219)(APHI(I),I=J,NRAI)
      WRITE(KO,219)(R(I),I=1,NMMAX)
      WRITE(KO,219)(REND(I),I=J,NRAI)
      WRITE(KO,400)(NMASS(I),I=J,NRAI)
      IF(IDRUCK.GT.0)WRITE(KO,220)AXS,AH,ARW,ROREF,ETREF,UFESTR
      WRITE(KO,400)NREIX,NMMAX
      IF(IDRUCK.LE.0)WRITE(KO,239)(APHI(I),I=J,NRAI)
      IF(IDRUCK.GT.0)WRITE(KO,239)(POSS(I),I=J,NRAI)
      WRITE(KO,239)(YYY(I),I=1,NMMAX)
      IF(IDRUCK.GT.0)WRITE(KO,239)(YMAX(I),I=J,NRAI+1)
      IF(IDRUCK.LE.0)WRITE(KO,239)(YMAX(I),I=J,NRAI)
      IF(IDRUCK.GT.0)WRITE(KO,239)(POSB(I),I=J,NRAI+1)
    1 CONTINUE
      REWIND KO
```

```
      KFALL=KFALL+1
      KO=KO+1
      IF(KFALL.GE.6)GOTO70
      GOTO2
   70 WRITE(KO,71)AXS,ARW
   71 FORMAT(2F10.3)
      NRAIK=NRAI-1
      WRITE(KO,72)NRAIK
   72 FORMAT(I5)
      IF(IDRUCK.LE.0)WRITE(KO,73)(APHI(I),TAU(I),I=2,NRAI)
      IF(IDRUCK.GT.0)WRITE(KO,73)(POSS(I),TAU(I),I=2,NRAI)
   73 FORMAT(F10.2,F10.6)
  217 FORMAT(//,' ','PLOTS AUF USTREF BEZOGEN ( R/FI TRAVERSE 0 GRAD )')
  218 FORMAT(//,' ','PLOTS AUF LOKALES U* BEZOGEN'/)
  219 FORMAT(7E11.4)
  220 FORMAT(6E13.6)
  227 FORMAT(//,(1H ,4I4))
  228 FORMAT(//,(1H ,5X,6E11.4))
  229 FORMAT(/,(1H ,8E11.4))
  239 FORMAT(7F10.7)
   96 FORMAT(' ',7F10.7)
  400 FORMAT(36I2)
  403 FORMAT(14F5.2)
      END
```

```
      SUBROUTINE RIDHOP
C ***************************************************************************
C ***************************************************************************
C
C     LIEST HOOPER-SONDEN DATEN
C
C ***************************************************************************
C ***************************************************************************
C
C  COMMON BLOCS FUER INPUT - OUTPUT
C
      COMMON/HAND/REI(20),NPNKT(25),Y(25),YMAX(20),ZET(7),VOLZ(7),YAXS
      COMMON/TAU/TAU(20),UST(20),POSP(20),NREI,POSB(21),ALFAMR
      COMMON/PITOUT/UPIT(20,25),CORU(20,25)
      COMMON/REF/ROREF,ETREF,XNUERF,TAUREF,USTREF,UFESTR
      COMMON/GERADE/POSG(20),NPKTG(20),DPFG(20,25),BARG(20,25),TEMPG(20,
     125),M1G(20,25),M2G(20,25),RMSG(20,25),EG(20,25),EG11(20,25),
     2EG22(20,25),NREIG
      COMMON/SCHVHX/POSS(20),NPKTS(20),DPFS(20,25,7),BARS(20,25,7),TEMPS
     1(20,25,7),M1S(20,25,7),M2S(20,25,7),RMSS(20,25,7),ES(20,25,7),
     2ES11(20,25,7),ES22(20,25,7),NREIS
      COMMON/TURBUL/US(20,25),VS(20,25),WS(20,25),UVS(20,25),UWS(21,25),
     1VWS(20,25),UVK(20,25),UWK(20,25),VWK(20,25),EKIN(20,25),VKO(20,25)
     2,WKO(20,25)
      COMMON/TURREL/USREL(20,25),VSREL(20,25),WSREL(20,25),UVSREL(20,25)
     1,UWSREL(20,25),VWSREL(20,25),EKIREL(20,25),YREL(20,25)
      COMMON/GAS/IGAS
      COMMON/MAINV/AH,ARW,AXS,IDRUCK,PI,LV,MNPNKT,NORM,IAUSW
      COMMON/EICH/ANG1,ANG2,VO1,VO2,TO1,TO2,GN,GB,SN,SM25,SM35,SB25,SB35
     1,SB,WK25,WK35
C
      COMMON/DRUKK/DAT,JA,ANG(20),NMASS(20),UPAT(20,30)
C
      DIMENSION GRMS(7),GE(7)
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C     EINLESEN  HOOPER  DATEN
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
      READ(11,100)NREIS
      READ(11,102)(Y(I),I=1,16)
      WRITE(6 ,200)NREIS
      WRITE(6 ,201)(Y(I),I=1,16)
      DO 50 I=1,NREIS
      READ(11,103)IDAT,MO,JAR
      DAT=FLOAT(IDAT)+(FLOAT(MO)/100)
      JA=1900+FLOAT(JAR)
      READ(11,101)VOS,VOG
      READ(11,119)POSS(I),NPKTS(I)
      DO 107 J=1,NPKTS(I)
      DO 108 K=1,6
      READ(11,105)DPFS(I,J,K),BARS(I,J,K),TEMPS(I,J,K),ID,ID
      READ(11,106)RMSS(I,J,K),GRMS(K),ES(I,J,K),GE(K),ES11(I,J,K),
     1ES22(I,J,K)
  108 CONTINUE
      GOTO(1,2,3,4),LV
```

