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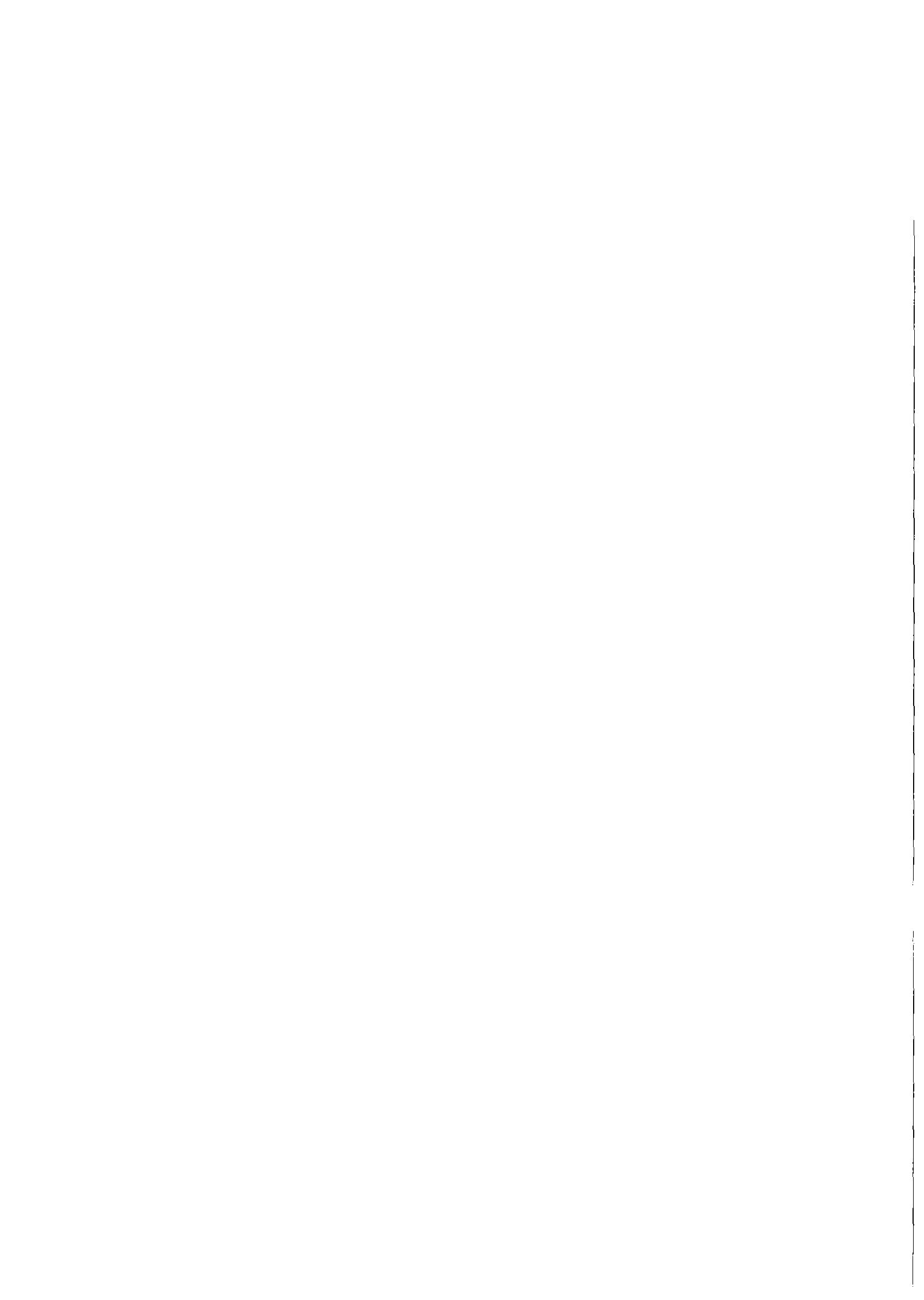
SAGAPO-A

Code Description

and User's Guide

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KERNFORSCHUNGSZENTRUM KARLSRUHE

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Abstract

This paper describes the new models inserted in the computer code SAGAPØ-A for the thermo-fluiddynamic analysis of gas cooled fuel element bundles. Moreover, it is intended to be a guide for the user of the code.

The physical background of the new models inserted in the code has been described by the author of this work in a previous paper.

A listing of the code is included in the Appendix.

SAGAPØ-A Beschreibung des Rechenprogramms und Benutzerhandbuch

Zusammenfassung

In diesem Bericht werden die in dem für die thermo- und fluiddynamische Analyse von gasgekühlten Brennelementbündeln neu eingefügten Modelle beschrieben.

Die physikalischen Grundlagen der in dem Rechenprogramm eingefügten Modelle wurden vom Verfasser dieses Berichts in einer vorherigen Arbeit vorgestellt.

Eine Liste des Rechenprogramms wird als Anhang gegeben.

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1. Introduction

SAGAPØ-A is an improved version of the computer code SAGAPØ /1/ for the thermo- fluiddynamic analysis of gas cooled fuel element bundles.

The most important improvements with respect to the earlier version of the code are: 1) the insertion of models for the calculation of the heat transfer due to radiation and 2) the heat conduction within the pins and the shroud. Further modifications regard the treatment of some physical phenomena, such as laminar flow and spacer grids effect on the heat transfer.

The physical models and the mathematical procedures used in the earlier version of the code are described in ref. /2/, while the physical phenomena relative to the improvements introduced in the last version were described by the author of this work in a previous paper /3/.

Further modifications are concerned with the structural part of the code, in order to allow the insertion of the new models and the interaction between the different parts.

Purpose of this work is:

- a) to describe the structure of the new developed models and the modifications performed on the code in order to allow their insertion
- b) to supply a guide to the user of the code.

To avoid repetitions, no description of the unchanged parts of the code will be given here. The reader is also supposed to be familiar with the ref. /1/ and, of course, ref. /2/ and /3/.

As pointed out in ref. /5/, SAGAPØ-A can run with dynamic dimensioning. However, in this work the dimension of arrays and vectors will be referred to the whole 19-rod bundle.

2. General informations

2.1 Geometries

In axial direction we consider first the physical subdivision of the bundle in axial portions; generated by the fact that the rods are only partially heated and only partially roughened: Fig. 2.1 shows the generation of the axial portions from the superposition of the heated/unheated and of the rough/smooth subdivisions.

Furthermore, the axial portions are subdivided, for a mathematical purpose, in axial sections: these represent the mesh used for the calculation in axial direction. The length of the axial sections is defined as factor X_D times the equivalent diameter of the central channels (cfr. 3.1 in /1/).

The flow section is subdivided into channels, subchannels and sub-subchannels, as described in ref. /1,2,3/. Figures 2.2 to 2.7 show the indexing of the channels and of the subchannels for some different bundles, both in the case where the calculation is performed for the whole bundle and in the case when the calculation is limited to a symmetry section.

The pins and the liner are subdivided, in circumferential direction, into sectors; these represent the part of the pin (or of the liner) adjacent to a subchannel. Figures 2.7 and 2.9 show the sector subdivision of pin and liner.

In radial direction the pins are subdivided in different manner depending on their nature: when the pin consists of a directly heated tube (KE4 and B193D bundles), no radial subdivision is performed. In this case, by assuming the inner wall adiabatic and the thickness of the tube small in comparison with the diameter, the one-dimensional Fourier's equation is solved, neglecting the temperature gradient in radial direction at this point of the calculation; a further correction is introduced to consider the position of the thermo-couples within the wall (cfr. ref./3/).

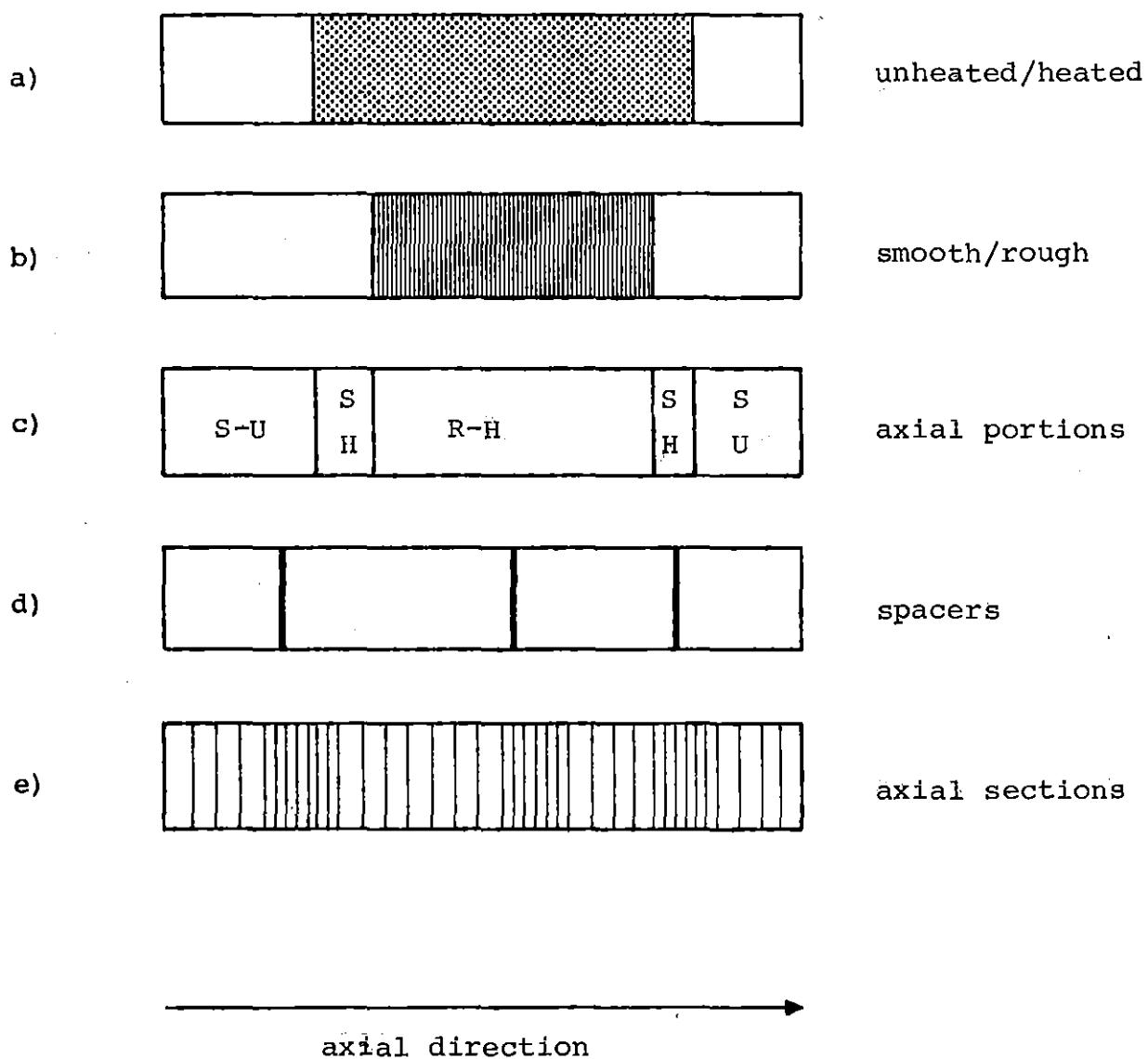


Fig.2.1: Definition of axial portions and axial sections.

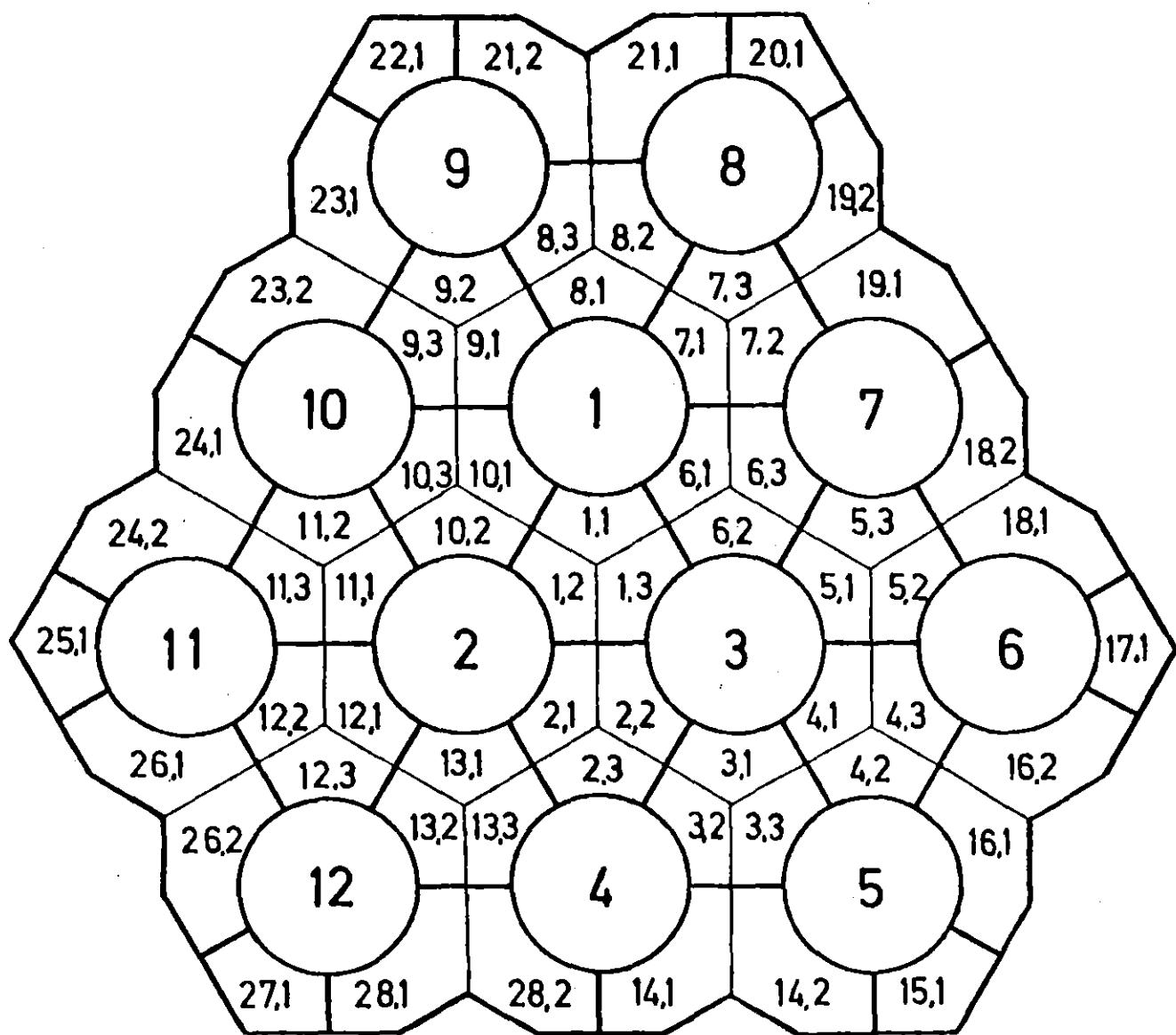


Fig. 2.8: Indexing of the channels and of the subchannels for the whole flow section of the 12-rod bundles.

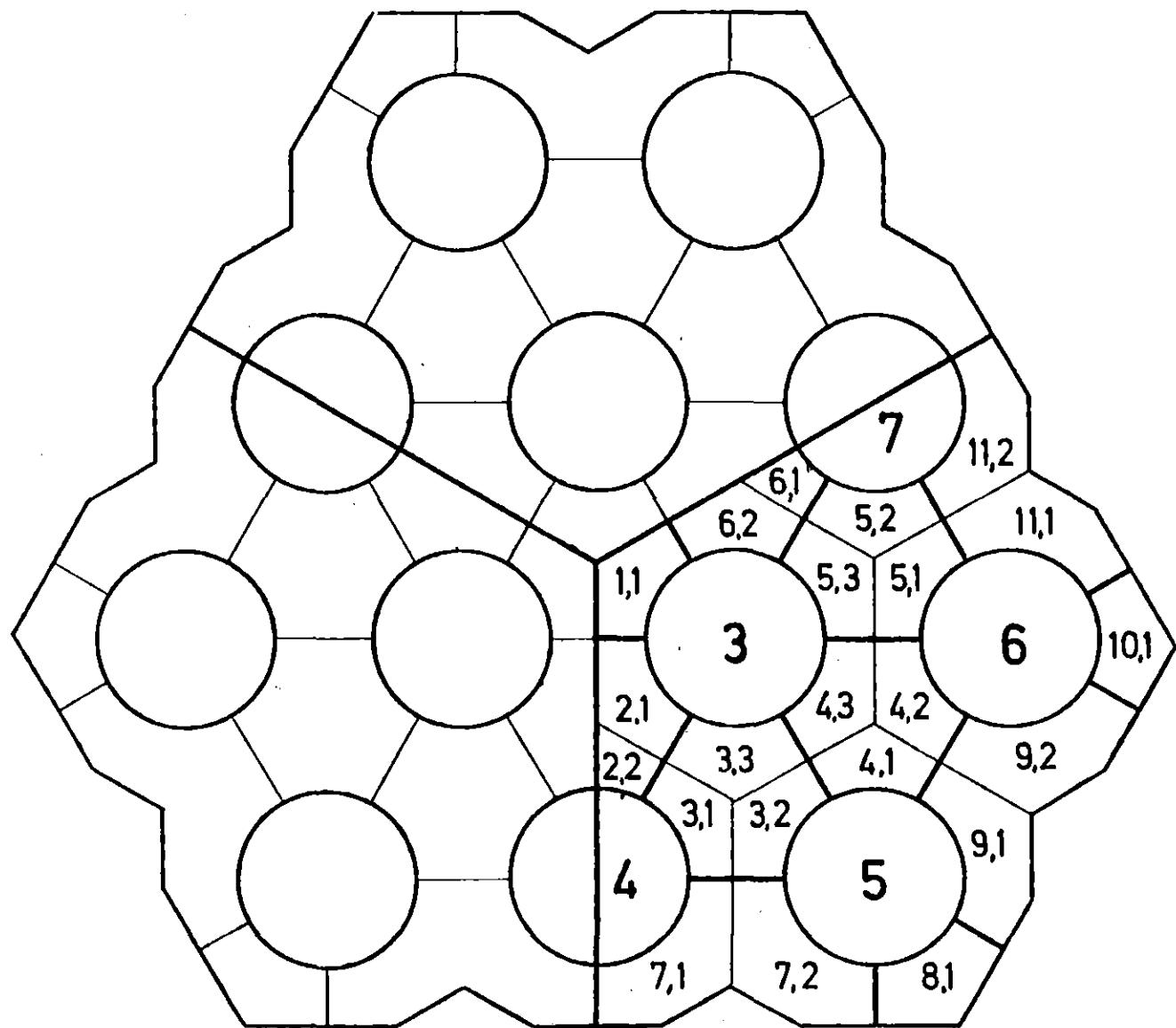


Fig. 2.3: Indexing of the channels and of the subchannels for 1/3rd of the whole flow section of the 12-rod bundles.

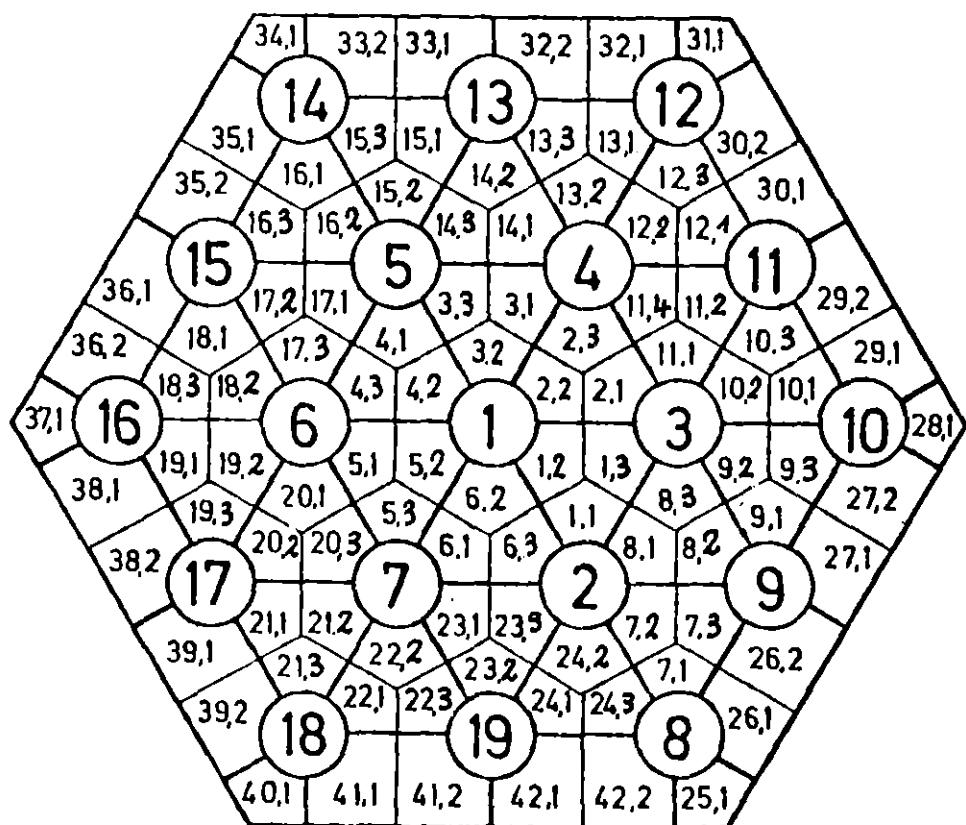


Fig. 2.4: Indexing of the channels and of the subchannels for the whole flow section of a 19-rod bundle

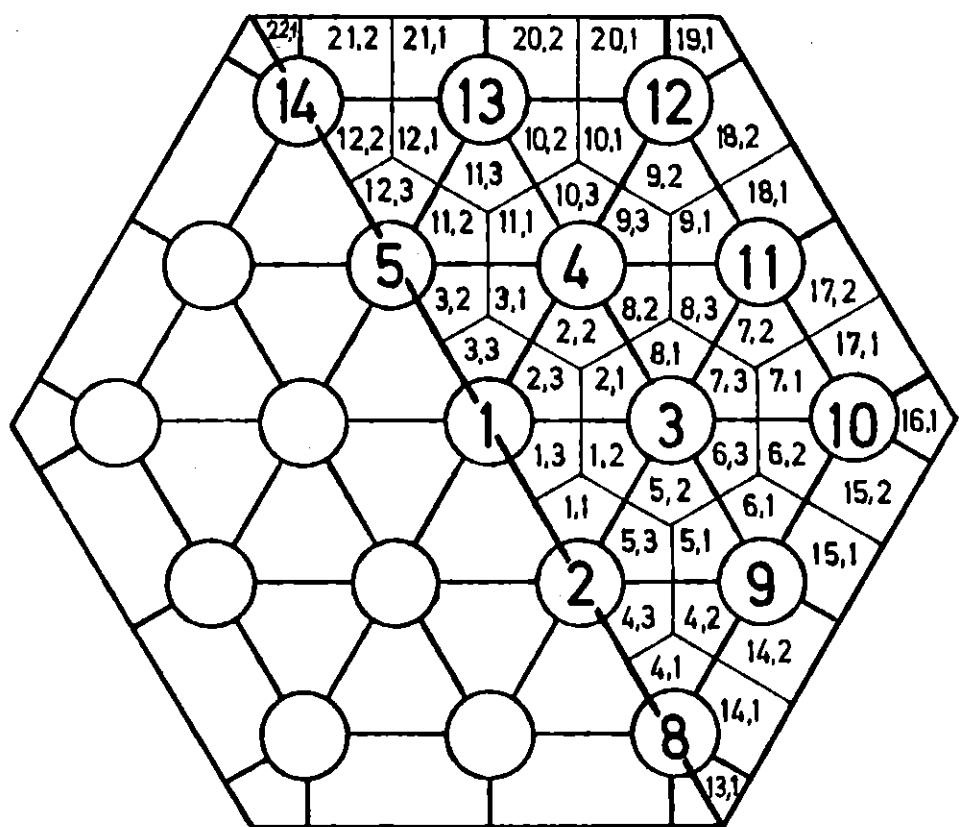


Fig.2.5: Indexing of the channels and of the subchannels for a half of the whole flow section of a 19-rod bundle.

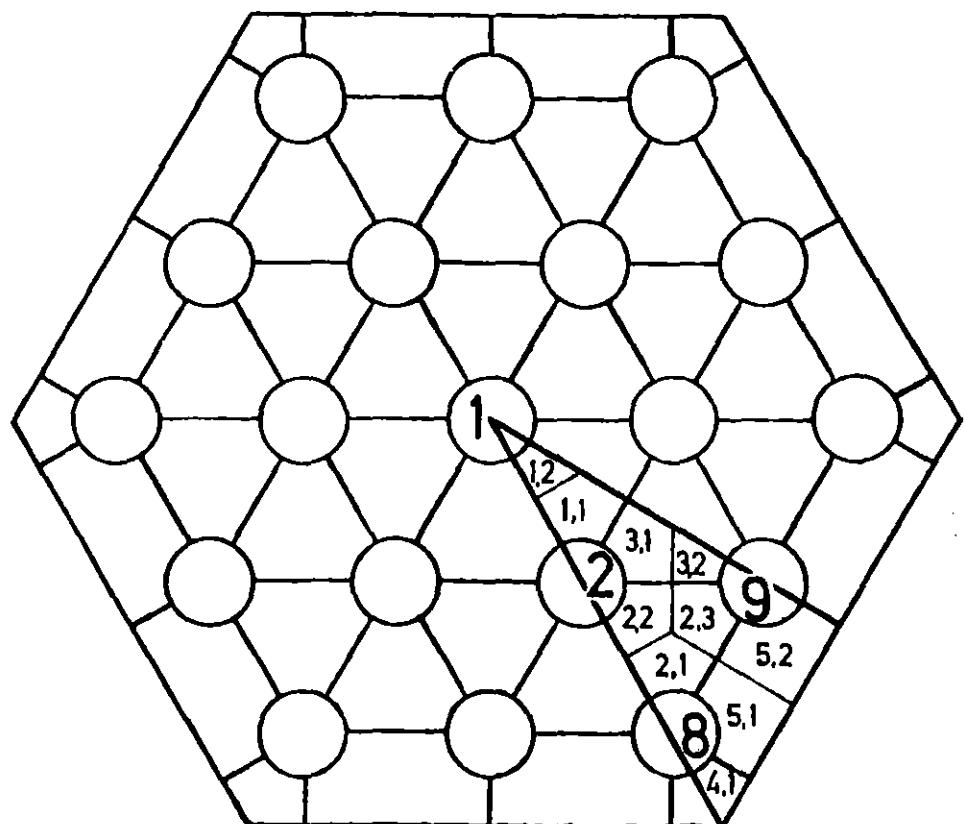


Fig.2.6: Indexing of the channels and of the subchannels for 1/12th of the whole flow section of a 19-rod bundle.

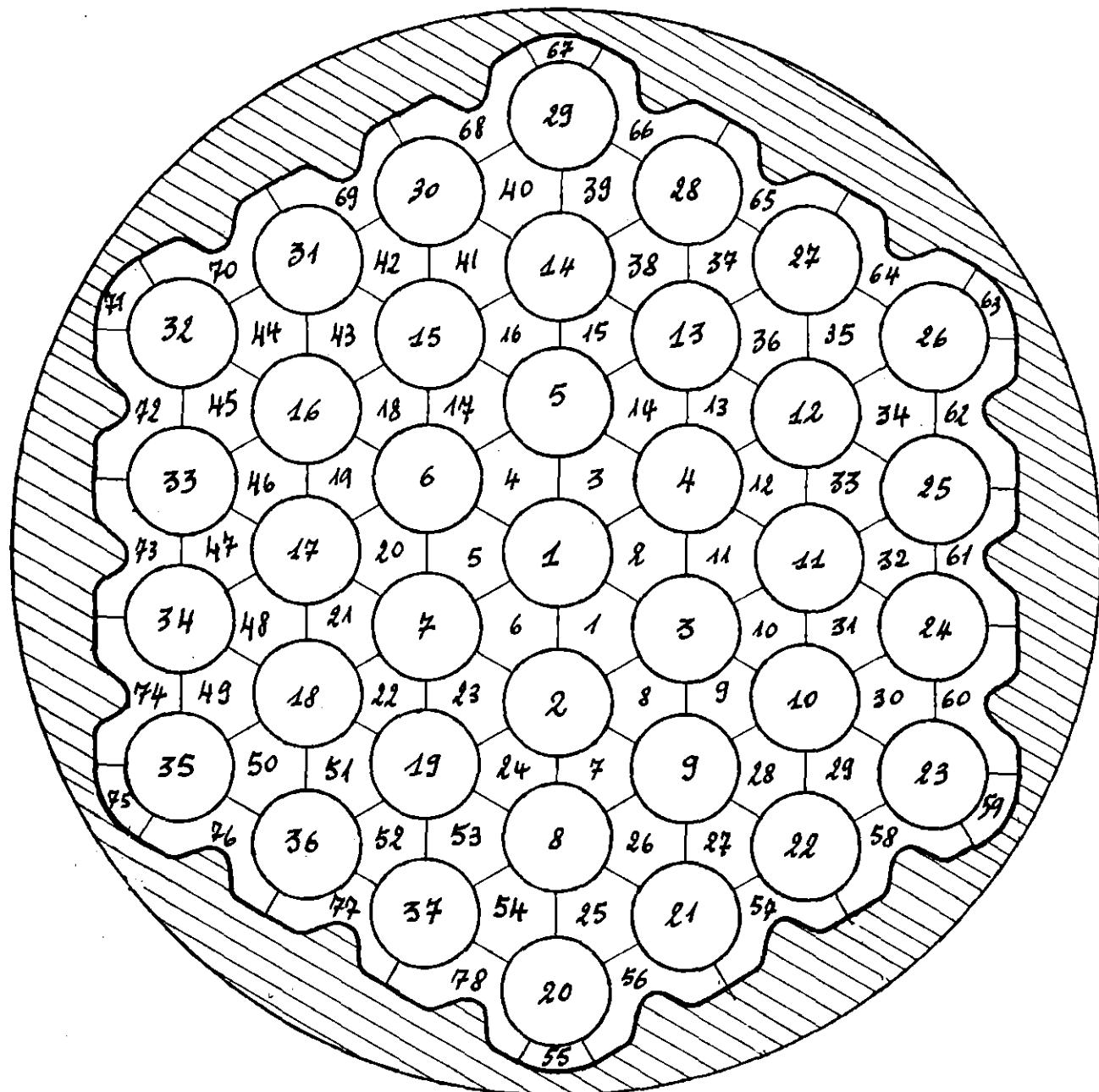


Fig.2.7: Indexing of the channels and of the rods for the whole 37-rod bundle.

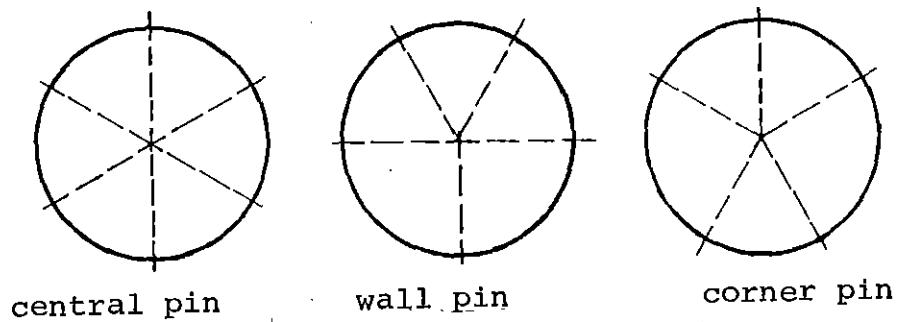


Fig. 2.8: Sector subdivision for the pins

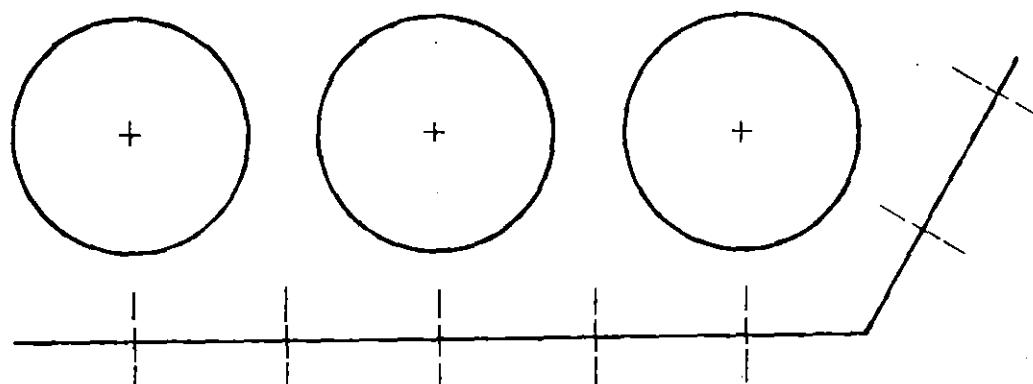


Fig. 2.9: Sector subdivision for the shroud.

If the pin consists of an inner generating core separated from the external tube by an insulated gap, the two-dimensional Fourier's equation is used.

Also for the thermal conduction within the shroud, no radial subdivision is performed: by assuming the thickness of the shroud to be small in comparison with the diameter, the problem is solved using the one-dimensional Fourier equations. The explained sector subdivision in circumferential direction is also used for the radiation calculation: the sector is the surface unit for the analysis of the radiation exchange.

The geometrical aspects of the convergence procedure are shown in fig. 2.10, where the general flow chart of SAGAPØ-A is presented: starting from the beginning of the bundle, each axial portion will be subdivided into axial sections. In each axial section the calculation is performed for each channel, subchannel and sector (SUB-CHANNEL ANALYSIS). When the convergence is reached (INDICE=0), the calculations goes on to the next section, until the end of the bundle is reached.

2.2 Recall of the solution method

As described in /3/, the solution of the thermo- and fluiddynamic problem is obtained separating the different phenomena: as shown in fig.2.11, at each axial section, at the beginning of the calculation, the convective heat flux relative to each sector is computed as geometrical function of the heat generated within the pin (or within the shroud).

On the basis of these heat fluxes, the flow problem is solved for the distributions of mass flow, gas temperature, and pressure loss. In this step also the convective heat transfer coefficients are

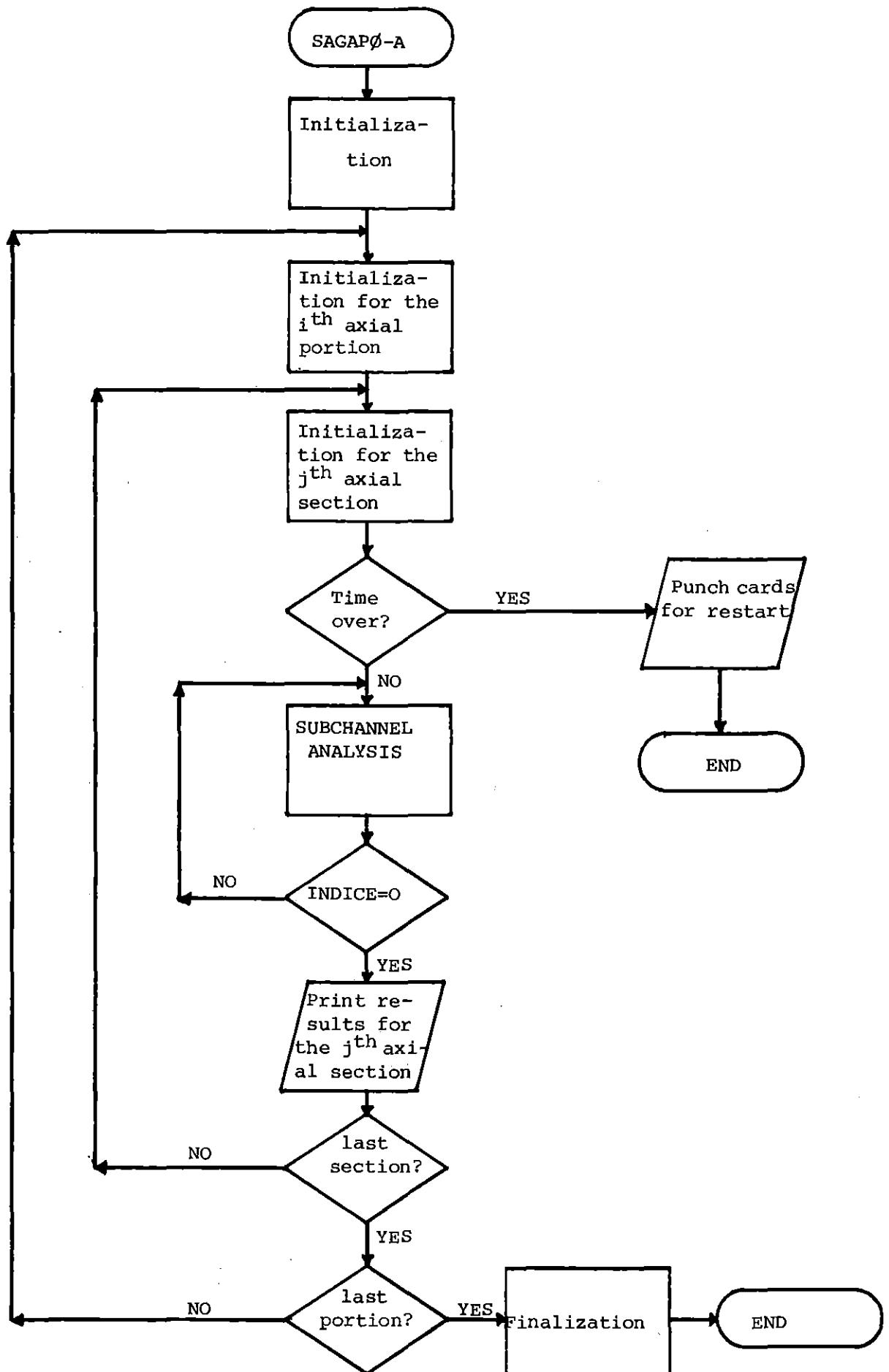


Fig. 2.10: Schematical flow chart of SAGAPφ-A

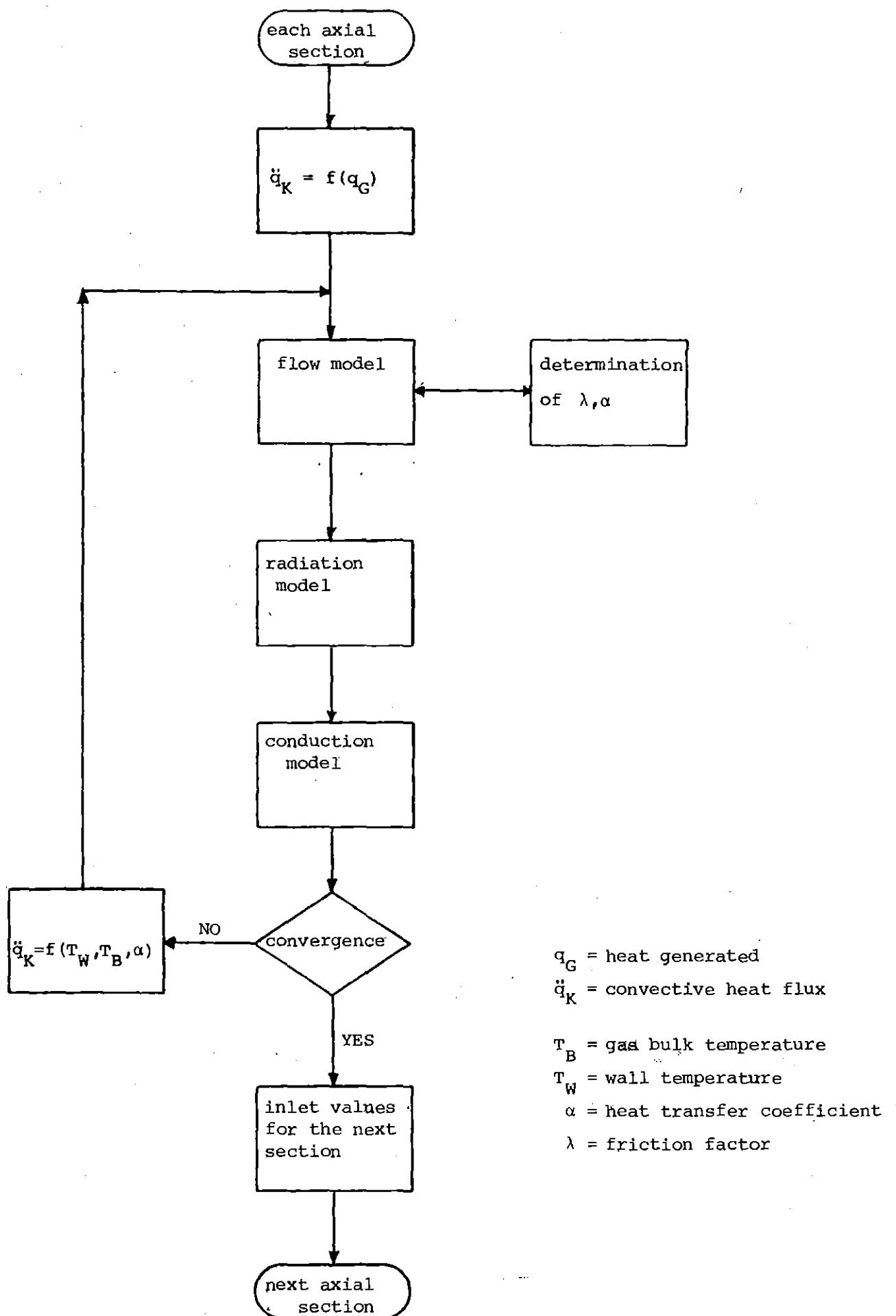


Fig. 2.11: Separation process for the different heat transfer modes.

computed. It is therefore possible to compute approximate values for the wall temperatures. Using these wall temperatures as boundary conditions, it is possible to solve the radiation problem for the heat exchanged by radiation.

At this point, the thermal conduction equations are solved, using the bulk temperatures, the radiative heat fluxes and the heat transfer coefficients as boundary conditions.

The convergence is now tested (for pressure drop, bulk and wall temperatures), and, if no convergence is achieved, the convective heat fluxes are calculated one more time as a function of the heat transfer coefficient and the bulk and wall temperatures. The process is now repeated, until the convergence is reached. With reference to the figures 2.12 and 2.10 it must be pointed out that the flags INDICE, IFLØW and IHEAT are used just to explain the convergence process: they do not correspond to the flags really used in the code. This is due to the fact that the convergence process in the code is slightly (but merely formally) different from the process shown here.

2.3 Structure of the code

The flow chart of the procedure explained in the previous paragraph is shown in the figures 2.12 to 2.14.

The main connexion between the earlier version of the code and the new models is given by the subroutine TEMCØN, which organizes the thermal calculation.

At the beginning, TEMCØN (see fig. 2.13) calls the subroutine WALLTE, which computes the heat transfer coefficients and a first approximate value for the wall temperatures. WALLTE is a modified version of the subroutine with the same name present in the earlier version of the code. Then TBRTBS computes the dummy bulk temperatures (cfr. 5.5 in ref. /3/) and RADIA organizes the calculation for the radiation problem. The option IRAD allows neglecting the radiation calculation.

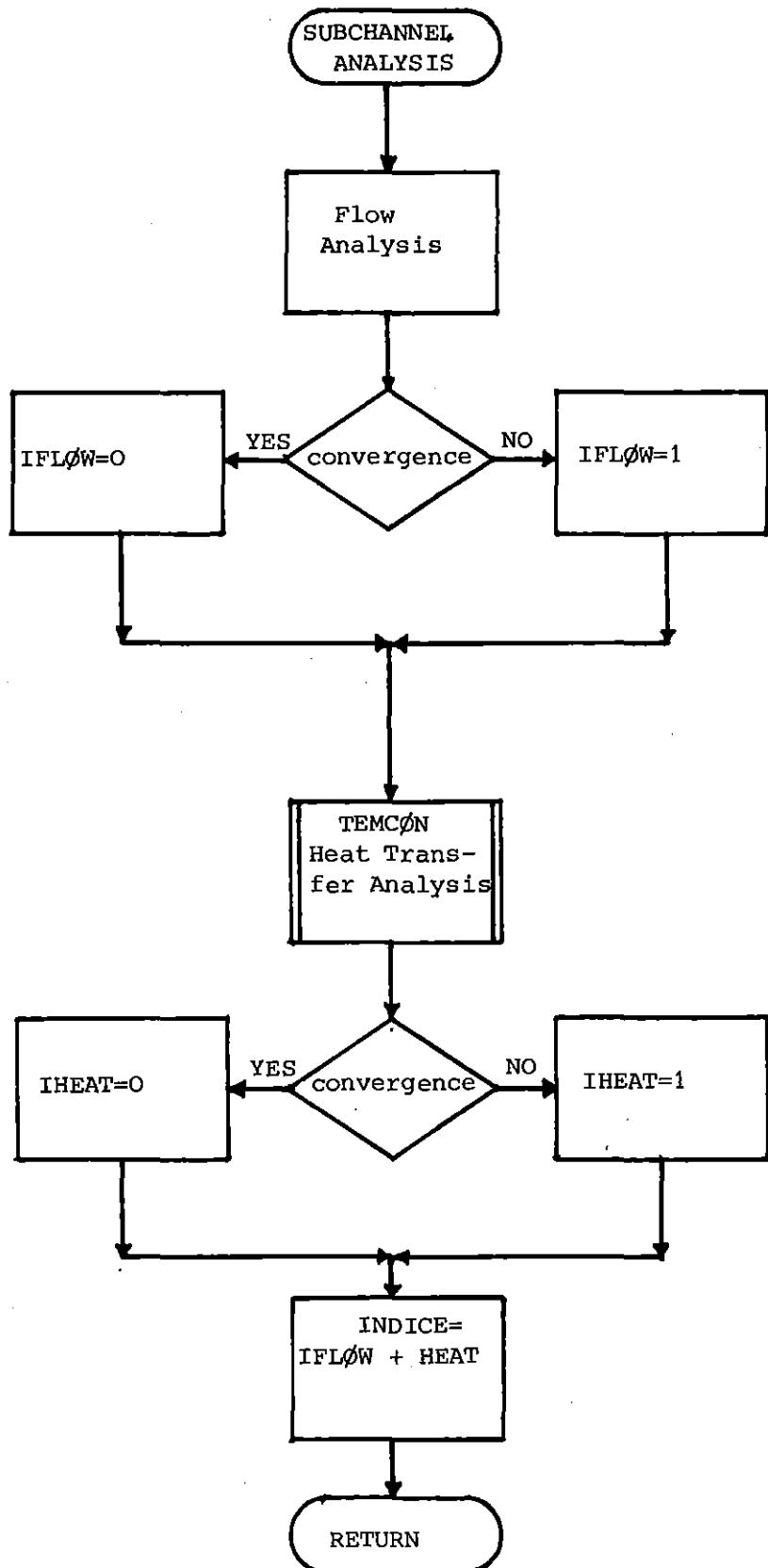


Fig. 2.12: Schematic flow chart of the loop ITCORR (subchannel analysis).

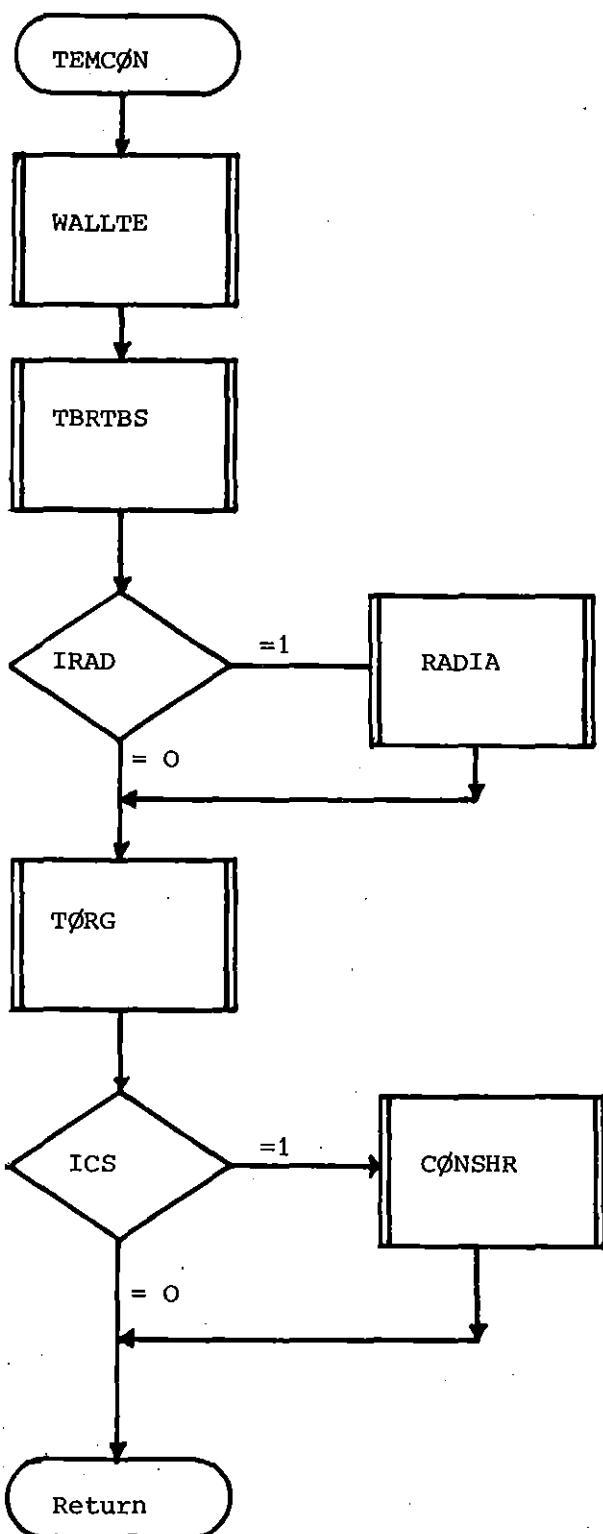


Fig. 2.13: Schematic flow chart of the subroutine TEMCØN

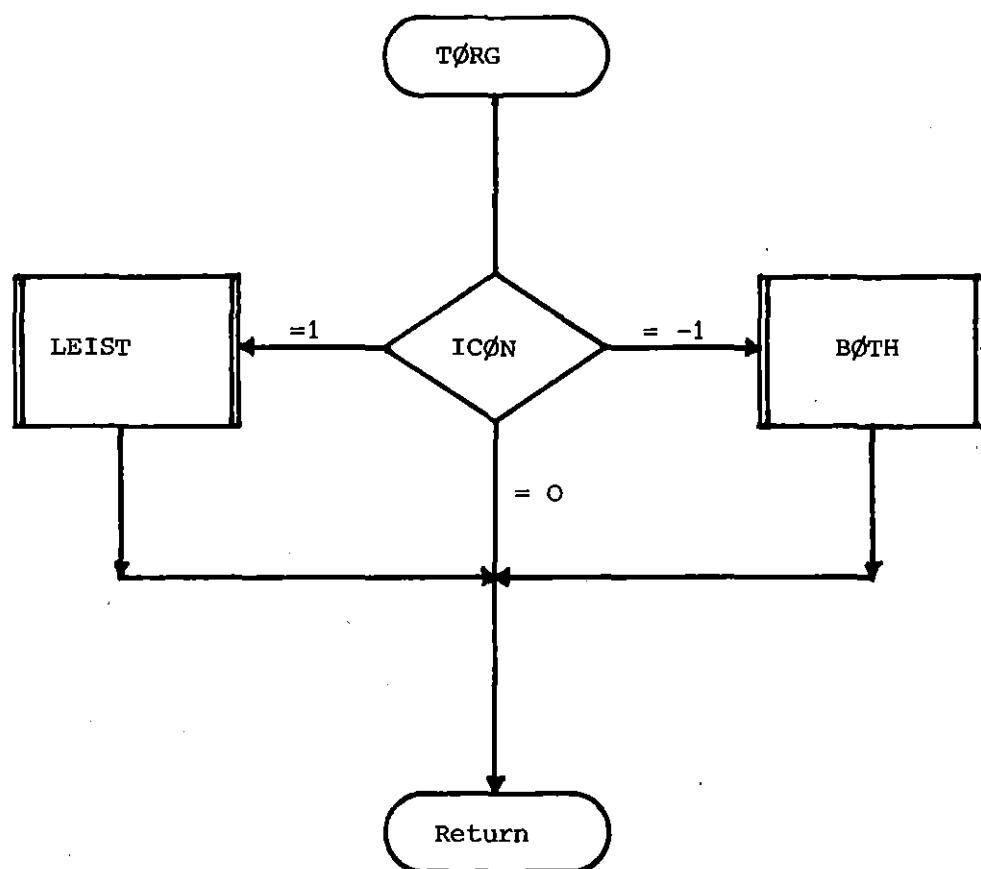


Fig. 2.14: Flow chart of the subroutine TØRG

The subroutine TØRG (see also fig. 2.14) determines the conduction model to be used depending on the option ICØN: the subroutine LEIST performs the one-dimensional analysis, while BØTH uses the two-dimensional approach in the case of central heated core. Also the thermal conduction can be neglected (ICØN=0), but in this case no radiation calculation is allowed. Finally, the subroutine CØNSHR organizes the calculation for the thermal conduction within the shroud, also under the option ICS.

3. Input/Output

In fig. 3.1 the input/output files of SAGAPØ-A are shown.

The input is provided as "INPUT DATA", whose records are read from the code, and "BLOCK DATA". The main modifications of the input parameters, with respect to the earlier version of the code, have been performed on the "BLOCK DATA".

The output files consist of a LISTING, partly modified with respect to the earlier version, of the files RESULTS*4, where the results of the calculation are stored for further plotting and comparison with experimental results, and of the file RESTART which are automatically written by the code if the available calculation time is going to be exceeded.

3.1 INPUT DATA

The geometrical data of the bundle and the thermo- and fluiddynamic conditions of the case to be computed are mainly given in this file.

No significant modifications have been performed with respect to the earlier version of the code. The changes are concerned with the following items:

- a) A new card must be inserted before the first card in ref. /1/. Any text can be written in this new card, no use of which will be done by the code: the card allows the identification of the block of input cards.
- b) Cards 39,40 and 41 (and 39a, 40a, 41/a etc) have been eliminated. Moreover no use of the parameters GRIP, GRI1 and GRI2 is done in the present version of the code. These parameters are automatically set to 1.

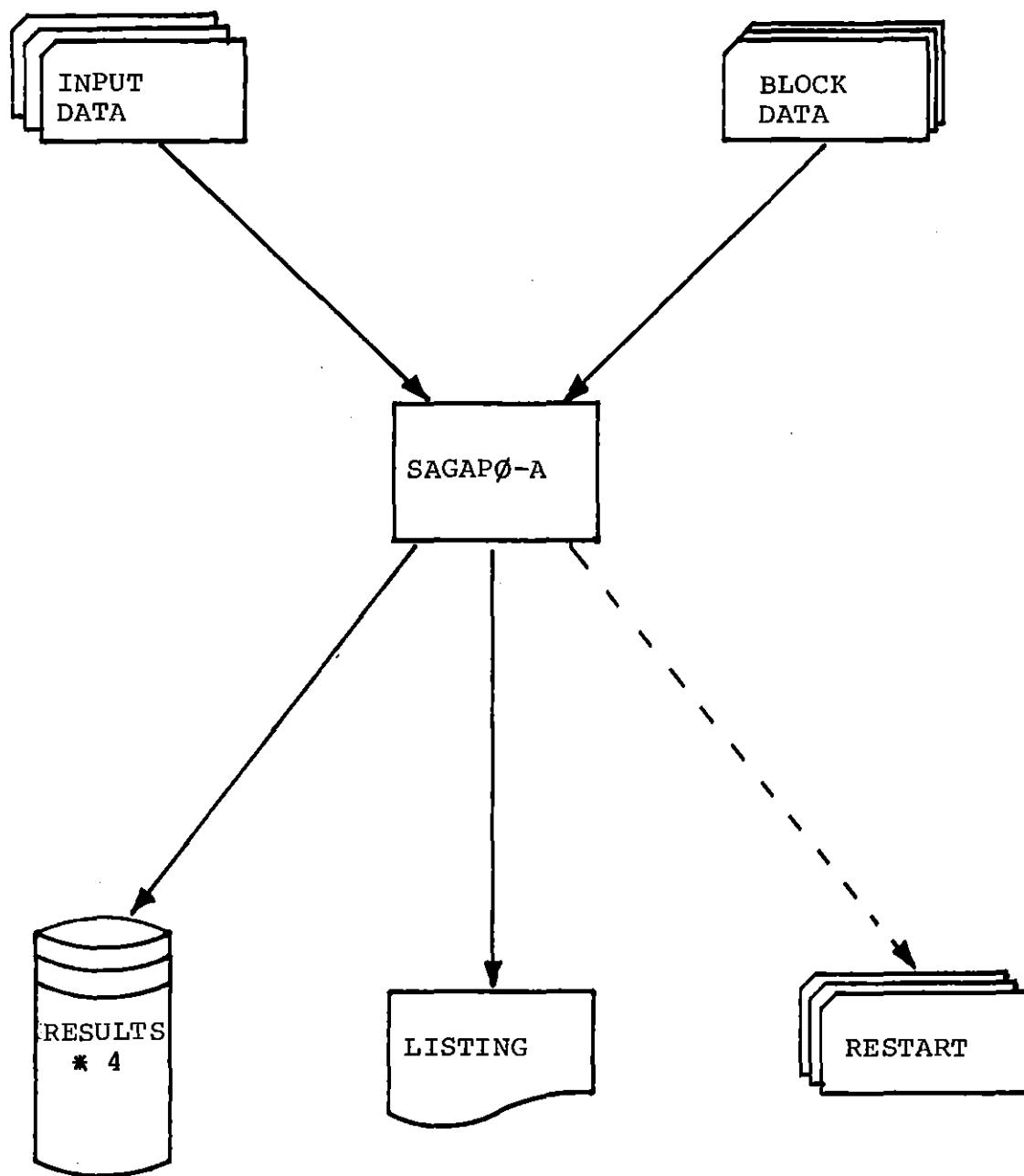


Fig. 3.1: Input/output for SAGAPØ-A

3.2 BLOCK DATA

The BLOCK DATA has been strongly expanded with respect to the earlier version. Actually, it provides the options for the calculations, the coefficients for some functions and, in some cases, arrays concerned with the indexing of the bundle.

The new parameters to be provided in the BLOCK DATA (beyond the parameters already described in /1/) are listed in Tab.3.1.

According to /1/, in case of a 12-rod bundle further parameters are to be provided in BLOCK DATA.

If a symmetry section of the bundle (12-rod bundle case) is computed, also the parameters listed in Tab. 3.2 are to be provided in BLOCK DATA. Differently from the other parts of the paper, in this table the dimensions of the arrays are referred to 1/3 of the whole 12-rod bundle.

COMMON BLOCK	ARGUMENT	EXPLANATION
SCO4C	RFUEL	Radius of the heated pin core (fuel); it corresponds to r_f of fig. 5.1 in /3/ (cm)
SCO6C	D3(3)	Coefficients for the thermal conductivity of the cladding material ($K = D3(1) + T \cdot D3(2) + T^2 \cdot D3(3)$).
SCO9C	IS	IS=1 The superposition principle for the external channels (cfr. 5.5 in /3/) is to be used. IS=0 no superposition principle
SC18C	RE, RI, ALFW, ALFC	RE = outer radius of the ring corresponding to the liner (cfr. 5.3 in /3/) (cm) RI = inner radius of the liner equivalent ring (cm) ALFW = angle (in radians) corresponding to 1/2 of a wall channel: $2 * RI * ALFW$ = perimeter of a wall channel ALFC = angle in radians corresponding to a corner channel.
SC19C	ICØN	ICØN = 1 Conduction within the clad ICØN = -1 Conduction within core and clad ICØN = 0 no conduction
SC22C	NTØT	Total number of sectors in the shroud
SC23C	ICS	ICS = 1 conduction in the liner ICS = 0 no conduction in the liner
SC25C	NPRINT AR(10)	NPRINT < 0 Print results at each axial section NPRINT = 0 Print results between the positions defined by $AR(1) \leq x \leq AR(2)$ NPRINT > 0 (≤ 10) Print results at the axial sections corresponding to $AR(1), AR(2), \dots, AR(NPRINT)$
SCO2L	JLAM	JLAM = 1 The K values for the laminar friction factor for corner and wall channel are averaged (cfr. 3.3.2 in /3/). JLAM = 0 no average

Tab. 3.1: New COMMON BLOCKS in BLOCK DATA

COMMON BLOCK	ARGUMENT	EXPLANATION
SCO3L	IPHUD	IPHUD = 1 Heat losses at the shroud are computed by means of the EIR method. IPHUD = 0 Heat losses at the shroud are given by input.
SCO4L	TAMB, HUDFAC, TMS	TAMB: Room temperature during the experiment (C) HUDFAC: total heat transfer coefficient between liner and room ($\text{cal sec}^{-1} \text{cm}^2 \text{C}^{-1}$) TMS: average shroud temperature (C)
SCO5R	IRAD	IRAD = 1 Thermal radiation is taken into account IRAD = 0 no thermal radiation
SC15R	IEPS	IEPS = 0 constant emissivity for the pins and on the shroud sectors. IEPS = 1 emissivity as function of the temperature
SCO7R	EPSR, EPSS, SIGMA	EPSR = constant value assumed for the rod emissivity (if IEPS = 0) EPSS = the same as EPSR, but for the shroud SIGMA = Stephan-Boltzmann constant ($1.35 \times 10^{-12} \text{ cal cm}^{-2} \text{ sec}^{-1} \text{ K}^{-4}$)
SCO1S	IHAS	IHAS = 1 the correlation for the heat transfer improvement due to the spacer is based on the local Re , Pr , ϵ , D_h . IHAS = 0 the spacer correlation is based on average Re , Pr , ϵ , D_h
SC16R	ICOMP	ICOMP = 1 The view factors are normalized by modifying each factor. ICOMP = 0 The normalization is performed by introducing the dummy factor f_{ii} (cfr. 4.3.2 in /3/).

Tab. 3.1: Cont.

COMMON BLOCK	ARGUMENT	EXPLANATION
SCO1P	S(19)	<p>Alternative method to define non-uniform power distribution in the pins: instead to read Q(I), I=1,NRØDS als input data, it is possible to read only one Q and to define the vector S; for each pin it will be</p> $Q(I) = Q + S(I)$ <p>This method was used for the 19-rod bundle calculation by <u>uniform</u> heating, to consider the slight power differences between the pins.</p>
CEVO1	LAMOP1	<ul style="list-style-type: none"> = 2 in laminar flow, the spacer smooth correlation for the pressure loss is used in the rough part too = 1 spacer rough correlation in the rough part
CEVO3	LAMOP2	<ul style="list-style-type: none"> = 1 corrections for gas thermal conduction between the ribs = 2 no correction
CEVO4	LAMOP3	<ul style="list-style-type: none"> = 1 for laminar flow = 2 for turbulent flow
CEVO2	RTIP4	Tip radius of the rough part of the pin (cm).
SC34C	ISUC	<ul style="list-style-type: none"> = 1 Superposition principle for the central sectors (cfr. 7.45) = 0 No superposition principle for the central sectors
SCO2P	IPSUB	<ul style="list-style-type: none"> = 1 New and old print for the subchannel variables = 0 only new print

Tab. 3.1: Cont.

COMMON BLOCK	ARGUMENT	EXPLANATION
SCO1C	NCAN(12) : LIPS(12,10) :	NCAN(J) : number of channels adjacent to pin 5 LIPS(J,K) : index of the K TH channel adjacent to pin J. LIPS is used for the conduction calculation: the channels LIPS(J,K) must be contigues
SC13R	NAFF(30)	NAFF(J) number of sectors interacting with sector J through radiation
SC14R	KAFF(30,13)	KAFF(J,K) : index of the K TH sector interacting through radiation with sector J.

Tab. 3.2: Parameters to be provided in BLOCK DATA only in the case of 1/3 of the whole 12-rod bundle.

3.3 Listing

Many modifications have been introduced in the listing produced by the code. The main modifications regard the following items:

- a) View factors information: at the beginning of each axial portion the computed view factors are printed together with their sum and the result of the normalization.
- b) The subchannels variables can be printed by means of a new method using the three subroutines JELLA, JELLB, JELLC (cfr. also COMMON Block SCO2P in 3.2).

The subroutines JELLA supply the following results:

CHA	Channel index
ROD	rod index
QGEN	Heat generated in the portion of pin corresponding to that sector /W/.
QFLUX	Convective heat flux, also $\frac{QGEN + QJ}{AREA}$ /W cm ⁻² /
QRAD	Heat exchanged through radiation /W/. QRAD > 0 means heat transmitted to the sector.
NU	Nusselt number: it corresponds to the final value, i.e. it is modified by spacer effect and inlet effect (if any).
YH	Spacer effect: NU = YH * NUO
ALFA	Heat transfer coefficient based on NU. /W cm ⁻² C ⁻¹ /
TBULK	Subchannel bulk temperature /°C/
TBR	Subchannel reference temperature /°C/; as described in 5.5 of /3/ it is: $QFLUX = ALFA * (TWINF - TBR)$
TWINF	Sector wall temperature at the infinite conductivity of the canning material /°C/.
TWALL	Temperature at the position where the thermocouple is placed (also TWALL is corrected for the Biot effect, cfr. 5.8 in /3/, and for the conduction in radial direction cfr. 5.9 in /3/).

The same results are printed for the shroud sectors; in this case YH is always set to 1 because no spacer effect on the Nu number of the shroud is considered.

The subroutine JELLAC supplies the following results:

CHA	channel index
RØD	rod index
QTRA	Heat transmitted to the subchannel by the adjacent pins and shroud /W/.
MASS	Mass flow rate in the subchannel, average on the axial section /g sec ⁻¹ /
CP	Specific heat of the coolant /J g ⁻¹ C ⁻¹ /
T2-T1	Temperature increase in the coolant between the inlet and the outlet of the axial section /°C/
LAMDA	Subchannel friction factor (4 times the Fanning friction factor).
DP	Pressure loss in the subchannel /Bar/
REB	Subchannel Reynold's number
DENSITY	Density of the coolant /g cm ⁻³ /
TH.CØND.	Thermal conductivity of the coolant /W cm ⁻¹ °C ⁻¹ /
ETA	Dynamic viscosity of the coolant /g cm ⁻¹ sec ⁻¹ /.

Subroutine JELLC supplies the following data:

CHA	channel index
RØD	rod index
H+B	h^+ evaluated at the bulk temperature of the coolant
H+W	h^+ evaluated at the wall temperature
RSM	$R(h_W^+)$ in case of hydraulically smooth flow
RO1	Parameter $R_{O1}(h_W^+)$
RH+	Parameter $R(h_W^+)$
GO1	Parameter $G_{O1}(h_W^+)$
GH+	Parameter $G(h_W^+)$
TW/TB	Wall to bulk temperature ratio
TW/TE	Ratio between wall and inlet temperature
BIOT	Biot number (cfr. 5.8 in /3/).

These subroutines are called only in case of heated sections.
Once more, JELLC is called only in case of rough surfaces.

- c) At the end of the calculation some data referred to the general heat balance are printed.

3.4 RESULTS*4

To allow the generation of a graphical output, the results of SAGAPØ-A (wall temperatures and pressure drop) are stored in 4 files on a disk. The plot procedure, which also allows the comparison with the experimental results, is described in Ref. /5/.

The four files are written in free format and contain index, axial position and value to be plotted. A description of these files is shown in Tab.3.3; for more information cfr. ref. /5/.

File	Format	Contents	Note
FTO2FO01	free	X,DP	DP = pressure drop at height x
FTO3FO01	free	NS,M,X,T	T = wall temperature of the sector of pin adjacent to subchannel M of channel NS at the height X
FTO4FO01	free	NW,M,X,T	T = wall temperature of the sector of liner adjacent to subchannel M of wall channel NW at the height X
FTO9FO01	free	NW,M,J,X,T	T = wall temperature of the surface adjacent to the part J of subchannel M of wall channel NW at the height X

Tab. 3.3: Output files RESULTS*4

3.5 RESTART

This procedure was already present in the earlier version of the code. If the given calculation time is almost used up, the cards with the mass flow rate - and temperature distribution are punched. This procedure allows the restart of the calculation. Because this procedure was not modified, the description given in Ref. /1/ is still valid and no more details will be presented here.

4. Thermal conduction model

4.1 Conduction within the pins

As previously pointed out, two conduction models are available: the first one (one-dimensional model) is organized by the subroutine LEIST, while the calculations for the two-dimensional model are performed by the subroutine BØTH.

In fig.4.1 the flow chart of the subroutine LEIST is shown. The subroutines ALFAC and FGEØ determine the heat transfer coefficients (in the form requested by the following part of the code) and some geometrical factors. Then the coefficient matrix is built up and the resulting system of linear equations is solved by the subroutine GAUSS1. GAUSS1 solves the system of linear equations by means of the Gauss elimination method with pivotal condensation /8/.

TNEW assignes the computed temperature values to the arrays used in the other parts of the code and QCØC builds up an array (QJ) for the definition of the modified convective heat fluxes. In fact, the convective heat fluxes are defined as

$$\ddot{q} = \frac{q_{GEN} + QJ}{AREA}$$

At the first iteration is QJ = 0.0 (cfr. 2.2 and fig.2.12).

In the following iterations, QJ is defined by QCØC and \ddot{q} results a function of radiation and conduction as well. QCØC also performs the control on the thermal balance.

In case of two-dimensional model, as shown in fig.4.2, together with ALFAC and FGEØ, also the subroutine KGAP is called, which computes the heat transfer coefficient at the gap between core and clad.

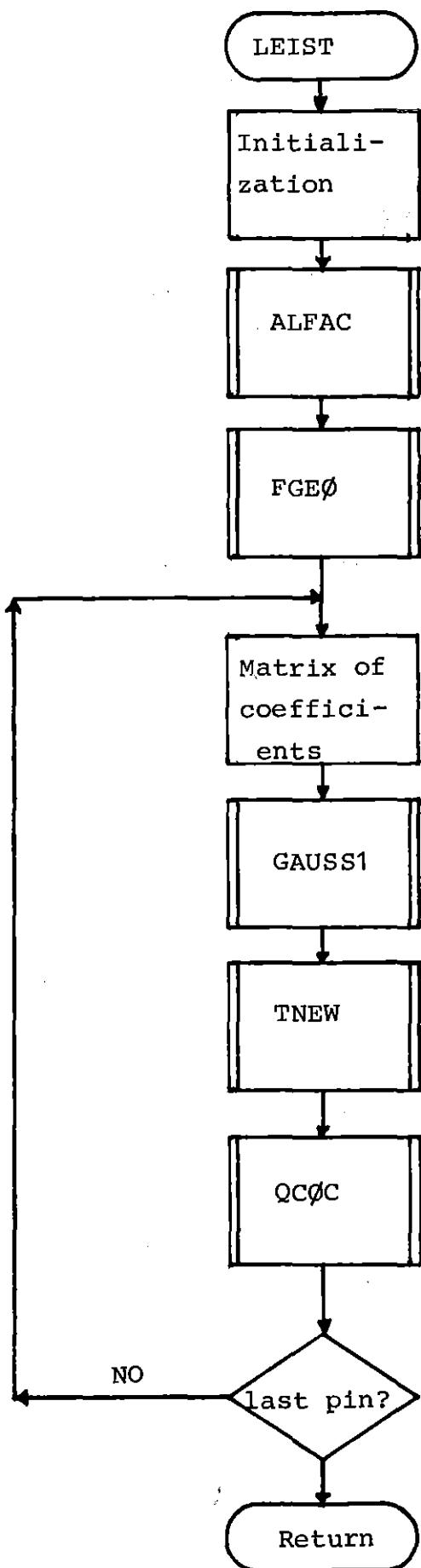


Fig.4.1: Flow chart of the subroutine LEIST

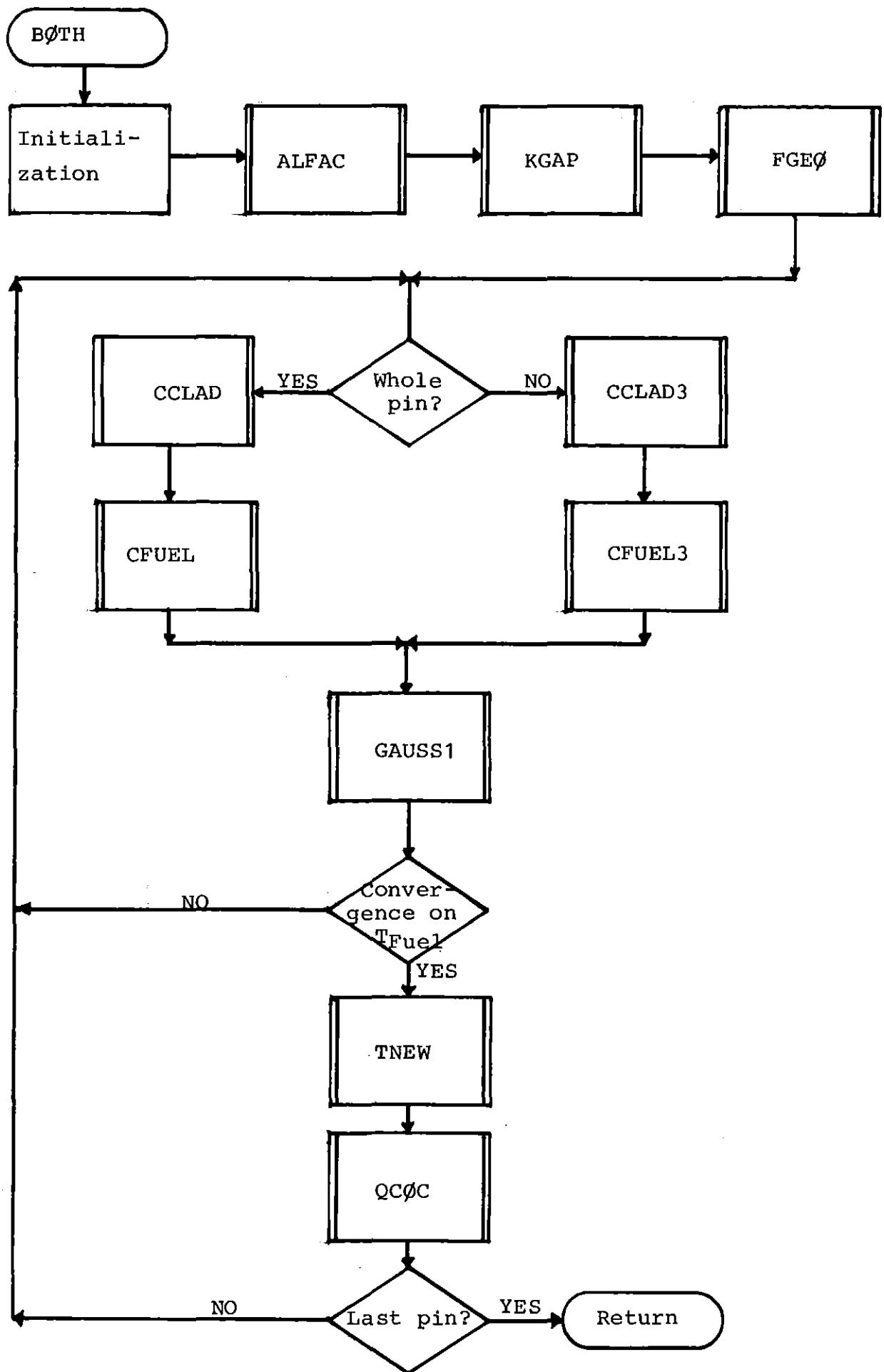


Fig. 4.2: Flow chart of the subroutine BØTH

The coefficient matrix is built up by the subroutines CCLAD (coefficient for the clad) and CFUEL (coefficient for the heated core). When the calculation is limited to a symmetry section of the whole bundle, for some of the pins the calculation is also restricted to a symmetry section of the pin. In this case the subroutines CCLAD3 and CFUEL3 are called.

Then the subroutine GAUSS1 solves the system and the convergence on the core temperature is tested. When the convergence is reached, the calculation goes on with TNEW and QCOC.

4.2 Conduction in the shroud

The calculation of the thermal conduction within the wrapper tube is organized by the subroutine CONSHR (see fig. 4.3).

As pointed out in 5.3 of /3/, the shroud is considered to consist of a ring, whose dimension must be given in BLOCK DATA (cfr. COMMON block /SCISC/), together with the angles corresponding to a half wall sector and to a whole corner sector.

The coefficient array is built up by the subroutine MATBUS and the system is solved by the subroutine GAUSS. GAUSS is a slight modification of the subroutine GAUSS1, the difference consisting in the method used to transfer the matrix of the coefficients.

Subroutine TNEWS assignes the computed values to the temperature array and QDEFIS computes the array for the definition of the modified convective heat fluxes (in analogy to QCOC in 4.1). QDEFIS performs also the control of the thermal balance.

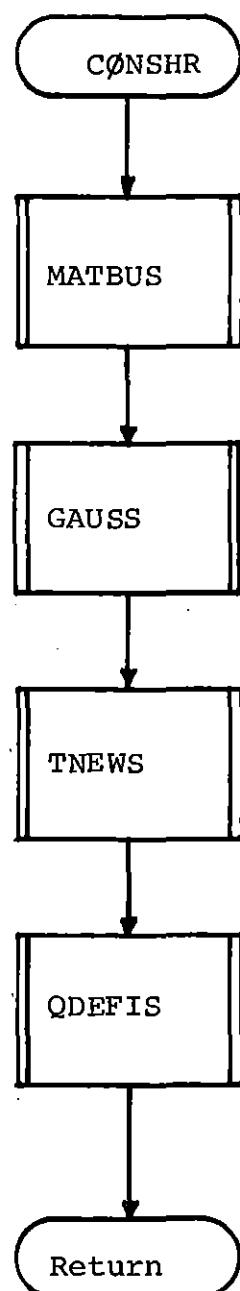


Fig. 4.3: Flow chart of the subroutine CØNSHR

4.3 New subroutines and modifications

The subroutines concerned with the conduction problem are:

LEIST, ALFAC, JZURU, KGAP, CCLAD, FGEØ, KFUEL, CFUEL, TESTNU, TNEW,
CCLAD3, CFUEL3, QCØC, TESTB, TESTW, ASSE, TEST1, MEZZI, TTØT, TØRG,
BØTH, CØNSHR, MATBUS, TNEWS, QDEFIS, GAUSS, PIVØT, GAUSS1, PIVØT1,
DELIP, TBRTBS.

To allow the insertion of the conduction model the following subroutines have been modified:

MAIN, ANGCA1, BALA, CEWA, RECANG, RECCA1, RECCA2, SUBBAL, TRICA1,
WALLTE.

5. Radiation model

5.1 General information

The radiation calculation is subdivided into two parts: the determination of the connexion arrays (which sector exchanges with which etc.) and the solution of the problem (determination of the heat transferred by radiation).

For the first purpose, five subroutines are called by the main program at the beginning of each axial portion.

TOTSEC: computes the total number of sectors.

TARRAY: builds up the arrays (ISU,IGI,ISS) which allow the interaction between the flow model and the radiation model.

VFXAL: computes the view-factors

VFDET: determines the sectors exchanging with each other
the relative view-factor type.

VFCTR: controls the produced arrays

The problem is then solved by the subroutine RADIA (see fig. 5.1): within it, MATBUI builds up the array of coefficients and SYSØL solves the system of linear equations by means of the Gauss-Seidel method /6/. For the solution of the radiation system, the Gauss-Seidel iterative method has been preferred to the Gauss elimination method because of the sensible decrease of storage requirement allowed by the iterative method.

It must be pointed out, that if EPSR \neq EPSS (see later 4.2) the sufficient convergence condition for the Gauss-Seidel method is not fulfilled: in this case you will get a warning on the listing, but the calculation will nevertheless be performed by means of the Gauss-Seidel method: in all the calculations performed up to now no convergence problems occurred also if the sufficient convergence condition was not fulfilled. QDEFI builds up the arrays QPR, QSR (heat exchanged by radiation for pin and shroud sectors) and performs the thermal balance.

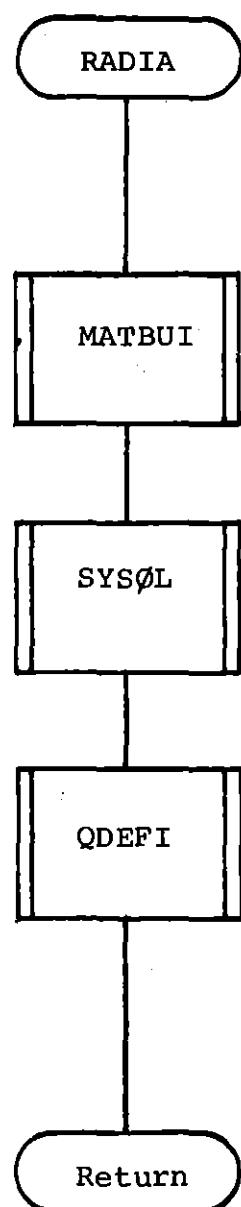


Fig. 5.1: Flow chart of the subroutine RADIA

For the solution of the radiation problem, the emissivity must be provided (see later 5.2) and the option ICOMP must be defined in BLCK data (see 3.2). The option ICOMP is concerned with the problems discussed in 4.3.2 of ref. /3/. No great differences between the two approaches have occurred up to now in the SAGAP ϕ -A calculations; however, the analysis of the radiation exchange performed on a simplified model shows that slightly better results are obtained by putting ICOMP=0 (normalization of all the computed view factors).

It must be pointed out that a radiation calculation for a symmetry section (1/2, 1/3,... etc. of the whole bundle) is not possible, because in this case the reciprocity rule for the view factors is no longer fulfilled.

However, a radiation model for 1/3 of the 12-rod bundle has been developed, because, due to the particular geometry of the 12-rod bundle, the error introduced by this schematization should be relatively small.

5.2 Emissivity

The emissivity is the parameter defining the radiative exchange. It depends on many factors, mainly on the temperature of the surfaces. In SAGAP ϕ -A two different methods are allowed to define the emissivity value to be used, depending on the option IEPS (cfr. 3.2) :

IEPS=0: the emissivity is assumed to be constant for the pins and for the shroud. In this case no dependence of the emissivity on the temperature (i.e. on the axial position of the surface) is considered. The constant values for the pin emissivity (EPSR) and for the liner emissivity (EPSS) must be defined in BLCK DATA.

IEPS=1: The emissivity is assumed to depend on the temperature.

In this case a function EPS must be defined, which provides the necessary correlation. If IEPS=1 the values EPSR and EPSS are not used at all. On the contrary, if IEPS=0 the function EPS is not used.

Due to the difficulty of determining the emissivity, both methods are approximated. The choice between the two methods is therefore mainly depending on operative problems (availability of data on the bundle to be analyzed, calculation at different emissivity values to evaluate the radiation effect, etc). In most of the performed calculations for the 12-rod bundle it was assumed IEPS=0 by setting

EPSR=0.6 EPSS=0.3.

while in the calculation for the 19-rod bundle it was generally assumed

EPSR=EPSS=0.42

5.3 New subroutines and modifications

The radiation model consists of the following subroutines:

RADIA, TARRAY, VFCAL, SYSØL, SUFCØN, GAUDEL, MATBUI, VECTR, QDEFI,
NØRMA, DAREA, VFDET, VFDE1, VFD3, EPS, CFC1, ..., FINDF1... .

To allow the insertion of this model the MAIN program has been modified.

6. Other modifications

6.1 Spacers effect on Nu number

A new method has been developed for the evaluation of this effect. It is based on the last experiment performed at the KfK in this field /7/.

The axial bundle subdivision has been left as it was in the earlier version of the code (also depending on the presence of the spacer), but the spacer effect is now computed at each section, irrespective of the presence of a spacer grid. This is performed by calling the subroutine SPANU, which in turn calls SPANUG (in case of smooth surfaces) or SPANUR (rough surfaces). The subroutines SPANUG und SPANUR are a slight modification of the subroutines used to elaborate the data presented in /7/ and are due to the courtesy of Md.A. Hassan.

To allow the insertion of this new method, modifications have been performed on the following subroutines:

MAIN, CEWA, RECANG, WALLTE, RTRI, RTSI, TEMLAM.

6.2 Laminar flow

As pointed out in 3.3.2 of /3/ in case of laminar flow the corner channel and the adjacent parts of wall channels are combined together for the calculation of pressure loss. This procedure consists of a modification of the K factors (eq. 3.20 in /3/) and is performed by the subroutine CORKA (see later 7.11).

To allow the use of this method, the subroutine KAPCQR has been modified.

6.3 Superposition principle

The superposition principle is used in two different cases:

1. Determination of the temperature of a pin sector facing the liner and of the temperature of the correspondent liner sector (cfr. 5.5 in /3/). In this case the superposition principle is switched on by the option IS (cfr. SC09C in 3.2). As already pointed out (2.3) some "dummy" gas temperatures are defined by the subroutine TBRTBS.
2. Determination of the temperature of the sectors facing a central channel (only in case of rough surfaces and turbulent flow) /9/. This method is switched on by the option ISUC (cfr. SC34C in 3.2). The calculations are performed by the subroutine SUPCEN, and the subroutine TBRTBS is also used.

7. New subroutines

In the present chapter a short description of the new inserted subroutines and functions is presented together with the explanation of their arguments. No description of the subroutines and functions contained in the earlier version of the code is given here.

7.1 Subroutine ALFAC

Builds up the array FALFA (42,3), to be used as boundary condition for the conduction equations.

ALFAC is called by LEIST and BØTH.

Arguments:

VDIAM: volumetric diameter of the pin (cm)

H : length of the axial section (cm)

7.2 Subroutine ASSE

Attributes a start value to the temperatures within the heated core (fuel).

ASSE is called by BØTH.

Arguments:

NCA : number of sectors in the actual pin

XF : temperatures.

7.3 Subroutine BØTH

BØTH organizes the calculation of the thermal conduction within the pins in the case of power generated within a heated core (two-dimensional approach to the problem). BØTH is called by the subroutine TØRG.

Arguments:

VDIAM: volumetric diameter of the pin (cm)

PIG : 3.1415.

H : length of the axial section (cm)

VDIA1: Tip or volumetric diameter of the pin (cm), depending on the option LAMØP3.

RINT: inner radius of the clad (cm).

The flow chart of this subroutine is presented in fig. 4.2.

7.4 Subroutine CCLAD

CCLAD computes the coefficients for the thermal conduction equations within the clad in case of power generated within a inner core (two-dimensional model).

CCLAD is called by BØTH.

Arguments:

NCA : number of sectors in the considered pin

A : array containing the a_{ij} coefficients (left hand six of the equations).

B : vector for the b_i coefficients (right hand side of the equations).

RSTAR : reference radius for the thermal exchange across the gap (cm). Cfr. 5.2.1 in /3/.

R : average radius of the clad (cm)

H : length of the axial section (cm)

J : index of the considered pin

S : clad thickness (cm)

7.5 Subroutine CCLAD3

CCLAD3 computes the coefficients for the thermal conduction equation within the clad when the two-dimensional model is used for a half of a pin. It is called by BØTH. The arguments are the same as in the case of CCLAD.

7.6 Subroutine CFUEL

CFUEL computes the coefficients for the thermal conduction equations within the core. It is called by BØTH.

Arguments:

NCA : number of sectors in the pin J
A : array of the coefficients $a_{i,k}$ (left hand side of the equations)
B : vector of coefficients b_i (right hand side of the equations)
RSTAR: reference radius (cm) cfr. 5.2.1 in /3/.
H : length of the axial section (cm)
J : index of the considered pin
XF : vector containing the temperatures within the heated core (fuel).

7.7 Subroutine CFUEL3

CFUEL3 is the analog to CFUEL (see) in the case when only a half of a pin is computed.

7.8 Subroutines_CFC1, CFC3, ...

CFC1 computes the view factor of type F1 (pg. 134 in ref. /3/). Analogously CFC3 computes the view factor of type F3 (pg. 135 in /3/) and so on. Because of the similarity of these subroutines, no individual description will be presented. They all are called by the subroutine VFCAL.

Arguments:

P : pitch of the rods (cm)
D : volumetric diameter (cm)
PIG : 3.1415
FCX : view factor corresponding to the numerator of definition 4.27 in /3/: i.e.

$$FCX = f_{ij} * 2A_i = f_{ji} * 2A_j$$

where A_i is the surface of sector i.

R = volumetric radius (cm)
Z = distance between the center of a wall pin and the shroud wall (cm).
ZWC = height of the blocking triangles (cm).

7.9 Subroutine_C0NSHR

Organizes the calculation of the thermal conduction within the shroud. It is called by TEMC0N and has no arguments. The flow chart is presented in fig. 4.3.

7.10 Subroutine_C0NTR0

Prints information about the convergence process. It is called by the MAIN program.

Arguments:

FA : friction factor in the precedent iteration
FA1 : friction factor in the present iteration
ITCØRR: index of the ITCØRR loop (cfr. /1/)
INDICE: convergence flag for the thermal calculation.

7.11 Subroutine CØRKA

CØRKA modifies the computed K-values (for the calculation of the friction factor in laminar flow) if the corner channel and the adjacent part of wall channel are computed together (case of JLAM=1) according to the procedure described in 3.3.2 of /3/. CØRKA is called by KAPCØR and has no arguments.

7.12 Function DAREA

The function DAREA computes the area of the sector L. To allow its direct use in the equation (4.27) of /3/, it supplies the double of this area, i.e.:

$$\text{DAREA}(L) = 2 * \text{Area of the sector } L.$$

DAREA is called by MATBUI, VFCTR, NØRMA and has the following argument

L : index of the sector.

7.13 Subroutine DECP

DECP fixes the switch IPRINT, which determines the print (IPRINT=1) or not (IPRINT=0) of the thermo- fluiddynamic variables at the actual axial section. The value of IPRINT depends on the input data NPRINT and AR (see CØMMØN/SC25C/ in 3.2).

DECP is called by the MAIN program.

Arguments:

IPRINT: = 1 The results for the actual axial section are printed
on the output listing
= 0 no print

X1 : distance between the beginning of the actual axial section and
the point where the calculation is started (cm)

X2 : distance between the end of the actual axial section and
the point where the calculation is started (cm).

STLEN: Distance between the bundle inlet and the point where the
calculation is started (cm).

7.14 Subroutine DELIP

DELIP builds up the array LIPS (19,10) and the vector NCAN (19):

NCAN(J): number of channels adjacent to the Jth pin, J = 1, NRØDS
LIPS(J,I): index of the Ith channel adjacent to the pin J,
I=1, NCAN(J)

DELIP is called by the MAIN program and has no arguments.

7.15 Function DPIN

DPIN represents the coefficient for the pressure loss at the
bundle inlet (cfr. equation 6.9 in /3/).

It is called by the MAIN program.

Arguments:

MFLØW: mass flow rate relative to the whole bundle (g/sec⁻¹)
PE : inlet pressure (kg cm⁻²)
TE : inlet temperature (°C)
CINL : limit value for DPIN at high turbulent flow: 1.2.

7.16 Function EPS

EPS represents the emissivity of the sector L. The values of EPS are computed depending on the option IEPS as described in 5.2. EPS is called by the subroutine MATBUI.

Arguments:

T : temperature of the sector L ($^{\circ}$ C)
L : index of the sector for which the emissivity has to be determined.

7.17 Subroutine FGEØ

FGEØ computes the average radius of the clad (R), his thickness (S) and the reference radius RSTAR (cfr. 4.1). It is called by LEIST and BØTH.

Arguments:

VDIAM: volumetric diameter of the considered pin (cm)
RSTAR: reference radius (cm)
S : clad thickness (cm)
R : average radius of the clad (cm)
RINT : inner radius of the clad (cm)

7.18 Subroutines FIND ...

The subroutines of this group fill the arrays KAFF(132,13), VFAC(132,13):

KAFF (L,N): index of the Nth sector having a radiation exchange with the sector L
VFAC (L,N): view factor f_{L,N}

There is a subroutine of this type for each type of view factor,
as it is shown in Tab. 7.1.

All these subroutines are called by VFDET.

Arguments:

L : index of the sector

NAFF : counter of the sectors interacting with sector L through
radiation

NS : index of the channel adjacent to the sector L

J : index of the rod to which the sector L belongs.

Subroutine	Detects the view factor(s) of type
FINDF1	F1
FINDF3	F3,F15
FINDF4	F4
FINDF5	F5
FINDF9	F9
FINDW2	F2
FW7	F7
FW8	F8
FW1112	F11,F12
FW13	F13
FW16	F16
FW1718	F17,F18
FINDA	F24
FS1112	F11,F12 *
FFS13	F13 *
FFS24	F24 *
FSA	F17,F18 *
FF32	F32
FFW31	F31 (relative to wall sectors)
FFA31	F31 (relative to corner sectors)
FS2	F15 *

Tab. 7.1: Reference table for the subroutines of type FIND....

* relative to shroud sectors.

7.19 Subroutine GAUDEL

This subroutine solves the system of linear equations for the radiation problem using the GAUSS-SEIDEL method /6/. In order to reduce the requested storage amount, the coefficient matrix has been compressed from A(132,132) to A(132,13) (case of 19-rod bundle) by means of a particular index manipulation. The subroutine GAUDEL has been written to solve this particular system of equation. It cannot be used for general purpose. The accuracy of the convergence process and the maximum number of allowed iteration are fixed in the calling subroutine, SYSOL.

Arguments:

A : matrix of coefficients (left hand side of the equations)
B : vector of coefficients (right hand side of the equations)
X : solution of the system: X(L) is the net heat quantity
 (cal/sec) exchanged through radiation at the sector L.
PERC : accuracy of the calculation
ITMAX : maximum allowed number of iterations.

7.20 Subroutine GAUSS

GAUSS solves the system of linear equations generated by the thermal conduction within the wrapper tube by means of the Gauss elimination method with pivotal condensation. It is called by the subroutine CONNSHR and it is written to solve this particular problem (it cannot be used for general purpose).

Arguments:

A : array containing the coefficients for the left hand side
 of the equations
B : vector containing the coefficients for the right hand side
 of the equations
X : vector containing the computed temperatures.

7.21 Subroutine GAUSS1

GAUSS1 is a general purpose subroutine suitable to solve a system of linear equations by means of the Gauss elimination method with pivotal condensation. It is used to solve the equations for the thermal conduction within the pins and is called by LEIST or by BQTH.

Arguments:

A : array containing the coefficients for the left hand side of the equations
B : vector containing the coefficients for the right hand side of the equations
X : vector containing the computed temperatures
NTOT : number of equations
N1 : first dimension in the DIMENSIØN statement for A in the calling subroutine; i.e.: if in the calling subroutine it is DIMENSIØN A (6,7)
Then N1=6.

7.22 Subroutine HEATBA

HEATBA checks the heat balance for the whole bundle. At each axial section the heat transmitted to the gas from the pins and from the shroud is computed for each subchannel. HEATBA is called by the MAIN program and has following arguments:

IND: =-1 initialization of the arrays.
= 0 the arrays are filled up
= 1 print the results
PBT : average gas pressure
INDQ: cfr. pg. 25 in /1/
TE : inlet gas temperature
MFLØW: mass flow rate.

7.23 Subroutine JELLA

JELLA prints the subchannel heat transfer results at each axial section (cfr. 3.3). JELLA is called by the MAIN program and has the following arguments:

JL : index which establishes what results are to be written:
JL<0 the results for all subchannel are printed
JL>0 the results of the subchannel adjacent to pin JL are printed; also, if JL>0 it must be
 $1 \leq JL \leq NRQDS.$

JELLA is called only at the heated sections.

7.24 Subroutine JELLB

JELLB prints the results relative to the gas conditions in the different subchannels (cfr. 3.3).

It is called by the MAIN program and has the following arguments:

JL : has the same meaning as in JELLA (cfr. 7.23)
PBT : Average pressure of the gas at the present axial section.

JELLB is called only in case of heated sections.

7.25 Subroutine JELLC

JELLC prints information about the roughness parameters in the different subchannels at each axial section (only in the case of rough heated part and turbulent flow). It is called by the MAIN program and has the following arguments:

JL : cfr. 7.2.3
TE : gas bulk temperature at the bundle inlet

TE1 : gas bulk temperature at the point where the calculation is started

BIOT : Biot number

7.26 Subroutine JZURU

JZURU builds the array JZUR(19,42), used for the conduction calculation. It is called by the MAIN program and has no arguments.

JZURU(J,NS) is the index M of the subchannel of the channel NS adjacent to the pin J.

7.27 Real Function KFUEL

KFUEL computes the thermal conductivity of the heated pin core ($\text{cal sec}^{-1} \text{ cm}^{-1} \text{ C}^{-1}$) as function of the temperature.

It is called by CFUEL and CFUEL3 and has as argument the temperature of the actual sector of heated core.

7.28 Real Function KGAP

KGAP determines the heat transfer coefficient at the gap between the heated core and the clad material ($\text{cal sec}^{-1} \text{ cm}^{-2} \text{ C}^{-1}$). It is called by CFUEL and CFUEL3 and has no arguments.

7.29 Subroutine LEIST

LEIST organizes the calculation for the thermal conduction within the pins in case of heated clad (one-dimensional model). In fig. 4.1 the flow chart of LEIST is presented. It is called by the subroutine TØRG and has the following arguments:

VDIA : volumetric diameter of the pins
PIG : 3.141593
H : height of the axial section
VDIA1 : For laminar calculation only, tip diameter of the pins.
RINT : inner radius of the clad

7.30 Subroutine LINPOW

LINPOW fills the matrix SHQ(18,2) with the initial values of the power generated in the shroud. It is called by the MAIN program and has no arguments.

7.31 Subroutine MATBUI

MATBUI builds the array of the coefficients for the radiation calculations. It is called by the subroutine RADIA and has the following arguments:

A : matrix of coefficients for the left hand side of the radiation equations
B : vector of coefficients for the right hand side of the radiation equations.

7.32 Subroutine MATBUS

MATBUS builds the array of coefficients for the calculation of the thermal conduction within the wrapper tube. It is called by the subroutine CØNSHR and has the following arguments:

A : array of coefficients for the left hand side of the equations.
B : vector of coefficients for the right hand side of the equations.

7.33 Subroutine MEZZI

The subroutine MEZZI determines the arrays $GE\phi_1(42,3)$ and $GE\phi(42,3)$; they represent the fraction of the whole pin corresponding to the correspondent sector: for instance, in case of calculations referred to the whole bundle, it is:

Type of adjacent channel	$GE\phi_1$	$GE\phi$
CENTRAL	6	$\pi/6$
WALL	4	$\pi/4$
CORNER	6	$\pi/6$

MEZZI is called by the MAIN program and has following arguments:

NR ϕ DS : total number of rods
NSEL : index for the considered symmetry section (1 = whole 19-rod bundle, 2 = 1/2 of the whole 19-rod bundle, 3 = 1/12 of the whole 19-rod bundle)
NST ϕ T : total number of channels.

7.34 Subroutine NORMA

Performs the normalization of the computed view factors depending on the option IC ϕ MP (cfr. 4.3.2 in /3/ and C ϕ MM ϕ N /SC16R/ in 3.2 of this paper). NORMA is called by the subroutine VFCTR and has the following arguments:

T_{QT} : sum of the computed view factors for sector L (in input,
before the normalization, in output after it)
L : considered sector

7.35 Subroutine PIV_{QT}

PIV_{QT} finds the pivotal element for the solution of the thermal conduction equation within the shroud with the Gauss elimination method. It is called by subroutine GAUSS and has following arguments:

A : array of coefficients for the left hand side of the equations
B : vector of coefficients for the right hand side of the equations
N : index of the row reached by the calculation during the elimination process at the moment when PIV_{QT} is called

7.36 Subroutine PIV_{QT1}

This subroutine is equivalent to the subroutine PIV_{QT}, but it can be used for general purpose. It is called by the subroutine GAUSS1 and has the same arguments as PIV_{QT} plus:

N_{TQT}: number of equations in the system
N₁ : first number for the size of the array A(N₁,N₂) in the calling subroutine

7.37 Subroutine QC_{QC}

QC_{QC} builds the array QJ(19,42) /W/ to define the convective heat transferred at the sector corresponding to J and NS, i.e.

$$\dot{q}_{\text{CONVECTION}(J,NS)} * \text{Area}_{(J,NS)} = q_{\text{GENERATED}(J,NS)} + Q^J_{(J,NS)}$$

Furthermore QC ϕ C controls the heat balance for the pin J after the conduction calculation.

QC ϕ C is called by LEIST and BO ϕ H and has following arguments:

NCA : number of sector in the pin J

J : index of the considered pin

X : vector containing the computed wall temperatures

NSE : dimension of the vector X in the calling subroutine

7.38 Subroutine QDEFI

QDEFI builds the arrays QPR(NS,M) , heat transferred by radiation at the correspondent pin sector (cal/sec) , and QSR(NSW,M) , heat transferred by radiation at the correspondent shroud sector (cal/sec) , where

$$\text{NSW} = \text{NS}-\text{NSTR},$$

NSTR = number of central type channels.

QDEFI is called by the subroutine , RADIA and as the following argument:

QJR : vector, of length NSECT, where are stored the values of the heat transferred through radiation (cal/sec)

7.39 Subroutine QDEFIS

QDEFIS builds the array SHQC(18,2) after the calculation of the thermal conduction within the shroud. SHQC is analog to the array QJ for the conduction within the pins (cfr. 7.37). QDEFIS controls also the thermal balance. It is called by C ϕ NSHR and has no arguments.

7.40 Subroutine RADIA

RADIA organizes the calculation for the thermal radiation. It's flow chart is presented in fig. 5.1. RADIA is called by the subroutine TEMC ϕ N and has no arguments.

7.41 Subroutine SPANU

SPANU organizes the calculation of the spacer effect on the Nu number of the rods (cfr. 5.7 in /3/).

SPANU is called by the subroutines CEWA, BALA, RTRI, RTSI, RECANG, TEMLAM.

It has following arguments:

R1 : Reynolds number of the considered subchannel
P1 : Prandtl number of the considered subchannel
NS : channel index
M : subchannel index
Y : factor $\frac{Nu}{Nu_0}$

7.42 Subroutine SPANUG

SPANUG computes the effect of the spacer on the Nu number in case of smooth surfaces

$$y = Nu/Nu_0$$

where Nu_0 is the undisturbed Nu number. It is called by SPANU and has the following arguments:

X : dimensionless axial distance between the considered point and the begin of the spacer (distance referred to a reference hydraulic diameter: if IHAS=0, then the hydraulic diameter of the whole bundle is used; IHAS=1, the diameter of the considered channel is used. cfr. IHAS in 3.2)
Y : factor Nu/Nu_0
RE : Reynolds number, also depending on the option IHAS
PR : Prandtl number, also depending on IHAS
AL : dimensionless axial width of the spacer (also depending on IHAS)
E : Blockage area of the considered subchannel

7.43 Subroutine SPANUR

SPANUR is perfectly analogous to the subroutine SPANUG, but it is called in case of rough surfaces.

7.44 Subroutine SUFCØN

SUFCØN tests the sufficient condition for the convergence of the Gauss-Seidel Method /6/ by the solution of the radiation equations (cfr. 5.1). It is called by SYSØL and has the following arguments:

A : array of the coefficients for the left hand side of the equations

INDEX:=0 the array A satisfies the sufficient convergence condition
>0 the condition is not respected.

7.45 Subroutine SUPCEN

In SUPCEN is applied the superposition principle in the determination of the wall temperatures of the sectors adjacent to a central channel or to a central part of wall subchannel. The subroutine SUPCEN is called by RTRI only in case of turbulent flow. It has the following arguments:

RH : height of the roughness

PBT : average pressure of the coolant

TWALL : wall temperature of the sector

LAM1 : friction factor of the adjacent subchannel

U1DW : cfr. pg. 129 in /1/

YYI : factor for the Nu number improvement due to the spacers
(cfr. SPANU)

ITYP : type of subchannel

1: central part of a wall subchannel

2: wall

3: corner

KI : thermal conductivity of the coolant
DEI : hydraulic diameter of the subchannel
FACHE : correction factor which takes into account the inlet effect
on Nu number
QA : heat flux at the sector (cal sec⁻¹ cm⁻²)
TW1 : surface pin temperature (work area)
G1A : Parameter G(h^+), by supposing unheated adjacent pins
NU11 : Nu number, by supposing unheated adjacent pins
I : channel index
M : subchannel index
REI : Reynolds number
ITW1 : iteration index in the calling subroutine

7.46 Subroutine SYSØL

SYSØL organizes the solution of the radiation equations by means of the Gauss-Seidel iterative method. It is called by RADIA and has the following arguments:

A : array of the coefficients for the left hand side of the equations
B : vector of the coefficient for the right hand side of the equations
Y : vector for the computed results.

7.47 Subroutine TARRAY

Tarray prepares the connexion arrays for the radiation calculation:
ISU(L,1)=NS, index of the channel adjacent to the sector L
ISU(L,2)=M, index of the subchannel adjacent to the sector L
IGI(NS,M)=L, index of the sector of pin adjacent to subchannel M
of channel NS.
ISS(NSW,M)=L, index of the sector of shroud adjacent to subchannel
M of channel NS (NSW=NS-NSTR, for NSTR see 7.38).

TARRAY is called by the MAIN program and has no arguments

7.48 Subroutine TBRTBS

TBRTBS builds the arrays

TBR(NS,M) : reference gas temperature for the pin in the subchannel
NS,M

TBS(NSW,M) : reference gas temperature for the shroud in the subchannel
NS,M (for NSW see 7.38).

For the meaning of these temperatures see 5.5 in /3/. TBRTBS is called by the subroutine TEMC \emptyset N and has no arguments.

7.49 Subroutine TEMC \emptyset N

Subroutine TEMC \emptyset N organizes the heat transfer calculations (see flow chart in fig. 2.13). It is called by the MAIN program and has the following arguments.

IRH : =1 smooth section
=2 rough section

K : index of the axial section

RH : height of the roughness ribs

SUR : cfr. pg. 163 in /1/

D : volumetric diameter of the pins

TE1 : bulk temperature at the point where the calculation is startet

PBT : average pressure of the gas in the axial section

H : length of the axial section

V : volumetric or tip diameter of the pins (cfr. 3.2)

R : inner radius of the pins

INDICE: number of the sectors for which no convergence for the wall temperature has been reached

QT \emptyset T : total heat generated by the pins in this section

7.50 Subroutine TESTB

TESTB performs the convergence test on the bulk temperatures. It is called from the subroutine TEMC \emptyset N and has the following argument:

INDICE : =0 convergence has been reached for all subchannels
>0 no convergence for N=INDICE subchannels.

7.51 Subroutine TESTNU

TESTNU is called by the subroutine TEMC \emptyset N in order to average the heat transfer coefficients between two successive iterations in case of convergence problems. Such problems arise due to the spacer effect on the Nu number at low Reynolds numbers: at $Re \approx 5000$ the factor $Y=Nu/Nu_0$ (cfr. 7.42) has a maximum and a small variation of the Re number (i.e. of the mass flow rate of the channel) generates a great variation of the Y factor generating convergence problems.

Argument of the subroutine is the switch

IND = 0 the heat transfer coefficients are stored in a work area.
IND=0 is the input for TESTNU at each iteration.

IND = 1 only in case of convergence problems: the heat transfer coefficients are averaged.

7.52 Subroutine TESTW

Performs the test of convergence on the wall temperatures of the pin and shroud sectors. It is called by TEMC \emptyset N and the argument, INDW, indicates the number of sector for which no convergence has been reached; also INDW=0 when the convergence is reached.

7.53 Subroutine TEST1

Performs the test of convergence on the temperatures within the heated core (fuel). It is called by the subroutine BØTH and has following arguments:

NCA : number of sectors in the pin
X : new value for the temperatures
XF : old value for the temperatures (in output, also new value)
KK : convergence index: number of sectors for which no convergence has been reached; also KK = 0 when the convergence is attained.

7.54 Subroutine TNEW

Because the wall temperatures within the conduction model are stored in the vector X(NSECT) while in the flow model they are stored in the array TW(NS,M), TNEW copies the contents of X into TW.

It is called from subroutines LEIST and BØTH and has the following arguments:

NCA : number of sectors in the pin
X : computed results for the wall temperatures of the sectors
J : pin index
NSE : Size of the array X in the calling subroutine.

7.55 Subroutine TNEWS

Is analogous to the subroutine TNEW for the LINER temperatures.

It is called by CØNSHR and has the following argument:

X : vector containing the computed wall temperature for the shroud.

7.56 Subroutine TØRG

Organizes the calculation of the conduction model (see flow chart in fig. 2.14). It is called by subroutine TEMCØN and has the following arguments:

VDIAM : volumetric diameter of the pin
RINT : inner radius of the clad
PIG : 3.141593
H : length of the axial section

7.57 Subroutine_TOTSEC

Computes the total number of sectors of pin and liner. It is called by the MAIN program and has the argument NSEL (type of symmetry section, cfr. 7.33).

7.58 Subroutine_TTQT

TTQT fills the array containing the bulk temperatures, TB \emptyset LD(NS,M) and the wall temperatures for the pins, TD(NS,M), and for the shroud TLD(NS,M), relative to the precedent iteration, to allow the further convergence test. It is called by the MAIN program and by the subroutine TEMC \emptyset N and has the following argument:

INDEX : = 1 the array TB \emptyset LD is filled
 ≠ 1 the array TD and TLD are filled.

7.59 Subroutine_VFCAL

Organizes the calculation of the view factors for pin and shroud sectors. It is called by the MAIN program and has no arguments.

7.60 Subroutine_VFCTR

Controls the view factors computed by VFCAL and the correspondence arrays (determined by VFDET). It is called by the main program and has no arguments.

7.61 Subroutine VFDET

Organize the determination of the correspondence arrays for the radiation calculations.

It is called by the MAIN program and has following arguments:

NSEL : index for the symmetry section (cfr. 7.38)

NRDOS: total number of rods.

7.62 Subroutine VFDE1

Determines the correspondence arrays:

NAFF(L) : number of sectors exchanging through radiation with sector

KAFF(L,K) : index L1 of the KTH sector exchanging with sector L;
1 ≤ K ≤ NAFF(L)

VFAC(L,K) : view factor $f_{L,L1}$, being L1=KAFF(L,K)

in case of whole bundle flow section. It is called by VFDET and has no arguments.

7.63 Subroutine VFD3

Analogous to VFED1 used in case of 1/3 of the whole 12-rod bundle (cfr. 5.1).

8. New COMMON Blocks

The new CØMMØNS blocks inserted in the program are listed in Tab. 8.1. For each of it the explanation of the arguments and the subroutine where the arguments are defined are given.

COMMON BLOCK	Argument(s)	Explanation	Defined in
SCO1C	NCAN(19), LIPS(19,10)	NCAN(J) : number of channels adjacent to the pin J LIPS(J,K) : index of the K TH channel adjacent to the pin J	DELIP or BLØCK DATA
SCO2C	QJ(19,42)	QJ(J,NS) : cfr. 7.37	QCØC
SCO3C	NRØDS	total number of rods	MAIN
SCO4C	RINT, RFUEL	RINT = inner radius of the clad RFUEL = radius of the heated core (fuel)	BLØCK DATA
SCO5C	JZUR(19,42)	JZUR(J,NS) : index M of the sub-channel in channel NS adjacent to the pin J	
SCO6C	D3(3)	coefficient for the thermal conductivity of the cladding material $K(T)=D3(1)+D3(2)T+D3(3)T^2$	BLØCK DATA
SCO7C	H1	length of the axial section	MAIN
SCO8D	TLD(18,2)	work area for the shroud wall temperature	TTØT
SCO9C	IS	option for the superposition principle between wall pins and shroud (cfr. 3.2)	BLØCK DATA
SC10C	ANU(42,3)	ANU(NS,M) : Nu number for the sector adjacent to subchannel M of channel NS	TELIN TEMLAM RTRI RTSI
SC11C	FALFA(42,3)	Modified heat transfer coefficient for the pin by NS,M	ALFAC
SC12C	GEØ(42,3)	geometrical factor (cfr. 7.33)	MEZZI
SC13C	GEØ1(42,3)	geometrical factor (cfr. 7.33)	MEZZI
SC14C	TBØLD(42,3)	work area for the bulk temperatures	TTØT MAIN

Tab. 8.1: New COMMON blocks

COMMON BLØCK	Argument(s)	Explanation	Defined in
SC15C	ALFA(42,3)	Heat transfer coefficient for the pin sector by NS,M	RTRI RTSI TEMLAM TELIN
SC16C	SNU(18,2)	Nu number for the shroud sector by NW (=NS-NSTR),M	TELIN TEMLAM
SC17C	SALFA(18,2)	Heat transfer coefficient for the shroud sector by NW(=NS-NSTR),M	TELIN TEMLAM
SC18C	RES,RIS,ANGW, ANGA	RES: outer radius for the shroud equivalent ring (cm) RIS: inner radius for the shroud equivalent ring (cm) ANGW: angle subtended by a wall shroud sector (R) ANGA: angle subtended by a corner shroud sector (R) (cfr. 3.2)	BLØCK DATA
SC19C	ICON	Option for the heat conduction model	BLØCK DATA
SC20C	CGAP	Heat transfer coefficient at the gap between clad and fuel (cal sec ⁻¹ cm ⁻¹ C ⁻¹)	KGAP
SC21C	SHQC(18,2)	cfr. 7.39	QDEFIS
SC22C	NTQT	Total number of shroud sectors	BLØCK DATA
SC23C	ICS	Option for the conduction in the shroud (cfr. 3.2)	BLØCK DATA
SC25C	TBR(42,3) TBS(18,2)	Dummy gas temperatures (cfr.7.48)	TBRTBS

Tab. 8.1: Cont.

COMMON BLOCK	Argument(s)	Explanation	Defined in
SC30C	ANO(42,3), SNO(18,2)	work areas for the Nu numbers	TESTNU
SC32C	GHPIU(42,3)	Parameter G(h_w^+)	RTRI
SC33C	TWINF(42,3)	Wall temperature at the infinite conductivity of the cladding	MAIN
SC34C	ISUC	Option for the superposition principle in the central channels (cfr. 3.2)	BLOCK DATA
SC99C	TD(42,3)	Work area for the wall temperatures	TTOT
SCO1L	STLEN	Distance between the bundle inlet and the point where the calculation is started	MAIN
SCO2L	JLAM	Option for laminar calculations (cfr. 3.2)	BLOCK DATA
SCO3L	IPHUD	Option to compute the shroud heat losses with the EIR Method (cfr. 3.2)	BLOCK DATA
SCO4L	TAMB, HUFAC, TMS	TAMB: room temperature during the experiment HUFAC: heat transfer coefficient at the outer shroud surface TMS: average outer shroud surface temperature	BLOCK DATA
SCO5L	PERLT	wetted perimeter for the whole bundle cross section	MAIN
SCO6L	SHQ(18,2)	Heat generation in the shroud	LINPQW
SCO7L	WSPØ,XM,NSPACT	WSPØ: spacers width XM : distance between the middle of the axial section and the bundle inlet NSPACT: total number of spacers	MAIN
SCO8L	AGRI(42,3,7)	AGRI(NS,M,KS): blockage factor for subchannel M of channel NS at the KSTH spacer	MAIN

Tab. 8.1: Cont.

COMMON BLØCK	Argument(s)	Explanation	Defined in
SCO9L	SDIS(7)	SDIS(KS) : distance between the KSTH spacer and the bundle inlet	MAIN
SC1OL	RES,PRS,EPSS, DETØLA	RES: Re number for the whole bundle PRS: Pr number for the whole bundle EPSS: blockage factor of the spacer for the whole cross section DETØLA: hydraulic diameter of the whole bundle cross section	MAIN
SCO1P	S(19)	Factor taking into account systematic non-uniform heating of the rods: by NDVQ=1 it will be QPIN(J)=QPIN(1)*S(J) (cfr. pg.32 in /1/). For uniform heating, or NDVQ≠1, put S(J)=1.0	BLØCK DATA
SCO2P	IPSUB	cfr. Tab. 3.1	BLØCK DATA
SCO1R	NSECT,NSECP	SECT: total number of sectors NSECP: total number of pin sectors	TØTSEC
SCO2R	P,D,Z,ZWC,H, LENGTH	P = pitch of the rods D = volumetric diameter of the rods Z = Distance between the center of the wall pin and the shroud ZWC = height of the blockage triangles H = length of the axial section LENGTH = length of the axial portion	MAIN
SCO3R	F1,F2,F3, ....,FI,....	View factor of type f_i	VFCAL
SCO4R	VFAC(132,13)	VFAC(L,K) : view factor f_{L,L_1} , being L1=KAFF(L,K)	VFDE1 VFD3
SCO5R	IRAD	Option for the radiation calculation (cfr. 3.2)	BLØCK DATA

Tab. 8.1: Cont.

CØMMØN BLØCK	Argument(s)	Explanation	Defined in
SCO6R	ISU(42,3)	cfr. 7.47	TARRAY
SCO7R	EPSR,EPSS SIGMA	EPSR: constant value for the pin emissivity (cfr. 5.2) EPSS: constant value for the shroud emissivity (cfr. 5.2) SIGMA: Stefan-Boltzmann constant (cfr. Tab. 3.1)	BLOCK DATA
SCO8R	QPR(42,3)	Heat transferred through radiation by the pin sectors (cfr. 7.38)	QDEFI
SCO9R	QSR(18,2)	Heat transferred by radiation at the shroud sectors (cfr. 7.38)	QDEFI
SC10R	QSTØT, QRTØT	QSTØT: Total heat generated in the shroud at the axial section QRTØT: total heat generated in the pins at the axial section	MAIN
SC11R	ISS(18,2)	cfr. 7.47	TARRAY
SC12R	IGI(42,3)	cfr. 7.47	TARRAY
SC13C	NAFF(132,13)	cfr. 7.62, 7.63, 3.2	VFDE1, VFD3, BLØCK DATA
SC14R	KAFF(132,13)	cfr. 7.62, 7.63, 3.2	VFDE1, VFD3, BLØCK DATA
SC15R	IEPS	Option for the emissivity model to be used (cfr. 5.2)	BLØCK DATA
SC16R	ICØMP	Option for the view factors normalization method to be used (cfr. Tab. 3.1)	BLØCK DATA
SCO1Z	YH(42,3)	YH(NS,M) = ratio $\frac{Nu}{Nu_0}$ for the sector of pin corresponding to the subchannel M of channel NS	RTRI, RTSI, TEMLAM

Tab. 8.1: Cont.

COMMON BLOCK	Argument(s)	Explanation	Defined in
CEVO1	LAMOP1	cfr. Tab. 3.1	BLOCK DATA
CEVO2	RTIP4	cfr. Tab. 3.1	BLOCK DATA
CEVO3	LAMOP2	cfr. Tab. 3.1	BLOCK DATA
CEVO4	LAMOP3	cfr. Tab. 3.1	BLOCK DATA

Tab. 8.1: Cont.

9. Recommendations to the user

- 1) If IC \emptyset N=0 no radiation calculation is allowed (also put IRAD=0)
- 2) In case of laminar flow, if you wish to use the superposition principle (also IS=1) and the shroud is unheated, a dummy power for the shroud (QLINMT, pg.33, and 31 in /1/) must be defined. The recommended value is

$$\text{QLINMT} = 0.0007 \text{ W/cm}$$

- 3) In case of laminar calculation, to avoid convergence problems by the spacers, it is recommended to "smooth" the blockage ratio of the spacers in the corner channels and the adjacents part of wall channels.
- 4) In case of laminar calculation, it is recommended to put
 $\text{JLAM} = 1$
- 5) The option IPHUD is concerned with a very particular problem.
Put $\text{IPHUD} = 0.0$
- 6) By the radiation calculation it is recommended to put IC \emptyset MP=0.
- 7) No radiation calculation for symmetry sections (1/3 of the bundle etc.), with the exception of 1/3 of the 12-rod bundle, is allowed.
- 8) Always $\text{IPHUD} = 0.$

References

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of gas cooled fuel element bundles
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Thermo- und fluiddynamische Analyse von gasgekühlten Brenn-
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Thermo- und fluiddynamische Analyse von gasgekühlten Brenn-
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- /7/ Md.A. Hassan
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Cliffs, New Jersey, 1965

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unpublished, 1981.

Appendix 1: Text of the Code

C S. CEVOLANI A. MARTELLI 0000010
C ***** 0000020
C 0000030
C 0000040
C 0000050
C ====== 0000060
C S A G A P O - A 0000070
C 0000080
C A COMPUTER CODE FOR THE THERMO-FLUIDDYNAMIC ANALYSIS OF GAS COOLED 0000090
C BUNDLES OF PARTLY SMOOTH AND PARTLY ROUGHENED RODS IN STEADY STATE 0000100
C CONDITIONS 0000110
C ====== 0000120
C 0000130
C 0000140
C THE CODE HAS BEEN WRITTEN IN FORTRAN IV FOR THE COMPUTER IBM 3033 0000150
C OF THE KARLSRUHE NUCLEAR CENTER. 0000160
C 0000170
C DESCRIPTION OF THE PHYSICAL MODEL: KFK 2436-EUR 5508D 0000180
C KFK 3148-EUR 7051D 0000190
C USER'S GUIDE: KFK 2483-EUR 5510E 0000200
C KFK 3185-EUR 7054e 0000210
C 0000220
C 0000230
C MAIN PROGRAM 0000240
C ----- 0000250
C THE MAIN PROGRAM READS MOST OF THE INPUT DATA, PRINTS AND PUNCHES 0000260
C MOST OF THE COMPUTED RESULTS, PERFORMS SOME SIMPLE CALCULATIONS 0000270
C AND ORGANIZES ALL THE CALCULATIONS OF SAGAPO 0000280
C 0000290
C REAL LENGTH,LAMBDM,MFLOW,MA,MSCH ,MI,MO,MEC,LAM ,MEA1,LAM1,MM2 0000300
1 ,MSCH1,LAMSCH,MSCHB,MSCHB1,LAMBDA(100),MAV,MAWC,MSWC1,LAMWC, 0000310
2 NDE1,NDE2,KAPPA 0000320
C REAL*8 COOLA(4) /'HELIUM ','CO2 ','NYTROGEN',' ' / 0000330
C REAL*8 TITLE(4,7) /'INITIAL ','UNHEATED',' SMOOTH ','PART', 0000340
1 'FIRST HE','ATED SMO','OTH PART',' ','FIRST UN', 0000350
2 'HEATED R','OUGH PAR','T','ROUGH PA','RT (HEAT', 0000360
3 'ED OR UN','HEATED')','LAST UN','HEATED R','OUGH PAR','T', 0000370
4 'SECOND H','EATED SM','OOTH PAR','T','LAST UNH','EATED SM', 0000380
5 'OOTH PAR','T'/ 0000390
C DIMENSION PGDPT(4),EPSIT(4),CSPT(4),DPBAR(100),PBAR(100), 0000400
1 T(100),RHOBT(100),ETABT(100),UBT(100),REBT(100),P(100), 0000410
2 GRI(42,3,7),GRIP(42,3,7),XDE1(7),XDE2(7), 0000420
3 QPIN(19),XLAM1(7),NSPAC(7),PLEN(7),VDIAM(7),FAREL(7), 0000430
4 CIPA(7),ZIPA(7),TWTIPA(7),TBTIPA(7),TBPIPA(7),WSP(7), 0000440
5 PLEN(7),RHIPA(3),ACW(46),DECW(46),MEC(46), 0000450
6 AA1(30),DEA1(30),MEA1(30),RMISTW(7),RINT(7), 0000460
7 HPLUS1(42,3),HPLUS2(42,3),TWA(42,3),QPLUSA(42,3), 0000470
8 PRBA (42,3),XSTART(7),XEND(7),AMASST(42,3) 0000480
9 ,AMASSB(42,3),TEMPBA(42,3),YDHA(42,3),TEMPTA(42,3) 0000490
C DIMENSION INDSP(100),NEXPR(7),PEX(10),XEXPR(10),NEXTW(7), 0000500
1 XEXTW(3),TWTH(42,3,3),TWP(42,3),DELTIO(18,2,90), 0000510
2 GRI1(18,2,7),GRI2(18,2,7),YDHA(42,3), 0000520
3 X2DPRQ(7),NDPRQ(7),QDCOI(7),QLDCOI(7),QDCO(7,7), 0000530
4 QLDCO(7,7),XPRQ(3),BIOT(42,3),QSECT(3) 0000540
CC 28.02.1981 0000550
C 4 QLDCO(7,7),XPRQ(3),BIOT(42,3),TWINF(42,3),QSECT(3) 0000560
C DIMENSION TWP(42,3,2),TWH(42,3,2,10) 0000570
C 0000580
C COMMON /SC33C/ TWINF(42,3) 0000590
C COMMON /GASD4/ IGAS 0000600
C COMMON /CEV04/ LAMOP3 0000610

COMMON /GRIDWC/	EPSWC(18,2,2,4),CSPWC(18,2,2,4)	0000620
COMMON /CORRE/	QHRDAR,QRMDAR,QLAMR	0000630
COMMON /QPAR1/	QDEV	0000640
COMMON /QPAR2/	QLINM,QLDEV	0000650
COMMON /QPAR3/	PERL(3)	0000660
COMMON /CORR/	SIGMA(42),PHI(42),SBMNS	0000670
COMMON /IDISPB/	IDISP2	0000680
COMMON /CORR1/	SIGMAI(42,3),PHII(42,3)	0000690
COMMON /CORR2/	CHI(18,2,2),PSI(18,2,2)	0000700
COMMON /GEN1/	LAM(42)	0000710
COMMON /GEN2/	A(42)	0000720
COMMON /GEN3/	MI(42)	0000730
COMMON /GEN4/	TEMP(42)	0000740
COMMON /GEN5/	DE(42)	0000750
COMMON /GEN6/	MO(42)	0000760
COMMON /HEA1/	Q(19)	0000770
COMMON /HEA5/	QQ(42,3)	0000780
COMMON /GRID/	CSPC(42,4)	0000790
COMMON /GASD1/	NSTOT	0000800
COMMON /GRID0/	CSPSC(42,3,4)	0000810
COMMON /GRID1/	EPSISC(42,3,5),DIST(7)	0000820
COMMON /GRID3/	X(100)	0000830
COMMON /GRID6/	EPSIC(42,4)	0000840
COMMON /GRID7/	PGDPC(42,4)	0000850
COMMON /GRID8/	PGDPSC(42,3,4)	0000860
COMMON /IND3/	NTYP(42)	0000870
COMMON /GEO2/	ATOT,DETOT,ASEC	0000880
COMMON /GEO0/	ACH(3)	0000890
COMMON /GAGR/	DPSI	0000900
COMMON /GEO5/	ATC,DETC,ATW,DETW,ATA,DETA,AAC,AAW,AAA	0000910
COMMON /HB3/	TEMP2(42)	0000920
COMMON /MOB1/	MM2(42)	0000930
COMMON /MOB4/	WCF(42)	0000940
COMMON /MOB2/	UAV(42)	0000950
COMMON /MOB5/	TAV(42)	0000960
COMMON /MOB6/	MAV(42)	0000970
COMMON /MOB8/	DPNS(42)	0000980
COMMON /MOB24/	WT(42,3)	0000990
COMMON /HEA6/	NPIN(42),JPIN(42,3)	0001000
COMMON /SUB1/	ASCH(42,3)	0001010
COMMON /SUB2/	TSCH(42,3),MSCH(42,3)	0001020
COMMON /SUB6/	TSCH1(42,3)	0001030
COMMON /SUB5/	LAMSCH(42,3)	0001040
COMMON /SUB8/	MSCH1(42,3)	0001050
COMMON /SUB20/	PROVI(18,2)	0001060
COMMON /SUB22/	TW(42,3)	0001070
COMMON /SUB23/	HPLUSB(42,3),HPLUSW(42,3),QPLUS(42,3), PRB(42,3),YODH(42,3)	0001080
> COMMON /COLAM1/	COLAMB	0001090
COMMON /IJ1/	NER(42),NIS(42,3)	0001110
COMMON /MART/	ITCORR	0001120
COMMON /DAT/	PIG	0001130
COMMON /COLAM2/	COLAMA	0001140
COMMON /SUB21/	TTSCHA(18,2),TTSCHB(18,2)	0001150
COMMON /PRSPA/	DISTOO	0001160
COMMON /DAT1/	00,01,02,03,04,05,016,017,018,019	0001170
COMMON /DAT2/	06,07,08,09,010,011,012,013,014,015	0001180
COMMON /DAT4/	NDEST,NDEEND	0001190
COMMON /DAT6/	IRHPL	0001200
COMMON /DAT7/	CNUSS(2)	0001210
COMMON /WAC01/	XMSCHB(18,2),XMSCHA(18,2)	0001220
COMMON /WCSE2/	MSCWC1(18,2,2)	0001230
COMMON /WCSE3/	LAMWC(18,2,2)	0001240
COMMON /WCSE5/	TSCWC1(18,2,2)	0001250
COMMON /WCSE6/	ASCWC1(18,2,2)	0001260

COMMON /WCSE7/	MAWC(18,2,2)	0001270
COMMON /WCSE8/	ASCHWC(18,2,2)	0001280
COMMON /WCSE9/	TAVWC(18,2,2)	0001290
COMMON /WCSE1/	DEWC(18,2,2),PPWWCC(18,2,2)	0001300
COMMON /WCSE12/	TWWC(18,2,2)	0001310
COMMON /GRAV/	IGRAV	0001320
COMMON /PARTB/	TEMPB(42,3),XMASSB(42,3),YDH(42,3)	0001330
COMMON /INITL/	XMLE	0001340
COMMON /WSSCH/	T1SSC1(18,2),T2SSC1(18,2), T1SSC2(18,2),T2SSC2(18,2)	0001350 0001360
> COMMON /WSSCH0/	TBSSC1(42,3),TWSSC1(42,3), TBSSC2(42,3),TWSSC2(42,3)	0001370 0001380
> COMMON /WSSCH1/	DELTIE(18,2,90),DTIEAV(18,2)	0001390
COMMON /WSSCH2/	TIO(18,2,90)	0001400
COMMON /IROSMO/	IRH	0001410
COMMON /SUBLA/	CLASUB	0001420
COMMON /SHROUD/	TLINER(18,2)	0001430
COMMON /QSHR/	QALIN	0001440
COMMON /LAMIN3/	F1ATIP(42),F1DTIP(42)	0001450
COMMON /LAMIN4/	F2ATIP(42,3),F2DTIP(42,3)	0001460
COMMON /LAMIN5/	RTIP(7)	0001470
COMMON /LAMINO/	I2TIP(42,3)	0001480
COMMON /MART5/	NSTR	0001490
COMMON /GAAGT/	FCOPWT	0001500
COMMON /INPAR/	IPA	0001510
COMMON /LIRGR/	IRGRI(42,3)	0001520
COMMON /SCO1L/	STLEN	0001530
COMMON /SCO2C/	QJ(19, 42)	0001540
COMMON /SCO3C/	NRODS	0001550
COMMON /SC07C/	H1	0001560
COMMON /SC13C/	GE01(42,3)	0001570
COMMON /SC15C/	ALFA(42,3)	0001580
COMMON /SC19C/	ICON	0001590
COMMON /SC32C/	GHPIU(42,3)	0001600
COMMON /CEV02/	RTIP4	0001610
COMMON /CEV03/	LAMOP2	0001620
COMMON /SC99C/	TD(42,3)	0001630
COMMON /SC03L/	IPHUD	0001640
COMMON /SC04L/	TAMB,HUDFAC,TMS	0001650
COMMON /SC05L/	PERLTT	0001660
COMMON /SC02R/	PIT,DIT,ZIT,ZWCIT,H,LENGTH	0001670
COMMON /SC10R/	QSTOT,QRTOT	0001680
COMMON /SC06L/	SHQ(18,2)	0001690
COMMON /SC07L/	WSP0,XM,NSS	0001700
COMMON /SC08L/	AGRI(42,3,7)	0001710
COMMON /SC09L/	SDIS(7)	0001720
COMMON /SC10L/	RES,PRS,EPSS,DETOLA	0001730
COMMON /SC05R/	IRAD	0001740
COMMON /SC01P/	S(19)	0001750
COMMON /SC02P/	IPSUB	0001760
C		0001770
C EXTERNAL RTRI,RTSI		0001780
C		0001790
C		0001800
C		0001810
C 1-READ AND WRITE INPUT DATA		0001820
C		0001830
WRITE(6,4721)		0001840
4721 FORMAT(' BEGINN OF SAGAPO, FIRST EXECUTABLE STATEMENT')		0001850
TIME0=0.		0001860
TIME1=ZEIT(TIME0)		0001870
DIST00=-1.E07		0001880
PEXOUT=0.		0001890
COLAMB=1.		0001900
SQ3=SQRT(3.)		0001910
PIG=3.141593		0001920

1 FORMAT(8I10)	0001930
2 FORMAT(8F10.5)	0001940
357 FORMAT(20A4)	0001950
READ(5,357) ADUMMY	0001960
READ(5,1)NEXCON,NRODS,NSPACT,NSPAC	0001970
CALL HEATBA(-1,PBT,INDQ,TE,MFLOW)	0001980
NSS=NSPACT	0001990
READ(5,2)C,Z,ZWC,RH,PLEN,VDIAM	0002000
READ(5,2)AREFB,RMISTW,RINT,RTIP	0002010
READ(5,1)NDVQ,NSEL,NSC30C,NSC30W,NSC30A	0002020
READ(5,2)PE,PE1,TE,TE1,MFLOW,XLAM1	0002030
READ(5,2)COLAMA	0002040
READ(5,1)IPAST,IPAEND,IREAD1	0002050
READ(5,2)STLEN	0002060
READ(5,1)INDPR,INDQ	0002070
READ(5,1)NEXPRT,NEXPR	0002080
READ(5,1)NEXTWT,NEXTW	0002090
READ(5,1)ITCM,ITC1,ITC2,MSUBDH	0002100
READ(5,2)XDE1,XDE2	0002110
READ(5,2)FT,PCORR,CTU1,CTU2,CTU3	0002120
READ(5,2)TWRRCF,TCPRCF	0002130
READ(5,2)CINL,COUT	0002140
READ(5,2)FAREL	0002150
READ(5,2)TWITPA,TBTIPA,TBPIPA	0002160
IF(NEXPRT.GT.0)READ(5,2)(XEXPR(I),PEX(I),I=1,NEXPRT),PEXOUT	0002170
IF(NEXTWT.GT.0)READ(5,2)(XEXTW(I),I=1,NEXTWT)	0002180
IF(NDVQ.EQ.1)GOTO 3	0002190
READ(5,2)(QPIN(I),I=1,NRODS)	0002200
GOTO 5	0002210
3 READ(5,2)Q1	0002220
DO 4 I=1,NRODS	0002230
C	0002240
4 QPIN(I)=Q1*S(I)	0002250
C	0002260
5 CONTINUE	0002270
READ(5,2)QLINMT	0002280
IF(INDQ.EQ.1)GOTO 3800	0002290
DO 3799 I=1,NRODS	0002300
3799 QPIN(I)=QPIN(I)/4.186	0002310
QLINMT=QLINMT/4.186	0002320
3800 CONTINUE	0002330
READ(5,1)NDPRQT,NDPRQ	0002340
IF(NDPRQT.EQ.0)GOTO 3716	0002350
READ(5,2)(X2DPRQ(I),I=1,NDPRQT)	0002360
READ(5,1)NQDCO	0002370
READ(5,4001)((QDCO(I,J),J=1,NQDCO),I=1,NDPRQT)	0002380
READ(5,4001)((QLDCO(I,J),J=1,NQDCO),I=1,NDPRQT)	0002390
4001 FORMAT(6E12.5)	0002400
3716 CONTINUE	0002410
HEALEN=PLEN(2)+PLEN(4)+PLEN(6)	0002420
TOTLEN=PLEN(1)+PLEN(3)+PLEN(5)+PLEN(7)+HEALEN	0002430
IF(ABS(PE/PE1-1.).GT.1.E-05)CINL=0.	0002440
PE0=PE1	0002450
IF(INDPR.EQ.1)GOTO 6529	0002460
PE=PE/0.980665	0002470
PE0=PE1/0.980665	0002480
6529 CONTINUE	0002490
PEBAR=PE*0.980665	0002500
PEOBAR=PE0*0.980665	0002510
WRITE(6,6)NRODS,PE0,PEOBAR,TE1,MFLOW,COOLA(IGAS),C,Z,ZWC,TOTLEN,	0002520
> HEALEN	0002530
6 FORMAT(1H1,5X,I4,' RODS BUNDLE : //5X,'INLET PRESSURE=',F10.7,' KG0002540	
>/SQCM =' ,F10.7,' BARS'	0002550
1 /5X,'INLET TEMPERATURE=',F10.2,' C'/5X,'TOTAL MASS FLOW RATE0002560	
2=' ,F12.6,' G/SEC'/5X,'COOLANT : ',A8,	0002570

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2      // /5X, GEOMETRY AT 20 DEGREES : //          0002580
3      5X,'ROD PITCH=' ,F10.6, ' CM' / 0002590
45X,'DISTANCE CENTER OF ROD - EXAGONAL WALL=' ,F10.6, ' CM' /5X, 0002600
5'ZWC=' ,F10.7, ' CM' //5X, 0002610
6 'TOTAL LENGTH=' ,F10.3, ' CM' /5X,'HEATED LENGTH=' ,F10.3, ' CM' /5X, 0002620
7'LENGTH AND VOL. DIAMETERS FOR THE EXISTING PARTS :') 0002630
DO 972 IPA=1,7 0002640
IF(PLEN(IPA).LE.1.E-06)GOTO 972 0002650
WRITE(6,971)IPA,PLEN(IPA),IPA,VDIAM(IPA) 0002660
971 FORMAT(5X,'LENGTH(' ,I1,')=' ,F10.6, ' CM' ,5X,'VOL. DIAM.(' ,I1,')=' , 0002670
1     F10.6, ' CM') 0002680
972 CONTINUE 0002690
IF(PLEN(4).GT.1.E-06) 0002700
*WRITE(6,980)RH, 0002710
1           016,017,04,05,00,01,02,03, 06,07,08,09 0002720
2,010,011,013,014,015 0002730
980 FORMAT(////////5X,'HEIGHT OF ROUGHNESS (RH) =' ,F8.5, ' CM' /5X, 0002740
1'G(H+) * ((R2-R1)/RH*' ,F6.3,')**' ,F6.3, ' / (PR**' ,F6.3, '*'((TW+273.0002750
215)/(TB+273.15))**' ,F6.3,')=' ,F6.3, '*'(HW+)**' ,F6.3, '+' ,F9.30002760
3, '/(HW+)**' ,F6.3//5X, 0002770
5 'R(H+)=((' ,F6.3, '+' ,F7.1, '/(HW+)**' ,F6.3,')**' ,F6.3, '+' ,F6.3, 0002780
6'*LN(RH/((' ,F6.3, '*'(R0-R1))' /12X, '+' ,F6.3, '/(HW+)**' ,F6.3, '*'((TW+270002790
73.16) /(TB1+273.16)-1)**' ,F6.3//) 0002800
WRITE(6,3727)QLINMT,(I,QPIN(I),I=1,NRODS) 0002810
3727 FORMAT(//5X,'MAXIMUM POWER FROM THE LINER:' //5X,'Q MAX=' ,E15.5, 0002820
1     ' CAL/SEC*CM' 0002830
2     //5X,'MAXIMUM POWER OF RODS:' //5X,'Q MAX(' ,I4,')=' ,E15.5,0002840
3     ' CAL/SEC*CM')) 0002850
IF(NDPRQT.EQ.0)GOTO 3730 0002860
WRITE(6,3731) 0002870
3731 FORMAT(//5X,'COEFFICIENTS FOR THE POLYNOMIAL PROFILES OF THE ROD P0002880
1OWER ( 0 TAKEN AT THE BEGINNING OF THE ACTUAL PART ):' /) 0002890
DO 3729 I=1,NDPRQT 0002900
3729 WRITE(6,3728)X2DPRQ(I),(QDCO(I,J),J=1,NQDCO) 0002910
3728 FORMAT(5X,'AS FAR AS X =' ,F10.6, ' CM : '/'(5X,8E15.5)) 0002920
WRITE(6,3733) 0002930
3733 FORMAT(//5X,'COEFFICIENTS FOR THE POLYNOMIAL PROFILE OF THE LINER 0002940
1POWER ( 0 TAKEN AT THE BEGINNING OF THE ACTUAL PART ):' /) 0002950
DO 3732 I=1,NDPRQT 0002960
3732 WRITE(6,3728)X2DPRQ(I),(QLDCO(I,J),J=1,NQDCO) 0002970
3730 CONTINUE 0002980
C ..... 0002990
C ..... 0003000
C 2-INDEXING AND CONNECTIONS FOR THE CHANNELS 0003010
C ..... 0003020
CALL INDEX(NSEL,NEXCON,NSTR,NSTOT,NROM1) 0003030
NSPER=NSTOT-NSTR 0003040
C ..... 0003050
C ..... 0003060
C 3-READ AND WRITE INPUT DATA 0003070
C ..... 0003080
IF(NSPACT.EQ.0)GOTO 7 0003090
READ(5,2)WSP0,(DIST(I),I=1,NSPACT) 0003100
WRITE(6,970)WSP0,(I,DIST(I),I=1,NSPACT) 0003110
970 FORMAT(//5X,'SPACERS (AT 20 DEGREES):' //5X,'WIDTH=' ,F10.6, ' CM' // 0003120
1(5X,'DIST(' ,I2,')=' ,F10.3, ' CM')) 0003130
WRITE(6,83) 0003140
DO 11 I=1,NSPACT 0003150
READ(5,981)((GRI(NS,J,I ),J=1,3),NS=1,NSTOT) 0003160
C READ(5,981)((GRIP(NS,J,I ),J=1,3),NS=1,NSTOT) 0003170
C READ(5,981)((GRI1(K,J,I ),J=1,2),K=1,NSPER) 0003180
C READ(5,981)((GRI2(K,J,I ),J=1,2),K=1,NSPER) 0003190
11 CONTINUE 0003200
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 0003210
DO 1119 I=1,NSPACT 0003220
SDIS(I)=DIST(I) 0003230

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DO 1115 NS=1,NSTOT	0003240
DO 1113 J=1,3	0003250
GRIP(NS,J,I)=1.0	0003260
AGRI(NS,J,I)=GRI(NS,J,I)	0003270
CONTINUE	0003280
1113 CONTINUE	0003290
DO 1118 NS=1,NSPER	0003300
DO 1116 J=1,2	0003310
GRI1(NS,J,I)=1.0	0003320
GRI2(NS,J,I)=1.0	0003330
1116 CONTINUE	0003340
1118 CONTINUE	0003350
1119 CONTINUE	0003360
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC	0003370
READ(5,982)((IRGRI(NS,J),J=1,3),NS=1,NSTOT)	0003380
981 FORMAT(6F10.5)	0003390
982 FORMAT(6I10)	0003400
7 CONTINUE	0003410
READ(5,2)TIMEPU	0003420
READ(5,1)IPUNCH	0003430
C	0003440
C	0003450
C 4-CORRECTION OF THE INPUT DIMENSIONS TO TAKE INTO ACCOUNT THE	0003460
C THERMAL EXPANSION OF THE BUNDLE STRUCTURE	0003470
C	0003480
SPLENO=0.	0003490
NEXPRP=0	0003500
NEXTWP=0	0003510
NSPACP=0	0003520
NDPRQP=0	0003530
DO 882 IPA=1,7	0003540
EXFTBP=1.+EXPCL(TBPIPA(IPA))*(TBPIPA(IPA)-20.)	0003550
EXFTWT =1.+EXPCL(TWTIPA(IPA))*(TWTIPA(IPA)-20.)	0003560
IF(NEXPR(IPA).EQ.0)GOTO 1010	0003570
IEXPR1=NEXPRP+1	0003580
IEXPR2=NEXPRP+NEXPR(IPA)	0003590
NEXPRP=IEXPR2	0003600
DO 1009 IEXPR=IEXPR1,IEXPR2	0003610
1009 XEXPR(IEXPR)=(XEXPR(IEXPR)-SPLENO)*EXFTBP	0003620
1010 CONTINUE	0003630
IF(NEXTW(IPA).EQ.0)GOTO 1012	0003640
IEXTW1=NEXTWP+1	0003650
IEXTW2=NEXTWP+NEXTW(IPA)	0003660
NEXTWP=IEXTW2	0003670
DO 1011 IEXTW=IEXTW1,IEXTW2	0003680
1011 XEXTW(IEXTW)=(XEXTW(IEXTW)-SPLENO)*EXFTWT	0003690
1012 CONTINUE	0003700
IF(NDPRQ(IPA).EQ.0)GOTO 1015	0003710
IDPRQ1=NDPRQP+1	0003720
IDPRQ2=NDPRQP+NDPRQ(IPA)	0003730
NDPRQP=IDPRQ2	0003740
DO 1014 IDPRQ=IDPRQ1, IDPRQ2	0003750
CALL MODFQD(IDPRQ,NDPRQT,NQDCO,QDCO,EXFTWT)	0003760
CALL MODFQD(IDPRQ,NDPRQT,NQDCO,QLDCO,EXFTWT)	0003770
1014 X2DPRQ(IDPRQ)=(X2DPRQ(IDPRQ)-SPLENO)*EXFTWT	0003780
1015 CONTINUE	0003790
IF(NSPAC(IPA).EQ.0)GOTO 882	0003800
ISPAC1=1+NSPACP	0003810
ISPAC2=NSPACP+NSPAC(IPA)	0003820
NSPACP=ISPAC2	0003830
WSP(IPA)=WSP0*(1.+EXPCL(TBTIPA(IPA))*(TBTIPA(IPA)-20.))	0003840
DO 881 ISPAC=ISPAC1,ISPAC2	0003850
881 DIST(ISPAC)=(DIST(ISPAC)-SPLENO)*EXFTBP	0003860
882 SPLENO=SPLENO+PLEN(IPA)	0003870
EXCON=NEXCON	0003880

DO 983 IPA=1,7	0003890
EXFTBP=1.+EXPCL(TBPIPA(IPA))*(TBPIPA(IPA)-20.)	0003900
EXFTWT =1.+EXPCO(TWTIPA(IPA))*(TWTIPA(IPA)-20.)	0003910
PLENO(IPA)=PLEN(IPA)	0003920
PLEN(IPA)=PLEN(IPA)*EXFTBP	0003930
RMISTW(IPA)=RMISTW(IPA)*EXFTWT	0003940
RINT (IPA)=RINT (IPA)*EXFTWT	0003950
RTIP (IPA)=RTIP (IPA)*EXFTWT	0003960
VDIAM(IPA)=VDIAM(IPA)*EXFTWT	0003970
CIPA(IPA)=C*(1.+EXPCO(TBTIPA(IPA))*(TBTIPA(IPA)-20.))	0003980
ZIPA(IPA)=(Z+EXCON*C*SQ3*0.5)*EXFTBP-EXCON*CIPA(IPA)*SQ3*0.5	0003990
983 CONTINUE	0004000
SPLEN=0.	0004010
NEXPRP=0	0004020
NSPACP=0	0004030
NDPRQP=0	0004040
DO 885 IPA=1,7	0004050
IF(NEXPR(IPA).EQ.0)GOTO 1020	0004060
IEXPR1=NEXPRP+1	0004070
IEXPR2=NEXPRP+NEXPR(IPA)	0004080
NEXPRP=IEXPR2	0004090
DO 1019 IEXPR=IEXPR1,IEXPR2	0004100
1019 XEXPR(IEXPR)=XEXPR(IEXPR)+SPLEN	0004110
1020 CONTINUE	0004120
IF(NSPAC(IPA).EQ.0)GOTO 885	0004130
ISPAC1=1+NSPACP	0004140
ISPAC2=NSPACP+NSPAC(IPA)	0004150
NSPACP=ISPAC2	0004160
DO 884 ISPAC=ISPAC1,ISPAC2	0004170
884 DIST(ISPAC)=DIST(ISPAC)+SPLEN	0004180
885 SPLEN=SPLEN+PLEN(IPA)	0004190
DO 8 IPA=1,7	0004200
IF(PLEN(8-IPA).LE.1.E-06)GOTO 8	0004210
IPAM=8-IPA	0004220
GOTO 9	0004230
8 CONTINUE	0004240
9 CONTINUE	0004250
PLEN(IPAM)=SPLEN	0004260
IPA1=IPAM-1	0004270
DO 10 IPA=1,IPA1	0004280
PLEN(IPA)=PLEN(IPA)*(1.+EXPCO(TWTIPA(IPA))*(TWTIPA(IPA)-20.))	0004290
PLEN(IPAM)=PLEN(IPAM)-PLEN(IPA)	0004300
10 CONTINUE	0004310
DO 886 IPA=3,5	0004320
IF(PLEN(IPA).LE.1.E-06)GOTO 886	0004330
RHIPA(IPA-2)=RH*(1.+EXPCO(TWTIPA(IPA))*(TWTIPA(IPA)-20.))	0004340
886 CONTINUE	0004350
SPLEN=0.	0004360
NEXTWP=0	0004370
DO 1013 IPA=1,7	0004380
IF(NDPRQ(IPA).EQ.0)GOTO 1017	0004390
IDPRQ1=NDPRQP+1	0004400
IDPRQ2=NDPRQP+NDPRQ(IPA)	0004410
NDPRQP=IDPRQ2	0004420
DO 1016 IDPRQ=IDPRQ1,IDPRQ2	0004430
1016 X2DPRQ(IDPRQ)=X2DPRQ(IDPRQ)+SPLEN	0004440
X2DPRQ(IDPRQ2)=X2DPRQ(IDPRQ2)*1.1	0004450
1017 CONTINUE	0004460
IF(NEXTW(IPA).EQ.0)GOTO 1022	0004470
IEXTW1=NEXTWP+1	0004480
IEXTW2=NEXTWP+NEXTW(IPA)	0004490
NEXTWP=IEXTW2	0004500
DO 1021 IEXTW=IEXTW1,IEXTW2	0004510
1021 XEXTW(IEXTW)=XEXTW(IEXTW)+SPLEN	0004520
1022 CONTINUE	0004530

1013	SPLEN=SPLEN+PLEN(IPA)	0004540
	UNHLE=PLEN(1)+PLEN(3)	0004550
C	.....	0004560
C		0004570
C	5-REARRANGEMENT OF THE GEOMETRIC AXIAL DATA IF THE CALCULATION DOES	0004580
C	NOT START AT THE BUNDLE INLET	0004590
C		0004600
	ISTAIN=1	0004610
	SPLEN=0.	0004620
	IPAST1=IPAST-1	0004630
	NEXPRS=0	0004640
	NEXTWS=0	0004650
	NSPACS=0	0004660
	NDPRQS=0	0004670
	IF(IPAST1.EQ.0)GOTO 2222	0004680
	DO 6532 IPA=1,IPAST1	0004690
	SPLEN=SPLEN+PLEN(IPA)	0004700
	PLEN(IPA)=0.	0004710
	NEXPRT=NEXPRT-NEXPR(IPA)	0004720
	NEXPRS=NEXPRS+NEXPR(IPA)	0004730
	NEXPR(IPA)=0	0004740
	NEXTWT=NEXTWT-NEXTW(IPA)	0004750
	NEXTWS=NEXTWS+NEXTW(IPA)	0004760
	NEXTW(IPA)=0	0004770
	NDPRQT=NDPRQT-NDPRQ(IPA)	0004780
	NDPRQS=NDPRQS+NDPRQ(IPA)	0004790
	NDPRQ(IPA)=0	0004800
	NSPACT=NSPACT-NSPAC(IPA)	0004810
	NSPACS=NSPACS+NSPAC(IPA)	0004820
	NSPAC(IPA)=0	0004830
6532	CONTINUE	0004840
	IF(IPAST.EQ.4)AREFB=AREFB*(PLEN(4)+SPLEN-STLEN)/PLEN(4)	0004850
2222	CONTINUE	0004860
	PLEN(IPAST)=PLEN(IPAST)+SPLEN-STLEN	0004870
	IF(ABS(STLEN-SPLEN).GT.1.E-04)ISTAIN=2	0004880
	IF(NEXPRT.EQ.0)GOTO 6534	0004890
	IEXPR1=0	0004900
	DO 6533 I=1,NEXPRT	0004910
	XEXPR(I)=XEXPR(I+NEXPRS)-STLEN	0004920
	IF(XEXPR(I).LE.0.)IEXPR1=IEXPR1+1	0004930
6533	PEX(I)=PEX(I+NEXPRS)	0004940
	NEXPR(IPAST)=NEXPR(IPAST)-IEXPR1	0004950
	NEXPRT=NEXPRT-IEXPR1	0004960
	IF(NEXPRT.EQ.0)GOTO 6534	0004970
	DO 973 I=1,NEXPRT	0004980
	XEXPR(I)=XEXPR(I+IEXPR1)	0004990
973	PEX(I)=PEX(I+IEXPR1)	0005000
6534	CONTINUE	0005010
	IF(NEXTWT.EQ.0)GOTO 6536	0005020
	IEXTW1=0	0005030
	DO 6535 I=1,NEXTWT	0005040
	XEXTW(I)=XEXTW(I+NEXTWS)-STLEN	0005050
	IF(XEXTW(I).LE.0.)IEXTW1=IEXTW1+1	0005060
6535	CONTINUE	0005070
	NEXTW(IPAST)=NEXTW(IPAST)-IEXTW1	0005080
	NEXTWT=NEXTWT-IEXTW1	0005090
	IF(NEXTWT.EQ.0)GOTO 6536	0005100
	DO 974 I=1,NEXTWT	0005110
974	XEXTW(I)=XEXTW(I+IEXTW1)	0005120
6536	CONTINUE	0005130
	IF(NDPRQT.EQ.0)GOTO 6539	0005140
	IDPRQ1=0	0005150
	DO 6540 I=1,NDPRQT	0005160
	X2DPRQ(I)=X2DPRQ(I+NDPRQS)-STLEN	0005170
	IF(X2DPRQ(I).LE.0.)IDPRQ1=IDPRQ1+1	0005180
	DO 6540 IQDCO=1,NQDCO	0005190

QDCO(I,IQDCO)=QDCO(I+NDPRQS,IQDCO)	0005200
QLDCO(I,IQDCO)=QLDCO(I+ NDPRQS,IQDCO)	0005210
6540 CONTINUE	0005220
NDPRQ(IPAST)=NDPRQ(IPAST)-IDPRQ1	0005230
NDPRQT=NDPRQT-IDPRQ1	0005240
IF(NDPRQT.EQ.0)GOTO 6539	0005250
DO 976 I=1,NDPRQT	0005260
X2DPRQ(I)=X2DPRQ(I+IDPRQ1)	0005270
DO 976 IQDCO=1,NQDCO	0005280
QDCO(I,IQDCO)=QDCO(I+IDPRQ1,IQDCO)	0005290
QLDCO(I,IQDCO)=QLDCO(I+IDPRQ1,IQDCO)	0005300
976 CONTINUE	0005310
6539 CONTINUE	0005320
IF(NSPACS.NE.0)DIST00=DIST(NSPACS)-STLEN	0005330
NSPA00=NSPACT+1	0005340
IF(NSPACS.GT.NSPA00)NSPA00=NSPACS	0005350
IF(NSPACT.EQ.0 .AND. NSPACS.EQ.0)GOTO 6538	0005360
ISPAC1=0	0005370
DO 6537 I=1,NSPA00	0005380
IF(I.GT.NSPACT)GOTO 2006	0005390
DIST(I)=DIST(I+NSPACS)-STLEN	0005400
IF(DIST(I).LE.0.)ISPAC1=ISPAC1+1	0005410
IF(DIST(I).LE.0.)DIST00=DIST(I)	0005420
2006 CONTINUE	0005430
DO 2000 NS=1,NSTOT	0005440
DO 2001 J=1,3	0005450
IF(NSPACS.GT.0)GRI00=GRI(NS,J,I)	0005460
IF(I.LE.NSPACT)GRI(NS,J,I)=GRI(NS,J ,I+NSPACS)	0005470
IF(I.LE.NSPACT .AND. I.GE.NSPACS .AND. NSPACS.GT.0)GRI(NS,J,I+1)=	0005480
=GRI00	0005490
IF(I.GT.NSPACT .AND. I.GE.NSPACS .AND. NSPACS.GT.0)GRI(NS,J,NSPACT)++1)=GRI00	0005500
IF(I.LE.NSPACT)GRIP(NS,J,I)=GRIP(NS,J,I+NSPACS)	0005510
2001 CONTINUE	0005520
IF(NS.LE.NSTR .OR. I.GT.NSPACT)GOTO 2000	0005530
NSW=NS-NSTR	0005540
DO 2002 J=1,2	0005550
GRI1(NSW,J,I)=GRI1(NSW,J,I+NSPACS)	0005560
2002 GRI2(NSW,J,I)=GRI2(NSW,J,I+NSPACS)	0005570
2000 CONTINUE	0005580
6537 CONTINUE	0005590
NSPAC(IPAST)=NSPAC(IPAST)-ISPAC1	0005600
NSPACT=NSPACT-ISPAC1	0005610
NSPA00=NSPACT+1	0005620
IF(ISPAC1.GT.NSPA00)NSPA00=ISPAC1	0005630
IF(NSPACT.EQ.0 .AND. ISPAC1.EQ.0)GOTO 6538	0005640
DO 977 I=1,NSPA00	0005650
DO 2003 NS=1,NSTOT	0005660
DO 2004 J=1,3	0005670
IF(ISPAC1.GT.0)GRI00=GRI(NS,J,I)	0005680
IF(I.LE.NSPACT)GRI(NS,J,I)=GRI(NS,J,I+ISPAC1)	0005690
IF(I.GE.ISPAC1 .AND. ISPAC1.GT.0 .AND. I.LE.NSPACT)GRI(NS,J,I+1)=	0005700
=GRI00	0005710
IF(I.GE.ISPAC1 .AND. ISPAC1.GT.0 .AND. I.GT.NSPACT)GRI(NS,J,	0005720
*NSPACT+1)=GRI00	0005730
IF(I.GT.NSPACT)GOTO 2004	0005740
GRIP(NS,J,I)=GRIP(NS,J,I+ISPAC1)	0005750
2004 CONTINUE	0005760
IF(NS.LE.NSTR .OR. I.GT.NSPACT)GOTO 2003	0005770
NSW=NS-NSTR	0005780
DO 2005 J=1,2	0005790
GRI1(NSW,J,I)=GRI1(NSW,J,I+ISPAC1)	0005800
2005 GRI2(NSW,J,I)=GRI2(NSW,J,I+ISPAC1)	0005810
2003 CONTINUE	0005820
IF(I.LE.NSPACT)DIST(I)=DIST(I+ISPAC1)	0005830
977 CONTINUE	0005840
	0005850

6538 CONTINUE 0005860
HEALEN=PLEN(2)+PLEN(4)+PLEN(6) 0005870
UNHLE1=PLEN(1)+PLEN(3) 0005880
TOTLEN=UNHLE1+HEALEN+ PLEN(5)+PLEN(7) 0005890
HRDAR=RH/AREFB 0005900
CC 0005910
IF(PLEN(4).GT.1.E-06)FCORLA=ALOG(RTIP(4)/(RTIP4-RHIPA(2)))/ 0005920
/ (2.*PIG*PLEN(4)) 0005930
C IF(PLEN(4).GT.1.E-06)FCORLA=ALOG(RTIP(4)/(RTIP(4)-RHIPA(2)))/ 0005940
C / (2.*PIG*PLEN(4)) 0005950
CCCCCCCCCC 0005960
C 0005970
C 0005980
C 6-INITIALIZATION OF VARIABLES 0005990
C
QLINMT=QLINMT*HEALEN 0006010
DO 3734 I=1,NRODS 0006020
3734 QPIN(I)=QPIN(I)*HEALEN 0006030
ANCE=NSC30C 0006040
ANWA=NSC30W 0006050
ANCO=NSC30A 0006060
ALFACE=PIG/(6.*ANCE) 0006070
ALFAWA=PIG/(6.*ANWA) 0006080
ALFACO=PIG/(ANCO*6.) 0006090
NSC90=3*NSC30W 0006100
NSC45=NSC30C/2+1+NSC30C 0006110
L=1 0006120
T(1)=TE 0006130
P(1)=PE 0006140
PBAR(1)=PEBAR 0006150
X(1)=0. 0006160
XDEST=NDEST 0006170
XDEEND=NDEEND 0006180
TO=TE 0006190
PO=PE 0006200
INLET=1 0006210
ISPAC=1 0006220
II=1 0006230
HH=0. 0006240
IEXPR1=1 0006250
IEXTW1=1 0006260
IEXTWC=1 0006270
IDPRQ=1 0006280
SPRLEN=0. 0006290
IRHPL=1 0006300
C 0006310
C 0006320
C 7- LOOP IPA : A SUBDIVISION OF RODS INTO SEVEN POSSIBLE DIFFERENT 0006330
C PARTS IS MADE (BUT ONLY FIVE TOGETHER ARE SUPPOSED TO EXIST : 0006340
C 1) SMOOTH UNHEATED+SMOOTH HEATED+ROUGH+SMOOTH HEATED+SMOOTH 0006350
C UNHEATED 0006360
C 2) SMOOTH UNHEATED+ROUGH UNHEATED+ROUGH HEATED+ROUGH UNHEATED+ 0006370
C SMOOTH UNHEATED) 0006380
C 0006390
C IPA=1 : INITIAL UNHEATED SMOOTH PART 0006400
C IPA=2 : FIRST HEATED SMOOTH PART 0006410
C IPA=3 : FIRST UNHEATED ROUGH PART 0006420
C IPA=4 : ROUGH PART (HEATED OR UNHEATED) 0006430
C IPA=5 : LAST UNHEATED ROUGH PART 0006440
C IPA=6 : SECOND HEATED SMOOTH PART 0006450
C IPA=7 : LAST UNHEATED SMOOTH PART 0006460
C 0006470
C DO 8888 IPA=1,7 0006480
C IF(IPA.EQ.IPAEND+1)CALL TMPUN(NSTOT,NSTR,T(L),P(L),PBAR(L), 0006490
*TE1,PEO,PEOBAR,INDPR,MFLOW,IPA,IPAEND,2,XLAM1,X(L)+STLEN,&742) 0006500
C IF(PLEN(IPA) .LE.1.E-06)GOTO 8888 0006510

SPLENG=SPRLEN	0006520
IF(IPA.EQ.IPAST)SPLENG=SPLEN-STLEN	0006530
C=CIPA(IPA)	0006540
Z=ZIPA(IPA)	0006550
D=VDIAM(IPA)	0006560
LENGTH=PLEN(IPA)	0006570
LAM1=XLAM1(IPA)	0006580
MSPAC=NSPAC(IPA)	0006590
NDE1=XDE1(IPA)	0006600
NDE2=XDE2(IPA)	0006610
FREL=FAREL(IPA)	0006620
ZWCIPA=ZWC *(1.+EXPC0(TBPIPA(IPA))*(TBPIPA(IPA)-20.))	0006630
CCCCCCCCCC	0006640
DIT=D	0006650
PIT=C	0006660
ZIT=Z	0006670
ZWCIT=ZWCIPA	0006680
CCCCCCCCCC	0006690
POBAR=P0*0.980665	0006700
WRITE(6,991)(TITLE(I,IPA),I=1,4),C,Z,ZWCIPA,D,LENGTH,MSPAC,T0,P0	0006710
1,POBAR	0006720
991 FORMAT(1H1,5X,4A8//5X,'C=',F10.6,' CM'/5X,'Z=',F10.6,' CM'/5X,	0006730
1'ZWC=',F10.6,' CM'/5X,'VOL. DIAMETER=',F10.6,' CM'/5X,'PART LENGTH',0006740	
2H=',F10.5,' CM'/5X,'NUMBER OF SPACERS=',I3//5X,'INLET CONDITIONS',0006750	
3 : '/5X,'INLET AVERAGE TEMPERATURE=',F7.2,' C'/5X,'INLET PRESSURE='0006760	
4,F10.7,' KG/SQCM =',F10.7,' BARS'////)	0006770
IF(MSPAC.EQ.0)GOTO 968	0006780
ISPAC2=ISPAC+MSPAC-1	0006790
WRITE(6,967)WSP(IPA),(I,DIST(I),I=ISPAC,ISPAC2)	0006800
967 FORMAT(5X,'SPACERS (DISTANCES ARE EVALUATED FROM THE BUNDLE ENTRANCE)',0006810	
1CE) : '/5X,'WIDTH=',F10.6,' CM'/(5X,'DIST('I2,')=',F10.3,' CM'))	0006820
WRITE(6,83)	0006830
968 CONTINUE	0006840
C2=C*0.5	0006850
EM1=C2-ZWCIPA*SQ3	0006860
X(1)=HH	0006870
DDD=HH+LENGTH	0006880
SUR=PIG*D*LENGTH	0006890
IF(IPA.EQ.5)RHPL=2	0006900
GOTO(993,994,993,994,993,994,993),IPA	0006910
993 PLDHL=0.	0006920
INDICE=0	0006930
GOTO 995	0006940
994 PLDHL= PLEN(IPA)/HEALEN	0006950
INDICE=0	0006960
995 CONTINUE	0006970
GOTO(996,996,997,997,997,996,996),IPA	0006980
996 IRH=1	0006990
CLASUB=1.0576	0007000
XMAXNU=1.6	0007010
CHSLNU=2./3.	0007020
GOTO 998	0007030
997 IRH=2	0007040
CLASUB=1.	0007050
XMAXNU=1.	0007060
CHSLNU=.5	0007070
RH=RHIPA(IPA-2)	0007080
WRITE(6,990)RH	0007090
990 FORMAT(//5X,'HEIGHT OF ROUGHNESS=',F10.7,' CM'////)	0007100
998 CONTINUE	0007110
CONST=CNUSS(IRH)	0007120
QTOT=0.	0007130
DO 992 I=1,NRODS	0007140
Q(I)=QPIN(I)*PLDHL	0007150
992 QTOT=QTOT+Q(I)	0007160
	0007170

C	.....	0007180
C		0007190
C	8-SUBROUTINES HEATI, TOTGEO, INQUA, KAPCOR	0007200
C		0007210
	CALL HEATI(NSTOT,NSTR,NSEL,NEXCON,IPA)	0007220
	CCCCCCCCCC	0007230
	CALL JZURU	0007240
	CALL MEZZI(NRODS,NSEL,NSTOT)	0007250
	CALL DELIP	0007260
	IF(IRAD.GT.0) CALL TOTSEC(NSEL)	0007270
	IF(IRAD.GT.0) CALL TARRAY	0007280
	IF(IRAD.GT.0) CALL VFICAL	0007290
	IF(IRAD.GT.0) CALL VFDET(NSEL,NRODS)	0007300
	IF(IRAD.GT.0) CALL VFCTR	0007310
	CCCCCCCCCC	0007320
	CALL TOTGEO(NSEL,D,C,Z,PIG,NEXCON,NRODS,WW,WA,ZA,EM1,PERLT, *RTIP(IPA))	0007330
	CCCCCCCCCC 02.11.1979	0007340
	PERLTT=PERLT	0007350
	CCCCCCCCCC 02.11.1979	0007360
	QLINM=QLINMT*PLDHL/PERLT	0007370
	CALL INQUA(NSEL,NSTOT,NEXCON,ATC,ATW,ATA,DETC,DETW,DETA)	0007380
	CALL KAPCOR(NSTOT,NSTR)	0007390
C	.....	0007400
C		0007410
C	9-DEFINITION OF THE REGIONS WHERE INDISTURBED FLOW IS ASSUMED AND	0007420
C	EVALUATION OF THE SPACER PARAMETERS	0007430
C		0007440
		0007450
	DXST =XDEST*DETC	0007460
	DXEND=XDEEND*DETC	0007470
	XSTART(1)=X(1)+DXST	0007480
	XEND(MSPAC+1)=X(1)+LENGTH-DXEND	0007490
	IMSPAC=ISPAC1+NSPACS	0007500
	IF(IMSPAC.EQ.0 .OR. IPA.NE.IPAST)GOTO 7007	0007510
	DO 7002 NS=1,NSTOT	0007520
	NP=NPIN(NS)	0007530
	DO 7002 J=1,NP	0007540
	DO 7002 M=1,NP	0007550
	IF(IRGRI(NS,J).EQ.JPIN(NS,M))EPSISC(NS,M,MSPAC+1)=GRI(NS,J,NSPACT+0007560 +1)	0007560
7002	CONTINUE	0007570
7007	CONTINUE	0007580
	IF(IPA.EQ.IPAST .OR. II.EQ.1)GOTO 7009	0007590
	DO 7008 NS=1,NSTOT	0007600
	NP=NPIN(NS)	0007610
	DO 7008 J=1,NP	0007620
	DO 7008 M=1,NP	0007630
	IF(IRGRI(NS,J).EQ.JPIN(NS,M))EPSISC(NS,M,MSPAC+1)=GRI(NS,J,II-1)	0007640
7008	CONTINUE	0007650
7009	CONTINUE	0007660
	IF(MSPAC.EQ.0)GOTO 12	0007670
	JSP=MSPAC+ISPAC-1	0007680
	IPAFD=1	0007690
	DO 4430 I=ISPAC,JSP	0007700
	I1SPAC=I-ISPAC+1	0007710
	IPAFD=IPAFD+1	0007720
	XSTART(IPAFD)=DIST(I)+DXST+WSP(IPA)*0.5	0007730
	XEND(IPAFD-1)=DIST(I)-WSP(IPA)*0.5-DXEND	0007740
	PGDPT(I1SPAC)=0.	0007750
	EPSIT(I1SPAC)=0.	0007760
	DO 5601 NS=1,NSTOT	0007770
	PGDPC(NS,I1SPAC)=0.	0007780
	EPSIC(NS,I1SPAC)=0.	0007790
	NP=NPIN(NS)	0007800
	DO 5600 J=1,NP	0007810
	DO 5599 M=1,NP	0007820
		0007830


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IF(INLET.NE.1)GOTO 4435          0008500
CALL INLCON(NSTOT,MFLOW,ATOT,TE,IREAD1,NSTR) 0008510
PI=PE                            0008520
DO 4432 I=1,10                  0008530
CCCCCCCCCCCCCCCCCCCCCCCCCCCC 0008540
CIN1= DPIN(MFLOW,PI,TE,CINL)    0008550
PO=PE+CIN1*PROV2/RHO(PI,TE)*0.5 0008560
CCCCCCCCCCCCCCCCCCCCCCCCCCC 0008570
IF(ABS(P0/PI-1.).LE.1.E-06)GOTO 4434 0008580
4432 PI=P0                      0008590
WRITE(6,4433)PO,PI              0008600
4433 FORMAT(1H1,5X,'MAIN',/5X,      0008610
>                               'CALCULATION STOPS : P0=' ,F10.7,' ; PI=' ,F10.7) 0008620
STOP                            0008630
4434 CONTINUE                   0008640
DPE=P0-PE                      0008650
DPEBAR=DPE*0.980665            0008660
WRITE(6,1333)DPE,DPEBAR,CIN1   0008670
1333 FORMAT(//130('*')/5X,      0008680
*                               'PRESSURE LOSS DUE TO ENTRANCE=' ,F10.7,' KG/SQCM =' ,0008690
*F10.7,' BARS ( CINL=' ,F4.2,' )'//) 0008700
INLET=2                          0008710
DPBAR(1)=PEOBAR-PEBAR-DPEBAR  0008720
IF(STLEN.GT.1.E-06 .OR. IPUNCH.EQ.2)GOTO 4435 0008730
WRITE(1,1)NSPACT                0008740
IF(NSPACT.GT.0)WRITE(1,6069)(DIST(I),I=1,NSPACT) 0008750
XLTOT=0.                         0008760
WRITE(1,1)IPA                    0008770
WRITE(1,6069)XLTOT,DPBAR(1)    0008780
4435 CONTINUE                   0008790
C ..... 0008800
C ..... 0008810
C 12-EVALUATION OF SECTION LENGTHS AND CORRECTION FACTORS FOR NUSSELT 0008820
C ..... 0008830
CALL AXSEC(NDE1,NDE2,DETC,WSP(IPA),CONST,DDD,II,HH,MSPAC,LENGTH,N,0008840
*IPA,QTOT,NSTOT,XMAXNU,CHSLNU) 0008850
WRITE(6,14)LENGTH,N,FREL        0008860
14 FORMAT(//130('*')//          0008870
*      5X,'TOTAL LENGTH=' ,F7.2,1X,'CM',5X,'NUMBER OF SECTIONS=' ,I30008880
*,5X,'FREL=' ,F10.4//)        0008890
C ..... 0008900
C ..... 0008910
C 13-INITIALIZATION OF VARIABLES 0008920
C ..... 0008930
T(1)=T0                          0008940
P(1)=P0                          0008950
PBAR(1)=P0*0.980665            0008960
NSEFD=0                           0008970
IPAFD=1                           0008980
TM=0.                            0008990
PM=0.                            0009000
LAMBDM=0.                         0009010
REM=0.                            0009020
UM=0.                            0009030
DELTAX=0.                         0009040
TWTC=0.                           0009050
TBTC=0.                           0009060
TBPC=0.                           0009070
NSTR1=NSTR+1                     0009080
DO 5636 NS=NSTR1,NSTOT           0009090
NP=NPIN(NS)                      0009100
DO 5636 M=1,NP                  0009110
TLINER(NS-NSTR,M)=TSCH1(NS,M)   0009120
IF(ISTAIN.EQ.2)GOTO 978          0009130
DO 5634 JWC=1,2                 0009140
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5634 TSCWC1(NS-NSTR,M,JWC)=TSCH1(NS,M)	0009150
978 CONTINUE	0009160
DO 5635 I=1,NSC90	0009170
DELTIO(NS-NSTR,M,I)=0.	0009180
5635 TIO(NS-NSTR,M,I)=0.	0009190
5636 CONTINUE	0009200
IF(IRH.NE.2)GOTO 4439	0009210
DO 4438 NS=1,NSTOT	0009220
NP=NPIN(NS)	0009230
DO 4438 M=1,NP	0009240
HPLUS1(NS,M)=0.	0009250
HPLUS2(NS,M)=0.	0009260
TWA(NS,M)=0.	0009270
QPLUSA(NS,M)=0.	0009280
PRBA (NS,M)=0.	0009290
YDH(NS,M)=0.	0009300
YODH(NS,M)=0.	0009310
TEMPB(NS,M)=TE	0009320
XMASSB(NS,M)=1.	0009330
YDHA(NS,M)=0.	0009340
YDHA(NS,M)=0.	0009350
TEMPBA(NS,M)=0.	0009360
AMASSB(NS,M)=0.	0009370
TEMPTA(NS,M)=0.	0009380
AMASST(NS,M)=0.	0009390
4438 CONTINUE	0009400
4439 CONTINUE	0009410
C	0009420
C	0009430
C 14-THE AXIAL LOOP STARTS (K=INDEX OF THE AXIAL SECTION)	0009440
C	0009450
K1=1	0009460
NSUBDH=0	0009470
8503 CONTINUE	0009480
DO 9999 K=K1,N	0009490
C	0009500
TIME2=ZEIT(TIME1)	0009510
IF(TIME2.GT.TIMEPU)CALL TMPUN(NSTOT,NSTR,T(K),P(K),PBAR(K),	0009520
*TE1,PE0,PEOBAR,INDPR,MFLOW,IPA,IPAEND,2,XLAM1,X(K)+STLEN,&742)	0009530
ASECCLA=ASEC	0009540
DETOLA=DETOT	0009550
L=K+1	0009560
H=X(L)-X(K)	0009570
CCCCCCCCCCCCCCCCCCCCCCCC	0009580
CALL DECP(IPRINT,X(K),X(L),STLEN)	0009590
CCCCCCCCCCCCCCCCCCCCCCCC	0009600
QDEV=0.	0009610
QLDEV=0.	0009620
INDPRQ=1	0009630
IF(NDPRQ(IPA).EQ.0) GO TO 3702	0009640
XPRQ(1)=X(K)-SPLENG	0009650
IF(X(L).LT.X2DPRQ(IDPRQ))GOTO 1018	0009660
XPRQ(2)=X2DPRQ(IDPRQ)-SPLENG	0009670
INDPRQ=2	0009680
1018 XPRQ(INDPRQ+1)=X(L)-SPLENG	0009690
DO 3402 IQDEV=1,INDPRQ	0009700
IQDEV1=IQDEV+1	0009710
IIQDEV=IDPRQ+IQDEV-1	0009720
DO 3401 IQDCO=1,NQDCO	0009730
QDCOI(IQDCO)=QDCO(IIQDEV,IQDCO)	0009740
3401 QLDROI(IQDCO)=QLDCO(IIQDEV,IQDCO)	0009750
QDEV=FQDEV(QDCOI,NQDCO,XPRQ(IQDEV),XPRQ(IQDEV1))+QDEV	0009760
3402 QLDEV=FQDEV(QLDCOI,NQDCO,XPRQ(IQDEV),XPRQ(IQDEV1))+QLDEV	0009770
QDEV=QDEV/H	0009780
QLDEV=QLDEV/H	0009790
3702 CONTINUE	0009800

QALIN=QLINM*QLDEV/LENGTH 0009810
DO 6670 NS=NSTR1,NSTOT 0009820
NP=NPIN(NS) 0009830
DO 6670 M=1,NP 0009840
6670 DTIEAV(NS-NSTR,M)=0. 0009850
XM=(X(L)+ X(K))*0.5+STLEN 0009860
XMHE=XM-UNHLE 0009870
IF(NSUBDH.EQ.0)WRITE(6,8504) 0009880
8504 FORMAT(1H1) 0009890
WRITE(6,15)K,H,XM 0009900
15 FORMAT(5X,'AXIAL SECTION NR.',I4,5X,'(SECTION LENGTH=',F10.5,0009910
*' ; HEIGHT=',F10.5, ')') 0009920
H1=H/LENGTH 0009930
TMS=T(K) 0009940
QRTOT=QTOT*QDEV*H1 0009950
QSTOT=QLINM*QLDEV*H1*PERLT 0009960
IF(IPHUD.EQ. 1) QSTOT=HUDFAC*(TMS-TAMB)*H 0009970
DELTAH=(QRTOT+QSTOT)/MFLOW 0009980
CC 02.11.1979 0009990
RHO1=RHO(P(K),T(K)) 0010000
IF(NSPACT.EQ.0)GOTO 16 0010010
IF(X(K).LT.DIST(ISPAC))GOTO 4437 0010020
IF(IPAFD.LE.MSPAC)IPAFD=IPAFD+1 0010030
IF(ISPAC.EQ.NSPACT)GOTO 16 0010040
ISPAC=ISPAC+1 0010050
4437 CONTINUE 0010060
IF(X(L).LT.DIST(ISPAC))GOTO 16 0010070
INDSP(K)=2 0010080
I1SPAC= ISPAC-II+1 0010090
WRITE(6,4440)ISPAC 0010100
4440 FORMAT(1H+,80X,'SPACER NR.',I3,' IS PRESENT',24('.')/5X,21('-')) 0010110
IF(K.EQ.1)GOTO 8500 0010120
GOTO 17 0010130
16 INDSP(K)=1 0010140
SBMNS=MFLOW/ATOT*ASEC 0010150
WRITE(6,4441) 0010160
4441 FORMAT(1H+,78X,50('.')/5X,21('-')) 0010170
17 CONTINUE 0010180
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 0010190
WRITE(6,820) TIME2 0010200
820 FORMAT(/5X,'TIME = ',F10.5,' SEC.') 0010210
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 0010220
DO 4444 NS=1,NSTOT 0010230
SIGMA(NS)=0. 0010240
PHI(NS)=0. 0010250
NP=NPIN(NS) 0010260
DO 4443 M=1,NP 0010270
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 0010280
IF(NS.GT.NSTR) SHQ(NS-NSTR,M) = 0.0 0010290
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 0010300
MSCH(NS,M)=MSCH1(NS,M) 0010310
TSCH(NS,M)=TSCH1(NS,M) 0010320
IF(K.GT.1 .AND. NSUBDH.EQ.0)TWP(NS,M)=TW(NS,M) 0010330
SIGMAI(NS,M)=0. 0010340
PHII(NS,M)=0. 0010350
IF(NS.LE.NSTR)GOTO 4443 0010360
DO 4442 JWC=1,2 0010370
CCCCCCCCCCCCCCCCCCCCCCCCCCCC 0010380
IF(K.GT.1 .AND. NSUBDH .EQ.0) 0010390
> TWP(NS,M,JWC)=TWWC(NS-NSTR,M,JWC) 0010400
CCCCCCCCCCCCCCCCCCCCCCCCCCCC 0010410
CHI(NS-NSTR,M,JWC)=1. 0010420
PSI(NS-NSTR,M,JWC)=1. 0010430
4442 CONTINUE 0010440
4443 CONTINUE 0010450
4444 CONTINUE 0010460

ITGLT=0	0010470
DELTAP=0.	0010480
T(L)=DELTAH/CP(P(K),T(K))+T(K)	0010490
PBT=P(K)	0010500
CALL LINPOW	0010510
C	0010520
C	0010530
C 15-THE LOOP ITCORR STARTS	0010540
C	0010550
ITCON =0	0010560
DO 49 ITCORI1=1,ITCM	0010570
ITCORR=ITCORI1	0010580
CC 02.11.1979	0010590
IF(IPHUD.EQ.1) QSTOT=HUDFAC*(TMS-TAMB)*H	0010600
DELTAH=(QTOT*QDEV*H1+QSTOT)/MFLOW	0010610
IF(INDSP(K).EQ.2 .AND. ITCORR.GT.2)GOTO 45	0010620
C	0010630
LAMBDA(K)=LAM1	0010640
DDDDT=0.	0010650
C*****CALCULATION OF DELTAP AND DELTAT FOR THE WHOLE BUNDLE FLOW SECT.*	0010660
DO 4448 ITTE1=1,10	0010670
TL=T(L)	0010680
TBT=(T(L)+T(K))*0.5	0010690
DO 4445 ITTE2=1,10	0010700
TBT1=TBT	0010710
TBT=DELTAH/CP(PBT,TBT)*0.5+T(K)	0010720
IF(ABS(TBT/TBT1-1.).LE.1.E-04)GOTO 4447	0010730
4445 CONTINUE	0010740
WRITE(6,4446)TBT,TBT1	0010750
4446 FORMAT(1H1,'MAIN',/5X,	0010760
> 'CALCULATION STOPS: ITTE2=10 ; TBT=' ,E15.7,5X,'TBT1=' ,	0010770
* E15.7)	0010780
STOP	0010790
4447 CONTINUE	0010800
T(L)=DELTAH/CP(PBT,TBT)+T(K).	0010810
DO 18 ITPR=1,10	0010820
DP=DELTAP	0010830
PBT=P(K)+0.5*DP	0010840
P(L)=P(K)+DP	0010850
RHOBT(K)=RHO(PBT,TBT)	0010860
RH02=RHO(P(L),T(L))	0010870
DEL1RT=(RH01-RH02)/RHOBT(K)**2	0010880
DECORR=DETOLA/FCOPWT	0010890
DELTAP=PROV2*(LAMBDA(K)*H/(2.*RHOBT(K)*DECORR)+DEL1RT)*(ASEC/	0010900
/ASECLA)**2+IGRAV*RHOBT(K)*H*0.001	0010910
ETABT(K)=ETA(PBT,TBT)	0010920
REBT(K)=PROV1/ETABT(K)*DETOLA/DETOT*ASEC/ASECLA	0010930
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 08.02.1980	0010940
RES=REBT(K)	0010950
PRS=ETA(PBT,TBT)*CP(PBT,TBT)/KAPPA(PBT,TBT)	0010960
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC	0010970
IF(INDSP(K).EQ.2)DELTAP=DELTAP+PROV2*(CSPT(I1SPAC)+DSPDPF(EPSIT(	0010980
1 I1SPAC),DETOLA,LAMBDA(K),WSP(IPA),PGDPT(I1SPAC),REBT(K),4))/	0010990
2 RHOBT(K)	0011000
PLL=P(K)+DELTAP	0011010
IF(ABS(PLL/P(L)-1.).LE.1.E-05)GOTO 20	0011020
18 CONTINUE	0011030
WRITE(6,19)K,ITCORR,DP,DELTAP	0011040
19 FORMAT(1H1,5X,'MAIN',/5X,	0011050
> 'CALCULATION STOPS: ITPR=10 FOR SECTION',I4,2X,'(ITC0011060	
*ORR=' ,I2,') DP=' ,E20.5,5X,'AND DELTAP=' ,E20.5)	0011070
STOP	0011080
20 CONTINUE	0011090
T(L)=DELTAH/CP(PBT,TBT)+T(K)	0011100
IF(ABS(T(L)/TL-1.).LE.1.E-04)GOTO 4450	0011110
4448 CONTINUE	0011120