```
    1 RMSG(I,J)=GRMS(1)
      EG(I,J)=GE(1)
      TEMPG(I,J)=TEMPS(I,J,1)
      BARG(I,J)=BARS(I,J,1)
      DPFG(I,J)=DPFS(I,J,1)
      GOTO 107
    2 RMSG(I,J)=GRMS(3)
      EG(I,J)=GE(3)
      TEMPG(I,J)=TEMPS(I,J,3)
      BARG(I,J)=BARS(I,J,3)
      DPFG(I,J)=DPFS(I,J,3)
      GOTO 107
    3 RMSG(I,J)=GRMS(6)
      EG(I,J)=GE(6)
      TEMPG(I,J)=TEMPS(I,J,6)
      BARG(I,J)=BARS(I,J,6)
      DPFG(I,J)=DPFS(I,J,6)
      GOTO 107
    4 RMSG(I,J)=(GRMS(6)+GRMS(3))/2
      EG(I,J)=(GE(6)+GE(3))/2
      TEMPG(I,J)=(TEMPS(I,J,6)+TEMPS(I,J,3))/2
      BARG(I,J)=(BARS(I,J,6)+BARS(I,J,3))/2
      DPFG(I,J)=(DPFS(I,J,6)+DPFS(I,J,3))/2
  107 CONTINUE
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C     ENDE INPUT
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
      WRITE(6 ,203)DAT,JA
      WRITE(6 ,207)VOG,VOS
      WRITE(6 ,204)POSS(I),NPKTS(I)
      WRITE(6 ,206)
      DO 109 J=1,NPKTS(I)
      WRITE(6 ,205)J,Y(J),UPIT(I,J),RMSG(I,J),RMSS(I,J,1),RMSS(I,J,2),
     *RMSS(I,J,3),RMSS(I,J,4),RMSS(I,J,5),RMSS(I,J,6),RMSS(I,J,7)
      WRITE(6 ,209)EG(I,J),ES(I,J,1),ES(I,J,2),ES(I,J,3),ES(I,J,4),
     *ES(I,J,5),ES(I,J,6),ES(I,J,7)
  109 CONTINUE
   50 CONTINUE
  100 FORMAT(I5)
  101 FORMAT(2F8.3)
  102 FORMAT(14F5.2)
  103 FORMAT(3I2)
  105 FORMAT(3F15.3,2I5)
  106 FORMAT(6E13.6)
  119 FORMAT(F10.2,I5)
  200 FORMAT(/,' ','NREI = ',I5)
  201 FORMAT(/,' ','Y :'(' ',10F8.2))
  203 FORMAT(/,' ','DATUM : ',F5.2,'.',I4)
  204 FORMAT(' ','POS = ',F6.2,' GRD ODER MM ',' ANZ.DER MESSWERTE ='
     *,I3)
  205 FORMAT(' ',I2,F6.2,F7.3,8E13.6)
  206 FORMAT(/,' ',' J    Y    UPIT   RMSG           RMSS1          RMSS2
     * RMSS3             RMSS4            RMSS5            RMSS6            RMSS7',/,)
  207 FORMAT(' ','VOG= ',F6.3,' VOS= ',F6.3)
```

```
209 FORMAT(' ','GLEICH SPAN.',T17,8E13.6)
    RETURN
    END
```

```
      SUBROUTINE RIDHW7
C ***********************************************************************
C ***********************************************************************
C
C       LIEST HITZ-DRAHT DATEN MIT SIEBEN WERTEN
C
C ***********************************************************************
C ***********************************************************************
C
C  COMMON BLOCS FUER INPUT - OUTPUT
C
      COMMON/HAND/REI(20),NPNKT(25),Y(25),YMAX(20),ZET(7),VOLZ(7),YAXS
      COMMON/TAU/TAU(20),UST(20),POSP(20),NREI,POSB(21),ALFAMR
      COMMON/PITOUT/UPIT(20,25),CORU(20,25)
      COMMON/REF/ROREF,ETREF,XNUERF,TAUREF,USTREF,UFESTR
      COMMON/GERADE/POSG(20),NPKTG(20),DPFG(20,25),BARG(20,25),TEMPG(20,
     125),M1G(20,25),M2G(20,25),RMSG(20,25),EG(20,25),EG11(20,25),
     2EG22(20,25),NREIG
      COMMON/SCHVHX/POSS(20),NPKTS(20),DPFS(20,25,7),BARS(20,25,7),TEMPS
     1(20,25,7),M1S(20,25,7),M2S(20,25,7),RMSS(20,25,7),ES(20,25,7),
     2ES11(20,25,7),ES22(20,25,7),NREIS
      COMMON/TURBUL/US(20,25),VS(20,25),WS(20,25),UVS(20,25),UWS(21,25),
     1VWS(20,25),UVK(20,25),UWK(20,25),VWK(20,25),EKIN(20,25),VKO(20,25)
     2,WKO(20,25)
      COMMON/TURREL/USREL(20,25),VSREL(20,25),WSREL(20,25),UVSREL(20,25)
     1,UWSREL(20,25),VWSREL(20,25),EKIREL(20,25),YREL(20,25)
      COMMON/GAS/IGAS
      COMMON/MAINV/AH,ARW,AXS,IDRUCK,PI,LV,MNPNKT,NORM,IAUSW
      COMMON/EICH/ANG1,ANG2,VO1,VO2,TO1,TO2,GN,GB,SN,SM25,SM35,SB25,SB35
     1,SB,WK25,WK35
C
      COMMON/DRUKK/DAT,JA,ANG(20),NMASS(20),UPAT(20,30)
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C     EINLESEN DATEN FUER GERADEN HITZDRAHT
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
      READ(9,100)NREIG
100   FORMAT(I5)
      READ(9,102)(Y(I),I=1,MNPNKT)
      READ(10,100)NREIS
      IF(NREIG.NE.NREIS)GOTO 51
      READ(10,102)(Y(I),I=1,MNPNKT)
      WRITE( 6,200)NREIG
      WRITE( 6,201)(Y(I),I=1,MNPNKT)
 200  FORMAT(/,' ','NREI = ',I5)
 201  FORMAT(/,' ','Y :'(' ',10F8.2))
 102  FORMAT(14F5.2)
      DO 50 I=1,NREIG
      READ(9,103)IDAT,MO,JAR
 203  FORMAT(' ','DATUM : ',F5.2,'.',I4)
 103  FORMAT(3I2)
      READ(9,101) VOG,DD,DD
  101 FORMAT(2F8.3,F6.2)
      READ(9,119)POSG(I),NPKTG(I)
      WRITE( 6,204)POSG(I),NPKTG(I)
```

```
      DAT=FLOAT(IDAT)+(FLOAT(MO)/100)
      JA=1900+FLOAT(JAR)
      WRITE( 6,203)DAT,JA
 204  FORMAT(/,' ','POS = ',F8.2,' GRD ODER MM ',' ANZ.DER MESSWERTE ='
     *,I5)
      NPKT=NPKTG(I)
      DO 104 J=1,NPKT
      READ(9,105)DPFG(I,J),BARG(I,J),TEMPG(I,J),ID,ID
      GOTO(10,11,12,13,14,15,16),LV
   10 READ(9,106)RMSG(I,J),DD,EG(I,J),DD,DD,DD
      GOTO 104
   11 READ(9,106)DD,RMSG(I,J),DD,EG(I,J),DD,DD
      GOTO 104
   12 READ(9,106)RMS1,RMS2,EG1,EG2,DD,DD
      RMSG(I,J)=(RMS1+RMS2)/2
      EG(I,J)=(EG1+EG2)/2
      GOTO 104
   13 READ(9,106)DD,DD,EG(I,J),DD,RMSQ,DD
      RMSG(I,J)=SQRT(RMSQ)
      GOTO 104
   14 READ(9,106)DD,DD,DD,EG(I,J),DD,RMSQ
      RMSG(I,J)=SQRT(RMSQ)
      GOTO 104
   15 READ(9,106)DD,DD,EG1,EG2,RMSQ1,RMSQ2
      RMSG(I,J)=(SQRT(RMSQ1)+SQRT(RMSQ2))/2
      EG(I,J)=(EG1+EG2)/2
      GOTO 104
   16 READ(9,106)RMS1,RMS2,EG1,EG2,RMSQ1,RMSQ2
      RMSG(I,J)=(SQRT(RMSQ1)+SQRT(RMSQ2)+RMS1+RMS2)/4
      EG(I,J)=(EG1+EG2)/2
 105  FORMAT(3F15.3,2I5)
 106  FORMAT(6E13.6)
 104  CONTINUE
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C     EINLESEN DER DATEN FUER SCHRAEGEN HITZDRAHT
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
      READ(10,103)IDAT,MO,JAR
C      WRITE( 6,203)DAT,JA
 119  FORMAT(F10.2,I5)
      READ(10,101)VOS,DD,DD
      READ(10,119)POSS(I),NPKTS(I)
CC    WRITE( 6,204)POSS(I),NPKTS(I)
      IF(NPKTS(I).NE.NPKTG(I)) GOTO 51
      NPKT=NPKTS(I)
      DO 107 J=1,NPKT
      DO 108 K=1,7
      READ(10,105)DPFS(I,J,K),BARS(I,J,K),TEMPS(I,J,K),ID,ID
      GOTO(20,21,22,23,24,25,26),LV
   20 READ(10,106)RMSS(I,J,K),DD,ES(I,J,K),DD,DD,DD
      GOTO 108
   21 READ(10,106)DD,RMSS(I,J,K),DD,ES(I,J,K),DD,DD
      GOTO 108
   22 READ(10,106)RMS1,RMS2,ES1,ES2,DD,DD
      RMSS(I,J,K)=(RMS1+RMS2)/2
```