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        WRITE(6,4449)T(L),TL                                0011130
4449 FORMAT(1H1,5X,'MAIN',/5X,
      >           'CALCULATION STOPS: ITTE1=10 ; T(L)=' ,E15.7,5X,
      *     'TL=' ,E15.7)
      STOP
4450 CONTINUE
      UBT(K)=MA/RHOBT(K)/100. *ASEC/ASECCLA          0011180
      PROV=REBT(K)*ETABT(K)*SQRT(ABS(LAMBDA(K))*0.125/RHOBT(K)) 0011190
      SQDPG=SQRT(ABS(DELTAP)*980665.)                0011200
      SQDPGF=SQRT(ABS(DELTAP-IGRAV*RHOBT(K)*H*0.001)*980665.) 0011210
      IF(ITCORR.EQ.1)DPSI=DELTAP/ABS(DELTAP)            0011220
      SIGMST=(SQRT(ABS(DELTAP-IGRAV*RHOBT(K)*H*0.001)*980665.)-SQDPG)/ 0011230
      /SQRT(LAMBDA(K)*H/(2.*DETOLA*RHOBT(K)))         0011240
      IF(INDSP(K).EQ.2)GOTO 45                         0011250
      IF(INDSP(K).EQ.2)GOTO 45                         0011260
C .....                                         0011270
C
C FOR SECTIONS WITHOUT SPACERS: SUB-SUBCHANNEL CALCULATION 0011280
C
      DO 6671 NS=NSTR1,NSTOT                          0011290
      NP=NPIN(NS)                                     0011300
      DO 6671 M=1,NP                                 0011310
      DO 6671 I=1,NSC90                            0011320
6671  DELTIE(NS-NSTR,M,I)=DELTIO(NS-NSTR,M,I)-DTIEAV(NS-NSTR,M) 0011330
      ASECLA=0.                                      0011340
      DETOLA=0.                                      0011350
      DO 29 NS=1,NSTOT                            0011360
      IF(ITCORR.EQ.1)SIGMA(NS)=SIGMST              0011370
      IF(NTYP(NS).EQ.3)GOTO 25                     0011380
      NP=NPIN(NS)                                     0011390
      DDDDNS=0.                                       0011400
      TNS=0.                                         0011410
      AMNS=0.                                         0011420
      DO 24 M=1,NP                                 0011430
      IF(ITCORR.EQ.1)SIGMAI(NS,M)=SIGMST           0011440
      IF(NTYP(NS).EQ.2)GOTO 22                     0011450
      C*****SUB-SUBCHANNEL CALCULATION FOR THE CENTRAL CHANNELS***** 0011460
      C
      CALL TRICA1(K,NS,NSC30C,IRH,PROV,PBT,RH,ACW,DECW,MEC,AAC,DETC,DETO00011510
      *T,H1,ALFACE,H,M,P(K),P(L),SQDPG,TE1,SUR,D,AMT,DDDD,ATSCH,&8500,C) 0011470
      AMSCH=AMT*ASCH(NS,M)/AAC                      0011480
      GOTO 23                                         0011490
      C
      22 CONTINUE                                     0011500
      C*****SUB-SUBCHANNEL CALCULATION FOR THE WALL CHANNELS***** 0011510
      CALL RECCA1(K,NS,NSC90,NSC45,IRH,PROV,PBT, RH,H1,ALFAWA,ACW,DECW,M0011520
      *EC,AAW,DETW,ATOT,DETOT,MFLOW,WW,D,C,M,NSTR,H,P(K),P(L),SQDPG,TE1, 0011530
      *SUR,AMT,DDDD,ATSCH,CTU3,EM1,&8500,ALFACE)       0011540
      NSW=NS-NSTR                                     0011550
      IF(K.GT.1)GOTO 4455                           0011560
      DO 4451 JWC=1,2                               0011570
      IF(IREAD1.EQ.1 .OR. ISTAIN.EQ.1)MSCWC1(NSW,M,JWC)=MSCH1(NS,M)/ASCH 0011580
      *(NS,M)*ASCHWC(NSW,M,JWC)/F2ATIP(NS,M)        0011590
4451  ASCWC1(NSW,M,JWC)=ASCHWC(NSW,M,JWC)       0011600
      4455 CONTINUE                                    0011610
      AMSCH=AMT                                     0011620
      23 CONTINUE                                     0011630
      DDDDNS=DDDDNS+AMSCH/AMT*DDDD+ASCH(NS,M)*(SIGMAI(NS,M)-SIGMA(NS))/0011640
      *SQDPGF                                         0011650
      AMNS=AMNS+AMSCH                                0011660
      24 TNS=TNS+ATSCH*AMSCH                         0011670
      TNS=TNS/AMNS                                   0011680
      RHONS=RHO(PBT,TNS)                            0011690
      LAM(NS)=((A(NS)/DDDDNS)**2)*2.*DE(NS)*RHONS/H *F1ATIP(NS)**2* 0011700
      *F1DTIP(NS)                                     0011710
                                         0011720
                                         0011730
                                         0011740
                                         0011750
                                         0011760
                                         0011770
```

GOTO 28 0011780
C 0011790
*****SUB-SUBCHANNEL CALCULATION FOR THE CORNER CHANNELS***** 0011800
25 CONTINUE 0011810
IF(ITCORR.EQ.1)SIGMAI(NS,1)=SIGMST 0011820
CALL ANGCA1(K,NS,NSC30A,IRH,PROV,PBT,RH,H1,ALFACO,AA1,AAA,DETA,DET0011830
*OT,D,WA,NSTR,H,P(K),P(L),SQDPG,TE1,SUR, AMT,DDDDNS,&8500,AMAT, 0011840
2AMBT) 0011850
AMNS=AMT*ASCH(NS,1)/AAA 0011860
XMSCHA(NS-NSTR,1)=AMAT*ASCH(NS,1)/AAA 0011870
XMSCHB(NS-NSTR,1)=AMBT*ASCH(NS,1)/AAA 0011880
DDDDNS=DDDDNS*ASCH(NS,1)/AAA 0011890
LAM(NS)=LAMSCH(NS,1) 0011900
28 CONTINUE 0011910
ASECLA=ASECLA+A(NS)*F1ATIP(NS) 0011920
DETOLA=DETOLA+A(NS)/DE(NS)*F1ATIP(NS)/F1DTIP(NS) 0011930
MO(NS)=2.*AMNS-MI(NS) 0011940
DDDDT=DDDDT+DDDDNS 0011950
29 CONTINUE 0011960
DETOLA=ASECLA/DETOLA 0011970
C 0011980
C 0011990
C 16-NEW VALUE FOR THE WHOLE BUNDLE FRICTION FACTOR 0012000
C 0012010
IF(ITCORR.EQ.1)GOTO 48 0012020
DDDDT=DDDDT*(MFLOW*ASEC)/(SBMNS*ATOT) 0012030
LAM1=((ASECLA/DDDDT)**2-DEL1RT)*2.*DETOLA*RHOBT(K)/H 0012040
DPSI= DPAV/ABS(DPAV) 0012050
C 0012060
C 0012070
C 17-CONVERGENCE TEST FOR THE LOOP ITCORR 0012080
C 0012090
45 CONTINUE 0012100
IF(ITCORR.LE. ITC2)GOTO 48 0012110
DELAM=ABS(LAMBDA(K)/LAM1-1.) 0012120
CALL CONTRO(LAMBDA(K),LAM1,ITCORR,INDICE) 0012130
CC 06.11.1980 0012140
C IF(.NOT.(DELAM.LE.1.E-04 .OR. (DELAM.LE.1.E-03 .AND. ITCORR.GT. 0012150
C * ITC1) .OR. (DELAM.LE.1.E-02 .AND. ITCORR.GT.(ITC1+5))))GOTO 48 0012160
IF(.NOT.(DELAM.LE.1.E-01 .OR. (DELAM.LE.1.E-01 .AND. ITCORR.GT. 0012170
* ITC1) .OR. (DELAM.LE.1.E-01 .AND. ITCORR.GT.(ITC1+5))))GOTO 48 0012180
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 06.11.1980 0012190
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 0012200
ITCON=ITCON+1 0012210
IF(INDICE.GE. 1)GOTO 48 0012220
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 0012230
C 0012240
C 0012250
C 18-CONVERGENCE HAS BEEN REACHED: PRINT AND PUNCH RESULTS FOR SECT. K 0012260
C 0012270
C 0012280
9003 WRITE(6,46) 0012290
* T(L), P(L),PBT,DELTAP,LAMBDA(K),ITCORR,ITGL,ITGLT,ITERM,FREL,0012300
> ITCON,QDEV 0012310
46 FORMAT(/5X,'T 2=',F10.4,5X,'P 2=',F10.6,5X,'P AV=',F10.6,5X, 0012320
* 'DELTAP=',F11.8,5X,'LAMBDA=',F7.5/5X,'(ITCORR=',I2, 0012330
* 5X,' ITGL=',I5,5X,'ITGL1=',I5,5X,'ITERM=',I5,5X, 0012340
* 'FREL=',F5.2,5X,'ITCON = ',I3,5X,'QDEV=',E12.6, 0012350
* ')')// 5X,'CHANNEL',9X,'OUTLET MASS',8X,'AVERA0012360
*GE MASS',7X,'OUTLET TEMP.',8X,'AVERAGE TEMP.',7X,'PRESSURE LOSS')0012370
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 0012380
IF(IPRINT.LE.0) GO TO 2021 0012390
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 0012400
WRITE(6,81)(NS,MM2(NS),MAV(NS),TEMP2(NS),TAV(NS),DPNS(NS), 0012410
* NS=1,NSTOT) 0012420
81 FORMAT(I12,5E20.8) 0012430

IF(NTYP(NS).NE.2)GOTO 51 0013100
DO 3721 JWC=1,2 0013110
CALL CORRTE(TWWC(NSW,M,JWC),TAVWC(NSW,M,JWC),PBT, NS,M,JWC,BIOT 0013120
*WC,TWINWC) 0013130
3721 CONTINUE 0013140
51 CONTINUE 0013150
53 CONTINUE 0013160
CCCCCCCCCCCC 28.02.1981 0013170
IF(IPRINT.LE.0) GO TO 1949 0013180
IF(IPA/2*2.EQ.IPA) CALL JELLA(-1) 0013190
IF(IPA/2*2.EQ.IPA) CALL JELLB(-1,PBT) 0013200
IF(IPA.EQ.4 .AND. LAMOP3.NE.1) CALL JELLC(-1,TE,TE1,BIOT) 0013210
1949 CONTINUE 0013220
CCCCCCCCCCCC 28.02.1981 0013230
IF(IPUNCH.EQ.1)WRITE(1,6069)XM 0013240
DO 88 NS=1,NSTOT 0013250
NP=NPIN(NS) 0013260
DO 3723 M=1,NP 0013270
JP=JPIN(NS,M) 0013280
WRITE (3) NS,M,XM,TW(NS,M) 0013290
IF (NS.LE.NSTR) GO TO 3723 0013300
NSW=NS-NSTR 0013310
WRITE (4) NS,M,XM,TLINER(NSW,M) 0013320
DO 62 JWC=1,2 0013330
WRITE (9) NS,M,JWC,XM,TWWC(NSW,M,JWC) 0013340
62 CONTINUE 0013350
3723 CONTINUE 0013360
C 0013370
IF(IPUNCH.EQ.1) WRITE(1,6069) (TW(NS,M),M=1,NP) 0013380
IF(NS.LE.NSTR)GOTO 88 0013390
NSW=NS-NSTR 0013400
IF(IPUNCH.EQ.1)WRITE(1,6069)(TLINER(NSW,M),M=1,NP) 0013410
6069 FORMAT(3E15.5) 0013420
88 CONTINUE 0013430
GOTO 50 0013440
C 0013450
C 0013460
C 20-CALCULATION IN THE CHANNELS, IN THE SUBCHANNELS AND IN THE TWO 0013470
C PORTIONS OF THE WALL SUBCHANNELS 0013480
C 0013490
48 CONTINUE 0013500
CC
CALL TTOT(1) 0013510
CC
CALL BALA(K,NSTOT,INDSP(K),ASECLA,H,LENGTH,P(K),P(L),PBT,FREL,FT, 0013540
*ITCORR,ITCM,DPAV,ITERM,ITGL,&8500,WSP(IPA),I1SPAC) 0013550
ITGLT=ITGLT+ITGL 0013560
CALL SUBBAL(NSTOT,NSTR,INDSP(K),H,LENGTH,D,PIG,P(K),P(L),PBT,FREL, 0013570
*FT,ITCORR,DPAV,&8500,WSP(IPA),I1SPAC) 0013580
CALL NORMT(NSTOT,NSTR,TBT,ATOT,ASEC,MFLOW) 0013590
CALL TEMCON(IRH,K,RH,SUR,D,PIG,TE1,PBT,&8500,H,VDIAM(IPA),
> RINT(IPA),INDICE,QTOT) 0013600
CC
879 NS1=NSTR+1 0013620
DO 64 NS=NS1,NSTOT 0013630
NP=NPIN(NS) 0013640
NSTYP=NTYP(NS) 0013650
NSW=NS-NSTR 0013660
DO 7034 M=1,NP 0013670
GOTO(7033,7033,7032),NSTYP 0013680
7032 PROVI(NSW,M)=MSCH(NS,M)*DE(NS)/ASCH(NS,M)*SQRT(LAMSCH(NS,M)*0.125 0013700
*/RHO(PBT,TSCH(NS,M))) 0013710
GOTO 7034 0013720
7033 PROVI(NSW,M)=MAWC(NSW,M,1)*DEWC(NSW,M,1)/ASCHWC(NSW,M,1)*
*SQRT(LAMWC(NSW,M,1)*0.125/RHO(PBT,TAVWC(NSW,M,1))) 0013730
0013740
7034 CONTINUE 0013750

64 CONTINUE 0013760
49 CONTINUE 0013770
C 0013780
C 0013790
C 21-END OF THE LOOP ITCORR 0013800
C 0013810
WRITE(6,56)ITCORR,LAMRDA(K),LAM1,DELTAP,DPAV,DELAM 0013820
56 FORMAT(1H1,'CALCULATION STOPS: ITCORR=',I5/5X,'(LAMBDA=',E15.7,5X)0013830
*, 'LAM1=',E15.7,5X,'DELTAP=',E15.7,5X,'DPAV=',E15.7,')',5X, 0013840
> 'DELAM = ',E12.5) 0013850
WRITE(6,59) ITCON, INDICE 0013860
59 FORMAT(5X,'ITCON = ',I2,' INDICE = ',I3, 0013870
> //5X,'PIN TEMPERATURES : LAST ITERATION, WITHOUT CONDUCTION, WITH0013880
> CONDUCTION.') 0013890
CALL JELLA(-1) 0013900
STOP 0013910
C 0013920
C 0013930
C 22-DEFINITION OF THE INLET VALUES OF CHANNEL AND SUBCHANNEL 0013940
C VARIABLES FOR THE NEXT AXIAL SECTION; SUBSEQUENT ADDITIONS FOR 0013950
C AVERAGE VALUES OF VARIABLES 0013960
C 0013970
50 CONTINUE 0013980
NSUBDH=0 0013990
INDTW=1 0014000
PBAR(L)=P(L)*0.980665 0014010
DO 100 NS=1,NSTOT 0014020
TEMP(NS)=(2.*MAV(NS)*TAV(NS)-MI(NS)*TEMP (NS))/MM2(NS) 0014030
MI(NS)=MM2(NS) 0014040
NP=NPIN(NS) 0014050
DO 97 M=1,NP 0014060
PMSCH1=MSCH1(NS,M) 0014070
MSCH1(NS,M)=2.*MSCH(NS,M)-MSCH1(NS,M) 0014080
TSCH1(NS,M)=(2.*MSCH(NS,M)*TSCH(NS,M)-PMSCH1*TSCH1(NS,M))/MSCH1(NS0014090
*,M) 0014100
IF(NTYP(NS).NE.3 .OR. INDSP(K).EQ.2)GOTO 6647 0014110
DO 6646 I=1,NSC90 0014120
6646 DELTIO(NS-NSTR,M,I)=(TIO(NS-NSTR,M,I)-TSCH1(NS,M))*TCPRCF 0014130
6647 CONTINUE 0014140
IF(QQ(NS,M).GT.1.E-06)GOTO 5633 0014150
TW(NS,M)=TSCH(NS,M) 0014160
CC 0014170
NCEV=NS-NSTR 0014180
IF(NS.GT.NSTR) TLINER(NCEV,M)=TSCH(NS,M) 0014190
CC 0014200
TEMPB(NS,M)=TSCH(NS,M) 0014210
BIOT(NS,M)=0. 0014220
TWINF(NS,M)=TSCH(NS,M) 0014230
5633 CONTINUE 0014240
IF(K.EQ.1 .OR. NEXTW(IPA).EQ.0)GOTO 1180 0014250
IF(X(K).GT.XEXTW(IEXTWC).AND.X(K-1).LE.XEXTW(IEXTWC))GOTO 1181 0014260
IF(K.EQ.N .AND. X(N+1).GT.XEXTW(IEXTWC) .AND. X(N).LE.XEXTW(IEXTWC0014270
*))GOTO 1181 0014280
GO TO 1180 0014290
CC 0014300
C1181 TWTH(NS,M,IEXTWC)=(TW(NS,M)-TWP(NS,M))/(X(K+1)-X(K-1))*2.* (XEXTW(0014310
C *IEXTWC)-0.5*(X(K)+X(K-1)))+TWP(NS,M) 0014320
CC 0014330
1181 CONTINUE 0014340
TWTH(NS,M,IEXTWC)=(TW(NS,M)-TWP(NS,M))/(X(K+1)-X(K-1))*2.* (XEXTW(0014350
IEXTWC)-0.5(X(K)+X(K-1)))+TWP(NS,M) 0014360
IF(NTYP(NS) .NE. 2) GO TO 1183 0014370
DO 1182 JWC=1,2 0014380
TWWH(NS,M,JWC,IEXTWC)=(TWWC(NS-NSTR,M,JWC)-TWWP(NS,M,JWC))/ 0014390
>(X(K+1)-X(K-1)) *2.* (XEXTW(IEXTWC)-0.5*(X(K)+X(K-1)))+ 0014400

>TWWP(NS,M,JWC)	0014410
1182 CONTINUE	0014420
1183 CONTINUE	0014430
CCCCCCCCCCCCCCCCCCCCCCCCCCCC	0014440
INDTW=2	0014450
1180 CONTINUE	0014460
IF(NTYP(NS).NE.2)GOTO 97	0014470
NSW=NS-NSTR	0014480
DO 95 JWC=1,2	0014490
PMSCWC=MSCWC1(NSW,M,JWC)	0014500
MSCWC1(NSW,M,JWC)=2.*MAWC(NSW,M,JWC)-PMSCWC	0014510
TSCWC1(NSW,M,JWC)=(2.*MAWC(NSW,M,JWC)*TAVWC(NSW,M,JWC)-PMSCWC*	0014520
* TSCWC1(NSW,M,JWC))/MSCWC1(NSW,M,JWC)	0014530
ASCWC1(NSW,M,JWC)=ASCHWC(NSW,M,JWC)	0014540
95 CONTINUE	0014550
IF(INDSP(K).EQ.2)GOTO 97	0014560
DO 6648 I=1,NSC90	0014570
6648 DELTIO(NSW,M,I)=(TIO(NSW,M,I)-TSCWC1(NSW,M,1))*TWPRCF	0014580
97 CONTINUE	0014590
100 CONTINUE	0014600
IF(INDTW.EQ.2 .AND. IEXTWC.LT.NEXTWT)IEXTWC=IEXTWC+1	0014610
IF(INDPRQ.EQ.2 .AND. IDPRQ.LT.NDPRQT)IDPRQ=IDPRQ+1	0014620
TWTC=TWFUN(NRODS,NSTOT,PIG,AAC,AAA)*H+TWTC	0014630
TBPC=TBFUN(NSTR,NSTOT)*H+TBPC	0014640
TBTC=TBT*H+TBTC	0014650
IF(X(K).LT.XSTART(IPAFD) .OR. X(L).GT.XEND(IPAFD))GOTO 103	0014660
NSEFD=NSEFD+1	0014670
TM=TM+TBT*H	0014680
PM=PM+PBT*H	0014690
LAMBDM=LAMBDM+LAMBDA(K)*H	0014700
REM=REM+REBT(K)*H	0014710
UM=UM+UBT(K)*H	0014720
DELTAX=DELTAX+H	0014730
IF(IRH.EQ.1)GOTO 103	0014740
DO 9899 NS=1,NSTOT	0014750
NP=NPIN(NS)	0014760
DO 9899 M=1,NP	0014770
HPLUS1(NS,M)=HPLUS1(NS,M)+HPLUSB(NS,M)*H	0014780
HPLUS2(NS,M)=HPLUS2(NS,M)+HPLUSW(NS,M)*H	0014790
QPLUSA(NS,M)=QPLUSA(NS,M)+QPLUS(NS,M)*H	0014800
PRBA (NS,M)=PRBA (NS,M)+PRB (NS,M)*H	0014810
TWA(NS,M)=TWA(NS,M)+TW(NS,M)*H	0014820
YDHA(NS,M)=YDHA(NS,M)+YDH(NS,M)*H	0014830
YODHA(NS,M)=YODHA(NS,M)+YODH(NS,M)*H	0014840
AMASSB(NS,M)=AMASSB(NS,M)+XMASSB(NS,M)*H	0014850
TEMPBA(NS,M)=TEMPBA(NS,M)+TEMPB(NS,M)*XMASSB(NS,M)*H	0014860
AMASST(NS,M)=AMASST(NS,M)+MSCH(NS,M)*H	0014870
TEMPTA(NS,M)=TEMPTA(NS,M)+TSCH(NS,M)*MSCH(NS,M)*H	0014880
9899 CONTINUE	0014890
103 CONTINUE	0014900
C	0014910
C	0014920
C 23-PRINT SUBCHANNEL VARIABLES	0014930
C	0014940
IF(IPRINT.LE.0) GO TO 2023	0014950
IF(IPSUB.LE.0) GO TO 2023	0014960
C	0014970
WRITE(6,83)	0014980
DO 8887 NS=1,NSTOT	0014990
NTYPNS=NTYP(NS)	0015000
NP=NPIN(NS)	0015010
NSW=NS-NSTR	0015020
WRITE(6,8885)NS	0015030
8885 FORMAT(5X,'CHANNEL NR.',I5)	0015040
DO 8887 M=1,NP	0015050
CCC OLD	0015060

C IF(QQ(NS,M).GT.1.E-06)SCNUSS=QQ(NS,M)*QDEV*DE(NS)*F2DTIP(NS,M)/ 0015070
C /(SUR*(TWINF(NS,M)-TSCH(NS,M))*KAPPA(PBT,TSCH(NS,M)))*D*0.5/ 0015080
C /RTIP(IPA) 0015090
CC
C 07.03.1979 0015100
IF(QQ(NS,M).LE.1.E-06) GO TO 70 0015120
NT=NTYP(NS) 0015130
JP=JPIN(NS,M) 0015140
QF=QQ(NS,M)*QDEV/SUR + QJ(JP,NS)/(PIG*D*H/GEO1(NS,M)) 0015150
SCNUSS=QF*DE(NS)*F2DTIP(NS,M)/ 0015160
/((TWINF(NS,M)-TSCH(NS,M))*KAPPA(PBT,TSCH(NS,M)))*D*0.5/ 0015170
/RTIP(IPA) 0015180
ALFAD = SCNUSS * KAPPA(PBT,TSCH(NS,M)) / DE(NS) * 41860. 0015190
70 CONTINUE 0015200
CC
SCREB=MSCH(NS,M)*DE(NS)*F2DTIP(NS,M)/(ASCH(NS,M)*F2ATIP(NS,M)* 0015210
*ETA(PBT,TSCH(NS,M))) 0015220
SCREW=SCREB*ETA(PBT,TSCH(NS,M))*RHO(PBT,TWINF(NS,M))/(ETA(PBT, 0015230
*TWINF(NS,M))*RHO(PBT,TSCH(NS,M))) 0015240
CC 02.11.1979 (WRITE 3725) 0015250
C QLINSC=QLINM*QLDEV*PERL(NTYPNS)*ASCH(NS,M)/ACH(NTYPNS)*H1 0015260
QLINSC=0.0 0015270
IF(NS.GT.NSTR) QLINSC=SHQ(NSW,M) 0015280
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 02.11.1979 0015290
WRITE(6,8886)M,JPIN(NS,M),MSCH1(NS,M),TSCH1(NS,M),LAMSCH(NS,M) 0015300
*,SCREB,SCREW 0015310
8886 FORMAT(5X,I2,'-(ROD NR.',I4,')',T27,'OUT. MASS',F10.6,T52,'OUT. TE0015330
1MP.=',F7.2,T75,'LAMBDA=',F10.5,T99,'REB=',F7.0,T112,'REW=',F7.0) 0015340
WRITE(6,3725) QLINSC 0015350
3725 FORMAT(T27,'Q LINER=',E15.5) 0015360
IF(IRH.EQ.2 .AND. QTOT.GT.1.E-06 .AND. I2TIP(NS,M).NE.1) 0015370
* WRITE(6,3724)BIOT(NS,M) 0015380
3724 FORMAT(1H+,T52,'BIOT=',F10.5) 0015390
IF(QTOT.GT.1.E-06)WRITE(6,3722) TWINF(NS,M) 0015400
3722 FORMAT(1H+, T75,'TW INF.=',F10.2) 0015410
IF(QTOT.GT.1.E-06 .AND. NTYP(NS).NE.1)WRITE(6,3740)TLINER(NSW,M) 0015420
3740 FORMAT(1H+,T99,'T AT LINER=',F10.2) 0015430
IF(INDSP(K).EQ.2)GOTO 91 0015440
IF(IRH.EQ.1 .OR. I2TIP(NS,M).EQ.1)GOTO 3726 0015450
RHPLM=RHPLUS(HPLUSB(NS,M),TW(NS,M),TE1 ,QPLUS(NS,M),HPLUSW(NS,M), 0015460
*TEMPB(NS,M),YDH(NS,M)) 0015470
WRITE(6,8883)HPLUSB(NS,M),HPLUSW(NS,M),RHPLM 0015480
8883 FORMAT(T27,'HB+ =',E12.5,T52,'HW+ =',E12.5,T75,'R(H+)=',E12.5) 0015490
IF(QQ(NS,M).LE. 1.E-06)GOTO 91 0015500
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 09.10.1980 0015510
C GHPLM=GHPLUS(HPLUSW(NS,M),TW(NS,M),TSCH(NS,M),PRB (NS,M),YDH(NS,M))0015520
C 1,10000.,0.) 0015530
GHPLM=GHPIU(NS,M) 0015540
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 09.10.1980 0015550
TWDTEM=(TW(NS,M)+273.16)/(TE+273.16) 0015560
TWDTBM=(TW(NS,M)+273.16)/(TSCH(NS,M)+273.16) 0015570
PHIM=GHPLM/(PRB (NS,M)**04 * TWDTBM**05)*(016*YDH(NS,M))**017 0015580
WRITE(6,94)GHPLM,SCNUSS ,TWDTBM,TWDTEM,YDH(NS,M),04,05,016, 0015590
1 017,PHIM 0015600
94 FORMAT(1H+,T99,'G(HW+)=',E12.5/T27,'NU =' ,E13.6,T52,'TW/TB=',E13.0015610
1.5,T75,'TW/TE=',E13.5,T99,'Y/RH=',E13.5/T27,'G(HW+)/(PR**',F4.20015620
2,' * (TW/TB)**',F4.2,') * (' ,F6.3,'*Y/RH)**',F6.3,' =',E13.6) 0015630
3726 IF(QQ(NS,M).LE.1.E-06)GOTO 91 0015640
IF(IRH.EQ.1 .OR. I2TIP(NS,M).EQ.1)WRITE(6,4242)SCNUSS 0015650
4242 FORMAT(1H+,T52,'NU =' ,E13.6) 0015660
WRITE(6,6685)TBSSC1(NS,M),TWSSC1(NS,M),TBSSC2(NS,M),TWSSC2(NS,M) 0015670
6685 FORMAT(T27,'TBSSCH(1)=',F7.2,T52,'TWSSCH(1)=',F7.2,T75,'TBSSCH(N)=0015680
1',F7.2,T99,'TWSSCH(N)=',F7.2) 0015690
IF(NTYP(NS).EQ.1)GOTO 91 0015700
WRITE(6,6640)TTSCHA(NSW,M),TTSCHB(NSW,M),TEMPB(NS,M) 0015710

6640 FORMAT(T27,'TA=',F7.2,T52,'TB=',F7.2,T75,'TBC=',F7.2) 0015720
IF(NTYP(NS).EQ.2)WRITE(6,6644)TWWC(NSW,M,1),TWWC(NSW,M,2) 0015730
6644 FORMAT(T27,'TW(1)=',F7.2,T52,'TW(2)=',F7.2) 0015740
WRITE(6,6645)T1SSC1(NSW,M),T2SSC1(NSW,M),T1SSC2(NSW,M), 0015750
* T2SSC2(NSW,M) 0015760
6645 FORMAT(T27,'T1SSCH(1)=',F7.2,T52,'T2SSCH(1)=',F7.2,T75,'T1SSCH(N)=',F7.2,T99,'T2SSCH(N)=',F7.2) 0015770
0015780
91 CONTINUE 0015790
CC 0015800
ALFAW=ALFA(NS,M)*41860 0015810
IF(QQ(NS,M).GT.1.E-06) WRITE(6,8712) ALFAD,ALFAW 0015820
8712 FORMAT(T27,'ALFAD = ',E12.6,T52,'ALFA = ',E12.6) 0015830
IF(QQ(NS,M).LE.1.E-06 .AND. QTOT.GT.1.E-06) WRITE(6,8773) ALFAW 0015840
8773 FORMAT(T27,'ALFA = ',E12.6) 0015850
CC 0015860
IF(NTYP(NS).NE.2)GOTO 8887 0015870
WRITE(6,90)(JWC,MSCWC1(NSW,M,JWC),JWC,TSCWC1(NSW,M,JWC),JWC,ASCWC1,0015880
*(NSW,M,JWC),JWC,LAMWC(NSW,M,JWC),JWC=1,2) 0015890
90 FORMAT(T27,'MOUT('',I1,'')=',E13.6,T52,'TOUT('',I1,'')=',E13.6,T75,, 0015900
1 'AREA('',I1,'')=',E13.6,T99,'LAMBDA('',I1,'')=',E13.6) 0015910
8887 CONTINUE 0015920
2023 CONTINUE 0015930
IF(IPA/2*2.EQ.IPA) CALL HEATBA(0,PBT,INDQ,TE,MFLOW) 0015940
9999 CONTINUE 0015950
GOTO 8499 0015960
C 0015970
C 0015980
C 24-POINT REACHED IN THE CASE OF CONVERGENCE PROBLEMS (LOOP K ENDS 0015990
C AT LABEL 9999) 0016000
8500 CONTINUE 0016010
NSUBDH=NSUBDH+1 0016020
IF(NSUBDH.LE.MSUBDH)GOTO 8502 0016030
WRITE(6,8501)MSUBDH 0016040
8501 FORMAT(//' STOP DUE TO REACHED MAXIMUM NUMBER OF SUBDIVISIONS FOR 0016050
*AXIAL PITCH: NSUBDH=',I2) 0016060
STOP 0016070
C 0016080
8502 CALL SUBDH(N,K,K1,NSTOT) 0016090
GOTO 8503 0016100
C 0016110
C 0016120
C 25-VALUES OF VARIABLES FOR THE WHOLE BUNDLE FLOW SECTION 0016130
C 0016140
8499 CONTINUE 0016150
DEPTOT=P(L)-P(1) 0016160
WRITE(6,8889) 0016170
8889 FORMAT(1H1,4X,'VARIABLES FOR THE WHOLE BUNDLE'/5X,30('-')/// 0016180
* 5X,'A) INLET VALUES OF TEMPERATURE AND PRESSURE'/5X,'SECTION NR',0016190
*.,T26,'HEIGHT (CM)',T43,'TEMPERATURE (C)',T63,'PRESSURE (KG/SQC',0016200
*M)',T86,'PRESSURE (BARS)') 0016210
WRITE(6,8890)(I,X(I),T(I),P(I),PBAR(I),I=1,L) 0016220
8890 FORMAT(7X,I3,15X,F9.4,13X,F7.2,11X,F9.5,12X,F9.5) 0016230
WRITE(6,8891) 0016240
8891 FORMAT(////5X,'B) VALUES AVERAGED OVER AXIAL SECTIONS'//5X,'SECTI',0016250
*ON NR.',T23,'DENSITY (G/CCM)',T41,'VISCOSITY(G/CM*SEC)',T64,'VELOC',0016260
*ITY (M/SEC)',T85,'REYNOLDS NR.',T99,'FRICTION FACTOR') 0016270
WRITE(6,8892)(I,RHOBT(I),ETABT(I),UBT(I),REBT(I),LAMBDA(I),I=1,N) 0016280
8892 FORMAT(7X,I3,17X,F7.5,12X,F9.7,12X,F7.3,11X,F9.2,6X,F7.5) 0016290
WRITE(6,8878)DEPTOT 0016300
8878 FORMAT(///5X,'TOTAL PRESSURE DROP=',F9.6,' KG/SQCM') 0016310
C 0016320
C 0016330
C 26-EVALUATION AND PRINTING OF AVERAGE VALUES OF VARIABLES FOR THE 0016340
C REGIONS WHERE INDISTURBED FLOW IS ASSUMED 0016350
C 0016360
IF(NSEFD.EQ.0)GOTO 8897 0016370

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TM=TM/DELTAX 0016380
PM=PM/DELTAX 0016390
PMBAR=PM*0.980665 0016400
LAMBDM=LAMBDM/DELTAX 0016410
RHOM=RHO(PM,TM) 0016420
ETAM=ETA(PM,TM) 0016430
REM=REM/DELTAX 0016440
UM=UM/DELTAX 0016450
WRITE(6,8893) TM,PM,PMBAR,RHOM,ETAM,UM,REM,LAMBDM 0016460
8893 FORMAT(///5X,'C') TOTAL MEAN VALUES AVERAGED IN PARTS WHERE UNDIST0016470
*URBED FLOW IS SUPPOSED'// 5X,'TEMPERATURE',T22,'=',F9.0016480
*2,' C'/5X,'PRESSURE',T22,'=',F9.4,' KG/SQCM =',F9.4,' BARS' 0016490
* /5X,'DENSITY',T22,'=',0016500
* F9.5,' G/CCM'/5X,'VISCOSITY',T22,'=',F9.7,' G/CM*SEC'/5X, 0016510
*'VELOCITY',T22,'=',F9.3,' M/SEC'/5X,'REYNOLDS NR.',T22,'=',F9.2/5X0016520
* ,,'FRICITION FACTOR',T22,'=',F9.5//) 0016530
IF(IRH.EQ.1)GOTO 8897 0016540
WRITE(6,83) 0016550
DO 8876 NS=1,NSTOT 0016560
NP=NPIN(NS) 0016570
DO 8874 M=1,NP 0016580
IF(I2TIP(NS,M).EQ.1)GOTO 8897 0016590
WRITE(6,8885)NS 0016600
HPLUS1(NS,M)=HPLUS1(NS,M)/DELTAX 0016610
HPLUS2(NS,M)=HPLUS2(NS,M)/DELTAX 0016620
QPLUSA(NS,M)=QPLUSA(NS,M)/DELTAX 0016630
PRBA (NS,M)=PRBA (NS,M)/DELTAX 0016640
TWA(NS,M)=TWA(NS,M)/DELTAX 0016650
YDHA(NS,M)=YDHA(NS,M)/DELTAX 0016660
YODHA(NS,M)=YODHA(NS,M)/DELTAX 0016670
TEMPTA(NS,M)=TEMPTA(NS,M)/AMASST(NS,M) 0016680
TEMPBA(NS,M)=TEMPBA(NS,M)/AMASSB(NS,M) 0016690
RHPLA=RHPLUS(HPLUS1(NS,M),TWA(NS,M),TE1,QPLUSA(NS,M),HPLUS2(NS,M),0016700
1TEMPBA(NS,M),YODHA(NS,M)) 0016710
WRITE(6,8875)M,JPIN(NS,M),HPLUS1(NS,M),HPLUS2(NS,M),RHPLA 0016720
8875 FORMAT(5X,I2,'-(ROD NR.',I4,')',T27,'HB+ =',E12.5,T52,'HW+ =',E12.0016730
15,T75,'R( H+ )=',E12.5) 0016740
IF(QQ(NS,M).LE.1.E-06)GOTO 8874 0016750
TWDTEA=(TWA(NS,M)+273.16)/(TE+273.16) 0016760
TWDTBA=(TWA(NS,M)+273.16)/(TEMPTA(NS,M)+273.16) 0016770
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 09.10.980 0016780
C GHPLA=GHPPLUS(HPLUS2(NS,M),TWA(NS,M),TEMPTA(NS,M),PRBA (NS,M), 0016790
C 1YDHA(NS,M),10000.,0.) 0016800
C PHIA=GHPPLA/(PRBA (NS,M)**04 * TWDTBA**05)*(016*YDHA(NS,M))**017 0016810
C WRITE(6,94)GHPLA,QPLUSA(NS,M),TWDTBA,TWDTEA,YDHA(NS,M),04,05,016, 0016820
C 1017,PHIA 0016830
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 09.10.980 0016840
8874 CONTINUE 0016850
8876 CONTINUE 0016860
8897 CONTINUE 0016870
C ..... 0016880
C ..... 0016890
C 27-COMPARISON BETWEEN THE INPUT AND THE COMPUTED AVERAGE 0016900
C TEMPERATURES OF THE GAS, OF THE SHROUD AND OF THE PINS IN THE 0016910
C AXIAL PORTION 0016920
C ..... 0016930
TWTC=TWTC/LENGTH 0016940
TBTC=TBTC/LENGTH 0016950
TBPC=TBPC/LENGTH 0016960
WRITE(6,69) TWTIPA(IPA),TWTC,TBTIPA(IPA),TBTC,TBPIPA(IPA),TBPC 0016970
69 FORMAT(///5X,'COMPARISON OF INPUT TEMPERATURES WITH COMPUTED VALUE0016980
1S'//T17,'INPUT',T26,'COMPUTED'/5X,'TWTIPA',2F11.2/5X,'TBTIPA',2F11.0016990
2.2/5X,'TBPIPA',2F11.2) 0017000
C ..... 0017010
C ..... 0017020

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C 28-COMPARISON BETWEEN THE EXPERIMENTAL AND THE COMPUTED PRESSURE 0017030
C LOSSES 0017040
C 0017050
IF(NEXPR(IPA).GT.0 .OR. NEXTW(IPA).GT.0)WRITE(6,1023) 0017060
1023 FORMAT(//5X,'COMPARISON WITH EXPERIMENTAL RESULTS'/5X,36('')//)0017070
IF(NEXPR(IPA).EQ.0)GOTO 1040 0017080
GOTO (1069,1070),INDPR 0017090
1069 WRITE(6,1072) 0017100
GOTO 1071 0017110
1070 WRITE(6,1073) 0017120
1071 CONTINUE 0017130
1072 FORMAT(5X, '1) PRESSURES (KG/SQCM)'//) 0017140
1073 FORMAT(5X, '1) PRESSURES (BARS)'//) 0017150
IEXPR2=IEXPR1+NEXPR(IPA)-1 0017160
K1=1 0017170
DO 1037 IEXPR=IEXPR1,IEXPR2 0017180
DO 1024 K=K1,N 0017190
K2=K 0017200
IF(XEXPR(IEXPR).GE.X(K) .AND. XEXPR(IEXPR).LT.X(K+1))GOTO 1025 0017210
1024 CONTINUE 0017220
GOTO 1040 0017230
1025 K1=K2 0017240
IF(INDSP(K).EQ.2)GOTO 1026 0017250
KK=K2 0017260
GOTO 1027 0017270
1026 KK=K2-1 0017280
IF(KK.EQ.0)KK=2 0017290
1027 CONTINUE 0017300
GOTO (1028,1029),INDPR 0017310
1028 PR1=P(KK) 0017320
PR2= P(KK+1) 0017330
GOTO 1030 0017340
1029 PR1=PBAR(KK) 0017350
PR2=PBAR(KK+1) 0017360
1030 PTH=(PR2-PR1)/(X(KK+1)-X(KK))*(XEXPR(IEXPR)-X(KK))+PR1 0017370
DPEX=PEX(IEXPR)-PE1 0017380
DPTH=PTH-PE1 0017390
PTMPEX=PTH-PEX(IEXPR) 0017400
DPERR=(DPTH-DPEX)/DPEX*100. 0017410
WRITE(6,1031)IEXPR,XEXPR(IEXPR),PEX(IEXPR),DPEX,PTH,DPTH,PTMPEX, 0017420
*DPERR 0017430
1031 FORMAT(5X,I2,')HEIGHT=',F10.5,' CM',5X,'P EX.=',F10.5,5X,'P EX.-PE0017440
*1=',F10.7,5X,'P TH.=',F10.5,5X,'P TH.-PE1=',F10.7/33X,'P TH.-P EX.0017450
*=',F10.7,5X,'(DP TH.-DP EX.)/DP EX. *100 =',F7.3/) 0017460
1037 CONTINUE 0017470
1040 CONTINUE 0017480
C 0017490
C 0017500
C 29-PRINT OF THE PIN TEMPERATURES AT SPECIAL AXIAL POSITIONS 0017510
C 0017520
IF(NEXTW(IPA).EQ.0)GOTO 1060 0017530
WRITE(6,1041) 0017540
1041 FORMAT(//5X,'2) COMPUTED ROD TEMPERATURES (C)'//) 0017550
IEXTW2=IEXTW1+NEXTW(IPA)-1 0017560
DO 1050 IEXTW=IEXTW1, IEXTW2 0017570
WRITE(6,1045)IEXTW,XEXTW(IEXTW) 0017580
DO 1044 NS=1,NSTOT 0017590
NP=NPIN(NS) 0017600
WRITE(6,1046)(M,NS, JPIN(NS,M),TWTH(NS,M,IEXTW),M=1,NP) 0017610
1044 CONTINUE 0017620
1045 FORMAT(/5X,I2,')HEIGHT=',F10.5,' CM') 0017630
1046 FORMAT(3(5X,I2,' TW TH.(' ,I5,' ,',I5,')=',F10.3,' C')) 0017640
CFFFFFFF.....FFFF 0017650
WRITE(6,1047) 0017660
1047 FORMAT(//5X,'TEMPERATURES OF THE TWO PARTS OF WALL SUBCHANNEL',//)0017670
DO 1048 NS=1,NSTOT 0017680

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IF(NTYP(NS) .NE. 2) GO TO 1048          0017690
NP=NPIN(NS)                            0017700
DO 1043 M=1,NP                         0017710
    DO 1042 JWC=1,2                     0017720
        WRITE(6,1049) NS,JPIN(NS,M),JWC,TWH(NS,M,JWC,IEXTW) 0017730
1042      CONTINUE                      0017740
1043      CONTINUE                      0017750
1048 CONTINUE                          0017760
1049 FORMAT(5X,'TW(' ,I2,',',',I2,',',I1,') = ',F10.3) 0017770
CFFFFFFF CFFFFFFF CFFFFFFF CFFFFFFF 0017780
1050 CONTINUE                          0017790
1060 CONTINUE                          0017800
C .....                                0017810
C .....                                0017820
C 30-STARTING VALUES OF VARIABLES FOR THE NEXT AXIAL PORTION 0017830
C .....                                0017840
IF(X(L).GT.DIST(ISPAC) .AND. ISPAC.NE.NSPACT)ISPAC=ISPAC+1 0017850
T0=T(L)                                0017860
P0=P(L)                                0017870
DPBAR(1)=DPBAR(L)                      0017880
II=II+NSPAC(IPA)                      0017890
IEXPR1=IEXPR1+NEXPR(IPA)                0017900
IEXTW1=IEXTW1+NEXTW(IPA)              0017910
SPRLEN=SPRLEN+PLEN(IPA)                0017920
HH=SPRLEN                               0017930
IF(II.GT.1 .AND. IDISP2.EQ.1)DISTOO=DIST(II-1)-SPRLEN 0017940
IF(NDPRQ(IPA).GT.0)IDPRQ=IDPRQ+1     0017950
ISTAIN=1                                0017960
8888 CONTINUE                          0017970
C .....                                0017980
C .....                                0017990
C 31-END OF THE LOOP IPA; CALCULATION OF THE PRESSURE RECOVERY AT THE 0018000
C OUTLET OF THE BUNDLE                  0018010
C .....                                0018020
DEPOUT=-COUT*PROV2/RH02*0.5            0018030
POUT=P0+DEPOUT                         0018040
POBAR=POUT*0.980665                    0018050
WRITE(6,8896)DEPOUT,POUT,POBAR,COUT   0018060
8896 FORMAT(///5X,'PRESSURE RECAPTURE DUE TO EXIT=',F7.5,' KG/SQCM',5X) 0018070
*, 'PRESSURE OUTSIDE=',F10.5,' KG/SQCM  =',F10.5,' BARS ( COUT=0018080
*, F4.2, ' ')')                         0018090
DPOBAR=PEOBAR-POBAR                   0018100
IF(IPUNCH.EQ.1)WRITE(1,6069)DPOBAR    0018110
IF(PEXOUT.LE.1.E-06) GO TO 741       0018120
IF(INDPR.EQ.2)POUT=POBAR              0018130
DPEX=PEXOUT-PE1                        0018140
DPTH=POUT-PE1                          0018150
DPERR=( DPTH-DPEX)/DPEX*100.           0018160
WRITE(6,1008)PEXOUT,DPTH,DPEX,DPERR  0018170
1008 FORMAT(/5X,'EXP. PRESSURE OUTSIDE=',F10.5/5X,'P TH.-PE1=',F10.7/5X) 0018180
*, 'P EX.-PE1=',F10.7/5X,'(DP TH.- DP EX.)/DP EX.*100=',F6.3) 0018190
741 CONTINUE                          0018200
C .....                                0018210
CALL HEATBA(1,PBT,INDQ,TE,MFLOW)      0018220
WRITE(6,740)                           0018230
740 FORMAT(/5X,' REGULAR CALCULATIONS END') 0018240
742 STOP                                0018250
END                                     0018260

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FUNCTION AKA(R1DR2,PHI)          0000010
C ----- 0000020
C AKA COMPUTES THE ADDITIONAL FRICTION IN THE LAMINAR HYDRODYNAMIC 0000030
C ENTRANCE LENGTH           0000040
C                                         0000050
C
C IF(PHI.GT.0.002)GOTO 1          0000060
C AKA=132.53*PHI/R1DR2**0.013    0000070
C RETURN                         0000080
1 IF(PHI.GE.0.01755)GOTO 2       0000090
A=0.7982+0.3421*ALOG(PHI)      0000100
GOTO 4                          0000110
2 IF(PHI.GE.0.05)GOTO 3         0000120
A=-0.05033+0.1322*ALOG(PHI)   0000130
GOTO 4                          0000140
3 IF(PHI.GT.0.1)GOTO 5         0000150
A=-0.4463                      0000160
4 B=-0.205*PHI**0.44362        0000170
AKA=EXP(A)*R1DR2**B            0000180
RETURN                         0000190
5 AKA=0.64/R1DR2**0.0738       0000200
RETURN                         0000210
END                           0000220
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SUBROUTINE ALFAC (VDIAM,H)          0000010
C ----- 0000020
C TRANFORMS THE CONVECTION FACTORS ALFA TO THE COEFFICIENT FALFA. 0000030
C                                         0000040
C COMMON /SC11C/ FALFA( 42,3)        0000050
C COMMON /SC15C/ ALFA ( 42,3)        0000060
C COMMON /SC13C/ GEO1( 42,3)        0000070
C COMMON /GASD1/ NSTOT              0000080
C COMMON /HEA6 / NPIN( 42),JPIN( 42,3) 0000090
C COMMON /DAT  / PIG                0000100
C                                         0000110
C DO 200 NS=1,NSTOT                0000120
NP=NPIN(NS)                      0000130
DO 100 M=1,NP                     0000140
FALFA(NS,M)=ALFA(NS,M)*PIG*VDIAM*H/GEO1(NS,M) 0000150
100      CONTINUE                  0000160
200      CONTINUE                  0000170
C                                         0000180
RETURN                         0000190
END                           0000200
```

SUBROUTINE ANGCA1(K,NS,N,IRH,PROV,PB, RH,H1,ALFA,A,AT,DET,DETOT,0000010
D,W,NSTR,H,PR1,PR2,SQDPG,TE,SUR, AMT,DDDD,, AMA,AMB) 0000020
C-----0000030
C SUBROUTINE ANGCA1 CALCULATES FRICTION FACTORS AND APPROXIMATE 0000040
C OUTLET MASS FLOW RATES AND TEMPERATURES FOR CORNER CHANNELS 0000050
C 0000060
C REAL LAMSCH,LAMB,MSCH1,KAPPA,MSCH,LAMLAM 0000070
C 0000080
C DIMENSION A(30) 0000090
C 0000100
COMMON /WAC01/ XMSCHB(18,2),XMSCHA(18,2) 0000110
COMMON /DAT/ PIG 0000120
COMMON /ANG2/ PA(30) 0000130
COMMON /SUB1/ ASCH(42,3) 0000140
COMMON /SUB2/ TSCH(42,3),MSCH(42,3) 0000150
COMMON /SUB3/ ADAB(18,2),DETB(18,2) 0000160
COMMON /SUB4/ LAMB(18,2) 0000170
COMMON /SUB5/ LAMSCH(42,3) 0000180
COMMON /SUB6/ TSCH1(42,3) 0000190
COMMON /SUB8/ MSCH1(42,3) 0000200
COMMON /INPAR/ IPA 0000210
COMMON /SUB22/ TW(42,3) 0000220
COMMON /SUB23/ HPLUSB(42,3),HPLUSW(42,3), 0000230
* QPLUS(42,3),PRB(42,3),YODH(42,3) 0000240
COMMON /MART/ ITCORR 0000250
COMMON /HEA5/ QQ(42,3) 0000260
COMMON /LAMINO/ I2TIP(42,3) 0000270
COMMON /LAMIN1/ AKAPPA(42) 0000280
COMMON /LAMIN2/ FATIP(3),FDTIP(3) 0000290
COMMON /LAMIN3/ F1ATIP(42),F1DTIP(42) 0000300
COMMON /LAMIN4/ F2ATIP(42,3),F2DTIP(42,3) 0000310
COMMON /LAMIN5/ RTIP(7) 0000320
COMMON /LAMIN9/ I3TIP(42,3) 0000330
COMMON /WSSCH1/ DELTIE(18,2,90),DTIEAV(18,2) 0000340
COMMON /REC1/ PVERT(90),PRAD(90) 0000350
COMMON /REC2/ E(90) 0000360
COMMON /REC3/ P(90) 0000370
COMMON /WSSCH/ T1SSC1(18,2),T2SSC1(18,2), 0000380
> T1SSC2(18,2),T2SSC2(18,2) 0000390
COMMON /WSSCHO/ TBSSC1(42,3),TWSSC1(42,3), 0000400
> TBSSC2(42,3),TWSSC2(42,3) 0000410
COMMON /SHROUD/ TLINER(18,2) 0000420
COMMON /GAAG1/ FCOPW1(3) 0000430
COMMON /GAAG2/ FCOPW2(18,2) 0000440
COMMON /HEA6 / NPIN(42),JPIN(42,3) 0000460
COMMON /SC02C/ QJ(19, 42) 0000470
COMMON /SC13C/ GEO1(42,3) 0000480
COMMON /QPAR1/ QDEV 0000490
C 0000510
C 0000520
C 0000530
III=NS-NSTR 0000540
FCOPW2(III,1)=FCOPW1(3) 0000550
DTIEAV(III,1)=0. 0000560
I2TIP(NS,1)=I3TIP(NS,1) 0000570
IF(I2TIP(NS,1).EQ.1)GOTO 2999 0000580
C-----0000590
C 0000600
C I3TIP#1: THE TURBULENT CALCULATION MUST BE PERFORMED 0000610
C 0000620
TWIAV=0. 0000630

CS=1. 0000640
AMA1=MSCH1(NS,1)/AT 0000650
ANGT=0. 0000660
AMT=0. 0000670
TT=0. 0000680
AMB=0. 0000690
TTB=0. 0000700
SRAMIB=0. 0000710
DDDDA=0. 0000720
DDDDB=0. 0000730
ATB=0. 0000740
HPLUSB(NS,1)=0. 0000750
HPLUSW(NS,1)=0. 0000760
TI=TSCH1(NS,1) 0000770
DEPA=DETOT 0000780
C 0000790
DO 3 I=1,N 0000800
AI=I 0000810
ANGT=ANGT+ALFA 0000820
C*****FIRST STEP: EVALUATION OF THE TAU=0 LINE AS FOR WALL CHANNELS**** 0000830
CALL RECANG(I,AI,NS,K,1,IRH,ALFA,AMA1,TI,PB,D,W,RH,DETOT,PROV,DAI 0000840
*,DBI,AAI,ABI,GG,SSSA,SSSB,AMTI,3,H1,H,PR1,PR2,SQDPG,1,TE,SUR,TWI, 0000850
*AMAI,TAI,AMBI,TBI,III,TSCH1(NS,1),TSCH(NS,1),HPLUS1,HPLUS2,ANGT,0.0000860
*,0.,1.,&777,DEPA,CS) 0000870
C*****SECOND STEP: SUBCHANNELS DEFINED WITH RADII FROM ROD CENTER***** 0000880
AAI=A(I)-ABI 0000890
DAI=4.*AAI/PA(I) 0000900
TI1=TI 0000910
TAI1=TAI 0000920
TBI1=TBI 0000930
TW1=TWI 0000940
CS1=CS 0000950
CALL RECANG(I,AI,NS,K,2,IRH,ALFA,AMA1,TI1,PB,D,W,RH,DETOT,PROV,DA 0000960
*,DBI,AAI,ABI,GG,SSSA,SSSB,AMTI,3,H1,H,PR1,PR2,SQDPG,1,TE,SUR,TWI, 0000970
*AMAI,TAI1,AMBI,TBI1,III,TSCH1(NS,1),TSCH(NS,1),HPLUS1,HPLUS2,ANGT,0000980
*,0.,1.,&777,DEPA,CS1) 0000990
TWIAV=TWIAV+TW1*ALFA 0001000
DTIEAV(III,1)=DTIEAV(III,1)+DELTIE(III,1,I)*AMTI 0001010
AMT=AMT+AMTI 0001020
TT=TT+AMTI*TI1 0001030
AMB=AMB+AMBI 0001040
RAMIB=AMTI*ABI/(AAI+ABI) 0001050
SRAMIB=SRAMIB+RAMIB 0001060
TTB=TTB+RAMIB*TBI1 0001070
DDDDA=DDDDA+SSSA 0001080
DDDDB=DDDDB+SSSB 0001090
DDDD=DDDDA+DDDDB 0001100
ATB=ATB+ABI 0001110
IF(IRH.EQ.1)GOTO 3 0001120
HPLUSB(NS,1)=HPLUSB(NS,1)+HPLUS1*ABI 0001130
HPLUSW(NS,1)=HPLUSW(NS,1)+HPLUS2*ABI 0001140
3 CONTINUE 0001150
C 0001160
C 0001170
CC 21.09.1979 0001180
C TWIAV=TWIAV*12./PIG 0001190
CC 0001200
TWIAV=TWIAV*6./PIG 0001210
CC 0001220
DTIEAV(III,1)=DTIEAV(III,1)/AMT 0001230
AT SCH=TT/AMT 0001240
RHOT=RHO(PB,AT SCH) 0001250
LAMSCH(NS,1)=((AT/DDDD)**2)*2.*DET*RHOT/H 0001260
ADAB(III,1)=AT/ATB 0001270
DETB(III,1)=48.*ATB/(PIG*D) 0001280
AMA=AMT-AMB 0001290

TSCHB=TTB/SLRAMIB	0001300	
RHOBT=RHO(PB, TSCHB)	0001310	
LAMB(III,1)=((ATB/DDDB)**2)*2.*DETB(III,1)*RHOBT/H	0001320
I2TIP(NS,1)=0	0001330	
F1ATIP(NS)=1.	0001340	
F1DTIP(NS)=1.	0001350	
F2ATIP(NS,1)=1.	0001360	
F2DTIP(NS,1)=1.	0001370	
IF(I3TIP(NS,1).EQ.2)GOTO 3000	0001380	
C-----	0001390	
C-----	0001400	
C I3TIP=3: THE LAMINAR CALCULATION MUST BE ALSO PERFORMED	0001410	
C-----	0001420	
IF(ITCORR.GT.1)GOTO 2999	0001430	
MSCH(NS,1)=AMT*ASCH(NS,1)/AT	0001440	
TSCH(NS,1)=ATSCH	0001450	
TW(NS,1)=TWIAV	0001460	
C-----	0001470	
C-----	0001480	
C FOR I3TIP=1 OR I3TIP=3	0001490	
C-----	0001500	
2999 CONTINUE	0001510	
R1DR2L=1./SQRT(1.+12.*AT*FATIP(3)/(PIG*RTIP(IPA)**2))	0001520	
RELA=RELAM(ASCH(NS,1)*FATIP(3),DET*FDTIP(3),PB,TSCH(NS,1),TW(NS,1))	0001530	
& ,MSCH(NS,1),TLINER(III,1),3,R1DR2L,1.)	0001540	
LAMILAM=AKAPPA(NS)/RELA	0001550	
R2COR=RTIP(IPA)/R1DR2L	0001560	
CALL ENTRFR(K,1,3,RTIP(IPA),R2COR,R2COR,NS,III,1,DET*FDTIP(3),	0001570	
* ASCH(NS,1)*FATIP(3),MSCH(NS,1),PB,TSCH(NS,1),LAMILAM)	0001580	
IF(I2TIP(NS,1).EQ.1)GOTO 2997	0001590	
C-----	0001600	
C-----	0001610	
C I3TIP=3: SAGAPO DECIDES WHETHER THE FLOW IS LAMINAR OR TURBULENT	0001620	
C-----	0001630	
IF(LAMSCH(NS,1).GT.LAMILAM)GOTO 3000	0001640	
C-----	0001650	
C-----	0001660	
C THE FLOW IS LAMINAR	0001670	
C-----	0001680	
2997 CONTINUE	0001690	
LAMSCH(NS,1)=LAMILAM	0001700	
DDDD=AT*FATIP(3)/SQRT(LAMILAM*H/(2.*DET*FDTIP(3)*	0001710	
*RHO(PB, TSCH(NS,1))))	0001720	
AMT=MSCH(NS,1)*AT/ASCH(NS,1)	0001730	
ATSCH=TSCH(NS,1)	0001740	
I2TIP(NS,1)=1	0001750	
F1ATIP(NS)=FATIP(3)	0001760	
F1DTIP(NS)=FDTIP(3)	0001770	
F2ATIP(NS,1)=FATIP(3)	0001780	
F2DTIP(NS,1)=FDTIP(3)	0001790	
HPLUSB(NS,1)=1.	0001800	
HPLUSW(NS,1)=1.	0001810	
QPLUS(NS,1)=1.	0001820	
PRB(NS,1)=1.	0001830	
YODH(NS,1)=1.	0001840	
TBSSC1(NS,1)=TSCH(NS,1)	0001850	
T1SSC1(III,1)=TSCH(NS,1)	0001860	
T2SSC1(III,1)=TSCH(NS,1)	0001870	
TWSSC1(NS,1)=TW(NS,1)	0001880	
TBSSC2(NS,1)=TSCH(NS,1)	0001890	
T1SSC2(III,1)=TSCH(NS,1)	0001900	
T2SSC2(III,1)=TSCH(NS,1)	0001910	
TWSSC2(NS,1)=TW(NS,1)	0001920	
ADAB(III,1)=2.	0001930	
AMA=AMT*0.5	0001940	
AMB=AMA	0001950	

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      SUBROUTINE ASSE(NCA,XF)          0000010
C -----
C           ASSIGNE A START VALUE TO THE FUEL TEMPERATURES.    0000020
C                                                       0000030
C           DIMENSION XF(13)          0000040
C
C           NC1=NCA+1                0000050
C           NC2=NCA*2+1              0000060
C           DO 100 K=NC1,NC2        0000070
C 100 XF(K)=250.                  0000080
C           RETURN                  0000090
C           END                     0000100
C

```

SUBROUTINE AXSEC(NDE1,NDE2,DETC,WSP,CONST,DDD,II,HH,MSPAC,LENGTH,N0000010
*,IPA,QTOT,NSTOT,XMAXNU,CHSLNU) 0000020

C----- 0000030

C AXSEC EVALUATES SECTION LENGTHS AND CORRECTION FACTORS FOR NU. 0000040

C 0000050

C REAL LENGTH,NDE1,NDE2 0000060

C 0000070

C COMMON /HEA6/ NPIN(42),JPIN(42,3) 0000080

C COMMON /GRID1/ EPSISC(42,3,5),DIST(7) 0000090

C COMMON /GRID2/ YY(100, 42,3) 0000100

C COMMON /GRID3/ X(100) 0000110

C COMMON /PRSPA/ DIST0 0000120

C COMMON /IDISPA/ IDISP1 0000130

C 0000140

C DIMENSION B(42,3),AA(42,3),SLOPE(42,3),YYM(3, 42,3) 0000150

C 0000160

C 0000170

C 0000180

X1=NDE1*DETC 0000190

IF(IDISP1.EQ.2)GOTO 1040 0000200

DE11W=11.*DETC-WSP*0.5 0000210

ISPA0=0 0000220

IF(-DIST0.LT.DE11W*0.999)ISPA0=1 0000230

MOSPAC=MSPAC+ISPA0 0000240

IF(MOSPAC.GT.0 .AND. IPA.EQ.IPA/2*2 .AND. QTOT.GT.1.E-06)GOTO 2 0000250

C*****UNHEATED SMOOTH PART OR PART WITHOUT SPACERS OR IDISP1=2***** 0000260

C*****UNHEATED SMOOTH PART OR PART WITHOUT SPACERS OR IDISP1=2***** 0000270

C*****UNHEATED SMOOTH PART OR PART WITHOUT SPACERS OR IDISP1=2***** 0000280

1040 SEC=LENGTH/X1+1. 0000290

N=SEC 0000300

SEC=N 0000310

H=LENGTH/SEC 0000320

DO 1 K=1,N 0000330

DO 100 NS=1,NSTOT 0000340

NP=NPIN(NS) 0000350

DO 100 M=1,NP 0000360

100 YY(K,NS,M)=1. 0000370

1 X(K+1)=X(K)+H 0000380

IF(MSPAC.EQ.0)RETURN 0000390

N1=N 0000400

1044 III=II 0000410

K0=1 0000420

1045 CONTINUE 0000430

DO 1046 K=K0,N 0000440

IF(X(K).GT.DIST(III) .AND. III.LT.MSPAC)III=III+1 0000450

IF(III+1.GT.MSPAC)GOTO 1046 0000460

KK=K 0000470

IF(X(K).LT.DIST(III) .AND. X(K+1).GT.DIST(III+1))GOTO 1047 0000480

1046 CONTINUE 0000490

GOTO 1049 0000500

1047 N=N+1 0000510

NK1=N-KK 0000520

DO 1048 K=1,NK1 0000530

K1=N-K+2 0000540

1048 X(K1)=X(K1-1) 0000550

X(KK+1)=X(KK)+(DIST(III)+DIST(III+1))*0.5 0000560

K0=KK+1 0000570

GOTO 1045 0000580

1049 CONTINUE 0000590

IF(N1.EQ.N)RETURN 0000600

K1=N1+1 0000610

```
DO 1050 K=K1,N          0000620
DO 1050 NS=1,NSTOT      0000630
NP=NPIN(NS)             0000640
DO 1050 M=1,NP          0000650
1050 YY(K,NS,M)=1.       0000660
RETURN                   0000670
C*****HEATED PART WITH SPACERS: AXIAL STEPS FIT CORR. PROF. FOR NU**** 0000690
C*****HEATED PART WITH SPACERS: AXIAL STEPS FIT CORR. PROF. FOR NU**** 0000700
2 CONTINUE                0000710
ZETA1=2./(1.+XMAXNU)     0000720
JSPAC=MSPAC+II-1         0000730
C
AMM=8./NDE2+0.5          0000740
MM=AMM                   0000750
BMM=MM                   0000760
NDE2=8./BMM              0000770
X2=NDE2*DETC              0000780
C
( NOTE THAT 8/NDE2 MUST BE AN INTEGER TO FIT CORR. PROF. FOR NU) 0000790
NPSEC=0                  0000800
K=0                      0000810
M1=NPSEC+1               0000820
M2=M1+MM+3               0000830
M3=M2+1                 0000840
JSPAC0=JSPAC+1            0000850
XXX1=1.E07                0000860
XXX11=1.E07               0000870
KLK=0                    0000880
C
C
DO 16 ISPAC=II,JSPAC0      0000890
DELO=HH                   0000900
IF(ISPAC.LE.JSPAC)XXX1=DIST(ISPAC)-WSP*0.5-DETC      0000910
IF(XXX1.LE.HH)DIST0=-1.E07      0000920
1020 I1SPAC=ISPAC-II+1      0000930
IF(-DIST0.LE.DE11W*0.999)I1SPAC=MSPAC+1      0000940
IF(-DIST0.GT.DE11W*0.999 .AND. ISPAC.EQ.JSPAC+1)GOTO 1030 0000950
DO 3 NS=1,NSTOT             0000960
NP=NPIN(NS)                0000970
DO 3 NN=1,NP                0000980
B(NS,NN)=CONST*EPSISC(NS,NN,I1SPAC)**2      0000990
YYM(1,NS,NN)=1.+0.75*ZETA1*B(NS,NN)      0001000
YYM(2,NS,NN)=(1.+B(NS,NN)*0.5*(1.+ZETA1))*(XMAXNU-1.)+(2.-XMAXNU)*0001010
*(1.+0.5*B(NS,NN)*(1.+CHSLNU+(1.-CHSLNU)/(3.-XMAXNU))) 0001020
YYM(3,NS,NN)=1.+0.5*B(NS,NN)*(2.*CHSLNU+(1.-CHSLNU)/(3.-XMAXNU)) 0001030
AA(NS,NN)=1.+CHSLNU*B(NS,NN)      0001040
3 SLOPE(NS,NN)=CHSLNU*B(NS,NN)*0.125/DETC      0001050
IF(ISPAC.EQ.JSPAC+1)GOTO 4      0001060
IF(ISPAC.EQ.II .AND. HH.GE.XXX1)GOTO 11      0001070
4 K=K+1                    0001080
L=K+1                    0001090
IF(K.NE.NPSEC+1)GOTO 10      0001100
IF(-DIST0.GT.DE11W*0.999)GOTO 1010      0001110
C
C*****EFFECT OF THE LAST SPACER PRECEEDING THE POINT AT WHICH THE 0001120
C CALCULATION HAS BEEN STARTED (ADDED AT GA)      ***** 0001130
X10=X(1)                  0001140
DELO=DE11W+DIST0+X10      0001150
DIST0=-1.E07               0001160
XLL=DELO-8.*DETC           0001170
X00=X00+X2                 0001180
DO 1000 KI=1,MM             0001190
X00=X00+X2                 0001200
KI2=KI                   0001210
IF(X00.GE.DELO*0.999)GOTO 1003      0001220
                                0001230
                                0001240
                                0001250
                                0001260
                                0001270
```

1000	CONTINUE	0001280
MM1=MM+1		0001290
MM2=MM+3		0001300
DO 1001 KI=MM1,MM2		0001310
X00=X00+DETC		0001320
KI2=KI		0001330
IF(X00.GE.DELO*0.999)GOTO 1003		0001340
1001	CONTINUE	0001350
WRITE(6,1002)		0001360
1002	FORMAT(1H1,5X,'ERROR IN AXSEC (DELO)')	0001370
STOP		0001380
C		0001390
1003	L=KI2+1	0001400
J=4		0001410
X(L)=DELO		0001420
DO 1008 KI1=1,KI2		0001430
K=KI2+1-KI1		0001440
IF(KI1-MM)1004,1004,1006		0001450
1004	X(K)=X(K+1)-X2	0001460
DO 1005 NS=1,NSTOT		0001470
NP=NPIN(NS)		0001480
DO 1005 NN=1,NP		0001490
1005	YY(K,NS,NN)=AA(NS,NN)-(X(K)+X2*0.5-XLL)*SLOPE(NS,NN)	0001500
GOTO 1008		0001510
1006	X(K)=X(K+1)-DETC	0001520
J=J-1		0001530
DO 1007 NS=1,NSTOT		0001540
NP=NPIN(NS)		0001550
DO 1007 NN=1,NP		0001560
1007	YY(K,NS,NN)=YYM(J,NS,NN)	0001570
1008	CONTINUE	0001580
X(1)=X10		0001590
DO 1013 KI1=1,KI2		0001600
L=KI1+1		0001610
K=L-1		0001620
NPSEC=K		0001630
IF(X(L).GT.XXX1)GOTO 1015		0001640
IF(X(L).GT.DDD)GOTO 1014		0001650
1013	CONTINUE	0001660
GOTO 1020		0001670
C		0001680
C	THE END OF THE AXIAL PORTION HAS BEEN OVERTAKEN	0001690
1014	X(L)=DDD	0001700
N=KI1		0001710
RETURN		0001720
C		0001730
C		0001740
C	THE BEGINNING OF THE INFLUENCE REGION OF THE SUCCEEDING SPACER HAS	0001750
C	BEEN OVERTAKEN	0001760
1015	X(L)=XXX1	0001770
DELO=XXX1		0001780
GOTO 1020		0001790
C		0001800
C		0001810
C*****AXIAL STEPS WHERE NO EFFECT OF SPACERS ON NU IS PRESENT*****		0001820
1010	CONTINUE	0001830
DX=XXX1-DELO		0001840
SEC=DX/X1+1.		0001850
NSEC=SEC		0001860
SEC=NSEC		0001870
H=DX/SEC		0001880
IF(ABS(DX).LE.1.E-05)NSEC=0		0001890
M1=NSEC+NPSEC+1		0001900
M2=M1+MM+3		0001910
M3=M2+1		0001920
KLK=0		0001930

XXX11=1.E07 0001940
IF(ISPAC.LT.JSPAC)XXX11=DIST(ISPAC+1)-WSP*0.5-DETC 0001950
IF(NSEC.EQ.0)GOTO 10 0001960
7 CONTINUE 0001970
DO 8 NS=1,NSTOT 0001980
NP=NPIN(NS) 0001990
DO 8 NN=1,NP 0002000
8 YY(K,NS,NN)=1. 0002010
X(L)=X(K)+H 0002020
GOTO 4 0002030
10 IF(K-M1)7,11,13 0002040
11 CONTINUE 0002050
C 0002060
C*****AXIAL STEPS (DIST(ISPAC)-WSP/2-DETC)-(DIST(ISPAC)-WSP/2+3*DETC) ** 0002070
IF(ISPAC.EQ.II .AND. HH.GE.XXX1)K=1 0002080
XXX2=X(K)-XXX1 0002090
C XXX2#0 IF DETC > DISTANCE BETWEEN THE FIRST SPACER AND THE INLET 0002100
C OF THE PART 0002110
XXX3=DETC-XXX2 0002120
X(K+1)=X(K)+XXX3 0002130
K=K-1 0002140
M1=M1-1 0002150
M2=M2-1 0002160
M3=M3-1 0002170
IF(XXX3.LE.1.E-03)GOTO 101 0002180
K=K+1 0002190
M1=M1+1 0002200
M2=M2+1 0002210
M3=M3+1 0002220
XXX3=0. 0002230
DO 12 NS=1,NSTOT 0002240
NP=NPIN(NS) 0002250
DO 12 NN=1,NP 0002260
12 YY(K,NS,NN)=1.+0.25*B(NS,NN)*(1.+XXX2/DETC)*ZETA1 0002270
101 CONTINUE 0002280
DO 60 J=1,3 0002290
K=K+1 0002300
L=K+1 0002310
X(L)=X(K)+DETC+XXX3 0002320
IF(X(L).GT.X(K))GOTO 77 0002330
K=K-1 0002340
XXX3=XXX3+DETC 0002350
GOTO 60 0002360
77 XXX3=0. 0002370
DO 59 NS=1,NSTOT 0002380
NP=NPIN(NS) 0002390
DO 59 NN=1,NP 0002400
59 YY(K,NS,NN)=YYM(J,NS,NN) 0002410
IF(X(L).GT.DDD)GOTO 61 0002420
60 CONTINUE 0002430
LL=L 0002440
GOTO 4 0002450
C 0002460
C*****PART ENDS BEFORE (DIST(ISPAC)-WSP/2+3*DETC) IS REACHED ***** 0002470
61 CONTINUE 0002480
X(L)=DDD 0002490
N=K 0002500
RETURN 0002510
C 0002520
13 IF(K.EQ.M3)GOTO 15 0002530
C 0002540
C*****AXIAL STEPS WHERE INFLUENCE OF SPACERS IS DECREASING***** 0002550
X(L)=X(K)+X2 0002560
DO 14 NS=1,NSTOT 0002570
NP=NPIN(NS) 0002580
DO 14 NN=1,NP 0002590

14 YY(K,NS,NN)=AA(NS,NN)-(X(K)+X2*0.5-X(LL))*SLOPE(NS,NN) 0002600
IF(X(L).GT.XXX11 .AND. KLK.EQ.0)KLK=K 0002610
GOTO 4 0002620
15 CONTINUE 0002630
C 0002640
C END OF INFLUENCE OF THE SPACER. 0002650
IF(KLK.NE.0)M2=KLK 0002660
IF(KLK.NE.0) X(KLK+1)=XXX11 0002670
K=M2 0002680
NPSEC=M2 0002690
HH=DIST(ISPAC)+DE11W 0002700
IF(KLK.NE.0)HH=XXX11 0002710
DELO=HH 0002720
16 CONTINUE 0002730
C 0002740
C ALL SPACERS HAVE BEEN CONSIDERED. 0002750
1030 HH=DELO 0002760
IF(HH.GT.DDD)GOTO 21 0002770
C*****END OF SMOOTH OR ROUGH PART NOT YET REACHED***** 0002780
DX=DDD-HH 0002790
SEC=DX/X1+1. 0002800
NSEC=SEC 0002810
SEC=NSEC 0002820
H=DX/SEC 0002830
K1=K+1 0002840
N=K+NSEC 0002850
DO 20 K=K1,N 0002860
L=K+1 0002870
X(L)=X(K)+H 0002880
DO 19 NS=1,NSTOT 0002890
NP=NPIN(NS) 0002900
DO 19 NN=1,NP 0002910
19 YY(K,NS,NN)=1. 0002920
20 CONTINUE 0002930
RETURN 0002940
C 0002950
C*****END OF SMOOTH OR ROUGH PART OVERTAKEN: CORRECTION TO FIT END POINT 0002960
21 CONTINUE 0002970
DX=DDD-X(LL) 0002980
SEC=DX/X2+1. 0002990
NSEC=SEC 0003000
SEC=NSEC 0003010
H=DX/SEC 0003020
N=LL+NSEC-1 0003030
DO 25 K=LL,N 0003040
L=K+1 0003050
X(L)=X(K)+H 0003060
DO 24 NS=1,NSTOT 0003070
NP=NPIN(NS) 0003080
DO 24 NN=1,NP 0003090
24 YY(K,NS,NN)=AA(NS,NN)-(X(K)+H*0.5-X(LL))*SLOPE(NS,NN) 0003100
25 CONTINUE 0003110
RETURN 0003120
END 0003130

```
SUBROUTINE BALA(K,NSTOT,INDSP,ASEC,H,LENGTH,PR1,PR2,PBT,    FREL,FT0000010
*,ITCORR,ITCM,DPAV,ITERM,ITGL,*,WSP,I1SPAC)          0000020
C-----0000030
C   SUBROUTINE BALA EVALUATES OUTLET MASS FLOW RATES AND TEMPERATURES 0000040
C                                         0000050
C   REAL LAM,MI,M2,MAV,LENGTH,MAVCF,MAV1,MAV2,KAPPA        0000060
C                                         0000070
C   DIMENSION WCF1( 42),EP1( 42),A( 42),DE( 42),           0000080
1       TA( 42), RHOAV( 42),RH01( 42),XMEM( 42),I1TIP( 42) 0000090
C                                         0000100
COMMON/GEO0/ACH(3)/HEA6/NPIN( 42),JJROD( 42,3)/GRID/CSPAC( 42,4) 0000110
1       /CORR/SIGMA( 42),PHI( 42),SBMNS/LAMINO/I2TIP( 42,3) 0000120
2       /IJ1/NER( 42),NIS( 42,3) 0000130
3       /GEN4/TEMP( 42)/GEN5/DEZ( 42)/LAMIN3/F1ATIP( 42),F1DTIP( 42)0000140
4       /IND3/NTYP( 42)/MOB1/M2( 42)/MOB2/UAV( 42)/MOB8/DP( 42) 0000150
5       /MOB4/WCF( 42)/MOB5/TAV( 42)/MOB6/MAV( 42)/MOB24/WT( 42,3) 0000160
6       /MOB26/RUAS( 42) 0000170
7       /QPAR1/QDEV/QPAR2/QLINM,QLDEV/QPAR3/PERL(3)/GRID6/EPS( 42,4)0000180
8       /GRID7/PGDP( 42,4)/COND1/CCOND( 42,3)/MART2/NNSS1,NNSS2 0000190
9       /GRAV/IGRAV/GAAG1/FCOPW1(3) 0000200
COMMON/ENEOP/IENE/MIXS1/CY/MIXS2/CCY/SECIN/KK/GRID2/YY(100, 42,3) 0000210
COMMON /GEN1/LAM( 42)/GEN2/AZ( 42)/GEN3/MI( 42) 0000220
COMMON /TUR1/CTURB( 42,3)/HB3/TEMP2( 42)/HEA3/QT( 42) 0000230
COMMON /SC02C/ QJ( 19, 42) 0000250
COMMON /SC07C/ H1 0000260
COMMON /SC02L/ JLAM 0000270
COMMON /MART5/ NSTR 0000280
COMMON /SC06L/ SHQ( 18,2) 0000290
COMMON /SC21C/ SHQC( 18,2) 0000300
COMMON /SC09R/ QSR( 18,2) 0000310
C-----0000330
C APPROXIMATE METHOD FOR THE LAMINAR CALCULATIONS 0000340
C-----0000350
KK=K 0000360
CCY=CY 0000370
IENFR=1 0000380
DO 1001 NS=1,NSTOT 0000390
NP=NPIN(NS) 0000400
DO 1000 JJJ=1,NP 0000410
IF(I2TIP(NS,JJJ).EQ.0 .OR. NTYP(NS).EQ.1)GOTO 1000 0000420
IENFR=2 0000430
1000 CONTINUE 0000440
1001 CONTINUE 0000450
CCCCCCCCCCCCCCCCCCCCCCCCCCCC 0000460
IF (JLAM .EQ. 1 .AND. IENFR .EQ. 2 )      CALL ENFRC1 0000470
CCCCCCCCCCCCCCCCCCCCCCCCCCCC 0000480
IF(NNSS1.NE.0 .AND. NNSS2.NE.0 .AND. IENFR.EQ.2)CALL ENFRC0 0000490
C-----0000500
DO 400 NS=1,NSTOT 0000510
RH01(NS)=RHO(PR1,TEMP (NS)) 0000520
NP=NPIN(NS) 0000530
C-----0000540
C   THE FLOW AREAS AND THE EQUIVALENT DIAMETERS ARE BASED ON THE TIP 0000550
C   DIAMETER OF THE RODS IN THE CASE OF LAMINAR CALCULATIONS 0000560
C   I1TIP(NS)=0 FOR TURBULENT FLOW; I1TIP(NS)=1 FOR LAMINAR FLOW 0000570
C-----0000580
I1TIP(NS)=0 0000590
A(NS)=AZ(NS)*F1ATIP(NS) 0000600
DE(NS)=DEZ(NS)*F1DTIP(NS) 0000610
DO 399 JJJ=1,NP 0000620
399 I1TIP(NS)=I1TIP(NS)+I2TIP(NS,JJJ) 0000630
```

```

C DO 400 M=1,3
WT(NS,M)=0.
400 CONTINUE
XX=1./980665.

C .....ITERATION ON THE RELAXATION FACTOR (LOOP ITFREL)
C DO 999 ITFREL=1,98
IVIA=1
C .....
C CALCULATION OF THE PRESSURE LOSSES (LOOP ITGL)
C DO 15 ITGL=1,70
*****EVALUATION OF CROSS-FLOW SOLUTIONS*****
CALL CRFL1(ITGL,DPAV,FREL,ASEC,NSTOT,A,MI,DP,WCF,WCF1,EP1)
DO 1 NS=1,NSTOT
M2(NS)=MI(NS)-H*WCF(NS)
MAV(NS)=(M2(NS)+MI(NS))*0.5
TA(NS)=TEMP(NS)
1 CONTINUE
IF(ITGL.GT.1 .AND. IVIA.EQ.1)GOTO 9
C .....
C CALCULATION OF THE AVERAGE GAS TEMPERATURES (LOOP ITERM)
C XPREC=1.E-04
DO 7 ITERM=1,20
DO 3 NS=1,NSTOT
NP=NPIN(NS)
YYNS=0.
DO 1002 JJJ=1,NP
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 10.9.980
CALL SPANU(1.,2.,3,4,YY(K,NS,JJJ))
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
1002 YYNS=YYNS+YY(K,NS,JJJ)
YYNS=YYNS/FLOAT(NP)-1.
THEX=0.
CONHE=0.
NI=NER(NS)
NTYPNS=NTYP(NS)
ACH1=ACH(NTYPNS)
MAV1=MAV(NS)*ACH1/AZ(NS)
DO 2 M=1,NI
J=NIS(NS,M)
NP=NPIN(J)
YYJ=0.
DO 1003 JJJ=1,NP
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 10.9.980
CALL SPANU(1.,2.,3,4,YY(K,J,JJJ))
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
1003 YYJ=YYJ+ YY(K,J,JJJ)
YYJ=YYJ/FLOAT(NP)-1.
YYNSJ=(YYNS+YYJ)*CCY*0.5+1.
NTYPJ=NTYP(J)
ACH2=ACH(NTYPJ)
MAV2=MAV(J)*ACH2/AZ(J)
IF(TA(NS).LE.0. .OR. TA(NS).GT.3000. .OR. TA(J).LE.0. .OR. TA(J)
*.GT.3000.)GOTO 302
WT(NS,M)=TME(PBT,MAV1,MAV2,TA(NS),TA(J),LAM(NS),LAM(J),ACH1,ACH2,
*CTURB(NS,M))*YYNSJ
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C IF(I1TIP(NS).NE.0 .OR. I1TIP(J).NE.0)WT(NS,M)=0.
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 10.9.980
IF(ABS(YY(K,J,JJJ)*YY(K,NS,JJJ)-1.0) .GT. 1.E-03) GO TO 401
IF(I1TIP(NS).NE.0 .OR. I1TIP(J).NE.0)WT(NS,M)=0.
401 CONTINUE

```


NI=NER(NS)	0002180
NTYPNS=NTYP(NS)	0002190
ACH1=ACH(NTYPNS)	0002200
DO 11 M=1,NI	0002210
J=NIS(NS,M)	0002220
TMOEX=TMOEX-(UAV(NS)-UAV(J))*WT(NS,M)	0002230
11 CONTINUE	0002240
TMOEX=FT*TMOEX/A(NS)*H	0002250
IF(ITGL.GT.1)GOTO 103	0002260
CFMOEX=0.	0002270
GOTO 104	0002280
103 UCFAV=UA(NS,NI,ACH1,1)	0002290
CFMOEX=(2.*UAV(NS)-UCFAV)*WCF(NS)/A(NS) *H	0002300
104 CONTINUE	0002310
XMEM(NS)=LAM(NS)*H/(2.*DE(NS)*RHOAV(NS))*FCOPW1(NTYPNS)	0002320
RE=MAV(NS)*DE(NS)/(A(NS)*ETA(PBT,TAV(NS)))	0002330
IF(INDSP.EQ.2)XMEM(NS)=XMEM(NS)+(CSPAC(NS,I1SPAC)+DSPDPF(EPS(NS,I10002340 *SPAC), DE(NS), LAM(NS), WSP, PGDP(NS, I1SPAC), RE, NTYP(NS)))/RHOAV(NS) 0002350	
12 DP(NS)=XX*(-(MAV(NS)/A(NS))**2*(XMEM(NS)-(RHO(PR2,TEMP2(NS))-RHO1(0002360 *NS))/RHOAV(NS)**2)+TMOEX+CFMOEX+IGRAV*RHOAV(NS)*980.665*H) 0002370	
DPAV=DPAV+DP(NS)*MI(NS)	0002380
SMA=SMA+MI(NS)	0002390
13 CONTINUE	0002400
DPAV=DPAV/SMA	0002410
C	0002420
C TEST OF CONVERGENCE FOR THE CHANNEL PRESSURE LOSSES	0002430
C	0002440
DO 14 NS=1,NSTOT	0002450
IF(ABS(DP(NS)/DPAV-1.).GT.1.E-02)GOTO 15	0002460
IF(ABS(DP(NS)/DPAV-1.).GT.1.E-03 .AND. ITGL.LT.40)GOTO 15	0002470
14 CONTINUE	0002480
IF(IVIA.EQ.2)GOTO 17	0002490
DO 301 NS=1,NSTOT	0002500
IF(M2(NS).LE.0.)GOTO 302	0002510
301 CONTINUE	0002520
IVIA=2	0002530
15 CONTINUE	0002540
C	0002550
C END OF LOOP ITGL	0002560
C	0002570
302 CONTINUE	0002580
AIT=ITFREL	0002590
FREL=1.-AIT*0.01	0002600
999 CONTINUE	0002610
C	0002620
C END OF LOOP ITFREL	0002630
C	0002640
WRITE(6,16)ITCORR,(DP(NS),NS=1,NSTOT),(MAV(NS),NS=1,NSTOT),(TAV(NS0002650 *),NS=1,NSTOT)	0002660
16 FORMAT(// 5X,'SUB. BALA', > / 5X,'CHANNEL CALCULATION STOPS IN LOOP ITGL AT ITCORR=', *15/5X,'PRESSURE LOSSES, AVERAGE MASSES, AVERAGE TEMPERATURES:/' *(8E15.5))	0002670
RETURN 1	0002680
C	0002690
C CONTRIBUTIONS OF CROSS-FLOW, TURBULENT MIXING AND DENSITY	0002700
C TO THE PRESSURE DROPS OF THE CHANNELS (SIGMA)	0002710
C	0002720
17 CONTINUE	0002730
SBMNS=0.	0002740
DO 21 NS=1,NSTOT	0002750
NTYPNS=NTYP(NS)	0002760
RUAS(NS)=MAV(NS)*SQRT(LAM(NS)*0.125)/AZ(NS)*ACH(NTYPNS)	0002770
DPAVF=DPAV-IGRAV*RHOAV(NS)*0.001*H	0002780
BMNS=SQRT(ABS(DPAVF)/(XX*XMEM(NS)))*A(NS)	0002790
SIGMA(NS)=(MAV(NS)-BMNS)/AZ(NS)	0002800
	0002810
	0002820
	0002830

SBMNS=SBMNS+BMNS	0002840
21 CONTINUE	0002850
RETURN	0002860
END	0002870

FUNCTION BETAF(P,W,ZWC)	0000010
-----	0000020
C BETAF EVALUATES THE PARAMETER BETA FOR THE DETERMINATION OF THE	0000030
C SEPARATION LINE DEFINING THE TWO PORTIONS OF THE WALL SUBCHANNELS	0000040
C IN THE LAMINAR CALCULATIONS	0000050
C THE FOLLOWING EQUATION IS EXACTLY VALID AT ZWC=0, 1.2<P/D,W/D<1.5)	0000060
C	0000070
BETAF=(3.77165-2.0795*P)+(-1.71985+1.2139*P)*W	0000080
RETURN	0000090
END	0000100

SUBROUTINE BOTH (VDIAM,PIG,H,VDIA1,RINT) 0000010
C ----- 0000020
C ORGANIZES THE CALCULATION OF THE THERMAL CONDUCTION WITHIN THE PIN0000030
C POWER GENERATED WITHIN THE FUEL. 0000040
C 0000050
C DIMENSION A(13,13),B(13),X(13),XF(13) 0000060
C 0000070
C COMMON /SC01C/ NCAN(19),LIPS(19,10) 0000080
C COMMON /SC03C/ NRODS 0000090
C 0000100
C 1. ----- 0000110
C PROVIDES THE HEAT TRANSFER COEFFICIENTS. 0000120
C CALL ALFAC(VDIA1,H) 0000130
C CALL KGAP 0000140
C 0000150
C 2. ----- 0000160
C COMPUTES SOME GEOMETRICAL FACTORS. 0000170
C CALL FGEO(VDIAM,RSTAR,S,R,RINT) 0000180
C 0000190
C 3. ----- 0000200
C LOOP ON THE RODS. 0000210
C 0000220
C DO 1000 J=1,NRODS 0000230
C NCA=NCAN(J) 0000240
C IF (NCA - 1) 1000,990,100 0000250
C 3.0 ----- 0000260
C CONVERGENCE LOOP ON THE FUEL TEMPERATURE. 0000270
100 CALL ASSE(NCA,XF) 0000280
DO 900 LIN=1,10 0000290
C 3.1 ----- 0000300
C THE ARRAYS ARE SET TO ZERO AT THE BEGINN OF EACH ITERATION0000310
DO 300 I=1,13 0000320
B(I)=0.0 0000330
DO 200 L=1,13 0000340
A(I,L)=0.0 0000350
200 CONTINUE 0000360
300 CONTINUE 0000370
C 0000380
C IF (NCA .EQ. 3) GO TO 500 0000390
C 3.2 ----- 0000400
C COMPUTES THE COEFFICIENTS OF THE EQUATIONS FOR THE CLAD. 0000410
C CASE OF WHOLE PIN. 0000420
C 0000430
C CALL CCLAD(NCA,A,B,RSTAR,R,H,J,S) 0000440
C 3.3 ----- 0000450
C COMPUTES THE COEFFICIENTS OF THE EQUATIONS FOR THE FUEL. 0000460
C CASE OF WHOLE PIN. 0000470
C 0000480
C CALL CFUEL(NCA,A,B,RSTAR,H,J,XF) 0000490
GO TO 800 0000500
C 3.4 ----- 0000510
C COMPUTES THE COEFFICIENTS OF THE EQUATIONS FOR THE CLAD. 0000520
C CASE OF HALF PIN. 0000530
C 0000540
500 CALL CCLAD3(A,B,RSTAR,R,H,J,S) 0000550
C 3.5 ----- 0000560
C COMPUTES THE COEFFICIENTS OF THE EQUATIONS FOR THE FUEL. 0000570
C CASE OF HALF PIN. 0000580
C 0000590
C CALL CFUEL3(A,B,RSTAR,H,J,XF) 0000600
800 CONTINUE 0000610

C 3.6 ----- 0000620
C SOLVES THE SYSTEM OF EQUATIONS. 0000630
C 0000640
C NC2 = NCA*2+1 0000650
C CALL LINAL (A,NC2,13,A,B,1,13,X) 0000660
C CALL GAUSS1(A,B,X,NC2,13) 0000670
C 3.7 ----- 0000680
C CONVERGENCE TEST ON THE THERMAL CONDUCTIVITY OF THE FUEL. 0000690
C CALL TEST1(NCA,X,XF,KK) 0000700
C IF (KK.LE.0) GO TO 950 0000710
900 CONTINUE 0000720
WRITE(6,920) LIN,J 0000730
920 FORMAT (///5X,'SUBR. LEIT',/5X,
> 'LIN = ',I2,' ==> CONVERGENCE PROBLEMS ',5X, 0000740
> 'FOR PIN N. ',I3,/5X, 0000750
> 'IN THE LOOP FOR FUEL THERMAL CONDUCTIVITY',/5X, 0000760
> 'CALCULATION STOPS') 0000770
STOP 0000780
C 0000790
C 3.8 ----- 0000800
C ASSIGNS THE NEW TEMPERATURE VALUES (X) TO THE ARRAY TW. 0000810
C 0000820
C 0000830
950 CALL TNEW (NCA,X,J,13) 0000840
C 3.9 ----- 0000850
C DETERMINES THE HEAT EXCHANGED BY CONDUCTION. 0000860
C 0000870
990 CALL QCOC (NCA,J,X,13) 0000880
1000 CONTINUE 0000890
C 0000900
RETURN 0000910
END 0000920

```
SUBROUTINE CCLAD (NCA,A,B,RSTAR,R,H,J,S)          0000010
C -----0000020
C      COMPUTES THE COEFFICIENTS FOR THE EQUATIONS OF THERMAL CONDUCTION 0000030
C      WITHIN THE CLAD IN CASE OF POWER GENERATED IN THE FUEL.        0000040
C                                         0000050
C                                         0000060
C      DIMENSION A(13,13),B(13)                                         0000070
C                                         0000080
C      COMMON /SC01C/ NCAN( 19),LIPS( 19,10)                         0000090
C      COMMON /SC05C/ JZUR( 19, 42)                                     0000100
C      COMMON /SC11C/ FALFA( 42,3)                                     0000110
C      COMMON /SC12C/ GEO( 42,3)                                      0000120
C      COMMON /SC20C/ CGAP                                         0000130
C      COMMON /SC08R/ QPR( 42,3)                                     0000140
C      COMMON /SUB22/ TW( 42,3)                                      0000150
C      COMMON /SC26C/ TBR( 42,3),TBS( 18,2)                         0000160
C                                         0000170
C      REAL KMET                                         0000180
C                                         0000190
C      DO 1000 K=1,NCA                                         0000200
C          KP=K-1                                         0000210
C          IF(K .EQ. 1) KP=NCA                                0000220
C          KD=K+1                                         0000230
C          IF(K .EQ.NCA) KD=1                                0000240
C          KF=K+NCA                                         0000250
C                                         0000260
C          NS1 = LIPS(J,K)                                     0000270
C          NSP = LIPS(J,KP)                                    0000280
C          NSD = LIPS(J,KD)                                    0000290
C          MZ1 = JZUR(J,NS1)                                 0000300
C          MZP = JZUR(J,NSP)                                 0000310
C          MZD = JZUR(J,NSD)                                 0000320
C                                         0000330
C          TMP = (TW(NS1,MZ1)+TW(NSP,MZP))*0.5           0000340
C          TMD = (TW(NS1,MZ1)+TW(NSD,MZD))*0.5           0000350
C          FKP = KMET(TMP)*H*S/(R*(GEO(NS1,MZ1)+GEO(NSP,MZP))) 0000360
C          FKD = KMET(TMD)*H*S/(R*(GEO(NS1,MZ1)+GEO(NSD,MZD))) 0000370
C          FKF = CGAP*RSTAR*GEO(NS1,MZ1)*H*2.            0000380
C          B(K) = - TBR(NS1,MZ1)*FALFA(NS1,MZ1) - QPR(NS1,MZ1) 0000390
C                                         0000400
C      DO 500 L=1,12                                         0000410
C          A(K,L) = 0.0                                     0000420
C          IF (L .EQ. KP) A(K,L) = FKP                   0000430
C          IF (L .EQ. K ) A(K,L) = -FKF-FKD-FKP-FALFA(NS1,MZ1) 0000440
C          IF (L .EQ. KD) A(K,L) = FKD                   0000450
C          IF (L .EQ. KF) A(K,L) = FKF                   0000460
C          IF (L .EQ. KF) A(K,L) = FKF                   0000470
C          500      CONTINUE                               0000480
C      1000      CONTINUE                               0000490
C      RETURN                                         0000500
C      END                                           0000510
```

SUBROUTINE CCLAD3 (A,B,RSTAR,R,H,J,S) 0000010
C-----0000020
C COMPUTES THE COEFFICIENTS FOR THE EQUATIONS OF THERMAL CONDUCTION 0000030
C WITHIN THE FUEL IN CASE OF POWER GENERATED IN THE FUEL. 0000040
C CASE OF HALF ROD. 0000050
C 0000060
C 0000070
C DIMENSION A(13,13),B(13) 0000080
C 0000090
COMMON /SC01C/ NCAN(19),LIPS(19,10) 0000100
COMMON /SC05C/ JZUR(19, 42) 0000110
COMMON /SC11C/ FALFA(42,3) 0000120
COMMON /SC12C/ GEO(42,3) 0000130
COMMON /SC08R/ QPR(42,3) 0000140
COMMON /SC20C/ CGAP 0000150
COMMON /SUB22/ TW(42,3) 0000160
COMMON /SC26C/ TBR(42,3),TBS(18,2) 0000170
C 0000180
REAL KMET 0000190
C 0000200
NS1 = LIPS(J,1) 0000210
NS2 = LIPS(J,2) 0000220
NS3 = LIPS(J,3) 0000230
MZ1 = JZUR(J,NS1) 0000240
MZ2 = JZUR(J,NS2) 0000250
MZ3 = JZUR(J,NS3) 0000260
C 0000270
TM12 = (TW(NS1,MZ1) + TW(NS2,MZ2)) *0.5 0000280
TM23 = (TW(NS2,MZ2) + TW(NS3,MZ3)) *0.5 0000290
C 0000300
C 0000310
C 0000320
F12 = KMET(TM12) * H * S / (R*(GEO(NS1,MZ1)+GEO(NS2,MZ2))) 0000330
F23 = KMET(TM23) * H * S / (R*(GEO(NS3,MZ3)+GEO(NS2,MZ2))) 0000340
C 0000350
FGAP1 = CGAP * RSTAR * GEO(NS1,MZ1) * H * 2. 0000360
FGAP2 = CGAP * RSTAR * GEO(NS2,MZ2) * H * 2. 0000370
FGAP3 = CGAP * RSTAR * GEO(NS3,MZ3) * H * 2. 0000380
C 0000390
A(1,1) = -FALFA(NS1,MZ1) - FGAP1 - F12 0000400
A(1,2) = F12 0000410
A(1,4) = FGAP1 0000420
C 0000430
A(2,1) = F12 0000440
A(2,2) = - FALFA(NS2,MZ2) - FGAP2 - F12 - F23 0000450
A(2,3) = F23 0000460
A(2,5) = FGAP2 0000470
C 0000480
A(3,2) = F23 0000490
A(3,3) = - FALFA(NS3,MZ3) - FGAP3 - F23 0000500
A(3,6) = FGAP3 0000510
C 0000520
B(1) = -TBR(NS1,MZ1) * FALFA(NS1,MZ1) - QPR(NS1,MZ1) 0000530
B(2) = -TBR(NS2,MZ2) * FALFA(NS2,MZ2) - QPR(NS2,MZ2) 0000540
B(3) = -TBR(NS3,MZ3) * FALFA(NS3,MZ3) - QPR(NS3,MZ3) 0000550
C 0000560
RETURN 0000570
END 0000580

SUBROUTINE CEWA(K,NS,IRH,PROV,PB,RH,AA,DD,GG,AM1,DETOT,H1,ALFA, 0000010
*I,JJJ,H,PR1,PR2,SQDPG,AMT,TT,DDDD,TE,SUR,ITYP,III,HPLUS1,HPLUS2, 0000020
TIE,SIGMA,PHI,,D,TWI,TI,C) 0000030

C-----0000040

C SUBROUTINE CEWA EVALUATES FRICTION FACTORS AND APPROXIMATE 0000050
C VALUES OF MASS FLOW RATES AND TEMPERATURE FOR 'CENTRAL-TYPE' SUB-0000060
C SUBCHANNELS (CENTRAL AND WALL CHANNELS). 0000070
C 0000080

REAL LAMI,KI,KAPPA,NUI 0000090
COMMON/GRID2/YY(100, 42,3)/HEA5/QQ(42,3)/DAT/PIG/MART/ITCORR 0000100
1 /QPAR1/QDEV/COLAM1/COLAMB/SUB22/TW(42,3) 0000110
2 /GRAV/IGRAV/GAGR/DPSI 0000120
COMMON /MART5/ NSTR 0000140
COMMON /HEA6 / NPIN(42),JPIN(42,3) 0000150
COMMON /IND3 / NTYP(42) 0000160
COMMON /SC02C/ QJ(19, 42) 0000170
COMMON /SC13C/ GE01(42,3) 0000180

C 0000200
IF(IRH.EQ.1)GOTO 1000 0000210
C 0000220

C IN THE CASE OF SMOOTH RODS SINGLE VALUES OF THE SUB-SUBCHANNEL 0000230
C PIN TEMPERATURES ARE NOT COMPUTED 0000240

R1=D*0.5 0000250
R0=0.5*SQRT(D**2+DD*D) 0000260
FACHE=TIS(R1,R0,IRH) 0000270
R1DR0=R1/R0 0000280
YDH=(R0-R1)/RH 0000290

C 0000300
1000 CONTINUE 0000310
CC 0000320
C QROD=QQ(NS,JJJ)*QDEV 0000330
CC 0000340
JP=JPIN(NS,JJJ) 0000350
QAD=QJ(JP,NS)*GE01(NS,JJJ)/H1 0000360
QROD=QQ(NS,JJJ)*QDEV+QAD 0000370
CC 0000380
Q=QROD*ALFA/(2.*PIG)*H1 0000390
QA=QROD/SUR 0000400
TI=TIE 0000410

C0000420
C THE ITERATION PROCEDURE STARTS ASSUMING UNIFORM MASS-FLOW 0000430
C DISTRIBUTION 0000440
C 0000450
DO 10 ITW=1,10 0000460
C 0000470

DO 4 IT=1,50 0000480
DELTAT=(Q+PHI*AA)/(AM1*CP(PB, TI)) 0000490
TI=TIE+0.5*DELTAT 0000500
IF(ITW.EQ.1 .AND. I.EQ.1) TWI=TI 0000510
ETAI=ETA(PB, TI) 0000520
RHOI=RHO(PB, TI) 0000530
REI=AM1*DD/(AA*ETAI) 0000540
ETAIW=ETA(PB, TWI) 0000550
RHOIW=RHO(PB, TWI) 0000560
REIW=(ETAI*RHOIW)/(ETAIW*RHOI)*REI 0000570
IF(IT.EQ.1 .AND. ITW.EQ.1) GOTO 30 0000580

C0000590
C AFTER 1. ST ITERATION FRICTION FACTORS ARE EVALUATED FROM THE 0000600
C VALUES OBTAINED IN THE PRECEEDING ITERATION 0000610
C 0000620

IF(REI.GT.0. .AND. SQ8LI.GT.0.)GOTO 700 0000630