```
      ES(I,J,K)=(ES1+ES2)/2
      GOTO 108
   23 READ(10,106)DD,DD,ES(I,J,K),DD,RMSQ,DD
      RMSS(I,J,K)=SQRT(RMSQ)
      GOTO 108
   24 READ(10,106)DD,DD,DD,ES(I,J,K),DD,RMSQ
      RMSS(I,J,K)=SQRT(RMSQ)
      GOTO 108
   25 READ(10,106)DD,DD,ES1,ES2,RMSQ1,RMSQ2
      RMSS(I,J,K)=(SQRT(RMSQ1)+SQRT(RMSQ2))/2
      ES(I,J,K)=(ES1+ES2)/2
      GOTO 108
   26 READ(10,106)RMS1,RMS2,ES1,ES2,RMSQ1,RMSQ2
      RMSS(I,J,K)=(SQRT(RMSQ1)+SQRT(RMSQ2)+RMS1+RMS2)/4
      ES(I,J,K)=(ES1+ES2)/2
  108 CONTINUE
 107  CONTINUE
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C     ENDE INPUT
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
CC     WRITE( 6,207)VOG,VOS
      WRITE( 6,206)
      DO 109 J=1,NPKT
      WRITE( 6,205)J,Y(J),UPIT(I,J),RMSG(I,J),RMSS(I,J,1),RMSS(I,J,2),
     *RMSS(I,J,3),RMSS(I,J,4),RMSS(I,J,5),RMSS(I,J,6),RMSS(I,J,7)
      WRITE( 6,209)EG(I,J),ES(I,J,1),ES(I,J,2),ES(I,J,3),ES(I,J,4),
     *ES(I,J,5),ES(I,J,6),ES(I,J,7)
 109  CONTINUE
   50 CONTINUE
 205  FORMAT(' ',I2,F6.2,F7.3,8E13.6)
 206  FORMAT(/,' ',' J    Y     UPIT   RMSG         RMSS1         RMSS2
     * RMSS3         RMSS4         RMSS5         RMSS6         RMSS7',/,)
CC 207 FORMAT(' ','VOG= ',F7.4,'VOS= ',F7.4)
  208 FORMAT(' ',//,T5,'FEHLER IN DATEN')
  209 FORMAT(' ','GLEICH SPAN.',T17,8E13.6)
      GOTO 52
   51 WRITE( 6,208)
   52 RETURN
      END
```

```
      SUBROUTINE SQRFIT (XK,YK,NPKT,A,B)
C **********************************************************************
C **********************************************************************
C
C        LINEAR REGRESSION FCE :  Y = AX + B
C
C **********************************************************************
C **********************************************************************
      DIMENSION XK(NPKT),YK(NPKT)
      SX=0
      SY=0
      SXY=0
      SX2=0
      DO 10 I=1,NPKT
      SX=SX+XK(I)
      SY=SY+YK(I)
      SXY=SXY+XK(I)*YK(I)
      SX2=SX2+XK(I)**2
   10 CONTINUE
      WRITE(6,251)SX,SY,SXY,SX2
      A=(SXY-SX*SY/NPKT)/(SX2-SX**2/NPKT)
      B=(SY-A*SX)/NPKT
      WRITE(6,250)A,B
  250 FORMAT(' ','KOEFFIZIENTEN FCE  Y=AX+B : A=',E13.6,'    B= ',E13.6)
  251 FORMAT(/,' ','SX=',E13.6,'  SY=',E13.6,'  SXY=',E13.6,'  SX2='
     1,E13.6)
      RETURN
      END
```

```
      SUBROUTINE SYMAX
C ****************************************************************************
C ****************************************************************************
C
C     YMAX - WANDABSTAND ZUR MITTELLINIE
C
C ****************************************************************************
C ****************************************************************************
C
C  COMMON BLOCS FUER INPUT - OUTPUT
C
      COMMON/HAND/REI(20),NPNKT(25),Y(25),YMAX(20),ZET(7),VOLZ(7),YAXS
      COMMON/TAU/TAU(20),UST(20),POSP(20),NREI,POSB(21),ALFAMR
      COMMON/PITOUT/UPIT(20,25),CORU(20,25)
      COMMON/REF/ROREF,ETREF,XNUERF,TAUREF,USTREF,UFESTR
      COMMON/GERADE/POSG(20),NPKTG(20),DPFG(20,25),BARG(20,25),TEMPG(20,
     125),M1G(20,25),M2G(20,25),RMSG(20,25),EG(20,25),EG11(20,25),
     2EG22(20,25),NREIG
      COMMON/SCHVHX/POSS(20),NPKTS(20),DPFS(20,25,7),BARS(20,25,7),TEMPS
     1(20,25,7),M1S(20,25,7),M2S(20,25,7),RMSS(20,25,7),ES(20,25,7),
     2ES11(20,25,7),ES22(20,25,7),NREIS
      COMMON/TURBUL/US(20,25),VS(20,25),WS(20,25),UVS(20,25),UWS(21,25),
     1VWS(20,25),UVK(20,25),UWK(20,25),VWK(20,25),EKIN(20,25),VKO(20,25)
     2,WKO(20,25)
      COMMON/TURREL/USREL(20,25),VSREL(20,25),WSREL(20,25),UVSREL(20,25)
     1,UWSREL(20,25),VWSREL(20,25),EKIREL(20,25),YREL(20,25)
      COMMON/GAS/IGAS
      COMMON/MAINV/AH,ARW,AXS,IDRUCK,PI,LV,MNPNKT,NORM,IAUSW
      COMMON/EICH/ANG1,ANG2,VO1,VO2,TO1,TO2,GN,GB,SN,SM25,SM35,SB25,SB35
     1,SB,WK25,WK35
C
      P=AXS/ARW
      OHM=(AH-ARW)/ARW/2
      GAMA=P/(1+OHM)/2
      ALFAH=2*ATAN(GAMA)
      ALFAH=ALFAH*180/PI
      ALFAM=90-ALFAH
      ALFAMR=ALFAM*PI/180
      CSAM=COS(ALFAM*PI/180)
      YAXS=ARW*(P/CSAM-1)
      DO 10 I=1,NREI
      IF(IDRUCK.LT.0)GOTO 11
      POSB(I)=POSP(I)*PI/180
      IF(POSP(I).GT.ALFAM)GOTO 12
      CSA=COS(POSP(I)*PI/180)
      YMAX(I)=ARW*(P/CSA-1)
      GOTO 10
   12 CSA=COS((90-POSP(I))*PI/180)
      YMAX(I)=ARW*((2*OHM+1-CSA)/(1+CSA))
      GOTO 10
   11 POSB(I)=AXS-POSP(I)
      IF(POSB(I).EQ.0) GOTO 13
      ARG=2*ATAN(POSB(I)/(ARW+AH))
      YMAX(I)=POSB(I)/SIN(ARG)-ARW
      GOTO 10
   13 YMAX(I)=(AH-ARW)/2
```

```
 10 CONTINUE
    WRITE(6,201)ALFAM,GAMA,OHM,P,YAXS
    WRITE(6,200)(POSB(I),I=1,NREI)
    WRITE(6,200)(YMAX(I),I=1,NREI)
200 FORMAT(' ',10F10.4)
201 FORMAT(/,' ',5F10.4)
    RETURN
    END
```

```
      SUBROUTINE TAUWND
C *****************************************************************************
C *****************************************************************************
C
C     AUSWERTUNG VON PRESTON-MESSUNGEN
C     POS = WINKEL BZW. X-POSITION
C     NPKT= EIN PUNKT FUER JEDES PROFIL
C     DPF = DYN. DRUCK FEST EINGEBAUTES PITOT-ROHR - MBAR
C     DP  = DYN. DRUCK PRESTON - MBAR
C     BAR = BAROM. DRUCK - MBAR
C     TEMP= TEMPERATUR - GRAD CELSIUS
C
C *****************************************************************************
C *****************************************************************************
C
C  COMMON BLOCS FUER INPUT - OUTPUT
C
      COMMON/HAND/REI(20),NPNKT(25),Y(25),YMAX(20),ZET(7),VOLZ(7),YAXS
      COMMON/TAU/TAU(20),UST(20),POSP(20),NREI,POSB(21),ALFAMR
      COMMON/PITOUT/UPIT(20,25),CORU(20,25)
      COMMON/REF/ROREF,ETREF,XNUERF,TAUREF,USTREF,UFESTR
      COMMON/GERADE/POSG(20),NPKTG(20),DPFG(20,25),BARG(20,25),TEMPG(20,
     125),M1G(20,25),M2G(20,25),RMSG(20,25),EG(20,25),EG11(20,25),
     2EG22(20,25),NREIG
      COMMON/SCHVHX/POSS(20),NPKTS(20),DPFS(20,25,7),BARS(20,25,7),TEMPS
     1(20,25,7),M1S(20,25,7),M2S(20,25,7),RMSS(20,25,7),ES(20,25,7),
     2ES11(20,25,7),ES22(20,25,7),NREIS
      COMMON/TURBUL/US(20,25),VS(20,25),WS(20,25),UVS(20,25),UWS(21,25),
     1VWS(20,25),UVK(20,25),UWK(20,25),VWK(20,25),EKIN(20,25),VKO(20,25)
     2,WKO(20,25)
      COMMON/TURREL/USREL(20,25),VSREL(20,25),WSREL(20,25),UVSREL(20,25)
     1,UWSREL(20,25),VWSREL(20,25),EKIREL(20,25),YREL(20,25)
      COMMON/GAS/IGAS
      COMMON/MAINV/AH,ARW,AXS,IDRUCK,PI,LV,MNPNKT,NORM,IAUSW
      COMMON/EICH/ANG1,ANG2,VO1,VO2,TO1,TO2,GN,GB,SN,SM25,SM35,SB25,SB35
     1,SB,WK25,WK35
      COMMON/TAUZ/ZWERT
C
      DPIT=0.61
      READ(7,110)NREI
      READ(7,111)DAT,JA
C
      DO 10 I=1,NREI
      READ(7,112)POSP(I)
      READ(7,113)DPFP,DPTAU,BARP,TEMPP
C
      P1=BARP*100
      TA=TEMPP+273.15
      ETA=ET(P1,TA)
      ROF=RO(P1,TA)
      XNUE=ETA/ROF
C
C
C     PRESTONROHR
C
C
```