```
1001 WRITE(6,699)NS,JJJ,I,REI,SQ8LI 0000640
 699 FORMAT(/5X,'SUB. CEWA', 0000650
    >      /5X,'NS=',I5,5X,'M=',I2,5X,'I=',I3/5X,'RE=',E15.5,5X,'SQRT0000660
    *(8/LAMBDA)=' ,E15.5) 0000670
    RETURN 1 0000680
700 CONTINUE 0000690
  IF(IRH.EQ.2)GOTO 1 0000700
  SQ8LI=2.5*ALOG(REI/SQ8LI)+5.5-GG 0000710
  GOTO 3 0000720
1 IF(SQ8LI.LE.0.)GOTO 1001 0000730
  HPLUSB=RH/DD*REI/SQ8LI 0000740
  HPLUSW=HPLUSB*REIW/REI 0000750
  GOTO 31 0000760
C ..... 0000770
C 1. ST ITERATION: FRICTION FACTORS ARE EVALUATED BY MEANS OF THE 0000780
C EQUATION (LAMDAI*RHOI*UI**2/DI) = (LAMDA*RHO*U**2/D) TOT. 0000790
C 0000800
30 IF(IRH.EQ.2)GOTO 2 0000810
  SQ8LI=2.5*ALOG(Prov/ETAI*SQRT((DD/DETOT)**3*RHOI))+5.5-GG 0000820
  GOTO 3 0000830
2 HPLUSB=RH/DETOT*PROV/ETAI*SQRT(DD/DETOT*RHOI) 0000840
  HPLUSW=RH/DETOT*PROV/ETAIW*SQRT(DD/DETOT*RHOIW) 0000850
C 0000860
31 CONTINUE 0000870
  QPLUS=QA*AA/(AM1*(TE+273.16)*CP(PB, TI)) 0000880
  RHPL=RHPLUS(HPLUSB,TWI,TE,QPLUS,HPLUSW, TI,YDH) 0000890
  SQ8LI=2.5*ALOG(DD/RH)+RHPL-GG 0000900
3 LAMI=8./SQ8LI**2*COLAMB 0000910
  SSS=AA/SQRT(LAMI*H/(2.*RHOI*DD)) 0000920
  SQDPGI=SQRT(ABS(SQDPG**2*DPSI-IGRAV*RHOI*980.665*H)) 0000930
  AM2=SSS*SQDPGI+SIGMA*AA 0000940
  IF(IT.EQ.1 .AND. ITW.EQ.1)GOTO 50 0000950
  IF(ABS(PLAMI/LAMI-1.).LE.1.E-04)GOTO 6 0000960
  PLAMI=PLAMI 0000970
  AM3=AM1 0000980
50 PLAMI=LAMI 0000990
4 AM1=AM2 0001000
C ..... 0001010
C END OF LOOP IT 0001020
C 0001030
  WRITE(6,5)I,NS,K,ITW,ITCORR,AA,DD,ALFA,LAMI,PLAMI,AM3,AM2,TI,TIE, 0001040
  1TWI,PHI,SIGMA 0001050
5 FORMAT(1H1,5X,'SUB. CEWA', 0001060
    >      /5X,'CALCULATION STOPS: IT=10 FOR SUBCH.',I3,2X,'(CHANNE0001070
  *L NR.',I4,2X,'AXIAL SECTION NR.',I3,')',2X,'ITW=',I2,2X,'ITCORR=',0001080
  *I4/5X,'AA=' ,E15.5/5X,'DD=' ,E15.5/5X,'ALFA=' ,E15.5/5X,'LAMI=' ,E15.50001090
  */5X,'PLAMI=' ,E15.5/5X,'AM1=' ,E15.5/5X,'AM2=' ,E15.5/5X,'TI=' ,E15.5/0001100
  */5X,'TIE=' ,E15.5/5X,'TWI=' ,E15.5/5X,'PHI=' ,E15.5/5X,'SIGMA=' ,E15.7)0001110
  RETURN 1 0001120
C 0001130
6 IF(QQ(NS,JJJ).LE.1.E-06)GOTO 12 0001140
  IF(IRH.EQ.1)GOTO 13 0001150
C ..... 0001160
C ITERATION TO FIND ROD TEMPERATURE FOR THE ROUGH PART 0001170
C 0001180
  KI=KAPPA(PB, TI) 0001190
  PRI=ETAI*CP(PB, TI)/KI 0001200
CCCCCCCCCCCCCCCCCCCCCCCC 06.02.1980 0001210
  CALL SPANU(REI,PRI,NS,JJJ,YYI) 0001220
C CALL RNU(HPLUSW,TWI,LAMI,REI,PRI, TI,YDH,R1DRO,0.,1.,REIW,YY(K,NS, 0001230
C 1 JJJ),NUI,GHPL) 0001240
C CALL RNU(HPLUSW,TWI,LAMI,REI,PRI, TI,YDH,R1DRO,0.,1.,REIW,YYI, 0001250
C 1 NUI,GHPL,1) 0001260
C FURTHER MODIFIED AT 09.10.1980 0001270
  BK=2.0 0001280
  IF(ITYP.EQ.1 .AND. NS.GT.NSTR) BK=1.0 0001290
```

```
CALL RNU(HPLUSW,TWI,LAMI,REI,PRI,TI,YDH,R1DRO,0.,1.,REIW,YYI,      0001300
1 NUI,GHPL,1,R0,R1,0.0,BK)          0001310
CCCCCCCCCCCCCCCCCCCCCCCCCCCC 06.02.1980          0001320
ALFAI=NUI*KI/DD*FACHE          0001330
TIW=TI+QA/ALFAI          0001340
IF(ABS(TIW/TWI-1.).LE.1.E-04)GOTO12          0001350
10 TWI=TIW          0001360
C .....          0001370
C END OF LOOP ITW          0001380
C          0001390
C     WRITE(6,11)I,JJJ,NS          0001400
11 FORMAT(    5X,'SUB. CEWA ',          0001410
>           /5X,'CALCULATION STOPS: ITW=10 FOR SUBCH.',I3,2X, '(M=',0001420
*I2,2X,'NS=',I5,' )')          0001430
RETURN 1          0001440
C          0001450
C 13 TWI=TW(NS,JJJ)          0001460
C          0001470
C 12 AMT=AMT+AM2          0001480
TT=TT+TI*AM2          0001490
DDDD=DDDD+SSS          0001500
IF(IRH.EQ.1)RETURN          0001510
C          0001520
HPLUS1=HPLUS1+HPLUSB*AA          0001530
HPLUS2=HPLUS2+HPLUSW*AA          0001540
RETURN          0001550
END          0001560
```

```
SUBROUTINE CEWACO(N,NN,NTYP,ALFA,D,X,AT,DET,MFLOW,ATOT,AREA,DE,ME)0000010
C-----0000020
C SUBROUTINE CEWACO EVALUATES GEOMETRICAL PARAMETERS AND INLET MASS0000030
C FLOW RATES FOR 'CENTRAL-TYPE' AND CORNER SUB-SUBCHANNELS. 0000040
C 0000050
C REAL MFLOW,ME 0000060
C DIMENSION AREA(NN),DE(NN),ME(NN) 0000070
C COMMON/CEN1/G(46)/ANG1/RR2(30),ALF12(30)/ANG2/PER(30) 0000080
C PEROD=ALFA*D*0.5 0000090
C ARROD=PEROD*0.25*D 0000100
C E1=0. 0000110
C DO 3 I=1,NN 0000120
C AI=I 0000130
C E2=X*TAN(ALFA*AI) 0000140
C DELTAE=E2-E1 0000150
C AREA(I)=X*DELTAE*0.5-ARROD 0000160
C DE(I)=4.*AREA(I)/PEROD 0000170
C IF(NTYP.EQ.3)GOTO 1 0000180
C EPS=SQRT(1.+DE(I)/D) 0000190
C G(I)=GSTAR(EPS) 0000200
C GOTO 2 0000210
C 1 PER(I)=DELTAE 0000220
C RR2(I)=SQRT(D**2+DE(I)*D)*0.5 0000230
C ALF12(I)=D*0.5/RR2(I) 0000240
C DE(I)=4.*AREA(I)/(PEROD+PER(I)) 0000250
C 2 CONTINUE 0000260
C ME(I) =MFLOW*AREA(I)/ATOT 0000270
C 3 E1=E2 0000280
C IF(NTYP.EQ.3)GOTO 5 0000290
C WRITE(6,4) 0000300
C 4 FORMAT(///130('*')//) 0000310
C *      5X,'GEOMETRY OF CENTRAL CHANNELS (REFERENCE TO 1/6)'//)0000320
C GOTO 7 0000330
C 5 WRITE(6,6) 0000340
C 6 FORMAT(///130('*')///5X,'GEOMETRY OF ANGULAR CHANNELS (REFERENCE0000350
C * TO 1/2)'//) 0000360
C 7 CONTINUE 0000370
C WRITE(6,8)AT,DET 0000380
C 8 FORMAT(5X,'TOTAL FLOW AREA=',F5.2,1X,'SQCM',5X,'TOTAL EQUIVALENT D0000390
C *IAMETER=',F4.1,1X,'CM'//) 0000400
C WRITE(6,9) 0000410
C 9 FORMAT(5X,'SECTION NR.',5X,'FLOW AREA (SQCM)',4X,'EQUIV. DIAMETER(0000420
C *CM')/) 0000430
C WRITE(6,10)(I,AREA(I),DE(I),I=1,N) 0000440
C 10 FORMAT(7X,I3,15X,F7.5,17X,F5.3) 0000450
C RETURN 0000460
C END 0000470
```

```
SUBROUTINE CFC1 (P,D,PIG,FC1)          0000010
C -----0000020
C      COMPUTES THE VIEW FACTOR OF TYPE FC1    0000030
C                                              0000040
C      P3 = PIG/3.                            0000050
C      R  = D/2.                             0000060
C      PZD= P/D                           0000070
C                                              0000080
C      IF (PZD .GT. 1.0) GO TO 50           0000090
C      FC1=0.5                         0000100
C      GO TO 999                         0000110
C                                              0000120
C      50 A = R/(P-R)                      0000130
C      ALFA = ACOS(A)                     0000140
C      DELT = P3 - ALFA                   0000150
C      IF (ALFA .GE. P3) GO TO 100        0000160
C      AC = R*TAN(ALFA) + R*DELT         0000170
C      GO TO 200                         0000180
C      100 AC=SQRT(R**2+(P-R)**2-R*(P-R)) 0000190
C      200 AB=P-R                        0000200
C      GR=(2.*SQRT(3.)+3.)/6.            0000210
C      IF (PZD .GE. GR) GO TO 300        0000220
C      AB=(R*TAN(ALFA)+R*(PIG/6.-ALFA))*2. 0000230
C      300 DC=P-D                       0000240
C                                              0000250
C      FC1=(2*AC-AB-DC)                 0000260
C                                              0000270
C      999 RETURN                         0000280
C      END                                0000290
```

```
SUBROUTINE CFC2 (P,R,Z,ZWC,PIG,FC2)          0000010
C -----0000020
C COMPUTES THE VIEW FACTOR FOR TWO ADJACENTS WALL SECTORS. 0000030
C                                         0000040
C     CHL = ACOS(R/(P-R))          0000050
C     PHM = ATAN(P*0.5/(Z-ZWC))    0000060
C     PHL = ACOS(R/SQRT((Z-ZWC)**2+P**2/4.)) 0000070
C                                         0000080
C -- CB -----0000090
C                                         0000100
C     CB = P-2.*R          0000110
C                                         0000120
C -- AC -----0000130
C                                         0000140
C     XY=(P*0.5-R)/TAN(CHL)      0000150
C     IF (XY .LE. (Z-ZWC)) GO TO 200      0000160
C     WRITE(6,100)                  0000170
100 FORMAT ( 5X,' SUB. CFC2 ',/5X,           0000180
>' THE PRESENT COMBINATION OF P,D,Z,ZWC IS NOT PROVIDED IN THE PROG0000190
>RAM.',/5X,' YOU HAVE THE FOLLOWING POSSIBILITIES : ',/5X,      0000200
>' 1. INSERT THIS CASE IN CFC2.',/5X,      0000210
>' 2. COMPUTE FC2 BY HAND AND INTRODUCE IT IN CFC2.',//5X,      0000220
>' CALCULATION STOPS.')      0000230
      STOP                         0000240
C                                         0000250
200 AC = R*TAN(CHL)+R*(PIG/2.-CHL)          0000260
C                                         0000270
C -- AD -----0000280
C                                         0000290
      IF ((Z-R) .LT. ZWC) GO TO 300      0000300
      AD = P                         0000310
      GO TO 500                      0000320
C                                         0000330
300 AD = 2.*(SQRT((Z-ZWC)**2+P**2/4.)*SIN(PHL)+R*(PHM-PHL)) 0000340
500 CONTINUE                     0000350
C                                         0000360
C -----0000370
      FC2 = (2.*AC-CB-AD)          0000380
C                                         0000390
      RETURN                        0000400
      END                          0000410
```

```
SUBROUTINE CFC3 (P,D,PIG,FC3)          0000010
C -----0000020
C      COMPUTES THE VIEW FACTOR OF TYPE FC3   0000030
C                                              0000040
C      P3 = PIG/3.                           0000050
C      PZD= P/D                            0000060
C      R  = D/2.                           0000070
C                                              0000080
C      IF (PZD .GT. 1.000) GO TO 50        0000090
C      FC3=0.0                            0000100
C      GO TO 999                          0000110
C                                              0000120
C      50 IF (PZD .LT. 1.500) GO TO 100    0000130
C                                              0000140
C      AC=(P-R)*SQRT(3.)                  0000150
C      AD=SQRT(D**2 + 3.*P**2 - 3.*D*P)  0000160
C      AB=R                            0000170
C      FC3=(2.*AD-2.*AC)/(D*P3)          0000180
C      GO TO 999                          0000190
C                                              0000200
C      100 A= R/(P-R)                     0000210
C      ALFA=ACOS(A)                      0000220
C      DELTA= P3 - ALFA                   0000230
C      AC=2*((P-R)*SIN(ALFA) + R*DELTA)  0000240
C      AD=SQRT(D**2 + 3.*P**2 - 3.*D*P)  0000250
C      FC3=(2*AD-2*AC)                   0000260
C                                              0000270
C      999 RETURN                         0000280
C      END                                0000290
```

```
SUBROUTINE CFC4 (P,D,PIG,FC4)          0000010
C -----0000020
C      COMPUTES THE VIEW FACTOR OF TYPE FC4 0000030
C                                         0000040
C      P3 = PIG/3.                         0000050
C      R   = D/2.                          0000060
C      SQ3 = SQRT(3.)                      0000070
C      PZD=P/D                           0000080
C                                         0000090
C      A= R/(P-R)                         0000100
C      ALFA=ACOS(A)                      0000110
C      DELTA= P3 - ALFA                  0000120
C -BMD-----0000130
C      BMD=(P-R) *SIN(ALFA) + R*(P3+DELTA) 0000140
C -ALD-----0000150
C      AXKS=R/(P/2.)                      0000160
C      XKS=ACOS(AXKS)                    0000170
C      FK=P-D/4.                        0000180
C      AK=SQRT(FK**2 + (R*SQ3*0.5)**2)  0000190
C      CBETA= R/AK                      0000200
C      BETA=ACOS(CBETA)                 0000210
C      TGAM= R*SQ3*0.5/(P-D/4.)        0000220
C      GAMMA=ATAN(TGAM)                0000230
C      EPSI=2*P3-GAMMA-BETA           0000240
C      FKL=GAMMA+BETA                 0000250
C      FKS=P3+XKS                     0000260
C      ALD= R*TAN(BETA)+R*EPSI         0000270
C      IF (FKS .GE. FKL) GO TO 100     0000280
C      ALD= R*TAN(ALFA)+R*(P3-ALFA-XKS)+2.*R*TAN(XKS)+R*(EPSI+(FKL-FKS)) 0000290
100    CONTINUE                           0000300
C -BMC-----0000310
C      BMC=(P-R)*SIN(ALFA) + R*DELTA    0000320
C      IF (ALFA .GE. P3) BMC=SQRT(R**2+(P-R)**2-(P-R)*R) 0000330
C -AC  -----0000340
C      AC=P-R                           0000350
C      GR=(2.*SQRT(3.)+3.)/6.            0000360
C      IF (PZD .LT. GR) AC=2*(R*TAN(ALFA)+R*(PIG/6.-ALFA)) 0000370
C -----0000380
C      FC4=(AC + BMD - BMC - ALD)       0000390
C                                         0000400
C      IF (PZD .LE. 1.0) FC4=0.0         0000410
C                                         0000420
C      RETURN                           0000430
C      END                               0000440
```

```
SUBROUTINE CFC5 (P,D,PIG,FC5)          0000010
C -----0000020
C      COMPUTES THE VIEW FACTOR OF TYPE FC5    0000030
C                                              0000040
C      P3 = PIG/3.                            0000050
C      R  = D/2.                             0000060
C                                              0000070
C      A= R/(P-R)                           0000080
C      ALFA=ACOS(A)                         0000090
C      DELTA= P3 - ALFA                      0000100
C      B= D/P                                0000110
C      BETA=ACOS(B)                          0000120
C      EPSI=P3-BETA                         0000130
C BMD -----0000140
C      BMD=R*TAN(ALFA)+R*DELTA            0000150
C      IF ( DELTA .LE. 0) BMD=SQRT((P-R)**2+R**2-(P-R)*R) 0000160
C AC -----0000170
C      AC=BMD                            0000180
C BC -----0000190
C      BC=P-D                            0000200
C AFLD-----0000210
C      AFLD = 2.*(R*TAN(BETA)+R*EPSI)        0000220
C      IF (BETA .GE. P3) AFLD=2.*SQRT(R**2+P**2/4.-R*P*0.5) 0000230
C -----0000240
C
C      FC5=(AFLD+BC-2*BMD)                0000250
C                                              0000260
C      IF (PZD .LE. 1.0) FC4=0.0             0000270
C                                              0000280
C      RETURN                               0000290
C                                              0000300
C      END                                  0000310
```

```
SUBROUTINE CFC9 (P,D,PIG,FC9)          0000010
C -----                                     0000020
C COMPUTES THE VIEW FACTOR OF TYPE FC9    0000030
C                                         0000040
C     R=D/2.                                0000050
C     PZD=P/D                               0000060
C                                         0000070
C     BC1=2.* (P-R)*0.86603                 0000080
C     BC=BC1                                0000090
C     BKF=ACOS(R/(P-R))                     0000100
C     IF(PZD.LT.1.5) BC=D*(TAN(BKF)+(PIG/3.-BKF)) 0000110
C                                         0000120
C     AC=SQRT(BC1**2+R**2)                  0000130
C                                         0000140
C     IF(PZD.GE. 1.2) GO TO 100              0000150
C     WRITE(6,50)                           0000160
50 FORMAT(' SUB. CFC9: P/D< 1.2 ; CASE NOT PROVIDED.'/5X,
      >           ' FC9 IS SET TO 0.0. CALCULATION PROCEEDING')
      FC9=0.0                                0000170
      GO TO 9999                               0000180
100 CONTINUE                            0000190
      HX=(2.*P-R)*0.86603                  0000200
      AH=SQRT(HX**2+R**2/4.)                0000210
      AHL=ACOS(R/AH)                      0000220
      AHX=ASIN(R/2./AH)                    0000230
      DHL=PIG/2.+AHX-AHL                  0000240
      AD=R*(DHL+TAN(AHL))                0000250
C                                         0000260
      EKM=ACOS(R/(P/2.))                  0000270
      EKF=PIG*2./3.-EKM-BKF               0000280
      BD=R*(2.*TAN(EKM)+(PIG/3.-EKM)+TAN(BKF)+EKF) 0000290
C                                         0000300
      FC9=AD+BC-AC-BD                   0000310
C                                         0000320
9999 RETURN                                0000330
      END                                     0000340
                                         0000350
                                         0000360
```

SUBROUTINE CFUEL (NCA,A,B,RSTAR,H,J,XF) 0000010
C ----- 0000020
C COMPUTES THE COEFFICIENTS FOR THE EQUATIONS OF THERMAL CONDUCTION 0000030
C WITHIN THE FUEL IN CASE OF POWER GENERATED IN THE FUEL. 0000040
C 0000050
C 0000060
C DIMENSION A(13,13),B(13),XF(13) 0000070
C 0000080
COMMON /SC01C/ NCAN(19),LIPS(19,10) 0000090
COMMON /SC05C/ JZUR(19, 42) 0000100
COMMON /SC07C/ H1 0000110
COMMON /SC12C/ GEO(42,3) 0000120
COMMON /SC20C/ CGAP 0000130
COMMON /HEA5 / QQ(42,3) 0000140
COMMON /QPAR1/ QDEV 0000150
C 0000160
REAL KFUEL 0000170
C 0000180
PIG=3.141593 0000190
NCA1 = NCA+1 0000200
NCA2 = NCA*2 0000210
NCA3 = NCA*2+1 0000220
C 0000230
A(NCA3,NCA3)=0.0 0000240
C 0000250
DO 1000 K=NCA1,NCA2 0000260
C 0000270
KP=K-1 0000280
IF(K .EQ. NCA1) KP=NCA2 0000290
KD=K+1 0000300
IF(K .EQ. NCA2) KD=NCA1 0000310
KC=K-NCA 0000320
K1=KP-NCA 0000330
K2=KD-NCA 0000340
C 0000350
NS1 = LIPS(J,KC) 0000360
NSP = LIPS(J,K1) 0000370
NSD = LIPS(J,K2) 0000380
MZ1 = JZUR(J,NS1) 0000390
MZP = JZUR(J,NSP) 0000400
MZD = JZUR(J,NSD) 0000410
C 0000420
TFP = (XF(K)+XF(KP))*0.5 0000430
TFD = (XF(K)+XF(KD))*0.5 0000440
TFX = (XF(K)+XF(NCA3))*0.5 0000450
C 0000460
FKP = KFUEL(TFP)*H*0.5/(GEO(NS1,MZ1)+GEO(NSP,MZP)) 0000470
FKD = KFUEL(TFD)*H*0.5/(GEO(NS1,MZ1)+GEO(NSD,MZD)) 0000480
FKC = CGAP*RSTAR*GEO(NS1,MZ1)*H*2. 0000490
FKF = KFUEL(TFX)*H*GEO(NS1,MZ1) 0000500
B(K) = - QQ(NS1,MZ1)*QDEV*H1*(GEO(NS1,MZ1)/PIG)*0.75 0000510
C 0000520
DO 500 L=1,12 0000530
A(K,L) = 0.0 0000540
IF (L .EQ. KC) A(K,L) = FKC 0000550
IF (L .EQ. KP) A(K,L) = FKP 0000560
IF (L .EQ. K) A(K,L) = -FKD-FKP-FKC-FKF 0000570
IF (L .EQ. KD) A(K,L) = FKD 0000580
500 CONTINUE 0000590
A(K,NCA3)= FKF 0000600
A(NCA3,K)=-A(K,NCA3) 0000610

	A(NCA3,NCA3)=A(NCA3,NCA3)+A(K,NCA3)	0000620
	B(NCA3)=QQ(NS1,MZ1)*QDEV*H1*0.25	0000630
1000	CONTINUE	0000640
C		0000650
	RETURN	0000660
	END	0000670

SUBROUTINE CFUEL3 (A,B,RSTAR,H,J,XF) 0000010
C ----- 0000020
C COMPUTES THE COEFFICIENTS FOR THE EQUATIONS OF THERMAL CONDUCTION 0000030
C WITHIN THE FUEL IN CASE OF POWER GENERATED IN THE FUEL. 0000040
C HALF OF THE PIN. 0000050
C 0000060
C 0000070
C DIMENSION A(13,13),B(13),XF(13) 0000080
C 0000090
C COMMON /SC01C/ NCAN(19),LIPS(19,10) 0000100
COMMON /SC05C/ JZUR(19, 42) 0000110
COMMON /SC07C/ H1 0000120
COMMON /SC12C/ GEO(42,3) 0000130
COMMON /SC20C/ CGAP 0000140
COMMON /HEA5 / QQ(42,3) 0000150
COMMON /QPAR1/ QDEV 0000160
C 0000170
REAL KFUEL 0000180
C 0000190
PIG=3.141593 0000200
C 0000210
NS1 = LIPS(J,1) 0000220
NS2 = LIPS(J,2) 0000230
NS3 = LIPS(J,3) 0000240
MZ1 = JZUR(J,NS1) 0000250
MZ2 = JZUR(J,NS2) 0000260
MZ3 = JZUR(J,NS3) 0000270
C 0000280
TF12 = (XF(4)+XF(5))*0.5 0000290
TF23 = (XF(6)+XF(5))*0.5 0000300
TFC4 = (XF(4)+XF(7))*0.5 0000310
TFC5 = (XF(4)+XF(7))*0.5 0000320
TFC6 = (XF(4)+XF(7))*0.5 0000330
C 0000340
F12 = KFUEL(TF12)*H*0.5/(GEO(NS1,MZ1)+GEO(NS2,MZ2)) 0000350
F23 = KFUEL(TF23)*H*0.5/(GEO(NS2,MZ2)+GEO(NS3,MZ3)) 0000360
C 0000370
FGAP1 = CGAP * RSTAR * GEO(NS1,MZ1) * H * 2. 0000380
FGAP2 = CGAP * RSTAR * GEO(NS2,MZ2) * H * 2. 0000390
FGAP3 = CGAP * RSTAR * GEO(NS3,MZ3) * H * 2. 0000400
C 0000410
A(4,1) = FGAP1 0000420
A(4,4) = - FGAP1 - F12 - KFUEL(TFC4)*H*GEO(NS1,MZ1) 0000430
A(4,5) = F12 0000440
A(4,7) = KFUEL(TFC4)*H*GEO(NS1,MZ1) 0000450
C 0000460
A(5,2) = FGAP2 0000470
A(5,4) = F12 0000480
A(5,5) = - FGAP2 - F12 - F23 - KFUEL(TFC5)*H*GEO(NS2,MZ2) 0000490
A(5,6) = F23 0000500
A(5,7) = KFUEL(TFC5)*H*GEO(NS2,MZ2) 0000510
C 0000520
A(6,3) = FGAP3 0000530
A(6,5) = F23 0000540
A(6,6) = - FGAP3 - F23 - KFUEL(TFC6)*H*GEO(NS3,MZ3) 0000550
A(6,7) = KFUEL(TFC6)*H*GEO(NS3,MZ3) 0000560
C 0000570
A(7,4) = KFUEL(TFC4)*H*GEO(NS1,MZ1) 0000580
A(7,5) = KFUEL(TFC5)*H*GEO(NS2,MZ2) 0000590
A(7,6) = KFUEL(TFC6)*H*GEO(NS3,MZ3) 0000600
A(7,7) = -A(7,4)-A(7,5)-A(7,6) 0000610

C
B(4) = -QQ(NS1,MZ1) * QDEV * H1 * (GEO(NS1,MZ1)/PIG) * 0.75 0000620
B(5) = -QQ(NS2,MZ2) * QDEV * H1 * (GEO(NS2,MZ2)/PIG) * 0.75 0000630
B(6) = -QQ(NS3,MZ3) * QDEV * H1 * (GEO(NS3,MZ3)/PIG) * 0.75 0000640
B(7) = -QQ(NS1,MZ1) * QDEV * H1 * 0.25 0000650
C
RETURN 0000660
END 0000670
0000680
0000690

```

SUBROUTINE CF1(X1,X2,Y1,Y2,DP1,DP2,ITVIA,XYT,YT)          0000010
C-----0000020
C   CF1 IS USED IN THE CALCULATION OF THE AVERAGE CROSS-FLOW TEMPERA=0000030
C   TURES AND VELOCITIES0000040
C                                        0000050
C   COMMON/GAMAR/CXX0000060
C                                        0000050
C   XYT=(X1*Y1+X2*Y2)*CXX+XYT0000080
C   YT=(Y1+Y2)*CXX+YT0000090
C                                        13.03.1980000100
C   XYT=X2*Y2*CXX+XYT0000110
C   YT=Y2*CXX+YT0000120
C   RETURN0000140
C   END0000150

```

```

SUBROUTINE CF11(P,D,Z,ZWC,PIG,F11)
C -----
C   VIEW-FACTORS OF TYPE 11
C
C   AC = Z-D*0.5
C -----
HD=SQRT(P**2/4.+(Z-ZWC)**2)          0000050
EHD=ACOS(D/2./HD)                   0000060
DHF=ACOS((P/2.)/HD)                 0000070
C
AD = SQRT((Z-D/2.-ZWC)**2+(P/2.)**2) 0000080
IF (ZWC .LT. (Z-D/2.)) AD = D/2.*PIG/2.-EHD-DHF)+D/2.*TAN(EHD) 0000090
C
BD = SQRT((Z-ZWC)**2 + ((P-D)/2.)**2) 0000100
C
CHG=ACOS(D/2./Z)                   0000110
BC = D/2.*TAN(CHG)+D/2.*PIG/2.-CHG 0000120
C
F11=(BC+AD-BD-AC)                  0000130
C
RETURN                               0000140
END                                  0000150

```

```
SUBROUTINE CF12(P,D,Z,ZWC,PIG,F12)          0000010
C -----                                     0000010
C   VIEW-FACTORS OF TYPE 12                  0000020
C                                         0000030
C   AD = SQRT(((P-D)/2.)**2+(Z-ZWC)**2)      0000040
C -----                                     0000050
C   HD=SQRT(P**2/4.+ (Z-ZWC)**2)             0000060
C   EHD=ACOS(D/2./HD)                       0000070
C   DHF=ASIN((P/2.)/HD)                      0000080
C                                         0000090
C   BD = SQRT((Z-D/2.-ZWC)**2+(P/2.)**2)     0000100
C   IF (ZWC .GT. (Z-D/2.)) BD = D/2.* (PIG/2.-EHD-DHF)+D/2.*TAN(EHD) 0000110
C -----                                     0000120
C   BC = SQRT((Z-D/2.)**2+P**2)              0000130
C   IF((Z-D/2.)/2.) .LT. ZWC BC=SQRT((P/2.)**2+ZWC**2)+BD        0000140
C -----                                     0000150
C   ACL=ATAN((P-D/2.)/Z)                     0000160
C   GCL=ASIN(D/2./Z)                         0000170
C   ALM=ACOS(D/2./(P-D/2.))                   0000180
C   CLG=PIG/2.-GCL                           0000190
C                                         0000200
C   AC = SQRT(Z**2+(P-D/2.)**2)              0000210
C   IF (GCL .GT. ACL)                         0000220
C   >AC = D/2.*TAN(CLG)+D/2.*TAN(ALM)+D/2.* (PIG/2.-CLG-ALM)       0000230
C -----                                     0000240
C   F12=(BC+AD-BD-AC)                        0000250
C                                         0000260
C   RETURN                                     0000270
C   END                                       0000280
C                                         0000290
```

```
SUBROUTINE CF13(P,D,Z,ZWC,PIG,F13)          0000010
C -----                                     0000010
C   VIEW-FACTORS OF TYPE 13                  0000020
C                                         0000030
C                                         0000040
C   BHE=ACOS(D/2./(P-D/2.))                 0000050
C   HCB=ATAN((P-D/2.)/2)                     0000060
C   HCF=ASIN(D/2./Z)                         0000070
C                                         0000080
C   BC = SQRT(Z**2+(P-D/2.)**2)              0000090
C   IF (HCF .GT. HCB)                         0000100
C   >BC = D/2.*(TAN(BHE)+TAN(PIG/2.-HCF)+(HCF-BHE)) 0000110
C -----                                     0000120
C   HD=SQRT(P**2/4.+ (Z-ZWC)**2)             0000130
C   DHL=ACOS(D/2./HD)                         0000140
C   DHM=ACOS((P/2.)/HD)                       0000150
C                                         0000160
C   GD = SQRT((Z-D/2.-ZWC)**2+(P/2.)**2)     0000170
C   IF (ZWC .LT. (Z-D/2.)) GD = D/2.* (PIG/2.-DHL-DHM)+D/2.*TAN(DHL) 0000180
C                                         0000190
C   AC = SQRT((Z-D/2.)**2+P**2)               0000200
C   IF ((Z-D/2.)*0.5) .LT. ZWC                0000210
C   >AC = SQRT((P/2.)**2+ZWC**2)+GD           0000220
C -----                                     0000230
C   AD = 3.*GD                               0000240
C   IF(ZWC .LT. (Z-D/2.)) AD=SQRT((Z-D/2.-ZWC)**2+(P*1.5)**2) 0000250
C -----                                     0000260
C   BD = D/2.*(TAN(BHE)+(PIG/2.-BHE))+GD    0000270
C   IF(ZWC .LT. (Z-D/2.))                      0000280
C   >BD = D/2.*TAN(BHE)+HD*SIN(DHL)+D/2.* (PIG-BHE-DHL-DHM) 0000290
C -----                                     0000300
C   F13=(BC+AD-BD-AC)                        0000310
C                                         0000320
C                                         0000330
C   RETURN                                     0000340
C   END                                       0000350
```

```
SUBROUTINE CF14(P,D,Z,ZWC,PIG,F14)          0000010
C -----                                     0000010
C   VIEW-FACTORS OF TYPE 14                  0000020
C                                         0000030
C                                         0000040
C   AC = Z-D/2.                             0000050
C -----                                     0000060
C   EHD=ACOS(D/2./Z)                         0000070
C                                         0000080
C   AD = SQRT((D/2.)**2+Z**2-D/2.*Z)         0000090
C   IF (Z .LT. D) AD = D/2.*TAN(EHD)+D/2.* (PIG/3.-EHD) 0000100
C -----                                     0000110
C   F14=2.* (AD-AC)                          0000120
C                                         0000130
C                                         0000140
C   RETURN                                     0000150
C   END                                       0000160
```

```
SUBROUTINE CF15(P,D,Z,ZWC,PIG,F15)          0000010
C -----                                     0000010
C   VIEW-FACTORS OF TYPE 15                  0000020
C                                               0000030
C                                               0000040
C -----                                     0000050
C   CEG=ACOS(D/2./Z)                         0000060
C   AEL=ACOS(D/2./(P-D/2.))                   0000070
C   AC = D/2.*(TAN(CEG)+TAN(AEL)+(PIG*5./6.-AEL-CEG)) 0000080
C -----                                     0000090
C   XB=D/4.                                    0000100
C   XY=P*SQRT(3.)/2.-D/2.*SQRT(3.)/2.        0000110
C   ECB=ATAN((P/2.+XB)/(Z+XY))               0000120
C   ECG=PIG/2.-CEG                           0000130
C   BEY=ATAN(XY/(P/2.+XB))                  0000140
C   BEF=ACOS(D/2./SQRT(XY**2+(P/2+XB)**2)) 0000150
C   BC = SQRT((P/2.+XB)**2+(Z+XY)**2)       0000160
C   IF (ECG .GT. ECB)                         0000170
C   >BC = D/2.*(TAN(CEG)+TAN(BEF)+(PIG/2.-CEG-BEF+BEY)) 0000180
C -----                                     0000190
C   F15= (BC-AC)                            0000200
C                                               0000210
C                                               0000220
C   RETURN                                 0000230
C   END                                   0000240
```

```
SUBROUTINE CF16(P,D,Z,ZWC,PIG,F16)          0000010
C -----                                     0000010
C   VIEW-FACTORS OF TYPE 16                  0000020
C                                               0000030
C                                               0000040
C -----                                     0000050
C   BC = Z-D/2.                            0000060
C -----                                     0000070
C   HD=SQRT(P**2/4.+(Z-ZWC)**2)             0000080
C   EHD=ACOS(D/2./HD)                      0000090
C   DHF=ACOS((P/2.)/HD)                    0000100
C -----                                     0000110
C   BD = SQRT((Z-D/2.-ZWC)**2+(P/2.)**2)   0000120
C   IF (ZWC .LT. (Z-D/2.)) BD = D/2.* (PIG/2.-EHD-DHF)+D/2.*TAN(EHD) 0000130
C -----                                     0000140
C   AD = PIG*D/4.+BD                       0000150
C   IF (ZWC .LT. (Z-D/2.)) AD=D/2.*TAN(EHD)+D/2.* (PIG-EHD-DHF) 0000160
C -----                                     0000170
C   CHG=ACOS(D/2./Z)                      0000180
C   AC = D/2.*TAN(CHG)+D/2.* (PIG/2.-CHG) 0000190
C -----                                     0000200
C   F16=(BC+AD-BD-AC)                     0000210
C                                               0000220
C   RETURN                                 0000230
C   END                                   0000240
```

```
SUBROUTINE CF17(P,D,Z,ZWC,PIG,F17)          0000010
C -----                                     0000010
C   VIEW-FACTORS OF TYPE 17                  0000020
C                                             0000030
C   BC = Z-D/2.                             0000040
C -----                                     0000050
C   EHA=ACOS(D/2./Z)                      0000060
C                                             0000070
C   AC = SQRT((D/2.)**2+Z**2-D/2.*Z)       0000080
C   IF (Z.LT. D) AC = D/2.*TAN(EHA)+D/2.*(PIG/3.-EHA) 0000090
C -----                                     0000100
C   CHG=ACOS(D/2./Z)                      0000110
C   BD = D/2.*TAN(CHG)+D/2.*(PIG/2.-CHG)    0000120
C -----                                     0000130
C   AD = PIG*D/4.+AC                      0000140
C   IF( Z .GT. D) AD=D/2.*TAN(EHA)+D/2.*(PIG*5./6.-EHA) 0000150
C -----                                     0000160
C   F17=(BC+AD-BD-AC)                     0000170
C                                             0000180
C                                             0000190
C                                             0000200
C   RETURN                                0000210
C   END                                    0000220
```

```
SUBROUTINE CF18(P,D,Z,ZWC,PIG,F18)          0000010
C -----                                     0000010
C   VIEW-FACTORS OF TYPE 18                  0000020
C                                           0000030
C                                           0000040
C -----                                     0000050
C   FHA=ACOS(D/2./Z)                         0000060
C   AG = SQRT((D/2.)**2+Z**2-D/2.*Z)          0000070
C   IF (Z.LT. D) AG = D/2.*TAN(FHA)+D/2.*(PIG/3.-FHA) 0000080
C   CHL=ACOS(D/2./(P-D/2.))                   0000090
C                                           0000100
C   AC = D/2.*(TAN(CHL)+(PIG/2.-CHL))+AG      0000110
C -----                                     0000120
C   HE=SQRT(P**2/4.+ (Z-ZWC)**2)              0000130
C   EHM=ACOS(D/2./HE)                         0000140
C   EHC=ACOS(P/2./HE)                         0000150
C   EG=SQRT((Z-ZWC-D/2.)**2+(P/2.)**2)        0000160
C   IF (ZWC.GT. (Z-D/2.)) EG=D/2.*(TAN(EHM)+(PIG/2.-EHM-EHC)) 0000170
C -----                                     0000180
C   BD = SQRT((Z-D/2.)**2+P**2)               0000190
C   IF (((Z-D/2.)*0.5) .LT. ZWC) BD = SQRT((P/2.)**2+ZWC**2) + EG 0000200
C -----                                     0000210
C   CBH=ATAN((P-D/2.)/Z)                      0000220
C   HBN=ASIN(D/2./Z)                          0000230
C -----                                     0000240
C   BC = SQRT(Z**2+(P-D/2.)**2)               0000250
C   IF (CBH .LT. HBN) BC = D/2.*(COTAN(HBN)+TAN(CHL)+(HBN-CHL)) 0000260
C -----                                     0000270
C   AD = AG+2.*EG                            0000280
C   IF (Z.GT. D) WRITE(6,100)                  0000290
100 FORMAT(' CASE NOT PREVIDED IN CF18. F18 ARE ERRATED.') 0000300
C -----                                     0000310
C   F18=(BC+AD-BD-AC)                        0000320
C -----                                     0000330
C -----                                     0000340
C   RETURN                                    0000350
END                                         0000360
```

```
SUBROUTINE CF24(P,D,Z,ZWC,PIG,F24)          0000010
C ----- 0000010
C   VIEW-FACTORS OF TYPE 24                   0000020
C                                               0000030
C                                               0000040
C   BC = Z-D/2.                               0000050
C ----- 0000060
C   EHC=ACOS(D/2./Z)                         0000070
C                                               0000080
C   AC = SQRT((D/2.)**2+Z**2-D/2.*Z)          0000090
C   IF (Z.LT. D) AC = D/2.*TAN(EHC)+D/2.* (PIG/3.-EHC) 0000100
C ----- 0000110
C   HD=SQRT(P**2/4.+(Z-ZWC)**2)                0000120
C   GHD=ACOS(D/2./HD)                          0000130
C   DHF=ACOS((P/2.)/HD)                        0000140
C                                               0000150
C   BD = SQRT((Z-D/2.-ZWC)**2+(P/2.)**2)       0000160
C   IF (ZWC .LT. (Z-D/2.)) BD = D/2.* (PIG/2.-GHD-DHF)+D/2.*TAN(GHD) 0000170
C ----- 0000180
C   AD = PIG*D/6.+ BD                           0000190
C   AD=D/2.*TAN(GHD)+D/2.* (PIG*5./6.-GHD-DHF) 0000200
C ----- 0000210
C   F24= BC+AD-BD-AC                           0000220
C                                               0000230
C                                               0000240
C   RETURN                                     0000250
C   END                                         0000260
```

```
SUBROUTINE CF31(P,D,Z,ZWC,PIG,F31)          0000010
C -----                                     0000010
C   VIEW-FACTORS OF TYPE 31                  0000020
C   BD = SQRT(P**2/4.+ZWC**2)                0000030
C -----                                     0000040
C   AC = Z                                    0000050
C -----                                     0000060
C   HD=SQRT(P**2/4.+(Z-ZWC)**2)              0000070
C   EHD=ACOS(D/2./HD)                        0000080
C   FHD=ASIN((P/2.)/HD)                      0000090
C -----                                     0000100
C   GD = SQRT((Z-D/2.-ZWC)**2+(P/2.)**2)    0000110
C   IF (ZWC .GT. (Z-D/2.)) GD = D/2.* (FHD-EHD)+D/2.*TAN(EHD) 0000120
C -----                                     0000130
C   AHL=ACOS(D/2./Z)                         0000140
C   AM=Z*0.866                                0000150
C   AG=SQRT(AM**2+(D/2.-Z/2.)**2)            0000160
C   IF(Z/2. .LT. D/2.) AG=D/2.* (TAN(AHL)+(PIG/3.-AHL))      0000170
C -----                                     0000180
C   AD=AG+GD                                  0000190
C -----                                     0000200
C   PN=P/2.+Z*0.866                           0000210
C   BS=ZWC+P/2.*PN*(Z/2.-ZWC)                 0000220
C   IF(BS.LT.(Z-D/2.)) AD=SQRT(PN**2+(Z/2.-ZWC)**2)          0000230
C -----                                     0000240
C   F31=(AC+BD-AD)                           0000250
C -----                                     0000260
C   RETURN                                   0000270
C   END                                     0000280
C                                         0000290
C                                         0000300
C                                         0000310
```

```
SUBROUTINE CF32(P,D,Z,ZWC,PIG,F32)          0000010
C -----                                     0000010
C   VIEW-FACTORS OF TYPE 32                  0000020
C   -----                                     0000030
C   -----                                     0000040
C   -----                                     0000050
C   HD=SQRT(P**2/4.+(Z-ZWC)**2)              0000060
C   EHD=ACOS(D/2./HD)                        0000070
C   DHF=ACOS((P/2.)/HD)                      0000080
C -----                                     0000090
C   AD = P                                    0000100
C   IF (ZWC .GT. (Z-D/2.)) AD= D *(PIG/2.-EHD-DHF)+D*TAN(EHD) 0000110
C -----                                     0000120
C   AC = SQRT(P**2/4.+ZWC**2)                0000130
C -----                                     0000140
C   F32=(2*AC-AD)                           0000150
C -----                                     0000160
C   RETURN                                   0000170
C   END                                     0000180
C                                         0000190
```

SUBROUTINE CONNIJ(NSTR,NSTOT,NROMA,NSEL)	0000010
C-----	0000010
C CONNIJ EVALUATES FOR EACH CHANNEL I THE NUMBER NER(I) OF	0000020
C INTERACTIONS WITH OTHER CHANNELS J AND WHICH CHANNELS INTERACT	0000030
C WITH I.	0000040
C-----	0000050
COMMON/IND1/NROW(42),NUMS(42)/IND2/NOT(4,30)/IND3/NTYP(42)	0000060
1 /IND4/NUM3(4),NUM6(4),NUM12(4),NUM18(4),NUM24(4),NUM30(4),	0000070
2 NUM36(4)/IJ1/NER(42),NIS(42,3)	0000080
IF(NSEL.EQ.4)GOTO 99	0000090
NAN=NROMA+2	0000100
NBN=1	0000110
NCN=-1	0000120
DO 43 NS=1,NSTOT	0000130
NRO=NROW(NS)	0000140
NUM=NUMS(NS)	0000150
NUMA3=NUM3(NRO)	0000160
NUMA6=NUM6(NRO)	0000170
NUMA12=NUM12(NRO)	0000180
NUMA18=NUM18(NRO)	0000190
NUMA24=NUM24(NRO)	0000200
NUMA30=NUM30(NRO)	0000210
NUMA36=NUM36(NRO)	0000220
IF(NS.GT.NSTR)GOTO 29	0000230
IF(NUM.GT.1)GOTO 5	0000240
IF(NSEL-2)1,2,4	0000250
1 NER(NS)=3	0000260
NIS(NS,3)=NOT(NRO,NUMA36)	0000270
GOTO 3	0000280
2 NER(NS)=2	0000290
3 NIS(NS,1)=NS+1	0000300
GOTO 13	0000310
4 IF(NRO.GT.1)GOTO 2	0000320
NER(1)=1	0000330
NIS(1,1)=3	0000340
GOTO 43	0000350
5 IF(NSEL-2)6,7,8	0000360
6 NUMSP=NUMA36	0000370
GOTO 9	0000380
7 NUMSP=NUMA18	0000390
GOTO 9	0000400
8 NUMSP=NUMA3	0000410
9 IF(NUM.EQ.NUMSP)GOTO 10	0000420
NER(NS)=3	0000430
NIS(NS,3)=NS+1	0000440
GOTO 12	0000450
10 IF(NSEL.EQ.1)GOTO 11	0000460
NER(NS)=2	0000470
GOTO 12	0000480
11 NER(NS)=3	0000490
NIS(NS,3)=NOT(NRO,1)	0000500
12 NIS(NS,1)=NS-1	0000510
13 IF(NUM.GT.NUMA6)GOTO 14	0000520
NAM=NUM	0000530
GOTO 19	0000540
14 IF(NUM.GT.NUMA12)GOTO 15	0000550
NAM=NUM-NUMA6	0000560
GOTO 19	0000570
15 IF(NUM.GT.NUMA18)GOTO 16	0000580
NAM=NUM-NUMA12	0000590
GOTO 19	0000600
	0000610

16 IF(NUM.GT.NUMA24)GOTO 17	0000620
NAM=NUM-NUMA18	0000630
GOTO 19	0000640
17 IF(NUM.GT.NUMA30)GOTO 18	0000650
NAM=NUM-NUMA24	0000660
GOTO 19	0000670
18 NAM=NUM-NUMA30	0000680
19 IF(NAM.EQ.(NAM/2*2))GOTO 21	0000690
I1=1	0000700
IF(NRO.EQ.NROMA)GOTO 20	0000710
I2=1	0000720
I3=0	0000730
GOTO 22	0000740
20 I2=2	0000750
I3=1	0000760
GOTO 22	0000770
21 I1=-1	0000780
I2=1	0000790
I3=0	0000800
22 NRO1=NRO+I1	0000810
IF(NUM.GT.NUMA6)GOTO 23	0000820
NUMA=(NUM+I1)/I2+I3	0000830
GOTO 28	0000840
23 IF(NUM.GT.NUMA12)GOTO 24	0000850
NUMA=(NUM+I1-NUMA6)/I2 +NUM6(NRO1)	0000860
GOTO 28	0000870
24 IF(NUM.GT.NUMA18)GOTO 25	0000880
NUMA=(NUM+I1-NUMA12)/I2 +NUM12(NRO1)	0000890
GOTO 28	0000900
25 IF(NUM.GT.NUMA24)GOTO 26	0000910
NUMA=(NUM+I1-NUMA18)/I2 +NUM18(NRO1)	0000920
GOTO 28	0000930
26 IF(NUM.GT.NUMA30)GOTO 27	0000940
NUMA=(NUM+I1-NUMA24)/I2 +NUM24(NRO1)	0000950
GOTO 28	0000960
27 NUMA=(NUM+I1-NUMA30)/I2 +NUM30(NRO1)	0000970
28 NIS(NS,2)=NOT(NRO1,NUMA)	0000980
GOTO 43	0000990
29 IF(NUM.GT.1)GOTO 32	0001000
IF(NSEL.EQ.1)GOTO 30	0001010
NER(NS)=1	0001020
GOTO 31	0001030
30 NER(NS)=2	0001040
NIS(NS,2)=NSTOT	0001050
31 NIS(NS,1)=NS+1	0001060
GOTO 43	0001070
32 IF(NSEL-2)33,34,40	0001080
33 NUMSP=NUMA36	0001090
GOTO 35	0001100
34 NUMSP=NUMA18	0001110
35 IF(NUM.EQ.NUMSP)GOTO 37	0001120
NIS(NS,1)=NS+1	0001130
NIS(NS,2)=NS-1	0001140
IF(NUM.EQ.NAN)GOTO 36	0001150
NER(NS)=3	0001160
NUMA=(NUM-NBN)*2+NCN	0001170
NIS(NS,3)=NOT(NRO-1,NUMA)	0001180
GOTO 43	0001190
36 NER(NS)=2	0001200
NAN=NAN+NRO	0001210
NBN=NBN+NRO	0001220
NCN=NCN+2*NROMA-1	0001230
GOTO 43	0001240
37 IF(NSEL.EQ.1)GOTO 38	0001250
NER(NS)=1	0001260
GOTO 39	0001270

```
38 NER(NS)=3 0001320
  NIS(NS,2)=NOT(NR0,1) 0001330
  NIS(NS,3)=NIS(NS,2)-1 0001340
39 NIS(NS,1)=NS-1 0001360
  GOTO 43 0001370
40 IF(NUM.EQ.NUMA3)GOTO 41 0001380
  NER(NS)=3 0001390
  NIS(NS,3)=NS+1 0001400
  GOTO 42 0001410
41 NER(NS)=2 0001420
42 NIS(NS,1)=NS-1 0001430
  NUMA=(NUM-1)*2-1 0001440
  NIS(NS,2)=NOT(NR0-1,NUMA) 0001450
43 CONTINUE 0001460
99 CONTINUE 0001470
  DO 100 NS=1,NSTOT 0001480
  NI=NER(NS) 0001490
  WRITE(6,200)NS,NTYP(NS),(NIS(NS,M),M=1,NI) 0001500
200 FORMAT(5X,'NS=',I2,5X,'TYPE=',I1,5X,'CHANNELS CONNECTED:',3I5) 0001510
100 CONTINUE 0001520
  RETURN 0001530
END 0001540
```

```
SUBROUTINE CONSHR 0000010
C----- 0000010
C THERMAL CONDUCTION WITHIN THE SHROUD 0000020
C----- 0000030
C DIMENSION A( 34, 34),B( 34),X( 34) 0000040
C COMMON /SC22C/ NTOT 0000050
C----- 0000060
C DETERMINES THE ARRAY OF COEFFICIENTS. 0000070
C CALL MATBUS(A,B) 0000080
C----- 0000090
C SOLVES THE SYSTEM 0000100
C CALL GAUSS(A,B,X) 0000110
C----- 0000120
C ASSIGNE THE COMPUTED VALUES TO THE SHROUD TEMPERATURES 0000130
C CALL TNEWS(X) 0000140
C----- 0000150
C COMPUTES THE HEAT TRANSMITTED TO THE GAS 0000160
C CALL QDEFIS 0000170
C----- 0000180
C RETURN 0000190
END 0000200
0000210
```

```
SUBROUTINE CONTRO(FA,FA1,ITCORR,INDICE) 0000010
C----- 0000010
C PRINTS INFORMATIONS ON THE CONVERGENCE PROCESS. 0000020
C----- 0000030
C DELTA=ABS(FA/FA1-1.0) 0000040
C----- 0000050
C WRITE(6,1001) ITCORR,FA,FA1,DELTA,INDICE 0000060
C----- 0000070
C RETURN 0000080
1001 FORMAT(5X,'CONTRO, ITCORR =',I3,' LAM = ',E12.6,' LAM1 = ',E12.6, 0000090
>      ' DELTA=',E12.6,' INDICE=',I3) 0000100
END 0000110
```

SUBROUTINE CORKA 0000010
C----- 0000010
C CORKA MODIFIES THE COMPUTED LAMINAR FRICTION FACTOR IF WALL AND 0000020 0000030
C CORNER CHANNELS ARE COMPUTED TOGETHER. 0000040
C (CASE OF JLAM=1) 0000050
C 0000060
COMMON /GEN2/ A(42) 0000070
COMMON /GEN5/ DE(42) 0000080
COMMON /INPAR/ IPA 0000090
COMMON /LAMINK/ BKAPPA(7,3) 0000100
COMMON /LAMIN1/ AKAPPA(42) 0000110
COMMON /LAMIN2/ FATIP(3),FDTIP(3) 0000120
COMMON /IND3/ NTYP(42) 0000130
COMMON /IJ1 / NER(42),NIS(42,3) 0000140
COMMON /GASD1/ NSTOT 0000150
COMMON /MART2/ NS1,NS2 0000160
COMMON /SC03C/ NRODS 0000170
C 0000180
IF (NRODS .NE. 7) GO TO 50 0000190
NS1=7 0000200
NS2= 18 0000210
GO TO 9999 0000220
C 0000230
50 DO 1000 NS=1,NSTOT 0000240
ITYP=NTYP(NS) 0000250
IF(ITYP .NE. 3) GO TO 1000 0000260
C 0000270
PP = A(NS)*FATIP(ITYP)*(DE(NS)*FDTIP(ITYP))**2/BKAPPA(IPA,1) 0000280
AT = A(NS)*FATIP(ITYP) 0000290
C 0000300
NR = NER(NS) 0000310
DO 100 M=1, NR 0000320
NA=NIS(NS,M) 0000330
IYP=NTYP(NA) 0000340
PP=PP+A(NA)*FATIP(IYP)*(DE(NA)*FDTIP(IYP))**2/BKAPPA(IPA,2) 0000350
AT=AT+A(NA)*FATIP(IYP) 0000360
100 CONTINUE 0000370
C 0000380
PP=AT/PP 0000390
AKAPPA(NS)=(DE(NS)*FDTIP(ITYP))**2*PP 0000400
C 0000410
DO 500 M=1, NR 0000420
NA=NIS(NS,M) 0000430
IP=NTYP(NA) 0000440
AKAPPA(IP)=(DE(IP)*FDTIP(IP))**2*PP 0000450
500 CONTINUE 0000460
1000 CONTINUE 0000470
C 0000480
9999 RETURN 0000490
END 0000500

SUBROUTINE CORRTE(TW,TB,PB, NS,M,I,BIOT,TWINF)	0000010 0000010 ----- 0000020
C-----	
C CORRTE CORRECTS THE COMPUTED TEMPERATURES FOR THE BIOT EFFECT AND	0000030
C THE POSITION OF THE THERMOCOUPLE INSIDE THE CANNING	0000040
C	0000050
COMMON /CEV03/ LAMOP2	0000060
COMMON /CEV04/ LAMOP3	0000070
COMMON /IROS/ IRH	0000080
COMMON /BIDE/ IBIDE	0000090
COMMON /CORRE/ QHRDAR,QRMDAR,QLAMR	0000100
COMMON /LAMIN0/ I2TIP(42,3)	0000110
C	0000120
REAL KMET,KINF,KAPPA	0000130
C	0000140
TWINF=TW	0000150
IF(IRH.EQ.1) GO TO 100	0000190
IF(LAMOP3 .EQ. 1 .AND. LAMOP2 .EQ. 2) GO TO 100	0000200
C	0000210
C ONLY FOR ROUGHENED RODS	0000220
C IF(I2TIP(NS,M).NE.1)GOTO 9	0000230
C	0000240
C FOR ROUGHENED RODS AND LAMINAR FLOW	0000250
C	0000260
TW=TW+QLAMR/KAPPA(PB,TW)	0000270
GOTO 100	0000280
C	0000290
C FOR ROUGHENED RODS AND TURBULENT FLOW	0000300
C	0000310
9 TWBI=TWINF	0000320
DTWINF=TW-TB	0000330
DO 10 IT=1,10	0000340
TWP=TW	0000350
IF(IBIDE.EQ.1)TWBI=TW	0000360
BIOT=QHRDAR/((TWBI -TB) *KMET(TWBI))	0000370
TW=DTWINF/KINF(BIOT)+TB	0000380
IF(ABS(TWP/TW-1.).LE.1.E-04)GOTO 13	0000390
10 CONTINUE	0000400
WRITE(6,12)NS,M,I,BIOT,TWP,TW	0000410
12 FORMAT(1H1,5X,'CALCULATION STOPS IN SUBROUTINE CORRTE: NS=',I5, *=' ,I2,' I=' ,I3/5X,'BIOT=' ,E15.5,5X,'TWP=' ,E15.5,5X,'TW=' ,E15.5) STOP	0000420 0000430 0000440
C	0000450
13 IF(QRMDAR.LE.1.E-06)TW=DTWINF/EINF(BIOT)+TB	0000460
C	0000470
C FOR SMOOTH AND ROUGHENED RODS, TURBULENT AND LAMINAR FLOW	0000480
C	0000490
100 TW=TWCTEP(QRMDAR,TW)	0000500
RETURN	0000510
END	0000520

FUNCTION CP(P,T)	0000010
C-----	0000010
C FUNCTION CP EVALUATES THE SPECIFIC HEAT OF THE COOLANT (CAL/G K)	0000020
C	0000030
COMMON/GASD4/IGAS	0000040
GOTO(10,20,30,40),IGAS	0000050
10 CONTINUE	0000060
C CASE OF HELIUM COOLANT	0000070
C	0000080
CP=1.242	0000090
RETURN	0000100
C	0000110
20 CONTINUE	0000120
C CASE OF CO2 COOLANT	0000130
C	0000140
PP=P	0000150
TT=T	0000160
P=PP/1.0333	0000170
T=TT+273.16	0000180
TO=273.16	0000190
TF=TO/T	0000200
IF(P-1.) 1,1,2	0000210
1 ECP = P -1.	0000220
GO TO 3	0000230
2 ECP = (P -1.)**1.05	0000240
3 CPO=.118+3.51E-4*T-2.34E-7*T*T+6.00E-11*T*T*T	0000250
CPF = CPO*(1.+1.089E-2*ECP*(TF**3.35))	0000260
CP=CPF	0000270
T=TT	0000280
P=PP	0000290
RETURN	0000300
C	0000310
30 CONTINUE	0000320
C CASE OF N2 COOLANT	0000330
C	0000340
TT=T	0000350
T=TT+273.16	0000360
CPO=.2579-7.425E-5*T+1.604E-7*T*T-6.483E-11*T**3	0000370
CP=CPO*(1.+1.886E-3*(P/1.033-1.)*(273.16/T)**2.4)	0000380
T=TT	0000390
RETURN	0000400
40 CONTINUE	0000410
CP=0.	0000420
RETURN	0000430
END	0000440
	0000450

```
SUBROUTINE CRFL1(ITGL,DPJAV,FREL,AJT,JMAX,AJ,MJ,DPJ,WCFJ,WCF1J,  
*EP1J) 0000010  
0000010  
0000020  
-----  
C----- 0000030  
C CRFL1 EVALUATES THE CROSS FLOW SOLUTIONS 0000040  
C----- 0000050  
C REAL MJ 0000060  
C DIMENSION AJ(JMAX),MJ(JMAX),DPJ(JMAX),WCFJ(JMAX),WCF1J(JMAX), 0000070  
*EP1J(JMAX) 0000080  
C IF(ITGL-2)1,3,5 0000090  
C ..... 0000100  
C FIRST ITERATION : ASSUMED WCFJ(J)=0 0000110  
C----- 0000120  
C 1 CONTINUE 0000130  
DO 2 J=1,JMAX 0000140  
WCFJ(J)=0. 0000150  
2 WCF1J(J)=0. 0000160  
RETURN 0000170  
C----- 0000180  
C SECOND ITERATION : ASSUMED WCFJ(J)=-0.5*(DPJ(J)-DPJ AV)* 0000190  
C MJ(J)/DPJ(J) 0000200  
C----- 0000210  
C 3 CONTINUE 0000220  
WCFJT=0. 0000230  
DO 4 J=1,JMAX 0000240  
EP1J(J)=DPJ(J)-DPJAV 0000250  
WCFJ(J)=-0.5*EP1J(J)*MJ(J)/DPJ(J) 0000260  
4 WCFJT=WCFJT+WCFJ(J) 0000270  
GOTO 7 0000280  
5 CONTINUE 0000290  
C----- 0000300  
C ITGL>2: WCFJ(J) ARE OBTAINED BY USE OF THE TANGENT METHOD 0000310  
C----- 0000320  
C WCFJT=0. 0000330  
DO 6 J=1,JMAX 0000340  
EPJ=DPJ(J)-DPJAV 0000350  
IF(ABS(EP1J(J)-EPJ).LT.1.E-20)GOTO 6 0000360  
WCFJP=WCFJ(J) 0000370  
WCFJ(J)=WCFJP-FREL*EPJ*(WCFJP-WCF1J(J))/(EPJ-EP1J(J)) 0000380  
WCF1J(J)=WCFJP 0000390  
EP1J(J)=EPJ 0000400  
6 WCFJT=WCFJT+WCFJ(J) 0000410  
7 CONTINUE 0000420  
C----- 0000430  
C NORMALIZATION OF THE WCF(J): THEIR SUMMATION MUST BE =0 0000440  
C----- 0000450  
C WCFJT=WCFJT/AJT 0000460  
DO 8 J=1,JMAX 0000470  
8 WCFJ(J)=WCFJ(J)-WCFJT*AJ(J) 0000480  
RETURN 0000490  
END 0000500
```

```
FUNCTION CSFUN(IRH,REAI,SQ8LIA,SQ8LIB,GA)          0000010
C-----                                         0000010
C-----                                         0000020
C   CSFUN COMPUTES THE FACTOR CS=AS/2.5 FOR THE VELOCITY PROFILE 0000030
C   IN THE ZONES OUTSIDE THE TAU=0 LINE (IN THE CASE OF SMOOTH 0000040
C   RODS CSFUN=1)                                         0000050
C                                         0000060
C
COMMON/COLAM2/COLAMA                           0000070
IF(IRH.EQ.2)GOTO 1                           0000080
CSFUN=1.                                         0000090
RETURN                                         0000100
1 PROV=SQRT(1.056+0.005*(SQ8LIA/SQ8LIB)**2)      0000110
SQ8LIA=ABS(SQ8LIA)                           0000120
SQ8LIA=(2.5*ALOG(REAI/(SQ8LIA*PROV))+5.5*COLAMA-5.699) /PROV 0000130
SQ8LIA=ABS(SQ8LIA)                           0000140
CSFUN=(SQ8LIA-5.5*COLAMA)/(2.5*ALOG(REAI/SQ8LIA)-GA) 0000150
RETURN                                         0000160
END                                         0000170
```

FUNCTION DAREA(L)	0000010
C -----	0000010
C DAREA = 2 * AREA OF THE SECTOR L.	0000020
C	0000030
COMMON /SCO1R/ NSECT,NSECP	0000040
COMMON /SCO6R/ ISU(132,2)	0000050
COMMON /HEA6/ NPIN(42),JPIN(42,3)	0000060
COMMON /SCO2R/ P,D,Z,ZWC,H,LENGTH	0000070
COMMON /DAT/ PIG	0000080
COMMON /IND3/ NTYP(42)	0000090
C	0000100
NS=ISU(L,1)	0000110
NTY=NTYP(NS)	0000120
IF(L.GT.NSECP) GO TO 500	0000130
GO TO (100,200,100),NTY	0000180
100 DAREA =PIG*D/3.0	0000190
GO TO 1000	0000200
200 DAREA =PIG*D*0.5	0000210
GO TO 1000	0000220
C	0000230
500 GO TO (600,700,800),NTY	0000240
600 WRITE(6,610)	0000250
610 FORMAT(' ERROR IN DAREA ')	0000260
DAREA =1.	0000270
GO TO 1000	0000280
700 DAREA =PSTAR(ZWC,P)	0000290
GO TO 1000	0000300
800 DAREA =4.*Z/SQRT(3.)	0000310
C	0000320
1000 IF(DAREA.GT. 1.0E-06) GO TO 9999	0000330
WRITE(6,1100) L,PIG,Z,ZWC,P,D,NTY,DAREA	0000340
1100 FORMAT(' DAREA, DAREA LESSER THAN 0.0 FOR L = ',I4,/,	0000350
> 5X,' PIG = ',E12.6,/,	0000360
> 5X,' Z = ',E12.6,/,	0000370
> 5X,' ZWC = ',E12.6,/,	0000380
> 5X,' P = ',E12.6,/,	0000390
> 5X,' D = ',E12.6,/,	0000400
> 5X,' NTY = ',I2,/,	0000410
> 5X,' DAREA = ',E12.6,/,	0000420
> ' CALCULATION STOPS.'	0000430
STOP	0000440
C	0000450
9999 RETURN	0000460
END	0000470
	0000480

SUBROUTINE DDONNE(TWO,TBT,GHPL,RODR2,R1DR2,YDH,R2MR0H,FF,T2,T1,TE)0000010
C-----0000020
C DDONNE EVALUATES THE TEMPERATURES T1 AND T2 OF THE TWO REGIONS OF 0000030
C CORNER CHANNELS AND OF THE 'WALL PART' OF WALL SUBCHANNELS 0000040
C 0000050
RODR22=RODR2**2 0000060
R1DR22=R1DR2**2 0000070
F1=1.-RODR22 0000080
F2=1.-R1DR22 0000090
F3=RODR22-R1DR22 0000100
T2=TWO-FF*(GHPL+2.5/F1*(F2*ALOG(YDH+R2MR0H)-F3*ALOG(YDH)-0.5*(1.+ 0000110
+2.*R1DR2-RODR22-2.*R1DR2*RODR2))) 0000120
T1=F2/F3*TBT-F1/F3*T2 0000130
IF(T1.GE.TE .AND. T2.GE.TE)RETURN 0000140
C 0000150
T2=TE 0000160
T1=F2/F3*TBT-F1/F3*T2 0000170
RETURN 0000180
END 0000190

SUBROUTINE DECP(IPRINT,X1,X2,STLEN) 0000010
C-----0000010
C PRINT CONTROL 0000020
C 0000030
C 0000040
C NPRINT < 0 PRINTS THE RESULTS AT EACH AXIAL SECTION. 0000050
C NPRINT = 0 PRINTS ONLY AT THE SECTIONS BETWEEN AR(1) AND AR(2) 0000060
C NPRINT > 0 PRINTS AT THE SECTIONS BY A(1),...A(NPRINT) 0000070
C (NPRINT <= 10) 0000080
C 0000090
C COMMON /SC25C/ NPRINT,AR(10) 0000100
C 0000110
D1=X1+STLEN 0000120
D2=X2+STLEN 0000130
DM=(D1+D2)*0.5 0000140
IF(NPRINT) 100,200,300 0000150
100 IPRINT=1 0000160
GO TO 999 0000170
200 IPRINT=0 0000180
IF(DM.GT.AR(1) .AND. DM.LT.AR(2)) IPRINT=1 0000190
GO TO 999 0000200
300 IPRINT=0 0000210
DO 400 IPR=1,NPRINT 0000220
IF(AR(IPR).GE.D1 .AND. AR(IPR).LE.D2) IPRINT=1 0000230
400 CONTINUE 0000240
999 RETURN 0000250
END 0000260

SUBROUTINE DELIP 0000010
C----- 0000010
C DETERMINES THE ARRAYS LIPS AND NCAN 0000020
C----- 0000030
C DIMENSION LIP(6) 0000040
C----- 0000050
C COMMON /SC01C/ NCAN(19),LIPS(19,10) 0000060
C COMMON /SC03C/ NRODS 0000070
C COMMON /MART5/ NSTR 0000080
C COMMON /GASD1/ NSTOT 0000090
C COMMON /HEA6 / NPIN(42),JPIN(42,3) 0000100
C COMMON /IJ1 / NER(42),NIS(42,3) 0000110
C----- 0000120
C DO 1000 J=1,NRODS 0000130
C----- 0000140
C K=0 0000150
DO 400 NS=1,NSTOT 0000160
NP=NPIN(NS) 0000170
DO 300 M=1,NP 0000180
IF(JPIN(NS,M).NE. J) GO TO 300 0000190
IF(K.LT.1) GO TO 200 0000200
DO 100 L=1,K 0000210
IF(LIP(L).EQ.NS) GO TO 400 0000220
100 CONTINUE 0000230
200 K=K+1 0000240
LIP(K)=NS 0000250
300 CONTINUE 0000260
400 CONTINUE 0000270
IF(K .LE. 0) GO TO 1000 0000280
NCAN(J)=K 0000290
C----- 0000300
C----- 0000310
450 I=1 0000320
LIPS(J,I)=LIP(I) 0000330
500 CONTINUE 0000340
IF(I.EQ.K) GO TO 990 0000350
I=I+1 0000360
DO 900 L=I,K 0000370
NS=LIP(L) 0000380
NR=NER(NS) 0000390
DO 800 M=1,NR 0000400
IF(NIS(NS,M).NE.LIPS(J,I-1)) GO TO 800 0000410
LIPS(J,I)=NS 0000420
IF(L.NE. I) LIP(L)=LIP(I) 0000430
GO TO 500 0000440
800 CONTINUE 0000450
900 CONTINUE 0000460
NN=LIP(1) 0000470
K1=K-1 0000480
DO 950 LL=1,K1 0000490
LIP(LL)=LIP(LL+1) 0000500
950 CONTINUE 0000510
LIP(K)=NN 0000520
GO TO 450 0000530
990 CONTINUE 0000540
1000 CONTINUE 0000550
WRITE(6,1001) 0000560
DO 2000 J=1,NRODS 0000570
NC=NCAN(J) 0000580
IF(NC.LE.0) GO TO 2000 0000590
WRITE(6,*) J,NC,(LIPS(J,M),M=1,NC) 0000600
----- 0000610

```
2000      CONTINUE          0000620
C
C      RETURN
1001 FORMAT(//5X,'SUBR. DELIP',/10X,        0000630
>           'PIN    N. OF SECTORS      |--> CHANNEL ADJACENT TO ',0000640
>           'EACH SECTOR')          0000650
END                                     0000660
                                         0000670
                                         0000680
```

```
FUNCTION DPIN(MFLOW,PE,TE,CINL)          0000010
C ----- 0000020
C      DETERMINES THE PRESSURE LOSS AT THE BUNDLE INLET. 0000030
C                                         0000040
C      COMMON /GEO2/ ATOT,DETOT,ASEC          0000050
C      COMMON /SC01L/ STLEN                  0000060
C      REAL      MFLOW                     0000070
C                                         0000080
C      RE=MFLOW*DETOT/(ATOT*ETA(PE,TE))      0000090
C      DPIN=CINL+2000.0/RE                  0000100
C      IF (STLEN.GT. 0.0000) DPIN=0.0         0000110
C      IF (DPIN.GT.2.) DPIN=2.                0000120
C      RETURN                                0000130
C      END                                    0000140
```

```
FUNCTION EINF(BIOT)          0000010
C      EINF EVALUATES THE E INFINITE VALUE 0000010
C ----- 0000020
C                                         0000030
C                                         0000040
C      COMMON/BIDAT1/BI4,BI5,BI6,BI7,BI8,BI9,BI10 0000050
C      IF(BIOT.GT.BI4)GOTO 1                 0000060
C      EINF=BI5+BI6*BIOT+BI7*BIOT**2       0000070
C      RETURN                                0000080
1 EINF=BI8+BI9*BIOT+BI10*BIOT**2       0000090
C      RETURN                                0000100
C      END                                    0000110
```

SUBROUTINE ENFRCO	0000010
C-----	0000010
C ENFRCO COMPUTES AN AVERAGE GAMMA VALUE FOR THE LAMINAR	0000020
C CALCULATIONS IF WALL AND CORNER CHANNELS ARE COMPUTED TOGETHER	0000030
C (CASE OF NS1 = NS2 = 0)	0000040
C	0000050
REAL LAM,LAMSCH,LAMWC	0000060
COMMON/MART5/NSTR	0000070
COMMON/SUB5/LAMSCH(42,3)/GEN1/LAM(42)/GEN2/A(42)/GEN5/DE(42)	0000080
1 /LAMIN1/AKAPPA(42)/LAMIN2/FATIP(3),FDTIP(3)/IND3/NTYP(42)	0000090
2 /MART2/NS1,NS2/HEA6/NPIN(42),JPIN(42,3)/GAMCO/CGAMMA(18)	0000100
3 /WCSE3/LAMWC(18,2,2)	0000110
P=0.	0000120
PP=0.	0000130
DO 100 NS=NS1,NS2	0000140
ITYP=NTYP(NS)	0000150
ADDK=A(NS)*FATIP(ITYP)*(DE(NS)*FDTIP(ITYP))**2/AKAPPA(NS)	0000160
P=P+ADDK	0000170
100 PP=PP+ADDK/CGAMMA(NS-NSTR)	0000180
P=P/PP	0000190
DO 120 NS=NS1,NS2	0000200
ITYP=NTYP(NS)	0000210
PDCG=P/CGAMMA(NS-NSTR)	0000220
LAM(NS)=LAM(NS)*PDCG	0000230
NP=NPIN(NS)	0000240
DO 120 M=1,NP	0000250
LAMSCH(NS,M)=LAMSCH(NS,M)*PDCG	0000260
IF(ITYP.EQ.3)GOTO 120	0000270
DO 110 JWC=1,2	0000280
110 LAMWC(NS-NSTR,M,JWC)=LAMWC(NS-NSTR,M,JWC)*PDCG	0000290
120 CONTINUE	0000300
RETURN	0000310
END	0000320
	0000330

SUBROUTINE ENFRC1 0000010
C----- 0000010
C----- 0000020
C ENFRC0 COMPUTES AN AVERAGE GAMMA VALUE FOR THE LAMINAR 0000030
C CALCULATIONS IF WALL AND CORNER CHANNELS ARE COMPUTED TOGETHER 0000040
C (CASE OF JLAM=1) 0000050
C----- 0000060
C REAL LAM,LAMSCH,LAMWC 0000070
C----- 0000080
C COMMON /MART5/ NSTR 0000090
COMMON /SUB5/ LAMSCH(42,3) 0000100
COMMON /GEN1/ LAM(42) 0000110
COMMON /GEN2/ A(42) 0000120
COMMON /GEN5/ DE(42) 0000130
COMMON /LAMIN1/AKAPPA(42) 0000140
COMMON /LAMIN2/FATIP(3),FDTIP(3) 0000150
COMMON /IND3/ NTYP(42) 0000160
COMMON /HEA6/ NPIN(42),JPIN(42,3) 0000170
COMMON /GAMCO/ CGAMMA(18) 0000180
COMMON /WCSE3/ LAMWC(18,2,2) 0000190
COMMON /IJ1 / NER(42),NIS(42,3) 0000200
COMMON /GASD1/ NSTOT 0000210
C----- 0000220
C DO 1000 NS=1,NSTOT 0000230
ITYP=NTYP(NS) 0000240
IF(ITYP .NE. 3) GO TO 1000 0000250
C----- 0000260
P = A(NS)*FATIP(ITYP)*(DE(NS)*FDTIP(ITYP))**2/AKAPPA(NS) 0000270
PP = P/CGAMMA(NS-NSTR) 0000280
C----- 0000290
NR = NER(NS) 0000300
DO 100 M=1, NR 0000310
NA=NIS(NS,M) 0000320
I1TYP=NTYP(NA) 0000330
AD=A(NA)*FATIP(I1TYP)*(DE(NA)*FDTIP(I1TYP))**2/AKAPPA(NA) 0000340
P=P+AD 0000350
PP=PP+AD/CGAMMA(NA-NSTR) 0000360
100 CONTINUE 0000370
C----- 0000380
P=P/PP 0000390
GCOR=P/CGAMMA(NS-NSTR) 0000400
LAM(NS)=LAM(NS)*GCOR 0000410
DO 500 M=1, NR 0000420
NA=NIS(NS,M) 0000430
GCOR=P/CGAMMA(NA-NSTR) 0000440
LAM(NA)=LAM(NA)*GCOR 0000450
NP=NPIN(NA) 0000460
DO 400 L=1, NP 0000470
LAMSCH(NA,L)=LAMSCH(NA,L)*GCOR 0000480
DO 300 J=1,2 0000490
LAMWC(NA-NSTR,L,J)=LAMWC(NA-NSTR,L,J)*GCOR 0000500
300 CONTINUE 0000510
400 CONTINUE 0000520
500 CONTINUE 0000530
1000 CONTINUE 0000540
C----- 0000550
RETURN 0000560
END 0000570

```
0000010
SUBROUTINE ENTRFR(K,I,ITYP,R1,R0,R2,NS,III,JJJ,DE,A,M,P,TB,LAMLAM)0000010
C .....0000020
C ENTRFR COMPUTES THE GAMMA FACTORS TO CORRECT THE FRICTION FACTORS 0000030
C IN THE HYDRODYNAMIC ENTRANCE REGION 0000040
C 0000050
REAL M,LAMLAM 0000060
COMMON /SC01L/ STLEN 0000070
COMMON/GRID3/X(100)/RETEM/TNY/LAMIN1/AKAPPA( 42)/GAMCO/CGAMMA( 18)0000080
1 /ENTR1/CKAPPA(2),DEA(2),GAMMA(2),WGAMMA(2),A1/HEA6/NPIN( 42)0000090
2 ,JPIN( 42,3) 0000100
RE=M*DE/(A*RHO(P,TB))*RHO(P,TNY)/ETA(P,TNY) 0000110
IF(ITYP.EQ.1 .OR. I.EQ.2)CALL NEWTON(R0,R1,R2) 0000120
R1DR2=R1/R2 0000130
RODR1=R0/R1 0000140
DEA(I)=2.*(R2-R1) 0000150
CKAPPA(I)=FKAPPA(R1DR2) 0000160
DKAPPA=AKAPPA(NS) 0000170
IF(I.EQ.2)DKAPPA= GKAPPA(RODR1) 0000180
REA=RE*DEA(I)/DE 0000190
IF(ITYP.EQ.1 .OR. I.EQ.2)REA=RE *DKAPPA/CKAPPA(I)*(DEA(I)/DE)**3 0000230
PHIDX=4./ (DEA(I)*REA) 0000250
PHIA1=PHIDX*(X(K) + STLEN) 0000300
PHIA2=PHIDX*(X(K+1) + STLEN) 0000310
AKA1=AKA(R1DR2,PHIA1) 0000330
AKA2=AKA(R1DR2,PHIA2) 0000340
GAMMA(I)=1.+4./CKAPPA(I)*(AKA2-AKA1)/(PHIA2-PHIA1) 0000350
IF(ITYP.EQ.2)GOTO 10 0000360
LAMLAM=LAMLAM*GAMMA(1) 0000370
IF(ITYP.EQ.3)CGAMMA(III)=GAMMA(1) 0000380
RETURN 0000390
C .....0000400
C ONLY FOR THE WALL SUBCHANNELS 0000410
C 0000420
10 IF (I .NE.1) GO TO 11 0000480
A1=A 0000490
RETURN 0000500
11 C1=A1*DEA(1)**2/CKAPPA(1) 0000510
C2=A*DE**2/DKAPPA 0000530
WGAMMA(JJJ)=(C1+C2)/(C1/GAMMA(1)+C2/GAMMA(2)) 0000540
LAMLAM=LAMLAM*WGAMMA(JJJ) 0000550
IF(JJJ.LT.NPIN(NS))RETURN 0000560
CGAMMA(III)=0. 0000570
NP=NPIN(NS) 0000580
DO 20 JJ=1,NP 0000590
20 CGAMMA(III)=CGAMMA(III)+WGAMMA(JJ) 0000600
CGAMMA(III)=CGAMMA(III)/FLOAT(NP) 0000610
RETURN 0000620
END 0000630
```

```
FUNCTION EPS(T,L)          0000010
C ----- 0000010
C DETERMINES THE EMISSIVITY OF THE SURFACES. 0000020
C IEPS=0 ==> UNIFORM EMISSIVITY OVER THE WHOLE BUNDLE 0000030
C (BUT INDEPENDENT VALUES FOR PINS AND SHROUD) 0000040
C IEPS=1 ==> EMISSIVITY FUNCTION OF THE TEMPERATURE OF THE SURFACE 0000050
C (T IN CELTIUS) 0000060
C
C COMMON /SC01R/ NSECT,NSECP 0000070
C COMMON /SC07R/ EPSR,EPSS,SIGMA 0000080
C COMMON /SC15R/ IEPS 0000090
C
C IF (IEPS .GT. 0) GO TO 100 0000100
C   EPS=EPSR 0000110
C   IF(L.GT.NSECP) EPS=EPSS 0000120
C   GO TO 1000 0000130
100 CONTINUE 0000140
EPS=0.42+0.42*(T-500.0)/350.0 0000150
IF(T.LT.500.0) EPS=0.42 0000160
IF(T.GT.850.0) EPS=0.84 0000170
C
1000 RETURN 0000180
END 0000190
                                0000200
                                0000210
                                0000220
                                0000230
```

FUNCTION ETA(P,T)	0000010
C-----	0000010
C ETA EVALUATES THE DYNAMIC VISCOSITY OF THE COOLANT (G/CM S)	0000020
C	0000030
COMMON/GASD4/IGAS	0000040
GOTO(10,20,30,40),IGAS	0000050
10 CONTINUE	0000060
C CASE OF HELIUM COOLANT	0000070
C	0000080
ETA=18.84E-05*((T+273.16)/273.16)**0.66	0000090
RETURN	0000100
C	0000110
20 CONTINUE	0000120
C CASE OF CO2 COOLANT	0000130
C	0000140
PP=P	0000150
TT=T	0000160
P=PP/1.0333	0000170
T=TT+273.16	0000180
TO=273.16	0000190
TF=TO/T	0000200
ETAO=(1.54E-7*SQRT(T))/(1.+(228./T))	0000210
ETAF=ETAO*(1.+4.78E-3*(P-1.)*(TF**3))	0000220
ETA=ETAF*98.068	0000230
P=PP	0000240
T=TT	0000250
RETURN	0000260
C	0000270
30 CONTINUE	0000280
C CASE OF N2 COOLANT.	0000290
C	0000300
TT=T	0000310
T=TT+273.16	0000320
ETAO=1.425E-7*T**0.5/(1.+107./T)*98.0665	0000330
ETA=ETAO*(1.+8.E-4*(P/1.033-1.)*(273.16/T))	0000340
T=TT	0000350
C	0000360
RETURN	0000370
40 CONTINUE	0000380
ETA=0.	0000390
RETURN	0000400
END	0000410
	0000420

```
C FUNCTION EXPCL(T) 0000010
C----- 0000020
C EXPCL COMPUTES THE EXPANSION COEFFICIENTS FOR THE CORRECTION OF 0000030
C THE GEOMETRICAL DIMENSIONS OF THE LINER 0000040
C                                         0000050
COMMON/EXDAT1/EX4(7),EX5(7),EX6(7)/INPAR/IPA 0000060
EXPCL=EX4(IPA)+EX5(IPA)*T+EX6(IPA)*T**2 0000070
RETURN 0000080
END 0000090
```

SUBROUTINE FFA31(L,NAFF,NS,J)	0000010
C -----	0000010
C DETECTS THE VIEW-FACTORS OF TYPE FA31	0000020
C	0000030
COMMON /SC03R/ F1,F2,F3,F4,F5,F6,F7,F8,F9,	0000040
> F11,F12,F13,F14,F15,F16,F17,F18,F24,F31,F32	0000050
COMMON /SC04R/ VFAC(132, 13)	0000060
COMMON /SC11R/ ISS (18,2)	0000070
COMMON /SC14R/ KAFF(132,13)	0000080
COMMON /HEA6/ NPIN(42),JPIN(42,3)	0000090
COMMON /IJ1 / NER(42),NIS(42,3)	0000100
COMMON /MART5/ NSTR	0000110
C	0000120
NR=NER(NS)	0000130
DO 1000 M=1,NR	0000140
NS1=NIS(NS,M)	0000150
NP1=NPIN(NS1)	0000160
DO 500 M1=1,NP1	0000170
IF(JPIN(NS1,M1).NE.J) GO TO 500	0000180
NW1=NS1-NSTR	0000190
L1=ISS(NW1,M1)	0000200
NAFF=NAFF+1	0000210
KAFF(L,NAFF)=L1	0000220
VFAC(L,NAFF)=F31	0000230
500 CONTINUE	0000240
1000 CONTINUE	0000250
C	0000260
RETURN	0000270
END	0000280
	0000290

```
SUBROUTINE FFS13(L,NAFF,NS,J)          0000010
C -----                                     0000010
C   DETECTS THE VIEW-FACTORS OF TYPE FW13    0000020
C                                             0000030
C                                             0000040
C   COMMON /SC03R/ F1,F2,F3,F4,F5,F6,F7,F8,F9, 0000050
C   >           F11,F12,F13,F14,F15,F16,F17,F18,F24,F31,F32 0000060
C   COMMON /SC04R/ VFAC(132, 13)             0000070
C   COMMON /SC12R/ IGI ( 42,3)               0000080
C   COMMON /SC14R/ KAFF(132,13)              0000090
C   COMMON /HEA6/  NPIN( 42),JPIN( 42,3)      0000100
C   COMMON /IJ1 /  NER( 42),NIS( 42,3)        0000110
C   COMMON /IND3/  NTYP( 42)                  0000120
C   COMMON /MART5/ NSTR                     0000130
C                                             0000140
C   NP=NPIN(NS)                           0000150
C   NR=NER(NS)                            0000160
C   DO 1000 M=1,NR                         0000170
C     NS1=NIS(NS,M)                      0000180
C     IF(NTYP(NS1).NE.2) GO TO 1000       0000190
C     NP1=NPIN(NS1)                      0000200
C     DO 100 M1=1,NP1                     0000210
C       DO 50 M2=1,NP                      0000220
C         IF(JPIN(NS,M2).NE.JPIN(NS1,M1)) GO TO 50 0000230
C         IF(JPIN(NS1,M1).NE. J) GO TO 1000       0000240
C         GO TO 150                          0000250
C 50      CONTINUE                         0000260
C 100     CONTINUE                         0000270
C 110     WRITE(6,110)                      0000280
C 110     FORMAT(' ERROR IN FFS13, LOOP 100')
C 150     DO 200 M1=1,NP1                 0000290
C        IF(JPIN(NS1,M1).EQ. J) GO TO 200 0000300
C        L1=IGI(NS1,M1)                  0000310
C        NAFF=NAFF+1                    0000320
C        VFAC(L,NAFF)=F13              0000330
C        KAFF(L,NAFF)=L1                0000340
C        GO TO 1000                     0000350
C 200     CONTINUE                         0000360
C 1000    CONTINUE                         0000370
C
C   RETURN                                0000380
C   END                                   0000390
C                                         0000400
C                                         0000410
```

```
SUBROUTINE FFS16(L,NAFF,NS,J)          0000010
C ----- 0000020
C   DETECTS THE VIEW-FACTORS OF TYPE FS16 0000030
C                                         0000040
C   COMMON /SC03R/ F1,F2,F3,F4,F5,F6,F7,F8,F9, 0000050
C   >           F11,F12,F13,F14,F15,F16,F17,F18,F24,F31,F32 0000060
C   COMMON /SC04R/ VFAC(132, 13)            0000070
C   COMMON /SC12R/ IGI ( 42,3)              0000080
C   COMMON /SC14R/ KAFF(132,13)             0000090
C   COMMON /HEA6/  NPIN( 42),JPIN( 42,3)      0000100
C   COMMON /IJ1 /  NER( 42),NIS( 42,3)        0000110
C   COMMON /IND3/  NTYP( 42)                 0000120
C   COMMON /MART5/ NSTR                   0000130
C                                         0000140
NR=NER(NS)          0000150
DO 1000 M=1,NR      0000160
  NS1=NIS(NS,M)       0000170
  IF(NTYP(NS1).NE.2) GO TO 1000      0000180
  NP1=NPIN(NS1)        0000190
  DO 100 M1=1,NP1      0000200
    IF(JPIN(NS1,M1).NE.J) GO TO 100      0000210
    L1=IGI(NS1,M1)        0000220
    NAFF=NAFF+1           0000230
    VFAC(L,NAFF)=F16      0000240
    KAFF(L,NAFF)=L1        0000250
    GO TO 1000             0000260
  100                      CONTINUE      0000270
  1000                     CONTINUE      0000280
C                                         0000290
RETURN             0000300
END               0000310
```

```
          0000010
SUBROUTINE FFS24(L,NAFF,NS,J)          0000010
C ----- 0000020
C DETECTS THE VIEW-FACTORS OF TYPE FS24 0000030
C                                         0000040
COMMON /SC03R/ F1,F2,F3,F4,F5,F6,F7,F8,F9, 0000050
>           F11,F12,F13,F14,F15,F16,F17,F18,F24,F31,F32 0000060
COMMON /SC04R/ VFAC(132, 13)             0000070
COMMON /SC12R/ IGI ( 42,3)              0000080
COMMON /SC14R/ KAFF(132,13)            0000090
COMMON /HEA6/  NPIN( 42),JPIN( 42,3)    0000100
COMMON /IJ1 /  NER( 42),NIS( 42,3)     0000110
COMMON /IND3/  NTYP( 42)                0000120
COMMON /MART5/ NSTR                   0000130
C                                         0000140
NR=NER(NS)                           0000150
DO 1000 M=1,NR                      0000160
  NS1=NIS(NS,M)                     0000170
  IF(NTYP(NS1).NE.3) GO TO 1000      0000180
  IF(JPIN(NS1,1).NE.J) GO TO 1000      0000190
  L1=IGI(NS1,1)                     0000200
  NAFF=NAFF+1                       0000210
  VFAC(L,NAFF)=F24                  0000220
  KAFF(L,NAFF)=L1                   0000230
1000        CONTINUE                  0000240
C                                         0000250
RETURN                                0000260
END                                     0000270
```

SUBROUTINE FFW31(L,NAFF,NS,J)	0000010
C -----	0000010
C DETECTS THE VIEW-FACTORS OF TYPE FW31	0000020
C	0000030
COMMON /SC03R/ F1,F2,F3,F4,F5,F6,F7,F8,F9,	0000040
> F11,F12,F13,F14,F15,F16,F17,F18,F24,F31,F32	0000050
COMMON /SC04R/ VFAC(132, 13)	0000060
COMMON /SC11R/ ISS (18,2)	0000070
COMMON /SC14R/ KAFF(132,13)	0000080
COMMON /HEA6/ NPIN(42),JPIN(42,3)	0000090
COMMON /IJ1 / NER(42),NIS(42,3)	0000100
COMMON /IND3/ NTYP(42)	0000110
COMMON /MART5/ NSTR	0000120
C	0000130
NR=NER(NS)	0000140
DO 1000 M=1,NR	0000150
NS1=NIS(NS,M)	0000160
IF(NTYP(NS1) .NE. 3) GO TO 1000	0000170
IF(JPIN(NS1,1).NE.J) GO TO 1000	0000180
NW1=NS1-NSTR	0000190
L1=ISS(NW1,1)	0000200
NAFF=NAFF+1	0000210
KAFF(L,NAFF)=L1	0000220
VFAC(L,NAFF)=F31	0000230
500 CONTINUE	0000240
1000 CONTINUE	0000250
C	0000260
RETURN	0000270
END	0000280
	0000290