```
      DPRES=DPTAU*100
   92 XS=ALOG10(DPRES*DPIT**2*1.E-6/(4.*ROF*XNUE**2))
      IF(XS-2.9)54,54,55
   54 YS=.5*XS+.037
      GOTO63
   55 IF(XS-5.6)57,57,58
   57 YS=.8287-.1381*XS+.1437*XS**2-.006*XS**3
      GOTO63
   58 YS1=2.604+7./8.*XS
      XS1=YS1+2.*ALOG10(1.95*YS1+4.1)-XS
      YS2=YS1-XS1/2.
   60 XS2=YS2+2.*ALOG10(1.95*YS2+4.1)-XS
      YS3=YS1-XS1*(YS2-YS1)/(XS2-XS1)
      XS3=YS3+2.*ALOG10(1.95*YS3+4.1)-XS
      IF(ABS(XS3)-1.E-4)56,56,59
   59 YS2=YS3
      GOTO60
   56 YS=YS3
   63 TAUW=10.**YS*4.*ROF*XNUE**2/DPIT**2*1.E 6
C
C  KORREKTUR
C
      CORTAU=(ROREF/ROF)**.1*(XNUERF/XNUE)**.2*(ZWERT/DPFP)**.9
      TAU(I)=TAUW*CORTAU
      UST(I)=SQRT(TAU(I)/ROREF)
      IF(IDRUCK.LT.0)GOTO 20
      IF(I.NE.2)GO TO 20
      TAUREF=TAU(I)
      USTREF=UST(I)
      WRITE(29,214)USTREF
      REWIND 29
   20 CONTINUE
C
      WRITE(6,211) POSP(I),TAU(I),UST(I)
C
   10 CONTINUE
      IF(IDRUCK.GT.0)GOTO 21
      READ(29,214)USTREF
   21 CONTINUE
      WRITE(6,216)USTREF
C
  110 FORMAT(I5)
  111 FORMAT (F5.2,I5)
  112 FORMAT (F10.2)
  113 FORMAT (4F12.5)
  114 FORMAT (14F5.2)
  115 FORMAT (F10.2,I5)
C
  211 FORMAT(' ',/,' ','POS=',F5.2,'    TAU=',F8.4,'     UST=',F8.4)
  214 FORMAT(E13.6)
  216 FORMAT(' ',/,' ','USTREF=',F8.4)
C
      RETURN
      END
```

```
      SUBROUTINE UPITOT
C ***********************************************************************
C ***********************************************************************
C
C     GESCHWINDIGKEIT AUS PITOTROHR-MESSUNGEN
C
C ***********************************************************************
C ***********************************************************************
C
C  COMMON BLOCS FUER INPUT - OUTPUT
C
      COMMON/HAND/REI(20),NPNKT(25),Y(25),YMAX(20),ZET(7),VOLZ(7),YAXS
      COMMON/TAU/TAU(20),UST(20),POSP(20),NREI,POSB(21),ALFAMR
      COMMON/PITOUT/UPIT(20,25),CORU(20,25)
      COMMON/REF/ROREF,ETREF,XNUERF,TAUREF,USTREF,UFESTR
      COMMON/GERADE/POSG(20),NPKTG(20),DPFG(20,25),BARG(20,25),TEMPG(20,
     125),M1G(20,25),M2G(20,25),RMSG(20,25),EG(20,25),EG11(20,25),
     2EG22(20,25),NREIG
      COMMON/SCHVHX/POSS(20),NPKTS(20),DPFS(20,25,7),BARS(20,25,7),TEMPS
     1(20,25,7),M1S(20,25,7),M2S(20,25,7),RMSS(20,25,7),ES(20,25,7),
     2ES11(20,25,7),ES22(20,25,7),NREIS
      COMMON/TURBUL/US(20,25),VS(20,25),WS(20,25),UVS(20,25),UWS(21,25),
     1VWS(20,25),UVK(20,25),UWK(20,25),VWK(20,25),EKIN(20,25),VKO(20,25)
     2,WKO(20,25)
      COMMON/TURREL/USREL(20,25),VSREL(20,25),WSREL(20,25),UVSREL(20,25)
     1,UWSREL(20,25),VWSREL(20,25),EKIREL(20,25),YREL(20,25)
      COMMON/GAS/IGAS
      COMMON/MAINV/AH,ARW,AXS,IDRUCK,PI,LV,MNPNKT,NORM,IAUSW
      COMMON/EICH/ANG1,ANG2,VO1,VO2,TO1,TO2,GN,GB,SN,SM25,SM35,SB25,SB35
     1,SB,WK25,WK35
C
      READ(8,120)NRE
CC      WRITE( 6,224)NRE
C
      READ(8,124)(Y(J),J=1,MNPNKT+1)
C   MNPNKT+1 : SONST WIRD IN "PLOT.DATA(HOHLIN)" 0.0 AM LETZTE STELLE
CC      WRITE( 6,225)(Y(J),J=1,16)
C
      READ(8,121)DAT,JA
C
      DO 50 I=1,NRE
      READ(8,125)POS,NPKT
      WRITE( 6,226)POS,NPKT
      DO 40 J=1,NPKT
C
C     READ(8,123)DPF,DPP,BAR,TEMP
      READ(8,123)DPF,TEMP,DPP,BAR
C  ZWEITE ZEILE FUER WOERNER DATEN - IST IN OBJEKT
C
      BAR=BAR*100.
      TEMP=TEMP+273.15
      ROM=RO(BAR,TEMP)
      UPIT(I,J)=SQRT(2.*DPP*100./ROM)
C
C   CORRECTIONS
C
```