```
SUBROUTINE FF32 (L,NAFF,NS,J)          0000010
C -----                                     0000010
C   DETECTS THE VIEW-FACTORS OF TYPE F32    0000020
C                                             0000030
C                                             0000040
C   COMMON /SC03R/ F1,F2,F3,F4,F5,F6,F7,F8,F9, 0000050
C >           F11,F12,F13,F14,F15,F16,F17,F18,F24,F31,F32 0000060
C   COMMON /SC04R/ VFAC(132, 13)             0000070
C   COMMON /SC11R/ ISS ( 18,2)               0000080
C   COMMON /SC14R/ KAFF(132,13)             0000090
C   COMMON /HEA6/  NPIN( 42),JPIN( 42,3)     0000100
C   COMMON /IJ1 /  NER( 42),NIS( 42,3)     0000110
C   COMMON /IND3/  NTYP( 42)                 0000120
C   COMMON /MART5/ NSTR                   0000130
C                                             0000140
NR=NER(NS)                         0000150
NP=NPIN(NS)                        0000160
DO 1000 M=1,NR                      0000170
  NS1=NIS(NS,M)                     0000180
  IF(NTYP(NS1).NE. 2) GO TO 1000    0000190
  NP1=NPIN(NS1)                    0000200
  DO 500 M1=1,NP1                  0000210
    IF(JPIN(NS1,M1).NE.J) GO TO 500  0000220
    NW1=NS1-NSTR                   0000230
    L1=ISS(NW1,M1)                0000240
    NAFF=NAFF+1                   0000250
    KAFF(L,NAFF)=L1              0000260
    VFAC(L,NAFF)=F32            0000270
500      CONTINUE                     0000280
1000      CONTINUE                     0000290
C                                             0000300
RETURN                           0000310
END                             0000320
```

```
SUBROUTINE FGEO (VDIAM,RSTAR,S,R,RINT) 0000010
C -----                                     0000010
C   COMPUTES SOME GEOMETRICAL FACTORS FOR CONDUCTION. 0000020
C                                             0000030
C                                             0000040
C   COMMON /SC04C/ RFUEL                 0000050
C                                             0000060
C   S = VDIAM/2. - RINT                 0000070
C   R = (VDIAM/2. + RINT)/2.            0000080
C   RSTAR=(RFUEL+RINT)*0.5            0000090
C                                             0000100
C   RETURN                           0000110
END                             0000120
```

SUBROUTINE FINDA(L,NAFF,NS,J)	0000010	
C -----	0000010	
C DETECTS THE VIEW-FACTORS FOR A CORNER SECTOR.	0000020	
C	0000030	
COMMON /SC03R/ F1,F2,F3,F4,F5,F6,F7,F8,F9,	0000040	
> F11,F12,F13,F14,F15,F16,F17,F18,F24,F31,F32	0000050	
COMMON /SC04R/ VFAC(132, 13)	0000060	
COMMON /SC11R/ ISS (18,2)	0000070	
COMMON /SC14R/ KAFF(132,13)	0000080	
COMMON /HEA6/ NPIN(42),JPIN(42,3)	0000090	
COMMON /IJ1 / NER(42),NIS(42,3)	0000100	
COMMON /MART5/ NSTR	0000110	
C	0000120	
NW=NS-NSTR	0000130	
L1=ISS(NW,1)	0000140	
NAFF=NAFF+1	0000150	
VFAC(L,NAFF)=F14	0000160	
KAFF(L,NAFF)=L1	0000170	
C	0000180	
NR=NER(NS)	0000190	
DO 1000 M=1,NR	0000200	
NS1=NIS(NS,M)	0000210	
NP1=NPIN(NS1)	0000220	
DO 100 M1=1,NP1	0000230	
IF(JPIN(NS1,M1).NE.J) GO TO 100	0000240	
NW1=NS1-NSTR	0000250	
L1=ISS(NW1,M1)	0000260	
NAFF=NAFF+1	0000270	
VFAC(L,NAFF)=F24	0000280	
KAFF(L,NAFF)=L1	0000290	
100	CONTINUE	0000300
1000	CONTINUE	0000310
C	0000320	
RETURN	0000330	
END	0000340	
	0000350	

```
SUBROUTINE FINDF1(L,NAFF,NS,J)          0000010
C -----                                     0000010
C   DETECTS THE VIEW-FACTORS OF TYPE F1      0000020
C                                             0000030
C                                             0000040
C   COMMON /SC03R/ F1,F2,F3,F4,F5,F6,F7,F8,F9, 0000050
C   >          F11,F12,F13,F14,F15,F16,F17,F18,F24,F31,F32 0000060
C   COMMON /SC04R/ VFAC(132, 13)              0000070
C   COMMON /SC12R/ IGI ( 42,3)                0000080
C   COMMON /SC14R/ KAFF(132,13)               0000090
C   COMMON /HEA6/ NPIN( 42),JPIN( 42,3)       0000100
C                                             0000110
C   NP=NPIN(NS)                            0000120
DO 1000 M=1,NP                           0000130
    JP=JPIN(NS,M)                         0000140
    IF(J .EQ.JP) GO TO 1000               0000150
    NAFF=NAFF+1                           0000160
    L1=IGI(NS,M)                         0000170
    VFAC(L,NAFF)=F1                      0000180
    KAFF(L,NAFF)=L1                      0000190
1000      CONTINUE                         0000200
C                                             0000210
      RETURN                                0000220
END                                     0000230
```

```
SUBROUTINE FINDF3(L,NAFF,NS,J)          0000010
C ----- 0000010
C   DETECTS THE VIEW-FACTORS OF TYPE F3 / F15 0000020
C   COMMON /SC03R/ F1,F2,F3,F4,F5,F6,F7,F8,F9,      0000030
C             > F11,F12,F13,F14,F15,F16,F17,F18,F24,F31,F32 0000040
C   COMMON /SC04R/ VFAC(132, 13)                0000050
C   COMMON /SC11R/ ISS ( 18,2)                  0000060
C   COMMON /SC12R/ IGI ( 42,3)                  0000070
C   COMMON /SC14R/ KAFF(132,13)                0000080
C   COMMON /HEA6/  NPIN( 42),JPIN( 42,3)        0000090
C   COMMON /IJ1 /  NER( 42),NIS( 42,3)        0000100
C   COMMON /MART5/ NSTR                      0000110
C   COMMON /IND3/  NTYP( 42)                   0000120
C
C   NR=NER(NS)                                0000130
C   DO 1000 M=1,NR                            0000140
C
C   NS1=NIS(NS,M)                            0000150
C   NP1=NPIN(NS1)                           0000160
C   DO 100 M1=1,NP1                         0000170
C     IF(JPIN(NS1,M1).EQ.J) GO TO 1000       0000180
C   CONTINUE                                  0000190
100  IF(NTYP(NS1).GT.1) GO TO 500           0000200
C   NP=NPIN(NS)                           0000210
C   DO 300 M1=1,NP1                         0000220
C     DO 200 K=1,NP                         0000230
C       IF(JPIN(NS1,M1).EQ.JPIN(NS,K)) GO TO 300 0000240
C     CONTINUE                                0000250
C   IF(NTYP(NS1).GT.1) GO TO 500           0000260
C   NP=NPIN(NS)                           0000270
C   DO 300 M1=1,NP1                         0000280
C     DO 200 K=1,NP                         0000290
C       IF(JPIN(NS1,M1).EQ.JPIN(NS,K)) GO TO 300 0000300
C     CONTINUE                                0000310
300  J1=JPIN(NS1,M1)                     0000320
C   GO TO 400                                0000330
C   CONTINUE                                  0000340
C   WRITE(6,310)                            0000350
310  FORMAT( ' ERROR IN FINDF3, LOOP M1, CALC PROCEEDING') 0000360
400  CONTINUE                                0000370
C
C   L1=IGI(NS1,M1)                          0000380
C   NAFF=NAFF+1                            0000390
C   VFAC(L,NAFF)=F3                        0000400
C   KAFF(L,NAFF)=L1                        0000410
C   GO TO 9999                               0000420
C
C   500  NSW1=NS1-NSTR                      0000430
C   L1=ISS(NSW1,1)                          0000440
C   L2=ISS(NSW1,2)                          0000450
C
C   VFAC(L,NAFF+1)=F15                      0000460
C   VFAC(L,NAFF+2)=F15                      0000470
C   KAFF(L,NAFF+1)=L1                        0000480
C   KAFF(L,NAFF+2)=L2                        0000490
C   NAFF=NAFF+2                            0000500
C   GO TO 9999                               0000510
C
C   1000 CONTINUE                            0000520
C   WRITE(6,1100)                            0000530
1100 FORMAT( ' ERROR IN FINDF3, LOOP M, CALC. PROCEEDING') 0000540
C
C   9999 RETURN                             0000550
END                                     0000560
                                         0000570
                                         0000580
                                         0000590
```

SUBROUTINE FINDF4(L,NAFF,NS,J) 0000010
C ----- 0000010
C DETECTS THE VIEW-FACTORS OF TYPE F4 / F8 0000020
C 0000030
C 0000040
COMMON /SC03R/ F1,F2,F3,F4,F5,F6,F7,F8,F9, 0000050
> F11,F12,F13,F14,F15,F16,F17,F18,F24,F31,F32 0000060
COMMON /SC04R/ VFAC(132, 13) 0000070
COMMON /SC11R/ ISS (18,2) 0000080
COMMON /SC12R/ IGI (42,3) 0000090
COMMON /SC14R/ KAFF(132,13) 0000100
COMMON /HEA6/ NPIN(42),JPIN(42,3) 0000110
COMMON /IJ1 / NER(42),NIS(42,3) 0000120
COMMON /IND3/ NTYP(42) 0000130
COMMON /MART5/ NSTR 0000140
C 0000150
NR=NER(NS) 0000160
NP=NPIN(NS) 0000170
DO 1000 M=1,NR 0000180
C 0000190
NS1=NIS(NS,M) 0000200
NP1=NPIN(NS1) 0000210
DO 100 M1=1,NP1 0000220
IF(JPIN(NS1,M1).EQ.J) GO TO 500 0000230
100 CONTINUE 0000240
IF(NTYP(NS1).GT.1) GO TO 300 0000250
DO 200 M1=1,NP1 0000260
DO 150 M2=1,NP 0000270
IF(JPIN(NS1,M1).EQ.JPIN(NS,M2)) GO TO 250 0000280
150 CONTINUE 0000290
GO TO 200 0000300
250 L1=IGI(NS1,M1) 0000310
NAFF=NAFF+1 0000320
VFAC(L,NAFF)=F4 0000330
KAFF(L,NAFF)=L1 0000340
200 CONTINUE 0000350
GO TO 1000 0000360
300 CONTINUE 0000370
C 0000380
DO 400 M1=1,NP1 0000390
NAFF=NAFF+1 0000400
L1=IGI(NS1,M1) 0000410
VFAC(L,NAFF)=F8 0000420
KAFF(L,NAFF)=L1 0000430
400 CONTINUE 0000440
GO TO 1000 0000450
C 0000460
500 CONTINUE 0000470
IF(NTYP(NS1).GT.1) GO TO 1000 0000480
DO 700 M1=1,NP1 0000490
DO 600 M2=1,NP1 0000500
IF(JPIN(NS1,M1).EQ.JPIN(NS,M2)) GO TO 700 0000510
600 CONTINUE 0000520
NAFF=NAFF+1 0000530
L1=IGI(NS1,M1) 0000540
VFAC(L,NAFF)=F4 0000550
KAFF(L,NAFF)=L1 0000560
700 GO TO 1000 0000570
CONTINUE 0000580
C 0000590
1000 CONTINUE 0000600
0000610
RETURN 0000620
END 0000630

SUBROUTINE FINDF5(L,NAFF,NS,J)	0000010
C -----	0000010
C DETECTS THE VIEW-FACTORS OF TYPE F5	0000020
C	0000030
COMMON /SC03R/ F1,F2,F3,F4,F5,F6,F7,F8,F9,	0000040
> F11,F12,F13,F14,F15,F16,F17,F18,F24,F31,F32	0000050
COMMON /SC04R/ VFAC(132, 13)	0000060
COMMON /SC11R/ ISS (18,2)	0000070
COMMON /SC12R/ IGI (42,3)	0000080
COMMON /SC14R/ KAFF(132,13)	0000090
COMMON /HEA6/ NPIN(42),JPIN(42,3)	0000100
COMMON /IJ1 / NER(42),NIS(42,3)	0000110
COMMON /IND3/ NTYP(42)	0000120
COMMON /MART5/ NSTR	0000130
C	0000140
NR=NER(NS)	0000150
NP=NPIN(NS)	0000160
DO 1000 M=1, NR	0000170
C	0000180
NS1=NIS(NS,M)	0000190
NP1=NPIN(NS1)	0000200
DO 100 M1=1,NP1	0000210
IF(JPIN(NS1,M1).EQ.J) GO TO 110	0000220
100 CONTINUE	0000230
GO TO 1000	0000240
110 CONTINUE	0000250
DO 200 M1=1,NP1	0000260
IF (JPIN(NS1,M1).EQ.J) GO TO 200	0000270
DO 150 M2=1,NP	0000280
IF (JPIN(NS1,M1).EQ.JPIN(NS,M2)) GO TO 180	0000290
150 CONTINUE	0000300
GO TO 200	0000310
180 CONTINUE	0000320
F=F5	0000330
IF(NTYP(NS1).NE.1) F=F7	0000340
L1=IGI(NS1,M1)	0000350
NAFF=NAFF+1	0000360
VFAC(L,NAFF)=F	0000370
KAFF(L,NAFF)=L1	0000380
200 CONTINUE	0000390
C	0000400
1000 CONTINUE	0000410
C	0000420
RETURN	0000430
END	0000440
	0000450

```
SUBROUTINE FINDW2(L,NAFF,NS,J)          0000010
C ----- 0000010
C DETECTS THE VIEW-FACTORS OF TYPE F2      0000020
C                                         0000030
C                                         0000040
C     COMMON /SC03R/ F1,F2,F3,F4,F5,F6,F7,F8,F9, 0000050
C             > F11,F12,F13,F14,F15,F16,F17,F18,F24,F31,F32 0000060
C     COMMON /SC04R/ VFAC(132, 13)            0000070
C     COMMON /SC12R/ IGI ( 42,3)              0000080
C     COMMON /SC14R/ KAFF(132,13)            0000090
C     COMMON /HEA6/  NPIN( 42),JPIN( 42,3)    0000100
C
C     NP=NPIN(NS)                          0000110
C     DO 1000 M=1,NP                      0000120
C         IF(JPIN(NS,M).EQ.J) GO TO 1000   0000130
C         L1=IGI(NS,M)                   0000140
C         NAFF=NAFF+1                   0000150
C         VFAC(L ,NAFF)=F2            0000160
C         KAFF(L ,NAFF)=L1           0000170
C 1000      CONTINUE                     0000180
C
C     RETURN                                0000190
C
C                                         0000200
C                                         0000210
C                                         0000220
```

```
FUNCTION FKAPPA(R)                      0000010
C ----- 0000010
C FKAPPA EVALUATES THE KAPPA VALUES FOR THE CORNER CHANNELS AND THE 0000020
C WALL PORTION OF THE WALL SUBCHANNELS ( VALIDITY FOR CORNER CHANNE-0000030
C C LS 1.2< W/D <1.5)                  0000040
C                                         0000050
C                                         0000060
C FKAPPA=62.146*(1.-R)**2/(1.+R**2+(1.-R**2)/ ALOG(R)) 0000070
C RETURN                                0000080
C END                                    0000090
```

```
FUNCTION FQDEV(A,N,X1,X2)          0000010
C-----          0000010
C   FQDEV INTEGRATES THE PROFILES OF POWER 0000020
C                                           0000030
C
DIMENSION A(N)          0000040
FQDEV=0.          0000050
X1AI=0.          0000060
DO 10 I=1,N          0000070
AI=I          0000080
IF(X1.GT.0.)X1AI=X1**AI          0000090
10 FQDEV=FQDEV+A(I)*(X2**AI-X1AI) 0000100
RETURN          0000110
END          0000120
                                         0000130

SUBROUTINE FSA  (L,NAFF,NS,J)      0000010
C-----          0000010
C   DETECTS THE VIEW-FACTORS FOR A CORNER SECTOR OF THE SHROUD. 0000020
C                                           0000030
C
COMMON /SC03R/ F1,F2,F3,F4,F5,F6,F7,F8,F9,          0000040
>           F11,F12,F13,F14,F15,F16,F17,F18,F24,F31,F32 0000050
COMMON /SC04R/ VFAC(132, 13)          0000060
COMMON /SC12R/ IGI ( 42,3)          0000070
COMMON /SC14R/ KAFF(132,13)          0000080
COMMON /HEA6/  NPIN( 42),JPIN( 42,3) 0000090
COMMON /IJ1 /  NER( 42),NIS( 42,3) 0000100
COMMON /MART5/ NSTR          0000110
C                                           0000120
C
L1=IGI(NS,1)          0000130
NAFF=NAFF+1          0000140
VFAC(L,NAFF)=F14          0000150
KAFF(L,NAFF)=L1          0000160
C                                           0000170
C
NR=NER(NS)          0000180
DO 1000 M=1,NR          0000190
  NS1=NIS(NS,M)          0000200
  NP1=NPIN(NS1)          0000210
  DO 100 M1=1,NP1          0000220
    F=F17          0000230
    IF(JPIN(NS1,M1).NE.J) F=F18 0000240
    L1=IGI(NS1,M1)          0000250
    NAFF=NAFF+1          0000260
    VFAC(L,NAFF)=F          0000270
    KAFF(L,NAFF)=L1          0000280
100    CONTINUE          0000290
1000   CONTINUE          0000300
C                                           0000310
C
RETURN          0000320
END          0000330
                                         0000340
```

SUBROUTINE FS1112(L,NAFF,NS,J)	0000010
C -----	0000010
C DETECTS THE VIEW-FACTORS OF TYPE FS11-FS12	0000020
C	0000030
COMMON /SC03R/ F1,F2,F3,F4,F5,F6,F7,F8,F9,	0000040
> F11,F12,F13,F14,F15,F16,F17,F18,F24,F31,F32	0000050
COMMON /SC04R/ VFAC(132, 13)	0000060
COMMON /SC12R/ IGI (42,3)	0000070
COMMON /SC14R/ KAFF(132,13)	0000080
COMMON /HEA6/ NPIN(42),JPIN(42,3)	0000090
COMMON /IJ1 / NER(42),NIS(42,3)	0000100
COMMON /MART5/ NSTR	0000110
C	0000120
NP=NPIN(NS)	0000130
DO 1000 M1=1,NP	0000140
F=F11	0000150
IF(JPIN(NS,M1).NE.J) F=F12	0000160
C	0000170
L1=IGI(NS,M1)	0000180
NAFF=NAFF+1	0000190
VFAC(L,NAFF)=F	0000200
KAFF(L,NAFF)=L1	0000210
C	0000220
1000 CONTINUE	0000230
C	0000240
RETURN	0000250
END	0000260
	0000270

SUBROUTINE FS2 (L,NAFF,NS,J)	0000010
C -----	0000010
C DETECTS THE VIEW-FACTORS OF TYPE FS15	0000020
C	0000030
COMMON /SC03R/ F1,F2,F3,F4,F5,F6,F7,F8,F9,	0000040
> F11,F12,F13,F14,F15,F16,F17,F18,F24,F31,F32	0000050
COMMON /SC04R/ VFAC(132, 13)	0000060
COMMON /SC12R/ IGI (42,3)	0000070
COMMON /SC14R/ KAFF(132,13)	0000080
COMMON /HEA6/ NPIN(42),JPIN(42,3)	0000090
COMMON /IJ1 / NER(42),NIS(42,3)	0000100
COMMON /IND3/ NTYP(42)	0000110
COMMON /MART5/ NSTR	0000120
C	0000130
NR=NER(NS)	0000140
NP=NPIN(NS)	0000150
DO 1000 M=1,NR	0000160
NS1=NIS(NS,M)	0000170
NP1=NPIN(NS1)	0000180
IF(NTYP(NS1).NE. 1) GO TO 1000	0000190
DO 500 M1=1,NP1	0000200
DO 400 M2=1,NP	0000210
IF(JPIN(NS1,M1).EQ.JPIN(NS,M2)) GO TO 500	0000220
CONTINUE	0000230
400 L1=IGI(NS1,M1)	0000240
NAFF=NAFF+1	0000250
KAFF(L,NAFF)=L1	0000260
VFAC(L,NAFF)=F15	0000270
500 CONTINUE	0000280
1000 CONTINUE	0000290
C	0000300
RETURN	0000310
END	0000320
	0000330

SUBROUTINE FW1112(L,NAFF,NS,J)	0000010
C -----	0000010
C DETECTS THE VIEW-FACTORS OF TYPE FW11-FW12	0000020
C	0000030
COMMON /SC03R/ F1,F2,F3,F4,F5,F6,F7,F8,F9,	0000040
> F11,F12,F13,F14,F15,F16,F17,F18,F24,F31,F32	0000050
COMMON /SC04R/ VFAC(132, 13)	0000060
COMMON /SC11R/ ISS (18,2)	0000070
COMMON /SC14R/ KAFF(132,13)	0000080
COMMON /HEA6/ NPIN(42),JPIN(42,3)	0000090
COMMON /IJ1 / NER(42),NIS(42,3)	0000100
COMMON /MART5/ NSTR	0000110
C	0000120
NP=NPIN(NS)	0000130
DO 1000 M1=1,NP	0000140
F=F11	0000150
IF(JPIN(NS,M1).NE.J) F=F12	0000160
C	0000170
N1=NS-NSTR	0000180
L1=ISS(N1,M1)	0000190
NAFF=NAFF+1	0000200
VFAC(L,NAFF)=F	0000210
KAFF(L,NAFF)=L1	0000220
C	0000230
1000 CONTINUE	0000240
C	0000250
RETURN	0000260
END	0000270
	0000280

```

SUBROUTINE FW13(L,NAFF,NS,J)          0000010
C ----- 0000020
C DETECTS THE VIEW-FACTORS OF TYPE FW13 0000030
C                                         0000040
COMMON /SC03R/ F1,F2,F3,F4,F5,F6,F7,F8,F9, 0000050
>           F11,F12,F13,F14,F15,F16,F17,F18,F24,F31,F32 0000060
COMMON /SC04R/ VFAC(132, 13)            0000070
COMMON /SC11R/ ISS ( 18,2)              0000080
COMMON /SC14R/ KAFF(132,13)            0000090
COMMON /HEA6/  NPIN( 42),JPIN( 42,3)    0000100
COMMON /IJ1/   NER( 42),NIS( 42,3)      0000110
COMMON /IND3/  NTYP( 42)                0000120
COMMON /MART5/ NSTR                   0000130
C                                         0000140
NP=NPIN(NS)                          0000150
NR=NER(NS)                           0000160
DO 1000 M=1,NR                      0000170
  NS1=NIS(NS,M)                     0000180
  IF(NTYP(NS1).NE.2) GO TO 1000     0000190
  NP1=NPIN(NS1)                     0000200
  DO 100 M1=1,NP1                  0000210
    IF(JPIN(NS1,M1).EQ.J) GO TO 1000 0000220
    CONTINUE                         0000230
100  DO 300 M1=1,NP1                0000240
    DO 200 M2=1,NP                  0000250
      IF(JPIN(NS,M2).EQ.JPIN(NS1,M1)) GO TO 250 0000260
    CONTINUE                         0000270
200  GO TO 300                      0000280
250  NW1=NS1-NSTR                 0000290
    L1=ISS(NW1,M1)                 0000300
    NAFF=NAFF+1                    0000310
    VFAC(L,NAFF)=F13              0000320
    KAFF(L,NAFF)=L1               0000330
    GO TO 1000                     0000340
300  CONTINUE                       0000350
1000 CONTINUE                      0000360
C                                         0000370
RETURN                                0000380
END                                   0000390

```

SUBROUTINE FW16(L,NAFF,NS,J)	0000010
C -----	0000010
C DETECTS THE VIEW-FACTORS OF TYPE F16	0000020
C	0000030
COMMON /SC03R/ F1,F2,F3,F4,F5,F6,F7,F8,F9,	0000040
> F11,F12,F13,F14,F15,F16,F17,F18,F24,F31,F32	0000050
COMMON /SC04R/ VFAC(132, 13)	0000060
COMMON /SC11R/ ISS (18,2)	0000070
COMMON /SC14R/ KAFF(132,13)	0000080
COMMON /HEA6/ NPIN(42),JPIN(42,3)	0000090
COMMON /IJ1 / NER(42),NIS(42,3)	0000100
COMMON /IND3/ NTYP(42)	0000110
COMMON /MART5/ NSTR	0000120
C	0000130
NR=NER(NS)	0000140
DO 1000 M=1,NR	0000150
NS1=NIS(NS,M)	0000160
IF(NTYP(NS1).NE.2) GO TO 1000	0000170
NP1=NPIN(NS1)	0000180
DO 100 M1=1,NP1	0000190
IF(JPIN(NS1,M1).NE.J) GO TO 100	0000200
NW1=NS1-NSTR	0000210
L1=ISS(NW1,M1)	0000220
NAFF=NAFF+1	0000230
VFAC(L,NAFF)=F16	0000240
KAFF(L,NAFF)=L1	0000250
GO TO 1000	0000260
100 CONTINUE	0000270
1000 CONTINUE	0000280
C	0000290
RETURN	0000300
END	0000310
	0000320

SUBROUTINE FW1718(L,NAFF,NS,J)	0000010
C -----	0000010
C DETECTS THE VIEW-FACTORS OF TYPE F17-F18	0000020
C	0000030
COMMON /SC03R/ F1,F2,F3,F4,F5,F6,F7,F8,F9,	0000040
> F11,F12,F13,F14,F15,F16,F17,F18,F24,F31,F32	0000050
COMMON /SC04R/ VFAC(132, 13)	0000060
COMMON /SC11R/ ISS (18,2)	0000070
COMMON /SC14R/ KAFF(132,13)	0000080
COMMON /HEA6/ NPIN(42),JPIN(42,3)	0000090
COMMON /IJ1 / NER(42),NIS(42,3)	0000100
COMMON /IND3/ NTYP(42)	0000110
COMMON /MART5/ NSTR	0000120
C	0000130
NR=NER(NS)	0000140
DO 1000 M=1,NR	0000150
NS1=NIS(NS,M)	0000160
IF(NTYP(NS1).NE.3) GO TO 1000	0000170
F=F18	0000180
IF(JPIN(NS1,1).EQ.J) F=F17	0000190
NW1=NS1-NSTR	0000200
L1=ISS(NW1,1)	0000210
NAFF=NAFF+1	0000220
VFAC(L,NAFF)=F	0000230
KAFF(L,NAFF)=L1	0000240
1000 CONTINUE	0000250
C	0000260
RETURN	0000270
END	0000280
	0000290

SUBROUTINE FW7 (L,NAFF,NS,J)	0000010	
C -----	0000010	
C DETECTS THE VIEW-FACTORS OF TYPE F7	0000020	
C	0000030	
COMMON /SC03R/ F1,F2,F3,F4,F5,F6,F7,F8,F9,	0000040	
> F11,F12,F13,F14,F15,F16,F17,F18,F24,F31,F32	0000050	
COMMON /SC04R/ VFAC(132, 13)	0000060	
COMMON /SC12R/ IGI (42,3)	0000070	
COMMON /SC14R/ KAFF(132,13)	0000080	
COMMON /HEA6/ NPIN(42),JPIN(42,3)	0000090	
COMMON /IJ1 / NER(42),NIS(42,3)	0000100	
COMMON /IND3/ NTYP(42)	0000110	
C	0000120	
NR=NER(NS)	0000130	
NP=NPIN(NS)	0000140	
DO 1000 M=1,NR	0000150	
NS1=NIS(NS,M)	0000160	
IF (NTYP(NS1).NE.1) GO TO 1000	0000170	
NP1=NPIN(NS1)	0000180	
DO 500 M1=1,NP1	0000190	
IF(JPIN(NS1,M1).EQ.J) GO TO 500	0000200	
DO 400 M2=1,NP	0000210	
IF(JPIN(NS1,M1).NE.JPIN(NS,M2)) GO TO 400	0000220	
L1=IGI(NS1,M1)	0000230	
NAFF=NAFF+1	0000240	
VFAC(L,NAFF)=F7	0000250	
KAFF(L,NAFF)=L1	0000260	
CONTINUE	0000270	
400	0000280	
500	CONTINUE	0000290
1000	CONTINUE	0000300
C	0000310	
RETURN	0000320	
END	0000330	

SUBROUTINE FW8 (L,NAFF,NS,J)	0000010
C -----	0000010
C DETECTS THE VIEW-FACTORS OF TYPE F8	0000020
C	0000030
COMMON /SC03R/ F1,F2,F3,F4,F5,F6,F7,F8,F9,	0000040
> F11,F12,F13,F14,F15,F16,F17,F18,F24,F31,F32	0000050
COMMON /SC04R/ VFAC(132, 13)	0000060
COMMON /SC12R/ IGI (42,3)	0000070
COMMON /SC14R/ KAFF(132,13)	0000080
COMMON /HEA6/ NPIN(42),JPIN(42,3)	0000090
COMMON /IJ1 / NER(42),NIS(42,3)	0000100
COMMON /IND3/ NTYP(42)	0000110
C	0000120
NR=NER(NS)	0000130
NP=NPIN(NS)	0000140
DO 1000 M=1,NR	0000150
NS1=NIS(NS,M)	0000160
IF (NTYP(NS1).NE.1) GO TO 1000	0000170
NP1=NPIN(NS1)	0000180
DO 500 M1=1,NP1	0000190
DO 400 M2=1,NP	0000200
IF(JPIN(NS1,M1).EQ.JPIN(NS,M2)) GO TO 500	0000210
400 CONTINUE	0000220
L1=IGI(NS1,M1)	0000230
NAFF=NAFF+1	0000240
VFAC(L,NAFF)=F8	0000250
KAFF(L,NAFF)=L1	0000260
500 CONTINUE	0000270
1000 CONTINUE	0000280
C	0000290
RETURN	0000300
END	0000310
	0000320

```
SUBROUTINE GAUDEL (A,B,X,PERC,ITMAX)          0000010
C -----                                     0000020
C   SOLVES A SYSTEM OF LINEAR EQUATIONS USING THE GAUSS-SEIDEL METHOD.0000030
C
C   DIMENSION A(132,13),B(132),X(132)          0000040
C   COMMON /SC01R/ NSECT,NSECP                  0000050
C   COMMON /SC13R/ NAFF(132)                    0000060
C   COMMON /SC14R/ KAFF(132, 13)                 0000070
C
C   DO 100 I=1,NSECT                          0000080
C     X(I)=0.0                                  0000090
100  CONTINUE                                 0000100
C
C   DO 2000 IT=1,ITMAX                         0000110
      BIG=0.0                                  0000120
      DO 1000 L1=1,NSECT                      0000130
        P=B(L1)                                0000140
        NAF=NAFF(L1)                           0000150
        NAF1=NAF+1                            0000160
        DO 500 J=1,NAF                         0000170
          L2=KAFF(L1,J)                      0000180
          P=P-A(L1,J)*X(L2)                  0000190
500
          CONTINUE                               0000200
          TEMP=P/A(L1,NAF1)                   0000210
          TEMP1= ABS( X(L1)/TEMP -1.)         0000220
          IF (TEMP1 .GT. BIG) BIG=TEMP1       0000230
          X(L1)=TEMP                         0000240
1000
          CONTINUE                               0000250
          IF (BIG . LT. PERC) GO TO 3000       0000260
2000
          CONTINUE                               0000270
C
C   NO CONVERGENCE ----- 0000280
C
C   BIG1=BIG*100.                            0000290
C   PER1=PERC*100.                           0000300
C   WRITE(6,2500) IT,BIG1,PER1              0000310
2500 FORMAT( 5X, 'SUB. GAUDEL ',/5X,
>           'NO CONVERGENCE OBTAINED FOR ',I4,' ITERATIONS.',/5X, 0000320
>           'THE MAXIMAL DELTA X IS ',E12.6,' %',/5X, 0000330
>           'THE REQUIRED PRECISION IS ',E12.6,' %',/5X, 0000340
>           'CALCULATION STOPS.')            0000350
      STOP                                    0000360
C
C   -- CONVERGENCE ----- 0000370
C
C   3000 CONTINUE                             0000380
C
C   RETURN                                 0000390
END                                     0000400
```

```
SUBROUTINE GAUSS(A,B,X)          0000010
C ----- 0000020
C      SOLVES THE SYSTEM WITH THE GAUSS METHOD WITH PIVOTAL CONDENSATION 0000030
C                                         0000040
C      DIMENSION A( 34, 34),B( 34),X( 34)          0000050
C      COMMON /SC22C/ NTOT                      0000060
C                                         0000070
C                                         0000080
C      N1=NTOT-1          0000090
DO 1000 N=1,N1          0000100
      CALL PIVOT(A,B,N)          0000110
      I1=N+1          0000120
      DO 800 I=I1,NTOT          0000130
         DM=A(I,N)/A(N,N)          0000140
         DO 600 J=I1,NTOT          0000150
            A(I,J)=A(I,J)-DM*A(N,J)          0000160
600       CONTINUE          0000170
         A(I,N)=0.0          0000180
         B(I)=B(I)-DM*B(N)          0000190
800       CONTINUE          0000200
1000      CONTINUE          0000210
C ----- 0000220
C      BACK SUBSTITUTION ----- 0000230
C                                         0000240
      X(NTOT)=B(NTOT)/A(NTOT,NTOT)          0000250
      I=NTOT-1          0000260
1100     J1=I+1          0000270
      S=0.0          0000280
      DO 1200 J=J1,NTOT          0000290
         S=S+A(I,J)*X(J)          0000300
1200     CONTINUE          0000310
      X(I)=(B(I)-S)/A(I,I)          0000320
      I=I-1          0000330
      IF(I.GT.0) GO TO 1100          0000340
C
      RETURN          0000350
END          0000360
                                         0000370
```



```

FUNCTION GHPLUS(HPLUSW,TW,TBT,PR,YDH,REW,R2MROH,RX,R1)          0000010
C-----0000020
C-----GHPLUS EVALUATES THE FUNCTION G(H+)=G(HW+, PRANDTL, TW/TB, Y/RH) 0000030
C-----0000040
COMMON/DAT1/A1,A2,A3,A4,A5,A6,A7,A8,A9,A10                  0000050
GHPL =(A1*HPLUSW**A2+A3/HPLUSW**A4)                         0000060
IF(GHPL.LE.A9)GHPL=A10                                      0000070
GHPLUS=GHPL*PR**A5*((TW+273.16)/(TBT+273.16))**A6/(A7*(YDH+R2MROH))0000080
*)**A8                                         0000090
RETURN                                         0000100
END                                           0000110

```

```

FUNCTION GKAPPA(X)          0000010
C-----0000020
C GKAPPA EVALUATES THE KAPPA VALUES FOR THE CENTRAL SUBCHANNELS AND 0000030
C THE CENTRAL PORTIONS OF THE WALL SUBCHANNELS ( VALIDITY FOR THE 0000040
C CENTRAL CHANNELS AT 1.2< P/D <1.5)          0000050
C                                              0000060
C
GKAPPA=54.237*(X**2-1.)**3*X**0.342/ABS(3.*X**4-4.*X**2-4.*X**4* 0000070
*ALOG(X)+1.)          0000080
RETURN          0000090
END          0000100

```

```

FUNCTION GRIFUN(EPS)          0000010
C-----0000020
C GRIFUN EVALUATES THE COEFFICIENT K0/2=(KI+KO)/2 FOR THE LOCAL 0000030
C PRESSURE LOSSES AT THE INLET AND AT THE OUTLET OF A SPACER      0000040
C                                                               0000050
C GRIFUN      =0.5*(EPS*0.5+EPS**2)/(1.-EPS)**2                  0000060
C RETURN                                         0000070
C END                                           0000080

```

SUBROUTINE HEATBA(IND,PBT,INDQ,TE,MFLOW)	0000010
C-----	0000020
C HEAT BALANCE FOR THE RODS, THE SHROUD AND THE COOLANT	0000030
C	0000040
COMMON /GASD1/ NSTOT	0000050
COMMON /MART5/ NSTR	0000060
COMMON /SC03C/ NRODS	0000070
COMMON /HEA6/ NPIN(42),JPIN(42,3)	0000080
COMMON /SUB2/ TSCH(42,3),MSCH(42,3)	0000090
COMMON /SUB6/ TSCH1(42,3)	0000100
COMMON /SUB8/ MSCH1(42,3)	0000110
COMMON /HEA5/ QQ(42,3)	0000120
COMMON /QPAR1/ QDEV	0000130
COMMON /SC02R/ P,D,Z,ZWC,H,LENGTH	0000140
COMMON /SC02C/ QJ(19, 42)	0000150
COMMON /IND9/ NTYP(42)	0000160
COMMON /SC06L/ SHQ(18,2)	0000170
COMMON /SC21C/ SHQC(18,2)	0000180
COMMON /SC13C/ GE01(42,3)	0000190
C	0000200
DIMENSION TOCAN(42,3),TOPIN(19),TC(42,3),TGP(19)	0000210
REAL LENGTH,MFLOW,MOUT,MSCH,MSCH1,MMED	0000220
C	0000230
IF(IND) 100,500,1000	0000240
C	0000250
100 CONTINUE	0000260
TOLIN=0.0	0000270
TOROD=0.0	0000280
TOGAS=0.0	0000290
MOUT =0.0	0000300
DO 300 NS=1,NSTOT	0000310
DO 200 M=1,3	0000320
TOCAN(NS,M) = 0.0	0000330
TC(NS,M) = 0.0	0000340
200 CONTINUE	0000350
300 CONTINUE	0000360
DO 400 J=1,NRODS	0000370
TOPIN(J) = 0.0	0000380
TGP(J) = 0.0	0000390
400 CONTINUE	0000400
GO TO 9999	0000410
C	0000420
500 CONTINUE	0000430
TMED=0.0	0000440
MMED=0.0	0000450
DO 900 NS=1,NSTOT	0000460
NP=NPIN(NS)	0000470
DO 800 M=1,NP	0000480
J=JPIN(NS,M)	0000490
TMED=TMED+MSCH(NS,M)*TSCH1(NS,M)	0000500
MMED=MMED+MSCH(NS,M)	0000510
QG=QQ(NS,M)*QDEV/LENGTH/GE01(NS,M)*H	0000520
TOROD=TOROD+QG	0000530
TGP(J)=TGP(J)+QG	0000540
TOPIN(J)=TOPIN(J)+QG+QJ(J,NS)	0000550
TC(NS,M)=TC(NS,M)+QG+QJ(J,NS)	0000560
DT=(TSCH1(NS,M)-TSCH(NS,M))*2.	0000570
Q=MSCH(NS,M)*CP(PBT,TSCH(NS,M))*DT	0000580
TOCAN(NS,M)=TOCAN(NS,M)+Q	0000590
TOGAS=TOGAS+Q	0000600
IF(NTYP(NS) .EQ. 1) GO TO 800	0000610

NSW=NS-NSTR	0000620	
TOLIN=TOLIN+SHQ(NSW,M)	0000630	
TC(NS,M)=TC(NS,M)+SHQ(NSW,M)+SHQC(NSW,M)	0000640	
TOGAS=TOGAS+SHQ(NSW,M)+SHQC(NSW,M)	0000650	
800 CONTINUE	0000660	
900 CONTINUE	0000670	
TMED=TMED/MMED	0000680	
GO TO 9999	0000690	
C	0000700	
1000 CONTINUE	0000710	
F=1.000	0000720	
IF(INDQ.EQ.2) F=4.186	0000730	
TOLIN=TOLIN*F	0000740	
TOROD=TOROD*F	0000750	
TOGAS=TOGAS*F	0000760	
DO 1100 J=1,NRODS	0000770	
TOPIN(J) = TOPIN(J)*F	0000780	
TGP(J) = TGP(J)*F	0000790	
1100 CONTINUE	0000800	
DO 1300 NS=1,NSTOT	0000810	
NP=NPIN(NS)	0000820	
DO 1200 M=1,NP	0000830	
MOUT=MOUT+MSCH1(NS,M)	0000840	
TOCAN(NS,M)=TOCAN(NS,M)*F	0000850	
TC(NS,M) = TC(NS,M)*F	0000860	
1200 CONTINUE	0000870	
1300 CONTINUE	0000880	
WRITE(6,2000)	0000890	
IF(INDQ.EQ.1) WRITE(6,2100)	0000900	
IF(INDQ.EQ.2) WRITE(6,2200)	0000910	
WRITE(6,2300)	0000920	
DO 1400 J=1,NRODS	0000930	
WRITE(6,2400) J,TGP(J),TOPIN(J)	0000940	
1400 CONTINUE	0000950	
WRITE(6,2500)	0000960	
DO 1600 NS=1,NSTOT	0000970	
NP=NPIN(NS)	0000980	
DO 1500 M=1,NP	0000990	
WRITE(6,2600) NS,M,TC(NS,M),TOCAN(NS,M)	0001000	
1500 CONTINUE	0001010	
1600 CONTINUE	0001020	
TOGEN=TOROD+TOLIN	0001030	
DELTA=ABS((TOGEN/TOGAS)-1.)*100.	0001040	
DM= ABS((MFLOW/MOUT)-1.)*100.	0001050	
DELT = TMED - TE	0001060	
WRITE(6,2700) TOROD,TOLIN,TOGEN,TOGAS,DELTA	0001070	
WRITE(6,2800) MFLOW,MOUT,DM	0001080	
WRITE(6,2900) TE,TMED,DELT	0001090	
C	0001100	
9999 RETURN	0001110	
C	0001120	
2000 FORMAT(1H1,//5X,' FINAL BALANCE	UNIT=')	0001130
2100 FORMAT(1H+,40X,'(CAL/SEC), (G/SEC)')	0001140	
2200 FORMAT(1H+,40X,'(WATT) , (G/SEC)')	0001150	
2300 FORMAT(//4X,' PIN HEAT GENERATED',15X,'HEAT TO GAS',/)	0001160	
2400 FORMAT(4X,I3,10X,E12.6,15X,E12.6)	0001170	
2500 FORMAT(//4X,' CHANNEL M HEAT TRANSMITTED ',	0001180	
> ' HEAT INCREASE',/)	0001190	
2600 FORMAT(6X,I3,7X,I1,5X,E12.6,12X,E12.6)	0001200	
2700 FORMAT(//5X,' TOTAL POWER GENERATED IN THE RODS =',E12.6,	0001210	
> /5X,' TOTAL POWER GENERATED IN THE SHROUD =',E12.6,	0001220	
> /5X,' TOTAL POWER GENERATED =',E12.6,	0001230	
> /5X,' TOTAL POWER INCREASE IN THE GAS =',E12.6,	0001240	
> /5X,' (SUM OF THE PARTIAL M*CP*DT) ',	0001250	
> /5X,' PERCENTUAL ERROR =',F5.2,' %')	0001260	

2800 FORMAT(//5X,' INLET MASS FLOW RATE	=',E12.6,	0001270
> /5X,' OUTLET MASS FLOW RATE	=',E12.6,	0001280
> /5X,' ERROR	=',F5.2,', %')	0001290
2900 FORMAT(//5X,' INLET TEMPERATURE	=',F6.2,', C',	0001300
> /5X,' OUTLET TEMPERATUE (AVERAGE)	=',F6.2,', C',	0001310
> /5X,' TEMPERATURE INCREASE	=',F6.2,', C')	0001320
C		0001330
C		0001340
END		0001350

SUBROUTINE HEATI(NSTOT,NSTR,NSEL,NROMA,IPA) 0000010
C-----0000020
C HEATI EVALUATES THE HEAT FLUXES QQ(NS,I) FOR THE RODS ADJACENT TO 0000030
C EACH CHANNEL NS AND THE TOTAL FLUXES QT(NS) ENTERING EACH 0000040
C CHANNEL NS. HEATI IDENTIFIES ALSO THE CONNECTIONS BETWEEN THE 0000050
C SUBCHANNELS I AND THE ADJACENT RODS BY MEANS OF THE MATRIX JPIN 0000060
C (NPIN(NS)= NR. OF SUBCH. IN CH. NS = NR. OF PINS ADJ. TO CH. NS) 0000070
C 0000080
C VERSION FOR HEXAGONAL BUNDLES 0000090
C0000100
COMMON/IND1/NROW(42),NUMS(42)/HEA2/Q(3, 18),Q0/HEA3/QT(42) 0000110
1 /HEA5/QQ(42,3)/HEA6/NPIN(42),JPIN(42,3)/HEA7/IDPIN(3, 18)0000120
2 /IND4/NUM3(4),NUM6(4),NUM12(4),NUM18(4),NUM24(4),NUM30(4), 0000130
3 NUM36(4)/HEA10/QSCH(42,3)/HEA1/QQQ(19)/IND3/NTYP(42) 0000140
4 /GASD2/RAPPAI(42,3) 0000150
C 0000160
IF(NSEL.EQ.4)GOTO 100 0000290
CALL HEATR(NROMA) 0000300
C 0000310
NAN=1 0000320
NBN=-NROMA 0000330
NN=1-NROMA 0000340
DO 15 NS=1,NSTOT 0000350
NUM=NUMS(NS) 0000360
NRO=NROW(NS) 0000370
IF(NS.GT.NSTR)GOTO 12 0000380
C 0000390
C CENTRAL CHANNELS AND SUBCHANNELS 0000400
IF(NUM.GT.NUM6(NRO))GOTO 1 0000410
NAM=NUM 0000420
N1=0 0000430
N2=0 0000440
GOTO 6 0000450
1 IF(NUM.GT.NUM12(NRO))GOTO 2 0000460
NAM=NUM-NUM6(NRO) 0000470
N1=NRO 0000480
N2=N1-1 0000490
GOTO 6 0000500
2 IF(NUM.GT.NUM18(NRO))GOTO 3 0000510
NAM=NUM-NUM12(NRO) 0000520
N1=2*NRO 0000530
N2=N1-2 0000540
GOTO 6 0000550
3 IF(NUM.GT.NUM24(NRO))GOTO 4 0000560
NAM=NUM-NUM18(NRO) 0000570
N1=3*NRO 0000580
N2=N1-3 0000590
GOTO 6 0000600
4 IF(NUM.GT.NUM30(NRO))GOTO 5 0000610
NAM=NUM-NUM24(NRO) 0000620
N1=4*NRO 0000630
N2=N1-4 0000640
GOTO 6 0000650
5 NAM=NUM-NUM30(NRO) 0000660
N1=5*NRO 0000670
N2=N1-5 0000680
6 IF(NAM.EQ. NAM/2*2)GOTO 8 0000690
NUR=(NAM+1)/2+N1 0000700
Q1=Q(NRO,NUR) 0000710
JPIN(NS,1)=IDPIN(NRO,NUR) 0000720

IF(NUR.EQ.6*NRO) NUR=0	0000730
Q2=Q(NRO,NUR+1)	0000740
JPIN(NS,3)=IDPIN(NRO,NUR+1)	0000750
IF(NRO.EQ.1)GOTO 7	0000760
NUR=(NAM+1)/2+N2	0000770
IF(NUR.EQ. 6*NRO-5) NUR=1	0000780
Q3=Q(NRO-1,NUR)	0000790
JPIN(NS,2)=IDPIN(NRO-1,NUR)	0000800
GOTO 9	0000810
7 Q3=Q0	0000820
JPIN(NS,2)=1	0000830
GOTO 9	0000840
8 NUR=NAM/2+N2	0000850
Q1=Q(NRO-1,NUR)	0000860
JPIN(NS,1)=IDPIN(NRO-1,NUR)	0000870
IF(NUR.EQ.6*NRO-6) NUR=0	0000880
Q2=Q(NRO-1,NUR+1)	0000890
JPIN(NS,3)=IDPIN(NRO-1,NUR+1)	0000900
NUR=(NAM+2)/2+N1	0000910
Q3=Q(NRO,NUR)	0000920
JPIN(NS,2)=IDPIN(NRO,NUR)	0000930
9 CONTINUE	0000940
QQ(NS,1)=Q1	0000950
QQ(NS,2)=Q3	0000960
QQ(NS,3)=Q2	0000970
IF(NSEL.EQ.3 .AND. NUM.EQ.NRO)GOTO 10	0000980
NPIN(NS)=3	0000990
GOTO 11	0001000
10 Q2=0.	0001010
Q3=Q3/2.	0001020
NPIN(NS)=2	0001030
11 QT(NS)=(Q1+Q2+Q3)/6.	0001040
QSCH(NS,1)=Q1/6.	0001050
QSCH(NS,2)=Q3/6.	0001060
QSCH(NS,3)=Q2/6.	0001070
GOTO 15	0001080
C	0001090
C	0001100
12 IF(NUM.LT.NAN)GOTO 14	0001110
C	0001120
C CORNER CHANNELS	0001130
NN=NN+NROMA	0001140
NAN=NAN+NRO	0001150
NBN=NBN+NRO	0001160
NPIN(NS)=1	0001170
QQ(NS,1)=Q(NROMA,NN)	0001180
JPIN(NS,1)=IDPIN(NROMA,NN)	0001190
IF(NSEL.EQ.3)GOTO 13	0001200
IF((NSEL.EQ.2 .AND. NUM.EQ.1).OR.(NSEL.EQ.2 .AND. NUM.EQ.NUM18(NR00001210	
*))GOTO 13	0001220
QT(NS)=Q(NROMA,NN)/6.	0001230
GOTO 29	0001240
13 QT(NS)=Q(NROMA,NN)/12.	0001250
29 QSCH(NS,1)=QT(NS)	0001260
GOTO 15	0001270
C	0001280
C WALL CHANNELS AND SUBCHANNELS	0001290
14 NUR=NUM-NBN+NN-1	0001300
Q1=Q(NROMA,NUR)	0001310
JPIN(NS,1)=IDPIN(NROMA,NUR)	0001320
IF(NS.EQ.NSTOT .AND. NSEL.EQ.1) NUR=0	0001330
Q2=Q(NROMA,NUR+1)	0001340
JPIN(NS,2)=IDPIN(NROMA,NUR+1)	0001350
QQ(NS,1)=Q1	0001360
QQ(NS,2)=Q2	0001370

```
IF(NSEL.EQ.3 .AND. NUM.EQ.(NRO/2+1) .AND. NRO.EQ.NRO/2*2)GOTO 30 0001380
NPIN(NS)=2
GOTO 31
0001390
0001400
0001410
0001420
0001430
0001440
0001450
0001460
0001470
30 Q2=0.
NPIN(NS)=1
31 CONTINUE
QT(NS)=(Q1+Q2)/4.
QSCH(NS,1)=Q1*0.25
QSCH(NS,2)=Q2*0.25
15 CONTINUE
C ADDED AT GA(NSEL=4)
GOTO 104
0001480
0001490
100 CONTINUE
DO 103 NS=1,NSTOT
0001500
NP=NPIN(NS)
0001510
QT(NS)=0.
0001520
0001530
DO 102 M=1,NP
0001540
JPINNM=JPIN(NS,M)
0001550
QQ(NS,M)=QQ(JPINNM)
0001560
IF(NTYP(NS).EQ.2)GOTO 101
0001570
QSCH(NS,M)=QQ(NS,M)/6.*RAPPAL(NS,M)
0001580
GOTO 102
0001590
101 QSCH(NS,M)=QQ(NS,M)*0.25
0001600
102 QT(NS)=QT(NS)+QSCH(NS,M)
0001610
103 CONTINUE
0001620
104 CONTINUE
0001630
9998 CONTINUE
0001650
IF(IPA.NE.IPA/2*2)RETURN
0001670
C
C
0001680
0001690
WRITE(6,16)
0001700
16 FORMAT(////5X,'RESULTS OF HEATI'////8X,'CHANNEL',3(21X,'ROD',2X)/)0001710
DO 19 NS=1,NSTOT
0001720
NP=NPIN(NS)
0001730
WRITE(6,18)NS,(M,NS,M,JPIN(NS,M),M=1,NP)
0001740
18 FORMAT(2X,I10,3(3X,I1,'')JPIN('',I5,'',I2,'')='',I5)) 0001750
19 CONTINUE
0001760
RETURN
0001770
END
0001780
```

SUBROUTINE HEATR(NROMA) 0000010

C----- 0000020

C HEATR PROVIDES INDICES TO THE ROD HEAT FLUXES (Q(NRO,NUM)) AND 0000030

C IDENTIFIES THE PINS BY MEANS OF THE MATRIX IDPIN 0000040

C 0000050

C EXISTS ONLY IN THE VERSION FOR HEXAGONAL BUNDLES 0000060

C 0000070

COMMON/HEA1/Q(19)/HEA2/QQ(3, 18),QQ0/HEA7/IDPIN(3, 18) 0000080

I=1 0000090

QQ0=Q(1) 0000100

DO 2 NRO=1,NROMA 0000110

NR36=6*NRO 0000120

DO 1 NUM=1, NR36 0000130

I=I+1 0000140

IDPIN(NRO,NUM)=I 0000150

1 QQ(NRO,NUM)=Q(I) 0000160

2 CONTINUE 0000170

RETURN 0000180

END 0000190

SUBROUTINE INDEX(NSEL,NROMA,NSTR,NSTOT,NRO)	0000010
C-----	0000020
C INDEX PROVIDES INDICES TO THE CHANNELS	0000030
C	0000040
C VERSION FOR HEXAGONAL BUNDLES	0000050
C	0000060
COMMON/IND1/NROW(42),NUMS(42)/IND2/NOT(4,30)/IND3/NTYP(42)	0000070
1/IND4/NUM3(4),NUM6(4),NUM12(4),NUM18(4),NUM24(4),NUM30(4),NUM36(4)	0000080
IF(NSEL.EQ.4)GOTO 100	0000090
NS=1	0000100
DO 6 NRO=1,NROMA	0000110
NUM3(NRO)=NRO	0000120
NUM6(NRO)=2*NRO-1	0000130
NUM12(NRO)=2*NUM6(NRO)	0000140
NUM18(NRO)=3*NUM6(NRO)	0000150
NUM24(NRO)=4*NUM6(NRO)	0000160
NUM30(NRO)=5*NUM6(NRO)	0000170
NUM36(NRO)=6*NUM6(NRO)	0000180
IF(NSEL-2)1,2,3	0000190
1 NUMSP=NUM36(NRO)	0000200
GOTO4	0000210
2 NUMSP=NUM18(NRO)	0000220
GOTO4	0000230
3 NUMSP=NUM3(NRO)	0000240
4 CONTINUE	0000250
DO 5 NUM=1,NUMSP	0000260
NUMS(NS)=NUM	0000270
NROW(NS)=NRO	0000280
NOT(NRO,NUM)=NS	0000290
NTYP(NS)=1	0000300
5 NS=NS+1	0000310
6 CONTINUE	0000320
NSTR=NS-1	0000330
NRO=NROMA+1	0000340
NUM3(NRO)=NRO/2+1	0000350
NUM6(NRO)=NRO+1	0000360
NUM12(NRO)=NUM6(NRO)+NRO	0000370
NUM18(NRO)=NUM12(NRO)+NRO	0000380
NUM24(NRO)=NUM18(NRO)+NRO	0000390
NUM30(NRO)=NUM24(NRO)+NRO	0000400
NUM36(NRO)=NUM30(NRO)+NROMA	0000410
IF(NSEL-2)7,8,9	0000420
7 NUMSP=NUM36(NRO)	0000430
GOTO 10	0000440
8 NUMSP=NUM18(NRO)	0000450
GOTO 10	0000460
9 NUMSP=NUM3(NRO)	0000470
10 NAN=1	0000480
DO 13 NUM=1,NUMSP	0000490
IF(NUM.EQ.NAN)GOTO 11	0000500
NTYP(NS)=2	0000510
GOTO 12	0000520
11 NTYP(NS)=3	0000530
NAN=NAN+NRO	0000540
12 NUMS(NS)=NUM	0000550
NROW(NS)=NRO	0000560
NOT(NRO,NUM)=NS	0000570
13 NS=NS+1	0000580
NSTOT=NS-1	0000590
C ADDED AT GA(NSEL=4)	0000600
100 IF(NSEL.EQ.4)NRO=NROMA+1	0000610

```

      WRITE(6,14)NRO,NSEL,NSTR,NSTOT          0000620
14 FORMAT( //4X,'RESULTS OF INDEX'//5X,'NROWS=',I2,5X,'TYPE OF SECTION',
     *ON=',I1,5X,'NR. OF CENTRAL CHANNELS=',I4,5X,'TOTAL NUMBER OF CHANNELS',
     *ELS=',I4//)                            0000630
      CALL CONNIJ(NSTR,NSTOT,NROMA,NSEL)      0000640
      RETURN                                  0000650
      END                                     0000660

```

```
SUBROUTINE INGE(NROMA,NSEL,NSTR,NSTOT,C,A,D,ATC,ATW,ATA,PIG,PCORR,0000010
*CTU1,CTU2,DETC,DETW,EM1) 0000020
C-----0000030
C      INGE EVALUATES THE TURBULENT MIXING CONSTANTS CTURB(I,J) FOR THE 0000040
C      THE CHANNEL EXCHANGES AND CTURB1(K) (K=1,2) FOR THE SUBCHANNEL 0000050
C      EXCHANGES. FURTHERMORE INGE EVALUATES THE CONSTANTS CCOND(I,J) 0000060
C      AND CCOND1(K) FOR THE ENTHALPY EXCHANGE DUE TO CONDUCTION IN GAS 0000070
C                                         0000080
C      VERSION FOR HEXAGONAL BUNDLES 0000090
C.....0000100
COMMON /IND3/NTYP( 42)/IJ1/NER( 42),NIS( 42,3) 0000110
COMMON/IND1/NROW( 42),NUMS( 42) 0000120
1      /TUR1/CTURB( 42,3)/GEN5/DE( 42)/GE00/ACH(3)/TUR2/CTURB1(2) 0000130
2      /COND0/FCOND/COND1/CCOND( 42,3)/COND2/CCOND1(2) 0000140
3      /GEN2/AREA( 42) 0000150
REAL NGAPS( 42) 0000160
DIMENSION SUM( 42) 0000170
WRITE(6,101) 0000180
101 FORMAT(//5X,'MIXING COEFFICIENTS (WITHOUT PCORR CORRECTION: ')
SQ3=SQRT(3.)
R=D*0.5 0000190
A2=A**2 0000200
A3=A*A2 0000210
R2=R**2 0000220
A4=R*R2 0000230
APIN=PIG*R2 0000240
EM2=C*0.5-EM1 0000250
ZWC=EM2/SQ3 0000260
ATW3=EM2*ZWC 0000270
GAP1=C-D 0000280
GAP2=GAP1*0.5 0000290
GAP3=A-R 0000300
YBC=C*0.5/SQ3 0000310
YBW3=A-ZWC/3. 0000320
XBWS3=C*0.5-EM2/3. 0000330
YBW=(A**2*C*0.5-2./3.*R3-YBW3*ATW3)/ATW 0000340
XBWS=2.* (A*C**2*0.125-R3/3.-XBWS3*ATW3*0.5)/ATW 0000350
XBA=(5./36.*A3-(A/SQ3-R/PIG)*APIN/6.)/(A2/SQ3-APIN/6.) 0000360
YBA=XBA*SQ3 0000370
YBA=XBA*SQ3 0000380
YBA=XBA*SQ3 0000390
YBA=XBA*SQ3 0000400
YBA=XBA*SQ3 0000410
YBA=XBA*SQ3 0000420
YBA=XBA*SQ3 0000430
YBA=XBA*SQ3 0000440
YBA=XBA*SQ3 0000450
YBA=XBA*SQ3 0000460
YBA=XBA*SQ3 0000470
YBA=XBA*SQ3 0000480
YBA=XBA*SQ3 0000490
YBA=XBA*SQ3 0000500
YBA=XBA*SQ3 0000510
YBA=XBA*SQ3 0000520
AS1=GAP1*YBC 0000530
AS2=GAP1*YBW 0000540
AS3=C*0.5*GAP3 0000550
AS4=(A/SQ3-XBA)*GAP3 0000560
R1A1=AS1/AP1 0000570
R1A2=AS2/AP2 0000580
R1A3=AS3/AP3 0000590
R1A4=AS4/AP4 0000600
DO 10 I=1,NSTOT 0000610
```

```
ITYP=NTYP(I)                                0000620
GOTO (1,2,4),ITYP                            0000630
1 SUM(I)=3.*R1A1                            0000640
    GOTO 3                                 0000650
2 SUM(I)=R1A2+2.*R1A3                      0000660
3 NGAPS(I)=3.                                0000670
    GOTO 10                               0000680
4 SUM(I)=2.*R1A4                            0000690
    NGAPS(I)=2.                           0000700
10 CONTINUE                                0000710
    DO 24 I=1,NSTOT                         0000720
        NTYPI=NTYP(I)                         0000730
        AREAII=ACH(NTYPI)                      0000740
        RAPPI=AREA(I)/AREAI                  0000750
        NI=NER(I)                            0000760
        DO 23 M=1,NI                          0000770
            J=NIS(I,M)                         0000780
            NTYPJ=NTYP(J)                      0000790
            AREAJJ=ACH(NTYPJ)                   0000800
            RAPPJ=AREA(J)/AREAJ                0000810
            RAPGAP=1.                           0000820
            IF(ABS(RAPPI-1.) .GT. 0.1 .AND. ABS(RAPPJ-1.) .GT. 0.1)RAPGAP=0.5 0000830
            IF(I .GT. NSTR)GOTO 16             0000840
            IF(NTYP(J).EQ.2)GOTO 15             0000850
            DELTA      =DELTA1                 0000860
            RAPPA=RA1                           0000870
            GOTO 17                           0000880
15 DELTA      =DELTA2                     0000890
            RAPPA=RA2                           0000900
17 GAP=GAP1*RAPGAP                         0000910
            GOTO 22                           0000920
16 IF(NTYP(I).EQ.3)GOTO 20                 0000930
    IF(NTYP(J)-2)15,19,20                   0000940
19 DELTA      =DELTA3                     0000950
            RAPPA=RA3                           0000960
            GOTO 21                           0000970
20 DELTA      =DELTA4                     0000980
            RAPPA=RA4                           0000990
21 GAP      =GAP3                        0001000
22 CONTINUE                                0001010
    DEIJ=(AREAI+AREAJ)/(AREAI/DE(I)+AREAJ/DE(J)) 0001020
    YH   = 1.14*SQRT((NGAPS(I)+NGAPS(J))/(SUM(I)+SUM(J)))*RAPPA**2 0001030
    WRITE(6,100)M,I,J,YH                    0001040
100 FORMAT(3(5X,I5,') YH(' ,I3,' ,',I2,' )=' ,E15.7)) 0001050
    CTURB( I,M)=YH*GAP/DELTA*DEIJ*0.05*PCORR 0001060
    CCOND(I,M)=GAP/DELTA*FCOND*0.5           0001070
23 CONTINUE                                0001080
24 CONTINUE                                0001090
    WRITE(6,102)                           0001100
102 FORMAT(//)
    DELSC1=C-(7.*C**3/48.-R3)/(0.25*C**2-PIG*R2*SQ3/6.) 0001120
    DELSC2=C-2.*XBWS                         0001130
    CTURB1(1)=CTU1*0.05*DETC*YBC/DELSC1 0001140
    CTURB1(2)=CTU2*0.05*DETW*(A-ZWC)/DELSC2 0001150
    CCOND1(1)=YBC/DELSC1*FCOND*0.5          0001160
    CCOND1(2)=(A-ZWC)/DELSC2*FCOND*0.5       0001170
    RETURN                                     0001180
    END                                         0001190
```

```
SUBROUTINE INLCON(NSTOT,MFLOW,ATOT,TE,IREAD1,NSTR)          0000010
C-----0000020
C   SUBROUTINE INLCON FIXES THE INLET CONDITIONS FOR MASS FLOW RATES 0000030
C   AND BULK TEMPERATURES OF THE CHANNELS AND THE SUBCHANNELS AND FOR 0000040
C   THE BULK TEMPERATURES OF THE TWO PORTIONS OF THE WALL SUBCHANNELS 0000050
C                                         0000060
C
C   REAL MFLOW,MI,MSCH1,MSCW1,MSCH                           0000070
C   COMMON/IND3/NTYP( 42)/SUB2/TSCH( 42,3),MSCH( 42,3)/SUB22/TW( 42,3)0000080
C   1      /GEN2/A( 42)/GEN3/MI( 42)/GEN4/TEMP( 42)           0000090
C   2      /HEA6/NPIN( 42),JPIN( 42,3)                      0000100
C   3      /SUB1/ASCH( 42,3)/SUB6/TSCH1( 42,3)/SUB8/MSCH1( 42,3) 0000110
C   4      /WCSE2/MSCWC1( 18,2,2)/WCSE5/TSCWC1( 18,2,2)       0000120
C   IF(IREAD1.EQ.2)GOTO 3                                    0000130
C   .....0000140
C   IREAD1=1 MEANS UNIFORM DISTRIBUTIONS                     0000150
C                                         0000160
C   DO 2 NS=1,NSTOT                                         0000170
C   MI(NS)=MFLOW*A(NS)/ATOT                                0000180
C   TEMP(NS)=TE                                              0000190
C   NP=NPIN(NS)                                             0000200
C   DO 1 M=1,np                                            0000210
C   MSCH1(NS,M)=MFLOW*ASCH(NS,M)/ATOT                      0000220
C   TSCH1(NS,M)=TE                                         0000230
C   IF(NTYP(NS).NE.2)GOTO 1                                 0000240
C   DO 6 JWC=1,2                                           0000250
C   TSCWC1(NS-NSTR,M,JWC)=TE                               0000260
C   1 CONTINUE                                              0000270
C   2 CONTINUE                                              0000280
C   GOTO 1000                                              0000290
C   .....0000300
C   IREAD1=2 MEANS NON-UNIFORM DISTRIBUTIONS               0000310
C                                         0000320
C   3 CONTINUE                                              0000330
C   READ(5,4)(MI(NS),TEMP(NS),NS=1,NSTOT)                 0000340
C   DO 5 NS= 1,NSTOT                                       0000350
C   NSW=NS-NSTR                                           0000360
C   NP=NPIN(NS)                                            0000370
C   READ(5,4)(MSCH1(NS,M),TSCH1(NS,M),M=1,np)            0000380
C   IF(NTYP(NS).EQ.2)READ(5,4)((MSCWC1(NSW,M,JWC),TSCWC1(NSW,M,JWC),
C   * JWC=1,2),M=1,2)                                     0000390
C   4 FORMAT(8F10.5)                                         0000400
C   5 CONTINUE                                              0000410
C   1000 CONTINUE                                         0000420
C   DO 1001 NS=1,NSTOT                                     0000430
C   NP=NPIN(NS)                                            0000440
C   DO 1001 M=1,np                                       0000450
C   MSCH(NS,M)=MSCH1(NS,M)                                0000460
C   TSCH(NS,M)=TSCH1(NS,M)                                0000470
C   TW(NS,M)=TSCH(NS,M)                                  0000480
C   1001 CONTINUE                                         0000490
C   RETURN                                                 0000500
C   END                                                   0000510
C                                         0000520
```

SUBROUTINE INQUA(NSEL,NSTOT,NROMA,ATC,ATW,ATA,DETC,DETW,DETA) 0000010
C-----0000020
C INQUA PROVIDES INDICES TO CHANNEL FLOW AREAS AND EQUIVALENT 0000030
C DIAMETERS AND TO SUBCHANNEL FLOW AREAS 0000040
C 0000050
C VERSION FOR THE EXAGONAL BUNDLES 0000060
C0000070
COMMON/IND1/NROW(42),NUMS(42)/IND3/NTYP(42)/SUB1/ASCH(42,3) 0000080
1 /GEN2/A(42)/GEN5/DE(42) 0000090
2 /HEA6/NPIN(42),JPIN(42,3)/GASD2/RAPPAI(42,3) 0000100
II=0 0000110
KK=0 0000120
DO 10 NS=1,NSTOT 0000130
A(NS)=0. 0000140
NP=NPIN(NS) 0000150
IF(NTYP(NS)-2)1,3,6 0000160
C***** CENTRAL CHANNELS AND SUBCHANNELS*****0000170
1 DE(NS)=DETC 0000180
IF(NSEL.EQ.4)GOTO 100 0000190
ASCH(NS,1)=ATC/3. 0000200
IF((NSEL.EQ.3).AND.(NROW(NS).EQ.NUMS(NS)))GOTO 2 0000210
A(NS)=ATC 0000220
ASCH(NS,2)=ASCH(NS,1) 0000230
ASCH(NS,3)=ASCH(NS,1) 0000240
GOTO 10 0000250
2 CONTINUE 0000260
A(NS)=ATC/2. 0000270
ASCH(NS,2)=ATC/6. 0000280
GOTO 10 0000290
C ADDED AT GA (NSEL=4) 0000300
100 CONTINUE 0000310
DO 101 M=1,NP 0000320
ASCH(NS,M)=ATC/3.*RAPPAI(NS,M) 0000330
101 A(NS)=A(NS)+ASCH(NS,M) 0000340
GOTO 10 0000350
C***** WALL CHANNELS AND SUBCHANNELS*****0000360
3 DE(NS)=DETW 0000370
C MODIFIED AT GA 0000380
DO 4 M=1,NP 0000390
ASCH(NS,M)=ATW*0.5 0000400
4 A(NS)=A(NS)+ASCH(NS,M) 0000410
GOTO 10 0000420
C***** CORNER CHANNELS AND SUBCHANNELS*****0000430
6 DE(NS)=DETA 0000440
IF(NSEL.EQ.4)GOTO 5 0000450
IF(NSEL.EQ.1)GOTO 7 0000460
IF(NSEL.EQ.3)GOTO 9 0000470
IF(II.EQ.0 .OR. KK.EQ.2) GOTO 8 0000480
KK=KK+1 0000490
7 CONTINUE 0000500
A(NS)=ATA 0000510
ASCH(NS,1)=A(NS) 0000520
GOTO 10 0000530
8 II=1 0000540
9 CONTINUE 0000550
A(NS)=ATA /2. 0000560
ASCH(NS,1)=A(NS) 0000570
C ADDED AT GA (NSEL=4) 0000580
GOTO 10 0000590
5 ASCH(NS,1)=ATA*RAPPAI(NS,1) 0000600
A(NS)=ASCH(NS,1) 0000610
10 CONTINUE 0000620
RETURN 0000630
END 0000640

SUBROUTINE JELLA (JL)	0000010
C -----	0000020
C PRINT THERMAL DATA	0000030
C	0000040
COMMON /SUB22/ TW(42,3)	0000050
COMMON /HEA6 / NPIN(42),JPIN(42,3)	0000060
COMMON /GASD1/ NSTOT	0000070
COMMON /MART5/ NSTR	0000080
COMMON /SC03C/ NRODS	0000090
COMMON /SC99C/ TD(42,3)	0000100
COMMON /SC14C/ TBOLD(42,3)	0000110
COMMON /SC26C/ TBR(42,3),TBS(18,2)	0000120
COMMON /SUB2 / TSCH(42,3),MSCH(42,3)	0000130
COMMON /SC02C/ QJ(19, 42)	0000140
COMMON /MART / ITCORR	0000150
COMMON /SC06L/ SHQ(18,2)	0000160
COMMON /SC21C/ SHQC(18,2)	0000170
COMMON /SC15C/ ALFA(42,3)	0000180
COMMON /SC17C/ SALFA(18,2)	0000190
COMMON /SC08R/ QPR(42,3)	0000200
COMMON /SC09R/ QSR(18,2)	0000210
COMMON /HEA5 / QQ(42,3)	0000220
COMMON /QPAR1/ QDEV	0000230
COMMON /SC02R/ P,D,Z,ZWC,H,LENGTH	0000240
COMMON /SC13C/ GEO1(42,3)	0000250
COMMON /SHROUD/ TLINER(18,2)	0000260
COMMON /SC08C/ TLD(18,2)	0000270
COMMON /SC10C/ ANU(42,3)	0000280
COMMON /SC16C/ SNU(18,2)	0000290
COMMON /SC18C/ RE,RI,ALFW,ALFC	0000300
COMMON /DAT/ PIG	0000310
COMMON /IND3/ NTYP(42)	0000320
COMMON /LAMIN5/ RTIP(7)	0000330
COMMON /INPAR/ IPA	0000340
COMMON /CEV04/ LAMOP3	0000350
COMMON /SC33C/ TWINF(42,3)	0000360
COMMON /SC01Z/ YH(42,3)	0000370
C	0000380
REAL LENGTH	0000390
C	0000400
DU=D	0000410
IF(LAMOP3.EQ.1) DU=RTIP(IPA)*2.	0000420
C	0000430
WRITE(6,50) ITCORR	0000440
WRITE(6,100)	0000450
C	0000460
WRITE(6,110)	0000470
C	0000480
200 DO 1010 JP=1,NRODS	0000490
C	0000500
DO 1000 NS=1,NSTOT	0000510
NSW=NS-NSTR	0000520
NP=NPIN(NS)	0000530
DO 500 M=1,np	0000540
JJ=JPIN(NS,M)	0000550
IF(JJ.NE.JP) GO TO 500	0000560
AREA=PIG*DU*H/GEO1(NS,M)	0000570
QUNIF=QQ(NS,M)*QDEV/LENGTH/GEO1(NS,M)*4.186*H	0000580
QTOT=(QUNIF+QJ(JP,NS)*4.186)/AREA	0000590
QRAD=QPR(NS,M)*4.186	0000600
WALFA=ALFA(NS,M)*4.186	0000610

DELT4=	TW(NS,M)-TD(NS,M)	0000620
DELT5=	TSCH(NS,M)-TBOLD(NS,M)	0000630
IF (JL.LT. 0) GO TO 400		0000640
IF (JL.EQ. JP)GO TO 400		0000650
GO TO 500		0000660
400	WRITE(6,9000) NS,JP,QUNIF,QRAD,QTOT,	0000670
>	ANU(NS,M),YH(NS,M),WALFA,TSCH(NS,M),	0000680
>	TBR(NS,M),TWINF(NS,M),TW(NS,M)	0000690
500	CONTINUE	0000700
1000	CONTINUE	0000710
1010	CONTINUE	0000720
C	IF (JL .GT. 0) GO TO 9999	0000730
C	WRITE(6,9200)	0000740
	WRITE(6,100)	0000750
	WRITE(6,110)	0000760
C	NSTR1=NSTR+1	0000770
DO 2000	NS=NSTR1,NSTOT	0000780
	NSW=NS-NSTR	0000790
	NP=NPIN(NS)	0000800
DO 1500	M=1,NP	0000810
	ALF=ALFW	0000820
	IF(NTYP(NS).EQ.3) ALF=ALFC/GEO1(NS,M)*6.0	0000830
	AREA=RI*ALF*H	0000840
	JP=JPIN(NS,M)	0000850
	QLINER=SHQ(NSW,M)*4.1860	0000860
	QTOT=(SHQ(NSW,M)+SHQC(NSW,M))/AREA*4.1860	0000870
	QRAD=QSR(NSW,M)*4.1860	0000880
	WALFA=SALFA(NSW,M)*4.1860	0000890
	ZZ=1.0	0000900
	WRITE(6,9000) NS,JP,QLINER,QRAD,QTOT,	0000910
>	SNU(NSW,M),ZZ,WALFA,TSCH(NS,M),TBS(NSW,M),	0000920
>	TLINER(NSW,M),TLINER(NSW,M)	0000930
1500	CONTINUE	0000940
2000	CONTINUE	0000950
C	WRITE(6,9200)	0000960
9999	RETURN	0000970
50	FORMAT(' JELLA, ITCORR = ',I3,//)	0000980
100	FORMAT(' CHA. ROD QGEN ',	0000990
>	T26,' QRAD',	0001000
>	T37,' QFLUX',	0001010
>	T50,' NU ',	0001020
>	T62,' YH ',	0001030
>	T75,' ALFA ',	0001040
>	T87,' TBULK ',	0001050
>	T98,' TB R ',	0001060
>	T110,' TWINE ',	0001070
>	T122,' TWALL ')	0001080
110	FORMAT(' W. ',	0001090
>	T26,' W ',	0001100
>	T37,' W/CM**2 ',	0001110
>	T50,' ',	0001120
>	T61,' ',	0001130
>	T72,' W/CM**2 C ',	0001140
>	T88,' C ',	0001150
>	T99,' C ',	0001160
>	T110,' C ',	0001170
>	T122,' C ',/)	0001180
9000	FORMAT(' ',I3,2X,I3,10(2X,E10.4))	0001190
9200	FORMAT(//)	0001200
END		0001210
		0001220
		0001230
		0001240
		0001250
		0001260

SUBROUTINE JELLB (JL,PBT)	0000010	
C-----	0000020	
C PRINT SUBCHANNEL DATA.	0000030	
C CAUTION: JELLB CAN BE CALLED ONLY BY THE MAIN PROGRAM.	0000040	
C (BECAUSE OF PBT)	0000050	
C THE MEANING OF TSCH1,MSCH1 VARIES TROUGH THE PROGRAM.	0000060	
C-----	0000070	
COMMON /HEA6/ NPIN(42),JPIN(42,3)	0000080	
COMMON /GASD1/ NSTOT	0000090	
COMMON /MART5/ NSTR	0000100	
COMMON /SUB1/ ASCH(42,3)	0000110	
COMMON /SUB2/ TSCH(42,3),MSCH(42,3)	0000120	
COMMON /SUB6/ TSCH1(42,3)	0000130	
COMMON /SUB8/ MSCH1(42,3)	0000140	
COMMON /SUB5/ LAMSCH(42,3)	0000150	
COMMON /MOB8/ DPNS(42)	0000160	
COMMON /GEN5/ DE(42)	0000170	
COMMON /LAMIN4/ F2ATIP(42,3), F2DTIP(42,3)	0000180	
COMMON /SC02C/ QJ(19, 42)	0000190	
COMMON /HEA5/ QQ(42,3)	0000200	
COMMON /QPAR1/ QDEV	0000210	
COMMON /SC13C/ GE01(42,3)	0000220	
COMMON /SC02R/ P,D,Z,ZWC,H,LENGTH	0000230	
C-----	0000240	
REAL LAMSCH,MSCH,MSCH1,KAPPA,LENGTH	0000250	
C-----	0000260	
C-----	0000270	
WRITE(6,1001)	0000280	
WRITE(6,1002)	0000290	
WRITE(6,1003)	0000300	
DO 1000 NS=1,NSTOT	0000310	
NSW=NS-NSTR	0000320	
NP=NPIN(NS)	0000330	
DO 500 M=1,NP	0000340	
JP=JPIN(NS,M)	0000350	
QUNIF=QQ(NS,M)*QDEV/LENGTH/GE01(NS,M)*4.186*H	0000360	
QTOT=(QUNIF+QJ(JP,NS)*4.186)	0000370	
CPX=CP(PBT,TSCH(NS,M))*4.186	0000380	
ROX=RHO(PBT,TSCH(NS,M))	0000390	
ETX=ETA(PBT,TSCH(NS,M))	0000400	
XKA=KAPPA(PBT,TSCH(NS,M))*4.186	0000410	
M2=2.*MSCH(NS,M)-MSCH1(NS,M)	0000420	
CCCCCC	T=(2.*MSCH(NS,M)*TSCH(NS,M)-MSCH1(NS,M)*TSCH1(NS,M))/0000430	
CCCC >	MSCH1(NS,M)	0000440
>	RE=MSCH(NS,M)*DE(NS)*F2DTIP(NS,M)/	0000450
C	(ASCH(NS,M)*F2ATIP(NS,M)*ETA(PBT,TSCH(NS,M)))	0000460
DT=T-TSCH(NS,M)	0000470	
DT=(TSCH(NS,M)-TSCH1(NS,M))*2.0	0000480	
PD=DPNS(NS)*0.980667	0000490	
IF (JL.LT. 0) GO TO 400	0000500	
IF (JL.EQ. JP)GO TO 400	0000510	
GO TO 500	0000520	
400	WRITE(6,1004) NS,JP,QTOT,MSCH(NS,M),CPX,DT,	0000530
>	LAMSCH(NS,M),PD,RE,ROX,XKA,ETX	0000540
500	CONTINUE	0000550
1000	CONTINUE	0000560
	WRITE(6,1005)	0000570
C		0000580
9999 RETURN	0000590	
1001 FORMAT(1H1,5X,' SUBR. JELLB')	0000600	

1002 FORMAT(	'CHA. ROD QTRA ',	0000610
>	T26,' MASS ',	0000620
>	T37,' CP ',	0000630
>	T51,' T2-T1 ',	0000640
>	T62,' LAMDA ',	0000650
>	T75,' DP ',	0000660
>	T87,' REB ',	0000670
>	T98,' DENSITY ',	0000680
>	T109,' TH.COND. ',	0000690
>	T122,' ETA ')	0000700
1003 FORMAT(	' W ',	0000710
>	T26,' G/SEC ',	0000720
>	T38,' J/G C ',	0000730
>	T51,' C ',	0000740
>	T60,' ',	0000750
>	T75,' BAR ',	0000760
>	T88,' ',	0000770
>	T99,' G/CM3 ',	0000780
>	T110,' W/CM C ',	0000790
>	T122,' G/CM S ',/)	0000800
1004 FORMAT(,I3,2X,I3,10(2X,E10.4))		0000810
1005 FORMAT(//)		0000820
END		0000830

```
SUBROUTINE JELLC (JL,TE,TE1,BIOT)          0000010
C-----0000020
C PRINT SUBCHANNEL DATA.                   0000030
C CAUTION: JELLC CAN BE CALLED ONLY BY THE MAIN PROGRAM. 0000040
C (BECAUSE OF PBT,TE,TE1,BIOT)           0000050
C                                         0000060
C DIMENSION BIOT( 42,3)                  0000070
C                                         0000080
COMMON /HEA6 /  NPIN( 42),JPIN( 42,3)      0000090
COMMON /GASD1/ NSTOT                      0000100
COMMON /MART5/ NSTR                       0000110
COMMON /SUB2 /  TSCH( 42,3),MSCH( 42,3)    0000120
COMMON /SUB22/ TW( 42,3)                   0000130
COMMON /SUB23/ HPLUSB( 42,3),HPLUSW( 42,3),QPLUS( 42,3),
>          PRB( 42,3),YODH( 42,3)           0000140
COMMON /PARTB/ TEMPB( 42,3),XMASSB( 42,3),YDH(42,3) 0000150
COMMON /SC32C/ GHPIU( 42,3)                0000160
COMMON /DAT1 /  00,01,02,03,04,05,016,017,018,019 0000170
COMMON /DAT2 /  06,07,08,09,010,011,012,013,014,015 0000180
COMMON /DAT6 /  IRHPL                      0000190
C                                         0000200
C                                         0000210
C                                         0000220
REAL MSCH                                0000230
C                                         0000240
C                                         0000250
WRITE(6,1001)                            0000260
WRITE(6,1002)                            0000270
DO 1000 NS=1,NSTOT                      0000280
  NSW=NS-NSTR                         0000290
  NP=NPIN(NS)                         0000300
  DO 500 M=1,NP                         0000310
    GOTO(100,200),IRHPL                 0000320
100   HPLUS=HPLUSW(NS,M)                 0000330
    GO TO 300                           0000340
200   HPLUS=HPLUSB(NS,M)                 0000350
300   CONTINUE                           0000360
  JP=JPIN(NS,M)                        0000370
  RHP=RHPLUS(HPLUSB(NS,M),TW(NS,M),TE1,QPLUS(NS,M),
>          HPLUSW(NS,M),TEMPB(NS,M),YODH(NS,M)) 0000380
  R01=(06+07/HPLUS**08)**09            0000390
  RSM=2.5+5.5* ALOG(HPLUS)             0000400
  TWE=(TW(NS,M)+273.16)/(TE+273.16)   0000410
  TWB=(TW(NS,M)+273.16)/(TSCH(NS,M)+273.16) 0000420
  G01=GHPIU(NS,M)/(PRB(NS,M)**04*TWB**05)*
>          (016*YDH(NS,M))**017        0000430
  IF ( JL.LT. 0) GO TO 400             0000440
  IF ( JL.EQ. JP)GO TO 400            0000450
  GO TO 500                           0000460
400   WRITE(6,1004) NS,JP,HPLUSB(NS,M),HPLUSW(NS,M),
>          RSM,R01,RHP,G01,GHPIU(NS,M),TWB,TWE,BIOT(NS,M) 0000470
500   CONTINUE                           0000480
1000  CONTINUE                           0000490
  WRITE(6,1005)                         0000500
C                                         0000510
C                                         0000520
9999 RETURN                               0000530
1001 FORMAT(1H1,5X,' SUBR. JELLC',//)     0000540
1002 FORMAT(' CHA. ROD      H+B ',
>          T26,' H+W ',                  0000550
>          T37,' RSM ',                  0000560
>          T50,' R01 ',                  0000570
                                         0000580
                                         0000590
                                         0000600
```

```
>      T62,' RH+ ',          0000610
>      T75,' GO1 ',          0000620
>      T87,' GH+ ',          0000630
>      T98,' TW/TB ',        0000640
>      T109,' TW/TE ',       0000650
>      T122,' BIOT ')        0000660
1004 FORMAT(' ',I3,2X,I3,10(2X,E10.4))
1005 FORMAT( //)
      END                      0000670
                                0000680
                                0000690
```

SUBROUTINE JZURU

```
C -----
C DETERMINES THE ARRAY JZUR(J,NS)  (INDEX OF THE SUBCHANNEL OF CHAN0000030
C NEL NS ADJACENT TO PIN J).          0000040
C                                         0000050
      COMMON /GASD1/ NSTOT             0000060
      COMMON /SC03C/ NRODS              0000070
      COMMON /SC05C/ JZUR( 19, 42)       0000080
      COMMON /HEA6 / NPIN( 42),JPIN( 42,3) 0000090
C                                         0000100
      DO 300 J=1,NRODS                0000110
        DO 200 NS=1,NSTOT               0000120
          NP=NPIN(NS)                  0000130
          DO 100 M=1,NP                 0000140
            IF(JPIN(NS,M).EQ.J) JZUR(J,NS)=M 0000150
100           CONTINUE                  0000160
200           CONTINUE                  0000170
300           CONTINUE                  0000180
      RETURN                         0000190
      END                           0000200
```

SUBROUTINE KAPCOR(NSTOT,NSTR) 0000010
C -----0000020
C KAPCOR COMPUTES THE KAPPA VALUES FOR THE LAMINAR CALCULATIONS 0000030
C (IF IKAPPA=1, OTHERWISE SAVES THE VALUES OF BLOCK DATA) AND 0000040
C CORRECTS THE KAPPA VALUES OF THE CORNER AND WALL CHANNELS IF IT IS0000050
C DESIRED TO HAVE THERE ABOUT THE SAME VALUE OF (LAMBDA/EQ. DIAM.) 0000060
C 0000070
COMMON/LAMIN2/FATIP(3),FDTIP(3)/IND3/NTYP(42)/GEN2/A(42)/GEN5/ 0000080
1 DE(42)/INPAR/IPA/LAMINK/BKAPPA(7,3)/LAMIN1/AKAPPA(42) 0000090
2 /MART2/NS1,NS2/WALLCO/WFC01(18,2),WFC0(18,2) 0000100
3 /WAKA1/IKAPPA 0000110
COMMON /WALLKA/ AKAWC(2) 0000120
COMMON /SC02L/ JLAM 0000140
C 0000150
AKAWC(1)=BKAPPA(IPA,2) 0000170
AKAWC(2)=BKAPPA(IPA,2) 0000180
IF(IKAPPA.EQ.1)CALL SELAWA 0000190
DO 5 NS=1,NSTOT 0000200
IF(NS.LE.NSTR)GOTO 3 0000210
DO 4 I=1,2 0000220
WFC0 (NS-NSTR,I)=1. 0000230
4 WFC01(NS-NSTR,I)=1. 0000240
3 ITYP=NTYP(NS) 0000250
AKAPPA(NS)=BKAPPA(IPA,ITYP) 0000260
5 CONTINUE 0000270
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 0000280
IF (JLAM .EQ. 1) CALL CORKA 0000290
CCCCCCCCCCCCCCCCCCCCCCCCCCCC 0000300
IF(NS1.EQ.0 .AND. NS2.EQ.0)GOTO 35 0000310
IF(NS1.GT.NSTR .AND. NS2.LE.NSTOT)GOTO 9 0000320
WRITE(6,6)NS1,NS2 0000330
6 FORMAT(1H1,5X,'SUB. KAPCOR',
> /5X,'STOP BECAUSE NS1=',I5,', AND NS2=',I5) 0000340
STOP 0000350
C 0000360
9 AT=0. 0000370
PP=0. 0000380
DO 10 NS=NS1,NS2 0000390
ITYP=NTYP(NS) 0000400
CCCCCCCCCCCCCCCCCCCCCCCCCCCC 21.09.1979 0000410
C ATIP=A(NS)*FATIP(NS) 0000420
CCCCCCCCCCCCCCCCCCCCCCCCCCCC 0000430
ATIP=A(NS)*FATIP(ITYP) 0000440
CCCCCCCCCCCCCCCCCCCCCCCCCCC 0000450
PP=PP+ATIP*(DE(NS)*FDTIP(ITYP))**2/BKAPPA(IPA,ITYP) 0000460
10 AT=AT+ATIP 0000470
PP=AT/PP 0000480
DO 20 NS=NS1,NS2 0000490
ITYP=NTYP(NS) 0000500
20 AKAPPA(NS)=(DE(NS)*FDTIP(ITYP))**2*PP 0000510
C 0000520
35 CONTINUE 0000530
DO 29 NS=1,NSTOT 0000540
ITYP=NTYP(NS) 0000550
29 WRITE(6,30)NS,AKAPPA(NS),BKAPPA(IPA,ITYP) 0000560
30 FORMAT(5X,'CHANNEL',I5,' : USED KAPPA=',F10.3,' (INPUT KAPPA=' 0000570
* ,F10.3,')') 0000580
RETURN 0000590
END 0000600
0000610

REAL FUNCTION KAPPA(P,T) 0000010
C----- 0000020
C KAPPA EVALUATES THE THERMAL CONDUCTIVITY OF THE COOLANT 0000030
C (CAL/CM S K) 0000040
C 0000050
C COMMON/GASD4/IGAS 0000060
GOTO(10,20,30,40),IGAS 0000070
10 CONTINUE 0000080
C CASE OF HELIUM COOLANT 0000090
C 0000100
KAPPA=35.1E-05*((T+273.16)/273.16)**0.66 0000110
RETURN 0000120
C 0000130
20 CONTINUE 0000140
C CASE OF CO2 COOLANT 0000150
C 0000160
PP=P 0000170
TT=T 0000180
P=PP/1.0333 0000190
T=TT+273.16 0000200
TO=273.16 0000210
TF=TO/T 0000220
IF(P-1.) 4,4,5 0000230
4 ECL = P-1. 0000240
GO TO 6 0000250
5 ECL = (P -1.)**1.25 0000260
6 IF(T-TO-725.) 1,1,2 0000270
1 CA=3.4943E2 0000280
CB=1.6768E5 0000290
CC=2.7331E7 0000300
GO TO 3 0000310
2 CA=4.0476E2 0000320
CB=1.5904E5 0000330
CC=-1.9206E7 0000340
3 CLAMO=(SQRT(T))/(CA+(CB/T)+(CC/(T*T))) 0000350
CLAMF=CLAMO*(1.+2.14E-3*ECL*(TF**2.36)) 0000360
KAPPA=CLAMF/360. 0000370
P=PP 0000380
T=TT 0000390
RETURN 0000400
C 0000410
30 CONTINUE 0000420
C CASE OF N2 COOLANT. 0000430
C 0000440
TT=T 0000450
T=TT+273.16 0000460
XLA0 = 1.99E-3*T**.5/(1.+188./T*10.**(-12./T)) 0000470
KAPPA = XLA0*(1.+1.74E-3*(P/1.033-1.)*(273.16/T))/360. 0000480
T=TT 0000490
C 0000500
RETURN 0000510
40 CONTINUE 0000520
KAPPA=0. 0000530
RETURN 0000540
END 0000550

REAL FUNCTION KFUEL (TEMP) 0000010
C ----- 0000020
C COMPUTES THE THERMAL CONDUCTIVITY OF THE FUEL. (CAL/SEC*CM*C) 0000030
C 0000040
C KFUEL = (16.5 + 0.0132 * TEMP) / 4.186 * 1.E-02 0000050
C 0000060
C RETURN 0000070
C END 0000080

SUBROUTINE KGAP 0000010
C ----- 0000020
C DETERMINES THE HEAT TRANSFER COEFFICIENT BETWEEN FUEL AND CLAD. 0000030
C (CAL/SEC CM2 C) 0000040
C 0000050
C COMMON /SC20C/ CGAP 0000060
C 0000070
C CGAP = 2200.0 / 4.186 * 1.E-04 0000080
C RETURN 0000090
C END 0000100

REAL FUNCTION KINF(BIOT) 0000010
C ----- 0000020
C KINF EVALUATES THE K INFINITE VALUE 0000030
C 0000040
C COMMON/BIDAT/BI1,BI2,BI3 0000050
KINF=BI1+BI2*BIOT+BI3*BIOT**2 0000060
C RETURN 0000070
C END 0000080

REAL FUNCTION KMET(TW) 0000010
C KMET EVALUATES THE CONDUCTIVITY OF THE PIN CANNING 0000020
C ----- 0000030
C 0000040
C COMMON/DATKM/D1(7),D2(7) /INPAR/IPA 0000050
COMMON /SC06C/ D3(3) 0000060
C 0000070
C KMET = D3(1) + D3(2)*TW + D3(3)*TW**2 0000080
C KMET=D1(IPA)+D2(IPA)*TW 0000090
C RETURN 0000100
C END 0000110

SUBROUTINE LEIST (VDIAM,PIG,H,VDIA1,RINT) 0000010
C ----- 0000020
C ORGANIZES THE CALCULATION OF THE THERMAL CONDUCTION WITHIN THE PIN0000030
C IN THE CASE OF CONDUCTION WITHIN THE PIN ONLY (POWER GENERATED IN0000040
C THE CAN). 0000050
C 0000060
C DIMENSION A(6,6),B(6),X(6) 0000070
C 0000080
COMMON /SC01C/ NCAN(19),LIPS(19,10) 0000090
COMMON /SC03C/ NRODS 0000100
COMMON /SC05C/ JZUR(19, 42) 0000110
COMMON /SC07C/ H1 0000120
COMMON /SC11C/ FALFA(42,3) 0000130
COMMON /SC12C/ GEO(42,3) 0000140
COMMON /SC08R/ QPR(42,3) 0000150
COMMON /HEA5 / QQ(42,3) 0000160
COMMON /SUB22/ TW(42,3) 0000170
COMMON /SC26C/ TBR(42,3),TBS(18,2) 0000180
COMMON /QPAR1/ QDEV 0000190
C 0000200
REAL KMET 0000210
C 0000220
C ALFAC PROVIDES FOR EACH CHANNEL THE CONVECTIVE HEAT TRANSFER CO. 0000230
CALL ALFAC(VDIA1,H) 0000240
C 0000250
CALL FGEO(VDIAM,RS,S,R,RINT) 0000260
C ----- 0000270
C 0000280
C DETERMINES THE COEFFICIENTS FOR THE LINEAR SYSTEM. 0000290
C 0000300
DO 1000 J=1,NRODS 0000310
NCA=NCAN(J) 0000320
IF (NCA-1) 1000,900,100 0000330
100 IF (NCA .EQ. 3) GO TO 710 0000340
DO 700 K=1,NCA 0000350
KP=K-1 0000360
KD=K+1 0000370
IF (K .EQ. NCA) KD=1 0000380
IF (K .EQ. 1) KP=NCA 0000390
C 0000400
NS1=LIPS(J,K) 0000410
NSD=LIPS(J,KD) 0000420
NSP=LIPS(J,KP) 0000430
MZ1= JZUR(J,NS1) 0000440
MZD= JZUR(J,NSD) 0000450
M2P= JZUR(J,NSP) 0000460
C 0000470
TP=(TW(NS1,MZ1) + TW(NSP,MZP)) * 0.5 0000480
TD=(TW(NS1,MZ1) + TW(NSD,MZD)) * 0.5 0000490
FP=KMET(TP)*H*S/(R*(GEO(NS1,MZ1)+GEO(NSP,MZP))) 0000500
FD=KMET(TD)*H*S/(R*(GEO(NS1,MZ1)+GEO(NSD,MZD))) 0000510
C 0000520
DO 500 L=1,6 0000530
A(K,L)=0.0 0000540
IF(L.EQ.K) A(K,L)=FALFA(NS1,MZ1) + FP + FD 0000550
IF(L.EQ.KP) A(K,L)= - FP 0000560
IF(L.EQ.KD) A(K,L)= - FD 0000570
TBULK=TBR(NS1,MZ1) 0000580
B(K) = QQ(NS1,MZ1)*QDEV*H1*(GEO(NS1,MZ1)/PIG) + 0000590
TBULK*FALFA(NS1,MZ1) + QPR(NS1,MZ1) 0000600

500	CONTINUE	0000610
C		0000620
700	CONTINUE	0000630
C	GO TO 790	0000640
C		0000650
710	DO 730 K=1,NCA	0000660
	DO 720 L=1,6	0000670
	A(K,L)=0.0	0000680
720	CONTINUE	0000690
730	CONTINUE	0000700
C		0000710
	NS1=LIPS(J,1)	0000720
	NS2=LIPS(J,2)	0000730
	NS3=LIPS(J,3)	0000740
C		0000750
	MZ1=JZUR(J,NS1)	0000760
	MZ2=JZUR(J,NS2)	0000770
	MZ3=JZUR(J,NS3)	0000780
C		0000790
	T12=(TW(NS1,MZ1) + TW(NS2,MZ2)) * 0.5	0000800
	T23=(TW(NS2,MZ2) + TW(NS3,MZ3)) * 0.5	0000810
	F12=KMET(T12)*H*S/(R*(GEO(NS1,MZ1)+GEO(NS2,MZ2)))	0000820
	F23=KMET(T23)*H*S/(R*(GEO(NS2,MZ2)+GEO(NS3,MZ3)))	0000830
C		0000840
	A(1,1) = FALFA(NS1,MZ1) + F12	0000850
	A(1,2) = - F12	0000860
	A(2,1) = - F12	0000870
	A(2,2) = FALFA(NS2,MZ2) + F12 + F23	0000880
	A(2,3) = - F23	0000890
	A(3,2) = - F23	0000900
	A(3,3) = FALFA(NS3,MZ3) + F23	0000910
C		0000920
>	B(1) = QQ(NS1,MZ1)*QDEV*H1*(GEO(NS1,MZ1)/PIG) +	0000930
>	TBR(NS1,MZ1)*FALFA(NS1,MZ1) +	0000940
>	QPR(NS1,MZ1)	0000950
>	B(2) = QQ(NS2,MZ2)*QDEV*H1*(GEO(NS2,MZ2)/PIG) +	0000960
>	TBR(NS2,MZ2)*FALFA(NS2,MZ2) +	0000970
>	QPR(NS2,MZ2)	0000980
>	B(3) = QQ(NS3,MZ3)*QDEV*H1*(GEO(NS3,MZ3)/PIG) +	0000990
>	TBR(NS3,MZ3)*FALFA(NS3,MZ3) +	0001000
>	QPR(NS3,MZ3)	0001010
C		0001020
790	CONTINUE	0001030
C	-----	0001040
C	LINAL SOLVES THE SYSTEM. THE NEW TEMPERATURES ARE IN THE	0001050
C	FIELD X.	0001060
C		0001070
C	CALL LINAL(A,NCA,6,A,B,1,6,X)	0001080
C	CALL GAUSS1(A,B,X,NCA,6)	0001090
C		0001100
C	-----	0001110
C	ASSIGNE THE NEW TEMPERATURES TO THE ARRAY TW.	0001120
C	CALL TNEW(NCA,X,J,6)	0001130
C	-----	0001140
C	DETERMINES THE HEAT EXCHANGED BY CONDUCTION.	0001150
900	CALL QCOC (NCA,J,X,6)	0001160
C		0001170
1000	CONTINUE	0001180
C	-----	0001190
C		0001200
	RETURN	0001210
	END	0001220

SUBROUTINE LINPOW	0000010
C-----	0000020
C INITIALIZATION OF THE HEAT GENERATED IN THE SHROUD (CAL/SEC)	0000030
C	0000040
COMMON /SC06L/ SHQ(18,2)	0000050
COMMON /GASD1/ NSTOT	0000060
COMMON /QPAR2/ QLINM,QLDEV	0000070
COMMON /SC03L/ IPHUD	0000080
COMMON /SC04L/ TAMB,HUDFAC,TMS	0000090
COMMON /MART5/ NSTR	0000100
COMMON /HEA6/ NPIN(42),JPIN(42,3)	0000110
COMMON /SC02R/ DUM1,DUM2,DUM3,DUM4,H,LENGTH	0000120
COMMON /SUB2/ TSCH(42,3),MSCH(42,3)	0000130
COMMON /IND3/ NTYP(42)	0000140
COMMON /QPAR3/ PERL(3)	0000150
COMMON /SUB1/ ASCH(42,3)	0000160
COMMON /GEO0/ ACH(3)	0000170
COMMON /SC05L/ PERLT	0000180
C	0000190
REAL LENGTH	0000200
C	0000210
NSTR1=NSTR+1	0000220
DO 1000 NS=NSTR1,NSTOT	0000230
NSW=NS-NSTR	0000240
ITYP=NTYP(NS)	0000250
NP=NPIN(NS)	0000260
DO 900 M=1,NP	0000270
SHFLUX=QLINM*QLDEV/LENGTH	0000280
IF(IPHUD .EQ. 1)	0000290
> SHFLUX=HUDFAC/PERLT*(TSCH(NS,M)-TAMB)	0000300
SHQ(NSW,M)=SHFLUX*H*PERL(ITYP)*ASCH(NS,M)/ACH(ITYP)	0000310
900 CONTINUE	0000320
1000 CONTINUE	0000330
C	0000340
RETURN	0000350
END	0000360