```
      ETAM=ET(BAR,TEMP)
      XNUEM=ETAM/ROM
      CORU(I,J)=XNUERF/XNUEM
      UPIT(I,J)=UPIT(I,J)*CORU(I,J)
   40 CONTINUE
C
      WRITE( 6,227)(J,UPIT(I,J),CORU(I,J),J=1,NPKT)
   50 CONTINUE
C
  120 FORMAT(I5)
  121 FORMAT(F5.2,I5)
  122 FORMAT(F10.2)
  123 FORMAT(4F12.5)
  124 FORMAT(14F5.2)
  125 FORMAT(F10.2,I5)
C
  224 FORMAT(' ',T3,'NREI = ',I5)
  225 FORMAT(' ',T3,'WANDABSTAENDE'//(20F6.2))
  226 FORMAT(/,' ',T3,'POS = ',F7.2,'  NPKT = ',I3)
  227 FORMAT(' ',/,T3,'GESCHWINDIGKEIT  PITOTROHR  -  KORREKTUR'/(I3,2E
     120.6))
C
      RETURN
      END
```

```
      SUBROUTINE YAWFAC
C ***********************************************************************
C ***********************************************************************
C
C        YAW-FAKTOR BERECHNUNG
C
C ***********************************************************************
C ***********************************************************************
C
C  COMMON BLOCS FUER INPUT - OUTPUT
C
      COMMON/HAND/REI(20),NPNKT(25),Y(25),YMAX(20),ZET(7),VOLZ(7),YAXS
      COMMON/TAU/TAU(20),UST(20),POSP(20),NREI,POSB(21),ALFAMR
      COMMON/PITOUT/UPIT(20,25),CORU(20,25)
      COMMON/REF/ROREF,ETREF,XNUERF,TAUREF,USTREF,UFESTR
      COMMON/GERADE/POSG(20),NPKTG(20),DPFG(20,25),BARG(20,25),TEMPG(20,
     125),M1G(20,25),M2G(20,25),RMSG(20,25),EG(20,25),EG11(20,25),
     2EG22(20,25),NREIG
      COMMON/SCHVHX/POSS(20),NPKTS(20),DPFS(20,25,7),BARS(20,25,7),TEMPS
     1(20,25,7),M1S(20,25,7),M2S(20,25,7),RMSS(20,25,7),ES(20,25,7),
     2ES11(20,25,7),ES22(20,25,7),NREIS
      COMMON/TURBUL/US(20,25),VS(20,25),WS(20,25),UVS(20,25),UWS(21,25),
     1VWS(20,25),UVK(20,25),UWK(20,25),VWK(20,25),EKIN(20,25),VKO(20,25)
     2,WKO(20,25)
      COMMON/TURREL/USREL(20,25),VSREL(20,25),WSREL(20,25),UVSREL(20,25)
     1,UWSREL(20,25),VWSREL(20,25),EKIREL(20,25),YREL(20,25)
      COMMON/GAS/IGAS
      COMMON/MAINV/AH,ARW,AXS,IDRUCK,PI,LV,MNPNKT,NORM,IAUSW
      COMMON/EICH/ANG1,ANG2,VO1,VO2,TO1,TO2,GN,GB,SN,SM25,SM35,SB25,SB35
     1,SB,WK25,WK35
C
      DIMENSION PSI(25),E1(25),E2(25),ES1(25),ES2(25),FI(25),U(25)
      DIMENSION CK1(14),CK2(14),YK1(25),YK2(25)
C
      REWIND 13
      READ(13,100) DAT,JA,NPKT,NTYP
      READ(13,101) ANG1,ANG2
      READ(13,101) VO1,VO2
      READ(13,101) TO1,TO2
      READ(13,101) TE1,TE2
      DO 11 I=1,NPKT
      READ(13,102) U(I),E1(I),E2(I)
   11 CONTINUE
      READ(13,101) U1,U2
      DO 12 I=1,NPKT+1
      READ(13,102) FI(I),ES1(I),ES2(I)
   12 CONTINUE
C
      DO 13 I=1,NPKT
      PSI(I)=45-FI(I)
      PSI(I)=PSI(I)*3.141592654/180
      CK1(I)=(ES1(I)*ES1(I))/(ES1(NPKT+1)*ES1(NPKT+1))
      YK1(I)=(SQRT(CK1(I)-SIN(PSI(I))*SIN(PSI(I))))/COS(PSI(I))
   13 CONTINUE
      CALL SQRFIT(PSI,YK1,NPKT,A,B)
      WK25=A*.78539816+B
```

```
      DO 14 I=1,NPKT
      CK2(I)=(ES2(I)*ES2(I))/(ES2(NPKT+1)*ES2(NPKT+1))
      YK2(I)=(SQRT(CK2(I)-SIN(PSI(I))*SIN(PSI(I))))/COS(PSI(I))
   14 CONTINUE
      CALL SQRFIT(PSI,YK2,NPKT,A,B)
      WK35=A*.78539816+B
C
      WRITE(6,202)
      DO 15 I=1,NPKT
      WRITE(6,201)FI(I),PSI(I),CK1(I),ES1(I),YK1(I),CK2(I),ES2(I),YK2(I)
   15 CONTINUE
C
      WRITE(6,200)WK25,WK35
  200 FORMAT(/,' ','WK25 = ',F8.5,'  WK35 = ',F8.5)
  201 FORMAT(' ',F6.2,7E13.6)
  202 FORMAT(//,' ','DATEN FUER YAW FAKTOR BERECHNUNG',//)
  100 FORMAT(F5.2,I5,I3,I2)
  101 FORMAT(2F7.3)
  102 FORMAT(3F7.3)
      RETURN
      END
```