```
SUBROUTINE MATBUI(A,B)          0000010
C -----
C   BUILDS THE ARRAY OF COEFFICIENTS FOR THE SYSTEM OF EQUATIONS OF 0000020
C   RADIANT EXANGE.          0000030
C
C   DIMENSION A(132, 13),B(132)          0000040
C
C   COMMON /SC01R/  NSECT,NSECP          0000050
C   COMMON /SC04R/  VFAC(132, 13)         0000060
C   COMMON /SC06R/  ISU(132,2)           0000070
C   COMMON /SC07R/  EPSR,EPSS,SIGMA      0000080
C   COMMON /SC13R/  NAFF(132)            0000090
C   COMMON /SC14R/  KAFF(132,13)          0000100
C   COMMON /MART5/  NSTR                0000110
C   COMMON /SUB22/  TW( 42,3)             0000120
C   COMMON /SHROUD/ TLINER( 18,2)          0000130
C
C   DO 1000 L1=1,NSECT          0000140
C     NAF1=NAFF(L1)          0000150
C     NAF11=NAF1+1           0000160
C     DA=DAREA(L1)           0000170
C     NS1=ISU(L1,1)           0000180
C     M1 =ISU(L1,2)           0000190
C     NW1=NS1-NSTR           0000200
C     T0 = TW(NS1,M1)          0000210
C     IF(L1.GT.NSECP) T0= TLINER(NW1,M1)
C     T1 =(T0+273.16)**4      0000220
C     EPS1=EPS(T0,L1)          0000230
C
C     KAFF(L1,NAF11)=L1        0000240
C     B(L1)= -SIGMA*T1          0000250
C     A(L1,NAF11)= -1./EPS1      0000260
C
C     DO 500 K=1,NAF1          0000270
C       L2=KAFF(L1,K)           0000280
C       NS2=ISU(L2,1)           0000290
C       M2 =ISU(L2,2)           0000300
C       NW2=NS2-NSTR           0000310
C       T0 = TW(NS2,M2)          0000320
C       IF(L2.GT.NSECP) T0= TLINER(NW2,M2)
C       EPS2=EPS(T0,L2)          0000330
C       T2 =(T0+273.16)**4      0000340
C
C       B(L1)=B(L1)+SIGMA*T2*VFAC(L1,K)/DA
C       IF(L1.EQ.L2) GO TO 100
C
C       A(L1,K)=VFAC(L1,K)/DA*(1.0-EPS2)/EPS2
C       GO TO 200
C
100    >     A(L1,NAF11)= A(L1,NAF11) +
C                  VFAC(L1,K)/DA*(1.0-EPS2)/EPS2
C
200    A(L1,K)=0.0          0000490
C
C      CONTINUE          0000500
C
500    CONTINUE          0000510
C
1000   CONTINUE          0000520
C
C      RETURN          0000530
C
END          0000540
C
C          0000550
C
C          0000560
C
C          0000570
C
C          0000580
```

SUBROUTINE MATBUS(A,B)	0000010
C -----	0000020
C BUILDS THE ARRAY OF COEFFICIENTS FOR THE CONDUCTION WITHIN THE	0000030
C SHROUD.	0000040
C	0000050
DIMENSION A(34, 34),B(34)	0000060
C	0000070
COMMON /SC17C/ SALFA(18,2)	0000080
COMMON /SC18C/ RE,RI,ALFW,ALFC	0000090
COMMON /SC02R/ P,D,Z,ZWC,H,ENG	0000100
COMMON /SC09R/ QSR(18,2)	0000110
COMMON /SC06L/ SHQ(18,2)	0000120
COMMON /MART5/ NSTR	0000130
COMMON /GASD1/ NSTOT	0000140
COMMON /SC13C/ GEO1(42,3)	0000150
COMMON /SC22C/ NTOT	0000160
COMMON /SC24C/ NSEL	0000170
COMMON /SHROUD/ TLINER(18,2)	0000180
COMMON /HEA6/ NPIN(42),JPIN(42,3)	0000190
COMMON /SC26C/ TBR(42,3),TBS(18,2)	0000200
COMMON /IND3/ NTYP(42)	0000210
C	0000220
REAL KMET	0000230
C	0000240
NSW=NSTOT-NSTR	0000250
RM=(RE+RI)/2.	0000260
S=RE-RI	0000270
C	0000280
DO 20 N=1,NTOT	0000290
B(N)=0.0	0000300
DO 10 L=1,NTOT	0000310
A(N,L)=0.0	0000320
10 CONTINUE	0000330
20 CONTINUE	0000340
C	0000350
N=0	0000360
DO 1000 NW=1,NSW	0000370
NS=NW+NSTR	0000380
NP=NPIN(NS)	0000390
DO 900 M=1,NP	0000400
NSP=0	0000420
MP=0	0000430
NSD=0	0000440
MD=0	0000450
N=N+1	0000470
ALF=ALFW	0000480
IF(NTYP(NS).EQ.3) ALF=ALFC*6.0/GEO1(NS,1)	0000490
B(N)=SHQ(NW,M)+QSR(NW,M)+	0000500
> ALF*H*RI*SALFA(NW,M)*TBS(NW,M)	0000510
IF(N.EQ.1 .AND. NSEL.NE.1) GO TO 300	0000520
IF(M.EQ.2) GO TO 100	0000530
NSP=NS-1	0000540
IF(N.EQ.1) NSP=NSTOT	0000550
MP=2	0000560
IF(NTYP(NSP).EQ.3) MP=1	0000570
GO TO 200	0000580
100 CONTINUE	0000590
NSP=NS	0000600
MP=1	0000610
200 CONTINUE	0000620
NWP=NSP-NSTR	0000630

	TM=(TLINER(NWP,MP)+TLINER(NW,M))*0.5	0000640
	ALP=ALFW	0000650
	IF(NTYP(NSP).EQ.3) ALP=ALFC*6.0/GEO1(NSP,1)	0000660
	AP=KMET(TM)*S*H/(RM*(ALF+ALP)*0.5)	0000670
	N1=N-1	0000680
	IF(N.EQ.1) N1=NTOT	0000690
	A(N,N1)=-AP	0000700
	GO TO 400	0000710
300	AP=0.0	0000720
400	CONTINUE	0000730
C		0000740
	IF(N.EQ.NTOT .AND. NSEL.NE.1) GO TO 700	0000750
	IF(M.EQ.1 .AND. NTYP(NS).EQ.2) GO TO 500	0000760
	NSD=NS+1	0000770
	IF(N.EQ.NTOT) NSD=NSTR+1	0000780
	MD=1	0000790
	GO TO 600	0000800
500	CONTINUE	0000810
	NSD=NS	0000820
	MD=2	0000830
600	CONTINUE	0000840
	NWD=NSD-NSTR	0000850
	TM=(TLINER(NWD,MD)+TLINER(NW,M))*0.5	0000860
	ALD=ALFW	0000870
	IF(NTYP(NSD).EQ.3) ALD=ALFC*6.0/GEO1(NSD,1)	0000880
	AD=KMET(TM)*S*H/(RM*(ALD+ALF)*0.5)	0000890
	ND=N+1	0000900
	IF(N.EQ.NTOT) ND=1	0000910
	A(N,ND)=-AD	0000920
	GO TO 800	0000930
700	CONTINUE	0000940
	AD=0.0	0000950
800	CONTINUE	0000960
	A(N,N)=AD+AP+SALFA(NW,M)*ALF*H*RI	0000970
C		0000980
900	CONTINUE	0000990
1000	CONTINUE	0001000
C		0001010
	IF(N.EQ.NTOT) GO TO 9999	0001020
	WRITE(6,2000) NTOT,N	0001030
2000	FORMAT ('SUB. MATBUS; NTOT = ',I4,' N = ',I4,5X,	0001040
	> 'CALCULATION STOPS.')	0001050
	STOP	0001060
C		0001070
9999	RETURN	0001080
	END	0001090

SUBROUTINE MEZZI(NRODS,NSEL,NSTOT)	0000010
C -----	0000020
C DETERMINES THE ARRAYS GEO1 AND GEO	0000030
C	0000040
COMMON /HEA6/ NPIN(42),JPIN(42,3)	0000050
COMMON /IND3/ NTYP(42)	0000060
COMMON /SC12C/ GEO(42,3)	0000070
COMMON /SC13C/ GEO1(42,3)	0000080
COMMON /SC24C/ NNSEL	0000090
C	0000100
PIG=3.141593	0000110
NNSEL=NSEL	0000120
C	0000130
DO 200 NS=1,NSTOT	0000140
NP=NPIN(NS)	0000150
DO 100 M=1,NP	0000160
GEO1(NS,M)=6.	0000170
IF(NTYP(NS) .EQ. 2) GEO1(NS,M)=4.	0000180
100 CONTINUE	0000190
200 CONTINUE	0000200
C	0000210
IF(NSEL .EQ. 1) GO TO 900	0000220
IF(NRODS .NE. 12) GO TO 300	0000230
C	0000240
GEO1(2,2)=12.	0000250
GEO1(6,1)=12.	0000260
GO TO 900	0000270
300 IF(NSEL .GT. 2) GO TO 500	0000280
DO 400 NS=1,NSTOT	0000290
IF (NTYP(NS) .EQ. 3) GO TO 460	0000300
400 CONTINUE	0000310
WRITE(6,420)	0000320
420 FORMAT(/5X,'SUB. MEZZI, ERROR IN LOOP 400',/5X,	0000330
> 'CALCULATION STOPS.')	0000340
STOP	0000350
460 GEO1(NS,1)=12.	0000360
GEO1(NSTOT,1)=12.	0000370
GO TO 900	0000380
500 DO 550 NS=1,NSTOT	0000390
IF(NTYP(NS) .EQ. 3) GEO1(NS,1)=12.	0000400
550 CONTINUE	0000410
900 CONTINUE	0000420
C	0000430
DO 1000 NS=1,NSTOT	0000440
NP=NPIN(NS)	0000450
DO 950 M=1,NP	0000460
GEO(NS,M)=PIG/GEO1(NS,M)	0000470
950 CONTINUE	0000480
1000 CONTINUE	0000490
RETURN	0000500
END	0000510

SUBROUTINE MODFQD(I,NI,NJ,A,EXF)	0000010
C-----	0000020
C MODFQD COMPUTES THE COEFFICIENTS A OF THE INTEGRAL PROFILES OF	0000030
C POWER	0000040
C	0000050
DIMENSION A(7,7)	0000060
DO 10 J=1,NJ	0000070
AJ=J	0000080
10 A(I,J)=A(I,J)/(AJ*EXF**AJ)	0000090
RETURN	0000100
END	0000110

SUBROUTINE NEWTON(R0,R1,R2)	0000010
C-----	0000020
C NEWTON FINDS R2 IN THE LAMINAR CALCULATIONS OF THE CENTRAL	0000030
C SUBCHANNELS AND THE CENTRAL PORTIONS OF THE WALL SUBCHANNELS	0000040
C BY MEANS OF THE NEWTON ITERATION METHOD	0000050
C	0000060
R2P=2.*R0-R1	0000070
A=-0.5/R0**2	0000080
B=- ALOG(R1)+0.5*(R1/R0)**2	0000090
C=2.*A	0000100
DO 10 IT=1,20	0000110
F=A LOG(R2P)+A*R2P**2+B	0000120
DF=1./R2P+C*R2P	0000130
R2=R2P-F/DF	0000140
IF(ABS(R2/R2P-1).LE.1.E-04)GOTO 20	0000150
10 R2P=R2	0000160
WRITE(6,15)R2	0000170
15 FORMAT(/5X,'STOP IN SUBROUTINE NEWTON ; R2=' ,E15.5)	0000180
STOP	0000190
20 RETURN	0000200
END	0000210

```
SUBROUTINE NORMA(TOT,L)          0000010
C ----- 0000020
C   NORMALIZATION OF THE COMPUTED VIEW FACTORS. 0000030
C                                                 0000040
C
C   COMMON /SC01R/ NSECT,NSECP          0000050
C   COMMON /SC04R/ VFAC(132, 13)        0000060
C   COMMON /SC13R/ NAFF(132)           0000070
C   COMMON /SC14R/ KAFF(132,13)         0000080
C   COMMON /SC16R/ ICOMP               0000090
C
C   IF(ICOMP.GT.0) GO TO 200          0000100
C
C   ALL VIEW-FACTORS ARE COMPENSED (ICOMP=0) 0000110
C   SUM=0.0                           0000120
C   NAF=NAFF(L)                      0000130
C   DO 100 K=1,NAF                   0000140
C     VFAC(L,K)=VFAC(L,K)/DAREA(L)+VFAC(L,K)/DAREA(L)*(1-TOT)/TOT 0000150
C     SUM=SUM+VFAC(L,K)              0000160
C     VFAC(L,K)=VFAC(L,K)*DAREA(L) 0000170
100    CONTINUE                         0000180
      GO TO 400                         0000190
C
C   GO.210
C   THE VIEW-FACTOR FII IS USED FOR THE COMPENSATION (ICOMP=1) 0000200
200    CONTINUE                         0000210
      NA1=NAFF(L)+1                   0000220
      VFAC(L,NA1)=(1.0-TOT)*DAREA(L) 0000230
      SUM=0.0                           0000240
      DO 300 K=1,NA1                  0000250
        SUM=SUM+VFAC(L,K)/DAREA(L)    0000260
300    CONTINUE                         0000270
      400 CONTINUE                     0000280
      IF ((SUM-1.) .GT. 0.01) WRITE(6,1001) SUM 0000290
C
C   RETURN                            0000300
1001  FORMAT( 5X,'NORMA, ERROR: SUM=',E12.6) 0000310
END                                0000320
                                         0000330
                                         0000340
                                         0000350
                                         0000360
                                         0000370
```

SUBROUTINE NORMT(NSTOT,NSTR,TBT,ATOT,ASEC1,MFLOW) 0000010
C-----0000020
C NORMT NORMALIZES THE CHANNEL TEMPERATURES TO THE TOTAL BULK 0000030
C TEMPERATURE, THE SUBCHANNEL TEMPERATURES TO THE TEMPERATURE OF THE 0000040
C CONTAINING CHANNELS. IT NORMALIZES ALSO THE VALUES OF THE 0000050
C TEMPERATURES OF THE TWO PORTIONS OF THE WALL SUBCHANNELS TO THE 0000060
C TEMPERATURE OF THE CONTAINING WALL SUBCHANNELS 0000070
C 0000080
REAL MAV,MSCH,MAWC,MFLOW 0000090
DIMENSION A(42),ASCH(3) 0000100
COMMON/GEN2/AZ(42)/SUB1/ASCHZ(42,3)/SUB2/TSCH(42,3),MSCH(42,3)0000110
1 /IND3/NTYP(42)/HEA6/NPIN(42),JPIN(42,3)/MOB5/TAV(42) 0000120
2 /MOB6/MAV(42)/WCSE7/MAWC(18,2,2)/WCSE8/ASCHWC(18,2,2) 0000130
3 /WCSE9/TAVWC(18,2,2)/LAMIN3/F1ATIP(42),F1DTIP(42)/LAMIN4/0000140
4 F2ATIP(42,3),F2DTIP(42,3) 0000150
DEH=TBT*MFLOW*ASEC1/ATOT 0000160
ASEC=0. 0000170
DO 10 NS=1,NSTOT 0000180
A(NS)=AZ(NS)*F1ATIP(NS) 0000190
ASEC=ASEC+A(NS) 0000200
10 DEH=DEH-TAV(NS)*MAV(NS) 0000210
DEHA=DEH/ASEC 0000220
DO 11 NS=1,NSTOT 0000230
11 TAV(NS)=TAV(NS)+DEHA*A(NS)/MAV(NS) 0000240
DO 5 NS=1,NSTOT 0000250
NP=NPIN(NS) 0000260
SHSCH=0. 0000270
DO 1 M=1,NP 0000280
ASCH(M)=ASCHZ(NS,M)*F2ATIP(NS,M) 0000290
1 SHSCH=SHSCH+MSCH(NS,M)*TSCH(NS,M) 0000300
DEH=MAV(NS)*TAV(NS)-SHSCH 0000310
DO 4 M=1,NP 0000320
RAPPA=ASCH(M)/A(NS) 0000330
TSCH(NS,M)=TSCH(NS,M)+DEH*RAPPA/MSCH(NS,M) 0000340
IF(NTYP(NS).NE.2)GOTO 4 0000350
NSW=NS-NSTR 0000360
SHWC=0. 0000370
DO 2 JWC=1,2 0000380
2 SHWC=SHWC+MAWC(NSW,M,JWC)*TAVWC(NSW,M,JWC) 0000390
DEHWC=MSCH(NS,M)*TSCH(NS,M)-SHWC 0000400
DO 3 JWC=1,2 0000410
RAPPA=ASCHWC(NSW,M,JWC)/ASCH(M) 0000420
3 TAVWC(NSW,M,JWC)=TAVWC(NSW,M,JWC)+DEHWC*RAPPA/MAWC(NSW,M,JWC) 0000430
4 CONTINUE 0000440
5 CONTINUE 0000450
RETURN 0000460
END 0000470

```
SUBROUTINE PIVOT(A,B,N)          0000010
C ----- 0000020
C   INTERCHANGES ROWS IN ORDER TO GET THE PIVOTAL ELEMENT AS A(I,I) 0000030
C   0000040
C     DIMENSION A( 34, 34),B( 34)          0000050
C     COMMON /SC22C/ NTOT                  0000060
C   0000070
C   C --- FINDS THE PIVOT ----- 0000080
C   0000090
C     L=N          0000100
C     I1=N+1      0000110
C     DO 100 I=I1,NTOT          0000120
C       IF(ABS(A(I,N)).GT.ABS(A(L,N))) L=I 0000130
C     100    CONTINUE          0000140
C     IF(L.EQ.N) GO TO 900          0000150
C   0000160
C   C --- IF NECESSARY INTERCHANGES ROWS ----- 0000170
C   0000180
C     DO 200 J=N,NTOT          0000190
C       AC=A(N,J)          0000200
C       A(N,J)=A(L,J)      0000210
C       A(L,J)=AC          0000220
C     200    CONTINUE          0000230
C     BC=B(N)          0000240
C     B(N)=B(L)          0000250
C     B(L)=BC          0000260
C   0000270
C   900 CONTINUE          0000280
C   0000290
C   RETURN          0000300
C   END            0000310
```

```
SUBROUTINE PIVOT1(A,B,N,NTOT,N1)          0000010
C -----
C   INTERCHANGES ROWS IN ORDER TO GET THE PIVOTAL ELEMENT AS A(I,I) 0000020
C                                         0000030
C   DIMENSION A(N1,NTOT),B(NTOT)          0000040
C                                         0000050
C   ----- FINDS THE PIVOT -----          0000060
C                                         0000070
C                                         0000080
C   L=N                                     0000090
C   I1=N+1                                  0000100
C   DO 100 I=I1,NTOT                      0000110
C     IF(ABS(A(I,N)).GT.ABS(A(L,N))) L=I 0000120
100    CONTINUE                                0000130
      IF(L.EQ.N) GO TO 900                  0000140
C   ----- IF NECESSARY INTERCHANGES ROWS ----- 0000150
C                                         0000160
C                                         0000170
C   DO 200 J=N,NTOT                      0000180
C     AC=A(N,J)                          0000190
C     A(N,J)=A(L,J)                      0000200
C     A(L,J)=AC                          0000210
200    CONTINUE                                0000220
      BC=B(N)                            0000230
      B(N)=B(L)                          0000240
      B(L)=BC                           0000250
C   900  CONTINUE                                0000260
C                                         0000270
C                                         0000280
C   RETURN                                 0000290
END                                     0000300
```

```
FUNCTION PSTAR(ZWC,P)          0000010
C -----
C   PERIMETER OF A WALL TYPE SECTOR OF SHROUD 0000020
C                                         0000030
C   PSTAR=2.* (P/2.-ZWC*1.732051+2.*ZWC) 0000040
C                                         0000050
C                                         0000060
C   RETURN                                 0000070
END                                     0000080
```

SUBROUTINE QCOC (NCA,J,X,NSE) 0000010
C ----- 0000020
C DETERMINES THE HEAT TRANSMITTED FROM EACH SECTOR TO THE GAS IN 0000030
C CASE OF POWER GENERATED WITHIN THE FUEL. 0000040
C 0000050
C DIMENSION X(NSE) 0000060
C 0000070
COMMON /SC01C/ NCAN(19),LIPS(19,10) 0000080
COMMON /SC02C/ QJ(19, 42) 0000090
COMMON /SC03C/ NRODS 0000100
COMMON /SC05C/ JZUR(19, 42) 0000110
COMMON /SC07C/ H1 0000120
COMMON /SC11C/ FALFA(42,3) 0000130
COMMON /SC12C/ GEO(42,3) 0000140
COMMON /SC08R/ QPR(42,3) 0000150
COMMON /SC26C/ TBR(42,3),TBS(18,2) 0000160
COMMON /HEA5 / QQ(42,3) 0000170
COMMON /QPAR1/ QDEV 0000180
C 0000190
PIG = 3.141593 0000200
C 0000210
IF (NCA .EQ. 1 .AND. NRODS .NE. 12) GO TO 2000 0000220
C 0000230
SUM=0.0 0000240
QTOT=0.0 0000250
DO 1000 K=1,NCA 0000260
NS=LIPS(J,K) 0000270
M =JZUR(J,NS) 0000280
Q = FALFA(NS,M)*(X(K)-TBR(NS,M)) 0000290
SUM=SUM+Q 0000300
QU= QQ(NS,M)*H1*QDEV*GEO(NS,M)/PIG 0000310
QTOT=QTOT+QU+QPR(NS,M) 0000320
C 0000330
QJ(J,NS)=Q-QU 0000340
C 0000350
1000 CONTINUE 0000360
C ----- 0000370
C CONTROL ON THE COMPUTED HEAT 0000380
C 0000390
IF(QTOT.LT.1.E-05) GO TO 9999 0000400
DELTAQ=ABS((SUM/QTOT)-1.) 0000410
IF (DELTAQ .GT. 0.01) WRITE(6,1100) J,DELTAQ 0000420
1100 FORMAT(' SUB. QCOC, HEAT BALANCE NOT RESPECTED FOR PIN ',I3,
> ' THE PERCENTUAL ERROR IS ',F10.5,' ',
> ' CALCULATION PROCEEDING') 0000430
GO TO 9999 0000440
C 0000450
C ----- 0000460
C CASE OF NCA = 1 : QJ IS EQUAL TO QPR. 0000470
C 0000480
2000 CONTINUE 0000490
C 0000500
QJ(1,1)=QPR(1,1) 0000510
C 0000520
9999 RETURN 0000530
END 0000540
0000550
0000560

SUBROUTINE QDEFI(QJR) 0000010
C -----
C DEFINITION OF THE ARRAYS QPR AND QSR 0000020
C QPR=(CAL/SEC) QSR=(CAL/SEC) 0000030
C 0000040
C 0000050
C COMMON /SCO1R/ NSECT,NSECP 0000060
COMMON /SCO2R/ P,D,Z,ZWC,H,LENGTH 0000070
COMMON /SCO6R/ ISU(132,2) 0000080
COMMON /SCO8R/ QPR(42,3) 0000090
COMMON /SCO9R/ QSR(18,2) 0000100
COMMON /SC10R/ QSTOT,QRTOT 0000110
COMMON /SC13C/ GEO1(42,3) 0000120
COMMON /SC05L/ PERLT 0000130
COMMON /DAT/ PIG 0000140
COMMON /QPAR3/ PERL(3) 0000150
COMMON /GEO0 / ACH(3) 0000160
COMMON /SUB1/ ASCH(42,3) 0000170
COMMON /IND3/ NTYP(42) 0000180
COMMON /MART5/ NSTR 0000190
C 0000200
DIMENSION QJR(132) 0000210
C 0000220
REAL LENGTH 0000230
C 0000240
AQTOT=0.0 0000250
QTOT=0.0 0000260
DO 1000 L=1,NSECT 0000270
NS=ISU(L,1) 0000280
M =ISU(L,2) 0000290
C 0000300
IF (L .GT. NSECP) GO TO 500 0000310
C 0000320
QPR(NS,M)=-QJR(L)*PIG*D*H/GEO1(NS,M) 0000330
QTOT=QTOT+QPR(NS,M) 0000340
AQTOT=AQTOT+ABS(QPR(NS,M)) 0000350
GO TO 1000 0000360
C 0000370
500 CONTINUE 0000380
NW=NS-NSTR 0000390
NTY=NTYP(NS) 0000400
QSR(NW,M)= -QJR(L)*PERL(NTY)*ASCH(NS,M)/ACH(NTY)*H 0000410
QTOT=QTOT+QSR(NW,M) 0000420
AQTOT=AQTOT+ABS(QSR(NW,M)) 0000430
C 0000440
1000 CONTINUE 0000450
C 0000460
C ----- 0000470
C CONTROL ON THE COMPUTED HEAT 0000480
C 0000490
DELT=0.0 0000500
QTOT1=QRTOT+QSTOT 0000510
IF(QTOT1.GT. 1.E-06) DELT=ABS(QTOT/QTOT1) 0000520
IF(DELT .LE. 0.01) GO TO 9999 0000530
C 0000540
DELF=DELT*100. 0000550
WRITE(6,9100) DELF 0000560
ADEL=ABS(QTOT) 0000570
DO 2000 L=1,NSECT 0000580
NS=ISU(L,1) 0000590
M =ISU(L,2) 0000600
IF (L .GT. NSECP) GO TO 1500 0000610

	QPR(NS,M)= QPR(NS,M)+QPR(NS,M)*ADELT/AQTOT	0000620
	GO TO 2000	0000630
1500	CONTINUE	0000640
	NW=NS-NSTR	0000650
	NTY=NTYP(NS)	0000660
2000	QSR(NW,M)= QSR(NW,M)+QSR(NW,M)*ADELT/AQTOT	0000670
	CONTINUE	0000680
C		0000690
	9999 RETURN	0000700
9100	FORMAT(' SUB. QDEFI - ',	0000710
>	' HEAT BALANCE AFTER RADIATION, DELT = ',F10.5,' % ',	0000720
>	' CALCULATION PROCEEDING.')	0000730
	END	0000740

	SUBROUTINE QDEFIS	0000010
C	-----	0000020
C	HEAT TO THE GAS AFTER THE CONDUCTION IN THE SHROUD (CAL/SEC)	0000030
C		0000040
	COMMON /SHROUD/ TLINER(18,2)	0000050
	COMMON /MART5/ NSTR	0000060
	COMMON /GASD1/ NSTOT	0000070
	COMMON /SC06L/ SHQ(18,2)	0000080
	COMMON /SC09R/ QSR(18,2)	0000090
	COMMON /SC17C/ SALFA(18,2)	0000100
	COMMON /SC18C/ RE,RI,ALFW,ALFC	0000110
	COMMON /SC21C/ SHQC(18,2)	0000120
	COMMON /SC02R/ P,D,Z,ZWC,H,ENG	0000130
	COMMON /SC26C/ TBR(42,3),TBS(18,2)	0000140
	COMMON /HEA6/ NPIN(42),JPIN(42,3)	0000150
	COMMON /IND3/ NTYP(42)	0000160
C		0000170
	QU=0.0	0000180
	QD=0.0	0000190
	NW1=NSTR+1	0000200
	DO 1000 NS=NW1,NSTOT	0000210
	NW=NS-NSTR	0000220
	NP=NPIN(NS)	0000230
	DO 500 M=1,NP	0000240
	ALF=ALFW	0000250
	IF(NTYP(NS).EQ.3) ALF=ALFC	0000260
	Q=SALFA(NW,M)*H*RI*ALF*(TLINER(NW,M)-TBS(NW,M))	0000270
	QD=QD+Q	0000280
	QU=SHQ(NW,M)+QSR(NW,M)+QU	0000290
	SHQC(NW,M)=Q-SHQ(NW,M)	0000300
500	CONTINUE	0000310
1000	CONTINUE	0000320
C		0000330
	PC=ABS(QU/QD-1.)	0000340
	IF(ABS(QU/QD-1.).GT.0.01) WRITE(6,2000) PC	0000350
2000	FORMAT(' SUB.QDEFIS; PRECISION (WORSE THAN 1%) =',E12.6,5X,	0000360
>	' CALCULATION PROCEEDING')	0000370
C		0000380
	RETURN	0000390
	END	0000400

SUBROUTINE RADIA	0000010
C -----	0000020
C MODEL FOR THE THERMAL EXCHANGES DUE TO RADIATION.	0000030
C	0000040
C DIMENSION A(132, 13),B(132),QJR(132)	0000050
C	0000060
C	0000070
C 01 -----	0000080
C CONSTRUCTION OF THE COEFFICIENTS ARRAY.	0000090
C	0000100
C CALL MATBUI (A,B)	0000110
C	0000120
C 02 -----	0000130
C SOLUTION OF THE SYSTEM.	0000140
C	0000150
C CALL SYSOL (A,B,QJR)	0000160
C	0000170
C 03 -----	0000180
C REDEFINITION OF THE COMPUTED HEAT.	0000190
C	0000200
C CALL QDEFI(QJR)	0000210
C	0000220
C 04 -----	0000230
C	0000240
RETURN	0000250
END	0000260

```
SUBROUTINE RECANG(I,AI,NS,K,IVIA,IRH,ALFA,AMA1,TI,PB,D,W,RH,DETOT 0000010
*,PROV,DAI,DBI,AAI,ABI,G,SSSA,SSSB, AMTI,NTYP,H1,H,PR1,PR2,SQDPG,JJ0000020
*J,TE,SUR,TW1,AMAI,TAI,AMBI,TBI,III,TIE,TIAV,HPLUSB,HPLUSW,ANGT,EM10000030
*,XC1,XC2,*,DEPA,CS) 0000040
C-----0000050
C SUBROUTINE RECANG EVALUATES FRICTION FACTORS AND APPROXIMATE MASS 0000060
C FLOW RATES AND TEMPERATURES FOR WALL-TYPE SUB-SUBCHANNELS. 0000070
C 0000080
C      REAL LAMIA,LAMIB,KI, KAPPA,NUI,NUO 0000090
C      COMMON/CORR1/SIGMA1( 42,3),PHII( 42,3)/COLAM1/COLAMB/COLAM2/COLAMA0000100
1      /CORR2/CHI( 18,2,2),PSI( 18,2,2)/GRID2/YY(100, 42,3) 0000110
2      /ANG1/RA2(60)/HEA5/QQ( 42,3)/DAT/PIG/REC1/PVERT(90),PRAD(90)0000120
3      /SUB20/PROVI( 18,2)/GEN5/DE( 42)/SUB22/TW( 42,3)/MART/ITCORR0000130
4      /SUB21/TSCHA( 18,2),TSCHB( 18,2) 0000140
5      /WSSCH1/DELTIE( 18,2,90),DTIEAV( 18,2)/WSSCH2/TIO( 18,2,90) 0000150
6      /WSSCH/T1SSC1( 18,2),T2SSC1( 18,2), 0000160
A      T1SSC2( 18,2),T2SSC2( 18,2) 0000170
7      /WSSCH0/TBSSC1( 42,3),TWSSC1( 42,3),TBSSC2( 42,3), 0000180
A      TWSSC2( 42,3) 0000190
8      /GRAV/IGRAV/GAGR/DPSI/GAAG2/FCOPW2( 18,2) 0000200
COMMON /QPARI/QDEV/QPAR2/QLINM,QLDEV 0000210
COMMON /HEA6 / NPIN( 42),JPIN( 42,3) 0000230
COMMON /SC02C/ QJ( 19, 42) 0000240
COMMON /SC13C/ GEO1( 42,3) 0000250
COMMON /SC06L/ SHQ( 18,2) 0000260
COMMON /SC21C/ SHQC( 18,2) 0000270
COMMON /SC09R/ QSR( 18,2) 0000280
COMMON /GEO0 / ACH(3) 0000290
COMMON /SUB1 / ASCH( 42,3) 0000300
COMMON /QPARI3/ PERL(3) 0000310
C-----0000320
C      PERLS=PERL(NTYP)*ASCH(NS,JJJ)/ACH(NTYP) 0000330
C-----0000350
C      ICS=1 0000360
IF(I.GT.1)TWI=TW1 0000370
IF(ITCORR.EQ.1)PROVI(III,JJJ)=PROV 0000380
PROVI(III,JJJ)=PROV 0000390
DEPA=DETOT 0000400
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 0000410
C      QROD=QQ(NS,JJJ)*QDEV 0000420
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 0000430
JP=JPIN(NS,JJJ) 0000440
QROD=QQ(NS,JJJ)*QDEV+QJ(JP,NS)*GEO1(NS,JJJ)/H1 0000450
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 0000460
Q=QROD*ALFA/(2.*PIG)*H1 0000470
QA=QROD/SUR 0000480
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 07.11.1979 CCCCCCCCCCCC 0000490
C      QLIN=QLINM*H1*QLDEV 0000500
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 07.11.1979 CCCCCCCCCCCC 0000510
QLIN=(SHQ(III,JJJ)+SHQC(III,JJJ))/PERLS 0000550
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 07.11.1979 CCCCCCCCCCCC 0000560
AMABI=AMAI 0000570
C-----0000580
C      LOOP ITW1 STARTS (CALCULATION OF THE BULK TEMPERATURES OF THE 0000590
C      TWO ZONES DIVIDED BY THE TAU=0 LINE, TAI AND TBI) 0000600
C-----0000610
C      DO 2000 ITW1=1,10 0000620
C-----0000630
C      LOOP ITW STARTS (CALCULATION OF THE PIN TEMPERATURE TWI) 0000640
C-----0000650
C      DO 14 ITW=1,20 0000660
C-----0000670
```

C LOOP ITTEMP STARTS (CALCULATION OF THE FRICTION FACTORS AND OF 0000680
C THE MASS FLOW RATES FOR THE TWO ZONES DIVIDED BY THE TAU=0 LINE 0000690
C AND OF THE BULK TEMPERATURE TI FOR THE WHOLE SUB-SUBCHANNEL) 0000700
C 0000710
DO 7 ITTEMP=1,60 0000720
IF(ITW1.GT.1)GOTO 1998 0000730
IF(ITcorr .GT.1 .AND. QQ(NS,JJJ).GT. 1.E-06)GOTO 250000740
TAI=TI 0000750
TBI=TI 0000760
GOTO 26 0000770
25 CONTINUE 0000780
TAI=TSCHA(III,JJJ) 0000790
TBI=TSCHB(III,JJJ) 0000800
TI=TIAV 0000810
26 CONTINUE 0000820
IF(ITW.EQ.1 .AND. I.EQ.1)TWI=TBI 0000830
IF(ITW.EQ.1)TWO=TWI 0000840
1998 CONTINUE 0000850
ETAA=ETA(PB,TAI) 0000860
ETAB=ETA(PB,TBI) 0000870
RHOA=RHO(PB,TAI) 0000880
RHOB=RHO(PB,TBI) 0000890
ETAIW=ETA(PB,TWI) 0000900
RHOIW=RHO(PB,TWI) 0000910
QPLUS=QA/(AMABI*CP(PB,TBI)*(TE+273.16)) 0000920
C 0000930
IF(IVIA.EQ.2 .OR. ITW1.GT.1)GOTO 1 0000940
C 0000950
C CALCULATION OF THE POSITION OF THE TAU=0 LINE 0000960
C 0000970
CALL TLINE(I,AI,ITTEMP,NS,K,ALFA,D,W,RH,DEPA ,PROVI(III,JJJ),IRH,0000980
*DAI,DBI,AAI,ABI,RHPL,G,TWI,TE,QPLUS,ETAA,RHOA,ETAB,RHOB,ETAIW, 0000990
*RHOIW,ANGT,EM1,XC1,XC2,TBI,&8500,CS) 0001000
C 0001010
1 CONTINUE 0001020
PAI=4.*AAI/DAI 0001030
R0=0.5*SQRT(D**2+D*DBI) 0001040
YDH=(R0-0.5*D)/RH 0001050
IF(ITTEMP.EQ.1 .AND. ITW.EQ.1 .AND. ITW1.EQ.1)GOTO 30 0001060
C 0001070
C AFTER THE FIRST ITERATION THE FRICTION FACTORS ARE EVALUATED 0001080
C BY MEANS OF THE REYNOLDS NUMBERS AND OF THE FRICTION FACTORS 0001090
C COMPUTED AT THE PRECEEDING ITERATION 0001100
C 0001110
REAI=AMAI*DAI/(AAI*ETAA) 0001120
REBI=AMBI*DBI/(ABI*ETAB) 0001130
REIW=(ETAB*RHOIW)/(ETAIW*RHOB)*REBI 0001140
IF(REAI.GT.0 . .AND. REBI.GT.0 . .AND. SQ8LIA.GT.0 . .AND. SQ8LIB.GT.0001150
*0.)GOTO 700 0001160
WRITE(6,699)NS, JJJ,I,REAI,SQ8LIA,REBI,SQ8LIB,ITCORR,ICS 0001170
699 FORMAT(//5X,'SUB. RECANG', 0001180
> /5X,'NS=',I5,5X,'M=',I2,5X,'I=',I3/5X,'RE A=',E15.5,5X,'SQ0001190
*RT(8/LAMBDA) A=',E15.5/5X,'RE B=',E15.5,5X,'SQRT(8/LAMBDA) B=',E150001200
*.5/5X,'ITCORR=',I5,5X,'ICS=',I2) 0001210
8500 RETURN 1 0001220
C 0001230
700 CONTINUE 0001240
IF(IRH.EQ.2)GOTO 27 0001250
SQ8LIB=2.5* ALOG(REBI/SQ8LIB)+5.5-G 0001260
GA=6.0737 0001270
GOTO 28 0001280
27 HPLUSB=RH/DBI*REBI /SQ8LIB 0001290
HPLUSW=HPLUSB*REIW/REBI 0001300
RHPL=RHPLUS(HPLUSB,TWI,TE,QPLUS,HPLUSW,TBI,YDH) 0001310
SQ8LIB=2.5* ALOG(DBI/RH)+RHPL-G 0001320

GA=5.966 0001330
28 IF(NTYP.EQ.3 .AND. IVIA.EQ.2)GOTO 29 0001340
SQ8LIA=CS*(2.5*ALOG(REAL/SQ8LIA)-GA)+5.5*COLAMA 0001350
GOTO 3 0001360
29 SQ8LIA =SMFUN1(RHOA,ETAA,DETOT,PROV,I,2,REAL,DAI,SQ8LIA,R0,GA,CS) 0001370
3 CS=CSFUN(IRH,REAL,SQ8LIA,SQ8LIB,GA) 0001380
GOTO 6 0001390
C 0001400
C FIRST ITERATION : THE FRICTION FACTORS ARE EVALUATED BY MEANS 0001410
C OF THE EQUATION (LAMBDAI*RHOI**2/DI) = (LAMBDA*RHO*U**2/D) TOT. 0001420
C 0001430
30 IF(IRH.EQ.2)GOTO 2 0001440
SQ8LIB=2.5*ALOG(PROV/ETAB*SQRT((DBI/DETOT)**3*RHOB))+5.5-G 0001450
GA=6.0737 0001460
GOTO 4 0001470
2 HPLUSB=RH/DETOT*PROV/ETAB*SQRT(DBI/DETOT*RHOB) 0001480
HPLUSW=RH/DETOT*PROV/ETAIW*SQRT(DBI/DETOT*RHOIW) 0001490
RHPL=RPLUSB(TWI,TE,QPLUS,HPLUSW,TBI,YDH) 0001500
SQ8LIB=2.5*ALOG(DBI/RH)+RHPL-G 0001510
GA=5.966 0001520
4 IF(NTYP.EQ.3 .AND. IVIA.EQ.2)GOTO 5 0001530
SQ8LIA=CS*(2.5*ALOG(PROV/ETAA*SQRT((DAI/DETOT)**3*RHOA))-GA)+5.5 0001540
**COLAMA 0001550
GOTO 6 0001560
5 SQ8LIA =SMFUN1(RHOA,ETAA,DETOT,PROV,I,1,REAL,DAI,SQ8LIA,R0,GA,CS) 0001570
C 0001580
C 0001590
6 CONTINUE 0001600
LAMIA=8./SQ8LIA**2 0001610
LAMIB=8./SQ8LIB**2 0001620
SSSA=AAI/SQRT(LAMIA*H/(2.*RHOA*DAI)) 0001630
SSSB=ABI/SQRT(LAMIB*H/(2.*RHOB*DBI)) 0001640
SQDPGB=SQRT(ABS(SQDPG**2*DPSI-IGRAV*RHOB*980.665*H)) 0001650
*/FCOPW2(III,JJJ)) 0001660
SQDPGA=SQRT(ABS(SQDPG**2*DPSI-IGRAV*RHOA*980.665*H)) 0001670
*/FCOPW2(III,JJJ)) 0001680
AMBI=SSSB*SQDPGB+ABI*SIGMAI(NS,JJJ)*CHI(III,JJJ,1) 0001690
AMAI=SSSA*SQDPGA+AAI*SIGMAI(NS,JJJ)*CHI(III,JJJ,1) 0001700
AMTI=AMAI+AMBI 0001710
IF(ITcorr.GT.1 .AND. QQ(NS,JJJ).GT.1.E-06 .AND. 0001720
*ITW1.EQ.1)GOTO 48 0001730
C 0001740
DELTAT=(Q+QLIN*PAI+ PHII(NS,JJJ)*PSI(III,JJJ,1)*(AAI+ABI))/ 0001750
*(AMTI*CP(PB, TI)) 0001760
TI=TIE+0.5*DELTAT+DELTIE(III,JJJ,I) 0001770
TIO(III,JJJ,I)=TI+0.5*DELTAT 0001780
C 0001790
48 CONTINUE 0001800
IF(ITTEMP.EQ.1)GOTO 50 0001810
IF(ABS(AMAI/AMAI1-1.).LE.1.E-03 .AND. ABS(AMBI1/AMBI-1.).LE.1.E-03)GOTO 50 0001820
*)GOTO 9 0001830
50 AMAI1=AMAI 0001840
AMBI1=AMBI 0001850
AMABI=AMBI/ABI 0001860
7 CONTINUE 0001870
C 0001880
C END OF LOOP ITTEMP: POINT REACHED IN THE CASE OF CONVERGENCE 0001890
C PROBLEMS 0001900
C 0001910
WRITE(6,8)I,NS,K,ITW,ITCORR 0001920
8 FORMAT(5X,'SUB. RECANG.', 0001930
> /5X,'CALCULATION STOPS: ITTEMP=10 FOR SUBCHANNEL',I4,2X,0001940
*'OF CHANNEL',I4,2X,'(AXIAL SECTION',I4,') ITW=',I2,5X,'ITCORR=',I50001950
*) 0001960
RETURN 1 0001970
C 0001980

C CONVERGENCE IS REACHED IN THE LOOP ITTEMP 0001990
C 0002000
C 0002010
9 CONTINUE 0002020
IF(ITW1.EQ.1)TW1=TWI 0002030
IF(QQ(NS,JJJ).LE.1.E-06)GOTO 2002 0002040
ATI=AAI+ABI 0002050
DEI=ATI/(AAI/DAI+ABI/DBI) 0002060
IF(IRH.EQ.1)GOTO 600 0002070
C 0002080
C CALCULATION OF THE PIN TEMPERATURE ONLY FOR HEATED ROUGHENED 0002090
C SECTIONS 0002100
C 0002110
IF(ABS(TWO).LT.3000. .AND. ABS(TWI).LT.3000.)GOTO 2005 0002120
WRITE(6,2004)NS,JJJ,TWO,TWI 0002130
2004 FORMAT(5X,'STOP IN RECANG: NS=',I5,5X,'JJJ=',I5/5X,'TWO=',E15.0
*5,5X,'TWALL=',E15.5) 0002140
RETURN 1 0002150
2005 CONTINUE 0002160
CCCCCCCCCC 21.09.1979 0002170
C IF(NTYP.EQ.3 .AND. ITVIA.EQ.2)GOTO 500 0002180
CCCCCCCCCC 0002190
IF(NTYP.EQ.3 .AND. IVIA.EQ.2)GOTO 500 0002200
CCCCCCCCCC 0002210
R2=R0+0.25*DAI*XC2 0002220
GOTO 501 0002230
500 R2=RA2(I) 0002240
501 CONTINUE 0002250
R2MROH=(R2-R0)/RH 0002260
R1=D*0.5 0002270
R1DR2=R1/R2 0002280
FACHE=TIS(R1,R2,IRH) 0002290
KI=KAPPA(PB, TI) 0002300
ETAI=ETA(PB, TI) 0002310
RHOI=RHO(PB, TI) 0002320
CPI=CP(PB, TI) 0002330
PRI=ETAI*CPI/KI 0002340
REI=AMTI*DEI/(ETAI*ATI) 0002350
U1DU=AMBI*ATI*RHOI/(AMTI*ABI*RHOB) 0002360
REW0=REIW*ETAIW*RHO(PB, TWO)/(RHOIW*ETA(PB, TWO)) 0002370
HPLUSO=HPLUSW*REW0/REIW 0002380
CCCCCCCCCC 06.02.1980 0002390
CALL SPANU(REI,PRI,NS,JJJ,Y) 0002400
C CALL RNU(HPLUSW,TWI,LAMIB,REI,PRI, TI ,YDH,R1DR2,R2MROH,U1DU,REIW, 0002410
C 1 YY(K,NS,JJJ),NUI,GHPL) 0002420
C FURTHER MODIFIED AT 09.10.1980 0002430
C CALL RNU(HPLUSW,TWI,LAMIB,REI,PRI, TI ,YDH,R1DR2,R2MROH,U1DU,REIW, 0002440
C 1 Y,NUI,GHPL,2) 0002450
CALL RNU(HPLUSW,TWI,LAMIB,REI,PRI, TI ,YDH,R1DR2,R2MROH,U1DU,REIW, 0002460
1 Y ,NUI,GHPL,2,R0,R1,R2,0.0) 0002470
CALL RNU(HPLUSO,TWO,LAMIB,REI,PRI, TI ,YDH,R1DR2,R2MROH,U1DU,REW0, 0002480
1 NUO,GHPL,2,R0,R1,R2,0.0) 0002490
CCCCCCCCCC 06.02.1980 0002500
ALFAI=NUI*KI/DEI*FACHE 0002510
TIW=TI+QA/ALFAI 0002520
ALFAO=NUO*KI/DEI 0002530
TWO=TI+QA/ALFAO 0002540
IF(ABS(TWI/TIW-1.).LE.1.E-04)GOTO 16 0002550
14 TWI=TIW 0002560
C 0002570
C END OF LOOP ITW : POINT REACHED IN THE CASE OF CONVERGENCE 0002580
C PROBLEMS 0002590
C 0002600
WRITE(6,15)I,JJJ,NS 0002610
15 FORMAT(5X,'SUB. RECANG', 0002620
> /5X,'CALCULATION STOPS:ITW =10 FOR SUB-SUBCH.',I3,2X,'(M0002630

```
*=' ,I2,2X,'NS=',I5,')'))          0002640
      RETURN 1                         0002650
C .....                                0002660
C CONVERGENCE IS REACHED IN THE LOOP ITW 0002670
C                                         0002680
16 CONTINUE                           0002690
  IF(ITW1.GT.1)GOTO 1999              0002700
  TW1=TWI                            0002710
  IF(ITCORR.EQ.1)RETURN               0002720
C .....                                0002730
C CALCULATION OF THE BULK TEMPERATURES OF THE TWO ZONES DIVIDED BY 0002740
C THE TAU=0 LINE ONLY FOR HEATED ROUGHENED SECTIONS AT ITCORR>1 0002750
C                                         0002760
1999 U1STAR=AMBI/(RHOB*ABI)*SQRT(LAMIB*0.125) 0002770
  FF=QA/(RHOI*CPI*U1STAR)           0002780
  RODR2=R0/R2                        0002790
  CALL DDONNE(TWO, TI, GHPL, RODR2, R1DR2, YDH, R2MROH, FF, TAI, TIB, TE) 0002800
  IF(ABS(TBI/TIB-1.).LE.1.E-04)GOTO 2002 0002810
2000 TBI=TIB                          0002820
C .....                                0002830
C END OF LOOP ITW1: POINT REACHED IN THE CASE OF CONVERGENCE 0002840
C PROBLEMS                           0002850
C                                         0002860
  WRITE(6,2001)I,NS,JJJ,ITCORR,TBI,TAI,TI,TWI,TWO 0002870
2001 FORMAT(/5X,'STOP IN RECANG (LOOP ITW1) I=',I3,' NS=',I5,' M=',I2,
  1 ' ITCORR=',I3/5X,'TBI=',E15.5,5X,'TAI=',E15.5,5X,'TI=',E15.5,5X,0002880
  2 'TWI=',E15.5,5X,'TWO=',E15.5)           0002890
  RETURN 1                           0002900
C .....                                0002910
C CONVERGENCE IS REACHED IN THE LOOP ITW1 0002920
C                                         0002930
C                                         0002940
600 TWI=TW(NS,JJJ)                  0002950
C                                         0002960
2002 CONTINUE                         0002970
  TBSSC2(NS ,JJJ)=TI                0002980
  T1SSC2(III,JJJ)=TBI               0002990
  T2SSC2(III,JJJ)=TAI               0003000
  TWSSC2( NS,JJJ)=TWI               0003010
  IF(I.GT.1)RETURN                  0003020
C                                         0003030
  TBSSC1( NS,JJJ)=TI                0003040
  T1SSC1(III,JJJ)=TBI               0003050
  T2SSC1(III,JJJ)=TAI               0003060
  TWSSC1( NS,JJJ)=TWI               0003070
  RETURN                               0003080
END
```

0003090
SUBROUTINE RECCA1(K,NS,N,NSC45,IRH,PROV,PB, RH,H1,ALFA,A,DE,MEC,0000010
*AT,DET,ATOT,DETOT,MFLOW,W,D,C, JJJ,NSTR,H,PR1,PR2,SQDPG,TE,SUR, 0000020
AMT,DDDD,ATSCH,CTU3,EM1, ,ALFACE) 0000030
C-----0000040
C SUBROUTINE RECCA1 CALCULATES FRICTION FACTORS AND APPROXIMATE 0000050
C OUTLET MASS FLOW RATES AND TEMPERATURES FOR WALL CHANNELS AND SUBC0000060
C 0000070
REAL MEC,MFLOW,LAMB,LAMSCH,LAMWC,MSCH1,KAPPA,LAMLAM,MSCH, 0000080
1 MWC1L,MWC2L 0000090
DIMENSION A(46),DE(46),MEC(46) 0000100
COMMON/WACO1/XMSCHB(18,2),XMSCHA(18,2)/DAT/PIG/CEN1/G(46) 0000110
0 /REC1/ PVERT(90),PRAD(90)/REC2/E(90)/REC3/P(90) 0000120
1 /SUB1/ASCH(42,3) 0000130
2 /SUB4/LAMB(18,2)/SUB5/LAMSCH(42,3) 0000140
3 /SUB8/MSCH1(42,3)/SUB23/HPLUSB(42,3),HPLUSW(42,3) 0000150
4 ,QPLUS(42,3),PRB(42,3),YODH(42,3)/HEA5/QQ(42,3) 0000160
5 /SUB22/TW(42,3)/WCSE1/DEWC(18,2,2),PHWC(18,2,2) 0000170
6 /LAMINO/I2TIP(42,3)/LAMIN1/AKAPPA(42) /LAMIN2/FATIP(3), 0000180
7 FDTIP(3)/LAMIN3/F1ATIP(42),F1DTIP(42) 0000190
A /LAMIN4/F2ATIP(42,3), 0000200
8 F2DTIP(42,3)/LAMIN5/RTIP(7)/LAMIN6/ANGLAM/LAMIN7/F1PTIP 0000210
9 /WSSCH1/DELTIE(18,2,90),DTIEAV(18,2)/WSSCH2/TIO(18,2,90) 0000220
COMMON /INPAR/IPA 0000230
COMMON /SUB2/TSCH(42,3),MSCH(42,3)/SUB3/ADAB(18,2),DETB(18,2) 0000240
COMMON/LAMINK/BKAPPA(7,3)/QPAR1/QDEV/QPAR2/QLINM,QLDEV/HEA10/ 0000250
1 QSCH(42,3)/WALLCO/WFCO1(18,2),WFCO(18,2)/WALLKA/AKAWC(2) 0000260
2 /WCSE3/LAMWC(18,2,2) 0000270
A /WCSE4/CTURB2(18,2)/WCSE8/ASCHWC(18,2,2) 0000280
3 /WCSE5/TSCWC1(18,2,2)/WCSE9/TAVWC(18,2,2)/GEN2/ACHA(42) 0000290
4 /CORR1/SIGMAI(42,3),PHII(42,3) 0000300
A /CORR2/CHI(18,2,2),PSI(18,2,2) 0000310
5 /WSSCH/T1SSC1(18,2),T2SSC1(18,2), 0000320
A T1SSC2(18,2),T2SSC2(18,2) 0000330
6 /WSSCH0/TBSSC1(42,3),TWSSC1(42,3), 0000340
A TBSSC2(42,3),TWSSC2(42,3) 0000350
7 /LAMIN9/I3TIP(42,3)/SHROUD/TLINER(18,2)/MART/ITCORR 0000360
8 /GRAV/IGRAV/GAGR/DPSI/GAAG1/FCOPW1(3)/GAAG2/FCOPW2(18,2) 0000370
COMMON /HEA6 / NPIN(42),JPIN(42,3) 0000390
COMMON /SC02C/ QJ(19, 42) 0000400
COMMON /SC06L/ SHQ(18,2) 0000410
COMMON /SC21C/ SHQC(18,2) 0000420
COMMON /SC09R/ QSR(18,2) 0000430
COMMON /QPAR3/ PERL(3) 0000440
COMMON /GEO0 / ACH(3) 0000450
IF(JJJ.GT.1)GOTO 2998 0000470
F1ATIP(NS)=0. 0000480
F1PTIP=0. 0000490
2998 CONTINUE 0000500
III=NS-NSTR 0000510
IF(ITCORR.EQ.1 .AND. K.EQ.1) FCOPW2(III,JJJ)=FCOPW1(2) 0000520
DTIEAV(III,JJJ)=0. 0000530
I2TIP(NS,JJJ)=I3TIP(NS,JJJ) 0000540
IF(I2TIP(NS,JJJ).EQ.1)GOTO 2999 0000550
C 0000560
C 0000570
C I3TIP#1: THE TURBULENT CALCULATION MUST BE PERFORMED 0000580
C 0000590
TWIAV=0. 0000600
CS=1. 0000610

AMA1=MSCH1(NS ,JJJ)/AT	0000620
TETA=ALFA	0000630
ANGT=0.	0000640
AMT=0.	0000650
AMA=0.	0000660
TT=0.	0000670
TTA=0.	0000680
DDDDA=0.	0000690
ATA=0.	0000700
DDDB=0.	0000710
SRAMIB=0.	0000720
SRAMIA=0.	0000730
HPLUSB(NS ,JJJ)=0.	0000740
HPLUSW(NS ,JJJ)=0.	0000750
TI=TSCWC1(III ,JJJ, 1)	0000760
SIGMA2=SIGMA1(NS ,JJJ)*CHI(III ,JJJ, 2)	0000770
PHI2=PHII(NS ,JJJ)*PSI(III ,JJJ, 2)	0000780
ASCHWC(III ,JJJ, 1)=0.	0000790
IVIA=1	0000800
EMAX=EM1	0000810
XC1=0.	0000820
XC2=1.	0000830
IF(ITCORR.EQ.1)DEWC(III ,JJJ, 1)=DETOT	0000840
C	0000850
C CALCULATION OF THE "WALL-TYPE SUB-SUBCHANNELS (I= SUB-SUBCHANNEL	0000860
C INDEX)	0000870
C	0000880
DO 3 I=1,N	0000890
AI=I	0000900
C	0000910
1 CONTINUE	0000920
ANGT=ANGT+TETA	0000930
CALL RECANG(I, AI, NS, K, IVIA, IRH, TETA, AMA1, TI, PB, D, W, RH, DETOT, PROV,	0000940
*DAI, DBI, AAI, ABI, GG, SSSA, SSSB, AMTI, 2, H1, H, PR1, PR2, SQDPG, JJJ, TE, SUR,	0000950
*TWI, AMA1, TAI, AMBI, TBI, III, TSCWC1(III ,JJJ, 1), TAVWC(III ,JJJ, 1),	0000960
*HPLUS1, HPLUS2, ANGT, EM1, XC1, XC2, &777, DEWC(III ,JJJ, 1), CS)	0000970
IF(E(I).GE.EMAX .AND. IVIA.EQ.1)GOTO 5	0000980
C	0000990
TWIAV=TWIAV+TWI*TETA	0001000
AMT=AMT+AMTI	0001010
AMA=AMA+AMA1	0001020
RAMIA=AMTI*AAI/(AAI+ABI)	0001030
RAMIB=AMTI*ABI/(AAI+ABI)	0001040
TT=TT+AMTI*TI	0001050
TTA=TTA+RAMIA*TAI	0001060
SRAMIA=SRAMIA+RAMIA	0001070
SRAMIB=SRAMIB+RAMIB	0001080
DDDDA=DDDDA+SSSA	0001090
DDDB=DDDB+SSSB	0001100
DDDD=DDDDA+DDDB	0001110
ATA=ATA+AAI	0001120
ASCHWC(III ,JJJ, 1)=ASCHWC(III ,JJJ, 1)+AAI+ABI	0001130
DTIEAV(III ,JJJ)=DTIEAV(III ,JJJ)+AMTI*DELTIE(III ,JJJ,I)	0001140
IF(IRH.EQ.1)GOTO 30	0001150
HPLUSB(NS ,JJJ)=HPLUSB(NS ,JJJ)+HPLUS1*ABI	0001160
HPLUSW(NS ,JJJ)=HPLUSW(NS ,JJJ)+HPLUS2*ABI	0001170
30 CONTINUE	0001180
IF(IVIA.EQ.1)GOTO 3	0001190
IF(ABS(EMAX*2./C-1.).LE.1.E-05)GOTO 10	0001200
C	0001210
C POINT REACHED BY THE CALCULATION IF THE SHROUD PROFILE HAS	0001220
C BLOCKING TRIANGLES	0001230
C	0001240
IVIA=1	0001250
EMAX=C*0.5	0001260
XC1=1./SQRT(3.)	0001270

XC2=2.*XC1 0001280
TETA=ALFA 0001290
E(I)=EM1 0001300
P(I)=PP 0001310
3 CONTINUE 0001320
C 0001330
C I HAS REACHED THE VALUE N, WHICH WOULD MEAN NO "CENTRAL-TYPE" 0001340
C SUB-SUBCHANNELS 0001350
C 0001360
C WRITE(6,4)NS,JJJ,E(I),ITCORR ,(I,PVERT(I),PRAD(I),I=1,N) 0001370
4 FORMAT(1H1,5X,'SUB. RECCAI', 0001380
> /5X,'CALCULATION STOPS: NO CENTRAL SUBCHANNELS IN WALL C 0001390
*HANNEL',I4/5X,'M=',I2, 5X,'E(I)=' ,E15.5,5X, ' ITCORR=' ,I3 0001400
*/ (5X,'I=' ,I3,5X,'PVERT=' ,E15.5,5X,'PRAD=' ,E15.5)) 0001410
RETURN 1 0001420
C 0001430
C RECALCULATION OF THE SUB-SUBCHANNEL FOR WHICH IT WAS E(I)>EMAX, 0001440
C IN ORDER TO FIT EMAX (I.E. E(I)=EMAX) 0001450
C 0001460
5 CONTINUE 0001470
IVIA=2 0001480
II=I 0001490
ANGT=ANGT-TETA 0001500
DEE=EMAX-E(I-1) 0001510
PP=P(I-1)-DEE*(P(I-1)-P(I))/(E(I)-E(I-1)) 0001520
BETA=ATAN(EMAX*2./(PP*D)) 0001530
TETA=BETA-ANGT 0001540
PVERT(I)=PP*D*0.5 0001550
PRAD(I)=PVERT(I)/COS(BETA) 0001560
PAI=DEE*XC2 0001570
WW=W-((EMAX+E(I-1))*0.5-EM1)*XC1 0001580
DAI=4.* (WW-0.5*(D+PVERT(I)+PVERT(I-1)))/XC2 0001590
DBI=2.* (P(I-1)*EMAX-PP*E(I-1))/TETA-D 0001600
PBI=TETA *D*0.5 0001610
AAI=DAI*PAI*0.25 0001620
ABI=DBI*PBI*0.25 0001630
EPS=SQRT(1.+DBI/D) 0001640
GG=GSTAR(EPS) 0001650
GOTO 1 0001660
C 0001670
C ALL THE "WALL-TYPE SUB-SUBCHANNELS HAVE BEEN COMPUTED: CALCULATION 0001680
C OF AVERAGE SUB-SUBCHANNEL VARIABLES FOR THE WALL PORTION 0001690
C 0001700
10 CONTINUE 0001710
DTIEAV(III,JJJ)=DTIEAV(III,JJJ)/AMT 0001720
TSCHAB=TT/AMT 0001730
RHOTAB=RHO(PB,TSCHAB) 0001740
PHWC(III,JJJ,1)=BETA*D*0.5 0001750
PSHWC=(EMAX-EM1)*XC2+EM1 0001760
PHWCTL=PHWC(III,JJJ,1)+PSHWC 0001770
DEWC(III,JJJ,1)=4.*ASCHWC(III,JJJ,1)/PHWCTL 0001780
LAMWC(III,JJJ,1)=((ASCHWC(III,JJJ,1)/DDDD)**2)*2.*DEWC(III,JJJ,1)* 0001790
* RHOTAB/H 0001800
ATB=ASCHWC(III,JJJ,1)-ATA 0001810
ADAB(III,JJJ)=ASCHWC(III,JJJ,1)/ATB 0001820
DETB(III,JJJ)=4.*ATB/PHWC(III,JJJ,1) 0001830
DDDBB=DDDD-DDDDA 0001840
XMSCHA(III,JJJ)=AMA 0001850
XMSCHB(III,JJJ)=AMT-XMSCHA(III,JJJ) 0001860
TSCHB=(TT-TTA)/SRAMIB 0001870
RHOTB=RHO(PB,TSCHB) 0001880
LAMB(III,JJJ)=((ATB/DDDBB)**2)*2.*DETB(III,JJJ)*RHOTB/H 0001890
AMTAB=AMT 0001900
TTAB=TT 0001910
DDDDAB=DDDD 0001920
C 0001930

C CALCULATION OF THE "CENTRAL-TYPE" SUB-SUBCHANNELS 0001940
C
ALFC=ALFACE 0001950
GAMMA=PIG*0.5-BETA 0001960
AN1=GAMMA/ALFACE 0001970
N1=AN1 0001980
IF(N1.EQ.0)ALFC=GAMMA 0001990
IF(N1.EQ.0)N1=1 0002000
IF(N1.LE.NSC45)GOTO 12 0002010
WRITE(6,11)NS,K,ITCORR 0002020
11 FORMAT(1H1,5X,'SUB. RECCA1',
 > 0002030
 *CTION',I3,')'/5X,'ITCORR=',I3) 0002040
 RETURN 1 0002050
C
12 CONTINUE 0002060
L=II 0002070
III=II+1 0002080
DO 1000 I=III,N 0002090
1000 TIO(III,JJJ,I)=TIO(III,JJJ,L) 0002100
AN1=N1 0002110
BETA1=ALFC*AN1 0002120
IF(ABS(BETA1/GAMMA-1.).LT.1.E-06)GOTO 99 0002130
C
..... 0002140
C CALCULATION OF THE CENTRAL SUB-SUBCHANNEL DEFINED BY AN ANGLE 0002150
C OF THE ROD SECTOR = ALFA1 (IF ALFA1>0) 0002160
C
ALFA1=GAMMA-BETA1 0002170
E1=C*0.5*TAN(BETA1) 0002180
DELTAE=PVERT(II)-E1 0002190
AA=C*DELTAE*0.25-ALFA1*D**2*0.125 0002200
DD=8.*AA/(ALFA1*D) 0002210
EPS=SQRT(1.+DD/D) 0002220
GG=GSTAR(EPS) 0002230
AM1=MFLOW*AA/ATOT 0002240
L=II+1 0002250
CALL CEWA(K,NS,IRH,PROV,PB,RH,AA,DD,GG,AM1,DETOT,H1,ALFA1,L,JJJ,H,
*PR1,PR2,SQDPG,AMT,TT,DDDD,TE,SUR,2,III,HPLUSB(NS,JJJ),HPLUSW(NS,JJ
*J),TSCWC1(III,JJJ,2),SIGMA2,PHI2,&777,D,TWI,TICEN,C) 0002260
TWIAV=TWIAV+TWI*ALFA1 0002270
C
..... 0002280
C CALCULATION OF THE "CENTRAL-TYPE" SUB-SUBCHANNELS DEFINED BY AN 0002290
C ANGLE OF THE ROD SECTOR = ALFC 0002300
C
99 CONTINUE 0002310
DO 13 J=1,N1 0002320
I=N1-J+1 0002330
IF(N1.EQ.1)GOTO 100 0002340
AA=A(I) 0002350
DD=DE(I) 0002360
GG=G(I) 0002370
AM1=MEC(I) 0002380
GOTO 101 0002390
100 AA=(C**2*TAN(ALFC)-D**2*ALFC)*0.125 0002400
DD=8.*AA/(ALFC*D) 0002410
EPSEPS=SQRT(1.+DD/D) 0002420
GG=GSTAR(EPSEPS) 0002430
AM1=AA*MEC(1)/A(1) 0002440
101 LL=L+J 0002450
CALL CEWA(K,NS,IRH,PROV,PB,RH,AA,DD,GG,AM1,DETOT,H1,ALFC,LL,JJJ,H,
*PR1,PR2,SQDPG,AMT,TT,DDDD,TE,SUR,2,III,HPLUSB(NS,JJJ),HPLUSW(NS,JJ
*J),TSCWC1(III,JJJ,2),SIGMA2,PHI2,&777,D,TWI,TICEN,C) 0002460
TWIAV=TWIAV+TWI*ALFC 0002470
13 CONTINUE 0002480
C
..... 0002490
C THE CALCULATION OF THE "CENTRAL-TYPE" SUB-SUBCHANNELS HAS BEEN 0002500

C COMPLETED: CALCULATION OF AVERAGE SUB-SUBCHANNEL VARIABLES FOR THE 0002600
C WHOLE CENTRAL PORTION AND FOR THE WHOLE WALL SUBCHANNEL 0002610
C 0002620
TWIAV=TWIAV*2./PIG 0002630
PHWC(III,JJJ,2)=GAMMA*D*0.5 0002640
ASCHWC(III,JJJ,2)=AT-ASCHWC(III,JJJ,1) 0002650
DEWC(III,JJJ,2)=4.*ASCHWC(III,JJJ,2)/PHWC(III,JJJ,2) 0002660
TSCHC=(TT-TTAB)/(AMT-AMTAB) 0002670
RHOTC=RHO(PB,TSCHC) 0002680
DDDDC=DDDD-DDDDAB 0002690
LAMWC(III,JJJ,2)=((ASCHWC(III,JJJ,2)/DDDC)*2)*2.*DEWC(III,JJJ,2) 0002700
* *RHOTC/H 0002710
AT SCH=TT/AMT 0002720
RHOT=RHO(PB,AT SCH) 0002730
DO 14 JWC=1,2 0002740
14 DDDD=DDDD+ASCHWC(III,JJJ,JWC)*SIGMAI(NS,JJJ)*(CHI(III,JJJ,JWC)-1.) 0002750
*/(SQRT(ABS(SQDPG**2*DPSI-IGRAV*RHOT*980.665*H))) 0002760
LAMSCH(NS,JJJ)=((AT/DDDD)**2)*2.*DET*RHOT/H 0002770
CTURB2(III,JJJ)=TURBWC(CTU3,PVERT(II),PRAD(II),D,W,C,GAMMA,ASCHWC 0002780
(III,JJJ,1),ASCHWC(III,JJJ,2),DEWC(III,JJJ,1),DEWC(III,JJJ,2),EM1) 0002790
I2TIP(NS,JJJ)=0 0002800
F2ATIP(NS,JJJ)=1. 0002810
F2DTIP(NS,JJJ)=1. 0002820
IF(I3TIP(NS,JJJ).EQ.2)GOTO 3000 0002830
IF(ITCORR.GT.1)GOTO 2999 0002840
MSCH(NS,JJJ)=AMT 0002850
TSCH(NS,JJJ)=AT SCH 0002860
TW(NS,JJJ)=TWIAV 0002870
C 0002880
C 0002890
C FOR I3TIP=1 OR I3TIP=3 0002900
C 0002910
2999 CONTINUE 0002920
ZWC=(C*0.5-EM1)/SQRT(3.) 0002930
PPPP=(W-0.5*D-ZWC)*ANGLAM 0002940
OMEGA=ATAN(PPPP*2. /C) 0002950
PHWC1L=(PIG*0.5-OMEGA)*RTIP(IPA) 0002960
PHWC2L=OMEGA*RTIP(IPA) 0002970
AWC2L= C*0.25*PPPP-RTIP(IPA)**2*0.5*OMEGA 0002980
AWC1L=ASCH(NS,JJJ)*FATIP(2)-AWC2L 0002990
PHWCTL=PHWC1L+2.*ZWC+EM1 0003000
DEWC1L=4.*AWC1L/PHWCTL 0003010
DEWC2L=4.*AWC2L/PHWC2L 0003020
MWC1L=MSCH(NS,JJJ)*AWC1L/(ASCH(NS,JJJ)*FATIP(2)) 0003030
MWC2L=MSCH(NS,JJJ)-MWC1L 0003040
R1DR2L=1./SQRT(1.+2.*AWC1L/(PHWC1L*RTIP(IPA))) 0003050
R21WA=RTIP(IPA)/R1DR2L 0003060
R02WA=SQRT(RTIP(IPA)**2+2.*RTIP(IPA)*AWC2L/PHWC2L) 0003070
PHWCTE=1. 0003080
PHWC1E=1. 0003090
IF(QQ(NS,JJJ).LE.1.E-06)GOTO 4444 0003100
CC
C QROD=QSCH(NS,JJJ)*QDEV 0003110
CC
JP=JPIN(NS,JJJ) 0003120
CC
C QROD=QSCH(NS,JJJ)*QDEV + QJ(JP,NS)/H1 0003130
CC 07.11.1979 CCCCCCCC 0003140
CC 0003150
CC 0003160
CC 07.11.1979 CCCCCCCC 0003170
C QLIN=QLINM*QLDEV*C*0.5 0003180
CC 07.11.1979 CCCCCCCC 0003190
PERLS=PERL(2)*ASCH(NS,JJJ)/ACH(2) 0003220
QLIN=(SHQ(III,JJJ)+SHQC(III,JJJ))/(PERLS*H1) * C*0.5 0003240
CC 07.11.1979 CCCCCCCC 0003250
PHWCTE=(QROD+QLIN)*(PHWC1L+PHWC2L)/QROD 0003260
QROD1=QROD*PHWC1L/(PHWC1L+PHWC2L) 0003270

PHWC1E=(QROD1+QLIN)/QROD1*PHWC1L 0003280
4444 FPROV=(DET*FDTIP(2)**2*AT*FATIP(2)/PHWCTE 0003290
WFC01(III,JJJ)=AKAWC(1)*PHWC1E*FPROV/(AWC1L*DEWC1L**2) 0003300
WFC01(III,JJJ)=(WFC01(III,JJJ)*PHWC1L+AKAWC(2)*PHWC2L**2*FPROV/ 0003310
(AWC2L*DEWC2L**2))/((PHWC1L+PHWC2L)*BKAPPA(IPA,2)) 0003320
WFC01(III,JJJ)=WFC01(III,JJJ)/BKAPPA(IPA,2) 0003330
RELA=RELAM(AT*FATIP(2),DET*FDTIP(2),PB,TSCH(NS,JJJ),TW(NS,JJJ), 0003340
* MSCH(NS,JJJ),TLINER(III,JJJ),2,R1DR2L,PHWCTL/(PHWCTL+ 0003350
+PHWC2L)) 0003360
LAMLAM=AKAPPA(NS)/RELA 0003370
CALL ENTRFR(K,1,2,RTIP(IPA),R02WA,R21WA,NS,III,JJJ,DEWC1L,AWC1L, 0003380
* MWC1L,PB,TSCH(NS,JJJ),LAMLAM) 0003390
CALL ENTRFR(K,2,2,RTIP(IPA),R02WA,R22WA,NS,III,JJJ,DEWC2L,AWC2L, 0003400
* MWC2L,PB,TSCH(NS,JJJ),LAMLAM) 0003410
IF(I2TIP(NS,JJJ).EQ.1)GOTO 2997 0003420
C 0003430
C I3TIP=3: SAGAPO DECIDES WHETHER THE FLOW IS LAMINAR OR TURBULENT 0003440
C 0003450
C IF(LAMSCH(NS,JJJ).GT.LAMLAM)GOTO 3000 0003460
C 0003470
C THE FLOW IS LAMINAR 0003480
C 0003490
2997 CONTINUE 0003500
LAMSCH(NS,JJJ)=LAMLAM 0003510
LAMWC(III,JJJ,1)=LAMLAM 0003520
LAMWC(III,JJJ,2)=LAMLAM 0003530
DDDD=AT*FATIP(2)/SQRT(LAMLAM*H/(2.*DET*FDTIP(2)* 0003540
*RHO(PB,TSCH(NS,JJJ)))) 0003550
AMT=MSCH(NS,JJJ) 0003560
ATSCH=TSCH(NS,JJJ) 0003570
I2TIP(NS,JJJ)=1 0003580
F2ATIP(NS,JJJ)=FATIP(2) 0003590
F2DTIP(NS,JJJ)=FDTIP(2) 0003600
ASCHWC(III,JJJ,1)=AWC1L 0003610
ASCHWC(III,JJJ,2)=AWC2L 0003620
PHWC(III,JJJ,1)=(PIG*0.5-OMEGA)*D*0.5 0003630
PHWC(III,JJJ,2)=OMEGA*D*0.5 0003640
DEWC(III,JJJ,1)=DEWC1L 0003650
DEWC(III,JJJ,2)=DEWC2L 0003660
HPLUSB(NS,JJJ)=1. 0003670
HPLUSW(NS,JJJ)=1. 0003680
QPLUS(NS,JJJ)=1. 0003690
PRB(NS,JJJ)=1. 0003700
YODH(NS,JJJ)=1. 0003710
TBSSC1(NS,JJJ)=TSCH(NS,JJJ) 0003720
T1SSC1(III,JJJ)=TSCH(NS,JJJ) 0003730
T2SSC1(III,JJJ)=TSCH(NS,JJJ) 0003740
TBSSC2(NS ,JJJ)=TSCH(NS,JJJ) 0003750
T1SSC2(III,JJJ)=TSCH(NS,JJJ) 0003760
T2SSC2(III,JJJ)=TSCH(NS,JJJ) 0003770
TWSSC1(NS,JJJ)=TW(NS,JJJ) 0003780
TWSSC2(NS,JJJ)=TW(NS,JJJ) 0003790
XMSCHA(III,JJJ)=MSCH(NS,JJJ)*ASCHWC(III,JJJ,1)/(ASCH(NS,JJJ)* 0003800
*F2ATIP(NS,JJJ))*0.5 0003810
XMSCHB(III,JJJ)=XMSCHA(III,JJJ) 0003820
ADAB(III,JJJ)=2. 0003830
C FOR LAMINAR AND TURBULENT FLOW 0003840
C 0003850
3000 CONTINUE 0003860
FCOPW2(III,JJJ)=FCOPW1(2)+PHWC(III,JJJ,2)/PHWCTL*(FCOPW1(2)-1.) 0003870
F1ATIP(NS)=F1ATIP(NS)+ASCH(NS,JJJ)/ACHA(NS)*F2ATIP(NS,JJJ) 0003880
F1PTIP=F1PTIP+ASCH(NS,JJJ)/ACHA(NS)*F2ATIP(NS,JJJ)/F2DTIP(NS,JJJ) 0003890
F1DTIP(NS)=F1ATIP(NS)/F1PTIP 0003900
IF(IRH.EQ.1 .OR. I2TIP(NS,JJJ).EQ.1)RETURN 0003910
C 0003920
C ONLY FOR TURBULENT FLOW AND ROUGHENED RODS 0003930

```

C
ATBC=ATB+ASCHWC(III,JJJ,2)          0003940
HPLUSB(NS,JJJ)=HPLUSB(NS,JJJ)/ATBC   0003950
HPLUSW(NS,JJJ)=HPLUSW(NS,JJJ)/ATBC   0003960
AMTBC=AMT-SRAMIA                     0003970
TSCHBC=(TT-TTA)/AMTBC                0003980
CPTBC=CP(PB,TSCHBC)                  0003990
                                         0004000
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 0004010
C     QPLUS(NS,JJJ)=QQ(NS,JJJ)*ATBC/(SUR*AMTBC*CPTBC*(TE+273.16)) 0004020
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 0004030
                                         0004050
QAD=QQ(NS,JJJ)                      0004060
JP=JPIN(NS,JJJ)                     0004070
IF (QDEV .GT. 0.0) QAD=QQ(NS,JJJ) + QJ(JP,NS)/QDEV*4./H1 0004080
QPLUS(NS,JJJ)=QAD*ATBC/(SUR*AMTBC*CPTBC*(TE+273.16)) 0004090
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 0004100
                                         0004120
PRB(NS,JJJ)=ETA(PB,ATSCH)*CP(PB,ATSCH)/KAPPA(PB,ATSCH) 0004130
YODH(NS,JJJ)=0.5*(SQRT(D**2+16.*ATBC/PIG)-D)/RH        0004140
RETURN
777 RETURN 1
END

```

SUBROUTINE RECCA2 (NS, III, NP, INDSP, H, LENGTH, PR1, PR2, PBT, FRELI, FT, 0000010
*ITCORR, PIG, D, DPAV, *, WSP, I1SPAC) 0000020

C----- 0000030

C SUBROUTINE SUBBAL EVALUATES MASS FLOW RATES AND TEMPERATURES FOR 0000040
C THE TWO PARTS OF WALL SUBCHANNEL 0000050

C 0000060

REAL LENGTH, LAMWC, MAWC, MIWC(2), M2WC(2), MSCWC1, MSCH, MSCH1, MAVCF(2), 0000070
* MAV, MAVJT 0000080

DIMENSION WCFUD(2), WCFWC(2), WCF1WC(2), EP1WC(2), QWCL(2), TIWC(2), 0000090
1 TAWC(2), T2WC(2), RHO1(2), RHOAV(2), RUASWC(2), AWC(2), 0000100
2 TMOEX(2), TACF(2), UACF(2), ACF(2), WTWC2(2), WTWC3(2) 0000110
3 , XMEM(2), DELTAA(2), IPAWC(2), QLINWC(2), THEX(2), DPWC(2), 0000120
4 UWC(2) 0000130

COMMON /MOB8/ DP(42) 0000140

COMMON /SUBC2/ JCHC(3,2) 0000150

COMMON /SUB1/ ASCH(42,3) 0000160

COMMON /SUB2/ TSCH(42,3), MSCH(42,3) 0000170

COMMON /CORR1/ SIGMAI(42,3), PHII(42,3) 0000180

COMMON /CORR2/ CHI(18,2,2), PSI(18,2,2) 0000190

1 /GRID0/CSPAC(42,3,4)/IJ1/NER(42), NIS(42,3)/IND3/NTYP(42) 0000200

2 /GEN2/A(42)/MOB2/UAV(42)/MOB5/TAV(42)/MOB6/MAV(42) 0000210

4 /SUB8/MSCH1(42,3)/SUB31/WCFNS(3),DPNS(3),WTNS1(3, 0000220
5 3),WTNS2(3,2),UNS(3),RUASNS(3)/HEA10/QSCH(42,3) 0000230

6 /WCSE1/DEWC(18,2,2),PHWC(18,2,2) 0000240

A /WCSE2/MSCWC1(18,2,2)/WCSE5/ 0000250

7 TSCWC1(18,2,2)/ WCSE3/LAMWC(18,2,2)/WCSE4/CTURB(18,2) 0000260

8 /WCSE6/ASCWC1(18,2,2)/WCSE7/MAWC(18,2,2) 0000270

9 /WCSE8/ASCHWC(18,2,2)/WCSE9/TAVWC(18,2,2) 0000280

COMMON /SUBC1/NCHC(3),JSCH(3,3)/GEO0/ACH(3) 0000290

1 /GRID1/EPS(42,3,5),DIST(7)/GRID8/PGDP(42,3,4) 0000300

2 /SUB3/ADAB(18,2),DDBB(18,2) 0000310

> /WACO1/XMSCHB(18,2),XMSCHA(18,2) 0000320

3 /QPAR1/QDEV/QPAR2/QLINM,QLDEV/QPAR3/PERL(3) 0000330

4 /GRIDWC/EPSWC(18,2,2,4),CSPWC(18,2,2,4)/GRAV/IGRAV 0000340

5 /GAAG2/FCOPW2(18,2) 0000350

6 /ENEOP/IENE/GRID2/YY(100, 42,3)/MIXS2/CY/SECIN/K 0000360

COMMON /HEA6 / NPIN(42),JPIN(42,3) 0000380

COMMON /SC02C/ QJ(19, 42) 0000390

COMMON /SC07C/ H1 0000400

COMMON /SC13C/ GE01(42,3) 0000410

COMMON /SC06L/ SHQ (18,2) 0000420

COMMON /SC21C/ SHQC(18,2) 0000430

COMMON /SC09R/ QSR (18,2) 0000440

XX=1./980665. 0000460

DO 70 I=1,NP 0000470

FRELWC=FRELI 0000480

NCHCI=NCHC(I) 0000490

0000500

C IW IS THE OTHER SUBCHANNEL OF WALL CHANNEL NS; NCHCI IS THE NUMBER 0000510
C OF CHANNELS CONNECTED TO SUBCHANNEL I 0000520

C 0000530

IW=3-I 0000540

C 0000550

C PORTION 1 IS CONNECTED TO AN EXTERNAL CHANNEL; PORTION 2 TO A 0000560
C CENTRAL CHANNEL (PORTION INDEX = IPAWC) 0000570

C 0000580

DO 101 K1=1,NCHCI 0000590

JCHCIK=JCHC(I,K1) 0000600

J=NIS(NS,JCHCIK) 0000610

IPAWC(K1)=3-NTYP(J)+NTYP(J)/3 0000620

101 CONTINUE 0000630

MAVJT=MAV(J)*ACH(NTYPJ)/A(J) 0001330
WTWC2(IWC)=WTNS2(I,K1) 0001340
TAIJ=(TAWC(IWC)*MAWC(III,I,IWC)+TAV(J)*MAVJT)/(MAWC(III,I,IWC)+
* MAVJT) 0001350
THEX(IWC)=THEX(IWC)-(TAWC(IWC)-TAV(J))*WTWC2(IWC)*CP(PBT,TAIJ) 0001360
0001370
8 CONTINUE 0001380
IF(NP.EQ.1)GOTO 11 0001390
0001400
C C) TURBOLENT EXCHANGE WITH THE OTHER SUBCHANNEL 0001410
0001420
SRUAS=RUASWC(1)+RUASWC(2)+2.*RUASNS(IW) 0001430
DO 10 JWC=1,2 0001440
WTWC3(JWC)=WTNS1(1,2)*(RUASWC(JWC)+RUASNS(IW))/SRUAS 0001450
TAIJ=(TAWC(JWC)*MAWC(III,I,JWC)+TSCH(NS,IW)*MSCH(NS,IW))/
* (MAWC(III,I,JWC)+MSCH(NS,IW)) 0001460
THEX(JWC)=THEX(JWC)-(TAWC(JWC)-TSCH(NS,IW))*WTWC3(JWC)*CP(PBT,TAIJ) 0001470
*) 0001480
0001490
10 CONTINUE 0001500
11 CONTINUE 0001510
0001520
C D) CROSS FLOW EXCHANGE BETWEEN THE TWO PARTS OF SUBCHANNEL 0001530
0001540
TACF(1)=0. 0001550
MAVCF(1)=0. 0001560
CALL CF1(TAWC(1),TAWC(2),MAWC(III,I,1),MAWC(III,I,2),DPWC(1),
*DPWC(2),ITGL,TACF(1),MAVCF(1)) 0001570
0001580
TACF(2)=TACF(1) 0001590
MAVCF(2)=MAVCF(1) 0001600
0001610
C E) CROSS FLOW EXCHANGE WITH CHANNELS 0001620
0001630
DO 16 K1=1,NCHCI 0001640
IWC=IPAWC(K1) 0001650
JCHCIK=JCHC(I,K1) 0001660
J=NIS(NS,JCHCIK) 0001670
NTYPJ=NTYP(J) 0001680
MAVJT=MAV(J)*ACH(NTYPJ)/A(J) 0001690
CALL CF1(TAWC(IWC),TAV(J),MAWC(III,I,IWC),MAVJT,DPWC(IWC),DP(J),
*ITGL,TACF(IWC),MAVCF(IWC)) 0001700
0001710
16 CONTINUE 0001720
IF(NP.EQ.1)GOTO 18 0001730
0001740
C F) CROSS FLOW EXCHANGE WITH THE OTHER SUBCHANNEL 0001750
0001760
DO 17 JWC=1,2 0001770
CALL CF1(TAWC(JWC),TSCH(NS,IW),MAWC(III,I,JWC),MSCH(NS,IW),
*DPWC(JWC),DPNS(IW),ITGL,TACF(JWC),MAVCF(JWC)) 0001780
0001790
17 CONTINUE 0001800
18 CONTINUE 0001810
DO 20 JWC=1,2 0001820
TACF(JWC)=TACF(JWC)/MAVCF(JWC) 0001830
TAICF=(TAWC(JWC)*MAWC(III,I,JWC)+TACF(JWC)*MAVCF(JWC))/(MAWC(III,
*I,JWC)+MAVCF(JWC)) 0001840
0001850
CFHEX=WCFWC(JWC)*(TAWC(JWC)-TACF(JWC))*CP(PBT,TAICF) 0001860
XXMAV=MAWC(III,I,JWC) 0001870
XXM2=M2WC(JWC) 0001880
IF(IENE.EQ.2)XXMAV=MIWC(JWC) 0001890
IF(IENE.EQ.2)XXM2=XXMAV 0001900
T2WC(JWC)=TSCWC1(III,I,JWC)+H/(XXMAV*CP(PBT,TAWC(JWC)))*
*(QWCL(JWC)+QLINWC(JWC)+THEX(JWC)+CFHEX) 0001910
0001920
IF(ABS(PHII(NS,I)).GT.1.E-20)GOTO 200 0001930
PSI(III,I,JWC)=1. 0001940
GOTO 201 0001950
200 CONTINUE 0001960
PSI(III,I,JWC)=(THEX(JWC)+CFHEX)*H/(AWC(JWC)*PHII(NS,I)) 0001970
201 CONTINUE 0001980

```
TAVWC(III,I,JWC)=(XXM2*T2WC(JWC)+MIWC(JWC)*TSCWC1(III,I,JWC))      0001990
*          *0.5 /XXMAV
20 CONTINUE
  IF(ITGL.EQ.1)GOTO 30
  IF(ITERM.GT.10)XPREC=1.E-03
  IF(ITERM.GT.15)XPREC=1.E-02
  DO 21 JWC=1,2
    IF(ABS(TAWC(JWC)/TAVWC(III,I,JWC)-1.).GT.XPREC)GOTO 22
21 CONTINUE
  GOTO 30
22 CONTINUE
  DO 23 JWC=1,2
23 TAWC(JWC)=TAVWC(III,I,JWC)
25 CONTINUE
C ..... 0002130
C END OF THE LOOP ITERM: POINT REACHED IN THE CASE OF CONVERGENCE 0002140
C PROBLEMS 0002150
C 0002160
C WRITE(6,26)NS,I,(TAWC(JWC),JWC=1,2),ITCORR 0002170
26 FORMAT( 5X,'STOP IN LOOP ITERM OF SUB. RECCA2. NS=',I5,2X,'I=',0002180
*12,5X,'TEMPERATURES='/5X,2E15.7/5X,'ITCORR=',I5) 0002190
  RETURN 1
C ..... 0002210
C CONVERGENCE HAS BEEN REACHED FOR THE ENERGY EQUATIONS; THE CALCULATION OF THE PRESSURE DROPS STARTS 0002220
C 0002230
C 0002240
30 CONTINUE
  DO 31 JWC=1,2
    RHOAV(JWC)=RHO(PBT,TAVWC(III,I,JWC))
    UWC(JWC)=MAWC(III,I,JWC)/(AWC(JWC)*RHOAV(JWC))
31 CONTINUE
  DPWCAV=0.
  SMWC1=0.
C A) TURBOLENT EXCHANGE BETWEEN THE TWO PARTS OF SUBCHANNEL 0002320
C 0002330
C TMOEX(1)=-(UWC(1)-UWC(2))*WTWC1 0002350
C TMOEX(2)=-TMOEX(1) 0002360
C 0002370
C B) TURBOLENT EXCHANGE WITH CHANNELS 0002380
C 0002390
C DO 35 K1=1,NCHCI
  JCHCIK=JCHC(I,K1)
  J=NIS(NS,JCHCIK)
  IWC=IPAWC(K1)
  TMOEX(IWC)=TMOEX(IWC)-(UWC(IWC)-UAV(J))*WTWC2(IWC)
35 CONTINUE
C 0002460
C C) TURBOLENT EXCHANGE WITH THE OTHER SUBCHANNEL 0002470
C 0002480
C DO 37 JWC=1,2
  IF(NP.NE.1)TMOEX(JWC)=TMOEX(JWC)-(UWC(JWC)-UNS(IW))*WTWC3(JWC)
37 TMOEX(JWC)=TMOEX(JWC)*FT*H/AWC(JWC)
  UACF(1)=0.
  ACF(1)=0.
C 0002540
C D) CROSS FLOW EXCHANGE BETWEEN THE TWO PARTS OF SUBCHANNEL 0002550
C 0002560
C CALL CF1(UWC(1),UWC(2),AWC(1),AWC(2),DPWC(1),DPWC(2), 1,UACF(1),0002570
*          ACF(1))
  UACF(2)=UACF(1)
  ACF(2)=ACF(1)
C 0002610
C E) CROSS FLOW EXCHANGE WITH CHANNELS 0002620
C 0002630
```

DO 40 K1=1,NCHCI
IWC=IPAWC(K1)
JCHCIK=JCHC(I,K1)
J=NIS(NS,JCHCIK)
NTYPJ=NTYP(J)
AJT=ACH(NTYPJ)
CALL CF1(UWC(IWC),UAV(J),AWC(IWC),AJT,DPWC(IWC),DP(J),1,
* UACF(IWC),ACF(IWC))
40 CONTINUE
DO 45 JWC=1,2
C F) CROSS FLOW EXCHANGE WITH THE OTHER SUBCHANNEL
C IF(NP.NE.1) CALL CF1(UWC(JWC),UNS(IW),AWC(JWC),ASCH(NS,IW),
* DPWC(JWC),DPNS(IW),1,UACF(JWC),ACF(JWC))
C
C UACF(JWC)=UACF(JWC)/ACF(JWC)
CFMOEX=(2.*UWC(JWC)-UACF(JWC))*WCFWC(JWC)*H/AWC(JWC)
XMEM(JWC)=LAMWC(III,I,JWC)*H/(2.*DEWC(III,I,JWC)*RHOAV(JWC))
IF(JWC.EQ.1)XMEM(JWC)=XMEM(JWC)*FCOPW2(III,I)
RE=MAWC(III,I,JWC)*DEWC(III,I,JWC)/(AWC(JWC)*ETA(PBT,TAVWC(III,I,
1JWC)))
IF(INDSP.EQ.2)XMEM(JWC)=XMEM(JWC)+(CSPWC(III,I,JWC,I1SPAC)+DSPDPF(0002870
*EPSWC(III,I,JWC,I1SPAC),DEWC(III,I,JWC),LAMWC(III,I,JWC),WSP,
*PGDP(NS,I,I1SPAC),RE,2))/RHOAV(JWC)
DPWC(JWC)=XX*(-(MAWC(III,I,JWC)/AWC(JWC))**2*(XMEM(JWC)-(RHO(PR2,
* T2WC(JWC))-RHO1(JWC))/RHOAV(JWC)**2-DELTA(JWC)/(AWC(JWC)*
* RHOAV(JWC)))+TMOEX(JWC)+CFMOEX+IGRAV*980.665*RHOAV(JWC)*H)
DPWCAV=DPWCAV+DPWC(JWC)*MIWC(JWC)
SMWC1=SMWC1+MIWC(JWC)
45 CONTINUE
DPWCAV=DPWCAV/SMWC1
C
C TEST OF CONVERGENCE ON THE PRESSURE DROPS
C
C IF(ITGL.LT.4)GOTO 47
DO 46 JWC=1,2
IF(ABS(DPWC(JWC)/DPWCAV-1.).GT.1.E-02)GOTO 47
IF(ABS(DPWC(JWC)/DPWCAV-1.).GT.1.E-03 .AND. ITGL.LT.40)GOTO 47
46 CONTINUE
IF(IVIA.EQ.2)GOTO 55
IF(M2WC(1).LE.0. .OR. M2WC(2).LE.0.)GOTO 99
IVIA=2
47 CONTINUE
DO 48 JWC=1,2
48 WCFWC(JWC)=WCFWC(JWC)-WCFUD(JWC)
49 CONTINUE
C
C END OF LOOP ITGL
C
C 99 CONTINUE
AIT=ITFREL
FRELWC=1.-AIT*0.01
50 CONTINUE
C
C END OF LOOP ITFREL: POINT REACHED IN THE CASE OF CONVERGENCE
C PROBLEMS
C
C WRITE(6,51)ITCORR,NS,I,(DPWC(JWC),JWC=1,2),(MAWC(III,I,JWC),JWC=1,0003230
* 2),(TAVWC(III,I,JWC),JWC=1,2),(AWC(JWC),JWC=1,2) 0003240
51 FORMAT(// 5X,'STOP IN LOOP ITGL OF RECCA2: ITCORR=',I5,5X,'NS=', 0003250
1I5,5X,'I=',I2/5X,'PRESSURE LOSSES:',2E15.5/5X,'AVERAGE MASSES:', 0003260
22E15.5/5X,'AVERAGE TEMPERATURES:',2E15.5/5X,'AREAS:',2E15.5) 0003270
RETURN 1 0003280
C 0003290

C	THE ENERGY EQUATIONS AND THE AXIAL MOMENTUM EQUATIONS HAVE	0003300
C	REACHED CONVERGENCE	0003310
C		0003320
55	CONTINUE	0003330
	DO 56 JWC=1,2	0003340
	DPAVF=DPAV-IGRAV*RHOAV(JWC)*H*0.001	0003350
	BMWC=SQRT(ABS(DPAVF) /(XX*XMEM(JWC)))*AWC(JWC)	0003360
	CHI(III,I,JWC)=(MAWC(III,I,JWC)-BMWC)/(AWC(JWC)*SIGMAI(NS,I))	0003370
56	CONTINUE	0003380
	EPSM=MAWC(III,I,1)-(XMSCHA(III,I)+XMSCHB(III,I))	0003390
	XMSCHA(III,I)=XMSCHA(III,I)+EPSM*(1.-1./ADAB(III,I))	0003400
	XMSCHB(III,I)=XMSCHB(III,I)+EPSM/ADAB(III,I)	0003410
70	CONTINUE	0003420
	RETURN	0003430
	END	0003440

```
FUNCTION RELAM(A,D,P,TB,TW,M,TLINER,ITYP,R1DR2L,PH1DPH)      0000010
C-----0000020
C RELAM COMPUTES THE LAMINAR REYNOLDS NUMBERS FOR THE CALCULATION 0000030
C OF THE SUBCHANNEL FRICTION FACTORS                           0000040
C                                                               0000050
C
REAL M                                         0000060
COMMON /GAAG1/ FCOPW1(3)                      0000070
COMMON/INPAR/IPA/LAMIN5/RTIP(7)/DAT/PIG/QPAR3/PERL(3)/MART/ITCORR 0000080
1   /RETEM/TNY                                     0000090
TL=TLINER                                      0000100
IF(IPA/2*2.NE.IPA .OR. ITCORR.EQ.1)TW=TB       0000110
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 16.10.1979      0000120
RENU =M*D/FCOPW1(ITYP) /(A*RHO(P,TB))          0000130
PERLC=PERL(ITYP)*FCOPW1(ITYP)                  0000140
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 0000150
C   RENU =M*D /(A*RHO(P,TB))                   0000160
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 0000170
   TNY=TW                                         0000180
   IF(ITYP.NE.1 .AND. IPA/2*2.EQ.IPA .AND. ITCORR.GT.1) 0000190
*     TNY=TNU(TW,TL,ITYP,PERLC ,PIG,RTIP(IPA)) 0000200
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 16.10.1979      0000210
C   *     TNY=TNU(TW,TL,ITYP,PERL(ITYP),PIG,RTIP(IPA)) 0000220
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 0000230
   RELAM=RENU *RHO(P,TNY)/ETA(P,TNY)           0000240
C
RETURN                                         0000250
END                                           0000260
                                               0000270
```

```
FUNCTION RHO(P,T)          0000010
C-----0000020
C   RHO EVALUATES THE DENSITY OF THE COOLANT (G/CCM) 0000030
C   COMMON/GASD4/IGAS          0000040
C   GOTO(10,20,30,40),IGAS    0000050
10  CONTINUE                0000060
C   CASE OF HELIUM COOLANT   0000070
C   TODT=273.16/(273.16+T)    0000080
C   RHO=0.172823E-03*P*TODT-0.904002E-07*P**2*TODT**2.2 0000090
C   RETURN                   0000100
C   0000110
C   0000120
C   0000130
20  CONTINUE                0000140
C   CASE OF CO2 COOLANT      0000150
C   PP=P                     0000160
C   TT=T                     0000170
C   P=PP/1.0333               0000180
C   T=TT+273.16               0000190
C   TO=273.16                 0000200
C   IF(T-516.) 1, 1, 2       0000210
1   CK=.0134                 0000220
C   GO TO 5                  0000230
2   IF(T-750.) 3, 4, 4       0000240
3   CK=(650.-T)* 1.E-4       0000250
C   GO TO 5                  0000260
4   CK=-.01                  0000270
5   TF=TO/T                  0000280
C   ROF=1.9635*P*TF*(1.+CK*P*(TF**5)) 0000290
C   RHO=ROF*0.001             0000300
C   T=TT                     0000310
C   P=PP                     0000320
C   RETURN                   0000330
C   0000340
C   0000350
30  CONTINUE                0000360
C   CASE OF N2 COOLANT.      0000370
C   0000380
C   TT=T                     0000390
C   T=TT+273.16               0000400
C   RHO=1.2499*P*273.16/1.033/T*(1.-4.E-4*(P/1.033)*
>     (1.-.05*ABS((600.-T)/273.16)**.61))*001 0000410
C   T=TT                     0000420
C   RETURN                   0000430
C   0000440
40  CONTINUE                0000450
C   RHO=0.                   0000460
C   RETURN                   0000470
C   END                      0000480
C   0000490
```

```
FUNCTION RHPLUS(HPLUSB,TW,TE,QPLUS,HPLUSW,TB1,YDH)          0000010
C-----0000020
C-----0000030
C-----0000040
C-----0000050
C-----0000060
C-----0000070
C-----0000080
C-----0000090
C-----0000100
C-----0000110
C-----0000120
C-----0000130
C-----0000140
C-----0000150
C-----0000160
C-----0000170
C-----0000180
C-----0000190
C-----0000200
CCCCCCCCCCCCCCCC 12.10.1979                                0000210
C-----0000220
C-----0000230
C-----0000240
C-----0000250
C-----0000260
C-----0000270
C-----0000280
C-----0000290
C-----0000300
C-----0000310
C-----0000320

SUBROUTINE RNU(HPLUSW,TWI,LAMIB,REI,PRI,TBT,YDH,R1DR2,R2MROH,U1DU,0000010
*REW,YYI,NUI,GHPL,ITYP,R0,R1,R2,BK)                      0000020
C-----0000030
C-----0000040
C-----0000050
C-----0000060
C-----0000070
C-----0000080
C-----0000090
C-----0000100
C-----0000110
C-----0000120
```

```
SUBROUTINE RNU(HPLUSW,TWI,LAMIB,REI,PRI,TBT,YDH,R1DR2,R2MROH,U1DU,0000010
*REW,YYI,NUI,GHPL,ITYP,R0,R1,R2,BK)                      0000020
C-----0000030
C-----0000040
C-----0000050
C-----0000060
C-----0000070
C-----0000080
C-----0000090
C-----0000100
C-----0000110
C-----0000120
```

SUBROUTINE RTRI(PBT,TBT,MASSI,DE1,AREAI,ADAB,LAM1,QA,FACHE,TE, 0000010
* RH,I,II,M,JPIN,TW1,RU1DRU,ITYP,DEI,D,YYDH,*,F2ATIP,F2DTIP,QALIN) 0000020
C-----0000030
C RTRI EVALUATES ROD TEMPERATURES FOR CENTRAL AND CORNER SUBCHANNELS0000040
C AND FOR THE TWO PARTS OF WALL SUBCHANNELS IN THE ROUGH PORTION.THE0000050
C BULK TEMPERATURES OF THE TWO REGIONS DEFINED BY THE TAU=0 LINE ARE0000060
C ALSO COMPUTED. 0000070
C 0000080
REAL LAM1,MASSI,KI,KAPPA,NUI,NUO,NUTU 0000090
COMMON/SUB21/TSCHA(18,2),TSCHB(18,2)/SHROUD/TLINER(18,2) 0000100
1 /TRANS/RHTU,RHSM/LAMINO/I2TIP(42,3)/ISUP/IQLIN 0000110
COMMON /MART5/ NSTR 0000120
COMMON /SC15C/ ALFA(42,3) 0000130
COMMON /SC10C/ ANU(42,3) 0000140
COMMON /SC32C/ GHPIU(42,3) 0000150
COMMON /SC01Z/ YH(42,3) 0000160
COMMON /SC34C/ ISUC 0000170
C0000180
C TEMLAM IS CALLED IF THE FLOW IS LAMINAR; THE CALCULATION RETURNS 0000190
C THEN AT THE END OF RTRI 0000200
C 0000210
IF(I2TIP(I,M).EQ.1)CALL TEMLAM(&2000,PBT,TBT,MASSI,DEI,AREAI,QA, 0000220
& QALIN,TE,I,II,M,TW1,ITYP,F2ATIP,F2DTIP,D) 0000230
*****0000240
C THE FLOW IS TURBULENT: CALCULATION PERFORMED ASSUMING ROUGH FLOW 0000250
*****0000260
C 0000270
R1=D*0.5 0000280
R0=0.5*SQRT(D**2+DE1*D) 0000290
R2=SQRT(D**2+ADAB*DE1*D)*0.5 0000300
C0000310
C INLET EFFECT ON THE NUSSELT NUMBER OF THE RODS 0000320
C 0000330
FACHE=TIS(R1,R2,2) 0000340
C 0000350
YDH=(R0-R1)/RH 0000360
R2MROH=(R2-R0)/RH 0000370
YYDH=YDH+R2MROH 0000380
RODR2=R0/R2 0000390
R1DR2=R1/R2 0000400
KI=KAPPA(PBT,TBT) 0000410
ETAI=ETA(PBT,TBT) 0000420
RHOI=RHO(PBT,TBT) 0000430
CPI=CP(PBT,TBT) 0000440
REI=MASSI*DEI/(AREAI*ETAI) 0000450
PRI=ETAI*CPI/KI 0000460
UI=MASSI/(AREAI*RHOI) 0000470
TWALL=TBT 0000480
TWO=TBT 0000490
TB1=TBT 0000500
C0000510
C CALCULATION OF THE BULK TEMPERATURES OF THE TWO ZONES DIVIDED BY 0000520
C THE TAU=0 LINE (LOOP ITW) 0000530
C 0000540
DO 7 ITW=1,20 0000550
RHOI=RHO(PBT,TB1) 0000560
U1DU=RU1DRU*RHOI/RHOI 0000570
U1=U1DU*UI 0000580
U1STAR=U1*SQRT(LAM1*0.125) 0000590
C0000600
C CALCULATION OF THE SURFACE PIN TEMPERATURE AT INFINITE CONDUCTI= 0000610

C VITY OF THE CANNING METAL AND AT (Q")SHROUD = 0 (LOOP ITW1) 0000620
C DO 30 ITW1=1,30 0000630
IF(ABS(TWO).LT.3000..AND. ABS(TWALL).LT.3000.)GOTO 29 0000640
WRITE(6,28)I,JPIN,TWO,TWALL 0000650
28 FORMAT(5X,'STOP IN RTRI: NS=',I5,5X,'PIN=',I5/5X,'TWO=',E15.5,0000670
15X,'TWALL=',E15.5) 0000680
RETURN 1 0000690
29 CONTINUE 0000700
ETAW=ETA(PBT,TWALL) 0000710
RHOW=RHO(PBT,TWALL) 0000720
REW=U1*DE1*RHOW/ETAW 0000730
REWO=REW*ETAW*RHO(PBT,TWO)/(RHOW*ETA(PBT,TWO)) 0000740
HPLUSW=RH*REW*SQRT(LAM1*0.125)/DE1 0000750
HPLUSO=HPLUSW*REWO/REW 0000760
CCCCCCCCCC 06.02.1980 0000770
CALL SPANU(REI,PRI,I,M,YYI) 0000780
BK=2.0 0000790
IF(ITYP.EQ.1 .AND. I.GT.NSTR) BK=1.0 0000800
CALL RNU(HPLUSW,TWALL,LAM1,REI,PRI,TBT,YDH,R1DR2,R2MROH,U1DU,REW, 0000810
1 YYI,NUI,GHPL,ITYP,R0,R1,R2,BK) 0000820
CALL RNU(HPLUSO,TWO ,LAM1,REI,PRI,TBT,YDH,R1DR2,R2MROH,U1DU,REWO, 0000830
1 1.,NUO,GHPO,ITYP,R0,R1,R2,BK) 0000840
C 18.03.1981 0000850
IF(ITYP.NE.1 .OR. ISUC.EQ.0) GO TO 200 0000860
CALL SUPCEN (RH,PBT,TWALL,LAM1,U1DU,YYI,ITYP,KI,DEI,FACHE,QA,TW1, 0000870
> GHPL,NUI,I,M,REI,ITW1) 0000880
200 CONTINUE 0000890
C 0000900
GHPIU(I,M)=GHPL 0000910
ALFAI=NUI*KI/DEI*FACHE 0000920
ALFAO=NUO*KI/DEI 0000930
ALFA(I,M)=ALFAI 0000940
ANU(I,M)=NUI 0000950
YH(I,M)=YYI 0000960
IF(ISUC.NE.1 .OR. ITYP.NE.1)TW1=TBT+QA/ALFAI 0000970
C TW1=TBT+QA/ALFAI 0000980
CCCCCCCCCC 06.02.1980 0000990
TWO=TBT+QA/ALFAO 0001000
IF(ABS(TW1/TWALL-1.).LE.1.E-04)GOTO 32 0001010
30 TWALL=TW1 0001020
C 0001030
C END OF LOOP ITW1: POINT REACHED IN THE CASE OF CONVERGENCE 0001040
C PROBLEMS 0001050
C 0001060
WRITE(6,31)I,JPIN,TW1 0001070
31 FORMAT(1H1,5X,'STOP IN RTRI (LOOP ITW1) NS=',I5,5X,'PIN=',I5,5X, 0001080
*'TW1=',E15.5) 0001090
RETURN 1 0001100
C 0001110
C CONVERGENCE HAS BEEN REACHED FOR THE PIN TEMPERATURE 0001120
C 0001130
32 CONTINUE 0001140
IF(ITYP.EQ.1)GOTO 9 0001150
C 0001160
C ONLY FOR THE CORNER CHANNELS AND FOR THE WALL PORTION OF THE WALL 0001170
C SUBCHANNELS 0001180
C 0001190
FF=QA/(RHOT*CPI*U1STAR) 0001200
CALL DDONNE(TWO,TBT,GHPL,RODR2,R1DR2,YDH,R2MROH,FF,TSCHA(II,M), 0001210
1 TSCHB(II,M),TE) 0001220
IF(ABS(TSCHB(II,M)/TB1-1.).LE.1.E-04)GOTO 9 0001230
TB1=TSCHB(II,M) 0001240
7 CONTINUE 0001250
C 0001260
C END OF LOOP ITW: POINT REACHED IN THE CASE OF CONVERGENCE 0001270

C PROBLEMS 0001280
C 0001290
C WRITE(6,8)I,JPIN,TB1 0001300
8 FORMAT(1H1,5X,'STOP IN RTRI (LOOP ITW) I=',I5,5X,'PIN=',I5,5X,'TB10001310
\$=',E15.5) 0001320
RETURN 1 0001330
C 0001340
C CONVERGENCE HAS BEEN REACHED FOR THE BULK TEMPERATURES OF THE 0001350
C TWO ZONES DIVIDED BY THE TAU=0 LINE; THE ASSUMPTION OF ROUGH FLOW 0001360
C IF TESTED (THIS POINT IS REACHED ALSO BY THE CALCULATION FOR THE 0001370
C CENTRAL SUBCHANNELS AND THE CENTRAL PORTION OF THE WALL SUBCHANNEL 0001380
C 0001390
9 CONTINUE 0001400
ETA1=ETA(PBT,TB1) 0001410
HPLUSB=HPLUSW*RHO1*ETAW/(ETA1*RHOW) 0001420
RHPL=RHPLUS(HPLUSB,TWALL,TE,XYXYX,HPLUSW,TB1,YDH) 0001430
IF(RHTU.LE.RHSM)GOTO 100 0001440
***** 0001450
C THE FLOW IF "HYDRAULICALLY" SMOOTH: THE CALCULATION IS REPEATED IN 0001460
C SUBROUTINE RTSI. THE CALCULATION IS BASED STILL ON THE VOLUMETRIC 0001470
C DIAMETER. THE CALCULATION RETURNS IMMEDIATELY AFTER COMING BACK 0001480
C FROM RTSI 0001490
***** 0001500
CALL RTSI(PBT,TBT,MASSI,DE1,AREAI,ADAB,LAM1,QA,FACHE,TE,RH,I,
&II,M,JPIN,TW1,R1DRU,ITYP,DEI,D,YYDH,&8500,F2ATIP,F2DTIP,QALIN) 0001510
RETURN 0001520
***** 0001530
C POINT REACHED IN THE CASE OF ROUGH FLOW 0001550
***** 0001560
100 IF(ITYP.EQ.1)RETURN 0001570
C 0001580
C CALCULATION OF THE SHROUD TEMPERATURE FOR THE CORNER CHANNELS AND 0001590
C FOR THE WALL PORTION OF THE WALL SUBCHANNELS (VALUE AT 0001600
C (Q")SHROUD = 0) 0001610
C 0001620
TLINER(II,M)=TWO-FF*(2.5*ALOG((R2-R1)/RH)+GHPL) 0001630
IF(TLINER(II,M).LE.TE)TLINER(II,M)=TE 0001640
C 0001650
C CORRECTION OF THE PREVIOUSLY COMPUTED PIN AND SHROUD TEMPERATURES 0001660
C OF THE CORNER CHANNELS AND OF THE WALL PORTION OF THE WALL SUBCHA=0001670
C NNELS IN THE CASE OF HEATED SHROUD WALLS (SUPERPOSITION PRINCIPLE)0001680
C 0001690
DEIAN=2.*(R2-R1) 0001700
TETA2=0. 0001710
IF(QA.GT.1.E-06)TETA2=(TLINER(II,M)-TBT)*KI/(QA*DEIAN) 0001720
NUI=NUI*DEIAN/DEI 0001730
CCCCCCCCCC 0001740
ANU(I,M)=NUI 0001750
CCCCCCCCCC 0001760
REI=REI*DEIAN/DEI 0001770
A1=0.45/(2.4+PRI) 0001780
NUTU=TUBENU(REI,PRI) 0001790
PEI=REI*PRI 0001800
FTWA=22.* (0.27*R1DR2**2-1.)/(PEI**0.87*PRI**0.18)*R1DR2 0001810
CCCCCCCCCC 22.05.1980 0001820
C IF(IQLIN.EQ.1 .AND. ABS(QALIN) 0001830
C 1.GT.1.E-06)CALL TELIN(TW1,TLINER(II,M),TBT,TE,TETA2,FTWA,
C 1 QA,QALIN,NUI,NUTU,A1,KI,R1DR2,DEIAN,I,JPIN,YYI,FACHE,M)
CALL TELIN(TW1,TLINER(II,M),TBT,TE,TETA2,FTWA,
1 QA,QALIN,NUI,NUTU,A1,KI,R1DR2,DEIAN,I,JPIN,YYI,FACHE,M) 0001870
CCCCCCCCCC 22.05.1980 0001880
2000 RETURN 0001890
8500 RETURN 1 0001900
END 0001910

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SUBROUTINE RTSI(PBT, TI, MASSI, DE1, AREAI, ADAB, LAM1, QA, FACHE,      0000010
* TE, RH, I, II, M, JPIN, TWI, RU1DRU, ITYP, DEIR, D, XXXX, *, F2ATIP, F2DTIP, 0000020
* QALIN)                                         0000030
C-----0000040
C   RTSI EVALUATES ROD TEMPERATURES FOR CENTRAL AND CORNER SUBCHANNELS0000050
C   AND FOR THE TWO PARTS OF WALL SUBCHANNELS IN THE SMOOTH PART 0000060
C                                         0000070
C   REAL NUTU,NUIO,NUI,KI,KAPPA,MASSI,LAM1          0000080
C   COMMON/SUB21/TSCHA( 18,2),TSCHB( 18,2)/SHROUD/TLINER( 18,2) 0000090
C   1           /LAMINO/I2TIP( 42,3)/ISUP/IQLIN/ISMO/COTW 0000100
C   2           /ISMO1/ITECO                         0000110
C   1           /QSHR/QALIN/LAMINO/I2TIP( 42,3)/ISUP/IQLIN/ISMO/COTW 0000120
C   COMMON /SC15C/ ALFA( 42,3)                      0000140
C   COMMON /SC10C/ ANU( 42,3)                       0000150
C   COMMON /SC01Z/ YH( 42,3)                        0000160
C   .....0000180
C   TEMLAM IS CALLED IF THE FLOW IS LAMINAR; THE CALCULATION RETURNS 0000190
C   THEN AT THE END OF RTSI                         0000200
C                                         0000210
C   IF(I2TIP(I,M).EQ.1)CALL TEMLAM(&2000,PBT, TI, MASSI, DEIR, AREAI, QA, 0000220
&                               QALIN, TE, I, II, M, TWI, ITYP, F2ATIP, F2DTIP, D) 0000230
C   *****0000240
C   THE FLOW IS TURBULENT                          0000250
C   *****0000260
C   TG=TE                                         0000270
C   IF(ITECO.EQ.2)TG=TI                           0000280
C   R1=D*0.5                                     0000290
C   R0=0.5*SQRT(D**2+DE1*D)                     0000300
C   R2=SQRT(D**2+ADAB*DE1*D)*0.5                0000310
C   DEI=2.*(R2-R1)                                0000320
C   RODR2=R0/R2                                  0000330
C   R1DR2=R1/R2                                  0000340
C   R1DR0=R1/R0                                  0000350
C   .....0000360
C   INLET EFFECT ON THE NUSSELT NUMBER OF THE RODS 0000370
C                                         0000380
C   FACHE=TIS(R1,R2,1)                            0000390
C                                         0000400
C   TWIO=TWI                                      0000410
C   KI=KAPPA(PBT, TI)                            0000420
C   ETAI=ETA(PBT, TI)                            0000430
C   RHOI=RHO(PBT, TI)                            0000440
C   CPI=CP(PBT, TI)                             0000450
C   REI=MASSI*DEI/(AREAI*ETAI)                  0000460
C   PRI=ETAI*CPI/KI                            0000470
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 06.02.1980 0000480
C   CALL SPANU(REI,PRI,I,M,YYI)                 0000490
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 06.02.1980 0000500
A1=0.45/(2.4+PRI)                            0000510
A2=0.16*pri**(-0.15)                         0000520
A3=1.                                         0000530
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 21.09.1979 0000540
C   IF(R1DR2.LT.0.2)A3=1.+(7.5*(1./R1DR2-5.)/REI)**0.6 0000550
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 0000560
IF(R1DR2.LT.0.2)A3=1.+7.5*((1./R1DR2-5.)/REI)**0.6 0000570
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 0000580
NUTU=TUBENU(REI,PRI)                         0000590
FNU=(1.-A1)/R1DR2**A2 *A3*(TG+273.16)**COTW*NUTU 0000600
C   .....0000610
C   CALCULATION OF THE SURFACE PIN TEMPERATURE AT (Q")SHROUD = 0 0000620
C   ( LOOP ITW )                                0000630
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C DO 5 ITW=1,10 0000640
TWALL=TWI 0000650
NUI=FNU/(TWI+273.16)**COTW*YYI*FACHE 0000660
NUIO=FNU/(TWI0+273.16)**COTW 0000670
ALFAIO=NUI0*KI/DEI 0000680
ALFAI=NUI*KI/DEI 0000690
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 0000700
ALFA(I,M)=ALFAI 0000710
ANU(I,M)=NUI 0000720
YH(I,M)=YYI 0000730
CCCCCCCCCCCCCCCCCCCCCCCCCCCC 0000740
TWI=TI+QA/ALFAI 0000750
TWIO=TI+QA/ALFAIO 0000760
IF(ABS(TWALL/TWI-1.).LE.1.E-04)GOTO 7 0000770
5 CONTINUE 0000780
C 0000790
C END OF LOOP ITW: POINT REACHED IN THE CASE OF CONVERGENCE 0000800
C PROBLEMS 0000810
C 0000820
C 0000830
C WRITE(6,6)I,JPIN,TWI,TWALL 0000840
6 FORMAT(1H1,5X,'STOP IN RTSI (CHANNEL',I5,', PIN',I5,',') : TW=' , 0000850
*E15.7,5X,'TWALL=',E15.7) 0000860
RETURN 1 0000870
C 0000880
C CONVERGENCE HAS BEEN REACHED FOR THE PIN TEMPERATURE 0000890
C 0000900
7 IF (ITYP.EQ.1)RETURN 0000910
C 0000920
C CALCULATION OF THE SHROUD TEMPERATURE FOR THE CORNER CHANNELS AND 0000930
C FOR THE WALL PORTION OF THE WALL SUBCHANNELS (VALUE AT 0000940
C (Q")SHROUD = 0) 0000950
C 0000960
PEI=REI*pri 0000970
FTWA=22.*((0.27*R1DR2**2-1.)/(PEI**0.87*pri**0.18)*R1DR2 0000980
TLINER(II,M)=FTWA*QA*DEI/KI+TI 0000990
IF(TLINER(II,M).LE.TE)TLINER(II,M)=TE 0001000
TETA2=0. 0001010
TSCHA(II,M)=TI 0001020
TSCHB(II,M)=TI 0001030
IF(QA.LE.1.E-06)GOTO 22 0001040
TETA2=(TLINER(II,M)-TI)*KI/(QA*DEI) 0001050
GTI=(1.5*R1DR2+0.5)/(R1DR2+1.) 0001060
GT1=(1.5*R1DR0+0.5)/(R1DR0+1.) 0001070
UI=MASSI/(AREAI*RHOI) 0001080
F1=R0**2-R1**2 0001090
F2=R2**2-R0**2 0001100
FI=F1+F2 0001110
TB1=TI 0001120
C 0001130
C CALCULATION OF THE BULK TEMPERATURES OF THE TWO ZONES DIVIDED BY 0001140
C THE TAU=0 LINE FOR THE CORNER CHANNELS AND FOR THE WALL PORTION OF 0001150
C THE WALL SUBCHANNELS (LOOP ITW1) 0001160
C 0001170
DO 20 ITW1=1,10 0001180
RHO1=RHO(PBT,TB1) 0001190
ETA1=ETA(PBT,TB1) 0001200
U1DUAS=RU1DRU*RHO1/RHO1*SQRT(LAM1*0.125) 0001210
U1AS=U1DUAS*UI 0001220
FF=RHO1*CPI*U1AS/QA 0001230
DD=ETA1/(RHO1*U1AS) 0001240
AS=-TETA2*PEI*U1DUAS/GTI 0001250
BS=(TWI0-TI)*FF-AS*(ALOG((R2-R1)/DD)-GTI) 0001260
TSCHA(II,M)=FI/F2*TI-F1/F2*(TWI0-(AS*(ALOG((R0-R1)/DD)-GT1)+BS)/ 0001270
/FF) 0001280

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IF(TSCHA(II,M).LE.TE)TSCHA(II,M)=TE 0001290
TSCHB(II,M)=F1/F1*TI-F2/F1*TSCHA(II,M) 0001300
IF(ABS(TSCHB(II,M)/TB1-1.).LE.1.E-04)GOTO 22 0001310
TB1=TSCHB(II,M) 0001320
20 CONTINUE 0001330
C ..... 0001340
C END OF LOOP ITW1: POINT REACHED IN THE CASE OF CONVERGENCE 0001350
C PROBLEMS 0001360
C 0001370
C WRITE(6,21)I,JPIN,TB1 0001380
21 FORMAT(1H1,5X,'STOP IN RTSI (LOOP ITW1)I=',I5,5X,'PIN=',I5,'TB1=' ,0001390
   1E15.5) 0001400
   RETURN 1 0001410
C ..... 0001420
C CONVERGENCE HAS BEEN REACHED FOR THE BULK TEMPERATURES OF THE 0001430
C TWO ZONES DIVIDED BY THE TAU=0 LINE 0001440
C CORRECTION OF THE PREVIOUSLY COMPUTED PIN AND SHROUD TEMPERATURES 0001450
C OF THE CORNER CHANNELS AND OF THE WALL PORTION OF THE WALL SUBCHA=0001460
C NNELS IN THE CASE OF HEATED SHROUD WALLS (SUPERPOSITION PRINCIPLE)0001470
C 0001480
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 22.05.1980 0001490
22 CALL TELIN(TWI,TLINER(II,M),TI,TE,TETA2,FTWA,QA 0001500
   1,QALIN,NUI,NUTU,A1,KI,R1DR2,DEI,I,JPIN,YYI,FACHE,M) 0001510
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 0001520
C 22 IF(IQLIN.EQ.1 .AND. ABS(QALIN) 0001530
C   0.GT.1.E-06)CALL TELIN(TWI,TLINER(II,M),TI,TE,TETA2,FTWA,QA 0001540
C   1,QALIN,NUI,NUTU,A1,KI,R1DR2,DEI,I,JPIN,YYI,FACHE,M) 0001550
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 0001560
C 22 IF(IQLIN.EQ.1 .AND. ABS(QALIN) 0001570
C   0.GT.1.E-06)CALL TELIN(TWI,TLINER(II,M),TI,TE,TETA2,FTWA,QA 0001580
C   1,QALIN,NUI,NUTU,A1,KI,R1DR2,DEI,I,JPIN,YYI,FACHE) 0001590
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 0001600
2000 RETURN 0001610
END 0001620

```

SUBROUTINE SELAWA 0000010
C ----- 0000020
C SELAWA COMPUTES THE KAPPA VALUES FOR THE SUBCHANNELS AND THE TWO 0000030
C KAPPA VALUES FOR THE TWO PORTIONS OF THE WALL SUBCHANNELS IN THE 0000040
C LAMINAR CALCULATIONS 0000050
COMMON /LAMIN6/ANGLAM/WALLKA/AKAWC(2)/WAKAO/P,W,Z,ZWC,A,PW 0000060
1 /LAMINK/BKAPPA(7,3)/INPAR/IPA 0000070
C 0000080
BKAPPA(IPA,1)=GKAPPA(1.050075*P) 0000090
BKAPPA(IPA,3)=FKAPPA(0.476156/Z) 0000100
ALFA=ATAN(2.*(Z-ZWC)/P) 0000110
BETA=BETAF(P,W,ZWC) 0000120
ALFAB=ALFA*BETA 0000130
ANGLAM=TAN(ALFAB)/TAN(ALFA) 0000140
A2=P**2*TAN(ALFAB)*0.125-0.125*ALFAB 0000150
PW2=ALFAB*0.5 0000160
A1=A-A2 0000170
PW1=PW-PW2 0000180
R=SQRT((1.570796-ALFAB)/(4.*Z*P-P**2*TAN(ALFAB)-6.928204*ZWC**2)) 0000190
X=P*SQRT(TAN(ALFAB)/ALFAB) 0000200
AKAWC(1)=FKAPPA(R) 0000210
AKAWC(2)=GKAPPA(X) 0000220
100 BKAPPA(IPA,2)=A**3/(PW**2*(A2**3/(PW2**2*AKAWC(2))+A1**3/(PW1**2*
*AKAWC(1)))) 0000230
RETURN 0000240
END 0000250
0000260

SUBROUTINE SIMLA1(TE, TI, TWI, TLI, NUI, TETAI, I, JJJ, TBEQ1, TBEQ2, II) 0000010

C SIMLA1 CORRECTS THE NUSSELT NUMBERS AND THE DIMENSIONLESS TEMPERAT0000030
C URES OF THE UNHEATED WALLS IN THE CORNER AND WALL CHANNELS IN THE 0000040
C LAMINAR CALCULATIONS IF THE KAPPA VALUES HAVE BEEN CORRECTED IN 0000050
C SUBROUTINE KAPCOR 0000060
C 0000070
REAL NUI 0000080
COMMON/HEA6/NPIN(42),JPIN(42,3)/IND3/NTYP(42)/QPAR3/PERL(3) 0000090
1 /SUB1/ASCH(42,3)/GEO0/ACH(3)/MART2/NS1,NS2/INPAR/IPA 0000100
2 /LAMINK/BKAPPA(7,3)/LAMIN1/AKAPPA(42)/WALLCO/WFC01(18,2), 0000110
3 WFC0(18,2)/SUB2/TB(42,3),BMASS(42,3)/SIMLAM/ISIMPL 0000120
IF(I.GT.NS1 .OR. JJJ.GT.1)GOTO 20 0000130
TBAVR=0. 0000140
TBAVL=0. 0000150
PERLT=0. 0000160
SANG=0. 0000170
AVRAKR=0. 0000180
AVRAKL=0. 0000190
DO 10 NS=NS1,NS2 0000200
NP=NPIN(NS) 0000210
ITYP=NTYP(NS) 0000220
DO 10 M=1,NP 0000230
PERLSC=PERL(ITYP)*ASCH(NS,M)/ACH(ITYP) 0000240
ANG=60.*FLOAT(7-2*ITYP)*ASCH(NS,M)/ACH(ITYP) 0000250
SANG=SANG+ANG 0000260
PERLT=PERLT+PERLSC 0000270
RAKA=BKAPPA(IPA,ITYP)/AKAPPA(NS) 0000280
RAKR=RAKA*ANG*WFC0(II,JJJ) 0000290
RAKL=RAKA*PERLSC*WFC01(II,JJJ) 0000300
AVRAKR=AVRAKR+RAKR 0000310
AVRAKL=AVRAKL+RAKL 0000320
TBAVR=TBAVR+TB(NS,M)*RAKR 0000330
10 TBAVL=TBAVL+TB(NS,M)*RAKL 0000340
TBAVR=TBAVR/AVRAKR 0000350
TBAVL=TBAVL/AVRAKL 0000360
AVRAKR=AVRAKR/SANG 0000370
AVRAKL=AVRAKL/PERLT 0000380
TBEQ1=TE+(TBAVR-TE)*AVRAKR 0000390
TBEQ2=TE+(TBAVL-TE)*AVRAKL 0000400
C 0000410
C 0000420
ENTRY SIMLA2(TI, TWI, TLI, NUI, TETAI, TBEQ1, TBEQ2) 0000430
20 C01=1.+ (TBEQ1-TI)/(TWI-TI) 0000440
C02=1.+ (TBEQ2-TI)/(TLI-TI) 0000450
IF(ISIMPL.EQ.2)GOTO 1111 0000460
C01=1. 0000470
C02=1. 0000480
1111 CONTINUE 0000490
NUI=NUI/C01 0000500
TETAI=TETAI*C02 0000510
TWI=TI+(TWI-TI)*C01 0000520
TLI=TI+(TLI-TI)*C02 0000530
RETURN 0000540
END 0000550

```
FUNCTION SMFUN1(RHOI,ETAI,DETOT,PROV,I,KVIA ,REAI,DAI,SQ8LIA,R0, 0000010
*G,CS) 0000020
C-----0000030
C FUNCTION SMFUN1 EVALUATES SQRT(LAMBDA/8) FOR THE SMOOTH REGION OF 0000040
C CORNER SUBCHANNELS (SECOND CALCULATION STEP) . 0000050
C 0000060
C COMMON/ANG1/R2(30),ALFA(30)/COLAM2/COLAMA 0000070
C BETA= R0/R2(I) 0000080
C G=(G*2.-8.1815+1.25*BETA)/(1.+BETA) 0000090
C IF(KVIA.EQ.1)GOTO 3 0000100
C .....0000110
C AFTER THE FIRST ITERATION IN RECANG 0000120
C 0000130
C SMFUN1=(2.5* ALOG((R2(I)-R0)/DAI*REAI/SQ8LIA)-G)*CS+5.5*COLAMA 0000140
C RETURN 0000150
C .....0000160
C AT THE FIRST ITERATION IN RECANG 0000170
C 0000180
C 3 UAST2=SQRT((1.-BETA**2)/(1.-ALFA(I)))*PROV/(DETOT*SQRT(RHOI)) 0000190
C SMFUN1=CS*(2.5* ALOG((R2(I)-R0)*RHOI/ETAI*UAST2)-G)+5.5*COLAMA 0000200
C RETURN 0000210
C END 0000220
```

SUBROUTINE SPANU(R1,P1,NS,M,Y) 0000010
C -----
C ORGANIZES THE CALCULATION OF THE COEFFICIENT FOR THE EFFECT OF 0000020
C THE SPACER ON THE NUSSELT NUMBER. 0000030
C 0000040
C 0000050
COMMON /GEO5/ ATC,DETC,ATW,DETW,ATA,DETA,AAC,AAW,AAA 0000060
COMMON /IROSMO/ IRH 0000070
COMMON /SC07L/ WSPO,XM,NSPACT 0000080
COMMON /SC08L/ AGRI(42,3,7) 0000090
COMMON /SC09L/ DIST(7) 0000100
COMMON /SC10L/ RE,PR,EPS,DET1 0000110
COMMON /SC01S/ IHAS 0000120
COMMON /GEO2 / ATOT,DET,ASEC 0000130
COMMON /IND3/ NTYP(42) 0000140
C 0000150
C LOCAL OR AVERAGE APPLICATION OF THE CORRELATION 0000160
C 0000170
DE=DETC 0000180
IF(NTYP(NS).EQ.2) DE=DETW 0000190
IF(NTYP(NS).EQ.3) DE=DETA 0000200
IF(IHAS .LE. 0) DE=DET 0000210
RX=RE 0000220
PX=PR 0000230
IF(IHAS.LE.0) GO TO 10 0000240
RX=R1 0000250
PX=P1 0000260
10 CONTINUE 0000270
C 0000280
AL=WSPO/DE 0000290
XA=XM/DE 0000300
Y=1.0 0000310
DO 1000 K=1,NSPACT 0000320
X=XA-(DIST(K)-(WSPO/2.))/DE 0000330
EPX=EPS 0000380
IF(IHAS.GT. 0) EPX=AGRI(NS,M,K) 0000390
IF(EPX.LT.0.001) GO TO 1000 0000400
GO TO (100,200), IRH 0000420
C ----- 0000430
C SMOOTH 0000440
100 CALL SPANUG(X,YK,RX,PX,AL,EPX) 0000450
GO TO 300 0000460
C ----- 0000470
C ROUGH 0000480
200 CALL SPANUR(X,YK,RX,PX,AL,EPX) 0000490
C ----- 0000500
300 CONTINUE 0000510
IF (YK.GT.Y) Y=YK 0000520
1000 CONTINUE 0000530
IF(Y.LT.1.0 .OR. Y.GT.3.0) WRITE(6,2000) K,NS,M,Y 0000540
C 0000550
RETURN 0000560
2000 FORMAT(/5X,' ERROR IN SPANU: SPACER ',I2,' CHANNEL ',I3, 0000570
> ' SUBCH. ',I2,/5X, 0000580
> ' THE FACTOR FOR THE NUSSELT IS ',E12.6,/5X, 0000590
> ' CALCULATION PROCEEDING') 0000600
2100 FORMAT(/5X,' SPANU: SPACER ',I2,' CHANNEL ',I3, 0000610
> ' SUBCH. ',I2,/5X, 0000620
> ' THE BLOCKAGE FACTOR IS ',E12.6, 0000630
> ' , OUT OF THE LIMITS OF VALIDITY OF THE CORRELATION',0000640
> ' (0.15 <= EPS <= 0.35) ',/5X, 0000650
> ' CALCULATION PROCEEDING ') 0000660
END 0000670

SUBROUTINE SPANUG(X,Y,RE,PR,AL,E) 0000010
C ----- 0000020
C M.D. HASSAN 0000030
C IMPROVEMENT OF THE HEAT TRANSFER IN THE SPACERS REGION. 0000040
C CASE OF SMOOTH RODS. 0000050
C 0000060
C RE =REYNOLDSNUMBER 0000070
C (RELATIVE TO THE HYDRAULIC DIAMETER OF THE CENTRAL CHANNEL) 0000080
C PR =PRANDTLNUMBER 0000090
C AL =DIMENSIONLESS AXIAL LENGTH OF THE SPACER. 0000100
C (RELATIVE TO THE HYDRAULIC DIAMETER OF THE CENTRAL CHANNEL) 0000110
C E =BLOCKAGE AREA (.15<E<.35) 0000120
C 0000130
C X =DIMENSIONLESS AXIAL DISTANCE OF THE CONSIDERED POINT TO THE 0000140
C BEGINN OF THE SPACER. 0000150
C (RELATIVE TO THE HYDRAULIC DIAMETER OF THE CENTRAL CHANNEL) 0000160
C Y =NUSSELTNUMBER RATIO (NUX/NUO) 0000170
C NUX = NUSSELT IN SPACER REGION 0000180
C NUO = NUSSELT IN THE UNDISTURBED REGION 0000190
C 0000200
C ----- 0000210
C EVALUATION OF THE MAXIMAL NUSSELT RATIO 0000220
IF(RE.LT.2.E3) AL=AL/2 0000230
RNUMX=1.+.174*E**2*RE**.5 0000240
IF(RE.LT.2.E3) GO TO 11 0000250
RNUL=RNUMX 0000260
RNUMX=1.+E**2.4*(6.38+4.55E3/RE**.8) 0000270
IF(RNUL.LT.RNUMX) RNUMX=RNUL 0000280
11 CONTINUE 0000290
C ----- 0000300
C EVALUATION OF THE STEIGUNG <M> 0000310
CMAX=4. 0000320
C=1.855E-3*RE 0000330
IF(C.GE.CMAX) C=CMAX 0000340
IF(RE.LT.3.E3) GO TO 12 0000350
C=30.34*RE**(-.253) 0000360
IF(C.GE.CMAX) C=CMAX 0000370
12 CM=-C*E**2 0000380
C ----- 0000390
C EVALUATION OF THE CONSTANT <K> 0000400
DMIN=.895 0000410
D=4.42-1.05*ALOG10(RE) 0000420
IF(D.LE.DMIN) D=DMIN 0000430
IF(RE.LT.3.E3) GO TO 13 0000440
D=.426+.113*ALOG10(RE) 0000450
IF(D.LE.DMIN) D=DMIN 0000460
13 CK=D-2.25*E 0000470
XE=AL 0000480
C ----- 0000490
C 0000500
YA=1+((RNUMX-1)/(XE+1))*(X+1) 0000510
IF(YA.LT.1.) YA=1. 0000520
YB=RNUMX 0000530
Y=YA 0000540
IF(YB.LT.YA) Y=YB 0000550
IF(X.LE.0.) GO TO 20 0000560
YC=CK*(X/RE/PR)**CM 0000570
IF(YC.LT.1.) YC=1. 0000580
IF(YC.LT.YB) Y=YC 0000590
20 CONTINUE 0000600
RETURN 0000610
END

SUBROUTINE SPANUR(X,Y,RE,PR,AL,E) 0000010
C ----- 0000020
C EIN FORTRAN-IV-UNTERPROGRAMM ZUR EMPIRISCHEN BERECHNUNG 0000030
C DES WAERMEUEBERGANGS IM ABSTANDSHALTERBEREICH 0000040
C 0000050
C INR/HASSAN 0000060
C 0000070
C 02.12.1979 0000080
C 0000090
C EINGABEDATEN 0000100
C 0000110
C RE =REYNOLDSZahl, BERECHNET MIT DEM HYDRAULISCHEN 0000120
C DURCHMESSER DES GESAMTKANALS 0000130
C PR =PRANDTLZahl 0000140
C AL =DIMENSIONLOSE ABSTANDSHALTERLAENGE, BEZOGEN AUF 0000150
C DEN HYDRAULISCHEN DURCHMESSER DES GESAMTKANALS 0000160
C E =QUERSCHNITTSVERSPELUNG (.15<E<.35) 0000170
C 0000180
C ERGEBNISSE 0000190
C X =DIMENSIONLOSER AXIALER ABSTAND VON DER VORDERSEITE 0000200
C DES ABSTANDSHALTTERS, BEZOGEN AUF DEN HYDRAULISCHEN 0000210
C DURCHMESSER DES GESAMTKANALS 0000220
C Y =NUSSELTZahl-VERHAELTNIS (NUX/NU0) 0000230
C *** NUX =DURCH DEN ABSTANDSHALTER GESTOERTE NU-ZAHL.(LOKAL) 0000240
C *** NU0 =UNGESTOERTE NU-ZAHL 0000250
C 0000260
C *** BESTIMMUNG DES MAX.NU-ZAHL-VERHAELTNISSES ***** 0000270
RNUMX=1.+.174*E**2*RE**.5 0000280
IF(RE.LT.2.E3) GO TO 31 0000290
RNUL=RNUMX 0000300
RNUMX=1.+E**2*(3.3+7.27E4/RE**1.2) 0000310
IF(RNUL.LE.RNUMX) RNUMX=RNUL 0000320
31 CONTINUE 0000330
C 0000340
C *** BESTIMMUNG DER STEIGUNG <M> ***** 0000350
CMAX=4. 0000360
C=1.855E-3*RE 0000370
IF(C.GE.CMAX) C=CMAX 0000380
IF(RE.LT.3.E3) GO TO 32 0000390
C=1.+4.9E4/RE**1.2 0000400
IF(C.GE.CMAX) C=CMAX 0000410
32 CM=-C*E**2 0000420
C *** BESTIMMUNG DER KONSTANTEN <K> ***** 0000430
DMIN=.885 0000440
D=4.42-1.05* ALOG10(RE) 0000450
IF(D.LE.DMIN) D=DMIN 0000460
IF(RE.LT.3.E3) GOTO 33 0000470
D=-.344+.35* ALOG10(RE) 0000480
IF(D.LE.DMIN) D=DMIN 0000490
IF(RE.LT.8E3) GO TO 33 0000500
DK=D 0000510
D=-1.8478+1.2466* ALOG10(RE)-.1298* ALOG10(RE)**2 0000520
IF(DK.LE.D) D=DK 0000530
33 CK=D-2.25*E 0000540
C 0000550
XE=AL/2 0000560
C ***** 0000570
YA=1+((RNUMX-1)/(XE+1))*(X+1) 0000580
IF(YA.LT.1.) YA=1. 0000590
YB=RNUMX 0000600
Y=YA 0000610

IF(YB.LT.YA) Y=YB	0000620
IF(X.LE.0.) GO TO 40	0000630
YC=CK*(X/RE/PR)**CM	0000640
IF(YC.LT.1.) YC=1.	0000650
IF(YC.LT.YB) Y=YC	0000660
40 CONTINUE	0000670
RETURN	0000680
END	0000690

SUBROUTINE SUBBAL(NSTOT,NSTR, INDSP,H,LENGTH,D,PIG,PR1,PR2,PBT,FRE0000010
L,FT,ITCORR,DPAV,,WSP,I1SPAC) 0000020

C-----0000030

C SUBROUTINE SUBBAL EVALUATES THE SUBCHANNEL MASS FLOW RATES AND 0000040

C BULK TEMPERATURES 0000050

C 0000060

REAL LAMSCH,MI,MAV,MSCH1,MSCH,MAVCF,LENGTH,MINS(3),M2NS(3), 0000070

1 MAV1,MAV2,MAWC,KAPPA 0000080

DIMENSION RHO1(3),TINS(3),WCFUD(3),WCF1NS(3),EP1NS(3),TANS(3), 0000090

1 T2NS(3),RHOAV(3),ANS(3),XMEM(3),DE(3),A(42) 0000100

COMMON/CORR/SIGMA(42),PHI(42)/CORR1/SIGMA1(42,3),PHII(42,3) 0000110

1 /GRID0/CSPAC(42,3,4)/IJ1/NER(42),NIS(42,3)/IND3/NTYP(42)0000120

2 /GEN2/AZ(42)/GEN3/MI(42)/GEN5/DEZ(42)/MOB2/UAV(42) 0000130

3 /MOB4/WCF(42)/MOB5/TAV(42)/MOB6/MAV(42)/MOB8/DP(42) 0000140

4 /SUBC1/NCHC(3),JSCH(3,3)/SUBC2/JCHC(3,2)/SUB1/ASCH(42,3) 0000150

5 /SUB2/TSCH(42,3),MSCH(42,3)/SUB5/LAMSCH(42,3) 0000160

6 /SUB6/TSCH1(42,3)/SUB8/MSCH1(42,3)/HEA10/QSCH(42,3) 0000170

7 /SUB31/WCFNS(3),DPNS(3),WTNS1(3,3),WTNS2(3,2),UNS(3),RUASNS(0000180

8 3)/MOB24/WT(42,3)/MOB26/RUAS(42)/TUR2/CTURB1(2) 0000190

9 /HEA6/NPIN(42),JPIN(42,3)/GE00/ACH(3) 0000200

COMMON/GRID1/EPS(42,3,5),DISTSP(7)/GRID8/PGDP(42,3,4) 0000210

1 /SUB3/ADAB(18,2),DDTBB(18,2) 0000220

> /WACO1/XMSCHB(18,2),XMSCHA(18,2) 0000230

2 /QPAR1/QDEV/QPAR2/QLINM,QLDEV/QPAR3/PERL(3) 0000240

3 /LAMIN0/I2TIP(42,3)/LAMIN3/F1ATIP(42),F1DTIP(42) 0000250

4 /LAMIN4/F2ATIP(42,3),F2DTIP(42,3)/WCSE7/MAWC(18,2,2) 0000260

5 /WCSE9/TAVWC(18,2,2)/CORR2/CHI(18,2,2),PSI(18,2,2) 0000270

6 /WCSE8/ASCHWC(18,2,2)/COND1/CCOND(42,3)/COND2/CCOND1(2) 0000280

7 /GRAV/IGRAV/SUBDI/IDIV1, IDIV2/GAAG1/FCOPW1(3) 0000290

8 /ENEOP/IENE/GRID2/YY(100,42,3)/MIXS2/CY/SECIN/K 0000300

COMMON /SC06L/ SHQ(18,2) 0000320

COMMON /SC21C/ SHQC(18,2) 0000330

COMMON /SC09R/ QSR(18,2) 0000340

COMMON /SC02C/ QJ(19,42) 0000350

COMMON /SC07C/ H1 0000360

C 0000380

XX=1./980665. 0000390

C0000400

C CORRECTION OF THE CHANNEL FLOW AREAS TO TAKE INTO ACCOUNT THAT 0000410

C THE SUBCHANNEL GEOMETRIC PARAMETERS MUST BE BASED ON THE TIP 0000420

C DIAMETER OF THE RODS IN THE CASE OF LAMINAR FLOW 0000430

C 0000440

DO 1000 NS=1,NSTOT 0000450

1000 A(NS)=AZ(NS)*F1ATIP(NS) 0000460

C0000470

C LOOP "NS" STARTS (NS = CHANNEL INDEX) 0000480

C 0000490

C 0000500

DO 80 NS=1,NSTOT 0000510

III=NS-NSTR 0000520

FRELI=FREL 0000530

NP=NPIN(NS) 0000540

ITYP=NTYP(NS) 0000550

C 0000560

NI=NER(NS) 0000570

NP1=NP-1 0000580

NSCH=4-ITYP 0000590

SCH=NSCH 0000600

AREASC=ACH(ITYP)/SCH 0000610

C0000620

C CONNECTIONS BETWEEN THE SUBCHANNELS OF CHANNEL "NS" AND THE 0000630

C CHANNELS ADJACENT TO "NS" 0000640
C
C CALL SUBCON(NS,NP,NP1,NI) 0000650
IF(NPIN(NS).EQ.1)GOTO 65 0000660
IF(ITYP.EQ.1 .AND. IDIV1.EQ.IDIV1/2*2)GOTO 65 0000670
IF(ITYP.EQ.2 .AND. IDIV1.GT.2)GOTO 65 0000680
C
C DO 1 I=1,NP 0000690
RHO1(I)=RHO(PR1,TSCH1(NS,I)) 0000700
MINS(I)=MSCH1(NS,I) 0000710
ANS(I)=ASCH(NS,I)*F2ATIP(NS,I) 0000720
DE(I)=DEZ(NS)*F2DTIP(NS,I) 0000730
TINS(I)=TSCH1(NS,I) 0000740
1 WCFUD(I)=WCF(NS)*ANS(I)/A(NS) 0000750
C 0000760
C ITERATION ON THE RELAXATION FACTOR (LOOP ITFREL) 0000770
C
C DO 48 ITFREL=1,98 0000780
IVIA=1 0000790
C 0000800
C CALCULATION OF THE PRESSURE LOSSES (LOOP ITGL) 0000810
C
C DO 47 ITGL=1,60 0000820
C 0000830
C EVALUATION OF THE CROSS-FLOW SOLUTIONS 0000840
C
C CALL CRFL1(ITGL,DPNSAV,FRELI,A(NS),NP,ANS,MINS,DPNS,WCFNS,WCF1NS, 0000850
* EP1NS) 0000860
DO 2 I=1,NP 0000870
WCFNS(I)=WCFNS(I)+WCFUD(I) 0000880
M2NS(I)=MINS(I)-H*WCFNS(I) 0000890
MSCH(NS,I)=(M2NS(I)+MINS(I))*0.5 0000900
TANS(I)=TAV(NS) 0000910
2 RUASNS(I)=MSCH(NS,I)*SQRT(LAMSCH(NS,I)*0.125)/ASCH(NS,I)*AREASC 0000920
IF(ITGL.GT.1 .AND. IVIA.EQ.1)GOTO 25 0000930
C 0000940
C CALCULATION OF THE BULK TEMPERATURES (LOOP ITERM) 0000950
C
XPREC=1.E-04 0000960
DO 20 ITERM=1,20 0000970
C
C A) TURBOLENT EXCHANGE SUBCHANNEL-SUBCHANNEL 0000980
C
DO 4 I=1,NP1 0000990
MAV1=MSCH(NS,I)*AREASC/ASCH(NS,I) 0001000
I1=I+1 0001010
DO 3 II=I1,NP 0001020
MAV2=MSCH(NS,II)*AREASC/ASCH(NS,II) 0001030
IF(TANS(I).LE.0. .OR. TANS(I).GT.3000. .OR. TANS(II).LE.0. .OR. 0001040
*TANS(II).GT.3000.)GOTO 302 0001050
YYIII=((YY(K,NS,I)+YY(K,NS,II))*0.5-1.)*CY+1. 0001060
WTNS1(I,II)=TME(PBT,MAV1,MAV2,TANS(I),TANS(II),LAMSCH(NS,I), 0001070
*LAMSCH(NS,II),AREASC,AREASC,CTURB1(ITYP))*YYIII 0001080
CC 10.9.1980 0001090
C IF(I2TIP(NS,I).EQ.1 .OR. I2TIP(NS,II).EQ.1)WTNS1(I,II)=0. 0001100
C 3 WTNS1(II,I)=WTNS1(I,II) 0001110
CC 10.9.1980 0001120
CC 10.9.1980 0001130
IF(ABS(YY(K,NS,I)*YY(K,NS,II)-1.) .GT. 1.E-03) GO TO 3 0001140
IF(I2TIP(NS,I).EQ.1 .OR. I2TIP(NS,II).EQ.1)WTNS1(I,II)=0. 0001150
3 WTNS1(II,I)=WTNS1(I,II) 0001160
CC 10.9.1980 0001170
4 CONTINUE 0001180
DO 16 I=1,NP 0001190
THEX=0. 0001200
CONHE=0. 0001210
0001220
0001230
0001240
0001250
0001260
0001270
0001280
0001290

```

MAV1=MSCH(NS,I)*AREASC/ASCH(NS,I)          0001300
DO 5 II=1,NP                                0001310
IF(I.EQ.II)GOTO 5                            0001320
MAV2=MSCH(NS,II)*AREASC/ASCH(NS,II)         0001330
TAIII=(MAV1*TANS(I)+MAV2*TANS(II))/(MAV1+MAV2) 0001340
CONHE=CONHE-(TANS(I)-TANS(II))*CCOND1(ITYP)*(KAPPA(PBT,TANS(I))+ 0001350
+KAPPA(PBT,TANS(II)))                         0001360
THEX=THEX-(TANS(I)-TANS(II))*WTNS1(I,II)*CP(PBT,TAIII) 0001370
5 CONTINUE                                     0001380
C
C      B) TURBOLENT EXCHANGE SUBCHANNEL-CHANNEL 0001390
C
NCHCI=NCHC(I)                                0001400
IF(NCHCI.EQ.0)GOTO 7                          0001410
DO 6 K1=1,NCHCI                             0001420
M=JCHC(I,K1)                                0001430
I1=JSCH(I,M)                                0001440
J=NIS(NS,M)                                 0001450
NTYPJ=NTYP(J)                                0001460
MAV2=MAV(J)*ACH(NTYPJ)/AZ(J)                0001470
WTNS2(I,K1)=WT(NS,M)                         0001480
IF(I2TIP(NS,I).EQ.1)WTNS2(I,K1)=0.           0001490
IF(I1.NE.0)WTNS2(I,K1)=WTNS2(I,K1)*(RUASNS(I)+RUAS(J))/(RUASNS(I)+ 0001500
*RUASNS(I)+2.*RUAS(J))                      0001510
*RUASNS(I)+2.*RUAS(J))                      0001520
TAIJ=(TANS(I)*MAV1+TAV(J)*MAV2)/(MAV1+MAV2) 0001530
CONHEP=(TANS(I)-TAV(J))*CCOND(NS,M)*(KAPPA(PBT,TANS(I))+KAPPA(PBT, 0001540
*TAV(J)))                                     0001550
IF((ACH(ITYP)/AZ(NS).LE.1.1 .OR. ACH(NTYPJ)/AZ(J).LE.1.1) .AND. 0001560
*(NTYP(NS).EQ.1 .OR. NTYP(J).EQ.1))CONHEP=CONHEP*0.5 0001570
CONHE=CONHE-CONHEP                           0001580
6 THEX=THEX-(TANS(I)-TAV(J))*WTNS2(I,K1)*CP(PBT,TAIJ) 0001590
C
C      C) CROSS FLOW HEAT EXCHANGE SUBCHANNEL-SUBCHANNEL 0001600
C
7 CONTINUE                                     0001610
TACF=0.                                       0001620
MAVCF=0.                                       0001630
DO 8 II=1,NP                                0001640
IF(I.EQ.II)GOTO 8                            0001650
MAV2=MSCH(NS,II)*AREASC/ASCH(NS,II)         0001660
CALL CF1(TANS(I),TANS(II),MAV1,MAV2,DPNS(I),DPNS(II), 0001670
* ITGL,TACF,MAVCF)                         0001680
C
C      D) CROSS FLOW HEAT EXCHANGE SUBCHANNEL-CHANNEL 0001690
C
8 CONTINUE                                     0001700
IF(NCHCI.EQ.0)GOTO 12                        0001710
DO 11 K1=1,NCHCI                            0001720
M=JCHC(I,K1)                                0001730
J=NIS(NS,M)                                 0001740
NTYPJ=NTYP(J)                                0001750
MAV2=MAV(J)*ACH(NTYPJ)/AZ(NS)               0001760
CALL CF1(TANS(I),TAV(J),MAV1,MAV2,DPNS(I),DP(J),ITGL,TACF,MAVCF) 0001770
11 CONTINUE                                     0001780
12 CONTINUE                                     0001790
C
C      TACF=TACF/MAVCF                         0001800
TAICF=(TANS(I)*MAV1+TACF*MAVCF)/(MAV1+MAVCF) 0001810
CFHEX=WCFNS(I)*(TANS(I)-TACF)*CP(PBT,TAICF) 0001820
PHII(NS,I)=(THEX+CFHEX+CONHE)*H/ASCH(NS,I) 0001830
XXMAV=MSCH(NS,I)                            0001840
XXM2=M2NS(I)                                0001850
IF(IENE.EQ.2)XXMAV=MINS(I)                  0001860
IF(IENE.EQ.2)XXM2=XXMAV                     0001870

```


28 TMOEX=TMOEX-(UNS(I)-UAV(J))*WTNS2(I,K1) 0002650
29 TMOEX=TMOEX*FT*H/ANS(I) 0002660
C UACF=0. 0002670
ACF=0. 0002680
AREAI =AREASC*F2ATIP(NS,I) 0002690
C CROSS-FLOW EXCHANGE SUBCHANNEL-SUBCHANNEL 0002700
C DO 30 II=1,NP 0002710
IF(I.EQ.II)GOTO 30 0002720
AREAI=AREASC*F2ATIP(NS,II) 0002730
CALL CF1(UNS(I),UNS(II),AREAI ,AREAI,DPNS(I),DPNS(II),
* 1,UACF,ACF) 0002740
30 CONTINUE 0002750
C CROSS-FLOW EXCHANGE SUBCHANNEL-CHANNEL 0002760
C IF(NCHCI.EQ.0)GOTO 36 0002770
DO 35 K1=1,NCHCI 0002780
M=JCNC(I,K1) 0002790
J=NIS(NS,M) 0002800
NTYPJ=NTYP(J) 0002810
AREAJ=ACH(NTYPJ)*F1ATIP(J) 0002820
CALL CF1(UNS(I),UAV(J),AREAI ,AREAJ,DPNS(I),DP(J),1,
* UACF,ACF) 0002830
35 CONTINUE 0002840
C 0002850
C 0002860
36 UCF=UACF/ACF 0002870
CFMOEX=(2.*UNS(I)-UCF)*WCFNS(I)/ANS(I)*H 0002880
XMEM(I)=LAMSCH(NS,I)*H/(2.*DE(I) *RHOAV(I))*FCOPW1(ITYP) 0002890
RE=MSCH(NS,I)*DE(I)/(ANS(I) *ETA(PBT,TSCH(NS,I))) 0002900
IF(INDSP.EQ.2)XMEM(I)=XMEM(I)+(CSPAC(NS,I,I1SPAC)+DSPDPF(EPS(NS,I,
*I1SPAC),DE(I) ,LAMSCH(NS,I),WSP,PGDP(NS,I,I1SPAC),RE,ITYP))/
/RHOAV(I) 0002910
DPNS(I)=XX*(-(MSCH(NS,I)/ANS(I))**2*(XMEM(I)-(RHO(PR2,T2NS(I))
* -RHO1(I))/RHOAV(I)**2)+TMOEX+CFMOEX+IGRAV*RHOAV(I)*980.665* 0002920
* H) 0002930
DPNSAV=DPNSAV+DPNS(I)*MSCH1(NS,I) 0002940
SMSCH1=SMSCH1+MSCH1(NS,I) 0002950
40 CONTINUE 0002960
DPNSAV=DPNSAV/SMSCH1 0002970
IF(ITGL.LT.4)GOTO 45 0002980
C 0002990
C TEST FOR THE CONVERGENCE OF THE PRESSURE DROPS 0003000
C 0003010
DO 41 I=1,NP 0003020
IF(ABS(DPNS(I)/DPNSAV-1.).GT.1.E-02)GOTO 45 0003030
IF(ABS(DPNS(I)/DPNSAV-1.).GT.1.E-03 .AND. ITGL.LT.40)GOTO 45 0003040
41 CONTINUE 0003050
IF(IVIA.EQ.2)GOTO 50 0003060
DO 301 I=1,NP 0003070
IF(M2NS(I).LE.0.)GOTO 302 0003080
301 CONTINUE 0003090
IVIA=2 0003100
45 CONTINUE 0003110
DO 46 I=1,NP 0003120
46 WCFNS(I)=WCFNS(I)-WCFUD(I) 0003130
47 CONTINUE 0003140
C 0003150
C END OF LOOP ITGL : POINT REACHED IN THE CASE OF CONVERGENCE 0003160
C PROBLEMS 0003170
302 CONTINUE 0003180
AIT=ITFREL 0003190
FRELI=1.-AIT*0.01 0003200

48 CONTINUE 0003310
C 0003320
C END OF LOOP ITFREL: POINT REACHED IN THE CASE OF CONVERGENCE 0003330
C PROBLEMS 0003340
C 0003350
C WRITE(6,49)ITCORR,NS,(DPNS(I),I=1,NP),(MSCH(NS,I),I=1,NP), 0003360
* (TSCH(NS,I),I=1,NP) 0003370
49 FORMAT(// 5X,'SUB. SUBBAL', 0003380
> /5X,'SUBCHANNEL CALCULATION STOPS IN LOOP ITGL: ITCORR=0003390
1',I5,5X,'NS=',I5/5X,'PRESSURE LOSSES + AVERAGE MASSES + AVERAGE TE0003400
2MPERATURES : '/(8E15.5)) 0003410
777 RETURN 1 0003420
C 0003430
C CONVERGENCE HAS BEEN REACHED FOR THE ENERGY EQUATIONS AND FOR THE 0003440
C AXIAL MOMENTUM EQUATIONS 0003450
C 0003460
50 CONTINUE 0003470
DO 60 I=1,NP 0003480
DPAVF=DPAV-IGRAV*RHOAV(I)*H*0.001 0003490
BMI=SQRT(ABS(DPAVF)/(XX*XMEM(I)))*ANS(I) 0003500
SIGMAI(NS,I)=(MSCH(NS,I)-BMI)/ASCH(NS,I) 0003510
60 CONTINUE 0003520
GOTO 70 0003530
C ***** 0003540
C FOR THE CHANNELS WITH ONLY ONE SUBCHANNEL 0003550
C 0003560
65 CONTINUE 0003570
DO 66 I=1,NP 0003580
IF(NTYP(NS).NE.2)GOTO 7007 0003590
WCFNS(I)=WCF(NS) 0003600
M1=JCHC(I,1) 0003610
M2=JCHC(I,2) 0003620
WTNS2(I,1)=WT(NS,M1) 0003630
WTNS2(I,2)=WT(NS,M2) 0003640
RUASNS(I)=RUAS(NS) 0003650
UNS(I)=UAV(NS) 0003660
7007 CONTINUE 0003670
MSCH(NS,I)=MAV(NS)*ASCH(NS,I)/AZ(NS) 0003680
TSCH(NS,I)=TAV(NS) 0003690
SIGMAI(NS,I)=SIGMA(NS) 0003700
PHII(NS,I)=PHI(NS) 0003710
IF(NTYP(NS).NE.3)GOTO 66 0003720
EPSM=MSCH(NS,I)-(XMSCHA(III,I)+XMSCHB(III,I)) 0003730
XMSCHA(III,I)=XMSCHA(III,I)+EPSM*(1.-1./ADAB(III,I)) 0003740
XMSCHB(III,I)=MSCH(NS,I)-XMSCHA(III,I) 0003750
66 CONTINUE 0003760
C 0003770
70 CONTINUE 0003780
IF(NTYP(NS).NE.2) GOTO 80 0003790
C ***** 0003800
C ONLY FOR THE WALL SUBCHANNELS 0003810
C 0003820
I2TTIP=0 0003830
DO 4001 I=1,NP 0003840
I2TTIP=I2TTIP+I2TIP(NS,I) 0003850
DO 4000 JWC=1,2 0003860
CHI(III,I,JWC)=1. 0003870
PSI(III,I,JWC)=1. 0003880
TAVWC(III,I,JWC)=TSCH(NS,I) 0003890
4000 MAWC(III,I,JWC)=MSCH(NS,I)*ASCHWC(III,I,JWC)/ANS(I) 0003900
IF(IDIV2.EQ.1)GOTO 4001 0003910
EPSM=MAWC(III,I,1)-(XMSCHA(III,I)+XMSCHB(III,I)) 0003920
XMSCHA(III,I)=XMSCHA(III,I)+EPSM*(1.-1./ADAB(III,I)) 0003930
XMSCHB(III,I)=MAWC(III,I,1)-XMSCHA(III,I) 0003940
4001 CONTINUE 0003950

C 0003960
C RECCA2 IS CALLED ONLY IF THE FLOW IS TURBULENT IN THE WHOLE WALL 0003970
C CHANNEL IN CASE OF IDIV2=1 0003980
C 0003990
C IF(IDIV2.EQ.2 .OR. I2TTIP.NE.0)GOTO 80 0004000
C IF(ITYP.EQ.2 .AND. IDIV1.GT.2)GOTO 80 0004010
C CALL RECCA2 (NS,III,NP,INDSP,H,LENGTH,PR1,PR2,PBT,FRELI,FT,0004020
*ITCORR,PIG,D,DPAV,&777,WSP,I1SPAC) 0004030
C 0004040
C 0004050
C 80 CONTINUE 0004060
C 0004070
C END OF LOOP "NS" : THE CALCULATIONS HAVE BEEN PERFORMED FOR ALL 0004080
C SUBCHANNELS OF ALL CHANNELS 0004090
C 0004100
C RETURN 0004110
C END 0004120

SUBROUTINE SUBCON(NS,NP,NP1,NI) 0000010
C----- 0000020
C SUBROUTINE SUBCON EVALUATES THE NUMBER OF CHANNELS CONNECTED TO 0000030
C EACH SUBCHANNEL I OF CHANNEL NS (NCHC(I)), IDENTIFIES THESE 0000040
C CHANNELS BY MEANS OF JCHC(I,K), IDENTIFIES WHICH SUBCHANNEL II OF 0000050
C THE SAME CHANNEL NS IS CONNECTED TO THE SAME CHANNEL (BY MEANS OF 0000060
C JSCH(I,M)). 0000070
C 0000080
COMMON/HEA6/NPIN(42),JPIN(42,3)/IJ1/NER(42),NIS(42,3) 0000090
1 /SUBC1/NCHC(3),JSCH(3,3)/SUBC2/JCHC(3,2)/IND3/NTYP(42) 0000100
DO 4 I=1,NP 0000110
NCHC(I)=0 0000120
DO 3 M=1,NI 0000130
J=NIS(NS,M) 0000140
NPJ=NPIN(J) 0000150
DO 1 IJ=1,NPJ 0000160
IF(JPIN(J,IJ).EQ.JPIN(NS,I))GOTO 2 0000170
1 CONTINUE 0000180
GOTO 3 0000190
2 NCHC(I)=NCHC(I)+1 0000200
NCHCI=NCHC(I) 0000210
JCHC(I,NCHCI)=M 0000220
JSCH(I,M)=0 0000230
3 CONTINUE 0000240
4 CONTINUE 0000250
IF(NP .EQ. 1)RETURN 0000260
C 0000270
DO 9 I=1,NP1 0000280
IF(NCHC(I).EQ.0)GOTO 9 0000290
NCHCI=NCHC(I) 0000300
DO 8 K1=1,NCHCI 0000310
I1=I+1 0000320
DO 6 II=I1,NP 0000330
IF(NCHC(II).EQ.0)GOTO 6 0000340
NCHCII=NCHC(II) 0000350
DO 5 K2=1,NCHCII 0000360
IF(JCHC(I,K1).EQ.JCHC(II,K2))GOTO 7 0000370
5 CONTINUE 0000380
6 CONTINUE 0000390
GOTO 8 0000400
7 JCHCIK=JCHC(I,K1) 0000410
JSCH(I,JCHCIK)=II 0000420
JSCH(II,JCHCIK)=I 0000430
8 CONTINUE 0000440
9 CONTINUE 0000450
RETURN 0000460
END 0000470

```
SUBROUTINE SUBDH(N,K,K1,NSTOT)          0000010
C-----0000020
C      SUBDH HALVES THE K.TH AXIAL SECTION IF CONVERGENCE PROBLEMS 0000030
C      OCCURRED IN IT          0000040
C          0000050
C      COMMON/GRID2/YY(100, 42,3)/GRID3/X(100)/HEA6/NPIN( 42),JPIN( 42,3)0000060
C.....0000070
C      THE MAXIMUM VALUE OF THE AXIAL INDICES IS 100          0000080
C          0000090
C      IF(N.LT.100)GOTO 2          0000100
C      WRITE(6,3)          0000110
3 FORMAT(1H1,5X,'SUB. SUBDH',
>           /5X,'NUMBER OF AXIAL SECTIONS BECOMES TOO BIG') 0000120
      STOP          0000130
C.....0000140
C.....0000150
C.....0000160
2 CONTINUE          0000170
NI=N-K          0000180
N=N+1          0000190
DO 10 I=1,NI          0000200
II=N-I+1          0000210
X(II+1)=X(II)          0000220
X(II)=X(II-1)          0000230
DO 1 NS=1,NSTOT          0000240
NP=NPIN(NS)          0000250
DO 1 M=1,NP          0000260
1 YY(II,NS,M)=YY(II-1,NS,M)          0000270
10 CONTINUE          0000280
X(K+1)=(X(K)+X(K+2))*0.5          0000290
DO 20 NS=1,NSTOT          0000300
NP=NPIN(NS)          0000310
DO 20 M=1,NP          0000320
20 YY(K+1,NS,M)=YY(K,NS,M)          0000330
K1=K          0000340
WRITE(6,30)          0000350
30 FORMAT(/130('*')//)
RETURN          0000360
END          0000370
          0000380
```



```
SUBROUTINE SUPCEN(RH,PBT,TWALL,LAM1,U1DU,YYI,ITYP,KI,DEI,FACHE, 0000010
>           QA,TW1,G1A,NU11,I,M,REI,ITW1) 0000020
C ----- 0000030
C   THE TEMPERATURES OF THE SECTORS FACING A CENTRAL CHANNEL (OR THE 0000040
C   CENTRAL PART OF A WALL SUBCHANNEL) ARE MODIFIED BY MEANS OF THE 0000050
C   SUPERPOSITION PRINCIPLE. 0000060
C   0000070
COMMON /SUB23/ HPLUSB( 42,3),HPLUSW( 42,3),QPLUS( 42,3), 0000080
>           PRB( 42,3),YODH( 42,3) 0000090
COMMON /SUB22/ TW( 42,3) 0000100
COMMON /SUB2/ TSCH( 42,3),MSCH( 42,3) 0000110
COMMON /HEA5/ QQ( 42,3) 0000120
COMMON /IJ1/ NER( 42),NIS( 42,3) 0000130
COMMON /DAT/ PIG 0000140
COMMON /MART5/ NSTR 0000150
COMMON /QPAR1/ QDEV 0000160
COMMON /SC02C/ QJ( 19, 42) 0000170
COMMON /SC02R/ P,D,Z,ZWC,H,LENGTH 0000180
COMMON /SC13C/ GEO1( 42,3) 0000190
COMMON /HEA6 / NPIN( 42),JPIN( 42,3) 0000200
COMMON /WCSE9/ TAVWC( 18,2,2) 0000210
COMMON /WCSET/ MAWC( 18,2,2) 0000220
COMMON /WCSE12/TWWC( 18,2,2) 0000230
C   0000240
REAL LENGTH,KAPPA,LAM1,KI,NU11,MAWC,MSCH 0000250
C   0000260
R1=D*0.5 0000270
S3=1.732051 0000280
IF(I.GT.NSTR) GOTO 1000 0000290
C ----- 0000300
C   CENTRAL SUBCHANNELS 0000310
C 1- DETERMINATION OF THE CHANNEL BULK TEMPERATURE 0000320
NR=NER(I) 0000330
SPM=0.0 0000340
T=0.0 0000350
DO 100 M1=1,NR 0000360
    SPM=SPM+MSCH(I,M1) 0000370
    T=T+TSCH(I,M1)*MSCH(I,M1) 0000380
100    CONTINUE 0000390
    TB=T/SPM 0000400
C   0000410
C 2- DETERMINATION OF NU11 0000420
R2A=SQRT(P**2*S3*3. / (2.*PIG)-R1**2*2.) 0000430
BETA=PIG/6.-ATAN((P*0.5-R1)/(P*S3*0.5)) 0000440
R2B=SQRT((P*0.5*S3*R1-PIG*R1**2/3.)/BETA) 0000450
YDA=(R2A-R1)/RH 0000460
YDB=(R2B-R1)/RH 0000470
R1DR2A=R1/R2A 0000480
R1DR2B=R1/R2B 0000490
CALL RNU(HPLUSW(I,M),TWALL,LAM1,REI,PRB(I,M),TB,YDA,R1DR2A,0.0, 0000500
>           U1DU,0.0,YYI,NU11,G1A,ITYP,R2A,R1,R2B,BK) 0000510
AL=NU11*KI/DEI*FACHE 0000520
DT=QA/AL 0000530
C   0000790
C 3- DETERMINATION OF TETA(I,J) 0000800
DO 200 M1=1,NR 0000810
    IF(M1.EQ.M) GOTO 200 0000820
    G1B=GPLUS(HPLUSW(I,M1),TW(I,M1),TB,PRB(I,M1),YDB,0.0,0.0, 0000830
>           R2B,R1) 0000840
    BB=2.5*ALOG((R2B-R1)/RH) 0000850
    BA=2.5*ALOG((R2A-R1)/RH) 0000860
```

```
BC=(1.25+3.75*R1/R2A)/(1.0+R1/R2A)          0000870
B=1.0-((BB+G1B)/(BA+G1A-BC))                0000880
TETA=B/NU11                                     0000890
JP=JPIN(I,M1)                                 0000900
QF=QQ(I,M1)*QDEV/(LENGTH*PIG*D)              0000910
QF=QF+QJ(JP,I)/(PIG*D*H)*GEO1(I,M1)        0000920
DT=DT+ TETA*QF*DEI/KAPPA(PBT,TB)            0000930
200    CONTINUE                                0001110
      TW1=DT+TB                                0001120
      GOTO 9999                                0001130
C                                              0001140
C -----
C CENTRAL PART OF WALL SUBCHANNELS           0001150
1000  CONTINUE                                0001160
C 1- DETERMINATION OF THE "CHANNEL" BULK TEMPERATURE 0001170
M1=2                                         0001180
IF(M.EQ.2) M1=1                            0001190
NW=I-NSTR                                    0001200
TB = (TAVWC(NW,M,2)*MAWC(NW,M,2) + TAVWC(NW,M1,2)*MAWC(NW,M1,2)) /0001220
> (MAWC(NW,M,2) + MAWC(NW,M1,2))           0001230
C 1- DETERMINATION OF NU11                  0001240
ALFA=0.445                                  0001250
R2A=SQRT(P**2*0.5*TAN(ALFA)/ALFA-R1**2)  0001260
R2B=R2A                                     0001270
YDA=(R2A-R1)/RH                            0001280
R1DR2A=R1/R2A                            0001290
CALL RNU(HPLUSW(I,M),TWALL,LAM1,REI,PRB(I,M),TB,YDA,R1DR2A,0.0,0.0,0.0,R2A,R1)
> U1DU,0.0,YYI,NU11,G1A,ITYP,R2A,R1,R2B,BK) 0001310
AL=NU11*KI/DEI*FACHE                      0001320
DT=QA/AL                                    0001330
C                                              0001340
C 3- DETERMINATION OF TETA(I,J)             0001350
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
      TWX=TWWC(NW,M,2)                         0001360
      IF(TWX.LT.0.5) TWX=TW(I,M1)              0001370
CCCCCCCCCCCCCCCCCCCCCCCCCCCC
      G1B=GHPPLUS(HPLUSW(I,M1),TWX,TB,PRB(I,M1),YDA,0.0,0.0,0.0,R2A,R1) 0001400
      BB=2.5*ALOG((R2B-R1)/RH)                0001410
      BA=2.5*ALOG((R2A-R1)/RH)                0001420
      BC=(1.25+3.75*R1/R2A)/(1.0+R1/R2A)    0001430
      B=1.0-((BB+G1B)/(BA+G1A-BC))          0001440
      TETA=B/NU11                             0001450
      JP=JPIN(I,M1)                           0001460
      QF=QQ(I,M1)*QDEV/(LENGTH*PIG*D)        0001470
      QF=QF+QJ(JP,I)/(PIG*D*H)*GEO1(I,M1)  0001480
      DT=DT+ TETA*QF*DEI/KAPPA(PBT,TB)       0001490
      TW1=DT+TB                               0001500
C                                              0001900
C -----
9999  RETURN                                 0001910
END                                         0001920
                                         0001930
```

```
SUBROUTINE SYSOL (A,B,X)          0000010
C -----0000020
C   SOLVES THE SYSTEM OF LINEAR EQUATIONS.      0000030
C                                               0000040
C   DIMENSION A(132, 13),B(132),X(132)      0000050
C   COMMON /SCO1R/ NSECT,NSECPL      0000060
C                                               0000070
C -----0000080
C   CONTROLS ON THE CONVERGENCE POSSIBILITY.    0000090
C                                               0000100
C   CALL SUFCON(A,INDEX)          0000110
C   IF (INDEX .EQ. 0) GO TO 1000      0000120
C                                               0000130
C -----0000140
C                                               0000150
C                                               0000160
C   WRITE (6,500)          0000170
500 FORMAT ( ' SUB. SYSOL- THE SUFFICIENT CONDITION FOR ', 0000180
>           'THE GAUSS-SEIDEL METHOD IS NOT RESPECTED.', 0000190
>           ' THE METHOD IS USED ANYWAY.')      0000200
C                                               0000210
1000 CONTINUE          0000220
C                                               0000230
C -----0000240
C   GAUSS-SEIDEL METHOD          0000250
C                                               0000260
C   PERC=0.001          0000270
C   ITMAX=NSECT*3          0000280
C   CALL GAUDEL(A,B,X,PERC,ITMAX)      0000290
C                                               0000300
C -----0000310
C                                               0000320
C   RETURN          0000330
END                  0000340
```

SUBROUTINE TARRAY 0000010
C -----
C DETERMINES THE ARRAYS ISU,IGI,ISS 0000020
C
COMMON /SC01C/ NCAN(19),LIPS(19,10) 0000030
COMMON /SC03C/ NRODS 0000040
COMMON /SC05C/ JZUR(19, 42) 0000050
COMMON /MART5/ NSTR 0000060
COMMON /GASD1/ NSTOT 0000070
COMMON /HEA6/ NPIN(42),JPIN(42,3) 0000080
COMMON /SC01R/ NSECT,NSECP 0000090
COMMON /SC06R/ ISU(132,2) 0000100
COMMON /SC11R/ ISS(18,2) 0000110
COMMON /SC12R/ IGI(42,3) 0000120
C
L=0 0000130
DO 1000 JP=1,NRODS 0000140
NCA=NCAN(JP) 0000150
IF (NCA .LE. 0) GO TO 1000 0000160
DO 800 K=1,NCA 0000170
NS=LIPS(JP,K) 0000180
M=JZUR(JP,NS) 0000190
L=L+1 0000200
ISU(L,1)=NS 0000210
ISU(L,2)=M 0000220
IGI(NS,M)=L 0000230
CONTINUE 0000240
800 0000250
1000 CONTINUE 0000260
C
NSTR1=NSTR+1 0000270
DO 1800 NS=NSTR1,NSTOT 0000280
NP=NPIN(NS) 0000290
DO 1600 M=1,NP 0000300
L=L+1 0000310
NSW=NS-NSTR 0000320
ISU(L,1)=NS 0000330
ISU(L,2)=M 0000340
ISS(NSW,M)=L 0000350
CONTINUE 0000360
1600 0000370
1800 CONTINUE 0000380
C
IF (L .EQ. NSECT) GO TO 3000 0000390
C
WRITE(6,2000) L,NSECT 0000400
2000 FORMAT(5X,'SUB. TARRAY',/5X,
> 'L = ',I4,/5X,
> 'NSECT = ',I4,/5X,
> 'CALCULATION STOPS.') 0000410
STOP 0000420
C
3000 RETURN 0000430
END 0000440
0000450
0000460
0000470
0000480
0000490
0000500
0000510
0000520
0000530
0000540
0000550
0000560

YDH=(SQRT(D**2+D*DBI)-D)*0.5/RH	0000620
RHPL=RHPLUS(HPLUSB,TWI,TE,QPLUS,HPLUSW,T1,YDH)	0000630
F01=SQRT(DBI*RHOA/(DAI*RHOB))*(2.5*ALOG(ZBI/RH)+RHPL)	0000640
C	0000650
C	0000660
4 F=F0-F01	0000670
RETURN	0000680
END	0000690

FUNCTION TBFUN(NSTR,NSTOT)	0000010
C-----	0000020
C TBFUN EVALUATES THE MEAN LINER TEMPERATURE IN THE AXIAL SECTION	0000030
C	0000040
COMMON/SHROUD/TLINER(18,2)/QPAR3/PERL(3)/IND3/NTYP(42)	0000050
1 /HEA6/NPIN(42),JPIN(42,3)/SUB1/ASCH(42,3)/GEO0/ACH(3)	0000060
C	0000070
NSTR1=NSTR+1	0000080
TBPIPA=0.	0000090
PERLT=0.	0000100
DO 10 NS=NSTR1,NSTOT	0000110
NTYPNS=NTYP(NS)	0000120
NP=NPIN(NS)	0000130
DO 10 M=1,NP	0000140
PERLSC=PERL(NTYPNS)*ASCH(NS,M)/ACH(NTYPNS)	0000150
PERLT=PERLT+PERLSC	0000160
10 TBPIPA=TBPIPA+TLINER(NS-NSTR,M)*PERLSC	0000170
TBFUN=TBPIPA/PERLT	0000180
RETURN	0000190
END	0000200

SUBROUTINE TBRTBS 0000010
C ----- 0000020
C DETERMINES THE ARRAYS 0000030
C TBR =REFERENCE GAS TEMPERATURE IN THE ZONE ADJACENT TO THE ROD 0000040
C TBS =REFERENCE GAS TEMPERATURE IN THE ZONE ADJACENT TO THE SHROUD 0000050
C TBR AND TBS ARE USED FOR THE CONDUCTION CALCULATIONS. 0000060
C 0000070
COMMON /SC26C/ TBR(42,3),TBS(18,2) 0000080
COMMON /SUB2 / TSCH(42,3),MSCH(42,3) 0000090
COMMON /SC15C/ ALFA(42,3) 0000100
COMMON /SC17C/ SALFA(18,2) 0000110
COMMON /SUB22/ TW(42,3) 0000120
COMMON /SHROUD/ TLINER(18,2) 0000130
COMMON /HEA5/ QQ(42,3) 0000140
COMMON /QPAR1/ QDEV 0000150
COMMON /SC02R/ P,DU,Z,ZWC,H,LENGTH 0000160
COMMON /SC13C/ GEO1(42,3) 0000170
COMMON /SC06L/ SHQ(18,2) 0000180
COMMON /SC21C/ SHQC(18,2) 0000190
COMMON /DAT/ PIG 0000200
COMMON /SC02C/ QJ(19, 42) 0000210
COMMON /SC18C/ RE,RI,ALFW,ALFC 0000220
COMMON /MART5/ NSTR 0000230
COMMON /GASD1/ NSTOT 0000240
COMMON /HEA6 / NPIN(42),JPIN(42,3) 0000250
COMMON /IND3/ NTYP(42) 0000260
COMMON /LAMIN5/ RTIP(7) 0000270
COMMON /INPAR/ IPA 0000280
COMMON /CEV04/ LAMOP3 0000290
COMMON /SC34C/ ISUC 0000300
C 0000310
REAL LENGTH 0000320
C 0000330
D=DU 0000340
IF(LAMOP3.EQ.1) D=RTIP(IPA)*2. 0000350
C 0000360
DO 1000 NS=1,NSTOT 0000370
NP=NPIN(NS) 0000380
DO 500 M=1,NP 0000390
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 18.03.1981 0000400
C IF(NS.GT.NSTR) GO TO 100 0000410
IF(ISUC.EQ.1 .OR. NS.GT.NSTR) GO TO 100 0000420
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 18.03.1981 0000430
TBR(NS,M)=TSCH(NS,M) 0000440
GO TO 500 0000450
100 J=JPIN(NS,M) 0000460
QF=QQ(NS,M)*QDEV/(LENGTH*PIG*D) 0000470
QF=QF+QJ(J,NS)/(PIG*D*H)*GEO1(NS,M) 0000480
TBR(NS,M)=TW(NS,M)-QF/ALFA(NS,M) 0000490
IF(NS.LE.NSTR) GO TO 500 0000500
NW=NS-NSTR 0000510
ALF=ALFW 0000520
IF(NTYP(NS).EQ.3) ALF=ALFC 0000530
QF=(SHQ(NW,M)+SHQC(NW,M))/(RI*ALF*H) 0000540
TBS(NW,M)=TLINER(NW,M)-QF/SALFA(NW,M) 0000550
500 CONTINUE 0000560
1000 CONTINUE 0000570
C RETURN 0000580
END 0000590
0000600