```
      SUBROUTINE YAWFKJ
C ******************************************************************************
C ******************************************************************************
C
C        BERECHNET YAW-FAKTOR FUER KJELLSTROEM-METHODE
C
C ******************************************************************************
C ******************************************************************************
C
C  COMMON BLOCS FUER INPUT - OUTPUT
C
      COMMON/HAND/REI(20),NPNKT(25),Y(25),YMAX(20),ZET(7),VOLZ(7),YAXS
      COMMON/TAU/TAU(20),UST(20),POSP(20),NREI,POSB(21),ALFAMR
      COMMON/PITOUT/UPIT(20,25),CORU(20,25)
      COMMON/REF/ROREF,ETREF,XNUERF,TAUREF,USTREF,UFESTR
      COMMON/GERADE/POSG(20),NPKTG(20),DPFG(20,25),BARG(20,25),TEMPG(20,
     125),M1G(20,25),M2G(20,25),RMSG(20,25),EG(20,25),EG11(20,25),
     2EG22(20,25),NREIG
      COMMON/SCHVHX/POSS(20),NPKTS(20),DPFS(20,25,7),BARS(20,25,7),TEMPS
     1(20,25,7),M1S(20,25,7),M2S(20,25,7),RMSS(20,25,7),ES(20,25,7),
     2ES11(20,25,7),ES22(20,25,7),NREIS
      COMMON/TURBUL/US(20,25),VS(20,25),WS(20,25),UVS(20,25),UWS(21,25),
     1VWS(20,25),UVK(20,25),UWK(20,25),VWK(20,25),EKIN(20,25),VKO(20,25)
     2,WKO(20,25)
      COMMON/TURREL/USREL(20,25),VSREL(20,25),WSREL(20,25),UVSREL(20,25)
     1,UWSREL(20,25),VWSREL(20,25),EKIREL(20,25),YREL(20,25)
      COMMON/GAS/IGAS
      COMMON/MAINV/AH,ARW,AXS,IDRUCK,PI,LV,MNPNKT,NORM,IAUSW
      COMMON/EICH/ANG1,ANG2,VO1,VO2,TO1,TO2,GN,GB,SN,SM25,SM35,SB25,SB35
     1,SB,WK25,WK35
C
      DIMENSION PSI(25),E1(25),E2(25),ES1(25),ES2(25),FI(25),U(25)
      DIMENSION CK1(14),CK2(14),YK1(25),YK2(25)
C
      REWIND 13
      READ(13,100) DAT,JA,NPKT,NTYP
      READ(13,101) ANG1,ANG2
      READ(13,101) VO1,VO2
      READ(13,101) TO1,TO2
      READ(13,101) TE1,TE2
      DO 11 I=1,NPKT
      READ(13,102) U(I),E1(I),E2(I)
   11 CONTINUE
      READ(13,101) U1,U2
      DO 12 I=1,NPKT+1
      READ(13,102) FI(I),ES1(I),ES2(I)
   12 CONTINUE
C
      VOK=VO1/(1-.00211*(TO1-TE1))
      DO 13 I=1,NPKT
      PSI(I)=45-FI(I)
      PSI(I)=PSI(I)*3.141592654/180
      CK1(I)=(ES1(I)*ES1(I)-VOK*VOK)/(ES1(NPKT+1)*ES1(NPKT+1)-VOK*VOK)
      CK1(I)=CK1(I)**(2./SN)
      YK1(I)=(SQRT(CK1(I)-SIN(PSI(I))*SIN(PSI(I))))/COS(PSI(I))
   13 CONTINUE
```

```
      CALL SQRFIT(PSI,YK1,NPKT,A,B)
      WK25=A*.78539816+B
      DO 14 I=1,NPKT
      CK2(I)=(ES2(I)*ES2(I)-VOK*VOK)/(ES2(NPKT+1)*ES2(NPKT+1)-VOK*VOK)
      CK2(I)=CK2(I)**(2./SN)
      YK2(I)=(SQRT(CK2(I)-SIN(PSI(I))*SIN(PSI(I))))/COS(PSI(I))
   14 CONTINUE
      CALL SQRFIT(PSI,YK2,NPKT,A,B)
      WK35=A*.78539816+B
C
      WRITE(6,202)
      DO 15 I=1,NPKT
      WRITE(6,201)FI(I),PSI(I),CK1(I),ES1(I),YK1(I),CK2(I),ES2(I),YK2(I)
   15 CONTINUE
C
      WRITE(6,200)WK25,WK35
  200 FORMAT(/,' ','WK25 = ',F8.5,'  WK35 = ',F8.5)
  201 FORMAT(' ',F6.2,7E13.6)
  202 FORMAT(//,' ','DATEN FUER YAW FAKTOR BERECHNUNG',//)
  100 FORMAT(F5.2,I5,I3,I2)
  101 FORMAT(2F7.3)
  102 FORMAT(3F7.3)
      RETURN
      END
```