SUBROUTINE TELIN(TW1,TLINER,TI,TE,TETA2,FTWA,QA,QALIN,NU1,NUTU, 0000010
1 A1,KI,R1DR2,DEI,I,JPIN,YYI,FACHE,M) 0000020
C-----0000030
C TELIN COMPUTES THE LINER TEMPERATURES AND CORRECTS THE PIN TEMPERA0000040
C OF THE EXTERNAL CHANNELS IN THE CASE OF HEATED LINER (TURB. FLOW) 0000050
C 0000060
COMMON /SC17C/ SALFA(18,2) 0000080
COMMON /SC16C/ SNU(18,2) 0000090
COMMON /MART5/ NSTR 0000100
COMMON /ISUP / IQLIN 0000110
COMMON /ISMO/ COTW 0000130
COMMON /ISMO1/ ITECO 0000140
C 0000150
REAL NUTU,NU1,NU2,KI 0000160
C0000170
C INLET EFFECT ON THE LINER NUSSELT NUMBER 0000180
C 0000190
R1=DEI*R1DR2*0.5/(1.-R1DR2) 0000200
R2=R1+0.5*DEI 0000210
FACHE=TIS(R1,R2,3) 0000220
C 0000230
TG=TE 0000240
IF(ITECO.EQ.2)TG=TI 0000250
FNU=(1.-A1*R1DR2**0.6)*NUTU*(TG+273.16)**COTW*YYI*FACHE 0000260
C0000270
C ITERATION FOR THE CALCULATION OF THE LINER TEMPERATURE AT 0000280
C (Q")ROD = 0 (LOOP ITW1) 0000290
C 0000300
DO 1 ITW=1,10 0000310
TW2=TLINER 0000320
NU2=FNU/(TW2+273.16)**COTW 0000330
ALFA2=NU2*KI/DEI 0000340
TLINER=TI+QALIN/ALFA2 0000350
IF(ABS(TLINER/TW2-1.).LE.1.E-04)GOTO 5 0000360
1 CONTINUE 0000370
C0000380
C CONVERGENCE PROBLEMS IN THE LOOP ITW1 0000390
C 0000400
WRITE(6,2)I,JPIN,TW2 0000410
2 FORMAT(1H1,5X,'STOP IN TELIN: I=',I5,5X,'PIN=',I5,5X,'TLINER=', 0000420
1E15.5) 0000430
STOP 0000440
C 0000450
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 22.05.1980 0000460
5 CONTINUE 0000470
II=I-NSTR 0000480
SNU(II,M)=NU2 0000490
SALFA(II,M)=ALFA2 0000500
IF(IQLIN.NE.1 .OR. ABS(QALIN) .LE.1.E-06) GO TO 9999 0000510
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 22.05.1980 0000520
C0000530
C CONVERGENCE IN LOOP ITW1; CALCULATION OF THE ROD TEMPERATURE AT 0000540
C (Q")ROD = 0 0000550
TW1 =FTWA/R1DR2*QALIN*DEI/KI+TI 0000560
IF(TW1 .LE. TE)TW1 =TE 0000570
TETA1=(TW1 -TI)*KI/(QALIN*DEI) 0000580
IF(QA.LE.1.E-06)GOTO 10 0000590
C0000600
C REAL ROD TEMPERATURE IN THE CASE OF HEATED ROD AND HEATED SHROUD 0000610
C 0000620
NU1=NU1/(1.+QALIN/QA*TETA1*NU1) 0000630

```
CCCCCCCCCCCCCCCCCCCCCCCCCCCC  
    IF (NU1 .GT. 9999.) NU1= 9999.0          0000640  
    IF (NU1 .LT.-9999.) NU1=-9999.0          0000650  
    ALFA1=NU1*KI/DEI                         0000660  
CCCCCCCCCCCCCCCCCCCCCCCCCCCC  
    TW1=TI+QA/ALFA1                           0000670  
C .....                                     0000680  
C     REAL SHROUD TEMPERATURE IN THE CASE OF HEATED ROD AND HEATED SHROU 0000690  
C .....                                     0000700  
C     .....                                     0000710  
C .....                                     0000720  
10  NU2=NU2/(1.+QA/QALIN*TETA2*NU2)        0000730  
CCCCCCCCCCCCCCCCCCCCCCCCCCCC  
    IF (NU2 .GT. 9999.) NU2= 9999.0          0000740  
    IF (NU2 .LT.-9999.) NU2=-9999.0          0000750  
    ALFA2=NU2*KI/DEI                         0000760  
CCCCCCCCCCCCCCCCCCCCCCCCCCCC  
    TLINER=TI+QALIN/ALFA2                    0000770  
9999 RETURN                                  0000780  
END                                         0000790  
                                         0000800  
                                         0000810
```

```
SUBROUTINE TEMCON(IRH,K,RH,SUR,D,PIG,TE1,PBT,*,H,V,R,INDICE,QTOT) 0000010
C -----0000020
C ORGANIZES THE CALCULATIONS OF THE WALL TEMPERATURES. 0000030
C 0000040
C COMMON /GASD1/ NSTOT 0000050
C COMMON /MART5/ NSTR 0000060
C COMMON /SC05R/ IRAD 0000070
C COMMON /SC23C/ ICS 0000080
C COMMON /INPAR/ IPA 0000090
C COMMON /MART / ITCORR 0000100
C 0000110
C EXTERNAL RTRI,RTSI 0000120
C 0000130
C IF (QTOT.LT.1.E-06) GO TO 8000 0000140
C CALL TTOT(2) 0000150
C 0000160
C -----0000170
C CALCULATION OF THE NUSSELT NUMBERS AND OF THE WALL TEMPERATURES 0000180
C AS FUCTION OF THE CONVECTIVE HEAT TANSFER ONLY. 0000190
C 0000200
C CALL TESTNU(0) 0000210
C IF(IRH.EQ.1 ) CALL WALLTE 0000220
C * (K,NSTOT,NSTR,RH,SUR,D,PIG, TE1 ,PBT,&8500,RTSI,H) 0000230
C IF(IRH.EQ.2 ) CALL WALLTE 0000240
C * (K,NSTOT,NSTR,RH,SUR,D,PIG, TE1 ,PBT,&8500,RTRI,H) 0000250
C IF ( ITcorr.GT.5 .AND. INDW.GT.0) CALL TESTNU(1) 0000260
C IF ( ITcorr.GT.5 .AND. INDW.GT.0) WRITE(6,1001) 0000270
C -----0000280
C DEFINITION OF THE DUMMIES BULK TEMPERATURES. 0000290
C 0000300
C CALL TBRTBS 0000310
C -----0000320
C RADIATIONS HEAT TRANSFER. 0000330
C 0000340
C IF(IRAD.GT.0) CALL RADIA 0000350
C -----0000360
C COMPUTES THE WALL TEMPERATURES 0000370
C 0000380
C CALL TORG(V,R,PIG,H) 0000390
C IF (ICS.GT.0) CALL CONSHR 0000400
C -----0000410
C CONVERGENCE TESTS FOR WALL AND BULK TEMPERATURES (LOOP ITCORR) 0000420
C 0000430
C INDICE=0 0000440
C INDW =0 0000450
C INDB =0 0000460
C CALL TESTB(INDB) 0000470
C CALL TESTW(INDW) 0000480
C INDICE=INDB+INDW 0000490
C IF(INDICE.GT. 0. AND. ITcorr .GT. 10) WRITE(6,1002) INDB,INDW 0000500
C IF(INDICE.GT. 0 .AND. ITcorr .GT. 15) CALL JELLA(-1) 0000510
C -----0000520
C 0000530
C 8000 RETURN 0000540
C 8500 RETURN 1 0000550
C 1001 FORMAT(5X,'***** NUSSELT NUMBERS HAVE BEEN AVERAGED') 0000560
C 1002 FORMAT( ' INDB= ',I3,' INDW = ',I3) 0000570
C END 0000580
```

SUBROUTINE TEMLAM(*,PBT, TI, MASSI, DEIR, AREA1, QQ, QALIN, TE, I, II, M, 0000010
& TW1, ITYP, F2ATIP, F2DTIP, DVOL) 0000020
C ----- 0000030
C TEMLAM COMPUTES THE PIN TEMPERATURES AND THE TEMPERATURE OF THE 0000040
C LINER IN THE SUBCHANNELS WHERE THE FLOW IS LAMINAR (THE VELOCITY 0000050
C PROFILE IS ASSUMED TO BE ALREADY DEVELOPED AT THE POSITION WHERE T0000060
C HEATING STARTS) 0000070
C ITYP=1 : CENTRAL SUBCHANNELS AND CENTRAL PART OF WALL SUBCHAN 0000080
C ITYP=2 : WALL PART OF WALL SUBCHANNELS 0000090
C ITYP=3 : CORNER CHANNELS 0000100
C 0000110
REAL MASSI, KI, KAPPA, NU1, NU1IN, NU2, NU2IN, KZ 0000120
COMMON /INPAR/ IPA/LAMIN5/RTIP(7)/QPAR3/PERL(3)/IND3/NTYP(42) 0000130
1 /SUB1/ASCH(42,3)/GE00/ACH(3)/INITL/X/SHROUD/TLINER(18,2) 0000140
2 /SUB21/TSCHA(18,2), TSCHB(18,2)/MART2/NS1, NS2/MART3/TBEQR, 0000150
3 TBEQL/ISUP/IQLIN 0000160
COMMON /MART5/ NSTR 0000170
COMMON /SC09C/ IS 0000190
COMMON /SC10C/ ANU(42,3) 0000200
COMMON /SC15C/ ALFA(42,3) 0000210
COMMON /SC01Z/ YH(42,2) 0000220
COMMON /SC16C/ SNU(18,2) 0000230
COMMON /SC17C/ SALFA(18,2) 0000240
C 0000260
QA=QQ*D VOL/RTIP(IPA)*0.5 0000270
IF (II .GT. NSTR) TSCHA(II,M)=TI 0000280
IF (II .GT. NSTR) TSCHB(II,M)=TI 0000290
NTYPI=NTYP(I) 0000300
PW=4.*AREAI*F2ATIP/(DEIR*F2DTIP) 0000310
PH=PW-PERL(ITYP)*ASCH(I,M)/ACH(NTYPI) 0000320
R2=SQRT(RTIP(IPA)**2+2.*RTIP(IPA)*AREAI*F2ATIP/PH) 0000330
DEI=2.* (R2-RTIP(IPA)) 0000340
RAS=RTIP(IPA)/R2 0000350
KI=KAPPA(PBT, TI) 0000360
ETAI=ETA(PBT, TI) 0000370
RHOI=RHO(PBT, TI) 0000380
CPI=CP(PBT, TI) 0000390
REI=MASSI*DEI/(AREAI*F2ATIP*ETAI) 0000400
PRI=ETAI*CPI/KI 0000410
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 06.02.1980 0000420
CALL SPANU(REI, PRI, I, M, YYI) 0000430
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 06.02.1980 0000440
PEI=REI*PRI 0000450
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 12.11.1979 0000460
C GRI=X/(DEI*PEI) 0000470
C THE GRAETZ NUMBER IS COMPUTED AT THE SAME REFERENCE TEMPERATURE 0000480
C DEFINED FOR THE REYNOLDS NUMBER USED IN THE CALCULATION OF THE 0000490
C FRICTION FACTOR. 0000500
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 12.11.1979 0000510
C 0000520
TNY=TW1 0000530
PIG=3.141593 0000540
IF(ITYP .NE. 1 .AND. ITCORR .GT. 1) 0000550
> TNY=TNU(TW1, TLINER(II, M), ITYP, PERL(ITYP), PIG, RTIP(IPA)) 0000560
KZ=KAPPA(PBT, TNY) 0000570
ETAZ=ETA(PBT, TNY) 0000580
RHOZ=RHO(PBT, TNY) 0000590
CPZ=CP(PBT, TNY) 0000600
REZ=MASSI*DEI/(AREAI*F2ATIP*ETAZ) 0000610
PRZ=ETAZ*CPZ/KZ 0000620
PEZ=REZ*PRZ 0000630

GRI=X/(DEI*PEZ) 0000640
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 12.11.1979 0000650
C 0000660
C----- (NU 1)INF IF (Q)LIN =0 0000670
C 0000680
IF(ITYP.EQ.1)GOTO 1 0000690
NU1IN=4.07+1.237/RAS**0.80272 0000700
GOTO 2 0000710
1 NU1IN=RAS/(1.+RAS)*(14.1207+4.1261*ALOG(0.952313/RAS-1.)) 0000720
2 CONTINUE 0000730
C 0000740
C----- YNU1=(NU 1)/(NU 1)INF IF (Q)LINER =0 0000750
C 0000760
IF(GRI.GT. 0.025)GOTO 3 0000770
B=-0.19327+.121747/GRI**0.14828 0000780
GOTO 4 0000790
3 B=-0.0013376+0.0000277181/GRI**1.76255 0000800
IF(B.LT.0.)B=0. 0000810
4 YNU1=(RAS/0.00062)**B 0000820
C 0000830
NU1=NU1IN*YNU1 0000840
CCCCCCCCCCCCCCCCCCCCCCCCCC 18.02.1980 0000850
C 0000860
NU1=NU1*0.967 0000870
IF(ITYP.NE.1) NU1=NU1*0.967 0000880
CCCCCCCCCCCCCCCCCCCCCCCCCC
ALFA1=NU1*KI/DEI*YYI 0000890
TW1=TI+QA/ALFA1 0000900
CCCCCCCCCCCCCCCCCCCCCCCCCC
ANU(I,M)=NU1*YYI 0000910
YH(I,M)=YYI 0000920
ALFA(I,M)=ALFA1 0000930
CCCCCCCCCCCCCCCCCCCCCCCCCC
TL1=0. 0000940
TETA2=0. 0000950
IF(NTYP(I).EQ.2 .AND. ITYP.EQ.1 .AND. I.GE.NS1 .AND. I.LE.NS2) 0000960
*CALL SIMLA2(TI,TW1,TL1,NU1,TETA2,TBEQR,TBEQL) 0000970
IF(ITYP.EQ.1)RETURN 1 0000980
C 0000990
C-----CALCULATIONS ONLY FOR THE CORNER CHANNELS AND THE WALL PARTS OF 0001000
C-----THE WALL SUBCHANNELS (IF (Q)LINER =0) 0001010
C 0001020
C----- (TETA 2)INF 0001030
C 0001040
IF(RAS.GT. 0.1)GOTO 5 0001050
TETA2I=-0.103313*RAS**0.9489 0001060
GOTO 6 0001070
5 TETA2I=0.0142-0.0784857*RAS**0.4828 0001080
6 CONTINUE 0001090
C 0001100
C----- YTE2=(TETA 2)/(TETA 2)INF 0001110
C 0001120
IF(GRI.GT. 0.01)GOTO 7 0001130
YTE2=31.105*GRI 0001140
GOTO 9 0001150
7 IF(GRI.GE. 0.025)GOTO 8 0001160
YTE2=15.59936*GRI**0.8501383 0001170
GOTO 9 0001180
8 YTE2=1./(0.98293+0.000125822/GRI**2.242421) 0001190
IF(YTE2.GT.1)YTE2=1. 0001200
C 0001210
9 TETA2P=TETA2I*YTE2 0001220
TLINER(II,M)=TETA2P*QA*DEI/KI+TI 0001230
TETA2=TETA2P 0001240
IF(I.GE.NS1 .AND. I.LE.NS2)CALL SIMLA1(TE,TI,TW1,TLINER(II,M),NU1, 0001250
* TETA2,I,M,TBEQR,TBEQL,II) 0001260
IF(TLINER(II,M).LT.TE)TLINER(II,M)=TE 0001270
0001280
0001290

C IF(ABS(QALIN).LE.1.E-06 .OR. IQLIN.EQ.2)RETURN 1 0001300
C 0001310
C 0001320
C----- CASE OF HEATED LINER (FOR CORNER CHANNELS AND WALL PART OF TH0001330
C----- WALL SUBCHANNELS) : (NU 2) AND (TETA 1) IF (Q)ROD =0 0001340
C 0001350
C TETA2=0. 0001360
IF(QA.GT.1.E-06)TETA2=(TLINER(II,M)-TI)*KI/(QA*DEI) 0001370
C 0001380
C----- (NU 2)INF 0001390
C 0001400
NU2IN=4.754*EXP(0.1246*RAS) 0001410
C 0001420
C----- YNU2=(NU 2)/(NU 2)INF 0001430
C 0001440
IF(GRI.GT. 0.003)GOTO 11 0001450
YNU2=0.2861/GRI**0.3334 0001460
GOTO 12 0001470
11 YNU2=1.+0.060344/GRI**0.506*EXP(-49.*GRI) 0001480
12 NU2=NU2IN*YNU2 0001490
NU2=NU2*0.967 0001500
CCCCCCCCCCCCCCCCCCCCCCCCCC 16.04.1980 0001510
SNU(II,M)=NU2 0001520
ALFA2=NU2*KI/DEI 0001530
SALFA(II,M)=ALFA2 0001540
CCCCCCCCCC 16.04.1980 0001550
C 0001560
C----- (TETA 1) 0001570
C 0001580
100 TETA1=TETA2P/RAS 0001590
TW1=TETA1*QALIN*DEI/KI+TI 0001600
ALFA2=NU2*KI/DEI 0001610
TLINER(II,M)=TI+QALIN/ALFA2 0001620
IF(I.GE.NS1 .AND. I.LE.NS2)CALL SIMLA2(TI,TLINER(II,M),TW1,NU2, 0001630
* TETA1,TBEQL,TBEQR) 0001640
IF (TW1.LE.TE)TW1=TE 0001650
TETA1=(TW1-TI)*KI/(QALIN*DEI) 0001660
C 0001670
C-----GENERAL CASE OF HEATED LINER AND ROD (CORNER CHANNELS AND WALL 0001680
C-----PART OF THE WALL SUBCHANNELS) 0001690
C 0001700
NU2=NU2/(1.+QA/QALIN*TETA2*NU2) 0001710
CCCCCCCCCC 0001720
IF(NU2.GT. 9999.0) NU2= 9999.0 0001730
IF(NU2.LT.-9999.0) NU2=-9999.0 0001740
ALFA2=NU2*KI/DEI 0001750
CCCCCCCCCC 0001760
TLINER(II,M)=TI+QALIN/ALFA2 0001770
IF(QA.LE.1.E-06)RETURN 1 0001780
C 0001790
NU1=NU1/(1.+QALIN/QA*TETA1*NU1) 0001800
CCCCCCCCCC 0001810
IF(NU1 .GT. 9999.0) NU1= 9999.0 0001820
IF(NU1 .LT.-9999.0) NU1=-9999.0 0001830
ALFA1=NU1*KI/DEI*YYI 0001840
CCCCCCCCCC 0001850
TW1=TI+QA/ALFA1 0001860
RETURN 1 0001870
END 0001880

SUBROUTINE TESTB (INDICE)	0000010	
C -----	0000020	
C TEST OF CONVERGENCE FOR THE BULK TEMPERATURES.	0000030	
C	0000040	
COMMON /SUB2/ TSCH(42,3),MSCH(42,3)	0000050	
COMMON /HEA6 / NPIN(42),JPIN(42,3)	0000060	
COMMON /SC14C/ TBOLD(42,3)	0000070	
COMMON /GASD1/ NSTOT	0000080	
COMMON /MART5/ NSTR	0000090	
C	0000100	
PERC=0.005	0000110	
INDICE=0	0000120	
C	0000130	
DO 1000 NS=1,NSTOT	0000140	
NW=NS-NSTR	0000150	
NP=NPIN(NS)	0000160	
DO 500 M=1,NP	0000170	
DELT1=ABS(TBOLD(NS,M)-TSCH(NS,M))	0000180	
IF (DELT1 .GT. 1.) INDICE=INDICE+1	0000190	
CONTINUE	0000200	
500	1000 CONTINUE	0000210
C	0000220	
RETURN	0000230	
END	0000240	

```
SUBROUTINE TESTNU(IND)          0000010
C -----0000020
C ONLY IN CASE OF CONVERGENCE PROBLEMS : AVERAGING OF THE NU NUMBERS00000030
C                                         0000040
C COMMON /SC10C/ ANU( 42,3)          0000050
C COMMON /SC15C/ ALFA( 42,3)         0000060
C COMMON /SC16C/ SNU( 18,2)          0000070
C COMMON /SC17C/ SALFA( 18,2)        0000080
C COMMON /HEA6/ NPIN( 42),JPIN( 42,3) 0000090
C COMMON /GASD1/ NSTOT              0000100
C COMMON /MART5/ NSTR               0000110
C                                         0000120
C DIMENSION ANO( 42,3),SNO( 18,2),ALO( 42,3),SAO( 18,2) 0000130
C                                         0000140
C IF ( IND .GT. 0 ) GOTO 500       0000150
C -----0000160
C IND LE 0 : THE NUSSELT OF THE PRECEDENT ITERATION ARE MEMORIZED 0000170
C DO 200 NS=1,NSTOT                0000180
C     NP=NPIN(NS)                  0000190
C     DO 100 M=1,NP                 0000200
C         ANO(NS,M) = ANU(NS,M)      0000210
C         ALO(NS,M) = ALFA(NS,M)     0000220
C         IF(NS.LE.NSTR) GOTO 100    0000230
C         NW=NS-NSTR                0000240
C         SNO(NW,M) = SNU(NW,M)      0000250
C         SAO(NW,M) = SALFA(NW,M)    0000260
C 100      CONTINUE                  0000270
C 200      CONTINUE                  0000280
C GOTO 9999                         0000290
C -----0000300
C IND GT 0 : CONVERGENCE PROBLEMS: THE NUSSELT ARE AVERAGED 0000310
C 500 CONTINUE                      0000320
C     DO 700 NS=1,NSTOT              0000330
C         NP=NPIN(NS)                0000340
C         DO 600 M=1,NP                0000350
C             ANU(NS,M) = (ANU(NS,M) +ANO(NS,M))*0.5 0000360
C             ALFA(NS,M) = (ALFA(NS,M) +ALO(NS,M))*0.5 0000370
C             IF(NS.LE.NSTR) GOTO 600    0000380
C             NW=NS-NSTR                0000390
C             SNU(NW,M) = (SNU(NW,M) +SNO(NW,M))*0.5 0000400
C             SALFA(NW,M) = (SALFA(NW,M)+SAO(NW,M))*0.5 0000410
C 600      CONTINUE                  0000420
C 700      CONTINUE                  0000430
C -----0000440
C 9999 RETURN                        0000450
C END                                0000460
```

SUBROUTINE TESTW (INDICE)	0000010	
C -----	0000020	
C TEST OF CONVERGENCE ON THE WALL TEMPERATURES.	0000030	
C	0000040	
COMMON /SUB22/ TW(42,3)	0000050	
COMMON /HEA6 / NPIN(42),JPIN(42,3)	0000060	
COMMON /GASD1/ NSTOT	0000070	
COMMON /SC99C/ TD(42,3)	0000080	
COMMON /SC08C/ TLD(18,2)	0000090	
COMMON /MART5/ NSTR	0000100	
COMMON /SHROUD/ TLINER(18,2)	0000110	
C	0000120	
PERC=0.005	0000130	
INDICE=0	0000140	
C	0000150	
DO 4000 NS=1,NSTOT	0000160	
NW=NS-NSTR	0000170	
NP=NPIN(NS)	0000180	
DO 3000 M=1,NP	0000190	
DELT1=ABS(TD(NS,M)-TW(NS,M))	0000200	
IF (DELT1 .GT. 1.) INDICE=INDICE+1	0000210	
C	0000220	
IF (NS.LE.NSTR) GO TO 3000	0000230	
DELT1=ABS(TLINER(NW,M)-TLD(NW,M))	0000240	
IF (DELT1 .GT. 1.) INDICE=INDICE+1	0000250	
3000	CONTINUE	0000260
4000	CONTINUE	0000270
C	0000280	
RETURN	0000290	
END	0000300	

SUBROUTINE TEST1(NCA,X,XF,KK)	0000010
C -----	0000020
C PERFORMS THE TEST OF CONVERGENCE ON THE CONDUCTIVITY OF THE FUEL.	0000030
C	0000040
DIMENSION X(13),XF(13)	0000050
C	0000060
REAL KFUEL	0000070
C	0000080
KK=0	0000090
NC1=NCA+1	0000100
NC2=NCA*2+1	0000110
DO 100 K=NC1,NC2	0000120
C DELTA=ABS(X(K)-XF(K))	0000130
C IF (DELTA .GT. 1.) KK=KK+1	0000140
DELTA=ABS(KFUEL(X(K))/KFUEL(XF(K))-1.0)	0000150
IF (DELTA.GT.0.01) KK=KK+1	0000160
XF(K)=X(K)	0000170
100 CONTINUE	0000180
RETURN	0000190
END	0000200

```
FUNCTION TIS(R1,R2,INU) 0000010
C----- 0000020
C TIS EVALUATES THE CORRECTION FACTOR FOR THE NUSSELT NUMBERS IN 0000030
C THE REGION WHERE THE TEMPERATURE PROFILE IS NOT YET FULLY 0000040
C DEVELOPED ( CASE OF TURBULENT FLOW ) 0000050
C INU=1 : FOR SMOOTH RODS 0000060
C INU=2 : FOR ROUGH RODS 0000070
C INU=3 : FOR SMOOTH LINER 0000080
C 0000090
C COMMON/INITL/X 0000100
C GOTO(1,2,3),INU 0000110
1 TSI=0.86+0.8*(2.*(R2-R1)/X)**0.4*(R1/R2)**0.2 0000120
C GOTO 4 0000130
C 0000140
C ***** 0000150
C NO EQUATIONS ARE AVAILABLE AT THE MOMENT FOR THE INLET EFFECT IN 0000160
C THE CASE OF ROUGHENED RODS: THUS, AT INU=2, TIS=1 IS IMPOSED 0000170
C ***** 0000180
2 TSI=1. 0000190
C GOTO 4 0000200
C 0000210
3 TSI=0.86+0.54*(2.*(R2-R1)/X)**0.4*(1.+0.48*(R1/R2)**0.37) 0000220
C 0000230
C 0000240
4 IF(TSI.LE.1.)TSI=1. 0000250
TIS=TSI 0000260
RETURN 0000270
END 0000280
```

```
SUBROUTINE TLINE(I,AI,ITTEMP,NS,K,ALFA,D,W,RH,DET,PROV,IRH,DAI,DBI0000010
*,AAI,ABI,RHPL,G,TWI,TE,QPLUS,ETAA,RHOA,ETAB,RHOB,ETAIW,RHOIW,ANGT,0000020
*EM1,XC1,XC2,T1,*,CS) 0000030
C-----0000040
C   SUBROUTINE TLINE EVALUATES THE POSITION OF THE TAU=0 LINE FOR EACH0000050
C   "WALL-TYPE" SUB-SUBCHANNEL 0000060
C   0000070
C   COMMON/REC1/      PVERT(90),PRAD(90)/REC2/E(90)/REC3/P(90) 0000080
C   NNN=20 0000090
C   SSCHFA=19.0986*ALFA 0000100
C   XIRH=IRH 0000110
C   I1=I-1 0000120
8400 IF(I.GT.1)GOTO 1 0000130
C   .....0000140
C   STARTING POINT (F(P),P) FOR THE 1. ST SUB-SUBCHANNEL 0000150
C   0000160
C   P1=1.0001-(W/D-1.)*0.39*(2.-XIRH) 0000170
C   XX=0.39 0000180
C   GOTO 2 0000190
C   .....0000200
C   STARTING POINT (F(P),P) FOR THE I.TH SUB-SUBCHANNEL ( I>1 ) 0000210
C   0000220
1 P1=P(I1) +0.08*(W/D-1.)*SSCHFA 0000230
XX=-0.04*SSCHFA 0000240
C   .....0000250
C   RESEARCH OF TWO CONSECUTIVE POINTS (F(P),P) AT WHICH F= FAI-FBI 0000260
C   HAS DIFFERENT SIGNS ( ITERATION LOOP ITAU1 ) 0000270
C   0000280
2 CONTINUE 0000290
DO 4 ITAU1=1,NNN 0000300
P2=P1+XX*(W/D-1.) 0000310
CALL TAU(I,AI,P2,ALFA,D,W,RH,DET,PROV,IRH,DAI,DBI,PAI,F2,RHPL,TWI,0000320
*TE,ITTEMP,QPLUS,ETAA,RHOA,ETAB,RHOB,ETAIW,RHOIW,ANGT,EM1,XC1,XC2, 0000330
2T1,&8500,CS) 0000340
IF(ITAU1.EQ.1)GOTO 3 0000350
IF(F1*F2.LE.0.)GOTO 6 0000360
3 F1=F2 0000370
4 P1=P2 0000380
C   .....0000390
C   TWO CONSECUTIVE POINTS AT WHICH F =FAI-FBI HAS DIFFERENT SIGNS 0000400
C   HAVE BEEN NOT FOUND : IT WILL BE TRIED TO START CLOSER TO THE RODS0000410
C   ( IF IT HAS NOT YET BEEN TRIED AND IF IT IS I>1 ) 0000420
C   0000430
C   WRITE(6,5)I,ITTEMP,NS,K 0000440
5 FORMAT(5X,'STOP IN TLINE IN LOOP ITAU1    FOR SUBCH.',I3,2X,'(ITTE0000450
*MP=',I2,')OF CHANNEL',I4,2X,'(AXIAL SECTION NR.',I4,')/130('*')) 0000460
IF(NNN.EQ.40)RETURN 1 0000470
NNN=40 0000480
IF(I.GT.2)I1=I-2 0000490
GOTO 8400 0000500
C   .....0000510
C   TWO CONSECUTIVE POINTS (F(P),P) HAVE BEEN FOUND, AT WHICH 0000520
C   F= FAI-FBI HAS DIFFERENT SIGNS; THE VALUE OF P AT WHICH F=0 WILL 0000530
C   BE NOW RESEARCHED BY MEANS OF THE TANGENT METHOD ( ITERATION LOOP 0000540
C   ITAU2 ) 0000550
C   0000560
6 CONTINUE 0000570
DO 8 ITAU2=1,30 0000580
PP=P1-F1*(P2-P1)/(F2-F1) 0000590
CALL TAU(I,AI,PP,ALFA,D,W,RH,DET,PROV,IRH,DAI,DBI,PAI,F ,RHPL,TWI,0000600
1TE,ITTEMP,QPLUS,ETAA,RHOA,ETAB,RHOB,ETAIW,RHOIW,ANGT,EM1,XC1,XC2, 0000610
```

```
2T1,&8500,CS) 0000620
IF(ABS(PP/P1-1.).LE.1.E-04 .OR. ABS(PP/P2-1.).LE.1.E-04) GOTO 10 0000630
IF(F*F1.GE.0.)GOTO 7 0000640
F2=F 0000650
P2=PP 0000660
GOTO 8 0000670
7 F1=F 0000680
P1=PP 0000690
8 CONTINUE 0000700
C ..... 0000710
C PROBLEMS IN FINDING THE POSITION OF THE TAU=0 LINE 0000720
C ..... 0000730
C WRITE(6,9)I,ITTEMP,NS,K 0000740
9 FORMAT(5X,'STOP IN TLINE IN LOOP ITAU2 FOR SUBCH.',I3,2X,'(ITT0000750
*EMP=',I2,')OF CHANNEL',I4,2X,'(AXIAL SECTION NR.',I4,')') 0000760
8500 RETURN 1 0000770
C ..... 0000780
C THE POSITION OF THE TAU=0 LINE HAS BEEN FOUND FOR SUB-SUBCHANNEL I0000790
C SOME GEOMETRIC PARAMETERS WILL BE NOW COMPUTED 0000800
C ..... 0000810
C ..... 0000820
10 PBI=ALFA*D*0.5 0000830
AAI=DAI*PAI*0.25 0000840
ABI=DBI*PBI*0.25 0000850
P(I)=PP 0000860
EPS=SQRT(1.+DBI/D) 0000870
G=GSTAR(EPS) 0000880
RETURN 0000890
END 0000900
```

```

SUBROUTINE TMCF(I,NI,TT,TOTM,MAVI)          0000010
C-----0000020
C      TMCF EVALUATES THE AVERAGE CROSS-FLOW TEMPERATURES FOR THE 0000030
C      CROSS-FLOW EXCHANGE BETWEEN CHANNELS                         0000040
C                                                               0000050
C
      REAL MAV,MAVI,MAVJ                           0000060
      COMMON /MOB5/ T( 42)/MOB8/DP( 42)/MOB6/MAV( 42)        0000070
      COMMON/IJ1/NER( 42),NIS( 42,3)                 0000080
      1      /GEO0/ACH(3)/IND3/NTYP( 42)/GEN2/A( 42)        0000090
      2      /HEA6/NPIN( 42),JPIN( 42,3)/GAMAR/CXX         0000100
      TT=0.                                         0000110
      TOTM=0.                                         0000120
      DO 2 M=1,NI                                     0000130
      J=NIS(I,M)                                     0000140
      NTYPJ=NTYP(J)                                 0000150
      MAVJ=MAV(J)*ACH( NTYPJ)/A(J)                  0000160
      CXX=0.5                                       0000170
      IF((NTYP(I)+NPIN(I).EQ.4) .OR. (NTYP(J)+NPIN(J).EQ.4))CXX=1. 0000180
      CALL CF1(T(I),T(J),MAVI, MAVJ, DP(I),DP(J),2,TT,TOTM)       0000190
2 CONTINUE                                         0000200
      CXX=1.                                         0000210
      TT =TT/TOTM                                    0000220
      RETURN                                         0000230
      END                                            0000240

```

SUBROUTINE TMPUN(NSTOT,NSTR,TE,PE,PEBAR,TE1,PE1,PE1BAR, 0000010
INDPR,MFLOW,IPAST,IPAEND,IREAD1,XLAM1,STLEN,) 0000020
0000030
C TMPUN PUNCHES THE CARDS WHICH MUST BE CHANGED TO START A NEW 0000040
C CALCULATION STEP (PUNCHING UNITY=1) 0000050
C THE ACTUAL CALCULATION STEP IS STOPPED BECAUSE THE ALLOWED 0000060
C CALCULATION TIME TIMEPU HAS BEEN ELAPSED OR BECAUSE THE END 0000070
C OF THE AXIAL PORTION IPAEND (IPAEND<7) HAS BEEN OVERTAKEN 0000080
C ----- 0000090
REAL MFLOW,MI,MSCH1,MSCW1 0000100
DIMENSION XLAM1(7) 0000110
COMMON/GEN3/MI(42) 0000120
COMMON /GEN4/TEMP(42)/SUB6/TSCH1(42,3)/SUB8/MSCH1(42,3) 0000130
1 /WCSE2/MSCWC1(18,2,2)/WCSE5/TSCWC1(18,2,2)/IND3/NTYP(42) 0000140
2 /HEA6/NPIN(42),JPIN(42,3) 0000150
C 0000160
C 10TH CARD: 0000170
IF(INDPR.EQ.1)GOTO 1 0000180
PE=PEBAR 0000190
PE1=PE1BAR 0000200
1 WRITE(1,2)PE,PE1,TE,TE1,MFLOW,(XLAM1(I),I=1,3) 0000210
2 FORMAT(8F10.5) 0000220
C 0000230
C 13TH CARD 0000240
WRITE(1,3)IPAST,IPAEND,IREAD1 0000250
3 FORMAT(3I10) 0000260
C 0000270
C 14TH CARD 0000280
WRITE(1,2)STLEN 0000290
C 0000300
C LAST BLOCK OF CARDS 0000310
WRITE(1,4)(MI(NS),TEMP(NS),NS=1,NSTOT) 0000320
DO 5 NS=1,NSTOT 0000330
NSW=NS-NSTR 0000340
NP=NPIN(NS) 0000350
WRITE(1,4)(MSCH1(NS,M),TSCH1(NS,M),M=1,NP) 0000360
IF(NTYP(NS).EQ.2)WRITE(1,4)((MSCWC1(NSW,M,JWC),TSCWC1(NSW,M,JWC), 0000370
* JWC=1,2),M=1,2) 0000380
4 FORMAT(8F10.5) 0000390
5 CONTINUE 0000400
RETURN 1 0000410
END 0000420

SUBROUTINE TNEW (NCA,X,J,NSE) 0000010
C ----- 0000020
C ASSIGNE THE NEW VALUES OF THE CLAD TEMPERATURE (X) TO ARRAY TW 0000030
C 0000040
COMMON /SC01C/ NCAN(19),LIPS(19,10) 0000050
COMMON /SC05C/ JZUR(19, 42) 0000060
COMMON /SUB22/ TW(42,3) 0000070
C 0000080
C DIMENSION X(NSE) 0000090
C 0000100
DO 100 K=1,NCA 0000110
NS1 = LIPS(J,K) 0000120
MZ1 = JZUR(J,NS1) 0000130
TW(NS1,MZ1) = X(K) 0000140
100 CONTINUE 0000150
RETURN 0000160
END 0000170

```

      SUBROUTINE TNEWS(X)                               0000010
C -----
C       ASSIGNES THE NEW VALUES TO THE SHROUD TEMPERATURES. 0000020
C
C       DIMENSION X( 34)                                0000030
C
C       COMMON /SHROUD/ TLINER( 18,2)                  0000040
C       COMMON /SC22C/   NTOT                         0000050
C       COMMON /MART5/  NSTR                         0000060
C       COMMON /GASD1/  NSTOT                        0000070
C       COMMON /HEA6/   NPIN( 42),JPIN( 42,3)        0000080
C
C       N=0                                              0000090
C       NW1=NSTR+1                                     0000100
C       DO 1000 NS=NW1,NSTOT                         0000110
C             NW=NS-NSTR                           0000120
C             NP=NPIN(NS)                          0000130
C             DO 500 M=1,NP                         0000140
C                   N=N+1                            0000150
C                   TLINER(NW,M)=X(N)                0000160
C             CONTINUE                           0000170
C 500
C 1000       CONTINUE                           0000180
C
C       IF(N.EQ.NTOT) GO TO 9999                    0000190
C       WRITE(6,2000) N,NTOT                         0000200
C 2000 FORMAT(' SUB. TNEWS; N = ',I4,' NTOT = ',I4,/5X,
C >           ' CALCULATION STOPS.')              0000210
C       STOP                                         0000220
C
C 9999 RETURN                                     0000230
C
C

```

SUBROUTINE TORG (VDIAM,RINT,PIG,H) 0000010
C ----- 0000020
C ORGANIZES THE CALCULATION OF THE THERMAL CONDUCTION WITHIN THE PIN0000030
C 0000040
C COMMON /LAMIN5/RTIP(7) 0000050
C COMMON /INPAR/ IPA 0000060
C COMMON /CEV04/ LAMOP3 0000070
C COMMON /SC05R/ IRAD 0000080
C COMMON /SC19C/ ICON 0000090
C 0000100
C 1 ----- 0000110
C CORRECTION FOR LAMINAR FLOW 0000120
C 0000130
C VDIA1=VDIAM 0000140
C IF(LAMOP3.EQ.1) VDIA1=RTIP(IPA)*2. 0000150
C 0000160
C 2 ----- 0000170
C DECIDES WHICH CONDUCTION MODEL IS TO BE USED: 0000180
C TWO MODELS ARE AVAILABLE DEPENDING ON THE OPTION ICON : 0000190
C ICON = 1 ==> CONDUCTION IN THE CLAD ONLY. 0000200
C (POWER GENERATED IN THE CAN) 0000210
C ICON = -1 ==> CONDUCTION IN THE CLAD AND IN THE FUEL. 0000220
C (POWER GENERATED IN THE FUEL) 0000230
C ICON = 0 ==> CONDUCTION IS NOT TAKED INTO ACCOUNT. 0000240
C 0000250
C IF (ICON) 100,300,200 0000260
C 0000270
C 3 ----- 0000280
C CONDUCTION IN THE CLAD AND IN THE FUEL. 0000290
C 0000300
C 100 CALL BOTH (VDIAM,PIG,H,VDIA1,RINT) 0000310
C GO TO 9999 0000320
C 0000330
C 4. ----- 0000340
C CONDUCTION WITHIN THE CLAD ONLY. 0000350
C 0000360
C 200 CALL LEIST (VDIAM,PIG,H,VDIA1,RINT) 0000370
C GO TO 9999 0000380
C 0000390
C 0000400
C 5. ----- 0000410
C THE USE OF A CONDUCTION MODEL IS NECESSARY WHEN YOU WISH CONSIDER 0000420
C THE RADIATION EFFECT (IRAD=1) 0000430
C 0000440
C 300 IF (IRAD.NE.1) GO TO 9999 0000450
C WRITE(6,330) 0000460
C 330 FORMAT(5X,'THE OPTION ICON=0 IS NOT ALLOWED WHEN IRAD =1.', 0000470
C > /5X,'CALCULATION STOPS') 0000480
C 0000490
C 0000500
C 9999 CONTINUE 0000510
C RETURN 0000520
C END 0000530

SUBROUTINE TOTGEO(NSEL,D,C,Z,PIG,NEXCON,NRODS,W,WA,ZA,EM1,PERLT,
&RTIP) 0000010
0000020
C-----0000030
C TOTGEO CALCULATES FLOW AREAS , EQUIVALENT DIAMETERS AND OTHER 0000040
C GEOMETRIC DATA FOR THE WHOLE BUNDLE FLOW SECTION , FOR THE 0000050
C CHANNELS AND FOR THE SUBCHANNELS 0000060
C 0000070
C VERSION FOR HEXAGONAL BUNDLES 0000080
C0000090
COMMON/GEO0/ACH(3)/LAMIN2/FATIP(3),FDTIP(3)/QPAR3/PERL(3) 0000100
1 /GEO2/ATOT,DETOT,ASEC/GEO5/ATC,DETC,ATW,DETW,ATA,DETA,AAC, 0000110
2 AAW,AAA/WAKAO/CD,WD,ZD,ZWCD,AWD2,PWWD/GASD3/FSYMM 0000120
SQ3=SQRT(3.) 0000130
W=Z+D*0.5 0000140
WA=W 0000150
ZA=Z 0000160
EXCON=NEXCON 0000170
RODS=NRODS 0000180
EM2=C*0.5-EM1 0000190
ZWC=EM2/SQ3 0000200
DTIP=RTIP*2. 0000210
SIDE=EXCON*C+(2.*W-D)/SQ3 0000220
RPER=RODS*PIG*D 0000230
PERLT=6.*SIDE+EXCON*(-12.*EM2+24.*ZWC) 0000240
ATOT=3.*SQ3/2.*SIDE**2-RPER*D/4.-6.*EM2*ZWC*EXCON 0000250
DETOT=4.*ATOT/(RPER+PERLT) 0000260
GOTO(20,21,22,24),NSEL 0000270
20 ASEC=ATOT 0000280
GOTO 23 0000290
21 ASEC=ATOT*0.5 0000300
GOTO 23 0000310
22 ASEC=ATOT/12. 0000320
C EXTENDED AT GA FOR OTHER SYMMETRY SECTIONS (NSEL=4) 0000330
GOTO 23 0000340
24 ASEC=ATOT/FSYMM 0000350
23 CONTINUE 0000360
ATC=(C**2*SQ3-PIG*D**2/2.)/4. 0000370
DETC=4.*ATC/(PIG*D/2.) 0000380
ATW=C*(W-D/2.)-D**2*PIG/8.-EM2*ZWC 0000390
DETW=4.*ATW/(PIG*D*0.5+2.*EM1+4.*ZWC) 0000400
ATA=(W-D/2.)**2/SQ3-D**2*PIG/24. 0000410
DETA=4.*ATA/(D*PIG/6.+(W-D/2)*2./SQ3) 0000420
AAC=ATC/6. 0000430
AAW=ATW*0.5 0000440
AAA=ATA*0.5 0000450
ACH(1)=ATC 0000460
ACH(2)=ATW 0000470
ACH(3)=ATA 0000480
PERL(1)=0. 0000490
PERL(2)=4.*ATW/DETW-0.5*PIG*D 0000500
PERL(3)=4.*ATA/DETA-PIG*D/6. 0000510
FATIP(1)=(C**2*SQ3-PIG*DTIP**2*0.5)*0.25 0000520
FDTIP(1)=4.*FATIP(1)/(PIG*0.5*DTIP)/DETC 0000530
FATIP(1)=FATIP(1)/ATC 0000540
FATIP(2)=C*(W-DTIP*0.5)-DTIP**2*PIG*0.125-EM2*ZWC 0000550
FDTIP(2)=4.*FATIP(2)/(PIG*DTIP*0.5+2.*EM1+4.*ZWC)/DETW 0000560
FATIP(2)=FATIP(2)/ATW 0000570
FATIP(3)=(W-DTIP*0.5)**2/SQ3-DTIP**2*PIG/24. 0000580
FDTIP(3)=4.*FATIP(3)/(DTIP*PIG/6.+(W-DTIP*0.5)*2./SQ3)/DETA 0000590
FATIP(3)=FATIP(3)/ATA 0000600

CD=C/DTIP	0000610
WD=W/DTIP	0000620
ZD=Z/DTIP	0000630
ZWCD=ZWC/DTIP	0000640
AWD2=AAW*FATIP(2)/DTIP**2	0000650
PWWDF=4.*AAW*FATIP(2)/(DETWF*DFTIP(2)*DTIP)	0000660
WRITE(6,1)ATOT,DETOT,ASEC	0000670
WRITE(6,3)ATC,ATW,ATA,DETC,DETW,DETA	0000680
1 FORMAT(// 5X,'TOTAL FLOW AREA=',F10.2,1X,'SQCM'/5X,'TOTAL EQUIVALENT DIAMETER=',F10.1,1X,'CM'/5X,'FLOW AREA OF SECTION=',F10.2,1X,'0000700 *SQCM')	0000690 0000700 0000710
3 FORMAT(5X,'FLOW AREAS OF CHANNELS: '/5X, 'CENTRAL=',F10.2/5X,'WALL',F10.2/5X,'CORNER=',F10.2//5X,'EQUIVALENT DIAMETERS'/5X,'CENTRAL',F10.1/5X,'WALL=',F10.1/5X,'CORNER=',F10.1///130('*'))	0000720 0000730 0000740
RETURN	0000750
END	0000760

SUBROUTINE TOTSEC(NSEL)	0000010
C -----	0000020
C COMPUTES THE TOTAL NUMBER OF SECTOR FOR THE RADIATION CALCULATIONS	0000030
C	0000040
COMMON /GASD1/ NSTOT	0000050
COMMON /MART5/ NSTR	0000060
COMMON /HEA6/ NPIN(42),JPIN(42,3)	0000070
COMMON /SC01R/ NSECT,NSECP	0000080
C	0000090
IF(NSEL.NE.1) GO TO 3000	0000100
C	0000110
NSECP=0	0000120
DO 1000 NS=1,NSTOT	0000130
NP=NPIN(NS)	0000140
DO 800 M=1,NP	0000150
NSECP=NSECP+1	0000160
800 CONTINUE	0000170
1000 CONTINUE	0000180
C	0000190
NSECT=NSECP	0000200
NSW=NSTR+1	0000210
DO 2000 NS=NSW,NSTOT	0000220
NP=NPIN(NS)	0000230
DO 1800 M=1,NP	0000240
NSECT=NSECT+1	0000250
1800 CONTINUE	0000260
2000 CONTINUE	0000270
GO TO 4000	0000280
C	0000290
3000 CONTINUE	0000300
IF(NSEL.EQ.3) GO TO 9999	0000320
WRITE(6,3500)	0000340
3500 FORMAT(' SUB TOTSEC - THE PRESENT VERSION CANNOT RUN WITH THE ',	0000350
> ' ACTUAL NRODS,NSEL. CALCULATION STOPS')	0000360
STOP	0000370
C	0000380
4000 WRITE(6,5000) NSECP,NSECT	0000390
5000 FORMAT(5X,'SUB. TOTSEC ',	0000400
> 'NUMBER OF SECTORS OF PIN = ',I5,	0000410
> 'TOTAL NUMBER OF SECTORS = ',I5,/))	0000420
C	0000430
9999 RETURN	0000440
END	0000450

```
SUBROUTINE TRICA1(K,NS,NN,IRH,PROV,PB,    RH,A,DE,MEC,AT,DET,DETOT,0000010
*H1,ALFA, H,M,PR1,PR2,SQDPG,TE,SUR,D,AMT,DDDD,ATSCH,*,C)          0000020
C-----0000030
C   SUBROUTINE TRICA1 CALCULATES FRICTION FACTORS AND APPROXIMATE 0000040
C   OUTLET MASS FLOW RATES AND TEMPERATURES FOR CENTRAL SUBCHANNELS 0000050
C   0000060
C   REAL MEC,LAMSCH,KAPPA,LAMILAM,MSCH                           0000070
COMMON/SUB5/LAMSCH( 42,3)/CEN1/G(46)/SUB1/ASCH( 42,3)/INPAR/IPA 0000080
1     /SUB6/TSCH1( 42,3)/CORR1/SIGMAI( 42,3),PHII( 42,3)        0000090
2     /LAMIN5/RTIP(7)/DAT/PIG/SUB23/HPLUSB( 42,3),HPLUSW( 42,3) 0000100
3     ,QPLUS( 42,3),PRB ( 42,3),YODH( 42,3)/HEA5/QQ( 42,3)      0000110
4     /WSSCH0/TBSSC1( 42,3),TWSSC1( 42,3),                      0000120
A     TBSSC2( 42,3),TWSSC2( 42,3)                                0000130
5     /LAMINO/I2TIP( 42,3)/LAMIN1/AKAPPA( 42) /LAMIN2/FATIP(3), 0000140
6     FDTIP(3)/LAMIN3/F1ATIP( 42),F1DTIP( 42)/LAMIN4/F2ATIP( 42,3)0000150
7     ,F2DTIP( 42,3)/LAMIN7/F1PTIP/GEN2/ACHA( 42)/SUB2/TSCH( 42,3)0000160
8     ,MSCH( 42,3) /SUB22/TW( 42,3)/MART/ITCORR                 0000170
9     /LAMIN9/I3TIP( 42,3)                                         0000180
DIMENSION A(30),DE(30),MEC(30)                                     0000190
COMMON /HEA6 / NPIN( 42),JPIN( 42,3)                               0000210
COMMON /SC02C/ QJ( 19, 42)                                         0000220
COMMON /SC13C/ GE01( 42,3)                                         0000230
C   0000250
IF(M.GT.1)GOTO 2998                                              0000260
F1ATIP(NS)=0.                                                       0000270
F1PTIP=0.                                                          0000280
2998 CONTINUE                                                       0000290
I2TIP(NS,M)=I3TIP(NS,M)                                           0000300
IF(           I2TIP(NS,M).EQ.1)GOTO 2999                         0000310
C   .....0000320
C   .....0000330
C   I3TIP#1: THE TURBULENT CALCULATION MUST BE PERFORMED       0000340
C   0000350
TWIAV=0.                                                           0000360
AMT=0.                                                             0000370
TT=0.                                                               0000380
DDDD=0.                                                            0000390
HPLUS1=0.                                                          0000400
HPLUS2=0.                                                          0000410
C   .....0000420
C   SUB-SUBCHANNEL CALCULATIONS ( I = SUB-SUBCHANNEL INDEX )    0000430
C   0000440
DO 1 I=1,NN                                                       0000450
AM1=MEC(I)                                                       0000460
AA=A(I)                                                         0000470
DD=DE(I)                                                       0000480
GG=G(I)                                                         0000490
CALL CEWA(K,NS,IRH,PROV,PB,RH,AA,DD,GG,AM1,DETOT,H1,ALFA,I,M,H,PR10000500
*,PR2,SQDPG,AMT,TT,DDDD,TE,SUR,1,III,HPLUS1,HPLUS2,TSCH1(NS,M),      0000510
*SIGMAI(NS,M),PHII(NS,M),&777,D,TWI,TI,C)                         0000520
TWIAV=TWIAV+TWI*ALFA                                            0000530
TBSSC2(NS ,M )=TI                                              0000540
TWSSC2( NS,M )=TWI                                             0000550
IF (I.GT.1) GOTO 1                                              0000560
TBSSC1( NS,M )=TI                                              0000570
TWSSC1( NS,M )=TWI                                             0000580
1 CONTINUE                                                       0000590
C   .....0000600
C   ALL SUB-SUBCHANNELS HAVE BEEN COMPUTED; AVERAGE SUB-SUBCHANNEL 0000610
C   VARIABLES WILL BE NOW COMPUTED                                0000620
C   0000630
```

CCCCCCCCCCCCCCCCCCCCCCCCCCCC 21.09.1979 0000640
C TWIAV=TWIAV*12./PIG 0000650
CCCCCCCCCCCCCCCCCCCCCCCCCCC
 TWIAV=TWIAV*6./PIG 0000660
CCCCCCCCCCCCCCCCCCCCCCCCCCC
 AT SCH=TT/AMT 0000670
 RHOT=RHO(PB,AT SCH) 0000680
 LAMSCH(NS,M)=((AT/DDDD)**2)*2.*DET*RHOT/H 0000690
 I2TIP(NS,M)=0 0000700
 F2ATIP(NS,M)=1. 0000710
 F2DTIP(NS,M)=1. 0000720
 IF(I3TIP(NS,M).EQ.2)GOTO 3000 0000730
C 0000740
C I3TIP=3: THE LAMINAR CALCULATION MUST BE ALSO PERFORMED 0000750
C 0000760
C 0000770
C 0000780
IF(ITCORR.GT.1)GOTO 2999 0000790
MSCH(NS,M)=AMT*ASCH(NS,M)/AT 0000800
TSCH(NS,M)=AT SCH 0000810
TW(NS,M)=TWIAV 0000820
C 0000830
C 0000840
C FOR I3TIP=1 OR I3TIP=3 0000850
C 0000860
2999 CONTINUE 0000870
RELA=RELAM(ASCH(NS,M)*FATIP(1),DET*FDTIP(1),PB,TSCH(NS,M),TW(NS,M)) 0000880
& ,MSCH(NS,M),0.,1,0.,1.) 0000890
LAMLAM=AKAPPA(NS)/RELA 0000900
ROCEN=C*SQRT(SQRT(3.)/(2.*PIG)) 0000910
CALL ENTRFR(K,1,1,RTIP(IPA),ROCEN,R2CEN,NS,III,M,DET*FDTIP(1), 0000920
* ASCH(NS,M)*FATIP(1),MSCH(NS,M),PB,TSCH(NS,M),LAMLAM) 0000930
IF(I2TIP(NS,M).EQ.1)GOTO 2997 0000940
C 0000950
C I3TIP=3: SAGAPO DECIDES WHETHER THE FLOW IS LAMINAR OR TURBULENT 0000960
C 0000970
IF(LAMSCH(NS,M).GT.LAMLAM)GOTO 3000 0000980
C THE FLOW IS LAMINAR 0000990
C 0001000
2997 CONTINUE 0001010
LAMSCH(NS,M)=LAMLAM 0001020
DDDD=AT*FATIP(1)/SQRT(LAMLAM*H/(2.*DET*FDTIP(1)* 0001030
*RHO(PB,TSCH(NS,M)))) 0001040
AMT=MSCH(NS,M)*AT/ASCH(NS,M) 0001050
AT SCH=TSCH(NS,M) 0001060
I2TIP(NS,M)=1 0001070
F2ATIP(NS,M)=FATIP(1) 0001080
F2DTIP(NS,M)=FDTIP(1) 0001090
HPLUSB(NS,M)=1. 0001100
HPLUSW(NS,M)=1. 0001110
QPLUS(NS,M)=1. 0001120
PRB (NS,M)=1. 0001130
YODH(NS,M)=1. 0001140
TBSSC1(NS,M)=TSCH(NS,M) 0001150
TBSSC2(NS ,M)=TSCH(NS,M) 0001160
TWSSC1(NS,M)=TW(NS,M) 0001170
TWSSC2(NS,M)=TW(NS,M) 0001180
C 0001190
C FOR LAMINAR AND FOR TURBULENT FLOW (HERE COMES THE CALCULATION 0001200
C IN THE CASE OF TURBULENT FLOW) 0001210
C 0001220
3000 CONTINUE 0001230
F1ATIP(NS)=F1ATIP(NS)+ASCH(NS,M)/ACHA(NS)*F2ATIP(NS,M) 0001240
F1PTIP=F1PTIP+ASCH(NS,M)/ACHA(NS) *F2ATIP(NS,M)/F2DTIP(NS,M) 0001250
F1DTIP(NS)=F1ATIP(NS)/F1PTIP 0001260
IF(IRH.EQ.1 .OR. I2TIP(NS,M).EQ.1)RETURN 0001270
C 0001280
C FOR TURBULENT FLOW AND ROUGHENED RODS 0001290

C	HPLUSB(NS,M)=HPLUS1/AT	0001300
	HPLUSW(NS,M)=HPLUS2/AT	0001310
	CPT=CP(PB,ATSCH)	0001320
	CC	0001330
C	QPLUS(NS,M)=QQ(NS,M)*AT/(SUR*AMT*CPT*(TE+273.16))	0001340
	CC	0001360
	JP=JPIN(NS,M)	0001370
	QAD= QQ(NS,M)	0001380
	IF (QDEV .GT. 1.E-06) QAD=QJ(JP,NS)*GE01(NS,M)/(H1*QDEV)+QQ(NS,M)	0001390
	QPLUS(NS,M)=QAD*AT/(SUR*AMT*CPT*(TE+273.16))	0001400
	CC	0001410
	PRB (NS,M)=ETA(PB,ATSCH)*CPT/KAPPA(PB,ATSCH)	0001420
	YODH(NS,M)=0.5*(SQRT(D**2+DET*D)-D)/RH	0001430
	RETURN	0001440
777	RETURN 1	0001450
	END	0001460
		0001470

	SUBROUTINE TTOT(INDEX)	0000010
C	-----	0000020
C	MEMORIZATION OF THE OLD BULK (INDEX=1) OR WALL (INDEX=2) TEMP.	0000030
C		0000040
	COMMON /SUB22/ TW(42,3)	0000050
	COMMON /SUB2 / TSCH(42,3),MSCH(42,3)	0000060
	COMMON /SC99C/ TD(42,3)	0000070
	COMMON /SC14C/ TBOLD(42,3)	0000080
	COMMON /SC08C/ TLD(18,2)	0000090
	COMMON /MART5/ NSTR	0000100
	COMMON /SHROUD/ TLINER(18,2)	0000110
	COMMON /GASD1/ NSTOT	0000120
	COMMON /HEA6 / NPIN(42),JPIN(42,3)	0000130
C		0000140
	IF (INDEX .EQ. 1) GO TO 300	0000150
C		0000160
	DO 200 NS=1,NSTOT	0000170
	NW=NS-NSTR	0000180
	NP=NPIN(NS)	0000190
	DO 100 M=1,NP	0000200
	TD(NS,M)=TW(NS,M)	0000210
	IF(NS.GT.NSTR) TLD(NW,M)=TLINER(NW,M)	0000220
100	CONTINUE	0000230
200	CONTINUE	0000240
	GO TO 9999	0000250
C		0000260
	300 DO 500 NS=1,NSTOT	0000270
	NW=NS-NSTR	0000280
	NP=NPIN(NS)	0000290
	DO 400 M=1,NP	0000300
	TBOLD(NS,M)=TSCH(NS,M)	0000310
400	CONTINUE	0000320
500	CONTINUE	0000330
C		0000340
	9999 CONTINUE	0000350
	RETURN	0000360
	END	0000370

```
FUNCTION TUBENU(REI,PRI)          0000010
C-----0000020
C   TUBENU EVALUATES THE NUSSELT NUMBER OF A TUBE WITH THE SAME REYNOL0000030
C   AND PRANDTL NUMBERS AS THE ANNULAR SECTION WHOSE CROSS SECTIONAL F0000040
C   AREA IS EQUAL TO THE ACTUAL AREA ( TURBULENT FLOW, SMOOTH RODS ) 0000050
C                                         0000060
C
A=1.07+900./REI-0.63/(1.+10.*PRI) 0000070
FTU=1./(1.82*ALOG10(REI)-1.64)**2 0000080
TUBENU=FTU*0.125*REI*pri/(A+12.7*SQRT(FTU*0.125)*(PRI**2./3.-1.))0000090
*)
RETURN                               0000100
END                                  0000110
                                         0000120
```

```
FUNCTION TURBWC(CTU3,E,PRAD,D,W,C,GAMMA,A1,A2,DE1,DE2,EM1) 0000140
C-----0000150
C   TURBWC EVALUATES THE GEOMETRIC CONSTANTS FOR THE TURBULENT 0000160
C   EXCHANGE BETWEEN THE TWO PORTIONS OF THE WALL SUBCHANNELS 0000170
C                                         0000180
C
SINGAM=SIN(GAMMA)                  0000190
COSGAM=COS(GAMMA)                 0000200
PERSEP=PRAD-0.5*D                  0000210
Z=W-D*0.5                          0000220
EM2=C*0.5-EM1                      0000230
ZWC=EM2/SQRT(3.)                   0000240
A3=EM2*ZWC*0.5                     0000250
D3=D**3                            0000260
C2=C**2                            0000270
E2=E**2                            0000280
Z2=Z**2                            0000290
YB3=C*0.5-EM2/3.                   0000300
XB3=Z-ZWC/3.                        0000310
YB1=(0.25*(C2*(0.5*Z-E/3.))+D3*(SINGAM-1.)/6.)-YB3*A3)/A1 0000320
XB1=(0.25*(C*(Z2-E2/3.))-D3*COSGAM)-XB3*A3)/A1           0000330
YB2=(E*C2-D3*SINGAM*0.5)/(12.*A2) 0000340
XB2=(E2*C-D3*(1.-COSGAM)*0.5)/(12.*A2) 0000350
DE12=(A1+A2)/(A1/DE1+A2/DE2)       0000360
DELTA=SQRT((YB1-YB2)**2+(XB1-XB2)**2) 0000370
TURBWC=0.05*CTU3*PERSEP/DELTA*DE12 0000380
RETURN                               0000390
END                                  0000400
```

```
FUNCTION TWCTEP(QRMDAR,TW)         0000010
C-----0000020
C   TWCTEP CORRECTS THE COMPUTED ROD TEMPERATURE TO TAKE INTO ACCOUNT 0000030
C   THE POSITION OF THE THERMOCOUPLES INSIDE THE CANNING             0000040
C                                         0000050
C
COMMON/DATKM/C1(7),C2(7)/INPAR/IPA 0000060
D1=C1(IPA)                         0000070
D2=C2(IPA)                         0000080
TWCTEP=(-D1+SQRT(D1**2+2.*D2*(D1*TW+0.5*D2*TW**2+QRMDAR)))/D2 0000090
RETURN                               0000100
END                                  0000110
```


SUBROUTINE VF CAL 0000010
C ----- 0000020
C COMPUTES THE VIEW FACTORS. 0000030
C 0000040
COMMON /SC02R/ P,D,Z,ZWC,H,LENGTH 0000050
COMMON /DAT/ PIG 0000060
COMMON /SC03R/ F1,F2,F3,F4,F5,F6,F7,F8,F9, 0000070
> F11,F12,F13,F14,F15,F16,F17,F18,F24,F31,F32 0000080
C 0000090
R=D*D*0.5 0000100
C 0000110
CALL CFC1 (P,D,PIG,F1) 0000120
CALL CFC2 (P,R,Z,ZWC,PIG,F2) 0000130
CALL CFC3 (P,D,PIG,F3) 0000140
CALL CFC4 (P,D,PIG,F4) 0000150
CALL CFC5 (P,D,PIG,F5) 0000160
C 0000170
CALL CF11(P,D,Z,ZWC,PIG,F11) 0000180
CALL CF12(P,D,Z,ZWC,PIG,F12) 0000190
CALL CF13(P,D,Z,ZWC,PIG,F13) 0000200
CALL CF14(P,D,Z,ZWC,PIG,F14) 0000210
CALL CF15(P,D,Z,ZWC,PIG,F15) 0000220
CALL CF16(P,D,Z,ZWC,PIG,F16) 0000230
CALL CF17(P,D,Z,ZWC,PIG,F17) 0000240
CALL CF18(P,D,Z,ZWC,PIG,F18) 0000250
CALL CF24(P,D,Z,ZWC,PIG,F24) 0000260
CALL CF31(P,D,Z,ZWC,PIG,F31) 0000270
CALL CF32(P,D,Z,ZWC,PIG,F32) 0000280
C 0000290
F7 = F5 0000300
F8 = F4 0000310
C 0000320
G1 =F1 /(PIG*D/3.) 0000330
G3 =F3 /(PIG*D/3.) 0000340
G4 =F4 /(PIG*D/3.) 0000350
G5 =F5 /(PIG*D/3.) 0000360
GP15=F15/(PIG*D/3.) 0000370
GP14=F14/(PIG*D/3.) 0000380
GP24=F24/(PIG*D/3.) 0000390
C 0000400
G2 =F2 /(PIG*D/2.) 0000410
G7 =F7 /(PIG*D/2.) 0000420
G8 =F8 /(PIG*D/2.) 0000430
GP11=F11/(PIG*D/2.) 0000440
GP12=F12/(PIG*D/2.) 0000450
GP13=F13/(PIG*D/2.) 0000460
GP16=F16/(PIG*D/2.) 0000470
GP17=F17/(PIG*D/2.) 0000480
GP18=F18/(PIG*D/2.) 0000490
C 0000500
GS11=F11/PSTAR(ZWC,P) 0000510
GS12=F12/PSTAR(ZWC,P) 0000520
GS13=F13/PSTAR(ZWC,P) 0000530
GS15=F15/PSTAR(ZWC,P) 0000540
GS16=F16/PSTAR(ZWC,P) 0000550
GS24=F24/PSTAR(ZWC,P) 0000560
GS32=F32/PSTAR(ZWC,P) 0000570
GW31=F31/PSTAR(ZWC,P) 0000580
C 0000590
GS14=F14/(4.*Z/SQRT(3.)) 0000600
GS17=F17/(4.*Z/SQRT(3.)) 0000610

GS18=F18/(4.*Z/SQRT(3.))	0000620
GA31=F31/(4.*Z/SQRT(3.))	0000630
C	0000640
WRITE(6,100) G1,G2,G3,G4,G5,G7,G8	0000650
100 FORMAT (5X,' F1 = ',F10.5,/5X,	0000660
> ' F2 = ',F10.5,/5X,	0000670
> ' F3 = ',F10.5,/5X,	0000680
> ' F4 = ',F10.5,/5X,	0000690
> ' F5 = ',F10.5,/5X,	0000700
> ' F7 = ',F10.5,/5X,	0000710
> ' F8 = ',F10.5,//)	0000720
C	0000730
WRITE(6,200) GP11,GP12,GP13,GP14,GP15,GP16,GP17,GP18,GP24	0000740
200 FORMAT (5X,' FP11 = ',F10.5,/5X,	0000750
> ' FP12 = ',F10.5,/5X,	0000760
> ' FP13 = ',F10.5,/5X,	0000770
> ' FP14 = ',F10.5,/5X,	0000780
> ' FP15 = ',F10.5,/5X,	0000790
> ' FP16 = ',F10.5,/5X,	0000800
> ' FP17 = ',F10.5,/5X,	0000810
> ' FP18 = ',F10.5,/5X,	0000820
> ' FP24 = ',F10.5,///)	0000830
C	0000840
WRITE(6,300)GS11,GS12,GS13,GS14,GS15,GS16,GS17,GS18,GS24,GA31,	0000850
> GW31,GS32	0000860
300 FORMAT(/5X,' FS11 = ',F10.5,/5X,	0000870
> ' FS12 = ',F10.5,/5X,	0000880
> ' FS13 = ',F10.5,/5X,	0000890
> ' FS14 = ',F10.5,/5X,	0000900
> ' FS15 = ',F10.5,/5X,	0000910
> ' FS16 = ',F10.5,/5X,	0000920
> ' FS17 = ',F10.5,/5X,	0000930
> ' FS18 = ',F10.5,/5X,	0000940
> ' FS24 = ',F10.5,/5X,	0000950
> ' FA31 = ',F10.5,/5X,	0000960
> ' FW31 = ',F10.5,/5X,	0000970
> ' F32 = ',F10.5,///)	0000980
C	0000990
RETURN	0001000
END	0001010

SUBROUTINE VFCTR 0000010
C ----- 0000020
C CONTROLS THE ARRAY OF VIEW-FACTORS. 0000030
C 0000040
COMMON /SC04R/ VFAC(132, 13) 0000050
COMMON /SC13R/ NAFF(132) 0000060
COMMON /SC14R/ KAFF(132, 13) 0000070
COMMON /SC01R/ NSECT,NSECP 0000080
C 0000090
DO 1000 L1=1,NSECT 0000100
NAF1=NAFF(L1) 0000110
IF(NAF1.LE.0) GO TO 1000 0000120
DO 500 K1=1,NAF1 0000130
L2=KAFF(L1,K1) 0000140
NAF2=NAFF(L2) 0000150
IF(NAF2.GT. 0) GO TO 200 0000160
WRITE(6,100) L1,K1,L2,NAF2 0000170
100 FORMAT(' VFCTR',4I4) 0000180
200 CONTINUE 0000190
DO 400 K2=1,NAF2 0000200
IF(KAFF(L2,K2).NE. L1) GO TO 400 0000210
IF(VFAC(L1,K1).EQ.0.0.OR .VFAC(L2,K2).EQ.0.0)GOTO 300 0000220
P=ABS(VFAC(L1,K1)/VFAC(L2,K2)-1.0) 0000230
P1=ABS(VFAC(L1,K1)*2./VFAC(L2,K2)-1.0) 0000240
P2=ABS(VFAC(L1,K1)/VFAC(L2,K2)/2.-1.0) 0000250
IF(P.LT.0.01) GO TO 400 0000260
IF(P1.LT.0.01) GO TO 400 0000270
IF(P2.LT.0.01) GO TO 400 0000280
300 WRITE(6,1100) L1,K1,VFAC(L1,K1),L2,K2,VFAC(L2,K2) 0000290
400 CONTINUE 0000300
500 CONTINUE 0000310
1000 CONTINUE 0000320
C 0000330
C 0000340
1100 FORMAT (5X,'NO CORRISPONDENCE IN VIEW-FACTORS ARRAY:',/5X, 0000350
> 'VIEW-FACTOR ',I3,',',I3,' = ',F10.5,/5X, 0000360
> 'VIEW-FACTOR ',I3,',',I3,' = ',F10.5,/) 0000370
C 0000380
DO 2000 L=1,NSECT 0000390
TOT=0.0 0000400
DA=DAREA(L) 0000410
NAF=NAFF(L) 0000420
IF(NAF.LE.0) GO TO 2000 0000430
DO 1500 K=1,NAF 0000440
TOT=TOT+VFAC(L,K)/DA 0000450
1500 CONTINUE 0000460
WRITE(6,2200) L,TOT 0000470
IF (ABS(TOT-1.).GT.0.001) WRITE(6,2300) 0000480
IF (TOT.GT.1.0) WRITE(6,2100) L,TOT 0000490
IF (TOT.LT.1.0) CALL NORMA(TOT,L) 0000500
2000 CONTINUE 0000510
C 0000520
2100 FORMAT (5X,/5X,'VFCTR, ERROR IN SUM FOR ',I3,' = ',F10.5,/) 0000530
2200 FORMAT (5X,'VFCTR, THE SUM OF VIEW FACTOR FOR THE SECTOR ',I4, 0000540
> ' IS ',F10.5) 0000550
2300 FORMAT (1H+,80X, ' IT IS COMPENSED TO 1.0') 0000560
C 0000570
RETURN 0000580
END 0000590

SUBROUTINE VFDET(NSEL,NRODS)	0000010
C -----	0000020
C ORGANIZES THE DETERMINATION OF THE ARRAYS NAFF, KAFF, VFAC	0000030
C	0000040
C IF (NRODS.NE.12) GO TO 100	0000050
C	0000060
C -----	0000070
C 12-ROD BUNDLE	0000080
C	0000090
IF(NSEL.NE.1) GO TO 50	0000100
CALL VFDE1	0000110
GO TO 999	0000120
50 CONTINUE	0000130
CALL VFD3	0000140
GO TO 999	0000150
100 CONTINUE	0000160
C	0000170
C -----	0000180
C HEXAGONAL BUNDLE	0000190
C	0000200
GO TO (200,300,300,300),NSEL	0000210
200 CALL VFDE1	0000220
GO TO 999	0000230
300 WRITE(6,350)	0000240
350 FORMAT (' THE ACTUAL VERSION OF SAGAPO CANNOT DETERMINE THE',	0000250
> ' ARRAYS NAFF, KAFF, VFAC FOR THE ACTUAL NRODS AND NSEL',	0000260
> /5X,' CALCULATION STOPS')	0000270
STOP	0000280
C	0000290
999 RETURN	0000300
END	0000310

SUBROUTINE VFDE1	0000010
C -----	0000020
C DETERMINES THE ARRAYS NAFF, KAFF, VFAC	0000030
C CASE OF THE WHOLE BUNDLE (BOTH 12-ROD AND HEXAGONAL)	0000040
C	0000050
COMMON /SC01R/ NSECT,NSECP	0000060
COMMON /SC04R/ VFAC(132, 13)	0000070
COMMON /SC06R/ ISU(132,2)	0000080
COMMON /SC13R/ NAFF(132)	0000090
COMMON /SC14R/ KAFF(132,13)	0000100
COMMON /HEA6/ NPIN(42),JPIN(42,3)	0000110
COMMON /IND3/ NTYP(42)	0000120
COMMON /SC03R/ F1,F2,F3,F4,F5,F6,F7,F8,F9, > F11,F12,F13,F14,F15,F16,F17,F18,F24,F31,F32	0000130
DO 100 L=1,NSECT	0000140
DO 50 K=1,13	0000150
VFAC(L,K)=0.0	0000160
CONTINUE	0000170
100 CONTINUE	0000180
DO 1000 L=1,NSECT	0000190
NAFF(L)=0	0000200
NS=ISU(L,1)	0000210
M =ISU(L,2)	0000220
J =JPIN(NS,M)	0000230
NTY=NTYP(NS)	0000240
IF (L .GT. NSECP) GO TO 500	0000250
GO TO (110,200,300), NTY	0000260
110 CALL FINDF1(L,NAFF(L),NS,J)	0000270
CALL FINDF3(L,NAFF(L),NS,J)	0000280
CALL FINDF4(L,NAFF(L),NS,J)	0000290
CALL FINDF5(L,NAFF(L),NS,J)	0000300
GO TO 1000	0000310
200 CALL FINDW2(L,NAFF(L),NS,J)	0000320
CALL FW7 (L,NAFF(L),NS,J)	0000330
CALL FW8 (L,NAFF(L),NS,J)	0000340
CALL FW1112(L,NAFF(L),NS,J)	0000350
CALL FW13 (L,NAFF(L),NS,J)	0000360
CALL FW16 (L,NAFF(L),NS,J)	0000370
CALL FW1718(L,NAFF(L),NS,J)	0000380
GO TO 1000	0000390
300 CALL FINDA(L,NAFF(L),NS,J)	0000400
GO TO 1000	0000410
500 CONTINUE	0000420
GO TO (600,700,800), NTY	0000430
600 WRITE(6,610)	0000440
610 FORMAT(' ERROR IN VCALC, CALCULATION PROCEEDING')	0000450
GO TO 1000	0000460
700 CALL FS1112(L,NAFF(L),NS,J)	0000470
CALL FFS13 (L,NAFF(L),NS,J)	0000480
CALL FFS16 (L,NAFF(L),NS,J)	0000490
CALL FFS24 (L,NAFF(L),NS,J)	0000500
CALL FF32 (L,NAFF(L),NS,J)	0000510
CALL FFW31 (L,NAFF(L),NS,J)	0000520
CALL FS2 (L,NAFF(L),NS,J)	0000530
GO TO 1000	0000540
800 CALL FSA (L,NAFF(L),NS,J)	0000550
CALL FFA31 (L,NAFF(L),NS,J)	0000560
1000 CONTINUE	0000570
RETURN	0000580
END	0000590
	0000600

SUBROUTINE VFD3 0000010
C ----- 0000020
C BUILDS THE ARRAY OF VIEW-FACTORS 0000030
C VERSION FOR 1/3 OF THE 12-ROD BUNDLE 0000040
C IN THIS CASE NAFF AND KAFF ARE GIVEN IN BLOCK DATA 0000050
C 0000060
COMMON /SC01R/ NSECT,NSECP 0000070
COMMON /SC03R/ F1,F2,F3,F4,F5,F6,F7,F8,F9, 0000080
> F11,F12,F13,F14,F15,F16,F17,F18,F24,F31,F32 0000090
COMMON /SC04R/ VFAC(132,13) 0000100
C 0000110
DO 100 L=1,NSECT 0000120
DO 50 K=1,13 0000130
VFAC(L,K)=0.0 0000140
50 CONTINUE 0000150
100 CONTINUE 0000160
C 0000170
VFAC(1, 1) = 2.*F1 0000180
VFAC(1, 2) = F3/2.+F4 0000190
VFAC(1, 3) = F3/2.+F4 0000200
VFAC(1, 4) = F4+F5 0000210
VFAC(1, 5) = F4+F5 0000220
C 0000230
VFAC(2, 1) = F1/2. 0000240
VFAC(2, 2) = F1/2. 0000250
VFAC(2, 3) = F1 0000260
VFAC(2, 4) = F3 0000270
VFAC(2, 5) = F4 0000280
VFAC(2, 6) = F4 0000290
VFAC(2, 7) = F4 0000300
VFAC(2, 8) = F4+F5 0000310
VFAC(2, 9) = F5 0000320
C 0000330
VFAC(3, 1) = F1 0000340
VFAC(3, 2) = F1 0000350
VFAC(3, 3) = F15 0000360
VFAC(3, 4) = F15 0000370
VFAC(3, 5) = F4 0000380
VFAC(3, 6) = F4 0000390
VFAC(3, 7) = F4 0000400
VFAC(3, 8) = F4 0000410
VFAC(3, 9) = F5/2. 0000420
VFAC(3,10) = F5/2. 0000430
VFAC(3,11) = F5 0000440
C 0000450
VFAC(4, 1) = F1 0000460
VFAC(4, 2) = F1 0000470
VFAC(4, 3) = F4 0000480
VFAC(4, 4) = F4 0000490
VFAC(4, 5) = F4 0000500
VFAC(4, 6) = F4 0000510
VFAC(4, 7) = F15 0000520
VFAC(4, 8) = F15 0000530
VFAC(4, 9) = F5 0000540
VFAC(4,10) = F5 0000550
C 0000560
VFAC(5, 1) = F1 0000570
VFAC(5, 2) = F1 0000580
VFAC(5, 3) = F15 0000590
VFAC(5, 4) = F15 0000600
VFAC(5, 5) = F4 0000610

	VFAC(5, 6) = F4	0000620
	VFAC(5, 7) = F4	0000630
	VFAC(5, 8) = F4	0000640
	VFAC(5, 9) = F5	0000650
	VFAC(5,10) = F5/2.	0000660
	VFAC(5,11) = F5/2.	0000670
C		0000680
	VFAC(6, 1) = F1	0000690
	VFAC(6, 2) = F1/2.	0000700
	VFAC(6, 3) = F1/2.	0000710
	VFAC(6, 4) = F3	0000720
	VFAC(6, 5) = F4	0000730
	VFAC(6, 6) = F4	0000740
	VFAC(6, 7) = F4+F5	0000750
	VFAC(6, 8) = F4	0000760
	VFAC(6, 9) = F5	0000770
C		0000780
	VFAC(7, 1) = F1	0000790
	VFAC(7, 2) = F1	0000800
	VFAC(7, 3) = F3+2.*F4	0000810
	VFAC(7, 4) = F4	0000820
	VFAC(7, 5) = F4	0000830
	VFAC(7, 6) = F5	0000840
	VFAC(7, 7) = F5	0000850
C		0000860
	VFAC(8, 1) = F1	0000870
	VFAC(8, 2) = F1	0000880
	VFAC(8, 3) = F3	0000890
	VFAC(8, 4) = F4	0000900
	VFAC(8, 5) = F4	0000910
	VFAC(8, 6) = F4	0000920
	VFAC(8, 7) = F5	0000930
	VFAC(8, 8) = F5	0000940
C		0000950
	VFAC(9, 1) = F2	0000960
	VFAC(9, 2) = F11	0000970
	VFAC(9, 3) = F12	0000980
	VFAC(9, 4) = F16	0000990
	VFAC(9, 5) = F8	0001000
	VFAC(9, 6) = F7	0001010
	VFAC(9, 7) = F18	0001020
C		0001030
	VFAC(10, 1) = F1	0001040
	VFAC(10, 2) = F1	0001050
	VFAC(10, 3) = F3	0001060
	VFAC(10, 4) = F4/2.	0001070
	VFAC(10, 5) = F4/2.	0001080
	VFAC(10, 6) = F4	0001090
	VFAC(10, 7) = F4	0001100
	VFAC(10, 8) = F5	0001110
	VFAC(10, 9) = F5	0001120
C		0001130
	VFAC(11, 1) = F1	0001140
	VFAC(11, 2) = F1	0001150
	VFAC(11, 3) = F3	0001160
	VFAC(11, 4) = F4	0001170
	VFAC(11, 5) = F4	0001180
	VFAC(11, 6) = F4	0001190
	VFAC(11, 7) = F5	0001200
	VFAC(11, 8) = F5	0001210
C		0001220
	VFAC(12, 1) = F2	0001230
	VFAC(12, 2) = F11	0001240
	VFAC(12, 3) = F12	0001250
	VFAC(12, 4) = F17	0001260
	VFAC(12, 5) = F18	0001270

	VFAC(12, 6) = F7	0001280
	VFAC(12, 7) = F8	0001290
C		0001300
	VFAC(13, 1) = F14	0001310
	VFAC(13, 2) = F24	0001320
	VFAC(13, 3) = F24	0001330
C		0001340
	VFAC(14, 1) = F2	0001350
	VFAC(14, 2) = F11	0001360
	VFAC(14, 3) = F12	0001370
	VFAC(14, 4) = F13	0001380
	VFAC(14, 5) = F17	0001390
	VFAC(14, 6) = F7	0001400
	VFAC(14, 7) = F8	0001410
C		0001420
	VFAC(15, 1) = F1	0001430
	VFAC(15, 2) = F1	0001440
	VFAC(15, 3) = F4	0001450
	VFAC(15, 4) = F4	0001460
	VFAC(15, 5) = F4	0001470
	VFAC(15, 6) = F3	0001480
	VFAC(15, 7) = F5	0001490
	VFAC(15, 8) = F5	0001500
C		0001510
	VFAC(16, 1) = F1	0001520
	VFAC(16, 2) = F1	0001530
	VFAC(16, 3) = F3	0001540
	VFAC(16, 4) = F4	0001550
	VFAC(16, 5) = F4	0001560
	VFAC(16, 6) = F4/2.	0001570
	VFAC(16, 7) = F4/2.	0001580
	VFAC(16, 8) = F5	0001590
	VFAC(16, 9) = F5	0001600
C		0001610
	VFAC(17, 1) = F2	0001620
	VFAC(17, 2) = F11	0001630
	VFAC(17, 3) = F12	0001640
	VFAC(17, 4) = F17	0001650
	VFAC(17, 5) = F13	0001660
	VFAC(17, 6) = F7	0001670
C		0001680
	VFAC(18, 1) = F14	0001690
	VFAC(18, 2) = F24	0001700
	VFAC(18, 3) = F24	0001710
C		0001720
	VFAC(19, 1) = F2	0001730
	VFAC(19, 2) = F11	0001740
	VFAC(19, 3) = F12	0001750
	VFAC(19, 4) = F18	0001760
	VFAC(19, 5) = F17	0001770
	VFAC(19, 6) = F7	0001780
C		0001790
	VFAC(20, 1) = F1	0001800
	VFAC(20, 2) = F1	0001810
	VFAC(20, 3) = F3+F4+F4	0001820
	VFAC(20, 4) = F4	0001830
	VFAC(20, 5) = F4	0001840
	VFAC(20, 6) = F5	0001850
	VFAC(20, 7) = F5	0001860
C		0001870
	VFAC(21, 1) = F1	0001880
	VFAC(21, 2) = F1	0001890
	VFAC(21, 3) = F3	0001900
	VFAC(21, 4) = F4	0001910
	VFAC(21, 5) = F4	0001920
	VFAC(21, 6) = F4	0001930

	VFAC(21, 7) = F5	0001940
	VFAC(21, 8) = F5	0001950
C		0001960
	VFAC(22, 1) = F2	0001970
	VFAC(22, 2) = F11	0001980
	VFAC(22, 3) = F12	0001990
	VFAC(22, 4) = F18	0002000
	VFAC(22, 5) = F16	0002010
	VFAC(22, 6) = F7	0002020
	VFAC(22, 7) = F8	0002030
C		0002040
	VFAC(23, 1) = F11	0002050
	VFAC(23, 2) = F12	0002060
	VFAC(23, 3) = F15	0002070
	VFAC(23, 4) = F32	0002080
	VFAC(23, 5) = F13	0002090
	VFAC(23, 6) = F16	0002100
C		0002110
	VFAC(24, 1) = F11	0002120
	VFAC(24, 2) = F12	0002130
	VFAC(24, 3) = F31	0002140
	VFAC(24, 4) = F24	0002150
	VFAC(24, 5) = F15	0002160
C		0002170
	VFAC(25, 1) = F14	0002180
	VFAC(25, 2) = F17	0002190
	VFAC(25, 3) = F17	0002200
	VFAC(25, 4) = F18	0002210
	VFAC(25, 5) = F18	0002220
	VFAC(25, 6) = F31	0002230
	VFAC(25, 7) = F31	0002240
C		0002250
	VFAC(26, 1) = F11	0002260
	VFAC(26, 2) = F12	0002270
	VFAC(26, 3) = F31	0002280
	VFAC(26, 4) = F24	0002290
	VFAC(26, 5) = F15	0002300
C		0002310
	VFAC(27, 1) = F11	0002320
	VFAC(27, 2) = F12	0002330
	VFAC(27, 3) = F31	0002340
	VFAC(27, 4) = F24	0002350
	VFAC(27, 5) = F15	0002360
C		0002370
	VFAC(28, 1) = F14	0002380
	VFAC(28, 2) = F17	0002390
	VFAC(28, 3) = F17	0002400
	VFAC(28, 4) = F31	0002410
	VFAC(28, 5) = F31	0002420
	VFAC(28, 6) = F18	0002430
	VFAC(28, 7) = F18	0002440
C		0002450
	VFAC(29, 1) = F11	0002460
	VFAC(29, 2) = F12	0002470
	VFAC(29, 3) = F15	0002480
	VFAC(29, 4) = F31	0002490
	VFAC(29, 5) = F24	0002500
C		0002510
	VFAC(30, 1) = F11	0002520
	VFAC(30, 2) = F12	0002530
	VFAC(30, 3) = F15	0002540
	VFAC(30, 4) = F32	0002550
	VFAC(30, 5) = F13	0002560
	VFAC(30, 6) = F16	0002570
C		0002580
	RETURN	0002590
	END	


```
NTOP=NTYP(I) 0000640
QA=QQ(I,M)/SUR*QDEV + QJ(IPIN,I)/(PIG*D*H/GEO1(I,M)) 0000650
IF (I.EQ.1.AND.IPIN.EQ.1) 0000660
>QA=QQ(1,1)/SUR*QDEV + QJ(1,1)/(PIG*D*H/6.0) 0000670
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 0000680
GOTO(1,2,7),ITYP 0000690
C ..... 0000700
C--A) CENTRAL SUBCHANNELS 0000710
C 0000720
1 CALL RTI (PBT,TSCH(I,M),MSCH(I,M),DE(I),ASCH(I,M),1.,LAMSCH(I,M), 0000730
1 QA,FACHE,TE,RH,I,II,M,JPIN(I,M),TW(I,M),1.,1, 0000740
2 DE(I),D,YDH(I,M),&8500,F2ATIP(I,M),F2DTIP(I,M),QALIN) 0000750
TEMPB(I,M)=TSCH(I,M) 0000760
XMASSB(I,M)=MSCH(I,M) 0000770
GOTO 9 0000780
C ..... 0000790
C--B) WALL SUBCHANNELS 0000800
C 0000810
2 TW(I,M)=0. 0000820
DO 5 JWC=1,2 0000830
TWWC(II,M,JWC)=TSCH(I,M) 0000840
GOTO(3,4),JWC 0000850
C 0000860
C -1-WALL TYPE PART 0000870
C 0000880
3 CONTINUE 0000890
CCCCCCCCCCCCCCCCCCCCCCCCCCCC 02.11.1979 0000900
TS=TAVWC(II,M,1) 0000910
DO 1000 ITHUD=1,10 0000920
IF(IPHUD.EQ.1) SHQ(II,M)=HUDFAC*PERS/PERLT*(TS-TAMB)*H 0000930
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 0000940
QALIN=(SHQ(II,M)+SHQC(II,M))/(PERS*H) 0000960
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 0000970
C 0000980
RU1DRU=XMSCHB(II,M)*ADAB(II,M)/MAWC(II,M,1) 0000990
CALL RTI (PBT,TAVWC(II,M,1),MAWC(II,M,1),DETB(II,M),ASCHWC(II,M,1) 0001000
1 ,ADAB(II,M),LAMB(II,M),QA,FACHE,TE,RH,I,II,M, 0001010
2 JPIN(I,M),TWWC(II,M,1),RU1DRU,2,DEWC(II,M,1),D,XXXX,&85000001020
3 ,1.,1.,QALIN) 0001030
C 0001040
IF (IPHUD.EQ.0) GO TO 1200 0001050
DELT=ABS(TLINER(II,M)/TS-1.0) 0001060
IF( DELT .LT. 0.01) GO TO 1200 0001070
TS=TLINER(II,M) 0001080
1000 CONTINUE 0001090
WRITE(6,1100) DELT 0001100
1100 FORMAT( 5X,'WALLTE, WALL: NO CONVERGENCE IN ITHUD, DELT=',F10.5, 0001110
> /5X,'CALCULATION STOPS.') 0001120
STOP 0001130
1200 CONTINUE 0001140
CCCCCCCCCCCCCCCCCCCCCCCCCCCC 02.11.1979 AND 14.11.1980 0001150
ALFA1=ALFA(I,M) 0001160
ANU1 = ANU(I,M) 0001170
CCCCCCCCCCCCCCCC 02.11.1979 0001180
TMS=TMS+TLINER(II,M)*PERL(2)*0.5 0001190
PMS=PMS+PERL(2)*0.5 0001200
CCCCCCCCCCCCCCCC 0001210
GOTO 5 0001220
C 0001230
C -2-CENTRAL TYPE PART 0001240
C 0001250
4 CALL RTI (PBT,TAVWC(II,M,2),MAWC(II,M,2),DEWC(II,M,2),ASCHWC(II,M, 0001260
1 2),1.,LAMWC(II,M,2),QA,FACHE,TE,RH,I,II,M,JPIN 0001270
2 (I,M),TWWC(II,M,2),1.,1,DEWC(II,M,2),D,XXXX,&8500,1.,1., 0001280
3 0.0) 0001290
```

C
CCCCCCCCCCCCCCCCCCCCCCCCCCCC 02.11.1979 AND 14.11.1980 0001300
ALFA2=ALFA(I,M) 0001310
ANU2 = ANU(I,M) 0001320
CCCCCCCCCCCCCCCC
5 TW(I,M)=TW(I,M)+PHWC(II,M,JWC)*TWWC(II,M,JWC) 0001330
6 CONTINUE 0001340
TW(I,M)=TW(I,M)*4./(D*PIG) 0001350
CCCCCCCCCCCCCCCCCCCCCCCC 02.11.1979 AND 14.11.1980 0001360
ALFA(I,M)= (ALFA1*PHWC(II,M,1) + ALFA2*PHWC(II,M,2))/(D*PIG/4.) 0001370
ANU (I,M)= (ANU1*PHWC(II,M,1) + ANU2*PHWC(II,M,2))/(D*PIG/4.) 0001380
ANU (I,M)= ANU(I,M)/YH(I,M) 0001390
IF (QQ(I,M) .GT. 1.E-06) ALFA(I,M)=QA/(TW(I,M)-TSCH(I,M)) 0001400
CCCCCCCCCCCCCCCC
XMASSB(I,M)=XMSCHB(II,M)+MAWC(II,M,2) 0001410
TEMPB(I,M)=(XMSCHB(II,M)*TSCHB(II,M)+MAWC(II,M,2)*TAVWC(II,M,2))/ 0001420
/XMASSB(I,M) 0001430
IF (IRH.EQ.2) 0001440
YDH(I,M)=0.5(SQRT(D**2+16./PIG*ASCH(I,M))-D)/RH 0001450
GOTO 9 0001460
C 0001470
C--C) CORNER CHANNELS 0001480
C 0001490
7 CONTINUE 0001500
CCCCCCCCCCCCCCCCCCCCCCCCCCCC 02.11.1979 0001510
TS=TSCH(I,1) 0001520
DO 2000 ITHUD=1,10 0001530
IF(IPHUD. EQ. 1) SHQ(II,M)=HDFAC*PERS/PERLT*(TS-TAMB)*H 0001540
CC 0001550
QALIN=(SHQ(II,M)+SHQC(II,M))/(PERS*H) 0001560
CC 0001570
C QALI1=QA11 0001580
C IF(IPHUD.EQ.1) QALI1=HDFAC/PERLT*(TS-TAMB) 0001590
C QALIN=QALI1+QSR(II,M)/LENGTH 0001600
C 700 FORMAT(5X,' WALLTE, CHANNEL =',I3,' SUB. =',I3,' QALI1 =',E12.6, 0001610
C > 2X,' QSR=',E12.6,' QALIN =',E12.6) 0001620
C 0001630
RU1DRU=XMSCHB(II,1)*ADAB(II,1)/MSCH(I,1) 0001640
CALL RTI (PBT,TSCH(I,1),MSCH(I,1),DETB(II,1),ASCH(I,1),ADAB(II,1), 0001650
1 LAMB(II,1),QA,FACHE,TE,RH,I,II,1,JPIN(I,1), 0001660
2 TW(I,1),RU1DRU,3,DE(I),D,YDH(I,M),&8500,F2ATIP(I,1), 0001670
3 F2DTIP(I,1),QALIN) 0001680
C 0001690
IF (IPHUD. EQ. 0) GO TO 2200 0001700
DELT=ABS(TLINER(II,1)/TS-1.0) 0001710
IF(DELT .LT. 0.01) GO TO 2200 0001720
TS=TLINER(II,1) 0001730
2000 CONTINUE 0001740
WRITE(6,2100) DELT 0001750
2100 FORMAT(5X,'WALLTE, COR.: NO CONVERGENCE IN ITHUD, DELT=',F10.5, 0001760
> /5X,'CALCULATION STOPS.') 0001770
STOP 0001780
2200 CONTINUE 0001790
CCCCCCCCCCCCCCCCCCCCCCCC 02.11.1979 0001800
CCCCCCCCCCCCCCCCCCCC 02.11.1979 0001810
TMS=TMS+TLINER(II,M)*PERS 0001820
PMS=PMS+PERS 0001830
CCCCCCCCCCCCCCCC
TEMPB(I,1)=TSCHB(II,1) 0001840
XMASSB(I,1)=XMSCHB(II,1) 0001850
9 CONTINUE 0001860
11 CONTINUE 0001870
CCCCCCCCCCCCCCCC 02.11.1979 0001880
TMS=TMS/PMS 0001890
CCCCCCCCCCCCCCCC 0001900
0001910
0001920
0001930
0001940
CCCCCCCCCCCCCCCC 0001950

C 0001960
C IF AN AVERAGE VALUE IS DESIRED FOR THE PIN AND THE SHROUD 0001970
C TEMPERATURES OF THE EXTERNAL CHANNELS 0001980
C 0001990
C IF(IEXAV.EQ.1)RETURN 0002000
PERLT=0. 0002010
PERRT=0. 0002020
TLM=0. 0002030
TWM=0. 0002040
NSTR1=NSTR1+1 0002050
DO 20 I=NSTR1,NSTOT 0002060
ITYP=NTYP(I) 0002070
NP=NPIN(I) 0002080
DO 20 M=1,NP 0002090
PERLSC=PERL(ITYP)*ASCH(I,M)/ACH(ITYP) 0002100
PERLT=PERLT+PERLSC 0002110
PERRSC=1./NTYP(I) 0002120
PERRT=PERRT+PERRSC 0002130
TLM=TLM+TLINER(I-NSTR,M)*PERLSC 0002140
20 TWM=TWM+TW(I,M)*PERRSC 0002150
TLM=TLM/PERLT 0002160
TWM=TWM/PERRT 0002170
DO 30 I=NSTR1,NSTOT 0002180
NP=NPIN(I) 0002190
DO 30 M=1,NP 0002200
TLINER(I-NSTR,M)=TLM 0002210
30 TW(I,M)=TWM 0002220
RETURN 0002230
8500 RETURN 1 0002240
END 0002250